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Original Article

Determinants of Multi-drug resistant Tuberculosis in four treatment centers of Eastern Amhara, Ethiopia: A case-control study

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Abstract

Introduction: Tuberculosis is the major global burden of disease contributing about 2% of the global challenges. Poor tuberculosis treatment increased risk of multi-drug resistance tuberculosis occurence. Thus, we aimed to identify determinants of mult-drug resistant tuberclosis in treatment centers of Eastern Amhara, Ethiopia.

Methodology: Facility based unmatched case-control study was employed in East Amhara, Ethiopia. Cases were tuberculosis patients confirmed for mult-drug resistant tuberclosis while controls were tuberculosis patients with confirmed tuberculosis but susceptible to first line drugs. Respondents were selected using simple random sampling technique. Bivariable and multivariable analysis was conducted to identify diterminants at level of statistical significance $p < 0.05$.

Results: We enrolled 450 tuberculosis patients. Rural residents (AOR = 3, 95% CI: 1.4-6.0; $p = 0.024$), family size greater than five (AOR = 3.7, 95% CI: 1.6–8.6; $p = 0.0098$), having single room (AOR = 4.1, 95% CI:1.8-9.0; $p = 0.027$), room without window (AOR = 3.8, 95% CI: 1.6-8.5); $p = 0.043$), contact history of known mult-drug resistant tuberclosis patient (AOR = 5.1, 95% CI: 2.2-12.0; $p = 0.02$), history of tuberculosis treatment (AOR = 5.7, 95%CI: 2.6-12.9; $p = 0.008$), window opening practice (AOR = 3.7, 95% CI: 1.4-9.8; $p = 0.005$), tuberculosis treatment failure (AOR = 7.3, 95% CI: 5.2-7.8; $p = 0.035$) and tuberculosis relapse (AOR = 5,95% CI: 1.6-15.2; $p = 0.019$) were determinants of mult-drug resistant tuberclosis.

Conclusions: Socio-demographic (residence, family size), environmental (number of rooms, number of windows in a room, opening window practice) and clinical (history of tuberculosis treatment, treatment failure and having contact with known tuberculosis patient) variables were the identified determinants for increased multi-drug resistance tuberculosis.

Key words: Tuberculosis; Mult-drug; determinants; resistant; Ethiopia.

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Introduction

Tuberculosis (TB) is an airborne disease of the lung and most other body system with varying degrees. It is caused by mycobacterium tuberculosis (Mtb) complex. This complex is mainly composed of mycobacterium tuberculosis and other closely related species (mycobacterium bovis, mycobacterium africanum) [1]. TB was an ancient disease of the poor that affects humankind since 400 years ago. It became still the major global burden of disease (GBD) contributing about 2 % of the global challenges [2]. TB was the second leading cause of death next to acquired immune deficiency virus (AIDS) [3]. It was the fourth highest burden of disease contributor in Ethiopia [4]. Ethiopia was the seventh TB burdened country in the world [5].

Mult-drug resistant tuberclosis (MDR-TB) is an active tuberculosis disease caused by Mtb bacilli that are resistance to at least two most powerful first line ant-tuberculosis drugs, isoniazid and rifampicin [6]. Though poor surveillance will under estimate the figure [6], MDR-TB cases were due to transmission from the already MDR-TB acquired patients, retreatment for TB and TB treatment defaulters [6,7]. One untreated infectious TB patient is likely to infect 10-15 people during coughing [5, 8]. In TB pandemic areas, MDR-TB was cause by irrational use of antibiotics [9]. About 85 % of global all MDR-TB cases counted to the 27 high burdened countries. This prevalence was exacerbated by low socioeconomic conditions, high prevalence of immune depressant diseases (AIDS) and limited access of well-equipped healthcare facilities[10]. Poor treatment outcomes, longer treatment time, higher treatment costs, and other complications also made MDR-TB a more complex

disease than TB [10]. Among 1.5 million global TB deaths reported by world health organization (WHO) in 2013, 0.21 million was denoted to MDR-TB [3]. MDR-TB is common in both high and low income countries [5]. The emergence of MDR-TB is a great burden in resource-limited countries where early initiation of MDR-TB treatment is low due to sub-standard TB detection facilities [11]. Although the accessibility of molecular diagnosis of TB and MDR-TB is growing far a bit, MDR-TB cases are still a challenge in Sub-Saharan Africa including Ethiopia [12]. MDR-TB prevalence in Ethiopia among previously treated case for TB was between 6.7–25 % [5]. A study conducted in the country showed that the incidence of MDR-TB ranged from 1.6-4.1% [5]. Factors for the transmission of TB include infectiousness, susceptibility, environmental and exposure to confirmed case[13]. MDR-TB incidence is higher in HIV co-infected and previously treated TB patients [5,12]. HIV intensifies lifelong risk of MDR-TB[14]. Existing literatures had identified socio-demographic [15], clinical [16], life style [17] and housing condition [18] predictors for MDR-TB. Unfortunately the existing infrastructures providing TB care are not detecting and treating MDR-TB, particularly in Ethiopia [13]. In the country particularly in Eastern Amhara where MDR-TB burdens did not show reductions, factors associated with MDR-TB did not well described. Factors associated with MDR-TB vary from one treatment setting to another and as a result a context-specific study in a high-burdened MDR-TB area is important. Many professionals did not differentiate the case definition of MDR-TB from the ordinary TB case, and the perceived prevalence of MDR-TB in Ethiopia is reported incorrectly [13]. Thus, we aimed to identify the determinants of MDR-TB in Eastern Amhara, Ethiopia.

Methodology

Study design, setting and participants

We conducted unmatched case-control study between March 2 to April 30, 2018 in Eastern Amhara, Amhara regional state, which is located in the North East part of Ethiopia. According to the Amhara National Regional State Bureau of Finance and Economic Cooperation report, the projected population in this sub-region by 2016/2017 was 7,407,286, of these 3,718,458 (50.2%) were females. East Amhara has five administrative zones and 75 districts. There were also 23 hospitals, 339 health center, 1,377 health posts and 198 private health institutions in the study area. Four MDR-TB treatment centers were found in the study area, namly, Woldia hospital, Boru-Meda hospital, Ataye hospital, and Debre-Berhan hospital. All MDR-TB Treatment Initiating Centers (TICs) in the study area were included. In the area being studied, about 3913 patients were attended for TB treatment services and of them, 462 are MDR-TB patients in the year 2017. Tuberculosis is pandemic in the country, and there are high incidence rate of TB including MDR-TB[13]. Accoding to 2017 Amhara regional state Health bureau report, the TB control strategy was implemented in the region and case management was also improved in all four Zones through the distribution of free anti-TB combination therapy. The strategy was implemented by the government of Ethiopia in collaboration with several international organizations. Miss management of cases onwards contributing for resistivity of ant-TB drugs and people are developing MDR-TB and extremely drug-resistant tuberculosis (EXDR-TB). Cases were known TB adults who had resistance to first line anti TB drugs (rifampicin& isoniazid) during the data collection period. Whilst controls were those TB patients who had confirmed for pulmonary TB and were fully sensitive to the first-line anti-TB drugs. Drug susceptibility test was done according to the method designated by WHO using the molecular line probe assay. The diagnosis of active TB was based on one or more TB diagnostic investigations (sputum microscopy, X-ray, histopathology, culture or molecular). Patients with sputum smear negative, extra pulmonary TB and those patients transferred out were excluded from the study.

Operational Definitions and Definition of Terms according to National TB guidline

New: A patient who never had received treatment for TB, or has been on and become resistance for rifampicin and Isonized.

Defaulter: A known TB patient who interrupted treatments for two or more consecutive months.

Treatment Failure: A patient who has received treatment for TB is sputum smear positive at five months or later during treatment.

Relapse: A patient who was previously treated for TB and whose most recent treatment outcome was “cured” or “treatment completed”, and who is subsequently diagnosed with bacteriologically positive TB by sputum smear microscopy, Xpert MTB/RIF, or culture.

Sample size, sampling procedure and sampling technique

The sample size was estimated using Epi-Info version 3.5 with the following assumptions: the

proportion of households with one room was 43.2% for the controls and 61.4% for the cases [19], 95% confidence level, 80% power, 1:4 ratios of cases to controls and 10% non-response rate. Accordingly, the maximum sample size required for the study was 450 (90 cases and 360 controls). Proportional to size allocation was made to achieve the desired sample size of cases and controls from each selected TB treatment centers based on the number of TB patients found in the second and fourth month of treatment report at each centers: 19 cases and 76 controls from Woldia hospital, 35 cases and 140 controls from Boru-Meda hospital, 15 cases and 60 controls from Debre-Berhan and 21 cases and 84 controls from Ataye hospitals. In each treatment center, study participants were selected using simple random sampling technique from the sampling frame gotten after all the charts of TB patients and MDR-TB register logbook has been retrieved.

Data collection tools and process

Data were collected through trained nurses supervised by medical officers. A structured questionnaires, which was adapted from related literatures; was used to collect the data via face-to-face interview. The questionnaire were prepared in English by language experts and then translated into local language (Amharic). To check for consistency and ease of understanding, the questionnaire was back translated to English. To asure the quality of data, pre-test has performed on 5 % of the sample in other centeres and corrections has made on the data collection tool. An interview for cases was conducted first followed by controls so as to minimize information bias (contamination). Data on variables such as: socio-demographic (age, gender, education, marital status, family size), behavioral (alcohol consumption), clinical (co-morbid with HIV, contact history of TB, history of TB treatment and category of TB treatment) and environmental (window opening practice, number of rooms in house and number of windows in a house) were collected through interviews. Additional data on patients' were abstracted from the patient chart and TB register log book. At the end of each day of data collection period, the questionnaire was crosschecked by investigators and supervisors for completeness and data accuracy.

Data analysis

Data were coded and entered into EPI-Info version 3.5 and exported to SPSS version 20 for further analysis. First, frequency and proportions were computed to describe the data on selected variables. Then, χ^2 test was computed to compare determinants of MDR-TB between cases and controls. Bivariable binary logistic regression model was applied to assess the potential association between determinants and MDR-TB. The Hosmer-Lemeshow goodness of fit test was applied and fit of the model was checked; in this study, the model adequately fitted the data with *p*-value ≥ 0.05. To control the effect of possible confounders', variables found to be potential factors for MDR-TB (*p*-value < 0.25) was taken and included in the final multi-variable binary logistic regression model (forward likelihood ratio). Adjusted odds ratio (95% CI) and p-value were used to measure strength of association and test statistical significance. In addition, multicolinearity diagnosis was also conducted using variance inflation factor (VIF), which was < 10 for all variables. Stratified analysis was carried out to determine any confounding factors and effect modifiers. Effect modification was identified by determining whether the Chi-square for differing odds ratio by stratum (interaction) is significant (i.e. $p < 0.05$). Stratified analysis was used to identify socio-demographic factors to be included in unconditional binary logistic regression. All variables were processed as categorical.

Ethical consideration

Ethical clearance was obtained from the Institutional review board (IRB) of Bahir Dar University, College of Medicine and Health Sciences before the start of the study. Written permission letter was obtained from each Zonal health department and from the respective health facilities. A written informed consent was obtained from each study participants. Privacy of the study subjects and confidentiality of information was secured.

Results

Socio-demographic characteristics of study participants

Four hundred fifty pulmonary TB patients (90 cases and 360 controls) were invited to participate in the study and all of them were accepted to participate in the study (response rate of 100%). A higher proportion of males were observed in both cases 252 (70%) and controls 47 (52%). The mean and standard deviation of the age was 31.4 ±11 and 32.2 ± 10.5 years old for the cases and controls, respectively. The majority of respondents (62.2 %) were from rural among cases and significant percentages of respondents were illiterate: 42.2% among case and 31.1% among control groups. The majority of respondents in the case group (63.3%) had

higher family size (five and above) while only 47.2% of controls had family size of five and above (Table 1).

Clinical and environmental characteristics of respondents

Of the total patients who had previous TB treatment, 43(47.8%) were the cases (those had resistance to first line anti TB drugs) while 37 (10.3%) were controls. In new attendants for TB treatment, the controls (89.7%) were more than cases (52.2%) and the new attendants were higher among other TB treatment categories in both cases and controls. The HIV positive respondents were less in proportion in both cases and controls as compared to negatives. Lower proportion of cases (15.6%) and controls (15%) were lived in households with adequate number of windows (Table 2).

Factors associated with MDR-TB

In bi-variable logistic regression analysis; gender, employment status, residence, category of TB treatment, contact history with known TB, family size, drinking alcohol, HIV status, number of rooms, number of window, history of TB treatment and window opening practice were found statistically correlated with MDR-TB. All variables that were significantly associated with MDR-TB at 5% level of significance in bi-variable logistic regression analysis were taken for multivariable analysis. After fitting for conceivable confounders, eight variables still found in the final model**:** The odd of development of MDR-TB was 5.1 times higher with TB patients who had contact with history of know MDR-TB (AOR = 5.1, 95% CI: 2.2-12.0). The development of MDR-TB among TB patients who had family size greater than four was 3.7 times higher than the counter parts (AOR = 3.7, 95% CI: 1.6–8.6). Patients who had only one room to live was 4.1 times more likely to develop MDR-TB compared to patients who had lived in house with two and above rooms (AOR = 4.1, 95% CI:1.8-9.0). The absence of windows a TB patient lived in increases the odd of development of MDR-TB by 3.8 times (AOR = 3.8, 95% CI: 1.6-8.5). The odd of development of MDR-TB was three folds higher in rural residents (AOR = 3, 95% CI: 1.4-6.0). TB relapse (AOR = 5,95% CI: 1.6-15.2) and TB treatment failure (AOR = 7.3, 95% CI: 5.2-7.8) increases the risk of MDR-TB by 5 and 7.3 times respectively. Previous TB treatment

Table 1. Socio-demographic profiles of TB patients in Eastern Amhara, March 2-30, 2018.

Category	Cases *f* (%)	Controls *f* (%)	χ^2	P-value
Gender				
Male	63 (70)	187 (52)	9.51	0.002**
Female	27 (30)	173 (48)		
Age				
18-29	41 (45.6)	182 (50.6)		
30-45	38 (42.2)	123 (34.1)	4.69	0.446
≥45	11 (12.2)	55 (15.3)		
Residence				
Rural	56 (62.2)	177 (49.2)	4.92	0.027*
Urban	34 (37.8)	183 (50.8)		
Marital status				
Single	34 (37.8)	121 (33.6)		
Married	49 (54.4)	203 (56.4)	0.78	0.676
Widow	7 (7.8)	36 (10)		
Educational status				
Illiterate	38 (42.2)	112 (31.1)		
Read and write	21 (23.3)	76 (21.2)		
Primary school	17 (18.9)	85 (23.6)	5.97	0.201
Secondary school	8 (8.9)	53 (14.7)		
Above	6 (6.7)	34 (9.4)		
Employment status				
Unemployed	50 (55.5)	147 (40.8)	6.34	0.012*
Employed	40 (44.5)	213 (59.2		
Family size				
< 5	33 (36.7)	190 (52.7)	7.48	0.006**
≥ 5	57 (63.3)	170 (47.2)		

* Significant at p-value < 0.05; ** significant at p-value < 0.01.

history increases the development of MDR-TB by 5.7 folds (AOR = 5.7, 95% CI:2.6-12.9). The patients who had never opened window for ventilation was 3.7 times more likely to develop MDR-TB (AOR = 3.7, 95% CI: 1.4-9.8). However, gender, employment status, drinking alcohol, and HIV status did not found in the final regression adjustments (Table 3).

Discussion

Globally, the emergence of drug-resistant TB, particularly MDR-TB, was a dangerous alarm and undermine TB control efforts in many countries in the globe, including Ethiopia [20]. It is obvious that epidemiological data on determinants of MDR-TB is a paramount important for the global efforts to combat tuberculosis in countries where drug resistance and prevalent of HIV are the major problem. Thus, this study was conducted with the aim of identifying determinants of MDR-TB. The study showed that there is a statistically significant association between factors and MDR-TB include: history of contact with known MDR-TB patient, history of TB treatment, number of rooms a patient lived in, window opening practice, category of TB treatment, number of windows in a room, family size, and residence. The odd of MDR-TB was three folds greater in the rural residents, consistent with previous study [21]. This might be related to the fact that accessibility of treatment facility or a gap in knowledge on presumptive TB treatment protocol and difference in living conditions [22]. Other study has also revealed that the proportion of educated individuals was higher in the urban communities and the incidence of MDR-TB and level of schooling are inter-dependent [19]. Additionally, being unemployed was higher in percentages among rural respondents and showed the link between poverty and development of MDR-TB, complemented with previous studies [10,11]. Thus, those segments of population should be targeted in order to combat MDR-TB. Having larger family size increased the risk of MDR-TB, indicating possibility of intra-familial transmission of resistant strains. A former study had reported that overcrowding, poor housing condition, and poor ventilation are factors that enable transmission of tuberculosis, including

Table 2. Clinical and environmental characteristics for developing MDR-TB among pulmonary infected adults, Eastern Amhara, March 2-30, 2018.

Category	Cases *f* (%)	Control *f* (%)	χ^2	p-value
History of TB Treatment				
Yes	43 (47.8%)	37 (10.3%)	69.27	0.000***
No	47 (52.2%)	323 (89.7%)		
Category of TB treatment				
New	47 (52.2%)	321 (89.3%)	72.4	0.000***
Return after defaulter	10 (11.2%)	10 (2.7%)		
Treatment failure	21 (23.3%)	11 (3.5%)		
Relapse	12 (13.3)	18 (5%)		
Contact history with known MDR-TB patient				
No	34 (37.8%)	191 (53.0%)		
Yes	36 (40%)	49 (13.5%)	32.76	0.000***
I don't know	20 (22.2%)	120 (33.2%)		
HIV status (N = 372)				
Positive	19 (25%)	52 (17.5%)	2.16	0.141
Negative	57 (75%)	244 (82.5%)		
Drinking alcohol				
Yes	24 (26.7%)	65 (18.1%)	3.37	0.067
No	66 (73.3%)	295 (81.9 %)		
Number of rooms				
1	61 (67.8%)	160 (44.4%)	15.69	0.000***
≥2	29 (32.2%)	200 (53.6%)		
Number of window in a room				
No	21 (23.3%)	37 (10.3%)		
1	55 (61.1%)	269 (74.7%)	11.39	0.003**
≥ 2	14 (15.6%)	54 (15%)		
Window opening practice (N = 392)				
Yes	51 (73.9%)	288 (89.1%)	11.31	0.001**
No	18 (26.1 %)	35 (11.9%)		

* Significant at p-value <0.05; ** significant at p-value < 0.01; *** Significant at p-Value < 0.001.

MDR-TB[23]. This study showed that the odd of MDR-TB was four times greater in households with family size greater than or equal to five. This fact had been confirmed by different literatures in various nations includes Nepal [15, 24] and Belarus [25]. According to the previous study, patients with MDR-TB had history of living in crowded house and this created the possible proximity of contact or exposure with infectious source [13]. People who had risk of TB were due to where they live or work. Prisoners, sex workers, hospital visitors and healthcare workers were at risk of developing TB, including MDR-TB [7,8]. Individuals who live in urban slums and poorly ventilated rooms were accustomed to such problem [22]. It was found that the odd of development of MDR-TB was 4.1 times higher among individuals living in a household with one room, similar to previous studies [19,26]. The longer period stay in households with one room, the higher infection rate would be. This relation might be attributed to poor ventilation system which produced fertile ground to the aerosol to circulate several hours and facilitate the transmission. Thus, the main areas of intervention to prevent and control MDR-TB should be social determinants that embrace poor living conditions, poor

Table 3. Multi variable analysis for determinants of MDR-TB at East Amhara from March 2-30, 2018.

Category	COR (95% CI)	AOR (95%CI)	p-value
Gender			
Male	2.1 (1.3-3.5)	1.7 (0.8-3.7)	0.07
Female	1		
Residence			
Rural	1.7 (1.1-2.7)	2.9 (1.4-6.0)*	0.024
Urban	1		
Employment Status			
Unemployed	1.8 (1.1-2.8)	1.3 (0.6-2.8)	0.114
Employed	1		
History of TB Treatment			
Yes	8 (4.6-13)	5.7 (2.6-12.9)*	0.008
No	1		
Category of TB treatment			
New	1		
Return after defaulter	6.8 (2.7-17.2)	2.5 (0.6-9)	0.395
Treatment failure	13 (5.6-28)	7.3 (5.2-7.8)*	0.035
Relapse	4.5 (2.-10)	5.0 (1.6-15.2)*	0.019
Contact history with known MDR-TB patient			
No	1		
Yes	4 (2.3-7.2)	5.1 (2.2-12.0)*	0.02
I don't know	0.94(0.5-1.7)	1.3 (0.5-3.3)	0.066
Family size			
< 5	1		
≥ 5	2.0 (1.1-3.6)	3.7 (1.6-8.6)*	0.0098
Number of rooms			
1	2.6 (1.6-4)	4.1 (1.8-9.0)*	0.027
≥ 2	1		
Number of window			
No	2.1 (0.98-4.8)	3.8 (1.6-8.5)*	0.043
1	0.7 (0.4-1.5)	0.9 (0.3-2.3)	0.585
≥ 2	1		
Opening window practice			
Yes	1		
No	2.6 (1.4-5.0)	3.7 (1.4-9.8)*	0.005
HIV status			
Positive	1.5 (0.8-2.8)	1.6 (0.65-4.0)	0.063
Negative	1		
Drinking Alcohol			
Yes	1.07 (0.4-2.7)	1.2 (0.5-2.4)	0.227
No	1		

1-referenent category; *=p<0.05.

nutrition, hygiene and sanitation. In countries with high incidence of TB, WHO recommended to considering testing and early treatment for people with contacts of bacteriologically confirmed pulmonary TB hosts [5]. This is actually confirmed by the fact that in the current study the odds of developing MDR-TB was five times higher among patients who had previous history of contact with confirmed TB cases, consistent with previous study [27]. MDR-TB was common among previously treated tuberculosis patients than in newly acquired one, as reported in Ethiopia [26]. Known TB patients in a household was the alternate host of MDR-TB, supported by similar study in that MDR-TB patients have clear link with prior exposures to infectious TB patient resistant to numerous drugs [28]. Therefore, systematic screening for MDR-TB among specific populations with history of contact with known TB case is commendable to ensure early diagnosis and reduce levels of transmission. Globally, about 18% of previously treated cases had MDR-TB and this could visualize the association found between MDR-TB and having history of previous TB care regimen [5]. Moreover, MDR-TB was common in TB treatment failure and relapse. The same result had also reported by the current and other studies found in Amhara [22], Addis Abeba [26] and India [21]. This could be attributed to the fact that incomplete uptake of the prescribed drugs of choice by patients, improper prescription and order of antibiotic regimen, irregularities in taking medicine etc [29]. If the treatment is irregular, the number of bacterial death and growth cycles will be greater in giving more opportunities for individual mutation of different independent genes to accumulate. Thus, policy makers and program owners should give due emphasis in patient education and capacitating health providers efficiency of service delivery. Poor housing condition and ventilation system where the patients live in and work are the major contributing factors for MDR-TB infection [13]. The odd of MDR-TB was 3.8 times greater in respondents whose house was without window. In complement to this result, the risk of MDR-TB was 3.7 times higher in patients who opened window. Thus, the existence of window fixture in a room alone did not guarantee reductions of TB infection. Exposure to poor environmental conditions: narrow or enclosed space which is unventilated would enhance the probability of transmission and aggravate concentration of infectious droplet nuclei [1]. Window opening practice is wrongly believed to cause air draft related disorders due to cold air during ventilating rooms in morning & night time [30]. Hence, infection control through environmental methods is a crucial element to avert transmission of MDR-TB[13]. History of TB treatment failure increases the risk of MDR-TB and is common in resource limited settings. Similar to other studies in Ethiopia[22, 28], in this study, TB treatment failure increases the risk of MDR-TB by 7.3 times. The correlation between treatment failure and MDR-TB might be corroborated to poor treatment adherence, improper drug management, shortages of drug supply and weak managerial talents. This study was not conducted without any limitations. As the study was a retrospective case-control study, no temporal relationship could be established and the factors do not establish a temporal relationship; therefore, inference of causation is not possible.

Conclusions

The result of this study identified that socio-demographic (residence, family size) and environmental (number of rooms, number of windows in a room, opening window practice) variables were the most common determinants for having MDR-TB. Thus, the end TB strategy in Ethiopia, in particular in the study settings, should be adapted to determinants such as number of rooms, residence, number of windows in a room, family size, and opening window practice. TB infected patients who lived in rural area and poor housing condition as well as overcrowded family should be prioritized for MDR-TB screening and intervention. This study also confirmed that clinical variables (history of TB treatment, TB treatment failure and having contact with known TB patient) were the determinants for MDR-TB occurrence. The policy personnel should design appropriate treatment regimen and strengthen direct observed therapy targeting on rural communities so as to intensify treatment compliance. This finding contributes stimulus to strengthen tracing of household with history of TB treatment. Thus, primary prevention should be implemented to halt transmission of infection by instituting adequate ventilation and isolation of infectious patients.

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Authors' contributions

NO participated in the conception and coordination of the study, performed the statistical analyses and drafted the manuscript. DDA, GT and AK participated in the design of the study, data collection, analysis and draft of the manuscript. All authors read and approved the final manuscript.

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