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Clinicoepidemiologic considerations in the diagnosis of tuberculous lymphadenitis: evidence from a high burden country

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ABSTRACT

Objectives: Tuberculosis is the biggest health issue worldwide, with tuberculous lymphadenitis (TBL) being its most common extrapulmonary manifestation. Clinical diagnoses of TBL often pose challenges; thus, this study aimed to analyze the clinical, epidemiologic, and laboratory aspects of TBL in Debre Markos Specialized Comprehensive Hospital, northwest Ethiopia.

Methods: The study was conducted at Debre Markos Specialized Comprehensive Hospital from October 2019 to March 2021. Patients with lymphadenitis displaying cytomorphologic features of tuberculosis were enrolled. A checklist was used to collect clinicodemographic data.

Results: Among a total of 294 patients with TBL, 237 (80.61%) were adults aged 15–45 years. A fluctuant consistency (177; 60.20%; n = 294) with predominant involvement of cervical lymph nodes (229; 77.8%) was the most frequent presentation. Most patients did not have either HIV infection (235; 94.37%; n = 261) or known chronic medical illnesses (250; 95.8%). Constitutional symptoms (113; 41.85%; n = 270) and chronic cough (56; 20.74%; n = 270) were infrequent. The erythrocyte sedimentation rate (ESR) was increased in the majority of patients (133; 80%; n = 165), of whom extreme elevation (≥ 100 mm/hour) seen in 63 (38.18 %) patients and the mean ESR for our participants was 78.64 mm/hour.

Conclusion: TBL typically presents as a fluctuant neck mass, predominantly in young adults. The majority of patients have no constitutional symptoms or cough. HIV infection or chronic medical illnesses are uncommon. The raised erythrocyte sedimentation rate is a fairly consistent finding.

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Introduction

Tuberculosis (TB) is a communicable disease, placed as one of the top 10 causes of mortality worldwide and the leading cause of death caused by a single infectious agent (ranked ahead of HIV/AIDS). In 2019, an estimated 10 million individuals worldwide contracted TB, from which 5.6 million males, 3.2 million women, and 1.2 million children comprise the population (Chakaya *et al.*, 2021). According to World Health Organization (2020) report, Ethiopia is among the 30 high TB burden countries in the world.

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Despite efforts made by the international community, targeting to end the worldwide TB epidemic by 2030, the TB burden still remains high (Lönnroth and Raviglione, 2016).

Tuberculous lymphadenitis (TBL) is a chronic specific granulomatous inflammation that causes necrosis in a lymph node (LN) (Brizi *et al.*, 1998). It is the most common clinical presentation of extrapulmonary TB (EPTB), which most frequently involve the cervical LNs, followed by mediastinal, axillary, and mesenteric LNs (Nayak *et al.*, 2003).

The World Health Organization estimates that the proportion of EPTB among the total number of new TB cases is about 36.6%. Ethiopia ranks third in the number of EPTB cases worldwide, most of which are TBL (World Health Organization, 2020).

In Ethiopia, EPTB accounted for 34.8% of TB cases, with TBL being the most common type (80%) (Biadglegne *et al.*, 2013). This is in contrast to the proportion of EPTB in other high TB burden Asian

nations, such as India (14.9%), China (4%), and Indonesia (2.5%), as well as African countries like Nigeria (4.3%) (World Health Organization, 2020).

Fine-needle aspiration cytology (FNAC) technique remains a cheap and effective method for the diagnosis of TBL because it provides reliable cytomorphological features with clearly defined sufficient criteria (Saboorian and Ashfaq, 2001; Sulaiman *et al.*, 2010).

The clinical diagnosis of TBL in suspected cases may be difficult due to atypical and diverse presentations, and a definitive diagnosis needs microbiological, cytopathological, histopathological, and molecular methods, all of which may be costly and associated with diagnostic delay (Ahasan *et al.*, 2016; Golden and Vikram, 2005; Zeka *et al.*, 2011). For timely and appropriate diagnoses of TBL, clinicians in resource-scarce areas strongly rely on the supporting clinical and laboratory findings. Hence, this study aimed to investigate the epidemiologic, clinical, and laboratory aspects of TBL in one of the high TB burden regions of Ethiopia.

Material and methods

Study area and period

The study was conducted in Debre Markos Specialized Comprehensive Hospital (DMSCH), which is found in Debre Markos town, Amhara regional state, in the northwestern part of Ethiopia. DMSCH is a teaching university hospital serving an estimated 3.5 million patients.

The pathology department is one of the major units in DMSCH that has an estimated annual flow of 7000 cases. It is the unit where this research was carried out from October 2019 to March 2021.

Populations

Source population: all patients with lymphadenitis who presented to the cytopathology department.

Study population: patients with lymphadenitis who displayed cytomorphologic evidence of TB during the study period.

Sample size and sample technique

All the patients who came within the study period and fulfilled the inclusion criteria were included in this study.

Inclusion and exclusion criteria

Inclusion criteria: all patients with lymphadenitis who presented to the cytopathology department during the study period, showing cytomorphologic features of TB.

Exclusion criteria: patients on anti-TB treatment at the time of the LN aspiration were excluded from the study.

Study design: a cross-sectional study design with prospective data collection was used.

Data collection instrument

Recruitment of study participants and data collection: clients with suspected TBL were subjected to FNAC, from which only those cases which showed the cytomorphologic features of TB were recruited, and a structured questionnaire was used to assess the sociodemographic and clinical information. Moreover, a medical record review was made to collect relevant laboratory and radiologic results.

FNAC sample collection and processing: at the DMSCH Pathology Department, after receiving written informed consent, the FNAC of LN was performed as follows (Kocjan, 2006): first, the

FNAC was done on enlarged peripheral LN using a sterile 21-gauge needle. The overlying area was cleaned with 70% alcohol. Then, the target LN was immobilized with one hand, and the needle was carefully introduced into the lesion by developing a negative pressure in the syringe. At least six in and out passes were made by the needle without exiting the node. After removing the needle, two drops of aspirate were placed on three clean slides for cytomorphologic evaluation. The FNAC smears were prepared on clean slides on the spot. The slides were air dried and flooded with freshly filtered Weltered Wright stain and buffered with clean tap water. The buffered slides were then continuously stained with Wright stain for 10 minutes and with tap water, and air dried.

Finally, the slides were examined by pathologists to evaluate for the presence of the following cytomorphologic features of TBL: epithelioid cell aggregate with or without Langerhans giant cells and necrosis, epithelioid cell aggregate without necrosis, necrosis without epithelioid cell aggregate, or polymorphocytes with necrosis.

Data collector: a pathologist and three technical assistants participated in the data collection and preparation process.

Statistical analysis

After the data collection was completed, data were coded, edited, and entered into Epidata version 3.1. The statistical analysis was conducted using statistical software (STATA 14.1). Description of results was done using frequency, percentage, tables, and graphs. The chi-square test was conducted to look into the relationship of various independent variables with dependent variables.

Data quality control

The data collection was conducted by a well-trained and experienced senior pathologist, medical laboratory technicians, and technical assistants. On-the-spot supervision was done by the principal investigator, using a checklist and monitoring sheet to ensure the completeness of the information. Laboratory investigation was conducted as per the standard operating procedure manual, and the data collection instrument was pretested and checked for its validity.

Results

A total of 294 patients with cytomorphologic diagnoses of TBL using the FNAC method were enrolled in this study. Most of the participants (237; 80.61%) were under the age of 45 years. A vast majority (241; 82.25%) were from rural areas, and the female-to-male ratio in our study participants was 1.25: 1.

The most common sites of LN involvement by TB were found to be the cervical LNs (229; 77.89%), followed by axillary LNs (35; 11.90%), and generalized LN involvements were identified in about 11 (3.74%) cases. Over half (177; 60.2%) of the LNs were fluctuant in consistency, and approximately one-fourth of the participants (72; 24.49%) had sinus tract formation. Although more than half (161; 54.76%) of the patients took antibiotics within 2 weeks before their hospital visit, only 16 (5.44%) had a history of anti-TB medications.

Among our study participants, most (221; 75.17%) had no contact history with known patients with TB, and only a few (11; 3.74%) were found to have a chronic medical illness. Of the 249 subjects tested for HIV, 14 (5.6%) were found to be HIV-positive. In this study, we have found that most of the patients (157; 53.4%) and 214 (72.79%) had no constitutional symptoms and cough, respectively.

The mean erythrocyte sedimentation rate (ESR) for all our participants was 78.64 mm/hour. Raised ESR was seen in 133 (80.6%) patients. Although 29 (17.6%) patients had mild ESR elevation

Table 1
Characteristics of patients presented with TBL at Debre Markos Specialized Comprehensive Hospital (2021) (n = 294).

Sociodemographic characteristics		Frequency	Percent
Age	<15	23	7.82
	15-30	140	47.62
	31-45	74	25.17
	46-60	43	14.63
Sex	Male	131	44.56
	Female	163	55.44
Residence	Urban	52	17.75
	Rural	241	82.25
	Clinical characteristics of TBL		
Distribution pattern of TBL	Generalized	11	3.74
	Cervical	229	77.89
	Axillary	35	11.90
	Inguinal	6	2.04
	Others	13	4.42
Consistency of affected lymph node	Firm	117	39.80
	Fluctuant	177	60.20
Presence of sinus tract	Yes	72	24.49
	No	222	75.51
Constitutional symptoms	Present	113	38.44
	Absent	157	53.40
	Unknown	24	8.16
Cough	Present	56	19.05
	Absent	214	72.79
	Unknown	24	8.16
Medical history			
History of antibiotic treatment	Present	161	54.76
	Absent	60	20.41
	Unknown	73	24.83
History of anti-TB treatment	Present	16	5.44
	Absent	222	75.51
	Unknown	56	19.05
Contact with TB patient	Present	18	6.12
	Absent	221	75.17
	Unknown	55	18.71
Chronic medical illness	Present	11	3.74
	Absent	250	85.03
	Unknown	33	11.22
Investigation findings			
Chest X-ray finding (n=93)	Suggests Pulmonary TB	10	10.75
	Not pulmonary TB	83	89.25
HIV Test (n=249)	Positive	14	5.62
	Negative	235	94.38
Erythrocyte sedimentation rate (n=165)	Normal	32	19.39
	Raised	133	80.61

TB, Tuberculosis; TBL, Tuberculous lymphadenitis.

(ranging from 20-49 mm/hour for females and 15-49 mm/h for males), 42 (25.5%) and 63 (38.2%) patients had moderate (50-99 mm/hour) and extreme (>100 mm/hour) elevation of ESR, respectively. To assess factors associated with ESR, chi-square testing was done, and no statistically significant difference in mean ESR values was seen between age groups, distribution pattern, HIV status, and presence of constitutional symptoms.

The chest X-ray finding was suggestive of pulmonary TB (PTB) in around 10 (10.75 %) patients (Table 1).

After the chi-square tests were conducted, age was the only variable that was found to be significantly related to the distribution of TBL (Table 2).

Discussion

In this facility-based cross-sectional study conducted in Debre Markos Comprehensive Specialized Hospital, we investigated the clinical characteristics and possible associated factors among patients with a cytomorphologic diagnosis of TBL. Among 294 study participants, the majority of them were young adults (aged 15-45 years); this finding is in agreement with other studies (Mathiasen et al., 2019a, 2020; Muluye et al., 2013). This finding

Table 2
Chi-square test of respondent's characteristics with consistency and distribution of TB lymphadenitis (n=294).

Sociodemographic characteristics	Consistency (firm or fluctuant)	Distribution (cervical or noncervical)
Age	Chi ² = 1.3332 P-value = 0.856	Chi ² = 9.9077 P-value = 0.042
Sex	Chi ² = 1.5139 P-value = 0.219	Chi ² = 1.3033 P-value = 0.254
Residence	Chi ² = 0.0054 P-value = 0.941	Chi ² = 1.6932 P-value = 0.193
Medical history		
History of antibiotic treatment	Chi ² = 0.3191 P-value = 0.853	Chi ² = 1.5605 P-value = 0.458
History of anti-TB treatment	Chi ² = 1.4879 P-value = 0.475	Chi ² = 2.9893 P-value = 0.224
Contact with TB patient	Chi ² = 3.2327 P-value = 0.199	Chi ² = 3.2642 P-value = 0.196
Chronic medical illness	Chi ² = 2.1491 P-value = 0.341	Chi ² = 2.2547 P-value = 0.324
Investigation findings		
Chest X-ray finding (n=93)	Chi ² = 3.5881 P-value = 0.166	Chi ² = 1.1944 P-value = 0.550
HIV Test (n=249)	Chi ² = 2.0891 P-value = 0.352	Chi ² = 1.3550 P-value = 0.508
Erythrocyte sedimentation rate (n=165)	Chi ² = 1.2664 P-value = 0.260	Chi ² = 0.1212 P-value = 0.728

TB, Tuberculosis.

may challenge the previous thought of increased incidence of TB among elderlies and infants (Schaff et al., 2010).

The vast majority of our patients with TBL came from rural areas, and this high prevalence is supported by other studies conducted in Bangladesh and Ethiopia (Biadlegne et al., 2013; Kamal et al., 2016; Zenebe et al., 2021), suggesting the possibility of zoonotic transmission because close contact with domestic animals and the habit of raw milk ingestion are more commonly seen in rural settings (Gumi et al., 2012). Similar to other studies (Abebe et al., 2012; Fontanilla et al., 2011; Mekonnen et al., 2019; Taye et al., 2021), most of the patients were female, which can be explained by the immunologic (Bothamley, 1998), social (Kamal et al., 2016), and smoking status (Chiang et al., 2007) variations.

Cervical LNs are the most common site of involvement (77.89%); this finding is in agreement with other studies (Mathiasen et al., 2020; Mekonnen et al., 2019; Neelakantan et al., 2013), partly explained by the lymphohematogenous spread of PTB (Kent, 1967) and the hyper-reaction of LNs against previous PTB (Schlossberg, 2020). Most of the LNs in our patients with TBL presented as fluctuant swelling, in contrast to the predominant firm consistency seen in other studies (Bothamley, 1998). This could be explained by the delayed arrival of patients to the health facility (Mathiasen et al., 2019b), resulting in the late “Jones and Campbell stage” of the disease (Gandhare and Mahashur, 2017).

Around 5% of our study participants had a history of anti-TB treatment, which is lower in prevalence than the 9.1% (Metaferia et al., 2018) and 12% (Mekonnen et al., 2019) findings in other studies conducted in Africa. Among our study participants, only a quarter of patients had contact with known or suspected patients with TB, and this is similar to other studies conducted in Ethiopia (Berg et al., 2015; Zenebe et al., 2021). This might signify looking for non-airborne transmission dynamics.

In contrast to other study findings (Mathiasen et al., 2020; Metaferia et al., 2018; Taye et al., 2021), we have found a very low level of comorbidity with other chronic medical illnesses in our patients with TBL. The HIV positivity rate in patients with TBL was 5.6%, which is consistent with another study conducted in Denmark (Mathiasen et al., 2020).

In this study, constitutional symptoms were seen in nearly half of the cases, which are slightly lower than findings in other studies (Gupta and Bhake, 2017; Mathiasen et al., 2020). Nearly 27% of patients complained of cough of more than 2 weeks duration, which is similar to a finding in another study (Mekonnen et al., 2019); however, this finding is higher than in another study conducted in Northern Ethiopia (Biadlegne et al., 2013).

The radiologic suggestion of PTB was made in only 10.75%, which is significantly lower than the findings in Germany (Singh et al., 2011). This may suggest the occurrence of tubercular lymphadenitis through direct exposure to infection rather than an extension from pulmonary focus (Deveci et al., 2016). ESR elevation was noted in about 80%, which is similar to the 75% findings in Germany (Singh et al., 2011), of which extreme ESR elevation of ≥ 100 mm/hour was seen in about half of the patients. The mean ESR of all our participants was 78.64 mm/hour. No statistically significant difference in mean ESR values was seen between age groups, distribution pattern, HIV status, and the presence of constitutional symptoms.

Conclusion

In this study, we described the clinicoepidemiologic characteristics of TBL. Our findings outlined that TBL was most common among young adults residing in rural areas. Cervical LN involvement and fluctuant consistency were the most frequent pattern of presentation. Constitutional symptoms were infrequent among patients with TBL. Chronic cough and radiologic findings of PTB were uncommon. Most patients with TBL had neither contact with known patients with TB nor a history of anti-TB treatment. The majority of patients showed raised ESRI; one-third of whom displayed an extreme elevation of ≥ 100 mm/hour. Comorbidity with HIV and other chronic medical illnesses was rare in patients with TBL.

In summary, this study highlighted that fluctuant swellings on the neck, especially in young adults aged 15–30 years, should elicit strong suspicion of TBL, even in the absence of constitutional symptoms. ESR elevations strongly complement the diagnosis of TBL. The rare occurrence of chronic cough and radiologic features of PTB as well as the paucity of contact history with PTB, suggest the possibility of nonairborne transmission for TBL. The lower prevalence of HIV and other chronic medical illnesses in our patients may hint at the presence of other predisposing factors.

Recommendation

The authors recommend that health professionals in high TB burden countries to have a high degree of suspicion of TBL even in the absence of constitutional symptoms or known predisposing factors and to incorporate ESR evaluation as a diagnostic adjunct. The authors would like to suggest researchers to further investigate the transmission patterns and predisposing factors of TBL.

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Ethical approval and informed consent

This study has been approved by the Research Ethical Review Committee of the School of Medicine, Debre Markos University (S/R/C/44/08/12). Before the main data collection, written informed consent was acquired after the studies were well explained. The laboratory procedure done with the essence of beneficence and the data were kept confidential.

Author contributions

WA, TE, YS, and BM conceived the study, conducted data analysis, and designed and wrote the manuscript for publication. All the authors critically read and approved the final manuscript.

Consent for publication

Not applicable.

Availability of data and materials

Supporting data for the current study are available from the corresponding author on reasonable request.

Declaration of Competing Interest

The authors have no competing interests to declare.

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References

- Abebe G, Deribew A, Apers L, Abdissa A, Deribie F, Woldemichael K, et al. Tuberculosis lymphadenitis in Southwest Ethiopia: a community based cross-sectional study. *BMC Public Health* 2012;12:504.
- Ahasan HN, Bala CS. Hurdles in management of extra pulmonary tuberculosis. *J Bangladesh Coll Phys Surg* 2016;34:182–3.
- Berg S, Schelling E, Hailu E, Firdessa R, Gumi B, Erenso G, Hussein J, et al. Investigation of the high rates of extrapulmonary tuberculosis in Ethiopia reveals no single driving factor and minimal evidence for zoonotic transmission of *Mycobacterium bovis* infection. *BMC Infect Dis* 2015;15:112.
- Biadlegne F, Tesfaye W, Sack U, Rodloff AC. Tuberculous lymphadenitis in Northern Ethiopia: in a public health and microbiological perspectives. *PLoS One* 2013;8:e81918.
- Bothamley GH. Genetics and tuberculosis. *Thorax* 1998;1998. doi:10.1136/thx.53.12.1094a.
- Brizi MG, Celi G, Scaldazza AV, Barbaro B. Diagnostic imaging of abdominal tuberculosis: gastrointestinal tract, peritoneum, lymph nodes. *Rays* 1998;23:115–25.
- Chakaya J, Khan M, Ntoumi F, Aklilu E, Fatima R, Mwaba P, et al. Global tuberculosis Report 2020 - Reflections on the Global TB burden, treatment and prevention efforts. *Int J Infect Dis* 2021;113:S7–S12.
- Chiang C, Slama K, Enarson D. Associations between tobacco and tuberculosis. *Int J Tuberc Lung Dis* 2007;11:258–62.
- Deveci HS, Kule M, Kule ZA, Habesoglu TE. Diagnostic challenges in cervical tuberculous lymphadenitis: a review. *North Clin Istanbul* 2016;3:150–5.
- Fontanilla JM, Barnes A, Von Reyn CF. Current diagnosis and management of peripheral tuberculous lymphadenitis. *Clin Infect Dis* 2011;53:555–62.
- Gandhare A, Mahashur A. Tuberculosis of the lymph nodes: many facets, many hues. *Astrocyte* 2017;4:80.
- Golden MP, Vikram HR. Extrapulmonary tuberculosis: an overview. *Am Fam Physician* 2005;72:1761–8.
- Gumi B, Schelling E, Berg S, Firdessa R, Erenso G, Mekonnen W, et al. Zoonotic transmission of tuberculosis between pastoralists and their livestock in South-East Ethiopia. *EcoHealth* 2012;9:139–49.
- Gupta V, Bhake A. Clinical and cytological features in diagnosis of peripheral tubercular lymphadenitis - a hospital-based study from central India. *Indian J Tuberc* 2017;64:309–13.
- Kamal MS, Hoque MH, Chowdhury FR, Farzana R. Cervical tuberculous lymphadenitis: clinico-demographic profiles of patients in a secondary level hospital of Bangladesh. *Pak J Med Sci* 2016;32:608–12.
- Kent DC. Tuberculous lymphadenitis: not a localized disease process. *Am J Med Sci* 1967;254:866–74.
- Kocjan G. Fine needle aspiration cytology: diagnostic principles and dilemmas. New York: Springer Science & Business Media; 2006.
- Lönnroth K, Raviglione M. The WHO's new End TB Strategy in the post-2015 era of the Sustainable Development Goals. *Trans R Soc Trop Med Hyg* 2016;110:148–50.
- Mathiasen VD, Eiset AH, Andersen PH, Wejse C, Lillebaek T. Epidemiology of tuberculous lymphadenitis in Denmark: a nationwide register-based study. *PLoS One* 2019a;14.
- Mathiasen VD, Hansen AK, Eiset AH, Lillebaek T, Wejse C. Delays in the diagnosis and treatment of tuberculous lymphadenitis in low-incidence countries: a systematic review. *Respiration* 2019b;97:576–84.

- Mathiasen VD, Andersen PH, Johansen IS, Lillebaek T, Wejse C. Clinical features of tuberculous lymphadenitis in a low-incidence country. *Int J Infect Dis* 2020;98:366–71.
- Mekonnen D, Derbie A, Abeje A, Shumet A, Nibret E, Biadlegne F, et al. Epidemiology of tuberculous lymphadenitis in Africa: a systematic review and meta-analysis. *PLoS One* 2019;14.
- Metaferia Y, Seid A, Fenta GM, Gebretsadik D. Assessment of extrapulmonary tuberculosis using gene Xpert MTB/RIF assay and fluorescent microscopy and its risk factors at Dessie referral hospital, Northeast Ethiopia. *BioMed Res Int* 2018;2018.
- Muluye D, Biadgo B, Woldegerima E, Ambachew A. Prevalence of tuberculous lymphadenitis in gondar university hospital, Northwest Ethiopia. *BMC Public Health* 2013;13:435.
- Nayak S, Mani R, Kavatkari AN, Puranik SC, Holla VV. Fine-needle aspiration cytology in lymphadenopathy of HIV-positive patients. *Diagn Cytopathol* 2003;29:146–8.
- Neelakantan S, Nair PP, Emmanuel RV, Agrawal K. Diversities in presentations of extrapulmonary tuberculosis. *BMJ Case Rep* 2013 2013.
- Saboorian MH, Ashfaq R. The use of fine needle aspiration biopsy in the evaluation of lymphadenopathy. *Semin Diagn Pathol* 2001;18:110–23.
- Schaaf HS, Collins A, Bekker A, Davies PDO. Tuberculosis at extremes of age. *Respirology* 2010;15:747–63.
- Schlossberg DL. Tuberculosis and nontuberculous mycobacterial infections. UK: John Wiley & Sons; 2020.
- Singh DD, Vogel M, Müller-Stöver I, El Scheich T, Winzer M, Göbels S, et al. TB or not TB? Difficulties in the diagnosis of tuberculosis in HIV-negative immigrants to Germany. *Eur J Med Res* 2011;16:381–4.
- Sulaiman A, Afshan S, Tazeen M, Talat M, Akbar A, Rafiq K. A comparison of fine needle aspiration cytology with Ziehl Neelsen staining in diagnosis of tuberculosis lymphadenitis. *Comprehensive Cytol Pathol* 2010;16:707–9.
- Taye H, Alemu K, Mihret A, Wood JLN, Shkedy Z, Berg S, Aseffa A, consortium ETHICOBOTS. Factors associated with localization of tuberculosis disease among patients in a high burden country: a health facility-based comparative study in Ethiopia. *J Clin Tuberc Other Mycobact Dis* 2021;23.
- World Health Organization. Global Tuberculosis Report. Geneva: World Health Organization; 2020.
- Zeka AN, Tasbakan S, Cavusoglu C. Evaluation of the GeneXpert MTB/RIF assay for rapid diagnosis of tuberculosis and detection of rifampin resistance in pulmonary and extrapulmonary specimens. *J Clin Microbiol* 2011;49:4138–41.
- Zenebe Y, Adem Y, Tulu B, Mekonnen D, Derbie A, Mekonnen Z, Biadlegne F. Tuberculosis lymphadenitis and human immunodeficiency virus co-infections among lymphadenitis patients in Northwest Ethiopia. *Ethiop J Health Sci* 2021;31:653–62.