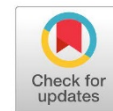


Research Article

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Epidemiology and Rifampicin Resistance Patterns of Tuberculosis at a Tertiary Chest Hospital in Benghazi, Libya: A Retrospective Analysis (2018-2023)

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Abstract

Tuberculosis (TB) remains a significant public health challenge in Libya. This retrospective study consolidates data from two periods (2018-2019 and 2021-2023) at Al-Kuwayfiya Teaching Hospital for Chest Diseases in Benghazi to analyze the local epidemiology and rifampicin resistance (RR-TB) trends. Among 833 total suspected cases, 380 (45.6%) were confirmed as pulmonary TB. A significant male predominance was observed, comprising 70.5% of all confirmed cases. Rifampicin-resistant TB was 877 identified in 43 patients, representing 11.3% of all culture-positive individuals. The GeneXpert MTB/RIF assay was instrumental in diagnosis, with semi-quantitative analysis revealing that most positive samples (41.8%) had a medium bacterial load. The incidence was higher during the dry season, and the 34–43-year age group showed the highest frequency of RR-TB. These findings confirm a high TB prevalence in the region with a concerning rate of rifampicin resistance, underscoring the need for sustained use of rapid molecular diagnostics and enhanced public health interventions.

Keywords: Tuberculosis, Rifampicin Resistance, Libya, GeneXpert, Epidemiology, Benghazi.

INTRODUCTION

Tuberculosis (TB), a disease caused by the bacterium *Mycobacterium tuberculosis*, continues to be a major contributor to global morbidity and mortality from infectious diseases (World Health Organization (WHO), 2023). The growing challenge of drug-resistant TB, particularly multidrug-resistant TB (MDR-TB)—defined as resistance to at least the first-line drugs rifampicin (RIF) and isoniazid—severely undermines global TB control efforts (WHO, 2024). Rifampicin resistance serves as a reliable proxy for MDR-TB, making its rapid and accurate detection critical for initiating effective, second-line treatment regimens and curbing the chain of transmission (Baya *et al.*, 2020). Tuberculosis remains an endemic problem in Libya, and as a result of the COVID pandemic and also the control of politicians in the country, there has been a significant decrease in reporting



of cases over the years regarding tuberculosis diagnostic services (WHO, 2022). Robust surveillance systems and contemporary, localized epidemiological data are fundamental for shaping and refining national TB control strategies. This retrospective study aims to consolidate and analyze the epidemiological characteristics and rifampicin resistance patterns among patients presenting at a major tertiary chest hospital in Benghazi, Libya, spanning two distinct timeframes (2018-2019 and 2021-2023), thereby providing an updated snapshot of the disease's profile in Eastern Libya.

MATERIALS AND METHODS

Study Design and Setting

A retrospective, cross-sectional analysis was conducted utilizing the medical records of Al-Kuwayfiya Teaching Hospital for Chest Diseases in Benghazi, a primary referral center for respiratory ailments in the region. Data were amalgamated from two discrete periods: an initial phase from January 2018 to December 2019, and a subsequent phase from January 2021 to December 2023.

Sample Collection and Processing

Sputum specimens were collected from individuals exhibiting clinical symptoms suggestive of pulmonary TB into sterile, leak-proof containers. For the 2021-2023 cohort, laboratory confirmation was primarily achieved using the GeneXpert MTB/RIF assay (Cepheid, USA), performed in strict adherence to the manufacturer's guidelines. This automated molecular diagnostic tool allows for the simultaneous identification of *M. tuberculosis* complex and rifampicin resistance. The earlier cohort (2018-2019) was also analyzed using molecular techniques, including the GeneXpert system, ensuring methodological consistency across the study periods.

Data Analysis

Demographic and clinical information, including patient age, sex, nationality, and diagnostic outcomes, were systematically extracted from hospital registries. The compiled dataset was analyzed to compute prevalence rates and delineate rifampicin resistance patterns. Descriptive statistics were employed to summarize the findings.

RESULTS

Overall Prevalence and Demographic Characteristics

The consolidated analysis encompassed 833 clinically suspected TB cases. From these, 380 were confirmed as positive for pulmonary TB, resulting in an overall prevalence of 45.6%. A pronounced male predominance was consistently noted across both study intervals, with male patients constituting 268 (70.5%) of the 380 confirmed cases.

Table:(1). Distribution of Cases by Study Period and Gender

Study Period	Total Cases	Male n (%)	Female n (%)
2018–2019	58	39 (67.2%)	19 (32.8%)
2021–2023	322	229 (71.1%)	93 (28.9%)
Total	380	268 (70.5%)	112 (29.5%)

Rifampicin Resistance Patterns

Rifampicin-resistant TB (RR-TB) was identified in 43 of the 380 confirmed TB cases, yielding an overall resistance rate of 11.3%. Gender-specific resistance was calculated using all 380 confirmed TB cases. However, age-group analysis was based on 209 cases for which age information was

available. Among these, the highest resistance rate was observed in the 44–53 years age group (26.7%), followed by the 34–43 years age group (24.0%).

Table:(2). Rifampicin Resistance by Gender and Age Group

Category	RR-TB Cases	Total TB Cases	Resistance Rate
Gender			
Male	32	268	11.9%
Female	11	112	9.8%
Age Group			
24–33 years	10	104	9.6%
34–43 years	18	75	24.0%
44–53 years	8	30	26.7%

Bacterial Load Distribution

Table 3 presents the distribution of GeneXpert bacterial load among the 322 confirmed TB-positive cases. The medium bacterial load was the most frequently observed category, accounting for 138 cases (42.8%), followed by high bacterial load with 75 cases (23.3%) and low bacterial load with 73 cases (22.7%). The very low bacterial load was the least common, representing 36 cases (11.1%). Overall, the findings indicate that most confirmed TB patients had a moderate to high bacterial burden, suggesting a considerable bacillary load among the study population.

Table:(3). Bacterial Load Distribution Among TB-Positive Cases (2021-2023)

Bacterial Load	Number of Cases	Percentage
Very Low	36	11.1%
Low	73	22.7%
Medium	138	42.8%
High	75	23.3%
Total	322	100%

DISCUSSION

Through a systematic study and meta-analysis of tuberculosis outcomes in low- and middle-income countries, the study found that men had a higher incidence of tuberculosis than women in most settings. This disparity was attributed to several factors, including smoking, alcohol consumption, occupation, and delays in seeking medical help from health centers. (Horton *et al.*, 2016). (Yang *et al.*, 2024), potentially linked to gender-based differences in healthcare-seeking behavior and social exposure. The rifampicin resistance rate of 11.3% is a pivotal and concerning finding. This figure aligns with recent reports from neighboring nations, such as Iraq (Aljanaby *et al.*, 2022), and underscores the escalating challenge of drug-resistant TB for the Libyan healthcare infrastructure. The high RR-TB burden necessitates an urgent scale-up of routine drug susceptibility testing (DST) and access to shorter, more tolerable MDR-TB regimens (Borisov *et al.*, 2022). The study by Al-awakally *et al.*, 2022 highlighted the health challenges associated with the spread of rifampicin-resistant tuberculosis (RR-TB) in Benghazi, underscoring the critical importance of continuous epidemiological surveillance. The study also emphasized the crucial role of rapid molecular diagnostic techniques, such as GeneXpert, in quickly diagnosing and limiting the spread of these rifampicin-resistant strains. The findings reflect the need to update clinical treatment protocols and integrate rapid susceptibility testing to improve tuberculosis management.

The concentration of RR-TB cases within the 34-43-year age group, which represents the core of the economically productive population, highlights the substantial socioeconomic repercussions of

the disease. The observed seasonal peak during the dry summer months may be associated with environmental factors and increased indoor crowding, which facilitate aerosol transmission of the bacillus (Kuddus *et al.*, 2019).

Furthermore, the type of bacterial load is associated with infection, as cases with high and moderate bacterial loads in sputum have a high capacity to transmit tuberculosis infection to others. Bacterial load is determined by molecular tests such as GeneXpert MTB/RIF. These findings highlight the importance of early detection of the disease in infected individuals, as well as the effectiveness of prompt treatment and strengthening infection control measures to reduce the spread of tuberculosis bacteria within the community (li *et al.*, 2023).

CONCLUSION

The merged data from 2018 to 2023 confirm a high prevalence of tuberculosis and a significant rate of rifampicin resistance in the Benghazi region. These results stress the imperative for continuous epidemiological surveillance and the unwavering integration of rapid molecular diagnostics like GeneXpert into the national TB program. Public health initiatives should be strategically directed towards targeted interventions for high-risk demographics and geographic clusters identified in this study, alongside a sustained commitment to strengthening laboratory capacity for comprehensive drug susceptibility testing.

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REFERENCES

- Aljanaby, A. A. J., Al-Faham, Q. M. H., Aljanaby, I. A. J., & Hasan, T. H. (2022). Epidemiological study of Mycobacterium tuberculosis in Baghdad governorate, Iraq. *Gene Reports*, 26, 101467 mISSN 2452-0144. <https://doi.org/10.1016/j.genrep.2021.101467>
- Baya, B., Diarra, B., Diabate, S., Kone, B., Goita, D., Sarro, Y. D. S., Cohen, K., Holl, J. L., Achenbach, C. J., Tolofoudie, M., Togo, A. C. G., Sanogo, M., Kone, A., Kodio, O., Dabita, D., Coulibaly, N., Siddiqui, S., Diop, S., Bishai, W., Dao, S., ... Maiga, M. (2020). Association of *Mycobacterium africanum* Infection with Slower Disease Progression Compared with *Mycobacterium tuberculosis* in Malian Patients with Tuberculosis. *The American journal of tropical medicine and hygiene*, 102(1), 36–41. <https://doi.org/10.4269/ajtmh.19-0264>
- Benbrik, O., Bounar, O., Chakri, I., Lahlou, L., & Serhane, H. (2026). Treatment outcomes and associated factors among persons with pulmonary tuberculosis in Morocco: a systematic re-

view and meta-analysis. *BMC infectious diseases*, 26(1), 1288. <https://doi.org/10.1186/s12879-026-13586-y>

Davies, G. R., & Aston, S. (2023). Update on drug treatments for multidrug resistant tuberculosis. *Current opinion in infectious diseases*, 36(2), 132–139. <https://doi.org/10.1097/QCO.0000000000000899>

Elhadi, M., Msherghi, A., Alkeelani, M., Zorgani, A., Zaid, A., Alsuyihili, A., Buzreg, A., Ahmed, H., Elhadi, A., Khaled, A., Boughididah, T., Khel, S., Abdelkadir, M., Gaffaz, R., Bahroun, S., Alhashimi, A., Biala, M., Abulmida, S., Elharb, A., Abukhashem, M., ... Amshai, A. (2020). Assessment of Healthcare Workers' Levels of Preparedness and Awareness Regarding COVID-19 Infection in Low-Resource Settings. *The American journal of tropical medicine and hygiene*, 103(2), 828–833. <https://doi.org/10.4269/ajtmh.20-0330>

Horton KC, MacPherson P, Houben RMGJ, White RG, Corbett EL (2016) Sex Differences in Tuberculosis Burden and Notifications in Low- and Middle-Income Countries: A Systematic Review and Meta-analysis. *PLOS Medicine* 13(9): e1002119. <https://doi.org/10.1371/journal.pmed.1002119>

Kuddus, M.A., McBryde, E.S. & Adegboye, O.A. (2019) Delay effect and burden of weather-related tuberculosis cases in Rajshahi province, Bangladesh, 2007–2012. *Sci Rep* 9, 12720. <https://doi.org/10.1038/s41598-019-49135-8>

Li, K., Hu, Q., Liu, J., Liu, S., & He, Y. (2023). Effects of sputum bacillary load and age on GeneXpert and traditional methods in pulmonary tuberculosis: a 4-year retrospective comparative study. *BMC infectious diseases*, 23(1), 831. <https://doi.org/10.1186/s12879-023-08832-6>

Alawkally, Noor Alhooda & Ali, Mareei & Al-Awkally, Alreda & ALAAEDIN.M.S.ELDROLLI,. (2022). Rifampicin Resistant Tuberculosis in patients attending chest hospital Al- quefia-Benghazi city. *Journal of human ecology (Delhi, India)*. 49-54.

World Health Organization. (2024). Global tuberculosis report 2024. Geneva, Switzerland: World Health Organization. <https://www.who.int/publications/i/item/9789240101531>

World Health Organization. (2023). Global tuberculosis report 2023. WHO.

World Health Organization. (2022). Revitalization of TB services in Libya following the COVID-19 pandemic. World Health Organization. <https://www.who.int/about/accountability/results/who-results-report-2020-mtr/country-story/2022/revitalization-of-tb-services-in-libya-following-the-covid-19-pandemic>

Yang, H., Ruan, X., Li, W. *et al.* Global, regional, and national burden of tuberculosis and attributable risk factors for 204 countries and territories, 1990–2021: a systematic analysis for the Global Burden of Diseases 2021 study. *BMC Public Health* 24, 3111 (2024). <https://doi.org/10.1186/s12889-024-20664-w> 43