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Original Article **Open Access**

Burden and predictors of drug-resistant tuberculosis in Burkina Faso

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Abstract:

Background: In Burkina Faso, the emergence of resistance within the *Mycobacterium tuberculosis* complex (MTBC) represents a growing public health challenge, threatening the progress made toward tuberculosis (TB) control. This study aimed to estimate the prevalence of rifampicin- and isoniazid-resistant TB and to identify factors associated with multidrug-resistant TB (MDR-TB) among patients managed at the National Tuberculosis Control Center (CNLAT).
Methodology: A cross-sectional study was conducted using samples from 3,485 presumptive and confirmed TB patients received at CNLAT from January 2020 to December 2023. MTBC detection and rifampicin resistance screening were performed using the Xpert MTB/RIF assay. Samples testing rifampicin-resistant were further analyzed with the GenoType MDR*plus* v2.0 assay to assess concurrent resistance to isoniazid and rifampicin.
Results: The overall prevalence of rifampicin-resistant TB (RR-TB) among 3,485 TB patients was 2.7% (95% CI: 2.2–3.3), 1.9% among new cases and 11.7% among previously treated cases. Of 60 RR-TB cases identified by Xpert MTB/RIF assay tested by GenoType MDR*plus*, 73.3% (44/60) were confirmed multidrug-resistant (MDR-TB). Significant associations were observed between MDR/RR-TB and age (p=0.044) and previous TB treatment history (p<0.001).
Conclusion: This study reveals a notable burden of MDR/RR-TB (2.7%) in Burkina Faso, emphasizing the need for systematic molecular testing and robust patient monitoring throughout treatment. Strengthening early diagnosis, treatment adherence, and molecular surveillance will be critical to limiting the spread of drug-resistant TB and achieving national TB elimination targets.

Keywords: Multidrug-resistant tuberculosis, rifampicin resistance, molecular diagnostics, surveillance, Burkina Faso

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Charge et facteurs prédictifs de la tuberculose pharmacorésistante au Burkina Faso

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Résumé:

Contexte: Au Burkina Faso, l'émergence de résistances au sein du complexe Mycobacterium tuberculosis (MTBC) représente un défi croissant de santé publique, menaçant les progrès réalisés dans la lutte contre la tuberculose (TB). Cette étude visait à estimer la prévalence de la TB résistante à la rifampicine et à l'isoniazide et à identifier les facteurs associés à la tuberculose multirésistante (TB-MR) chez les patients pris en charge au Centre national de lutte contre la tuberculose (CNLAT).
Méthodologie: Une étude transversale a été menée à partir d'échantillons prélevés chez 3 485 patients présentant une tuberculose présumée ou confirmée, admis au CNLAT entre janvier 2020 et décembre 2023. La détection du MTBC et le dépistage de la résistance à la rifampicine ont été réalisés à l'aide du test Xpert MTB/RIF. Les échantillons résistants à la rifampicine ont ensuite été analysés par le test GenoType MDRplus v2.0 afin d'évaluer la résistance concomitante à l'isoniazide et à la rifampicine.
Résultats: La prévalence globale de la tuberculose résistante à la rifampicine (TB-RR) parmi 3485 patients tuberculeux était de 2,7% (IC à 95%: 2,2–3,3), soit 1,9% parmi les nouveaux cas et 11,7% parmi les cas déjà traités. Sur 60 cas de TB-RR identifiés par le test Xpert MTB/RIF et confirmés par GenoType MDRplus, 73,3% (44/60) étaient des cas confirmés de tuberculose multirésistante (TB-MR). Des associations significatives ont été observées entre la TB-MR/RR et l'âge (p=0,044) ainsi que les antécédents de traitement antituberculeux (p<0,001).
Conclusion: Cette étude révèle une prévalence importante de TB-MR/RR (2,7%) au Burkina Faso, soulignant la nécessité de tests moléculaires systématiques et d'un suivi rigoureux des patients tout au long du traitement. Le renforcement du diagnostic précoce, de l'observance thérapeutique et de la surveillance moléculaire sera essentiel pour limiter la propagation de la tuberculose résistante aux médicaments et atteindre les objectifs nationaux d'élimination de la tuberculose.

Mots-clés: Tuberculose multirésistante, résistance à la rifampicine, diagnostic moléculaire, surveillance, Burkina Faso

Introduction:

Tuberculosis (TB) remains one of the leading causes of infectious morbidity and mortality worldwide, despite significant advances in diagnosis and treatment. The emergence and spread of drug-resistant forms of the *Mycobacterium tuberculosis* complex (MTBC) represent a major threat to global public health and a critical obstacle to achieving the World Health Organization (WHO) End TB Strategy targets for 2035 (1). Resistance to first-line anti-tuberculosis drugs, particularly rifampicin and isoniazid, compromises the efficacy of standard treatment regimens and increases the risk of treatment failure, relapse, and community transmission of resistant strains (2-5).

Globally, the WHO estimates that more than 10 million people continue to fall ill with TB each year, resulting in over one million deaths (5). Between 2020 and 2023, the annual number of individuals who developed rifampicin-resistant (RR-TB) or multidrug-resistant TB (MDR-TB) remained relatively stable, representing approximately 3–4% of new TB cases and 16–17% of previously treated cases (1,5). The highest proportions of MDR- and XDR-TB cases were reported in the Russian Federation and in several countries across Eastern Europe and Central Asia (5). According to the five most recent WHO global TB reports, Africa remains one of the three WHO regions most heavily affected by the disease (1,5). Within the continent, Nigeria, the Republic of the Congo, and South Africa are among the 30 countries with the highest TB burden (1,5).

In Burkina Faso, TB continues to pose a serious public health concern. The latest national drug resistance surveillance survey, conducted in 2019, reported rifampicin resistance in 2.0% of new cases and 14.5% of previously treated cases, 83% of which were classified as MDR-TB(6). However, since this survey, limited updated data have been available, and disruptions related to the COVID-19 pandemic may have further impacted TB detection, treatment adherence, and resistance dynamics.

Given the clinical and epidemiological implications of multidrug-resistant TB, continuous and up-to-date surveillance is essential to inform diagnostic and therapeutic strategies. This study, therefore aimed to estimate the prevalence of rifampicin-resistant and multi-drug-re-

sistant TB (RR/MDR-TB) among patients' managed at the National Tuberculosis Control Center (CNLAT) in Burkina Faso between 2020 and 2023, thereby contributing to the national update of anti-TB drug resistance surveillance data.

Materials and method:

Study setting:

This study was conducted at the National Tuberculosis Control Center (CNLAT), located in Ouagadougou, in the central region of Burkina Faso. The CNLAT hosts the National Reference Laboratory for Mycobacteria (LNR-M), which serves as the country's main facility for TB diagnosis, drug susceptibility testing, and molecular surveillance.

Study design and period:

A descriptive cross-sectional study was carried out over four years, from January 1, 2020, to December 31, 2023. This timeframe was selected to capture a representative overview of the evolution of drug resistance patterns in the MTBC during the post-COVID-19 period.

Study population:

The study included all patients with suspected or confirmed tuberculosis whose biological samples were received at the CNLAT for bacteriological confirmation and drug resistance testing. Patients originated from multiple regions across Burkina Faso, encompassing both new TB cases and previously treated cases.

Ethical considerations:

The study received approval from the Burkina Faso Health Research Ethics Committee (deliberation n° 2015-6-080). Patient confidentiality and anonymity were strictly maintained throughout the study in accordance with ethical standards for biomedical research.

Collection of biological samples:

Biological samples varied according to the suspected form of TB. For pulmonary TB, early-morning sputum specimens (≥5 mL) were collected by patients into sterile containers while for extrapulmonary TB, ascitic fluid, lymph node pus, pleural fluid, gastric aspirates, or bronchoalveolar lavage were collected aseptically by trained medical personnel.

Samples were transported to the LNR-M either by patients, accompanying staff, or through the Integrated Biological Sample Transport System (SITEB) within 48 hours. When immediate transport was not feasible, samples were refrigerated at +2°C to +8°C and shipped within a maximum of 48 hours.

Detection of the *Mycobacterium tuberculosis* complex and rifampicin resistance:

Detection of MTBC and rifampicin resistance was performed simultaneously using the Xpert MTB/RIF assay (Cepheid®, Sunnyvale, USA). This real-time PCR-based test targets the *rpoB* gene, identifying mutations within the Rifampicin Resistance Determining Region (RRDR, codons 505–533). Results were interpreted according to the manufacturer's guidelines and the National Tuberculosis Control Programme (PNLT) standards.

Detection of isoniazid resistance:

Isoniazid resistance testing was conducted on samples showing rifampicin resistance using the GenoType® MDR*plus* v2.0 Line Probe Assay (Hain Lifescience GmbH, Germany), following WHO-recommended protocols. This reverse hybridization assay detects mutations in *rpoB* gene (codons 505–533) for rifampicin resistance, and *katG* gene (codon 315) and *inhA* promoter for isoniazid resistance. Resistance profiles were determined based on the hybridization pattern of amplified DNA fragments to mutation-specific probes.

Data analysis:

Data were entered and cleaned using Microsoft Excel 2016, then analyzed with R software version 4.4.1. Descriptive statistics summarized baseline characteristics. Associations between independent variables (age, sex, treatment history, TB type) and resistance outcomes were assessed using Chi-square tests and univariate and multivariate logistic regression analyses. A p value < 0.05 was considered statistically significant.

Results:

Sociodemographic and clinical characteristics of the study population:

A total of 3,485 tuberculosis patients were included in the study, of whom 92.1% (n=3,211) were new cases, and 7.9% (n=274) had been previously treated. The participants' ages ranged from 1 to 99 years, with a mean age of 38 ± 5.8 years. Males accounted for the majority of cases (77.4%) compared with females (22.6%), with a male-to-female ratio of approximately 3.4:1. The most represented age group was 25–44 years, comprising 51.7% of the patients.

Table 1: Socio-demographic characteristics of the patients with suspected or confirmed tuberculosis at the National Tuberculosis Control Center (CNLAT), Ouagadougou, Burkina Faso

Characteristics	Number (n = 3,485)	Percentage (%)
Gender		
Male	2,698	77.4
Female	787	22.6
Age group (years)		
0–14	90	2.6
15–24	437	12.5
25–34	904	25.9
35–44	899	25.8
45–54	561	16.1
55–64	325	9.3
≥ 65	269	7.7
Treatment history		
New cases	3,211	92.1
Previously treated	274	7.9
Type of tuberculosis		
Pulmonary	3,388	97.2
Extrapulmonary	97	2.8

Most cases were pulmonary tuberculosis (97.2%), while extrapulmonary forms represented only 2.8% of diagnoses (Table 1). This demographic pattern reflects the typical profile of TB patients in high-burden settings, where young adult males, the most economically active segment of the population, are disproportionately affected.

Prevalence and risk factors associated with rifampicin resistance:

Among 3,485 tuberculosis cases confirmed by the Xpert MTB/RIF test, 94 rifampicin-resistant TB (RR-TB) cases were detected, corresponding to an overall prevalence of 2.7%. Of these, 1.9% (62/3,211) occurred among new cases, and 11.7% (32/274) among previously treated patients.

In univariate analysis, age group and treatment history were significantly associated with RR-TB. Adult patients aged 25–44 years had a higher likelihood of developing RR-TB (OR = 2.47; 95% CI: 1.25–5.60; $p = 0.017$), which remained significant in multivariate analysis (adjusted OR = 2.18; 95% CI: 1.08–5.01; $p = 0.044$).

Similarly, patients with a history of TB treatment showed a strong association with RR-TB (adjusted OR = 6.33; 95% CI: 3.99–9.87; $p < 0.001$). No significant association was found with sex ($p = 0.633$) or other age categories (Table 2). These findings indicate that previous TB treatment and adult age (25–44 years) are major determinants of rifampicin resistance in this population.

Table 2: Prevalence and risk factors associated with rifampicin resistance in the tuberculosis

Variable	Total (n)	RR-TB prevalence (%)	Univariate OR (95% CI)	*p* value	Multivariate OR (95% CI)	*p* value
Gender						
Male	2,698	2.78	1.16 (0.71–1.98)	0.578	0.88 (0.53–1.53)	0.633
Female	787	2.41	Ref	—	Ref	—
Age group (years)						
0–24	904	3.2	Ref	—	Ref	—
25–44	899	4.1	2.47 (1.25–5.60)	0.017	2.18 (1.08–5.01)	0.044
45–64	561	1.8	1.35 (0.60–3.30)	0.489	1.25 (0.55–3.09)	0.614
≥ 65	269	0.7	0.49 (0.07–1.96)	0.363	0.48 (0.07–1.94)	0.354
Treatment history						
New cases	3,211	1.93	Ref	—	Ref	—
Previously treated	274	11.68	6.72 (4.25–10.42)	<0.001	6.33 (3.99–9.87)	0.001

Table 3: Proportion of *Mycobacterium tuberculosis* complex resistant to rifampicin and isoniazid using Xpert MTB/RIF and GenoType MDR*plus* v2.0

Tests	Drug	Total (N)	New cases (Resistant/Total)	%	Previously treated (Resistant/Total)	%	Overall resistance (%)
Xpert MTB/RIF	RIF	3,485	62/3,211	1.9	32/274	11.68	2.7
GenoType MDRplus v2.0	INH	60	34/46	73.9	10/14	71.4	73.3
GenoType MDRplus v2.0	RIF	60	46/46	100	14/14	100	100
Combined (INH + RIF)	—	60	34/46	73.9	10/14	71.4	73.3

RIF = Rifampicin; INH = Isoniazid

Resistance profile of the *Mycobacterium tuberculosis* complex:

Among 60 RR isolates from Xpert MTB/RIF assay tested with GenoType MDR*plus* v2.0, all were confirmed resistant to rifampicin, and 44 (73.3%) were also resistant to isoniazid, meeting the definition of multidrug-resistant TB (MDR-TB). The MDR-TB prevalence was comparable between new (73.9%) and previously treated cases (71.4%) (Table 3).

Discussion:

This study aimed to estimate the prevalence and associated factors of multidrug-resistant and extensively drug-resistant tuberculosis (MDR/XDR-TB) among patients diagnosed at the National Tuberculosis Control Center (CNLAT) in Burkina Faso. The overall prevalence of MDR/XDR-TB was 2.7%, including 1.9% among new cases and 11.7% among previously treated cases. Among rifampicin-resistant isolates, 73.3% also exhibited isoniazid resistance, confirming MDR-TB.

The prevalence observed in this study is comparable to that reported in Ghana (2.4%) (7), but lower than that documented in Ethiopia (5.3%) (11), Botswana (5.4%) (9), and Nigeria (5.8%) (10), illustrating the heterogeneous geographical distribution of MDR/XDR-TB across Africa. These results place Burkina Faso among countries with a relatively low prevalence (<3%), consistent with the WHO 2024 global estimate of 3.2% (6). The similarity between our findings and those of the 2019 national resistance survey (2.0%) (7) suggests a stable trend in drug resistance in Burkina Faso over the past five years.

However, the higher prevalence of MDR/XDR-TB among previously treated patients (11.7%) underscores the need to strengthen treatment adherence and follow-up. This prevalence is slightly lower than that reported in Burkina Faso (14.5%) in 2019 (7) and below the global prevalence (16%) reported by WHO in 2024 (6). Similar findings have been observed in other African countries such as Ghana (1.3% vs 25%) (8), Ethiopia (2.3% vs 14.36%) (11), Nigeria (6.0% vs 32%) (10), and Botswana (1.3% vs 7.7%) (9). These differences confirm that previous treatment remains a major determinant of drug resistance, as shown by our results (aOR=6.33; 95% CI: 3.99–9.87; p<0.001), consistent with earlier studies in Burkina Faso (14,15).

Inadequate drug regimens, poor-quality medications, suboptimal prescription practices, and poor adherence (2,5,14) contribute to the development of resistance through selective pressure on *M. tuberculosis* strains. In addition, the study revealed that patients aged 25–44 years were more likely to develop MDR/XDR-TB (aOR=2.18; 95% CI: 1.08–5.01; p=0.044). This association was not observed in the 2019 national survey (7) but could be related to behavioural and occupational factors, as this age group represents the most active and mobile segment of the population. Frequent work-related mobility may compromise treatment adherence, favouring the emergence of resistant forms. Further studies are needed to explore socio-behavioural determinants of resistance in this group. Conversely, no significant association was found between gender and MDR/XDR-TB, consistent with previous studies conducted in Burkina Faso (8,15).

Regarding the resistance profile, 73.3% of rifampicin-resistant strains were also resistant to isoniazid, which aligns with previous national data from 2017 showing approximately 83% dual resistance (7). This observation confirms that in Burkina Faso, the majority of RR-TB cases correspond to MDR-TB. Globally, several studies have reported that rifampicin monoresistance is rare, as resistance to rifampicin is frequently associated with isoniazid resistance in about 75% of cases (2,3,16). For this reason, rifampicin resistance is widely used as a surrogate marker for MDR-TB, justifying the immediate initiation of MDR-TB treatment upon RR-TB detection (13).

Conclusion:

This study provides updated insights into the burden and determinants of drug-resistant tuberculosis in Burkina Faso, revealing a moderate but persistent prevalence of MDR/

XDR-TB. The findings show that resistance remains significantly associated with previous TB treatment and with the 25–44-year-old age group, suggesting that both therapeutic history and population mobility play a crucial role in the emergence of resistant forms.

To effectively contain the spread of MDR/XDR-TB, it is crucial to strengthen molecular diagnostic capacity and ensure the rapid and decentralized detection of resistant cases. Continuous monitoring of treatment adherence and improvement of directly observed therapy are essential to prevent therapeutic failure and relapse. Furthermore, expanding surveillance of drug resistance and integrating genomic tools such as whole genome sequencing will improve the early detection of transmission clusters and the understanding of circulating resistant strains.

Sustained investment in diagnostic infrastructure, health worker training, and patient education is indispensable to improving therapeutic outcomes and interrupting transmission chains. These actions are vital for achieving the WHO End TB Strategy targets for 2035 and for preventing the further expansion of drug-resistant tuberculosis in Burkina Faso and across the region.

Contributions of authors:

APY, TLS, YAN, and DK conceived and designed the study; APY, TLS, YAN, DK, AAZ, AD, AS, AmD, SJEP, and MAS were involved in data acquisition and drafting the manuscript; APY, AS, and GS performed the statistical analysis and interpretation; and TS, AC, IJOB and, and PSD approved the final version of the manuscript.

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Conflict of interest:

Authors declared no conflict of interest.

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