


# Primary Resistance to Anti-Tuberculosis Drugs: The Case of the Seven Health Regions in the Central African Republic

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## Abstract

**Introduction:** Resistance to anti-tuberculosis drugs poses a threat to tuberculosis control programs. The Central African Republic is no exception. The aim of this study is to determine the prevalence of primary tuberculosis resistance in the Central African Republic. **Methodology:** This study was conducted at the National Laboratory of Clinical Biology and Public Health and focused on tuberculosis data from the country's seven health regions. The sample consisted of patients who tested positive for tuberculosis using GeneXpert. The data collected were entered into Excel and analyzed using Epi Info 7. **Results:** A total of 12,112 patients aged between 4 months and 100 years were registered between January and June 2025 in the country's seven health regions. The median age was  $35 \pm 18$  years and the most common age was 40 years. The most represented age group was 15 to 49 years. The male-to-female ratio was 1.28. The overall prevalence of primary tuberculosis resistance was 6.07%. The prevalence of single-drug resistant tuberculosis was 5.67% and that of multi-drug resistant tuberculosis was 0.41%. Resistance to rifampicin alone accounted for 93.10%. This primary resistance was predominant in the 15 - 49 age group. The highest prevalence of resistance was found in June with 48 cases, or 8.7%. Among the 2862 positive cases recorded, 174 cases of resistant

tuberculosis were recorded, including 162 cases of resistance to first-line drugs and 12 cases of multidrug resistance. The highest prevalence of first-line resistance cases was found in the Bimbo health district with 11.8%, and cases of this resistance were most prevalent in Health Region No.7 of the country. Cases of primary resistance to anti-tuberculosis drugs were more common in sputum samples (93.67%) and in patients with a high bacterial load (33.33%). Month ( $p = 0.03$ ), sex (0.03), place of residence ( $p = 0.04$ ), pulmonary location (0.02), and bacterial load (0.01) were the variables significantly associated with resistance. The risk of developing resistant tuberculosis was 3.50 times higher in patients with pulmonary tuberculosis (adjusted OR = 3.50, CI = [1.07 - 8.15]). **Conclusion:** Measures focused on transmission and more specifically on the early detection of drug-resistant TB, the prevention of hospital acquired infections, contact tracing and the rapid provision of effective treatment are needed to better control primary resistance.

### Keywords

Primary Resistance, Anti-Tuberculosis Drugs, Health Regions, Central African Republic

## 1. Introduction

Tuberculosis is a transmissible disease whose morbidity and mortality continue to be a major global health concern. The World Health Organization (WHO) has published a report on tuberculosis indicating that approximately 8.2 million new cases were diagnosed in 2023 [1]. This is the highest number ever recorded since the WHO began monitoring tuberculosis worldwide in 1995. A contrary trend was observed for the number of tuberculosis-related deaths, which declined from 1.32 million in 2022 to 1.25 million in 2023 [1]. The world faces multiple challenges, including lack of funding and the heavy financial burden on people affected by tuberculosis, climate change, conflict, and migration. Added to these problems is resistance to anti-tuberculosis drugs. Resistance to an anti-tuberculosis drug is a phenotypic trait that characterizes the ability of a bacterium to survive and multiply in the presence of that antibiotic at a bacteriostatic or bactericidal concentration. It can be natural or acquired. Resistance to anti-tuberculosis drugs is referred to as primary when it is detected in a patient who has never been treated for tuberculosis. On the other hand, resistance is referred to as secondary if the patient has previously been treated for tuberculosis for at least one month (WHO, 1997). The treatment success rate for rifampicin-resistant or multidrug-resistant tuberculosis (RR-MR) has reached 68% [1]. However, of the estimated 400,000 people who developed RR-MR tuberculosis, only 44% were diagnosed and treated in 2023 [1]. The decline in the global incidence of tuberculosis is slow, and resistance to anti-tuberculosis drugs has become a major global public health problem. These data may compromise the WHO's targets of reducing the incidence of

tuberculosis by 90% and deaths from tuberculosis by 95% by 2035 in the most affected countries of sub-Saharan Africa [2]. Since December 2010, the WHO has recommended the use of GeneXpert MTB/RIF, a highly sensitive molecular biology technique for diagnosing tuberculosis and detecting rifampicin resistance [3]. The Central African Republic (CAR) is one of the countries with a high prevalence of tuberculosis. With the advent of GeneXpert, prevalences ranging from 31 to 79.1% have been reported in recent years [4]-[7]. The issue of resistance to anti-tuberculosis drugs has already been addressed by several authors in the CAR [8]-[13]. In 2021, the CAR recorded 12,785 cases of tuberculosis, including 118 cases of multidrug resistance (MDR-TB) [11]. The prevalence of MDR-TB rose from 0.4% in 2011 to 3.8% in 2021, a 9.5-fold increase [11]. However, these studies were largely limited to the city of Bangui, the country's capital. A study taking into account data from almost all of the country's health districts (32 out of 35) will provide a map of the disease. The present study aims to determine the prevalence of tuberculosis resistant to anti-tuberculosis drugs, to determine the prevalence according to the type of resistance, and to identify the sociodemographic characteristics associated with resistance.

## **2. Methodology**

### **2.1. Type and Duration**

This was a descriptive cross-sectional study lasting six months, from January 1 to June 30, 2025.

### **2.2. Study Population and Sampling**

The population study consisted of patients referred to Mycobacterium Laboratories for tuberculosis screening, regardless of location. The study sample consisted of all patients who tested positive for tuberculosis during the first half of 2025 and for whom data were available. Sampling was therefore exhaustive for the study period. Tuberculosis cases with indeterminate resistance tests, follow-up data for patients undergoing treatment, and tuberculosis data based on microscopy were not included in the study. This is because cases of resistance identified through laboratory testing are classified as secondary resistance cases and, unlike GeneXpert, microscopy does not detect resistance.

### **2.3. Operational Definition**

Primary resistance is confirmed on the basis of two criteria: the patient's lack of a clinical history of anti-tuberculosis treatment and laboratory findings. A case of primary resistance to anti-tuberculosis drugs is defined as a patient detected for the first time who presents either resistance to rifampicin or multidrug resistance and who has never been on anti-tuberculosis treatment, with supporting evidence (not registered in the tuberculosis register or having no clinical record).

### **2.4. Data Collection**

A data collection form was prepared in advance for the purpose of gathering data.

This form lists the variables to be recorded as part of the study. The data source was the Mycobacteria laboratories' database. The Access template for the form is made available to laboratories involved in the National Tuberculosis Control Programme. Duplicate data consisted of test errors caused by power cuts (the word "error" displayed on the screen instead of a negative or positive result). These erroneous data were excluded from the analysis as the patient must return for a second test. Data cleaning also addressed input errors for certain data.

## 2.5. Study Variables

The variables in the study were age, sex, place of residence (district or region), screening status (negative or positive), degree of test positivity (very low, low, high, very high), resistance to anti-tuberculosis drugs (yes or no), and type of resistance (resistance to rifampicin or multidrug resistance).

## 2.6. Laboratory Analysis

In the laboratory, the analysis technique used was the GeneXpert test. GeneXpert is a molecular biology technique that enables rapid detection of *Mycobacterium tuberculosis* DNA and rifampicin resistance. It is a semi-quantitative automated test based on real-time semi-nested amplification of the core region of the *rpoB* locus for the diagnosis of TB and for the detection of genetic mutations associated with rifampicin resistance. It also increases the detection rate of *Mycobacterium tuberculosis* and enables early screening for rifampicin resistance. Under the hood, carefully unscrew the spittoon. From direct sputum: Take 2 vol ml of Sample Reagent and 1 vol of sputum in a 15 ml Falcon tube. From the decontaminated pellet, take 1.5 ml of sample reagent and 0.5 ml of pellet. Shake the mixture and leave it at room temperature for 10 minutes. Shake again and leave for 5 minutes. Remove the cartridge from its packaging and open the cartridge cover. Use the pipette to draw up the liquefied sample. Transfer 2 ml of the sample into the cartridge chamber. Start the test within 30 minutes. The result is generated from the measured fluorescence signals and integrated calculation algorithms. The response appears on the screen in less than 2 hours. The result is semi-quantitative for the presence of *M. tuberculosis* complex DNA. The result indicates whether or not rifampicin resistance has been detected.

## 2.7. Data Processing and Analysis

The collected data were entered into Excel 2016 and analyzed using Epi Info version 7 software. The number and frequency of each variable in the study were determined. The tuberculosis prevalence rate was calculated as the ratio of the number of positive tests to the total number of patients screened. The prevalence rate of resistance was determined as the number of cases of resistance divided by the total number of positive tuberculosis cases. These calculated rates were expressed as percentages. Karl Pearson's chi-square test, significant for a p-value of

less than 5%, was used to highlight the association between tuberculosis and the study variables. The odds ratio (OR) and adjusted odds ratio (ORa) were determined by bivariate or multivariate analysis and logistic regression, respectively. We coded the variables using numerical codes in accordance with the requirements for logistic regression.

### 3. Results

#### 3.1. Sociodemographic Characteristics of Patients

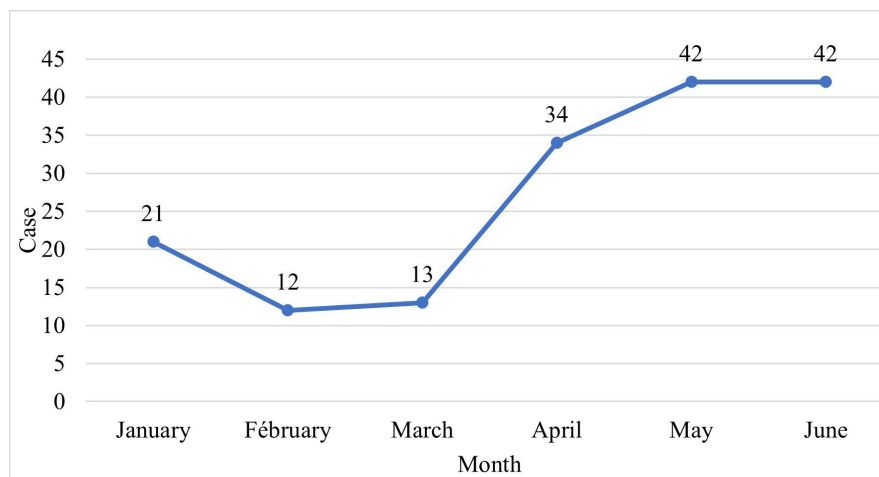
According to **Table 1**, 12,112 patients aged between 4 months and 100 years were registered between January and June 2025 in the Central African Republic. The median age was  $35 \pm 18$  years and the most common age was 40 years. The most represented age group was 15 to 49 years old, with 7536 participants and 2144 positive cases. The male-to-female ratio was 1.28. The overall prevalence of primary tuberculosis resistance was 6.07%. The prevalence of single-drug resistant tuberculosis was 5.67% and that of multi-drug resistant tuberculosis was 0.41%. Resistance to rifampicin alone accounted for 93.10% of resistant cases. This primary resistance was predominant in the 15 - 49 age group with  $N = 135$  and in men with  $N = 121$ . **Table 1** shows the distribution of tuberculosis cases by month, age, and sex.

**Table 1.** Distribution of tuberculosis cases by month, age, and sex.

Caractéristiques	Effectifs	TB+	Resistance to Rifampicin	Multi-resistance	Drug-resistant tuberculosis
		N	N	N	Cases (Prevalence)
<b>Mois</b>					
January	1931	485	21	0	21 (4.32%)
Fébruary	1615	359	12	1	13 (3.62%)
March	1302	308	13	0	13 (4.22%)
April	2013	522	34	2	36 (6.89%)
May	2246	517	42	3	45 (8.70%)
June	3005	671	42	6	48 (7.15%)
<b>Age group</b>					
≤14 years	1899	252	14	1	15 (5.59%)
15 - 49 years	7536	2142	129	6	135 (6.30%)
≥50 years	2677	468	21	3	24 (5.12%)
<b>Gender</b>					
Fémale	5303	1071	50	3	53 (4.94%)
Male	6809	1791	112	9	121 (6.75%)
<b>Total</b>	<b>12112</b>	<b>2862</b>	<b>162</b>	<b>12</b>	<b>174 (6.07%)</b>

### 3.2. Distribution of Resistant Tuberculosis Cases by Period

According to **Figure 1**, cases of primary resistance gradually decreased in January. From February onwards, this rate increased gradually until May, when it peaked at 8.7%, before decreasing in June to 7.15%. The highest prevalence of resistance was in June, with 48 cases, or 8.7%. **Figure 1** shows the distribution of resistant tuberculosis by month.



**Figure 1.** Distribution of drug-resistant tuberculosis by month.

### 3.3. Distribution of Drug-Resistant Tuberculosis Cases by Location

According to **Table 2**, 2862 positive cases were recorded, including 174 cases of drug-resistant tuberculosis, of which 162 were resistant to first-line drugs and 12 were multidrug-resistant. The highest prevalence of first-line resistance cases was found in the Bimbo health district with 11.8%, followed by the Nana Gribizi health district with 11.5% and the Kemo health district with 11.1%. Cases of single resistance (56.17%) and multi-resistance (100%) were most prevalent in the Bangui 1 health district. **Table 2** shows the distribution of tuberculosis cases and resistance by district and health region.

**Table 2.** Distribution of drug-resistant tuberculosis cases by place of residence.

Health region	Health district	TB+	Resistance to Rifampicin	Multi-resistance	Drug-resistant tuberculosis
		N (%)	N	N	Cases (Prevalence)
HR1	Bégoua	202	10	0	10 (4.95%)
	Bimbo	135	16	0	16 (11.85%)
	Boda	56	3	0	3 (5.35%)
	Bossembelé	58	0	0	0 (0%)
	Mbaïki	121	1	0	1 (0.83%)
Total HR1		572 (19.98)	30	0	30 (5.24%)

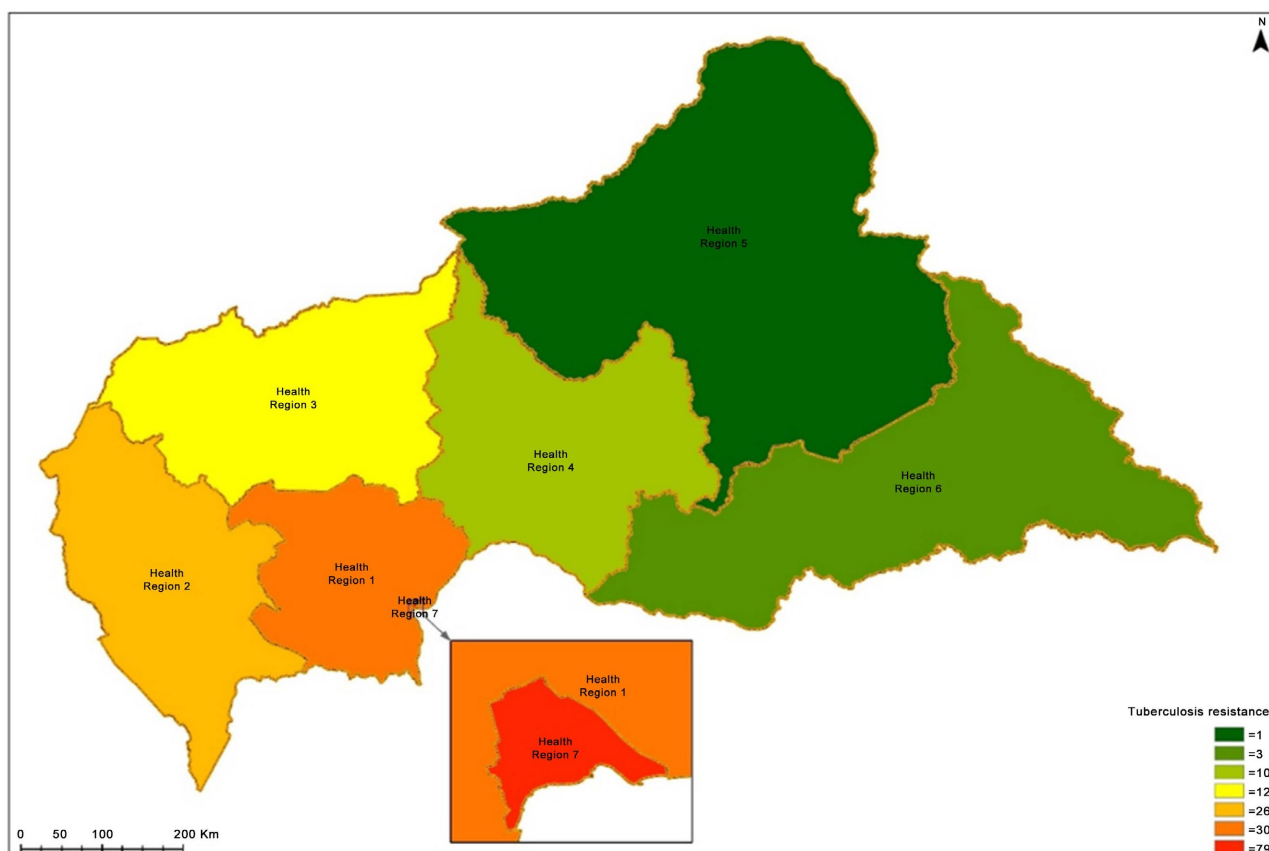
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	Baboua-Abba	29	0	0	0 (0%)
	Berberati	182	9	0	9 (4.94%)
HR2	Bouar-Baoro	91	5	0	5 (5.49%)
	Carnot-Gadzi	121	9	0	9 (7.43%)
	Gamboula	13	3	0	3 (5.76%)
	Sangha-Mbaéré	41	0	0	0 (0%)
Total HR2		607 (21.20)	26	0	26 (4.28%)
	Batangafo-Kabo	35	2	0	2 (5.72%)
	Bocaranga-Koui	14	0	0	0 (0%)
	Bossangoa	97	4	0	4 (4.12%)
HR3	Bouca	24	2	0	2 (8.33%)
	Bozoum-Bossemptelé	55	2	0	2 (3.63%)
	Nangha-Boguila	NR	NR	NR	NR
	Ngaoundaye	41	1	0	1 (2.43%)
	Paoua	60	1	0	1 (1.66%)
Total HR3		326 (11.39)	12	0	12 (3.68%)
	Bambari	65	2	0	2 (3.07%)
RS4	Grimari-Kouango	13	1	0	1 (7.69%)
	Kémo	36	4	0	4 (11.11%)
	Nana-Gribizi	26	3	0	3 (11.53%)
Total HR4		114 (3.98)	10	0	10 (8.77%)
	Bamingui-Bangoran	21	0	0	0 (0%)
HR5	Haute Kotto	44	1	0	1 (2.27%)
	Vakaga	NR	NR	NR	NR
Total HR5		65 (2.28)	1	0	1 (1.53%)
	Alindao-Mingala	28	0	0	0 (0%)
	Bangassou	25	2	0	2 (8)
HR6	Haut Mbomou	3	0	0	0 (0%)
	Kembé-Satéma	20	1	0	1 (5%)
	Mobaye-Zangba	21	0	0	0 (0%)
Total HR6		97 (3.39)	3	0	3 (3.09%)
	Bangui 1	609	44	12	56 (9.19%)
HR7	Bangui 2	221	18	0	18 (8.15%)
	Bangui 3	313	17	0	17 (5.43%)
Total HR7		143 (39.93)	79	12	91 (7.96%)
<b>Total</b>		<b>2862 (100)</b>	<b>162</b>	<b>12</b>	<b>174 (6.04%)</b>

HR = Health region and NR = Not received.

### 3.4. Distribution of Resistant Tuberculosis Cases by Health Region

The highest number of cases of tuberculosis resistant to anti-tuberculosis drugs was found in Health Region No. 7 of the country with 79 cases, followed by Health Region No. 1 with 30 cases. **Figure 2** shows the distribution of tuberculosis cases and resistance by region.



**Figure 2.** Distribution of tuberculosis cases by region.

### 3.5. Biological Characteristics of Resistance to Anti-Tuberculosis Drugs

Cases of primary resistance to anti-tuberculosis drugs were more common in sputum samples (93.67%) and in patients with a high bacterial load (33.33%). These data are presented in **Table 3**.

**Table 3.** Distribution of primary resistance by type.

Variables	Resistance cases	Resistance to Rifampicin	Multiresistance
<b>Type of sample</b>			
Expectoration	163	151	12
Cerebrospinal fluid	0	0	0

**Continued**

Joint aspiration	0	0	0
Ascites puncture	0	0	0
Lymph node biopsy	0	0	0
Pleural puncture	0	0	0
Pus	0	0	0
Stools	3	3	0
Gastric tube	5	5	0
Urine	3	3	0
<b>Bacterial load</b>			
Very low	1	1	0
Low	40	40	0
Medium	31	29	2
High	58	52	6
Very high	44	40	4
<b>Total</b>	<b>174</b>	<b>162</b>	<b>12</b>

Variables associated with the risk of drug-resistant tuberculosis.

Month ( $p = 0.03$ ), sex ( $0.03$ ), place of residence ( $p = 0.04$ ), pulmonary location ( $0.02$ ), and bacterial load ( $0.01$ ) were variables significantly associated with resistance. The risk of developing resistant tuberculosis was 3.50 times higher in patients with pulmonary tuberculosis (adjusted OR = 3.50, CI = [1.07 - 8.15]). These data are presented in **Table 4**.

**Table 4.** Presents the variables associated with the risk of resistance by logistic regression.

Features	Resistance		Bivariate analysis		Multivariate analysis	
	No	Yes	ORb (IC)	p-value	ORa (IC)	p-value
<b>Month</b>						
January	465	20	-		-	
Fébruary	347	12	-		-	
March	295	13	-		-	
April	486	36	-	0.03	-	0.03
May	472	45	-		-	
June	626	45	-		-	
<b>Age group</b>						
≤45 ans	2040	138	1		-	-
>45 ans	651	33	0.74 [0.50 - 1.10]	0.07	-	-

## Continued

<b>Gender</b>							
Female	1018	53	1		0.03	1	0.03
Male	1189	118	1.35 [0.97 - 1.89]			1.38 [1.17 - 3.11]	
<b>Place of residence</b>							
HR1	572	30					
HR2	607	26					
HR3	326	12					
HR4	114	10					
HR5	65	1	-		0.04	-	0.04
HR6	97	3					
HR7	143	91					
<b>Location</b>							
Pulmonary	2505	163	3.15 [1.03 - 8.10]		0.02	3.50 [1.07 - 8.15]	0.02
Extra pulmonary	183	11					
<b>Bacterial load</b>							
Low	1119	72	1			1	
High	1569	102	1.51 [1.05 - 7.41]		0.01	1.52 [1.06 - 7.12]	0.01
<b>Total</b>	<b>2688</b>	<b>174</b>					

Low load = very low + low + medium; High load = high + very high.

## 4. Discussion

### 4.1. Characteristics of the Study Sample

Tuberculosis remains the leading cause of morbidity and mortality in the Central African Republic despite numerous control programs. In addition to the complications of this disease caused by HIV/AIDS, there is now the phenomenon of *Mycobacterium tuberculosis* resistance to anti-tuberculosis drugs. During the first half of 2025, we recorded 2862 cases of tuberculosis in the seven health regions of the CAR, including 174 cases of resistance. In terms of proportion, these cases of resistance were most prevalent in June with 26.85% and May with 45 cases, in RS7, which includes the DS of Bangui 1, 2, and 3 (93 cases), among children aged 15 to 49 (137 cases), men (122 cases), sputum samples (162) and patients with a high bacterial load (58). The study samples were more numerous in June with 671 cases and May with 517 cases. In CAR, the rainy season lasts from April to October, creating conditions conducive to the survival of the bacillus in the environment due to humidity. The population, and indeed the cases of tuberculosis, were predominantly among young adults (n = 2142). In Africa in general, and in CAR in particular, young people predominate. This predominance among young adults is consistent with previous studies conducted in CAR [4]-[7]. The predominance of males is consistent with data from other studies conducted in the CAR and else-

where [4]-[12] [14]-[16]. This could be the result of differences in exposure between men and women in terms of their roles in society. Men are often involved in several sectors of activity, which could increase their exposure to the risk of disease [14]. Sputum samples were the predominant sample type among patients undergoing screening; this explains the high number of tuberculosis cases, including cases of resistance, for this type of sample. Added to this is the fact that pulmonary tuberculosis is the most common form of the disease and the form most likely to spread. The predominance of pulmonary tuberculosis in our study is consistent with studies conducted in the Central African Republic and elsewhere [17]-[19].

#### 4.2. Primary Resistance to Tuberculosis

Secondary resistance can develop into what is known as primary resistance. This can be explained by the context of treatment for each patient. When tuberculosis treatment is poorly designed or poorly followed by the patient, it can lead to the selection of resistant mutants. This is known as secondary resistance or resistance acquired during treatment. Tuberculosis patients carrying a resistant strain can infect those around them, who will develop tuberculosis with bacilli that are resistant from the outset. This is known as primary resistance. The increase in cases of primary resistance is proportional to that of secondary resistance when conditions are favorable for the spread of bacilli [14]. This increase reflects the cases of primary resistance already reported in the CAR. The prevalence of primary resistance reported in our series was 6.07%. This is higher than that reported in studies by Farra *et al.* in CAR (4.1%) and Burkina Faso (12.4%) [11] [15]. In contrast, this prevalence is lower than that reported in studies conducted by Natelao *et al.* (7.69%), Bamozouré *et al.* (6.15%) in the Central African Republic, and Walbang *et al.* in Chad [12] [13] [16]. The prevalence of primary resistance also reflects the reservoir of resistant strains among cases that have already been treated [17]. The natural resistance of *Mycobacterium tuberculosis* to anti-tuberculosis drugs is rare, and the selection of drug-resistant strains is almost always the result of inadequate treatment. The probability that a mutation will lead to drug resistance is directly proportional to the size of the bacterial population in the patient. The high bacterial load reported in this study was significantly associated with resistance to anti-tuberculosis drugs. It is therefore most often monotherapy or inadequate treatment that has allowed the emergence of MDR strains [17].

#### 4.3. Single Resistance and Multi-Resistance

Following the emergence of multi-resistant strains in several countries around the world, resistance to anti-tuberculosis drugs poses a threat to tuberculosis control programs [18]. A WHO study of 17,690 tuberculosis cases in 49 countries between 2020 and 2024 revealed that 20% of cases were MDR-TB. In our study, MDR-TB accounted for 6.07% of new cases. This proportion is below the critical threshold set by the WHO at 10% [17]. When standardized chemotherapy programs comply

with WHO recommendations, the prevalence of primary MDR-TB is less than 3% [17]. Multi-drug resistance rates higher than our data have been reported in Rwanda (7%) and in Henan Province (11%) in China [18] [19]. These differences could be explained by the high rates of TB in these countries. In contrast, lower rates have been observed in Madagascar (0.2%) and Kenya (0.54%) [20] [21]. The proportion of secondary MDR-TB reported in our study was 37.5% (3/8). The emergence of multidrug resistance is a major threat, both at the individual level and for the national tuberculosis control program. Patients harboring these strains are extremely difficult to treat and require much more expensive and toxic treatments [22]. As expected, the risk of resistance is much higher when the patient has already received anti-TB treatment in the past, which shows how important it is to know the patient's history [2] [3]. These observations show how important it is to know the country of birth of patients in order to interpret the results of resistance surveillance, as recommended by the WHO. Finally, the cases of multidrug resistance reported here are likely to be underestimated (12 cases of multidrug resistance compared to 162 cases of monoresistance). These are cases of multidrug resistance detected only in the capital by the two reference laboratories that use the GeneXpert 10-color test. This is because 32 districts do not use the GeneXpert 10-color test, which has the ability to detect monoresistance, multidrug resistance, and ultraresistance. Therapeutic failure could occur if another anti-tuberculosis drug prescribed in addition to rifampicin for cases of monoresistance is not the most appropriate (due to undetected resistance). The GeneXpert ten-color test needs to be rolled out to all districts in the country to enable wider diagnosis of cases of resistance. In fact, access to molecular testing (GeneXpert) is the same for laboratories in district and regional hospitals across the CAR. These laboratories all receive support from the Global Fund to Fight HIV, Tuberculosis and Malaria. The difference is that these two laboratories have been provided with this model of GeneXpert (ten-colour) by the Global Fund for specific reasons. The Pasteur Institute in Bangui is the Reference Laboratory for tuberculosis in the CAR, and the National Clinical Biology Laboratory is the national reference laboratory. Furthermore, the transport of samples in rural areas is secure, and there are no security-related constraints for tuberculosis. It should also be noted that regional comparisons may reflect testing coverage rather than genuine differences in incidence. The performance of GeneXpert in the screening for tuberculosis has been demonstrated in a number of studies. This relates to the test's sensitivity, its specificity (as it does not detect atypical mycobacteria), its speed (in contrast to culture), and its ability to detect cases of resistance to anti-tuberculosis drugs [23] [24]. Added to this is its significant contribution to the surveillance of cases of drug-resistant tuberculosis [25]-[27]. Implementing certain measures will enable better control of primary tuberculosis resistance. These measures focus on transmission and, more specifically, the rapid detection of drug-resistant TB, the prevention of infections in clinics, contact tracing and the provision of rapid, effective treatment. Secondary resistance is the direct consequence of poor management.

Early diagnosis of resistance allows for the rapid implementation of appropriate treatment and improves the patient's prognosis while reducing the risk of transmission of resistant strains, which leads to primary resistance. To prevent the occurrence of primary resistance, the transmission of mutant and drug-resistant bacilli must be interrupted. In addition to treatment history, which takes into account interruption of anti-tuberculosis treatment and treatment abandonment, cases of self-medication should also be reported. According to the policy of the Ministry of Health and Population, anti-tuberculosis treatment is free of charge in CAR. Anti-tuberculosis drugs are not sold on the market. First-line anti-tuberculosis drugs such as rifampicin, isoniazid, and ethambutol are not recommended for medical prescription for other diseases in CAR. This is to prevent the development of resistance to these molecules. However, these molecules are available at certain street drug outlets. The use of anti-tuberculosis drugs is not limited to tuberculosis, but also extends to other common diseases in the community (wounds, typhoid fever, COVID-19, etc.). The Central African government has just taken measures to ban the sale of drugs on the street. This initiative will enable the Ministry of Health and Population to better monitor trends in resistance to anti-tuberculosis drugs.

## 5. Study Limitations

The questionnaires were not administered to individuals who tested positive for resistance to anti-tuberculosis drugs. This should enable us to understand whether cases of primary resistance were associated with family history or other variables such as occupation, history of treatment for another condition with an anti-tuberculosis drug, alcohol consumption, smoking, etc. According to some authors, a patient with MDR-TB would naturally transmit resistant bacilli to those around them [10] [28] [29]. Similarly, alcohol and tobacco use have been reported by some authors to be associated with the development of resistance to anti-tuberculosis drugs [10] [30]. In addition, the HIV status of patients was not taken into account in the data, as it was not available.

## 6. Conclusion

Resistance to anti-tuberculosis drugs is a growing phenomenon in CAR. The study revealed that all seven health regions in CAR were affected. Cases of resistance were more frequent among patients aged 15 to 49, men, and those residing in RS7. Resistance to anti-tuberculosis drugs was found to be highly prevalent in this study. This highlights the need to strengthen surveillance of this resistance in the CAR. Collecting information on the progress and outcome of patients, as well as other specific cases, must be an integral part of providing quality care for these patients. Cases of multidrug resistance were only detected by reference laboratories in RS7 that use the GeneXpert 10-color test. Extending this GeneXpert model to all districts in the country is necessary for a diagnosis that takes into account all types of resistance. Tuberculosis resistant to rifampicin and isoniazid,

which are first-line antibiotics, remains a concern today. The inappropriate use of anti-tuberculosis drugs leads to the emergence of resistant strains of *Mycobacterium tuberculosis*. This resistance to anti-tuberculosis drugs poses a threat to tuberculosis control programs. Early diagnosis of resistance allows for the rapid implementation of appropriate treatment and improves prognosis, while reducing the risk of transmission of resistant strains. In order to prevent the emergence of new resistant strains, it would be best to ensure proper patient care, avoid interruptions in anti-tuberculosis treatment, and closely monitor newly diagnosed patients and those in isolation. To better manage the primary resistance associated with transmission-focused measures, and in particular the early detection of drug-resistant TB, infection prevention in clinics, contact tracing and rapid, effective treatment are essential.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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