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Emergence of non-categorised Drug-resistant Tuberculosis among non-HIV patients: A new threat to Antimicrobial Resistance in Iraq

Emerging TB Resistance Among Non-HIV Patients

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Abstract

Objective: Tuberculosis is one of the ancient infectious diseases that causes a significant rate of death worldwide. Drug-resistant *Mycobacterium tuberculosis* has been categorised into different categories according to its resistance type. Emergence of new noncategorized strains in the post-COVID-19 years among non-HIV-infected patients forms a new threat to public health in Iraq and limits therapeutic options. The aim is to investigate the effect of the COVID-19 pandemic and HIV infection on tuberculosis incidence and drug resistance category of *Mycobacterium tuberculosis* in association with age and sex as a risk factor.

Methods: A total of 1211 patients were clinically and microbiologically confirmed to have tuberculosis. Identification used sputum smears, culture, Gene-Xpert assay, and drug sensitivity testing using Gene-Xpert MTB/RIF assay. All confirmed cases were checked for HIV.

Results: A total of 1211 confirmed TB patients were included. Patients' sex significantly affected the site of infection; pulmonary tuberculosis was 1.22 times higher among males. In contrast, extrapulmonary tuberculosis was significantly higher among females (58.46%). Isolates of the period 2023-2024 showed the emergence of strains sensitive to rifampin and isoniazid but resistant to the second-line anti-TB drugs (13, 30.8%); such resistance is rare and not categorised yet. Age, COVID-19, and HIV infection were not identified as independent predictors for the incidence of tuberculosis.

Conclusion: The emergence of a new category of M. tuberculosis among non-HIV-infected patients is an alarming sign. A national screening in all Iraqi cities and health education are recommended to increase public awareness and encourage rational use of antibiotics.

Keywords: Tuberculosis, HIV, COVID-19, Drug Resistance, Non-categorised Drug Resistance

Plain English Summary

This study highlighted the problem of drug-resistant tuberculosis (TB) in Najaf city, Iraq, where TB is a concern for public health. TB is caused by a bacterium that primarily affects the lungs and can spread easily

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to other body sites or from person to person. Standard TB treatment involves a combination of antibiotics, but in some cases, the bacteria become resistant to these drugs, making treatment much harder. The research examined patients with suspected drug-resistant TB to determine its link with patients' age, sex, site of infection and underlying viral infections, especially COVID-19 and HIV. Laboratory tests showed that resistance to first-line TB drugs is still a threat, with many patients not responding to rifampicin and isoniazid, the two most important medicines in TB treatment. The study also found that some of the patients were resistant to second-line drugs, creating even more challenges for treatment. Factors such as previous infection with viral diseases were not a significant cause for drug resistance, while factors such as age and sex were more effective. The findings highlight the need for early detection using rapid molecular tests, stronger patient follow-up, and better access to effective treatment. The study concludes that drug-resistant TB is a growing threat in Iraq and requires urgent attention. Without more effective control measures, including better diagnostics, patient support, and drug supply, it could undermine national and global TB elimination goals.

Background

Tuberculosis (TB) is an infectious disease predominantly caused by the human bacterium *Mycobacterium tuberculosis* (MTB) (1). Tuberculosis is classified using several systems; the most common is the one based on the anatomical site, which categorises the disease into pulmonary tuberculosis (PTB) and extrapulmonary tuberculosis (EPTB). The incidence of PTB and EPTB differs and can be influenced by sex-related factors (2).

In Iraq, the incidence of tuberculosis declined substantially after the enforcement of the antituberculosis vaccine in the childhood routine vaccination program, the improvement in personal hygiene and cultural standards and finally through its partnerships with the National TB Program (NTP) (3). According to the World Health Organisation (WHO), the incidence of TB caused by MTB is within the lower-moderate range based on the incidence of TB cases reported per 100,000 population per year in 2019 (4).

The WHO announced in 2024 that Iraq has recorded a remarkable success in TB control, and along with the low incidence of HIV infected patients, it is not common to encounter this state of coinfection and record a high rate of multidrug-resistant MTB (4).

The novel viral disease COVID-19 has intensely affected public health systems, overshadowing current challenges in TB therapy. Post-COVID-19 data from different countries indicated a resurgence in TB infection rates, considering TB as a leading cause of death from an infectious disease. In contrast, MTB has been identified as the predominant drug-resistant pathogen responsible for airborne transmission (6, 7).

Multidrug-resistant MTB (MDR-TB) refers to strains that are resistant to both rifampicin and isoniazid. Extensively drug-resistant MTB (XDR-TB) refers to strains that are resistant to the first-line anti-TB drugs isoniazid and rifampin, in addition to any fluoroquinolone and at least one of the three second-line injectable drugs. The second line of Anti-TB drugs includes bedaquiline (Bdq), linezolid (Lzd), moxifloxacin (Mfx), levofloxacin (Lfx), clofazimine (Cfz), cycloserine (Cs), para-aminosalicylic acid (PAS), propylthiouracil, and amikacin (Am) (8, 9).

Research proved that treating XDR-TB-infected patients has a higher therapeutic efficacy than treating XDR-TB patients infected with human immunodeficiency virus (HIV). The low HIV prevalence in Iraq offers a promising context for advancing tuberculosis elimination efforts, according to the World Bank report (10).

During the COVID-19 pandemic in 2020, there was a global defect in the control and follow-up of TB patients due to quarantine measures and the preoccupation of health centres with the treatment of COVID-19 patients. Some studies recorded an increase in the incidence of XDR-TB because of long periods of infectiousness or delay in the diagnosis of drug-resistant MTB that facilitates rapid transmission and further development of drug resistance (1111).

The current study aimed to evaluate the incidence of TB, particularly XDR-MTB, in the post-COVID-19 period compared to its incidence in the pre-COVID-19 period among HIV and non-HIV-infected patients.

Methods

A retrospective cross-sectional study investigating the prevalence of TB in the period pre- and post-COVID-19 pandemic. The study began on August 3, 2021. The data covered the period from 2018–2019 (the pre-COVID-19 period). The previous data were collected retrospectively from the records of the Consultation Clinic for Chest and Respiratory Diseases (CCRD) in Najaf. The newly diagnosed cases covered in the current study spanned the period from January 2020 to August 2024 (the post-COVID-19 period). The study was

conducted on 21st June 2022, sputum samples were collected and diagnosed till the end of the study on 5th January 2025; data before the study starting date were collected from patients' records.

Patient's inclusion criteria

Initial clinical investigation was performed by a pulmonologist; diagnosis was made in accordance with the NTP guidelines (8). All probable TB patients, all age groups with clinical presentation of TB, patients with chest X-ray suspicion or a history of contact with TB patients were considered for the primary investigation and considered as suspected tuberculosis cases (STB). A detailed patient's history was documented, including age, sex and date of symptom starting. Confirmed cases (CTB) included in the study were those who showed positive results for the sputum slide examination, sputum culture and GeneXpert results.

Samples with saliva, food parts or vomit, empty containers on arrival or containers with insufficient volume were rejected.

Collection of samples

For PTB, a chest X-ray was taken for radiological evaluation for each patient. When TB TB-defining abnormality appeared on Chest X-ray examination, the patient was asked to collect sputum. Three sputum samples were collected in the early morning; sputum was obtained after a deep, productive cough (a satisfactory quality shows the presence of mucoid or mucopurulent material). Patients were told to rinse their mouths with water before the specimen was produced. For optimal results, the patients needed to cough out sputum into clean and sterile specimen containers that had been labelled accordingly (12).

For EPTB patients, postsurgical removal of TB lesions, samples were collected into a sterile cup and sent to the laboratory.

Laboratory investigation

Sputum samples were subjected to Acid Fast Bacilli (AFB) staining, Gene-Xpert MTB/RIF assay and culture. Lowenstein-Jensen media was used to isolate and grow MTB. Samples were inoculated for one week. When the growth did not appear in 2 months, the samples were considered negative (13).

Samples were immediately processed using *Gene-Xpert MTB/RIF assay* according to the manufacturer's instructions. The interpretation of data from the MTB/RIF tests depended on the software shown in Figure 1. Patients with TB positive results were further referred to the central laboratory for HIV testing according to the NTP recommendations (8).

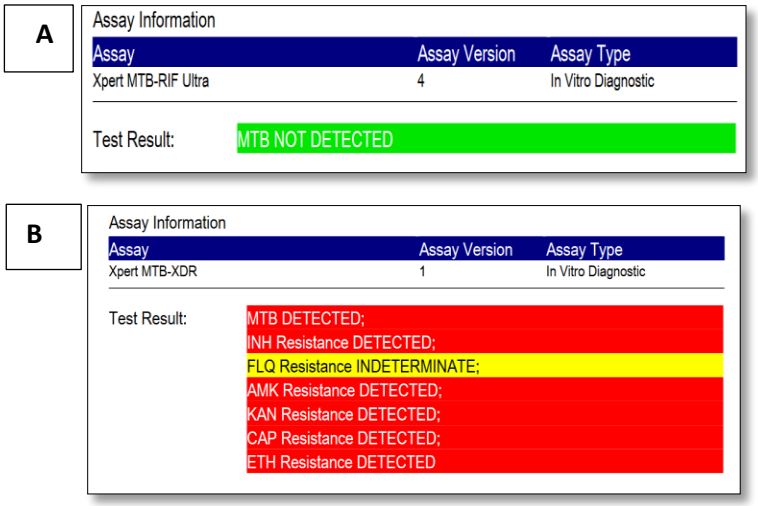

Figure 1 Gene-Xpert MTB/RIF assay results, (A) Negative Mycobacterium tuberculosis report, (B) Gene-Xpert MTB-XDR assay positive resistance report

Statistical analysis.

The age group of patients was specified in ten-year intervals starting from zero because one patient was nine 9 months old. Chi-square test was calculated using SPSS version 22.0. Antibiotic resistance was calculated using frequency and rate.

Results

A total of 1211 confirmed cases of TB were included in this study; 415/1211(34.3%) patients

were diagnosed in the pre-COVID-19 and 796/1211 (65.7%) patients were diagnosed post-COVID-19 pandemic. Male group formed [195/1211(16.1%) and 395/1211 (32.62%) cases] in the period pre- and post-Covid-19, respectively, compared to the female group, which formed [220/1211(18.17%) and 401/1211 (33.11%) cases] in the period pre- and post-Covid-19, respectively. The Mean = 302.75; SD 95.64, with a non-significant association between patients' sex and COVID-19 infection (P value > 0.05).

females recorded the highest rate of TB infection with a high predilection to EPTB (N=387, 54.66%), while males recorded a higher rate of PTB with a male: female ratio ranging from 1.1:1 to 1.5:1. The association between patients' sex and site of TB was non-significant (Table 1).

Table 1 Yearly distribution of TB patients according to sex and site of infection for the period (2018-2024)

Site	Total number/ Sex			Male: female ratio
	Male	Female	Total	
PTB	273 (54.6%)	227 (45.4%)	500 (41.29%)	1.2:1
EPTB	326 (45.85%)	385 (54.15%)	711 (58.71%)	0.85:1
Total	599 (49.46%)	612 (50.54%)	1211(100%)	P value 0.0032
Sex, site				
Year	**Site**	**Sex**		**Male: female ratio**
		Male No.	**Female No.**	**Total**
2018	PTB	55 (52.38%)	50(47.62%)	105(100%)	1.1:1
	EPTB	51(38.06%)	83(61.94%)	134(100%)	0.6:1
2019	PTB	42(60%)	28(40%)	70(100%)	1.5:1
	EPTB	47(44.34%)	59(55.66%)	106(100%)	0.8:1
2020	PTB	35(52.24%)	32(47.76%)	67(100%)	1.1:1
	EPTB	45(51.14%)	43(48.86%)	88(100%)	1.1:1
2021	PTB	30(55.56%)	24(44.44%)	54(100%)	1.3:1
	EPTB	51(53.68%)	44(46.32%)	95(100%)	1.2:1
2022	PTB	29(51.79%)	27(48.21%)	56(100%)	1.1:1
	EPTB	47(46.08%)	55(53.92%)	102(100%)	0.9:1
2023	PTB	45(54.88%)	37(45.12%)	82(100%)	1.2:1
	EPTB	52(46.43%)	60(53.57%)	112(100%)	0.9:1
2024	PTB	37(56.06%)	29(43.94%)	66(100%)	1.3:1
	EPTB	33(44.59%)	41(55.41%)	74(100%)	0.8:1
Total		599	612	1211(100%)	0.98:1
		P value= 0.19			

A total of 711 EPTB cases were diagnosed, lymph nodes were the most affected site (263 cases, (34.6%), followed by tuberculosis affecting different body sites (other sites) (91 cases, 12.0%) including ocular, pancreas, liver, etc., pleural effusion (89 cases, 11.7%), and bone and vertebral involvement (87 cases, 11.4%). Gastrointestinal TB was identified in 46 cases (6.1%), endocardial TB in 23 cases (3.0%), and cutaneous TB in 16 cases (2.1%). Less frequent forms included genitourinary TB (11 cases, 1.4%) and miliary TB (9 cases, 1.2%). The results were statistically significant ($\chi^2 = 1058.21$, df = 9, $p < 0.001$) (Figure 2).

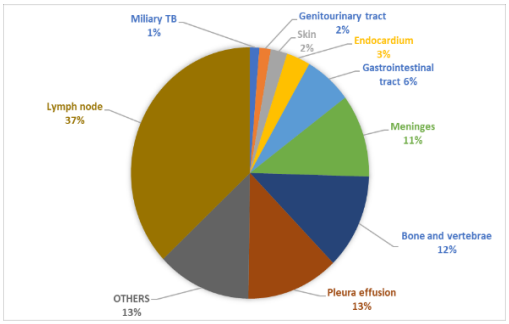

Figure 2 Site-specific distribution of Extrapulmonary Tuberculosis among the study group

The yearly distribution of TB cases exhibited temporal fluctuations, as illustrated in Table 2, with the peak incidence (19.74%) observed in the year 2018, a subsequent decline to a lower rate (12.3%) in the year 2021. The years 2022 and 2023 recorded a resurgence to higher incidence levels, 13.05% and 16.02 % respectively. The most affected age group was 21–30 with 252 cases (20.81%), while the lowest ratio was recorded among the age group 0–10 with 87 cases (7.18%). Age (51-60) years was significantly associated with tuberculosis risk ($p < 0.05$) compared to all other age groups.

Table 2 Association of tuberculosis cases with age groups for the period (2018-2024)

Year	2018	2019	2020	2021	2022	2023	2024	Total (Proportion)	P-value
*STB	318 (9.82%)	361 (18.30%)	276 (25.83%)	445 (17.08%)	673 (10.59%)	477 (13.85%)	256 (4.53%)	2606 (100%)	0
**CTB	239 (19.74%)	176 (14.53%)	155 (12.8%)	149 (12.3%)	158 (13.05%)	194 (16.02%)	140 (11.56%)	1211 (100%)	
Age, years									
0–10	9 (3.76%)	12 (6.81%)	11 (7.09%)	15 (10.06%)	14 (8.86%)	11 (5.67%)	15 (10.71%)	87 (7.18%)	0.123
11–20	44 (18.41%)	31 (17.61%)	20 (12.9%)	30 (20.13%)	24+ (15.18%)	32 (16.49%)	17 (12.14%)	198 (16.35%)	0.44
21–30	48 (20.08%)	33 (18.75%)	31 (20%)	41 (27.51%)	26 (16.45%)	47 (24.22%)	26 (18.57%)	252 (20.81%)	0.218
31–40	41 (17.15%)	24 (13.63%)	26 (16.77%)	23 (15.43%)	27 (17.08%)	27 (13.91%)	18 (12.86%)	186 (14.36%)	0.85
41–50	39 (16.31%)	23 (13.06%)	20 (12.9%)	19 (12.75%)	22 (13.92%)	31 (15.97%)	23 (16.43%)	177 (14.62%)	0.88
51–60	26 (10.87%)	29 (16.47%)	21 (13.54%)	5 (3.35%)	21 (13.29%)	23 (11.85%)	17 (12.14%)	142 (11.73%)	0.017*
≥61	32 (13.38%)	24 (13.63%)	26++ (16.77%)	16 (10.73%)	24 (15.18%)	23 (11.85%	24 (17.14%)	169 (13.96%)	0.61
Total	239 (100%)	176 (100%)	155 (100%)	149 (100%)	158 (100%)	194 (100%)	140 (100%)	1211 (100%)	0.22

Childhood tuberculosis data (below 5 years)

Sex	PTB	EPTB(No.=44)			PreCOVID-19 No (%)	PostCOVID-19 No. (%)	P-value
		LNTB	Skin	Bones			
Male	3(6%)	27(56%)	1(2.08%)	0	6 (75%)	26 (65%)	0.6
Female	1(2.08%)	13(27%)	0(0%)	3(6.25%)	2(25%)	14(35%)	

Year	2018	2019	2020	2021	2022	2023	2024	Total (Proportion)	P-value
Total (48)	4 (8%)	40 (83.33%)	1 (2.08%)	3 (6.25%)	8 (100%)		40 (100%)		

*STB, Suspected TB; **CTB, Confirmed TB; + HIV infected female; ++ HIV infected male

A total of 48 out of 87 (55.17%) children aged 0-10 years were found to have different forms of TB. The rate was calculated out of the entire study group; number 1211 was (No.= 48/1211, 3.96%). The majority of the cases were EPTB (No.= 44, 91.7%), the PTB formed (No.= 4, 8.3%) with male: female ratio of 1.82:1. There was an increase in the diagnosis of childhood TB in the post-COVID-19 period, cases observed (No.= 40, 83.3%), exceeding the numbers recorded before the COVID-19 (No.= 8, 16.7%).

Two patients (one male and one female) showed positive HIV/TB coinfection; the cases were reported in the years 2020 and 2022. HIV-infected patients' data were selectively highlighted in Table 2 to differentiate them from the broader cohort and to support targeted interpretation of data. In both cases, the male had sensitive miliary TB, and the female had PTB (P-value=0.989).

Drug-resistant MTB isolated in the years 2023 and 2024, the total number of isolates was (No. = 13, 1.07%). Isolates' resistance was variable, ranging from the highest recorded by isoniazid resistance (No. = 8, 61.5%) to the lowest for Ethambutol resistance (No. = 1, 7.7 %) (table 3).

Table 3 Comparison of different Resistance patterns to first- and second-line anti-tubercular drugs and their category among post-COVID-19 isolates

		General drug-resistance details							
No.	**Year**	**RIF-R**	**INH-R**	**FL-Q-R**	**AMK-R**	**KAN-R**	**CAP-R**	**ETH-R**	**Category of resistance**
1	2023	R	R	S	S	S	S	S	MDR
2		S	S	S	R	R	R	S	Noncategorized
3		R	S	R	R	R	S	S	XDR
4		S	R	S	S	S	S	S	Mono-resistant TB
5		S	S	R	R	R	S	S	Noncategorized
6		S	R	S	S	S	S	S	Mono-resistant TB
7		R	R	R	R	R	R	R	XDR
8		S	R	S	S	S	S	S	Mono-resistant TB
9		S	S	R	S	S	S	S	Noncategorized
10	2024	S	R	S	S	S	S	S	Mono-resistant TB
11		S	S	S	R	R	R	S	Noncategorized
12		S	R	S	S	S	S	S	Mono-resistant TB
13		S	R	S	S	S	S	S	Mono-resistant TB
Total		3/13 23.8%	8/13 61.5%	4/13 30.8%	5/13 38.5%	5/13 38.5%	3/13 23.8%	1/13 7.7%	$\chi^2 = 2.535$, df = 6 p < 0.86

RIF-R, Rifampicin-resistant; INH-R, Isoniazid-resistant; FL-Q-R, Fluoroquinolone-resistant; AMK-R, Amikacin-resistant; KAN-R, Kanamycin-resistant; CAP-R, Capreomycin-resistant; ETH-R, Ethionamide-resistant

Discussion

The study explored the incidence of tuberculosis among the Najaf city population, focusing on the influence of the COVID-19 pandemic and HIV infection on the category of drug resistance among MTB isolated from confirmed TB cases. Other epidemiological factors, such as sex and site of infection, were examined to determine their association with the incidence of tuberculosis among the population. Sex-based analysis of the data revealed a non-significant difference in TB incidence rates between males and females, with males showing higher incidence. The same conclusions were declared by the WHO and other studies, which recorded an increase in the rate of TB among the male group post COVID-19 (14, 15). The current results were inconsistent with preceding studies done in countries like the Philippines, India, Indonesia and China, which recorded a decrease in the number of TB cases in such period. The global pandemic of COVID-19 extensively affected health service delivery and

disease management, leading to an increase in disease incidence. Chronic disease management was particularly affected (16).

The cross-tabulation analysis between sex and the site of TB showed a notable distribution pattern, suggesting a strong association between sex and various disease manifestations. Males recorded a higher rate of PTB, while EPTB appeared to be relatively more common among female patients with a statistically significant difference (Table 1). Results align with trends reported in other regional and international studies (17, 18). Biological, immunological, and socio-cultural factors may contribute to these sex-based differences. Males are generally more exposed to risk factors such as smoking, occupational dust inhalation, and delayed health-seeking behaviours, which could contribute to the higher incidence of PTB. Females have relatively higher susceptibility to EPTB, which may be linked to differences in immune response or diagnostic pathways. Lymph node TB (LNTB) was the prevalent form in this study, accounting for 34.6% of all EPTB cases. Results agreed with other studies around the world, where LNTB is frequently reported as the predominant manifestation. A recent result highlighted that LNTB accounts for 35-40% of EPTB cases, predominantly affecting cervical lymph nodes and individuals in the productive age of 20 to 40 years. The high prevalence of LNTB may be attributed to the lymphatic system's role as a primary site for MTB dissemination and its function in initiating immune responses (18).

Pleural effusion was the third most common EPTB; this finding is consistent with previous reports indicating pleural TB as a frequent EPTB form, particularly in endemic regions. The main pathogenesis of tuberculous pleurisy involves a delayed hypersensitivity reaction to mycobacterial antigens in the pleural space, leading to granuloma formation (19).

Vertebral tuberculosis along with bone tuberculosis came in the second rate after lymph node TB and it was more prevalent among females compared to males such results were consistent with Al-Mashhadani, 2010 which recorded male to female ratio (0.9:1) in addition to a multicentre epidemiological study in Southwest China reported that spinal tuberculosis, particularly in the thoracic and lumbar regions, constituted the majority of bone TB cases (20, 21). The results disagree with results recorded in Africa that found that Pott's disease was predominant in men (sex ratio 1.3); such a difference could be due to occupational and environmental exposure of men to TB during work, such as mining, or due to the high rate of HIV infection (22). Although the exact cause of increased EPTB incidence among females remains unclear, evidence suggests that hormonal factors related to menopause and sex-based differences in healthcare access may contribute to their increased susceptibility (18).

Less frequent TB forms included Meningeal TB, gastrointestinal TB, endocardial TB, cutaneous TB, genitourinary TB, and miliary TB. The lower incidence of these forms may be due to nonspecific clinical presentations and diagnostic challenges. Gastrointestinal TB often presents with symptoms similar to other gastrointestinal disorders, leading to delayed diagnosis. Difficulty in diagnosing and managing gastrointestinal tuberculosis highlights the need for improved diagnostic strategies (23). Although Miliary TB recorded the lowest incidence through the study years, it still represents a dangerous form due to its high case fatality rate (CFR) if not promptly treated (24). In contrast to the current results, a nationwide multicentre retrospective study reported pleural TB as the most common form (29.6%), followed by LNTB (22.7%) and abdominal TB (21.0%) (25). While a study from Turkey observed that Miliary TB was the most common EPTB form, accounting for 22.83% of cases (26). Several factors may contribute to the differences between studies; the most significant are the environmental factors, healthcare infrastructure, and population demographics.

Age group analysis indicated that the more sensitive age group for TB was the 51-60 years old, which accounted for 11.73% of the study population. These results were inconsistent with similar results published by another study carried out in Iraq, where the age group 35 to 44 years was significant (27). Patients in this age group often have a risk for chronic underlying conditions, plus the effect of hormonal deviations like menopause in women or a decrease in testosterone among men. Such factors may increase the chance of TB reactivation.

Childhood tuberculosis recorded the lowest rate; however, it is considered the most dangerous type of TB, according to the WHO report and Dodd et al. (2017), children, especially those under 5 years, have a higher CFR when infected and are more prone to die once they get TB (3,5). The decline in the number of HIV infected patients in the current study can be supported by the evidence from the WHO records and previous studies conducted in Najaf city, which assured that HIV infection is very low among Iraqi patients (0.06%) (28, 29). Evidence from the Middle East and North Africa (MENA) region supporting the impact of HIV infection on drug resistance profile among TB

patients, the current results agree that HIV doesn't represent a dominant contributor to the number of observed cases or the resistance (30).

According to the current retrospective data analysis, a few non-indexed cases of drug-resistant TB were recorded in Najaf; this fact can be attributed to the successful implementation of the NTP recommendations. The Iraqi NTP was able to achieve a paradigm shift in changing the DR-TB treatment with the introduction of bedaquiline as part of a long regimen for newly and previously diagnosed and treated patients with complex resistance profiles (31).

However, the COVID-19 pandemic resulted in weakened TB control with an estimated increase in incidence among patients with MDR/RR-TB. The current study recorded the isolation of drug-resistant MTB with unusual resistance type (first-line sensitive / second-line resistant MTB) from 4 patients (Table 4). In Al-Najaf, published studies connecting the incidence of tuberculosis and drug resistance categories are very limited. A previous study conducted by Al-Hadraawy et al. (2022) highlighted the incidence rate of TB without mentioning the results of antibiotic sensitivity testing (32). Another review by Hassan et al (2020) expected the emergence of XDR-TB as a result of delayed diagnosis; however, the review did not provide data about the rate of drug-resistant TB (33). The irrational and extensive use of antibiotics during the COVID-19 pandemic significantly contributed to the upsurge of mutations, even within the human microbiome. Mutations among MTB could turn them from mono-drug resistant to totally drug resistant (TDR), through sequential accumulation of resistance mutations leading to the emerging threat of fluoroquinolone, bedaquiline, and linezolid resistance (34, 35). The implementation of advanced diagnostic tools, such as the GeneXpert, in recent years has improved TB detection rates in Najaf. However, the detection rate of drug-resistant TB is still challenging, especially since data on XDR-TB remains scarce. Although the current study tried to collect enough data, the accurate incidence of TB, the level of resistance and the underlying condition are unclear. The limited access to advanced diagnostic tools in Iraq limits data availability. In addition, tuberculosis remains a stigmatised disease, and some patients may avoid seeking medical care, leading to hidden cases and further limiting information resources.

The current study has encountered several obstacles, such as the limited ability to accurately detect MTB and drug-resistant MTB due to the shortage in XpertMTB/RIF test materials and depending on culture results, which takes a long time, which may affect the accurate frequency.

Conclusion

Iraq is not a global hotspot for tuberculosis; confirmed cases do exist, but in a low frequency compared to other countries, and the actual frequency may be higher than reported due to diagnostic limitations. The most affected age group is 20 to 31 years among non-HIV patients, and sex is a significant determinant for the site of TB infection, with females being more sensitive to EPTB than PTB patients. The scarcity of drug-resistant TB, especially XDR-TB studies in Najaf, reflects a combination of epidemiological under-detection, insufficient laboratory infrastructure, and systemic research barriers. Enhancing diagnostic capacity, training health workers, and building robust TB surveillance networks are crucial for filling this knowledge gap and guiding public health interventions for the management and control of TB in Iraq.

List of Abbreviations

TB: Tuberculosis
MDR-TB: Multidrug-Resistant Tuberculosis
XDR-TB: Extensively Drug-Resistant Tuberculosis
RR-TB: Rifampicin-Resistant Tuberculosis
INH: Isoniazid
RIF: Rifampicin
DST: Drug Susceptibility Testing
WHO: World Health Organisation
HIV: Human Immunodeficiency Virus
DNA: Deoxyribonucleic Acid
LJ: Lowenstein-Jensen (culture medium)
PCR: Polymerase Chain Reaction

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Medical Research and Ethics Committee at the Faculty of Medicine, Jabir Ibn Hayyan University of Medical and Pharmaceutical Sciences, Najaf, Iraq, and by the Directorate of Health in Al-Najaf Governorate (Approval No. 175, dated 18/09/2022).

Informed consent was obtained from all participants or their legal guardians.

Consent for Publication

Not applicable. This study does not include any identifying images or personal details of individuals.

Availability of Data and Materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests
The authors declare that they have no known competing financial or personal interests that could have influenced the work reported in this paper.

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Authors' contributions
AZMA: Performed microbiological isolation, antimicrobial susceptibility testing, and molecular analyses, and assisted in data interpretation.
AAMA: Conceived and designed the study, supervised laboratory experiments, and contributed to manuscript drafting.
AAN: Performed clinical sample collection, conducted statistical analysis, prepared figures and tables, and contributed to writing and critical revision of the manuscript. please let me know if you need further assistance.
best regards,

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