JAC Antimicrob Resist
https://doi.org/10.1093/jacamr/dlae206

JAC-Antimicrobial Resistance

Prevalence and factors associated with TB among presumptive TB patients in war-affected areas of North Wollo, Ethiopia

Zelalem Asmare [1,2]*, Abebe Assefa[1], Amanuel Belay[1], Ayehu Mulie[1], Dawit Aschil[1] and Yalewayker Gashaw[1]

[1]*Department of Medical Laboratory Science, College of Health Sciences, Woldia University, Woldia, Ethiopia;* [2]*Department of Medical Laboratory Science, College of Medicine and Health Sciences, Injibara University, Injibara, Ethiopia*

*Corresponding author. E-mail: zelalemasmare018@gmail.com

Received 25 September 2024; accepted 5 December 2024

Background: TB is a leading infectious disease globally, with war and displacement significantly increasing its burden. In Ethiopia, ongoing conflict and displacement have worsened health conditions, yet data on TB prevalence and resistance remain scarce. This study aimed to determine the prevalence of TB, rifampicin-resistant TB (RR-TB), and associated factors among presumptive TB patients in hospitals during the ongoing crisis.

Methods: A cross-sectional study was conducted with 273 presumptive TB participants, recruited via convenience sampling. Data on socio-demographic and behavioural factors were collected through interviews using a pre-tested structured questionnaire. Sputum samples were examined using the Xpert MTB/RIF molecular assay. Binary logistic regression was used to analyse the association between independent variables and TB. Variables with a *P* value ≤0.25 in the univariate analysis were included in the multivariable regression to identify independent predictors, with a *P* value ≤0.05 considered statistically significant.

Results: Among the 273 study participants, 47 were confirmed to have *Mycobacterium tuberculosis*, resulting in a prevalence of 17.2%. Of the 47 patients diagnosed with *M. tuberculosis*, 17 (36.2%) were found to have rifampicin-resistant strains. Previous contact with displaced persons [adjusted odds ratio (AOR): 4.237; 95% CI: 1.67–10.762; *P* value: 0.002), contact with TB-infected individuals (AOR: 5.644; 95% CI: 2.46–12.96; *P* value: <0.01) and being HIV positive (AOR: 3.074; 95% CI: 1.26–7.50; *P* value: 0.014) were the significant predictors for TB.

Conclusions: Our study revealed a troubling prevalence of RR-TB, underscoring the adverse effects of war and displacement on healthcare services. Significant associations with predictors like HIV infection and close contact with TB-infected individuals necessitate targeted interventions.

Introduction

TB is one of the most common infectious diseases, and has been the world's second leading cause of death from a single infectious agent for the past three years, overtaken only by COVID-19. However, TB has now regained its position as the leading cause of death from a single infectious agent.[1] The global incidence of TB is rising significantly and remains a severe public health issue, particularly in developing nations, with approximately 10.8 million people contracting TB and 1.25 million deaths in 2023, the majority occurring in low- and middle-income countries. In addition to the direct morbidity and mortality, TB imposes a substantial financial burden, with an estimated $16 billion needed annually to adequately fund prevention, diagnosis, treatment and care efforts.[1] Approximately half of TB patients and their families incur total expenses—including direct medical costs, non-medical expenditures, and indirect losses like income reductions—exceeding 20% of their annual household income, which is considered catastrophic.[2]

TB is a curable and preventable disease, and can be successfully treated in about 85% of cases with a 6 month drug regime, which also helps in curtailing the onward transmission of infection.[2,3] Despite being a curable and preventable disease, MDR-TB remains a public health crisis and a threat to global health security.[1] MDR-TB refers to a form of TB that does not yield to at least two of the most potent anti-TB medications, namely isoniazid and rifampicin.[4] Despite rifampicin being a cornerstone antibiotic for TB treatment,[5] the emergence of rifampicin-resistant tuberculosis

(RR-TB), often linked to MDR-TB, poses a significant challenge to TB control efforts.[6]

Even if TB is a global concern under all circumstances, war, conflict and displacement exacerbate existing TB burdens, creating environments where the control and management of the disease become significantly more complex.[7,8] War, conflict and displacement result in overcrowded living conditions, compromised healthcare infrastructure, disrupted supply chains, and limited access to medical care, all of which amplify the risk of TB transmission and hinder effective diagnosis and treatment. Furthermore, displacement compounds these challenges, as displaced populations face additional barriers to healthcare access and continuity of care.[7] Regions experiencing armed conflict and humanitarian crises face heightened vulnerability to TB due to disrupted healthcare systems, population displacement, limited access to essential services, and socioeconomic instability, exacerbating the risk of drug-resistant TB and compromising treatment accessibility and outcomes.[9]

TB remains a significant public health issue in developing countries due to factors like the HIV pandemic, poverty, migration of displaced populations and the emergence of MDR strains. Well-established risk factors for TB in impoverished nations include HIV, diabetes, malnutrition, alcoholism, smoking, close contact with active TB cases, extreme poverty and homelessness.[10] In low- and middle-income countries with limited resources, the economic impact of TB can be particularly devastating, leading to further impoverishment and hindering economic development.[11]

The ongoing conflict in the northern part of Ethiopia, which began in November 2020, has led to significant humanitarian crises, displacement of populations, loss of lives, and profound social, psychological and economic disruptions, exacerbating existing vulnerabilities and threatening regional stability.[12,13] The conflict in northern Ethiopia has severe immediate and long-term health impacts on populations, including treatment interruptions due to armed conflict, lack of access to healthcare and medications, transport disruptions, displacement of hospital staff, and pervasive insecurity and fear.[14]

In Ethiopia, the civil war ongoing since 2020 has exacerbated the burden of TB, disproportionately affecting the working-age population and placing immense strain on the healthcare system. Despite a decline in annual TB incidence from 1990 to 2016, the 2023 WHO Global TB Report lists Ethiopia as a high-burden country for TB, HIV-associated TB, and MDR/RR-TB.[2,15] In 2016, Ethiopia reported 48 910 TB-related deaths, along with 219 186 new and 156 602 prevalent TB cases, underscoring the significant impact of TB on public health in the country.[16] TB imposes a significant financial burden on Ethiopia as well. The average patient cost for TB is $115 per episode, with direct expenses comprising 46% of the total expenditure, and indirect costs averaging $63 per TB episode.[17]

In war-affected areas where access to healthcare is limited and treatment adherence is compromised, the prevalence of RR-TB and its contributing factors require urgent investigation. The ongoing conflict and disrupted healthcare services in Ethiopia exacerbate challenges in TB control, increasing the risk of transmission and drug-resistant strains. Despite the critical need to address TB in these regions, there is a lack of data on the prevalence and factors associated with TB and RR-TB, especially in northeast Ethiopia. This study aimed to fill that gap, providing valuable insights into TB and drug-resistant TB in conflict zones. By identifying the prevalence and contributing factors of RR-TB in war-affected areas, our study can support local and national TB programmes in Ethiopia, and offer global insights into TB epidemiology and resistance, guiding more effective interventions and treatment strategies.

Methods and materials

Study design, area, and period

A hospital-based cross-sectional study was conducted in Woldia Comprehensive Specialized Hospital (WCSH) from February to May 2024. It is one of the government hospitals in Ethiopia located in Woldia, a town in Amhara regional state located about 360 km to the northeast of the regional capital Bahir Dar and 521 km from Addis Ababa. The hospital serves around 3 million people in the neighbouring region and zones and acts as a referral institution for the neighbouring primary hospitals and health centres. WCSH serves as a TB diagnostic site for Woldia's population and referral service to diagnose TB for the neighbouring health institutions. The hospital uses an Xpert MTB/RIF assay as a diagnostic test and Ziehl–Neelsen staining and fluorescent microscopy examination for follow-up.

Eligibility criteria

Patients presumptive for pulmonary TB attending the TB clinic of WCSH and who volunteered to participate in the study were included. Presumptive TB patients who were not willing to participate, were unconscious or had a mental problem were excluded from the study. Presumptive TB patients are individuals showing symptoms or risk factors suggestive of TB, such as prolonged cough, fever, night sweats, weight loss or known exposure, requiring diagnostic evaluation.[18]

Study variables

The dependent variable was the prevalence of *M. tuberculosis*, diagnosed via GeneXpert MTB/RIF molecular testing of sputum samples, whereas socio-demographic factors, behavioural and clinical factors as well as war and displacement-related factors were the independent variables.

Sampling techniques and procedures

The sample size for this study was 273 presumptive TB individuals. The sample size was calculated using the single population proportion (23.2%) obtained from the previous study at Debre Markos referral hospital in northwest Ethiopia,[19] and considering a 5% margin of error and 95% CI. A convenience sample, which included all presumptive TB patients visiting the TB clinic in WCSH consecutively until the sample size was achieved, was used.

Data collection procedure and laboratory methods

Data collection

After written informed consent was obtained from study participants, a structured questionnaire prepared by the research team was used to collect the socio-demographic, behavioural, environmental, and clinical and treatment-related characteristics. The questions were presented to participants by face-to- face interview. Also, participants were instructed to bring a sputum specimen in a clean, sterile and screw-capped container.

Sample collection, processing, and laboratory methods

From each study participant presumptive for pulmonary TB, 5–10 mL of purulent sputum sample was collected and immediately processed. The samples were homogenized with buffers, and 2 mL of the homogenized sample was

Table 1. Socio-demographic, clinical and displacement-related characteristics of study participants

Socio-demographic factors	Positive		Negative		Total		*P* value
	n	%	*n*	%	*n*	%	
Age							0.287
<15	7	17.5	33	82.5	40	14.7	
15–30	13	16.5	66	83.5	79	28.9	
31–45	10	17.5	47	82.5	57	20.9	
46–60	7	11.1	56	88.9	63	23.1	
>60	10	29.4	24	70.6	34	12.5	
Sex							0.732
Male	25	18.0	114	82.0	139	50.9	
Female	22	16.4	112	83.6	134	49.1	
Educational status							0.340
No read and write	10	12.7	69	87.3	79	28.9	
Read and write	17	23.9	54	76.1	71	26.0	
Primary education	7	17.5	33	82.5	40	14.7	
Secondary education	4	10.8	33	89.2	37	13.6	
College/university and above	9	19.6	37	80.4	46	16.8	
Occupational status							0.294
Student	8	12.1	58	87.9	66	24.2	
Government employee	9	20.9	34	79.1	43	15.8	
Driver	5	38.5	8	61.5	13	4.8	
Merchant	10	19.2	42	80.8	52	19.0	
Farmer	9	12.9	61	87.1	70	25.6	
Private worker	4	26.7	11	73.3	15	5.5	
Others	2	14.3	12	85.7	14	5.1	
Family size							0.531
<3	13	17.1	63	82.9	76	27.8	
3–6	31	18.6	136	81.4	167	61.2	
>7	3	10	27	90	30	11	
Marital status							0.914
Single	17	18.1	77	81.9	94	34.4	
Married	23	16.0	121	84.0	144	52.8	
Divorced	3	17.6	14	82.4	17	6.2	
Widowed	4	22.2	14	77.8	18	6.6	
Residence							0.163
Urban	13	13	87	87	100	36.6	
Rural	34	19.7	139	80.3	173	63.4	
Family TB history							0.004
Yes	15	31.9	32	68.1	47	17.2	
No	32	14.2	194	85.8	226	82.8	
Personal TB history							0.212
Yes	7	25.9	20	74.1	27	9.9	
No	40	16.3	206	93.7	246	90.1	
Year of TB history							0.109
Before 2019	2	13.3	13	86.7	15	55.6	
After 2019	5	41.7	7	58.3	12	44.4	
Previous TB type							0.739
Pulmonary	6	27.3	16	72.7	22	81.5	
Extra-pulmonary	1	20	4	80	5	18.5	
History of contact with TB-infected persons							<0.001
No	22	11.6	168	88.4	190	69.6	
Yes	19	46.3	22	53.7	41	15.0	
Unknown	6	14.3	36	85.7	42	15.4	

Continued

Table 1. *Continued*

Socio-demographic factors	Positive		Negative		Total		*P* value
	n	%	*n*	%	*n*	%	
Alcohol user							0.049
Yes	13	27.1	35	72.9	48	17.6	
No	34	15.1	191	84.9	225	82.4	
Crowded living							0.033
Yes	25	23.4	82	76.6	107	39.2	
No	22	13.3	144	86.7	166	60.8	
Knows the signs and symptoms of TB							0.135
Yes	33	20.0	132	80.0	165	60.4	
No	14	13.0	94	87.0	108	39.6	
HIV status							0.001
Negative	27	13.2	178	86.8	205	75.1	
Positive	13	40.6	19	59.4	32	11.7	
Unknown	7	19.4	29	80.6	36	13.2	
DM status							0.510
Positive	7	24.1	22	75.9	29	10.6	
Negative	33	15.9	175	84.1	208	76.2	
Unknown	7	19.4	29	80.6	36	13.2	
Cigarette smoking							0.712
Yes	3	14.3	18	85.7	21	7.7	
No	44	17.5	208	82.5	252	92.3	
Raw milk using habit							0.095
Yes	23	22.1	81	77.9	104	38.1	
No	24	14.2	145	85.8	169	61.9	
Work in high-risk areas							0.079
Yes	24	22.2	84	77.8	108	39.6	
No	23	13.9	142	86.1	165	60.4	
Displacement history							0.002
Yes	22	28.6	55	71.4	77	28.2	
No	25	12.8	171	87.2	196	71.8	
Screening after displacement							0.205
Yes	2	14.3	12	85.7	14	18.2	
No	20	31.7	43	68.3	63	81.2	
Family TB history after displacement							0.189
Yes	5	45.5	6	54.5	11	14.3	
No	17	25.8	49	74.2	66	85.7	
Information about TB during displacement							0.297
Yes	6	21.4	22	78.6	28	36.4	
No	16	32.7	33	67.3	49	63.6	
Contact with displaced persons							<0.001
Yes	33	29.5	79	70.5	112	41.0	
No	14	8.7	147	91.3	161	59	

DM, diabetes mellitus.

placed in a cartridge. Then samples were examined for the presence of *M. tuberculosis* and RR-TB by using the GeneXpert MTB/RIF assay (Cepheid).[20]

Data analysis

Data were checked for completeness and consistency, and the Statistical Package for Social Science (SPSS) version 27 used to determine the frequency and percentage of TB and RR-TB, and analyse the associated factors. Binary logistic regression was computed to identify the association between independent and dependent variables. First binary logistic regression between each independent variable and dependent variable was computed; then, those independent variables with a *P* value <0.25 were subjected to multivariable binary logistic regression to identify independent predictors for TB. A *P* value <0.05 at a 95% CI after multivariable binary logistic regression was considered as statistically significant.

Quality control

The questionnaire was pre-tested in Woldia Health Center and the raw data were checked every day for completeness during and after data

Table 2. Logistic regression to determine factors associated with the occurrence of pulmonary tuberculosis

Factors	Positive	Negative	COR	AOR		*P* value
					95% CI	
Residence						0.966
Urban	13	87		1		
Rural	34	139	1.637	1.048	0.12–9.067	
Family TB history						
Yes	15	32	2.842	1.640	0.701–3.840	0.254
No	32	194		1		
Personal TB history						
Yes	7	20	1.802	1.138	0.408–3.177	0.805
No	40	206		1		
Year of TB history						
Before 2019	2	13		1		
After 2019	5	7	4.643	4.380	0.524–36.606	0.173
History of contact						
No	22	168		1		
Yes	19	22	6.595	5.644	2.457–12.963	<0.01
Unknown	6	36	1.273	1.223	0.452–3.308	0.692
Alcohol user						
Yes	13	35	2.087	2.093	0.931–4.708	0.74
No	34	191		1		
Crowded living						
Yes	25	82	1.996	1.756	0.878–3.512	0.111
No	22	144		1		
Knowledge of the signs and symptoms of TB						
Yes	33	132	1.679	1.210	0.164–8.939	0.852
No	14	94		1		
HIV status						
Negative	27	178		1		
Positive	13	19	4.511	3.074	1.260–7.499	0.014
Unknown	7	29	1.591	1.135	0.420–3.065	0.802
Raw milk using habit						
Yes	23	81	1.716	1.762	0.864–3.595	0.119
No	24	145		1		
Work in high-risk areas						
Yes	24	84	1.764	1.572	0.776–3.187	0.209
No	23	142		1		
Displacement history						
Yes	22	55	2.736	0.895	0.361–2.218	0.811
No	25	171		1		
Screening after displacement						
Yes	2	12	0.358	0.211	0.034–1.309	0.095
No	20	43		1		
Contact with displaced persons						
Yes	33	79	4.386	4.237	1.668–10.762	0.002
No	14	147		1		

AOR, adjusted odds ratio; COR, crude odds ratio; 1, reference category.

collection. The laboratory request forms were filled out with the patient's name, age, gender and identification number, as well as their address, collection date and time. Reagents were stored and used in accordance with manufacturers' guidelines, and equipment was calibrated regularly to ensure reliability. Positive and negative control samples were run to ensure reproducibility of results. All laboratory procedures upheld quality control by following the standard operating procedures in the detection and identification of RR-TB. The findings of the tests were analysed and reported in accordance with standard operating procedures.

Results

A total of 273 presumptive TB patients were included in this study. The demographic characteristics of the study population are summarized in Table 1. The mean age of the participants was 37.83 years, with 50.9% being male. The majority of the study participants were rural dwellers (63.4%), married (52.8%) and had a family size of 3–6 individuals (61.2%). A total of 17.2% of the patients reported a family history of previous TB infection, and 9.9% reported a personal history of TB infection; 11.7% were infected with HIV.

Prevalence of M. tuberculosis

Among the 273 presumptive TB patients, 47 were confirmed to have *M. tuberculosis*, resulting in a prevalence of 17.2%. The prevalence was higher among participants aged over 60 years (29.4%) compared with younger participants, who had a prevalence of less than 17.5%, but the association was not statistically significant at a *P* value of 0.287. In addition the prevalence was higher in participants who had been working as drivers (38.5%), and in rural residents (19.5%).

Of the 47 patients diagnosed with MTB, 17 (36.2%) were found to have RR-TB strains. The prevalence of RR-TB was notably higher in female patients (40.9%) compared with male patients (32%), and in widowed females (75%) and farmers (55.5%) (Table 1).

Associated factors of MTB

The multivariable logistic regression analysis revealed that previous contact with displaced and TB-infected individuals and being HIV positive were the significant predictors for TB. Individuals with a history of contact with TB patients were approximately 5.6 times more likely to test positive for TB compared with those without such contact [adjusted odds ratio (AOR): 5.644; 95% CI: 2.457–12.963; $P<0.01$]. Additionally, HIV-positive individuals had about 3.1 times higher odds of TB positivity compared with HIV-negative individuals (AOR: 3.074; 95% CI: 1.260–7.499; $P=0.014$). Lastly, those who had contact with displaced persons were found to be 4.2 times more likely to test positive for TB (AOR: 4.237; 95% CI: 1.668–10.762; $P=0.002$) (Table 2).

Initially the analysis showed several factors to be significantly associated with TB positivity. Family TB history, alcohol use, crowded living conditions, working in high-risk areas and displacement history were all significantly associated with TB positivity in the initial analysis. However, after multivariable analysis, these associations lost significance, indicating that their initial impact was likely influenced by confounding variables.

The analysis of socio-demographic factors showed no statistically significant associations with TB positivity across the variables studied. Age, sex, educational status, occupational status, family size, marital status and residence all had *P* values >0.05, indicating that these factors did not significantly impact TB positivity in this analysis. Notably, older adults (over 60 years) had the highest TB positivity rate (29.4%), and rural residents had a higher positivity rate (19.7%) compared with urban residents (13%), though these differences were not statistically significant. Additionally, TB positivity did not differ significantly between males and females, or across different educational and occupational groups (Table 2).

Impact of war on drug-resistant TB

In the study, the prevalence of RR-TB was found to be 36.2%. This indicates that more than one-third of the TB cases in the study population were resistant to rifampicin, a first-line anti-TB drug. Such a high prevalence suggests a substantial burden of drug-resistant TB in the population. The findings also highlight the presence of significant challenges in the control and treatment of TB, as RR-TB often signals MDR-TB, which requires more complex and prolonged treatment.

Discussion

This study assessed the prevalence of TB and RR-TB among 273 presumptive TB patients in war-affected areas of northeast Ethiopia in 2024. The prevalence of TB was found to be 17.2%, with 36.2% of these cases exhibiting rifampicin resistance. Significant predictors of TB positivity included previous contact with displaced individuals and TB-infected individuals, as well as being HIV positive. Although several socio-demographic factors showed initial associations with TB positivity in the bivariate analysis, these associations did not remain significant in the multivariable analysis, suggesting potential confounding effects.

The prevalence of TB in this study was 17.2%, and the prevalence of rifampicin resistance among the TB cases was 36.2%. The prevalence of TB in this study is similar to a study conducted in war-affected areas of Afghanistan (17.6%),[21] whereas the prevalence in different settings not affected by war ranges from 15.1% to 16.5%.[22–24]

The magnitude of TB in this study is higher than that found in a systematic review and meta-analysis conducted among key vulnerable populations and homeless individuals in Ethiopia, with a prevalence of 11.7% and 5.8%, respectively,[25] and among refugees in Brazil and Syria, with a prevalence of 3.07% and 11%, respectively.[26,27] However, the prevalence of TB is lower compared with a systematic review conducted among refugees in Ethiopia, at 28.4%,[25] and a single study in northern Ethiopia with a prevalence of 37%.[28] These disparities suggest that the ongoing conflict in northeast Ethiopia may have exacerbated TB transmission, potentially due to disrupted healthcare services, poor living conditions, and increased vulnerability among the population.[14] However, the lower prevalence might be because the systematic review and meta-analysis were conducted exclusively among refugee camps in Ethiopia, which might increase the prevalence compared with our study, which includes the general population but not refugees. In addition the method of diagnosis—either molecular techniques alone or molecular techniques along with culture—may affect the magnitude.

The high prevalence of both TB and RR-TB in this study highlights the urgent need for targeted interventions in war-affected areas, including strengthening TB diagnostic and treatment services, addressing the social determinants of health exacerbated by conflict, and implementing robust infection control measures. The prevalence of RR-TB obtained from this study is notably higher than the prevalence rates reported in several other studies conducted in non–war-affected regions and among different populations in Ethiopia, which range from 3.5% to 15.8%.[19,22–24,28–30] In addition to studies conducted in Ethiopia, the prevalence of RR-TB in this study is also higher than studies conducted abroad such as in Nigeria (12.1%).[31] The high prevalence of RR-TB in this study is alarming and highlights the urgent need for enhanced drug resistance surveillance and management strategies in conflict-affected areas. RR-TB poses significant challenges to treatment, requiring more prolonged and toxic drug regimens, which are difficult to implement in unstable settings. Strengthening TB control programmes by ensuring uninterrupted supply chains for TB medications, expanding access to rapid diagnostic tools like GeneXpert, and implementing targeted interventions for high-risk populations are imperative to mitigate the spread of drug-resistant TB.

Our findings indicate that HIV-positive individuals are approximately three times more likely to test positive for TB (AOR: 3.074), highlighting the synergistic relationship between HIV and TB.[32,33] Additionally, conflict, which disrupts healthcare facilities and access to medications, further exacerbates the TB burden, complicating ART adherence and treatment. HIV compromises the immune system, increasing susceptibility to TB infection and progression from latent to active disease. In conflict zones, access to ART may be limited, further exacerbating this vulnerability. Additionally, individuals who had contact with displaced persons were 4.2 times more likely to test positive for TB (AOR: 4.237). Displacement often leads to overcrowded living conditions, inadequate nutrition and limited access to healthcare, all of which are risk factors for TB transmission and progression.

Strengths and limitations

This study has notable strengths, including its focus on a vulnerable population in war-affected regions where data on TB are often scarce, providing valuable insights into TB dynamics in these settings. Additionally, the use of molecular diagnostics, specifically the GeneXpert system for detecting RR, enhances the accuracy of the diagnostic results. However, the study has limitations, particularly its cross-sectional design, which restricts the ability to establish causal relationships between the associated factors and TB positivity. Additionally, the lack of comprehensive, countrywide data limits the generalizability of the findings. Future research should focus on nationwide prevalence studies, comparative analyses to identify factors influencing TB, molecular epidemiology to explore strain diversity, and investigations into XDR TB for better-informed interventions.

Conclusion

This study highlights a substantial burden of TB and RR-TB among presumptive TB patients in war-affected areas of northeast Ethiopia. The prevalence of RR-TB in the study area was substantially higher compared to reports from regions of the country not affected by war, which shows the impact of war and displacement on health services, including access to medication. Significant associations with contact with TB-infected individuals, HIV positivity and contact with displaced persons underscore the complex interplay of social, economic and health factors exacerbated by conflict. Addressing these challenges requires a multifaceted approach that integrates TB and HIV services, enhances drug resistance surveillance and ensures the continuity of healthcare services even in unstable environments. Strengthening public health infrastructure and targeted interventions in conflict zones are crucial to controlling the spread of TB and preventing the rise of drug-resistant strains. This study explores the high burden of RR-TB, which may be exacerbated by the discontinuation of treatment and limited access to medications, often intensified by the impact of war and displacement.

Intervention-based studies are needed to evaluate the effectiveness of TB control measures, such as mobile clinics or community-based treatment programmes, in displaced populations. Exploring the impact of nutritional support and mental health services on TB outcomes in war-affected areas could also provide valuable insights.

Acknowledgements

Special thanks go to the study participants for their cooperation. We would also like to acknowledge Woldia University, WCSH and healthcare professionals for material and professional support for this study.

A permission letter from Woldia University College of Health Science, Department of Medical Laboratory Science and WCSH administration was obtained to conduct this research. Before starting data collection, permission was obtained from the Hospital administration. Furthermore, during the data collection, informed consent was obtained from each respondent by explaining the objectives of the study in brief. For study participants aged less than 16 years, assent from guardians or parents was obtained taken. Identifiers like names and codes were not taken in the questionnaire to maintain confidentiality.

Funding

This research work was not funded by any organization or individual.

Transparency declarations

The authors declare that they have no competing interests.

Author contributions

A.A., A.B., A.M. and D.A. designed the study, performed the laboratory work and statistical analysis, and participated in manuscript preparation. Z.A. and Y.G. designed the study, supervised the laboratory work, guided the statistical analysis, interpreted the data, and prepared and critically edited the manuscript. All authors reviewed the final manuscript.

Data availability

All data generated or analysed during this study are included in this manuscript.

References

1 WHO. Tuberculosis. 2024. https://www.who.int/news-room/fact-sheets/detail/tuberculosis

2 WHO. Global Tuberculosis Report 2023. https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2023

3 Bloom BR, Atun R, Cohen T *et al*. Tuberculosis. In: Holmes KK, Bertozzi S, Bloom BR *et al*. eds. *Major Infectious Diseases*. 3rd edn. The International Bank for Reconstruction and Development/The World Bank, 2017; 233–15.

4 CDC. About Drug-Resistant Tuberculosis Disease. 2023. https://www.cdc.gov/tb/about/drug-resistant.html#:~:text=Multidrug%2Dresistant%20TB%20disease%20(MDR,resistant%20TB%20(XDR%20TB)

5 Malenfant JH, Brewer TF. Rifampicin mono-resistant tuberculosis—a review of an uncommon but growing challenge for global tuberculosis control. *Open Forum Infect Dis* 2021; **8**: ofab018. https://doi.org/10.1093/ofid/ofab018

6 Prasad R, Gupta N, Banka A. Multidrug-resistant tuberculosis/rifampicin-resistant tuberculosis: principles of management. *Lung India* 2018; **35**: 78–81. https://doi.org/10.4103/lungindia.lungindia_98_17

7 Kimbrough W, Saliba V, Dahab M *et al.* The burden of tuberculosis in crisis-affected populations: a systematic review. *Lancet Infect Dis* 2012; **12**: 950–65. https://doi.org/10.1016/S1473-3099(12)70225-6

8 Ismail MB, Rafei R, Dabboussi F *et al.* Tuberculosis, war, and refugees: spotlight on the Syrian humanitarian crisis. *PLoS Pathog* 2018; **14**: e1007014. https://doi.org/10.1371/journal.ppat.1007014

9 Spiegel PB, Checchi F, Colombo S *et al.* Health-care needs of people affected by conflict: future trends and changing frameworks. *Lancet* 2010; **375**: 341–5. https://doi.org/10.1016/S0140-6736(09)61873-0

10 Narasimhan P, Wood J, MacIntyre CR *et al.* Risk factors for tuberculosis. *Pulm Med* 2013; **2013**: 828939. https://doi.org/10.1155/2013/828939

11 Essue BM, Laba M, Knaul F *et al.* Economic burden of chronic ill health and injuries for households in low- and middle-income countries. In: Jamison DT, Gelband H, Horton S *et al.* eds. *Disease Control Priorities: Improving Health and Reducing Poverty*. 3rd edn. The International Bank for Reconstruction and Development/The World Bank, 2018; 121–43.

12 Abbink G. *The Politics of Conflict in Northern Ethiopia, 2020-2021: A Study of War-Making, Media Bias and Policy Struggle*. ASCL, 2021.

13 Kassa MA, Anbesaw T, Nakie G *et al.* Investigating war trauma, its effects, and associated risk factors on anxiety among high school students in Woldia town, northeast Ethiopia, 2022. *Front Psychiatry* 2024; **15**: 1368285. https://doi.org/10.3389/fpsyt.2024.1368285

14 Mesfin B, Mersha Demise A, Shiferaw M *et al.* The effect of armed conflict on treatment interruption, its outcome and associated factors among chronic disease patients in North East, Amhara, Ethiopia, 2022. *Patient Relat Outcome Meas* 2023; **14**: 243–51. https://doi.org/10.2147/PROM.S388426

15 FMOH. National guideline for TB, DR-TB and Leprosy in Ethiopia. 2017. https://www.afro.who.int/sites/default/files/2019-04/Ethiopia-National%20guidelines%20for%20TB%2C%20DR-TB%20and%20Leprosy%20in%20Ethiopia%20-%20Sixth%20Edition.pdf

16 Deribew A, Deribe K, Dejene T *et al.* Tuberculosis burden in Ethiopia from 1990 to 2016: evidence from the global burden of diseases 2016 study. *Ethiop J Health Sci* 2018; **28**: 519–28. https://doi.org/10.4314/ejhs.v28i5.2

17 Assebe LF, Negussie EK, Jbaily A *et al.* Financial burden of HIV and TB among patients in Ethiopia: a cross-sectional survey. *BMJ Open* 2020; **10**: e036892. https://doi.org/10.1136/bmjopen-2020-036892

18 Lyon SM, Rossman MD. Pulmonary tuberculosis. *Microbiol Spectr* 2017; **5**: 1–13. https://doi.org/10.1128/microbiolspec.TNMI7-0032-2016

19 Mulu W, Abera B, Yimer M *et al.* Rifampicin-resistance pattern of *Mycobacterium tuberculosis* and associated factors among presumptive tuberculosis patients referred to Debre Markos referral hospital, Ethiopia: a cross-sectional study. *BMC Res Notes* 2017; **10**: 8. https://doi.org/10.1186/s13104-016-2328-4

20 CDC. Xpert MTB/RIF Assay. 2024. https://www.cdc.gov/tb/php/laboratory-information/xpert-mtb-rif-assay.html

21 Qader G, Seddiq MK, Rashidi KM *et al.* Prevalence of tuberculosis among mentally ill patients in conflict-stricken Afghanistan: a cross-sectional study. *Int J Infect Dis* 2019; **89**: 45–50. https://doi.org/10.1016/j.ijid.2019.08.020

22 Arega B, Menbere F, Getachew Y. Prevalence of rifampicin resistant *Mycobacterium tuberculosis* among presumptive tuberculosis patients in selected governmental hospitals in Addis Ababa, Ethiopia. *BMC Infect Dis* 2019; **19**: 307. https://doi.org/10.1186/s12879-019-3943-1

23 Hordofa MW, Adela TB. Prevalence of rifampicin mono resistant *Mycobacterium tuberculosis* among suspected cases attending at Yirgalem hospital. *Clin Med Res* 2015; **4**: 75–8. https://doi.org/10.11648/j.cmr.20150403.13

24 Geleta DA, Megerssa YC, Gudeta AN *et al.* Xpert MTB/RIF assay for diagnosis of pulmonary tuberculosis in sputum specimens in remote health care facility. *BMC Microbiol* 2015; **15**: 220. https://doi.org/10.1186/s12866-015-0566-6

25 Reta MA, Asmare Z, Sisay A *et al.* Prevalence of pulmonary tuberculosis among key and vulnerable populations in hotspot settings of Ethiopia. A systematic review and meta-analysis. *PLoS One* 2024; **19**: e0309445. https://doi.org/10.1371/journal.pone.0309445

26 Jezus SV, Sales CMM, Rissino SDD *et al.* Prevalence of tuberculosis, COVID-19, chronic conditions and vulnerabilities among migrants and refugees: an electronic survey. *Rev Lat Am Enfermagem* 2023; **31**: e3690. https://doi.org/10.1590/1518-8345.5928.3690

27 Eiset AH, Wejse C. Review of infectious diseases in refugees and asylum seekers—current status and going forward. *Public Health Rev* 2017; **38**: 22. https://doi.org/10.1186/s40985-017-0065-4

28 Mehari K, Asmelash T, Hailekiros H *et al.* Prevalence and factors associated with multidrug-resistant tuberculosis (MDR-TB) among presumptive MDR-TB patients in Tigray region, Northern Ethiopia. *Can J Infect Dis Med Microbiol* 2019; **2019**: 2923549. https://doi.org/10.1155/2019/2923549

29 Jaleta KN, Gizachew M, Gelaw B *et al.* Rifampicin-resistant *Mycobacterium tuberculosis* among tuberculosis-presumptive cases at University of Gondar Hospital, northwest Ethiopia. *Infect Drug Resist* 2017; **10**: 185–92. https://doi.org/10.2147/IDR.S135935

30 Reta MA, Tamene BA, Abate BB *et al.* *Mycobacterium tuberculosis* drug resistance in Ethiopia: an updated systematic review and meta-analysis. *Trop Med Infect Dis* 2022; **7**: 300. https://doi.org/10.3390/tropicalmed7100300

31 Audu ES, Gambo MS, Yakubu AA. Rifampicin resistant *Mycobacterium tuberculosis* in Nasarawa state, Nigeria. *Niger J Basic Clin Sci* 2017; **14**: 21–5. https://doi.org/10.4103/0331-8540.204075

32 Legesse T, Admenur G, Gebregzabher S *et al.* Tuberculosis (TB) in the refugee camps in Ethiopia: trends of case notification, profile, and treatment outcomes, 2014 to 2017. *BMC Infect Dis* 2021; **21**: 139. https://doi.org/10.1186/s12879-021-05828-y

33 Duarte R, Lönnroth K, Carvalho C *et al.* Tuberculosis, social determinants and co-morbidities (including HIV). *Pulmonology* 2018; **24**: 115–9. https://doi.org/10.1016/j.rppnen.2017.11.003