Trends of *Mycobacterium Tuberculosis* and Rifampicin resistance in Adigrat General Hospital, Eastern zone, Tigray Region, Northern Ethiopia

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Abstract

**Background:** *Tuberculosis* is an infectious disease usually caused by *Mycobacterium tuberculosis* bacteria. The global emergence of mono- or multidrug-resistant tuberculosis and extensively drug-resistant forms of tuberculosis poses a considerable challenge to tuberculosis control programs. There has been no reliable and organized data on trends and drug resistance of *Mycobacterium tuberculosis* in the study area. Therefore, this study aimed to determine the trends of *Mycobacterium tuberculosis* and Rifampicin resistance in the Adigrat General Hospital, eastern zone, Tigray, Northern Ethiopia.

**Methods:** A hospital-based retrospective cross-sectional study was conducted at Adigrat General Hospital from January 2015 to 2018. Data were collected retrospectively from the Genexpert™ TB registration books using a data extraction format. Data was entered into Epi-Info 3.1 and subsequently exported and analyzed using SPSS Version 20. The results were summarized using descriptive statistics, tables, and figures. P values < 0.05 were considered statistically significant.

**Result:** A total of 5,944 *Mycobacterium tuberculosis* presumptive patients were included in the study. The majority of the study participants were male (58.1%) with participants’ median age of 40.0 (IQR 57, 26) years, the majority were 30-44 years. The overall positive cases of *Mycobacterium tuberculosis* was 24.3% (1446) with a total of 132 (9.1%) found to be resistant to rifampicin. Within the total Rifampicin resistant sub-group, 129/132 (97.7 %) were newly identified cases and the rest were previously treated, tuberculosis patients. Age, the reason for diagnosis, site of presumptive tuberculosis, and/or being HIV infected showed significant association with our dependent variable; however, only age and being HIV infected were associated with rifampicin resistance.

**Conclusion:** In our study, the overall trends of *Mycobacterium tuberculosis* and rifampicin resistance were found to be high and gradually increasing. HIV co-infected and previously treated patients were more likely to develop rifampicin resistance. Therefore, maximizing early detection of drug-resistant *Mycobacterium tuberculosis* and strengthening tuberculosis infection control activities are recommended to reduce the burden of this contagious and potentially deadly disease.

**Introduction**

Tuberculosis (TB) is caused by a bacterium called Mycobacterium tuberculosis. The bacteria usually
attack the lungs, but TB bacteria can attack any part of the body such as the kidney, spine, and brain. Not everyone infected with TB bacteria becomes sick. As a result, two TB-related conditions exist: latent TB infection (LTBI) and TB disease. If not treated properly, TB disease can be fatal. Tuberculosis is spread from person to person through the air. When people with lung TB cough, sneeze or spit, they propel the TB germs into the air. A person needs to inhale only a few of these germs to become infected. Tuberculosis is curable and preventable [1 & 2]. A relatively small proportion of people infected with Mycobacterium tuberculosis will go on to develop TB disease; however, the probability of developing TB is much higher among people with immune suppression or compromise. About one-quarter of the world’s population has latent TB, which means people have been infected with TB bacteria but are not yet ill with the disease and cannot transmit the disease [2].

Tuberculosis (TB) has existed for millennia and remains a major global health problem. It causes ill-health of approximately 10 million people each year and is one of the top ten causes of death worldwide [3]. According to the Global Tuberculosis Report (2017), 10.4 million people have estimated the incidence to have all forms of TB in 2016 while an estimated 1.3 million people died from TB, excluding deaths attributed to TB/HIV in combination. In addition, an estimated 4.1% of these new TB cases and 19% of the previously treated cases are believed to harbor drug resistant-TB with an estimated 240,000 deaths annually due to multi-drug resistant tuberculosis (MDR-TB) [3]. The World Health Organization (WHO) estimates that 4.5 million people are co-infected with Human Immunodeficiency Virus (HIV) and TB globally [4].

Ethiopia is among the 30 highest TB, HIV, and MDR-TB burden countries, which accounted for 80% of all estimated TB cases worldwide. Ethiopia had an annual estimated TB incidence of 207/100,000 populations and a death rate of 33 per 100,000 populations in 2014 [5]. Among the notified TB cases in 2014, 1300 (1.6%) of new TB cases and 11.8% of previously treated TB cases were drug-resistant [3]. Besides, a drug resistance (DR-TB) sentinel report in 2013 showed the MDR-TB prevalence of 2.3% among new and 17.8% among previously retreated TB cases in Ethiopia [43]. In the same year, there was notification of 119, 592 new TB cases and enrollment of 597 DR-TB cases [6]. Furthermore,
a number of studies have shown the prevalence of *Mycobacterium tuberculosis* with rifampicin resistance Ethiopia ranged from 4.7- 18.3% [5, 7-8, 41 and 44]. Mutations region of 81 base pairs (bp) of the rpoB gene has been found in about 96% of rifampicin (RMP) resistant *Mycobacterium tuberculosis* [7-8].

Ethiopia is implementing a comprehensive TB/Leprosy and TB/HIV control programs and has achieved a lot in the past decade. However, In Ethiopia, the case detection rate was very low using smear microscopy in the past, but in its commitment against TB, the Ethiopian government has joined the post-2015 Global TB Strategy called “END TB strategy” which will increase case detection & further reduce the burden of this disease. To achieve these strategies Ethiopia endorsed many advanced technologies concordantly with WHO recommendations, including the implementation of the GeneXpert™ MTB/RIF assay. The assay detects *Mycobacterium tuberculosis* and rifampicin resistance by identifying mutations using three specific primers and five unique molecular probes through a rapid (2 hour) process with minimal bio-safety requirements and training [10].

Ethiopia is one of the high burden countries, reflected both in its TB incidence and the estimated rates of MDR-TB [11]. However, there is limited information regarding the trend analysis of TB and rifampicin resistance in our study area. To date, there are no studies conducted that have reviewed documents systematically to identify the trends in *Mycobacterium tuberculosis* and rifampicin resistance using GeneXpert™ in Adigrat General Hospital. Therefore, this study aimed to determine the trends in *Mycobacterium tuberculosis* and rifampicin resistance using GeneXpert™ among TB-presumptive cases at Adigrat General Hospital, northern Ethiopia.

**Methods And Materials**

**Study design, setting, and time**

A retrospective cross-sectional study design was used to collect the secondary data from June 01-August 30, 2019 at the Adigrat General Hospital. The Adigrat General Hospital is found in the Eastern zone of Tigay, northern Ethiopia at altitude and longitude of 14°16’N 39°27’E, with an elevation of 2457 m (8061 ft) above sea level and 560 miles far from capital city Addis Ababa. In the Eastern Zone based on the 2007 census conducted by central statistics agency of Ethiopia, has a total population of
755, 343, of 52.4 % women and 19.34 % are urban inhabitants and the majority have low income. There are 2 General Hospital, 5 primary Hospital and 37 health centers. Adigrat General Hospital is serving as a referral for surrounding health centers and primary hospitals, and teaching center for medical and health science students. The hospital has about 120 beds and more than 250 health care providers. Adigrat General Hospital is the only hospital that testing sputum using Genexpert and treated the MDR-TB for surrounding 7 districts in the Eastern zone Tigray.

Inclusion criteria

Those who had completed data in the GeneXpert™ TB registration book were included during the study period specified.

Exclusion criteria

Those cases with indeterminate and/or invalid GeneXpert™ results were excluded from the study.

Dependent variable

*Mycobacterium tuberculosis result* (Positive & Negative)

Independent variable

Sex, residence, age, co-infection, site of presumptive TB, reason for diagnosis and year of diagnosis

Operational Definition

Presumptive-TB: An individual who presents with symptoms or signs suggestive of TB like sweating, coughing more than two weeks, loss of appetite, weight loss and weakness.

MDR presumptive patient: Is a patient who relapses for TB, lost to follow up patients and having close contact with drug-resistant TB infected persons.

Sample size

Retrospectively all presumptive TB patients from a Genexpert TB registration book from January 01, 2015, to December 31, 2018, were included.

Laboratory investigation

Adigrat General Hospital TB Clinic operates under the national TB- and leprosy-control program of Ethiopia, in which the diagnosis of TB is followed by GeneXpert™ MTB/RIF assay for rifampicin
resistance. Samples were processed by GeneXpert™ MTB/ RIF (Cepheid) assay according to the manufacturer's manual.

Data collection
The data were collected retrospectively from TB registration books in Adigart General Hospital at The Directly Observed Treatment [short course clinic] (DOTS). Data was collected using a pre-developed checklist.

Quality of data
The quality of data was maintained by checking the completeness of necessary information; the obtained data were cross-checked and double entered and re-checked to ensure the quality of data.

Statistical analysis and interpretation
Data obtained through the checklist and laboratory test results were double entered into the Epi-Info 3.1 software. Data analysis was performed using SPSS™ 20. Descriptive analysis, frequencies, and figures were used to explain the findings. Chi-square analysis was used to correlate categorical variables. In all cases, p-values less than 0.05 were considered statistically significant.

Results
A total of 5944 presumptive TB and drug resistance TB patients was retrospectively included in this study. Among these patients, the majority were male 3455 (58.1%). The median age of the participants was 40.0 (IQC-57, 26), of which the majority were in the age group 30-44 years. Of the total participants, 513 (8.6%) were HIV positive. Among the presumptive TB patients majority were new case 5733 (96.5%). Diagnoses of Mycobacterium tuberculosis using the GeneXpert™ have increased between 2015 and 2018. (Table 1)

The overall positivity of Mycobacterium tuberculosis among all forms of presumptive TB patient was 1446/5944 (24.3 %). The Mycobacterium tuberculosis positivity rate was observed in the productive age group 30-44 years, with 420 cases (7.1%). Of the total, Mycobacterium tuberculosis detected 1188/1446 (82.2%) & 258/1446 (17.8%) were presumptive of TB and DR-TB respectively. The proportion of MTB detected among presumptive TB and DR-TB were found to be 1188/5027 (23.6%) & 258/917 (28.1%) respectively. MTB/HIV co-infection was observed in 171/513 (33.3%) of the involved
patients. From the total new and previously treated (Relapse, failure and Lost follow up) TB cases, 
1385/5733 (24.2%) and 61/211 (28.4 %) had MTB detected respectively. The trends of the positivity 
of *Mycobacterium tuberculosis* almost similar in the first three years but were considerably higher by 
2018. Correlation analysis of MTB showed a strong association with age, the reason for diagnosis, site 
of sample collection and being HIV infected. (Table 2)

In this study a total 5944 study subject data was collected from GeneXpert™ registration book that 
processed by GeneXpert™ MTB/RIF from January 01, 2015, to December 31, 2018, 1446/5944 (24.3%) 
were positive for *Mycobacterium tuberculosis*, From the total confirmed of all forms of presumptive TB 
cases, 132/1446 (9.1%) were resistant to rifampicin, of which 103/1188 (8.8%) and 29/258 (11.2 %) 
were presumptive TB and presumptive drug resistance-TB respectively. Of the total positive cases 
129/1385 (9.3%) and 3/61 (4.9%) were rifampicin resistance of new and previously treated patients 
respectively. The magnitude of rifampicin resistance was relatively higher in the productive age group 
of 30-44 years. Of the total TB-HIV co-infected patients, 26/171 (15.2 %) where RIF resistance. The 
trends of rifampicin-resistant were seen as a minimum variation from year to year, with the minimum 
observed in 2018 and the maximum in 2017. The sensitivity and resistance of rifampicin results 
showed a statistically significant difference with reason of diagnosis (p<=0.00), & HIV status 
(p<=0.02). (Table 3)

The trends of positivity in *Mycobacterium tuberculosis* and rifampicin resistance were increased 
between 2015 and 2018. In 2015, *Mycobacterium tuberculosis* was found in 142/604 (23.5%) of whom 
19/145 (13.4%) were rifampicin-resistant, but by 2018 *Mycobacterium tuberculosis* prevalence was 
540/1989 (27.1%) of whom 45/540 (8.3%) were rifampicin-resistant. In general, rifampicin-resistant in 
January 2015, 2016, 2017 and till December 31, 2018 were shown 13.4 %, 8.6 %, 9.2 % & 8.3 % 
respectively.

**Discussion**

The WHO continues to search for innovative technologies to enhance accurate and reliable laboratory 
diagnosis of TB to curb *Mycobacterium tuberculosis* and DR-TB worldwide. However, the emergence of 
drug-resistant forms of TB, which need more resources to detect, treat, and effectively reduce the
burden of disease is a wicked problem. GeneXpert™ MTB/RIF assay is a new automated real-time Nucleic Acid Amplification Technology that overcomes many of the current operational difficulties in TB diagnosis [12].

TB affects mostly adults in the economically productive age groups with approximately two-thirds of cases estimated to occur among people aged 15-59 years [1].

In the present study, the overall prevalence of all forms of presumptive *Mycobacterium tuberculosis* was 24.3%. Our finding was similar to studies conducted in the Debre Markos Hospital (23.2%) [13], Gondar Referral Hospital (24.6%) [14], Gambella (20.0%) [46], Afar (24.5%) [49], India (27.6%) [4], South Africa (26%) [15], Nigeria (22.9 %) [16] And the WHO report in Africa (25%) [2]. However, it was lower compared to reports in Jigjiga (65.5%) [17], Kenya (32.25%) [18], in eastern Uttar Pradesh (32.9%) [19] and Congo (79.1%) [47]. the main difference in these latter findings may show our inclusion of all forms of presumptive tuberculosis while other studies included identified cases of *Mycobacterium tuberculosis*. In contrast, our finding was higher when compared with studies conducted in Metema and Armacho (5.7%) [6], Felege Hiwot Referral Hospital, and Debre Tabor Hospital (14.6%) [20], in three referral hospitals and the regional laboratory in Addis Ababa (15.11%) [48], other parts of Ethiopia (4.7%-10.8%) [21-23], Nigeria (10.3%) [24] and India (2.31%) [25].The variations might be due to the difference in study design, type & number of participants, and environmental conditions.

The co-infection of TB-HIV in this study was found to be high at 33.3% (171). This finding was supported by previous studies conducted in Amhara (27.7%) [26], in Ethiopia (29.4%) [27], & in Central Nigeria (36.3%) [28]. However, our findings were higher than studies conducted in the Debre Markos Referral Hospital (16.6%) [13], different studies across Ethiopia (20.3-24.2 %) [14,29-32], and a WHO estimation for Ethiopia of 14% (9.6%-19%) [2]. Conversely, the findings were lower than studies conducted in the FelegeHiwot Referral Hospital and Debre Tabor Hospital (41.9%) [20], Zambia (98.3%) [33] & South Africa (>70%) [34]. The possible explanations for this difference could be reflect policy recommendations for which HIV infected patients, as an eligible group, are more likely to be tested using GeneXpert™.
In this study, *Mycobacterium tuberculosis* is prevalent in all ages, but has seriously hit the productive age group of 30-44 years with 29.0% prevalence and of whom 34/420 (8.1%) are Rifampicin resistant. The positivity finding was in line with studies conducted in Gonder (29.8%) [14], different studies in Ethiopia [21-23,35], WHO reports 2017 [2] & Agaro Teaching Health Center in southwestern Ethiopia [36]. There are however contrary findings with several studies in a different part of Nigeria and Zambia [18,24,33] which had lower prevalence, but higher than a study conducted in eastern Uttar Pradesh (40%) [19].

In the present study, the percentage of *Mycobacterium tuberculosis* positivity significantly higher in presumptive TB patients (20.0 %) compared to presumptive drug resistance (4.3 %) with (P < 0.00). This finding was comparable to studies conducted in Afar (20.9) [49], Debre Markos Referral Hospital (15.1%) [13] and Gambella (19.6%) [46]. However, it is much lower than studies conducted in Felege Hiwot Referral Hospital and Debre Tabor Hospital (54.8) [20], Gonder (25.2 %) [14] & Zimbabwe (37.1%) [37]. The discrepancies might be due to our inclusion of all presumptive TB cases, and a high number of participants.

According to our study, we found 132 (9.1%) of rifampicin-resistant cases among confirmed TB cases. This result is comparable with studies conducted in Debre Markos Referral Hospital (10.3%) [13], Felege Hiwot Referral Hospital and Debre Tabor Hospital (9.3%) [20], Addis Abeba (9.9 %) [48] and India (10.5%) [38]. Our finds are higher than earlier studies conducted on different parts of Ethiopia (2.9%-5.7%) [6,19,31-32,39,42,46 & 48], Nigeria (2.9%) [24] and Zambia (5.9%) [33]. The possible explanation for these variations could be related to our retrospective approach spanning four years, or differences in study designs. However, our prevalence was lower than for studies conducted in Gonder 15.8% [14], other parts of Ethiopia (11.5-39.4 [39-40 & 51], Congo (42.2%) [47] and China (17.6-26.3%) [43 and 50].

**Conclusion**

In our study, the overall trends of *Mycobacterium tuberculosis* and rifampicin resistance were found to be high and gradually increasing. HIV co-infected and previously treated patients were more likely to develop rifampicin resistance. Therefore, maximizing early detection of drug-resistant *Mycobacterium*
tuberculosis and strengthening tuberculosis infection control activities are recommended to reduce the burden of this contagious and potentially deadly disease as well as further study is needed to detect MDR-TB in the study area.

**Limitation of the Study**

As we collected retrospective data from Genexpert TB logbooks, we encountered data missing and incompleteness. Variables included for associated factors were also limited.

**Declarations**

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**Authors’ contributions**

GK conceived and designed the study, performed the analysis, interpreted data, and drafted the manuscript. BH assisted with the design, proposal preparation, data collection, performed analysis and interpretation of data, and critically prepared and reviewed the manuscript. All authors read and approved the submitted version of the manuscript.

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Not applicable.

**Availability of data**

The findings of this study are generated from the data collected and analyzed based on the stated methods and materials. All the data are found in the manuscript and there are no supplementary files. The original data supporting this finding will be available upon request through the
corresponding author.

**Ethics approval and consent to participate**

This study was reviewed and approved by research and community service Ethical Review Board (RERB) of Adigart University, College of Medicine and Health Sciences and after discussion of the purpose and aim of the study permission was obtained from Adigrat General Hospital Chief Executive Officer and Laboratory Head to access the registration book. Written informed consent was not sought from the study participants as secondary data were used. Confidentiality of the results were maintained through anonymous data set and not communicated for other purposes.

**Consent for publication**

Not applicable

**Conflicts of Interest**

The authors declare that they have no competing interests.

**Abbreviations**

ADU: Adigrat University; AGHL: Adigrat General Hospital Laboratory; DNA: Deoxyribonucleic Acid; DOTS: Directly Observed Treatment, short course; HIV: Human Immunodeficiency Virus; M. tuberculosis: *Mycobacterium tuberculosis*; MDR-TB: Multidrug Resistance Tuberculosis; RIF: Rifampicin; RNA: Ribonucleic Acid; TB: Tuberculosis; WHO: World Health Organization; XDR TB: Extensively Drug Resistant Tuberculosis

**References**

1. Centers of disease control and prevantion (CDC) .Basic TB facts.March 10,2016.Available on https://www.cdc.gov/tb/topic/basics/glossary.htm
2. World Health Organization. Tuberculosis fact sheet 2019.Available https://www.who.int/news-room/fact-sheets/detail/
3. World Health Organization. Resistant TB ( MDR / RR-TB):The global TB situation. 2017;34.Available from: https://www.who.int/tb/areas-of-work/drug-resistant-tb/MDR-TB
4. Alvarez-Uria G, Azcona JM, Midde M, Naik PK, Reddy S, Reddy R. Rapid diagnosis of
pulmonary and extrapulmonary tuberculosis in HIV-infected patients. Comparison of LED fluorescent microscopy and the GeneXpert MTB/RIF Assay in a district hospital in India. Tuberc Res Treat. 2012:1–4. Available from: http://www.hindawi.com/journals/trt/2012/932862/

5. Mekonnen F, Tessema B, Moges F, Gelaw A, Eshetie S, Kumera G. Multidrug resistant tuberculosis: Prevalence and risk factors in the districts of Metema and West Armachiho, Northwest Ethiopia. BMC Infect Dis. 2015;15(1):2–7.

6. Federal Democratic Republic of Ethiopia Ministry of Health; National Comprehensive Tuberculosis, Leprosy and TB/HIV Training Manual for Health Care Workers, 2012. Available from: https://www.slideshare.net/suleymanfantahun/new-ethiopian-tb-guideline-november-2012.

7. Nigus DM, Lingerew WM, Beyene BA, Tamiru AA, Lemma MT, Melaku MY. Prevalence of multi drug resistant tuberculosis among presumptive multi drug resistant tuberculosis cases in Amhara National Regional State, Ethiopia. Mycobact Diseases. 2014; 4(3):2–7.

8. Getahun M, Ameni G, Kebede A, Yaregal Z, Hailu E, Medihn G, et al. Molecular typing and drug sensitivity testing of Mycobacterium Tuberculosis isolated from a community-based survey in Ethiopia. BMC Public Health. 2015;15(1):1–7.

9. Ethiopian Public Heath Institute. Implementation Federal Democratic Republic of Ethiopia Mideline for GeneXpert™ MTB / RIF Assay in Ethiopia. 2014;7–50. Available from: https://www.ephi.gov.et/images/pictures/Implementation Guideline

10. Federal Democratic Republic of Ethiopia ministry of health. Guidelines for the programmatic management of drug-resistant tuberculosis in Ethiopia. 2013;2nd Available on the www.medbox.org

11. Girum T, Muktar E, Lentiro K, Wondiye H, Shewangizaw M. Epidemiology of multidrug-
resistant tuberculosis (MDR-TB) in Ethiopia: a systematic review and meta-analysis of the prevalence, determinants and treatment outcome. Trop Dis Travel Med Vaccines. 2018 Jun 14;4:5. doi: 10.1186/s40794-018-0065-5. PMID: 29942536; PMCID: PMC6000958

12. World Health organization. Automated Real-time Nucleic Acid Amplification Technology for Rapid and Simultaneous Detection of Tuberculosis and Rifampicin Resistance: In: MTB/RIF, WHO Policy Xpert, Xpert MTB/RIF system WHO/HTM/TB/20114 Geneva; 2011. Available on the WHO web site (www.who.int)

13. Mulu W, Abera B, Yimer M, Hailu T, Ayele H, Abate D. 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(1):1-8.

14. Jaleta KN, Gizachew M, Gelaw B, Tesfa H, Getaneh A, Biadgo B. Rifampicin-resistant mycobacterium tuberculosis among tuberculosis-presumptive cases at University of Gondar Hospital, northwest Ethiopia. Infect Drug Resist. 2017;10:185-92.

15. Cox HS, Mbhele S, Mohess N, Whitelaw A, Muller O, Zemanay W, et al. Impact of Xpert MTB/RIF for TB diagnosis in a primary care clinic with high TB and HIV Prevalence in South Africa: A pragmatic randomized trial. PLoS MED. 2014;11(11):1-12.

16. Ikuabe Po, Ebuenyi ID Prevalence of rifampicin resistance by automated Genexpert rifampicin assay in patients with pulmonary tuberculosis in Yenagoa, Nigeria. Pan Afr MED J [Internet]. 2018;(29):204. Available from: doi: 10.11604/Pam.j.2018.29.204.14579

17. Mesfin W., Mulualem A., Mubarek A., et al. Use of Xpert MTB/RIF for the identification of TB and drug resistance among smear-negative and re-treatment cases in rural
areas of Ethiopia. The Open Microbiolgy Journal. 2019;13,188-192. Available from https://openmicrobiologyjournal.com, DOI: 2174/1874285801913010188

18. Muia PK, Ngugi MP, Mburu DN. Performance of GeneXpert Assay in detecting pulmonary tuberculosis and rifampicin Resistance in Patients Attending Kitui County Hospital, Kenya. J Trop Dis. 2017;05(04). DOI: 10.4172/2329-891X.1000246

19. Gautam PB, Mishra A, Kumar S. Prevalence of rifampicin resistant Mycobacterium Tuberculosis and associated factors among presumptive tuberculosis patients in eastern Uttar Pradesh. Int J Community Med Public Health. 2018 Jun;5(6):2271-2276. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20182039

20. Derbie A, Worku S, Mekonnen D, Mezgebu Y, Teshager A, Birhan A, et al. GeneXpert™ MTB/RIF assay for the diagnosis of Mycobacterium Tuberculosis and its rifampicin resistance at Felege Hiwot Referral Hospital and Debre Tabor Hospitals, Northwest Ethiopia. Ethiopia J Heal Dev. 2016;30(2):60–5. Available on https://www.ajol.info/index.php/ejhd/article/view/167744/157153

21. Deribew A, Negussu N, Melaku Z, Deribe K. Investigation outcomes of tuberculosis suspects in the health centers of Addis Ababa, Ethiopia. PLoS One. 2011;6(4):2–6.

22. Gebre D, Mimano LN. Prevalence of smear positive pulmonary tuberculosis among patients attending Seka Health Center, Jimma, Oromia Region, Ethiopia. East Afr J Public Heal. 2010;3(7):268-73. DOI:10.4314/eajph.v7i3.64739

23. Yohanes A, Abera S, Ali S. Smear positive pulmonary tuberculosis among suspected patients attending metehara sugar factory hospital; eastern Ethiopia. Afr Health Sci. 2012;12(3):325–330. doi:10.4314/ahs.v12i3.12.

24. Azuonwu O., Ihua N., and Kpomasiruchi W. Molecular Detection of Mycobacterium tuberculosis (MTB) and rifampicin resistant strain among subjects accessing health care at the Federal Medical Centre, Yenegoa, Bayelsa State; Nigeria. iMedPub
25. Sharma S, Madan M, Agrawal C, Asthana A. Genotype MTB DR plus assay for molecular detection of rifampicin and isoniazid resistance in Mycobacterium tuberculosis. Indian J Pathol Microbiol [Internet]. 2014;57(3):423.

26. Mitku AA, Dessie ZG, Muluneh EK, Workie DL. Prevalence and associated factors of TB/HIV co-infection among HIV infected patients in Amhara region, Ethiopia. Afr Health Sci. 2016;16(2):588-95.

27. Ali SA, Mavundla TR, Fantu R, Awoke T. Outcomes of TB treatment in HIV co-infected TB patients in Ethiopia. BMC Infect Diseases. 2016;1-9.

28. Gyar SD, Dauda E, Reuben CR. Prevalence of Tuberculosis in HIV/AIDS patients in Lafia, Central Nigeria. Int J Curr Microbiol App Sci. 2014;3(6):831–8. Available on http://www.ijcemas.com

29. Ahmed A, Mekonnen D, Shiferaw AM, et al. Incidence and determinants of tuberculosis infection among adult patients with HIV attending HIV care in north-east Ethiopia: a retrospective cohort study. BMJ Open 2018;8:e016961. doi: 10.1136/bmjopen-2017-016961

30. Mohammed S, and Gebremariam TT. Tuberculosis among HIV-positive patients at Butajira Hospital, South-Central Ethiopia. International Journal of Pharmacological Science Research. 2015;6 (12) pp. 1406-1411.

31. Tarekegne D, Jemal M, Atanaw T, Ebabu A, Endris M, Moges F. Prevalence of human immunodeficiency virus infection in a cohort of tuberculosis patients at Metema Hospital, Northwest Ethiopia. BMC Res Notes. 2016;1-6.

32. Worku S, Derbie A, Mekonnen D, Biadglegne F. Treatment outcomes of tuberculosis patients under directly observed treatment, short-course at Debre Tabor General Hospital, northwest Ethiopia. Infect Dis Poverty. 2018 Feb 26;7(1):16. doi:
33. Masenga SK, Mubila H, Hamooya BM. Rifampicin resistance in Mycobacterium tuberculosis patients using the GeneXpert at The Livingstone Central Hospital. BMC Infectious Diseases. 2017;17(1):1-4.

34. Coovadia YM, Mahomed S, Pillay M, Werner L, Mlisana K. Rifampicin mono-resistance in Mycobacterium tuberculosis in KwaZulu-Natal, South Africa. PLoS One. 2013;8(11):8-12.

35. Abdella K, Abdissa K, Kebede W, Abebe G. Drug resistance patterns of Mycobacterium tuberculosis complex and associated factors among treatment cases around Jimma, Southwest Ethiopia. BMC Public Health. 2015;15(1):1-7.

36. Ali H, Zeynudin A, Mekonnen A, Ahera S, Ali S. Smear Posetive Pulmonary Tuberculosis (PTB) Prevalence Amongst Patients at Agaro Teaching Health Center, South West Ethiopia. Ethiop J Health Sci. 2012;22(1):71-76.

37. Makamure B, Mhaka J, Makumbirofa S, Mutetwa R, Mupfumi L, Mason P et al. Microscopic-observation drug-susceptibility assay for the diagnosis of drug-resistant tuberculosis in Harare Zimbabwe. PLoS One. 2013;8 (2): e55872.

38. Gupta A, Mathuria JP, Singh SK, Gulati AK, Anupurba S. Antitubercular drug resistance in four healthcare facilities in North India. J Health Popul Nutr. 2011;29(6):583-592.

39. Seyoum B, Demissie M, Worku A, Bekele S, Aseffa A. Prevalence and Drug Resistance Patterns of Mycobacterium tuberculosis among New smear positive pulmonary tuberculosis patients in Eastern Ethiopia. Tuberculosis Research and Treatment. 2014;2014:1-7.

40. Mesfin EA, Beyene D, Tesfaye A, Admasu A, Addise D, Amare M, et al. Drug-resistance patterns of Mycobacterium tuberculosis strains and associated risk factors among multi drug-resistant tuberculosis suspected patients from Ethiopia. PLoS One.
2018;13(6):1–16.

41. Ethiopian Health and Nutrition Research Institute. First Ethiopian National Population Based Tuberculosis Prevalence survey. Ethiopian Public health institute 2011; Available from:https://www.ephi.gov.et/images/downloads/Tuberculosis%20Prevalence%20Survey.pdf

42. Mekonnen D, Admassu A, Mulu W, Amor A, Benito A, Gelaye W, et al. Multidrug-resistant and heteroresistant Mycobacterium tuberculosis and associated gene mutations in Ethiopia. Int J Infect Dis. 2015;39:34–8.

43. Yang Y, Zhou C, Shi L, Meng H, Yan H. Prevalence and characterization of drug-resistant tuberculosis in a local hospital of Northeast China. Int J Infect Dis. 2014;22:83–6.

44. Sinshaw, W., Kebede, A., Bitew, A. et al. Prevalence of tuberculosis, multidrug resistant tuberculosis and associated risk factors among smear negative presumptive pulmonary tuberculosis patients in Addis Ababa, Ethiopia. BMC Infect Dis 19, 641 (2019). https://doi.org/10.1186/s12879-019-4241-7

45. Tessema B, Beer J, Emmrich F, Sack U, Rodloff AC. First- and second-line anti tuberculosis drug resistance in Northwest Ethiopia. Int J Tuberc Lung Dis.2012;16(6):805–811. doi: 10.5588/ijtld.11.0522

46. Ejeta E, Beyene G, Bonsa Z, Abebe G. Xpert MTB / RIF assay for the diagnosis of Mycobacterium tuberculosis and Rifampicin resistance in high Human Immuno deficiency Virus setting in Gambella regional state , southwest Ethiopia. J Clin Tuberc Other Mycobact Dis [Internet]. 2018; 12 (May):14–20. Available from: https://doi.org/10.1016/j.jctube.2018.06.002

47. Farra A, Manirakiza A, Yambio BM, Zandanga G, Lokoti B, Berlioz-arthaud A, et al. Surveillance of Rifampicin Resistance With GeneXpert MTB / RIF in the National
Reference Laboratory for Tuberculosis at the Institut Pasteur in Bangui, 2015–2017. Open Forum Infectious Diseases. 2019; 2015-7

48. Arega B., Menbere. F and 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

49. Gebrehiwet GB, Kahsay AG, Welekidan LN, et al. Rifampicin resistant tuberculosis in presumptive pulmonary tuberculosis cases in Dubti Hospital, Afar, Ethiopia. J Infect Dev Ctries. 2019; 13(1):21-27. doi:10.3855/jidc.10462

50. Song W, Li Y, Ma X, Liu J, Tao N, Liu Y, et al. Primary drug resistance of mycobacterium tuberculosis in Shandong, China, 2004 – 2018. Respir Res. 2019; 20(223):1-12

51. Abdella K, Abdissa K, Kebede W and Abebe G. Drug resistance patterns of Mycobacterium tuberculosis complex and associated factors among retreatment cases around Jimma, Southwest Ethiopia. BMC Public Health (2015) 15:599 DOI 10.1186/s12889-015-1955-3

Tables
Table-1-Socio-demographic and clinical characteristics of the study subjects in Adigrat General Hospital, Eastern Zone, Tigray, Ethiopia
| Variables               | Frequency | Percentage |
|------------------------|-----------|------------|
| Sex                    |           |            |
| Female                 | 2489      | 41         |
| Male                   | 3455      | 58         |
| Residence              |           |            |
| Urban                  | 5121      | 86         |
| Rural                  | 823       | 13         |
| Age (Years)            |           |            |
| ≤14                    | 236       | 4.0        |
| 15-29                  | 1568      | 26.4       |
| 30-44                  | 1620      | 27.3       |
| 45-59                  | 1107      | 18.6       |
| 60-74                  | 1039      | 17.5       |
| 75-89                  | 362       | 6.1        |
| 90                     | 12        | 0.2        |
| Total                  | 5944      | 100.0      |
| Reason for diagnosis   |           |            |
| Presumptive TB         | 5027      | 84.6       |
| Presumptive DR TB      | 917       | 15.4       |
| Presumptive DR-TB      |           |            |
| New                    | 5733      | 96.5       |
| Relapse                | 105       | 1.8        |
| Failure                | 87        | 1.5        |
| Lost to follow-up      | 19        | 0.3        |
| Site of presumptive TB |           |            |
| Pulmonary              | 5819      | 97.9       |
| Extra-pulmonary        | 125       | 2.1        |
| HIV status             |           |            |
| Negative               | 4761      | 80.1       |
| Positive               | 513       | 8.6        |
| Unknown                | 670       | 11.3       |
| Year of Diagnosis      |           |            |
| 2015                   | 604       | 10.2       |
| 2016                   | 1479      | 24.9       |
| 2017                   | 1872      | 31.5       |
| 2018                   | 1989      | 33.5       |

Table 2-Trends of positive M. *Tuberculosis* among presumptive TB patients diagnosed in Adigrat General Hospital using GeneXpert™ MTB/RIF assay

*
| Variables                        | M. tuberculosis result by GeneXpert™ |
|---------------------------------|-------------------------------------|
|                                 | Detected (%) | Not-Detected (%) | Total (%) |
| Sex                             |             |                 |           |
| Female                          | 596 (10.0)  | 1893 (31.9)     | 2489 (41.9) |
| Male                            | 850 (14.3)  | 2605 (43.8)     | 3455 (58.1) |
| Residence                       |             |                 |           |
| Urban                           | 1266 (21.3) | 3855 (64.9)     | 5121 (86.2) |
| Rural                           | 180 (3.0)   | 643 (10.8)      | 823 (13.8)  |
| Age (Years)                     |             |                 |           |
| <14                             | 44 (0.7)    | 192 (3.2)       | 236 (3.9)  |
| 15-29                           | 393 (6.6)   | 1175 (19.8)     | 1568 (26.4) |
| 30-44                           | 420 (7.1)   | 1200 (20.2)     | 1620 (27.3) |
| 45-59                           | 258 (4.3)   | 849 (14.3)      | 1107 (18.6) |
| 60-74                           | 235 (3.9)   | 804 (13.5)      | 1039 (17.4) |
| 75-89                           | 93 (1.6)    | 269 (4.5)       | 362 (6.1)  |
| 90                              | 3 (0.1)     | 9 (0.2)         | 12 (0.3)   |
| Reason for diagnosis            |             |                 |           |
| Presumptive TB                  | 1188 (20.0) | 3839 (64.6)     | 5027 (84.6) |
| Presumptive DR TB               | 258 (4.3)   | 659 (11.1)      | 917 (15.4)  |
| Presumptive DR-TB               |             |                 |           |
| New                             | 1385 (23.3) | 4348 (73.1)     | 5733 (96.4) |
| Relapse                         | 31 (0.5)    | 74 (1.2)        | 105 (1.8)  |
| Failure                         | 27 (0.4)    | 60 (1.0)        | 87 (1.4)   |
| Lost to follow-up               | 3 (0.1)     | 16 (0.3)        | 19 (0.4)   |
| Site of presumptive TB          |             |                 |           |
| Pulmonary                       | 1414 (23.8) | 4405 (74.1)     | 5819 (97.9) |
| Extra-pulmonary                 | 32 (0.5)    | 92 (1.6)        | 125 (2.1)  |
| HIV status                      |             |                 |           |
| Negative                        | 1128 (18.9) | 3633 (61.1)     | 4761 (80.0) |
| Positive                        | 171 (2.9)   | 342 (5.8)       | 513 (8.7)  |
| Unknown                         | 147 (2.5)   | 523 (8.8)       | 670 (11.3) |
| Year of Diagnosis               |             |                 |           |
| 2015                            | 142 (2.4)   | 462 (7.8)       | 604 (10.2) |
| 2016                            | 339 (5.7)   | 1140 (19.2)     | 1479 (24.9) |
| 2017                            | 425 (7.2)   | 1447 (24.3)     | 1872 (31.5) |
| 2018                            | 540 (9.0)   | 1449 (24.4)     | 1989 (33.4) |
Significantly associated, a-Reference category M.tuberculosis- Mycobacterium tuberculosis, DR TB - drug resistant tuberculosis & AOR-Adjusted odd ratio

Table 3 –Multivariate analysis of rifampicin-resistant among the total Mycobacterium tuberculosis cases using GeneXpert™ MTB/RIF assay, in Adigrat General Hospital
| Variables          | Pattern of RIF |          |          |          |          |
|--------------------|----------------|----------|----------|----------|----------|
|                    | Sensitive N (%)| Resistant N (%)| Total N (%)| AOR (95% CI) |
| Sex                |                |          |          |          |          |
| Female             | 535 (37.0)     | 61 (4.2) | 596 (41.2) | a         |
| Male               | 779 (53.9)     | 71 (4.9) | 850 (58.8) | 0.74 (0.5-1.09) |
| Residence          |                |          |          |          |          |
| Urban              | 1151 (79.6)    | 115 (7.9) | 1266 (87.5) | a         |
| Rural              | 163 (11.3)     | 17 (1.2)  | 180 (12.5) | 1.10 (0.61-1.9) |
| Age (Years)        |                |          |          |          |          |
| ≤14                | 41 (2.8)       | 3 (0.2)  | 44 (3.0)  | a         |
| 15-29              | 376 (26.0)     | 17 (1.2) | 393 (27.2) | 1.12 (0.37-3 |
| 30-44              | 386 (26.7)     | 34 (2.4) | 420 (29.1) | 0.52 (0.16-1 |
| 45-59              | 225 (15.6)     | 33 (2.3) | 258 (17.8) | 0.54 (0.18-1 |
| 60-74              | 205 (11.4)     | 30 (6.5) | 235 (16.3) | 0.53 (0.17-1 |
| 75-89              | 78 (5.4)       | 15 (1.0) | 93 (6.4)  | 1.48 (0.46-4 |
| ≥90                | 3 (0.2)        | 0        | 3 (0.2)   | a         |
| Reason for diagnosis|              |          |          |          |          |
| Presumptive TB     | 1085 (75.0)    | 103 (7.1) | 1188 (82.1) | a         |
| Presumptive DR TB  | 229 (15.9)     | 29 (2.0) | 258 (17.9) | 8.92 (5.81-1.9) |
| Presumptive DR-TB  |                |          |          |          |          |
| New                | 1256 (86.9)    | 129 (8.8) | 1385 (95.7) | a         |
| Relapse            | 30 (2.1)       | 1 (0.1)  | 31 (2.2)  | 0.32 (0.02-4 |
| Failure            | 26 (1.8)       | 1 (0.1)  | 27 (1.9)  | 0.16 (0.01-1 |
| Lost to follow-up  | 2 (0.1)        | 1 (0.1)  | 3 (0.2)   | 0.16 (0.01-2 |
| Site of presumptive TB |          |          |          |          |          |
| Pulmonary          | 1283 (88.7)    | 131 (9.0) | 1414 (97.8) | a         |
| Extra-pulmonary    | 31 (2.2)       | 1 (0.1)  | 32 (2.2)  | 0.62 (0.22-1 |
| HIV status         |                |          |          |          |          |
| Negative           | 1036 (71.7)    | 92 (6.4) | 1128 (78.1) | a         |
| Positive           | 145 (10.0)     | 26 (1.8) | 171 (11.8) | 1.97 (1.13-3 |
| Unknown            | 133 (9.2)      | 14 (0.9) | 147 (10.1) | 0.88 (0.45-1 |
| Year of Diagnosis  |                |          |          |          |          |
| 2015               | 123 (8.5)      | 19 (1.3) | 142 (9.8) | 2.24 (1.19-4.2 |
| 2016               | 310 (21.5)     | 29 (2.0) | 339 (23.5) | 0.91 (0.53-1.5 |
| 2017               | 386 (26.7)     | 39 (2.7) | 425 (29.4) | 1.20 (0.74-1.9 |
| 2018               | 495 (34.2)     | 45 (3.1) | 540 (37.3) | a         |

* Significantly associated, a-Reference category, RIF -rifampicin resistant, DR TB -drug resistant tuberculosis, M.tuberculosis- Mycobacterium tuberculosis and AOR-Adjusted odd ratio.

Figures
Figure 1

Trends of Mycobacterium tuberculosis and rifampicin resistant in Adigrat General Hospital, Tigray, Northern, Ethiopia