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Factors influencing treatment outcomes of tuberculosis patients attending health facilities in Galkayo Puntland, Somalia

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ABSTRACT

Aim This study evaluated the underlying factors associated with poor tuberculosis (TB) treatment outcomes among patients attending health care facilities in Galkayo, Puntland, Somalia.

Methods An institution-based cross-sectional study was conducted between 2016 and 2017 in three selected TB clinics. Data were collected from 400 TB patients, through medical record review and structured questionnaire. Multivariate logistic regression analyses were performed.

Results Of the 400 TB respondents, 57.3% were new cases, 12.3% had smear-negative TB and 12.5% had extrapulmonary TB. The median age was (35.66 ± 13.16) with majority being male (65.5%). Overall, 85% of patients were successfully treated, 9.7% failed and 5.3% defaulted. Multivariate analysis revealed that patient's body weight (odds ratio [OR]: 1.078); diabetes (OR: 8.022); family size (OR: 3.851); patients' delay in diagnosis (OR: 11.946); frequency of receiving anti-TB medication (OR: 9.068); smoker (OR: 5.723); category of patients (retreatment versus new, OR: 5.504; retreatment versus transfer in, OR: 4.957); health facilities (OR: 6.716) and treatment duration (OR: 132.091) were independent factors associated with poor TB outcomes.

Conclusions Our findings highlight the need to improve TB services for vulnerable groups. They also emphasize the need for health system strengthening, public awareness and risk of treatment interruption. This may reduce both patients' delay in seeking care and TB treatment failure in Galkayo district.

Keywords multidrug resistant tuberculosis, risk factors, Somalia, tuberculosis, treatment outcomes

Background

Tuberculosis (TB) remains a global public health challenge with African countries recording the highest burden of the disease. For instance, in 2017, African countries reported >25% of new TB cases (2.5 million cases) and TB deaths (417 000 people) worldwide.[1] Although highly effective treatments for TB are available, the control of the TB epidemic still remains a challenge in developing countries. Poverty,

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limited healthcare services, poor prevention programs and the emergence and rapid spread of human immunodeficiency virus (HIV) and multidrug-resistant TB (MDR-TB) have been identified as enabling factors for the high TB burden in African countries.[1–4]

Somalia is home to one of highest MDR-TB burden in the world. It has a prevalence rate of 491 cases per 100 000 population and an incidence rate of 274 cases per 100 000 population.[1,2] In addition, the case detection rate in Somalia is only 49%, which means 51% of all TB cases are undiagnosed, according to the World Health Organization (WHO) report of 2018.[1] In their bid to control the spread TB, the Somalia National TB Control Program adopted the directly observed treatment short course (DOTS) strategy in 1995. Through the implementation of this strategy, at least one TB Centre was set up in each of the eighteen regions of Somalia.[5] However, the treatment outcomes have not been satisfactory, mainly due to continual spread of infections and development of MDR-TB particularly in the south-central region (Puntland). This region is reported to have significantly higher risks of MDR-TB (OR: 4.3; $P = 0.003$) with low coverage of DOTS compared with Somaliland (OR: 3.6; $P < 0.001$).[6–9]

Evaluating the treatment outcomes of TB and assessing the factors influencing TB outcomes are viewed as important indicators in monitoring the effectiveness of TB control programs, as suggested by the WHO in conjunction with European Region of the International Union against Tuberculosis and Lung Disease (IUATLD).[10] Ideally, for TB treatment to be effective, it is crucial to initiate patients on the correct treatment regimens in a timely manner and to sustain such treatment for the correct period of time according to the national TB guidelines.[5,10] A large body of literature[2,6,7,11–13] has identified the risk factors associated with poor TB outcomes in resource-limited settings.

Nonetheless, the issues of TB treatment outcomes and its predictors have not been well addressed in Galkayo, Puntland. To our knowledge, only one study has assessed the factors influencing TB outcomes in Puntland in the past 5 years[7] but most of studies have been conducted in Somaliland and Mogadishu.[6,8] For instance, a recent cross-sectional study, using 385 TB patients attending TB treatment centers in Mogadishu, found that the treatment outcomes were mainly affected by patients' individual factors such as marital status, educational level, HIV status, treatment category and knowledge of TB.[6] This study therefore aimed to assess TB treatment outcomes and determine the underlying factors associated with poor TB outcomes among pulmonary TB patients attending selected health facilities in Galkayo, Puntland, Somalia.

Methods

Study setting

This study was undertaken at three selected public and private TB DOTS clinics in Galkayo, namely Galkayo National Referral Hospital (GNRH), Galkayo Medical Center (GMC) and Guryasamo Hospital (GSH). Galkayo is situated in the north-central Somalia and is the capital of the Mudug region, with an estimated population of ∼380 000 inhabitants.[7,14] Galkayo area was selected not only for limited studies on this research scope and high TB prevalence but also because of the high risk of MDR TB in Puntland based on the 2011 nationwide survey.[9] Since then efforts have been made by the Somalia National TB control program in conjunction with the private sector to educate the general public about TB. With these initiatives still ongoing, this study might highlight the overall improvement made in the past few years in Galkayo.

Study design and data collection

This study adopted a cross-sectional design and used medical record review and structured questionnaire of TB patients aged 15 years and above, who started treatment at one of the three selected hospitals between 2014 and 2017. Using the Stat Calc program of Epi Info version 7, with 95% confidence level, 80% power and proportion of 1/3 for each hospital, it was estimated that 400 TB cases were needed to achieve the objective of the study.[15] To achieve our target sample size of 400, TB patients at each hospital were selected based on proportional representation of the total number of TB patients' records at each of the hospitals in the past 4 years prior to data collection time. Thus, 68.5% (274), 19.5% (78) and 12.0% (48) TB patients were randomly selected from GNRH, GMC and GSH respectively.

All patients with cure or completed treatment outcomes were categorized as successful treatment, while other outcomes that were treatment default, treatment failure and/or death were categorized as unsuccessful treatment according to the national TB guidelines.[5,10] Treatment failure and default were considered unsuccessful treatment since none of the selected patients died during the follow-up period.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (IBM, SPSS 23.0). Data were presented with frequencies and percentages or median for socio-demographic characteristics, clinical characteristics and treatment outcomes. Categorical variables were compared using chi-square test. To evaluate the potential predictor variables of unsuccessful treatment outcome, we compared socio-demographic and clinical variables between the successful and unsuccessful

treatment outcome groups, using univariate and multivariate logistic regression models. Variables with a P-value < 0.20 in the univariate analysis were included in the multivariate logistic regression model. In constructing regression model procedures, two methods of variable selection were used, which were forward and backward stepwise variable selection methods to obtain preliminary model and the highest number of variables were included in further analysis. The removal of variables was based on the decision of P-value from the Wald statistics test. In the analysis, we checked for multicollinearity and interaction term problems. The goodness of fit and collinearity of the model were tested with Hosmer–Lemes how and Tolerance methods. The final multivariate logistic regression model included all the indicators of the significant variable. P-value < 0.05 was considered statistically significant.

Ethics approval

This study received ethical approval in China from the Institutional Review Boards of Southeast University (Nanjing, China) and in Somalia from the Ethics and Research Advisory Committee of the National Tuberculosis Control Programme, Ministry of Health and the three Hospitals. Participants were given a detailed explanation of the study by one of the authors in English and/or the local language (Somali, Arabic). A written informed consent was obtained from participants prior to the start of the interview. For participants below the age of 18 years (15–17 years), a written consent to participate in the study was obtained from their parents or guardians who accompanied them to the healthcare facilities.

Results

Socio-demographic and baseline clinical characteristics

Tables 1 and Supplementary Table S1 provide a summary of the socio-demographic and baseline clinical characteristics of respondents. The mean age of all the respondents was (35.66 ± 13.16) years and the mean weight and height were approximately (61.06 ± 10.69) Kg and (1.63 ± 0.11) meters respectively, ($P > 0.05$ for all three groups). About two-third of the patients were male (65.5%), reside in urban areas (68.8%), about half of the patients (51.5%) were married and one-quarter of them (25.5%) were uneducated. 37.5% affirmed that they had no knowledge about TB.

TB treatment outcomes among respondents

Out of the 400 TB patients, 49.8% of patients were found to be successfully cured while 35.2% of patients completed the treatment. However, 9.8% and 5.2% of patients, respectively, recorded treatment failure and default (stopped the treatments for various reasons). Overall, 85% of patients were successfully treated in this study. In addition, statistical differences among successful and unsuccessful treatment remained significant when stratified with risk factors, as presented in the Tables 1 and Supplementary Table S1.

Majority of TB cases in this study were smear-positive (75.3%), followed by smear-negative (12.3%) and extrapulmonary disease (12.5%) respectively, with no statistically significant differences within TB category ($P = 0.097$). In addition, there were more than half of new TB cases (57.8%), 27.5% and 14.8% were retreatment and referral cases respectively. With regard to patients' time of seeking medical care, only 40.8% of all cases were diagnosed a few days (i.e. early) after experiencing symptoms compared with 38.8% cases that sought medical care after 3 weeks or more. In addition, 52.0% (out of 400 cases) routinely took their daily medications, whereas 72.3% successfully completed the 6 months of therapy with statistically significant differences among the two groups ($P < 0.0001$). The co-infection rate of TB/HIV and TB/DM were 4.0% and 17.0% respectively, with statistically significant difference for HIV status (HIV positive versus HIV negative, ($P < 0.0001$) but not for diabetes status ($P = 0.992$) as presented in the Tables 2 and Supplementary Table S2. With respect to TB/DM status, >72.1% were male TB patients while 57.4% resided in urban areas. Moreover, there were statistically significant differences between successful and unsuccessful treatment when stratified by the following factors; type of patients, patients' delay in diagnosis, treatment duration and frequency of receiving anti-TB medication and diabetes status. No statistically significant differences were found for the category of TB and HIV status (all $P > 0.05$).

Univariate and multivariate analysis of factors associated with TB treatment outcomes

Through bivariate analysis, the following factors; patient's age, residence, marital status, educational level, household income, occupation, TB knowledge, body weight, body height, TB symptoms, health facilities, lifestyle, TB category, treatment category, patients' delay in diagnosis, treatment duration, frequency of receiving anti-TB medication, and TB/DM were statistically associated with TB treatment outcomes at $P < 0.05$ as presented in the Table 3. However, there were slightly difference in factors that were statistically different using multivariate analysis, when compared to bivariate analysis, body weight (OR: 1.078, 95% CI (1.021–1.138), $P = 0.007$); TB/DM (diabetes versus non-diabetes, OR:

Table 1 Socio-demographic characteristics and treatment outcomes of all TB patients interviewed across the three selected health facilities in Galkayo, Puntland, Somalia

Socio-demographic Characteristics	*All TB patients interviewed*		*Treatment outcomes (N = 400) selected TB patients*				
	Total TB patients N = 400 (%)	*P-value*	*Successful (n = 340) (85%)*		*Unsuccessful (n = 60) (15%)*		*P-value X^2-Test*
			Cured n = 199 (%)	*Completed n = 141(%)*	*Failure N = 39(%)*	*Default N = 21(%)*	
Age (mean ± SD)	*(35.66 ± 13.16)*	*0.104*	*(35.62 ± 12.58)*	*(34.05 ± 12.39)*	*(39.10 ± 14.46)*	*(40.43 ± 18.71)*	***0.014***
15–25	132 (33.0)		63 (31.7)	50 (35.5)	11 (28.2)	8 (38.1)	
26–30	49 (12.3)		21 (10.6)	23 (16.3)	4 (10.3)	1 (4.5)	
31–40	88 (22.0)		50 (25.1)	30 (21.3)	6 (15.4)	2 (9.5)	
41–50	68 (17.0)		38 (19.1)	20 (14.2)	8 (20.5)	2 (9.5)	
>50	63 (15.8)		27 (13.6)	18 (12.8)	10 (25.6)	8 (38.1)	
Gender		**<0.0001**					**0.093**
Male	262 (65.5)		135 (67.8)	82 (58.2)	26 (66.7)	19 (90.5)	
Female	138 (34.5)		64 (32.2)	59 (41.8)	13 (33.3)	2 (9.5)	
Residence		**0.002**					**<0.0001**
Urban	275 (68.8)		149 (74.9)	98 (69.5)	19 (48.7)	9 (42.9)	
Rural	125 (31.3)		50 (25.1)	43 (30.5)	20 (51.3)	12 (57.1)	
Marital status		**0.204**					**0.002**
Married	206 (51.5)		116 (58.3)	71 (50.4)	15 (38.5)	4 (19.0)	
Single	133 (33.3)		57 (28.6)	51 (36.2)	16 (41.0)	9 (42.9)	
Divorced	30 (7.5)		13 (6.5)	11 (7.8)	4 (10.3)	2 (9.5)	
Widowed	31 (7.8)		13 (6.5)	8 (5.7)	4 (10.3)	6 (28.6)	
Education levels		**0.374**					**<0.0001**
Uneducated	102 (25.5)		36 (18.1)	31 (22.0)	21 (53.8)	14 (66.7)	
Primary/elementary	66 (16.5)		32 (16.1)	25 (17.7)	5 (12.8)	4 (19.0)	
Secondary	64 (16.0)		27 (13.6)	28 (19.9)	8 (20.5)	1 (4.8)	
Post-secondary	80 (20.0)		48 (24.1)	29 (20.6)	3 (7.7)	0	
Diplomat	57 (14.2)		29 (14.6)	24 (17.0)	2 (5.1)	2 (9.5)	
Master/PhD	31 (7.8)		27 (13.6)	4 (2.8)	0	0	
Household Income		**0.027**					**<0.0001**
15–45 USD	39 (9.8)		11 (5.5)	10 (7.1)	10 (25.6)	8 (38.1)	
45–100 USD	125 (31.3)		52 (26.1)	44 (31.2)	18 (46.2)	11 (52.4)	
>100 USD	236 (59.0)		136 (68.3)	87 (61.7)	11 (28.2)	2 (9.5)	
Household Size		**0.771**					**<0.0001**
Small size ≤5	169 (42.3)		91 (45.7)	66 (46.8)	9 (23.1)	3 (14.3)	
Big size>5	231 (57.8)		108 (54.3)	75 (53.2)	30 (76.9)	18 (85.7)	
Occupation		**<0.0001**					**<0.0001**
Students	108 (27.0)		54 (27.1)	45 (31.9)	5 (12.8)	4 (19.0)	
Merchant	131 (32.8)		85 (42.7)	42 (29.8)	4 (10.3)	0	
Retired	35 (8.8)		19 (9.5)	4 (2.8)	4 (10.3)	8 (38.1)	
Household	60 (15.0)		26 (13.1)	27 (19.1)	5 (12.8)	2 (9.5)	
Unskilled	66 (16.5)		15 (7.5)	23 (16.3)	21 (53.8)	7 (33.3)	
TB Knowledge		**0.226**					**<0.0001**
Knowledgeable	250 (62.5)		146 (73.4)	93 (66.0)	9 (23.1)	2 (9.5)	
Unknowledgeable	150 (37.5)		53 (26.6)	48 (34.0)	30 (76.9)	19 (90.5)	

P < 0.05 was considered statistically significant.

8.022, 95% CI (1.794–35.861) $P = 0.006$); family size (big versus small, OR: 3.851, 95% CI (1.066–13.903), $P = 0.040$); patients' delay in seeking care (several versus early weeks, OR: 11.946, 95% CI (2.148–66.433), $P = 0.005$); frequency of receiving anti-TB medication (monthly versus daily, OR: 9.068, 95% CI (1.476–55.728), $P = 0.017$); lifestyle (smoker versus non-smoker, OR: 5.723, 95% CI (1.205–27.183), $P = 0.028$); treatment duration (6 months versus 2 months, OR: 132.091, 95% CI (10.389–1679.496), $P < 0.0001$); category of patients (retreatment versus new, OR: 5.504, 95% CI (1.102–27.484), $P = 0.038$; retreatment versus referral, OR: 4.957, 95% CI (1.129–21.766), $P = 0.034$); and health facilities (Public Center versus Referral Hospital, OR: 6.716, 95% (1.437–31.381), $P = 0.015$) independently predicted TB outcomes as presented in the Table 4.

Discussion

Main findings of this study

This study is one of the few operational research studies assessing TB treatment outcomes and risk factors associated with poor TB outcomes at three selected hospitals in Galkayo, Puntland, Somalia. Our study found that the treatment success rate of all respondents was 49.8% and 35.2% for the successfully cured patients and those who completed

Table 2 Clinical characteristics and treatment outcomes of all TB patients interviewed across the three selected health facilities in Galkayo, Puntland, Somalia

Clinical characteristics	*All TB patients interviewed*		*Treatment outcomes (N = 400) selected TB patients*				
	Total TB patients N = 400 (%)	*P-value*	*Successful (n = 340) (85%)*		*Unsuccessful (n = 60) (15%)*		*P-value X^2-Test*
			Cured n = 199 (%)	*Completed n = 141(%)*	*Failure N = 39(%)*	*Default N = 21(%)*	
Weight (mean ± SD)	*(61.06 ± 10.69)*	*0.199*	*(62.88 ± 9.73)*	*(62.13 ± 10.56)*	*(54.49 ± 11.32)*	*(48.81 ± 5.97)*	***<0.0001***
≤50 Kg	86 (21.5)		21 (10.6)	23 (16.3)	26 (66.7)	16 (76.2)	
51–60 Kg	115 (28.7)		67 (33.7)	40 (28.4)	4 (10.3)	4 (19.0)	
61–70 Kg	122 (30.5)		62 (31.2)	53 (37.6)	6 (15.4)	1 (4.8)	
>70 Kg	77 (19.3)		49 (24.6)	25 (17.7)	3 (7.7)	0	
Height (Mean ± SD)	(1.63 ± 0.11)	<0.0001	(1.64 ± 0.11)	(1.64 ± 0.11)	(1.60 ± 0.14)	(1.58 ± 0.11)	**0.002**
≤1.60	201 (50.2)		97 (48.7)	62 (44.0)	28 (71.8)	14 (66.7)	
1.62–1.74	134 (33.5)		68 (34.2)	57 (40.4)	3 (7.7)	6 (28.6)	
≥1.75	65 (16.3)		34 (17.1)	22 (15.6)	8 (20.5)	1 (4.8)	
Health Facilities		**<0.0001**					**<0.0001**
Public Center	78 (19.5)		33 (16.6)	21 (14.9)	13 (33.3)	11 (52.4)	
Referred Hospital	274 (68.5)		149 (74.9)	105 (74.5)	12 (30.8)	8 (38.1)	
Private Center	48 (12.0)		17 (8.5)	15 (10.6)	14 (35.9)	2 (9.5)	
TB category		**0.097**					**0.056**
Smear TB-positive	301 (75.3)		159 (79.9)	104 (73.9)	24 (61.5)	14 (66.7)	
Smear TB-negative	49 (12.3)		19 (9.5)	18 (12.8)	9 (23.1)	3 (14.3)	
Extrapulmonary	50 (12.5)		21 (10.6)	19 (13.5)	6 (15.4)	4 (19.0)	
Treatment category		**<0.0001**					**<0.0001**
New Patient	231 (57.8)		144 (72.4)	79 (56.0)	5 (12.8)	3 (14.3)	
Retreatment Patient	110 (27.5)		31 (15.6)	40 (28.4)	23 (59.0)	16 (76.2)	
Referred Patient	59 (14.8)		12 (6.0)	10 (7.1)	4 (10.3)	1 (4.8)	
Patients delay		**0.091**					**<0.0001**
Early	163 (40.8)		99 (49.7)	59 (41.8)	3 (7.7)	2 (9.5)	
Second week	82 (20.5)		40 (20.1)	34 (24.1)	7 (17.9)	1 (4.8)	
Third week	84 (21.0)		41 (20.6)	28 (19.9)	6 (15.4)	9 (42.9)	
Several weeks	71 (17.8)		19 (9.5)	20 (14.2)	23 (59.0)	9 (42.9)	
HIV Status		**<0.0001**					**0.668**
HIV positive	16 (4.0)		8 (4.0)	5 (3.5)	2 (5.1)	1 (4.8)	
HIV negative	384 (96.0)		191 (96.0)	136 (96.5)	37 (94.9)	20 (95.2)	
Diabetes Status		**0.992**					**<0.0001**
Diabetes	68 (17.0)		23 (11.6)	18 (12.8)	17 (43.6)	10 (47.6)	
Non-diabetes	332 (83.0)		176 (88.4)	123 (87.2)	22 (56.4)	11 (52.4)	
Anti-TB medication		**<0.0001**					**<0.0001**
Every day	208 (52.0)		130 (65.3)	72 (51.1)	5 (12.8)	1 (4.8)	
Twice week	90 (22.5)		40 (20.1)	37 (26.2)	9 (23.1)	4 (19.0)	
Once week	51 (12.8)		14 (7.0)	15 (10.6)	17 (43.6)	5 (23.8)	
Once monthly	51 (12.8)		15 (7.5)	17 (12.1)	8 (20.5)	11 (52.4)	

P < 0.05 was considered statistically significant.

the treatment regimen respectively. These findings represent an overall treatment success rate of 85%. These results are slightly below the 87% treatment success target set by the Stop TB partnership for the year 2015 and even further away from the new target of 90% by the Global Plan to End TB, 2016–2020.[16,17] Despite the unachieved target in respect of the Global Plan to End TB recommendation, the success rate of 85% is slightly higher compared with 81.8% for Mogadishu.[6] Our findings are in line with earlier studies (69–87%) conducted in Galkayo and Marere.[7]

Our study also indicates that, the treatment failure rate of 9.75% is higher compared to studies in Mogadishu,[6] Galkayo,[7] China[18] and Ethiopia.[19,20] The reasons for this relatively higher rate may be due to the differences in how health services are provided within and outside Somalia, respondents' limited knowledge of and awareness of TB, as well as the diagnosis and management of the disease.[21,22] A cross-sectional study that explored the underlying factors for delayed TB diagnosis among patients in the Somali Regional State found that, limited access to TB control programs was the most important barrier to seeking early biomedical care.[23] Close monitoring of TB patients and health education to improve knowledge are crucial in addressing the relatively high rate of treatment failure reported in our study. Failure to reducing such a TB high treatment failure rate has the tendency to increase the MDR-TB cases in Puntland. In addition, the unsuccessful treatment rate of 15%, is higher than that reported in Northern[19] and Southern[24] Ethiopia

Table 3 Univariate analysis of treatment outcomes of patients interviewed related with the risk factors across the three selected health facilities in Galkayo, Puntland, Somalia

Variable characteristics	*Univariate analysis*		*Variable characteristics*	*Univariate analysis*	
	OR (95% CI)	*P-value*		*OR (95% CI)*	*P-value*
Age (year)	*0.975 (0.956–0.995)*	*0.013*	*Body weight (Kg)*	*1.126 (1.084–1.170)*	***<0.0001***
15–25	2.379 (1.145–4.943)	0.020	≤50	Reference	
26–30	3.520 (1.202–308).	0.022	51–60	12.767 (5.547–29.384)	<0.0001
31–40	4.00 (1.611–9.931)	0.003	61–70	15.682 (6.555–37.518)	<0.0001
41–50	2.320 (0.976–5.513)	0.057	>70	23.545 (6.887–80.498)	<0.0001
>50	Reference		Duration therapy		**<0.0001**
Gender			2 Months	Reference	
Male	0.588 (0.315–1.098)	0.096	4 Months	0.405 (0.104–1.577)	0.192
Female	Reference		5 Months	0.517 (0.141–1.898)	0.320
Residence			6 Months	28.400 (6.396–126.109)	<0.0001
Urban	3.035 (1.733–5.316)	<0.0001	Health facilities		**<0.0001**
Rural	Reference		Public center	Reference	
Marital status		**0.003**	Referred hospital	5.644 (2.911–10.944)	<0.0001
Married	Reference		Private center	0.889 (0.412–1.918)	0.764
Single	0.439 (0.231–0.834)	0.012	TB category		**0.061**
Widowed	0.213 (0.088–0.519)	0.001	Smear TB-negative	Reference	
Divorced	0.406 (0.148–1.117)	0.081	Smear TB-positive	2.245 (1.077–4.679)	0.031
Education levels		**<0.0001**	Extrapulmonary	1.297 (0.501–3.357)	0.592
Uneducated	Reference		Patients delay		**<0.0001**
Primary/elementary	3.308 (1.467–7.461)	0.004	Early	Reference	
Secondary	3.192 (1.413–7.210)	0.005	Second week	0.293 (0.093–0.925)	0.036
Post-secondary	13.408 (3.944–45.584)	<0.0001	Third week	0.146 (0.051–0.416)	<0.0001
Diplomat	6.922 (2.315–20.699)	0.001	Several week	0.039 (0.014–0.105)	<0.0001
Master/PhD	No estimated		Treatment category		**<0.0001**
Household income		**<0.0001**	New patient	15.312 (6.837–34.290)	<0.0001
15–45 USD	Reference		Transfer-in patient	1.944 (0.937–4.030)	0.074
45–100 USD	2.837 (1.335–6.032)	0.007	Retreatment patient	Reference	
>100 USD	14.703 (6.335–34.128)	<0.0001	Anti-TB medication		**<0.0001**
Household size			Every day	19.990 (7.422–53.834)	<0.0001
Small size ≤ 5	3.432 (1.760–6.690)	<0.0001	Twice week	3.517 (1.553–7.962)	0.003
Big size > 5	Reference		Once week	0.783 (0.354–1.730)	0.545
Occupation		**<0.0001**	Once monthly	Reference	
Students	8.105 (3.503–18.756)	<0.0001	HIV status		
Merchant	23.395 (7.721–70.886)	<0.0001	HIV positive	Reference	
Household	5.579 (2.208–14.099)	<0.0001	HIV negative	1.324 (0.366–4.793)	0.669
Retired	1.412 (0.603–3.310)	0.427	Diabetes status		
Unskilled	Reference		Non-diabetes	Reference	
TB Knowledge			Diabetes	5.967 (3.260–10.919)	<0.0001
Knowledgeable	10.541 (5.266–21.101)	<0.0001			
Unknowledgeable	Reference				

P < 0.05 was considered statistically significant.

but lower than what was reported in Mogadishu,[6] Galkayo and Marere.[7]

In this study, the proportion of TB/HIV co-infection was found to be 4.0%, which is higher than the report of a similar study conducted in Mogadishu where the TB/HIV rate was 2.6%.[6] TB/DM co-infected patients have a lower chance of successful treatment outcome.[25] This fact was buttressed by the findings of a systematic review of observational studies, which showed that TB/DM co-infection is associated with an increased risk of treatment failure.[25]

In the multiple logistic regression analysis, the body weight significantly associated with higher chance of successful treatment outcome (OR: 1.078). Similar to the findings of our study, previous studies also reported low body weight at initiation of anti-TB treatment (<35 kg) was a significant risk factor of death and relapse during anti-TB treatment period.[26–28] We estimate from this study that, underweight is associated with a 10-fold increase in TB mortality.[29] In comparison to TB/DM patients, non-diabetic TB patients had ∼8 times higher chance of successful treatment outcome. This finding is similar to that of a systematic review, which showed that diabetes was associated with an increased risk of TB (1.16–7.89).[25]

What is already known on this topic

The results of the present study regarding the underlying factors associated with poor TB treatment outcomes are consistent with the results of other studies previously reported in the literature.[11,21,30,31] While, recent studies conducted in Somalia and elsewhere[2,6,7,11–13] have identified

Table 4 Multivariate analysis of Treatment Outcomes of patients interviewed related with the risk factors across the three selected health facilities in Galkayo

Variable Characteristics	*OR (95% CI)*	*P-value*
Body mass index	1.078 (1.021–1.138)	0.007
Diabetes status		
Diabetes versus non-diabetes	8.022 (1.794–35.861)	0.006
Family Size		
Small size ≤5 versus Big size > 5	3.851 (1.066–13.903)	0.040
Lifestyle habits		0.020
Drinker versus non-smoker	0.039 (0.001–1.307)	0.070
Qatchewing versus non-smoker	1.974 (0.349–11.170)	0.442
Smoker versus non-smoker	5.723 (1.205–27.183)	0.028
Health facilities		**0.036**
Referral hospital versus Public center	6.716 (1.437–31.381)	0.015
Private center versus Public center	1.695 (0.336–8.561)	0.523
Patients delay for seeking care		**0.034**
Several versus early week	11.946 (2.148–66.433)	0.005
Several versus second week	1.842 (0.387–8.777)	0.443
Several versus third week	3.847 (0.856–17.279)	0.079
Frequency of receiving Anti-TB medication		**0.009**
Every day versus once monthly	9.068 (1.476–55.728)	0.017
Twice weekly versus once monthly	0.974 (0.208–4.562)	0.973
Once weekly versus once monthly	0.321 (0.064–1.619)	0.169
Category of patients		**0.045**
New versus retreatment	5.504 (1.102–27.484)	0.038
Referred versus retreatment	4.957 (1.129–21.766)	0.034
Duration of treatment therapy		<**0.0001**
4 versus 2 months	1.574 (0.210–11.815)	0.659
5 versus 2 months	5.695 (0.660–49.154)	0.114
6 versus 2 months	132.091 (10.389–1679.496)	<0.0001

P < 0.05 was considered statistically significant.

association between the low socio-economic characteristics including household income and expenditure on illness to poor TB outcomes. With regard to the lifestyle, recent studies have also demonstrated high risk of unsuccessful TB treatment outcomes for unhealthy behavior of TB patients including smoking and drinking.[2,13,32]

Concurring with our own findings, prior studies[11,21,30,31] revealed that the type of health facilities is an independent predictor of TB treatment outcomes. Hence, it is likely due to the differential delivery of DOTS services including health staff not being sufficient in numbers, or not providing care according to standards, and/or not being responsive to the needs of the community and patients across the health facilities.[11,30,31] Several international and national organizations including the WHO-Global Plan to Stop TB[30,31] acknowledge that the main human resource issues affecting tuberculosis control are insufficient quality, quantity and distribution of health workers. According to the Stop TB Partnership, $US 250 million is required annually to provide training and technical support to tuberculosis endemic regions.[16,17] Training of health workers is an important strategy for improving health workers' productivity and monitoring of TB patients in the fight against TB. Such efforts are very important, particularly in rural areas where there are insufficient quality and quantity of health workers.[11,30,31]

In addition, earlier published studies, which linked the delay in diagnosis and initiation of effective treatment, found an increase in TB morbidity and mortality, as well as risk of transmission in the community.[12,13,32–36] A recent study in Southern Ethiopia pointed out that the treatment interruption is caused with factors such as feeling better, loss of hope, unaffordable transportation costs, and side effects of drugs.[11] A community-based approach has been recently proposed for the decentralization of treatment follow-up to commu-

nity health posts in order to improve patient health-provider communication during the period of treatment.[11] Furthermore, previous studies had demonstrated that the increased likelihood of successful treatment outcomes is linked with the treatment duration,[11,21,30,31] which is in line with WHO TB control policy.[1,2,10]

What this study adds

The study adds to the evidence regarding poor TB treatment outcomes in developing countries, particularly in fragile states like Somalia.[14] Understanding the underlying risk factors associated with poor TB outcomes may help to play an important role in the development of culturally appropriate TB prevention and increasing efforts targeting the risk development of MDR-TB cases. Our findings indicate the need for further investigation on how to prevent and reduce the risk factors of poor TB outcomes, as well as, the importance of health workers training in the fight against TB.

Limitation of this study

Beside the study design limitation, the database of health facilities did not contain information on other potential factors such as compliance with treatment, sputum smear test result at second month after initiation of treatment, duration of symptoms before treatment, health facilities' delays after TB patient diagnosis and drug resistance status—all of which are known to be associated with TB treatment outcomes. In addition, there was no information on the distance traveled by patients to the health facilities. The aforementioned variables may also affect treatment outcomes.

Conclusion

Despite the limitations of our study, the following conclusion can be deduced. Based on the relatively low success rate in terms of the treatment outcome, there is need to strengthen the health system toward raising more public awareness about the disease and risk of treatment interruption. We recommend increased implementation of community-based TB support centers in areas with poor access to health services.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare that they have no competing interests.

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