


Molecular Diagnosis of Incident Tuberculosis in Patients Attending Clinics in Health Districts of the Central African Republic

Henri Serge Gbazi^{1,2*}, Alain Farra^{3,4}, Ernest Lango Yaya^{2,4}, Christian Maucler Pamatika^{4,5}, Boniface Koffi^{2,4}, Emmanuel Nakouné³, Hervé Ngando⁵, Boris Jolly Lokoti^{1,3}, Elvis Makopa¹, Obed Hérítier Lango^{1,2}, Laris Michaël Danhouron Bejendo², Doriane Wanibilo³, Mireille Denissio^{4,5}, Séraphin Boukoni², Augustin Balekouzou^{4,6}, Henri Diemer^{1,4}, Sylvain Wilfried Nambei^{1,4,6}

¹Fundamental Unit for Research in Biological Sciences, Doctoral School of Human and Veterinary Health Sciences, University of Bangui, Bangui, The Central African Republic (CAR)

²National Laboratory of Clinical Biology and Public Health, Bangui, The Central African Republic (CAR)

³Pasteur Institute of Bangui, Bangui, The Central African Republic (CAR)

⁴Faculty of health sciences, University of Bangui, Bangui, The Central African Republic (CAR)

⁵Ministry of Health and Population, Bangui, The Central African Republic (CAR)

⁶National AIDS Control Coordination, Bangui, The Central African Republic (CAR)

Email: *hsgbazi@gmail.com

How to cite this paper: Gbazi, H.S., Farra, A., Yaya, E.L., Pamatika, C.M., Koffi, B., Nakouné, E., Ngando, H., Lokoti, B.J., Makopa, E., Lango, O.H., Bejendo, L.M.D., Wanibilo, D., Denissio, M., Boukoni, S., Balekouzou, A., Diemer, H. and Nambei, S.W. (2026) Molecular Diagnosis of Incident Tuberculosis in Patients Attending Clinics in Health Districts of the Central African Republic. *Health*, 18, 178-190.
<https://doi.org/10.4236/health.2026.182013>

Received: January 12, 2026

Accepted: February 23, 2026

Published: February 26, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Introduction: Tuberculosis remains a major cause of morbidity, with infection affecting more than one-third of the world's population, and mortality. The risk of transmission of pulmonary tuberculosis is determined by the presence of new cases. In The Central African Republic (CAR), the incidence of tuberculosis was first documented in 2014. The objective of this study was to determine the incidence of tuberculosis based on molecular screening carried out in the country's health districts. **Methodology:** This was a descriptive cross-sectional study conducted at the National Laboratory of Clinical Biology and Public Health in Bangui over a six-month period from January to June 2025. The study sample consisted of patients screened for tuberculosis in thirty-two health districts during this period. Patients currently undergoing anti-tuberculosis treatment were excluded to ensure that the focus was on incident cases. The biological samples collected were analyzed using GeneXpert, a semi-quantitative automated test based on real-time amplification of *Mycobacterium tuberculosis* complex DNA and rifampicin resistance. This molecular biology technique enables rapid detection of *Mycobacterium tuberculosis* complex DNA. 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 in 32 of the 35 districts in the CAR. The median age was 35 ± 18 years and the most common age was 40 years. The male-to-female ratio was 1.8. The most represented age group was 15 to 49 years old, with a rate of 62.23%. The overall incidence of tuberculosis was 45.50 per 100,000 person-months. The highest incidence was found in June (10.67 per 100,000 person-months), among patients aged ≥ 50 years (323.50/100,000 person-semester), men (57.99/100,000 person-months), and those in Bangui District 1 (319/100,000 person-months). Pulmonary tuberculosis was the most common location among cases (93.22%). High bacterial load (27.32%) and low bacterial load (25.29%) were more prevalent. Male gender ($p = 0.0004$) and place of residence ($p < 0.0001$) were significantly associated with the occurrence of tuberculosis. Advanced age provided a significant level of protection (ORa = 0.67 and $p < 0.0001$). Pulmonary localization accounted for 93.22% of tuberculosis cases. The other localizations were extrapulmonary (6.78%). Male gender ($p = 0.0004$, ORa = 1.30 [1.12 - 1.52]) and place of residence ($p < 0.0001$) were the variables significantly associated with the occurrence of tuberculosis. **Conclusion:** Tuberculosis remains a major public health problem in the CAR due to its morbidity. New cases of pulmonary tuberculosis, which are a source of new infections, are not insignificant. There is a need to focus on prevention through awareness-raising.

Keywords

Molecular Diagnosis, Tuberculosis, District, The Central African Republic

1. Introduction

Tuberculosis is an infectious disease caused by bacteria belonging to the genus *Mycobacterium* and species of the *Mycobacterium tuberculosis* complex. Pulmonary involvement is common in humans and animals, with the disease spreading through the air. This disease remains a major cause of morbidity and mortality, with 1.6 million deaths among the 10 million people with tuberculosis worldwide in 2022 (according to the World Health Organization). This reservoir of infection produces approximately 8 million new cases each year, with one new case occurring every second [1]. The infection affects more than one-third of the world's population, and nearly 2 million people die from the disease each year. All age groups are at risk, but 75% of cases occur in people aged 15 to 45, who represent the most economically productive group. The human immunodeficiency virus (HIV) pandemic has led to a resurgence of tuberculosis in many countries. The situation has worsened since the 1990s with the emergence of multidrug-resistant (MDR) strains and XDR (extensively or extremely drug-resistant tuberculosis) forms. Microscope-positive pulmonary tuberculosis (MPTB) is the most common form and the only contagious form. Incidence and prevalence are the two morbidity indicators that provide the best assessment of the burden of a disease. The risk of tuberculosis transmission is determined by the presence of new cases or

incident cases. In Africa, tuberculosis has always been a scourge despite the efforts of control programs. In most African countries, the annual incidence rate varies between 100 and 500 cases per 100,000 inhabitants [2]-[5]. The poor socioeconomic conditions of African populations contribute to the maintenance of these very high incidence rates [6]. In the Central African Republic (CAR), the fight against tuberculosis is implemented by the National Tuberculosis Control Program (PNLT). The prevalence of MDR-TB in the CAR has already been the subject of previous studies [7] [8]. The incidence of tuberculosis already documented among people living with HIV in the CAR dates back to 2014 [9]. The same is true for the molecular diagnosis of MDR-TB with reported cases of resistance [10]-[12]. These studies concern almost exclusively the city of Bangui. The CAR has a total of thirty-five health districts (HDs) spread across seven health regions. This study aims to identify new cases of tuberculosis through an incidence study based on molecular screening carried out in thirty-two health districts across the country.

2. Methodology

2.1. Study Setting

The study was conducted at the National Laboratory of Clinical Biology and Public Health in Bangui. The peripheral sites of the study were the health districts grouped together in the region.

2.2. Type and Duration

This was a descriptive cross-sectional study. The study was conducted over a six-month period, from January 1st to June 30th, 2025.

2.3. Study Population and Sample

The study population consisted of patients referred to district hospitals for persistent cough with suspected tuberculosis. The study sample consisted of patients screened for tuberculosis in the first half of 2025. Patients currently undergoing anti-tuberculosis treatment were excluded to ensure that the focus was on incident cases. Laboratory monitoring data for these patients were therefore not taken into account.

2.4. Study Variables

Age, sex, place of residence, screening status (negative or positive), degree of positivity (very low, low, mean, high, very high). To facilitate the analysis of data on patients' places of residence, villages, neighborhoods, and municipalities were grouped according to the health district to which they belonged.

2.5. Laboratory Analysis

CDT laboratories use two techniques for screening for tuberculosis: microscopy with Ziehl-Neelsen staining and GeneXpert. The technique chosen for laboratory

analysis was GeneXpert, a more sensitive molecular technique recommended by the WHO since 2011 for screening of pulmonary tuberculosis in countries with a high prevalence of HIV. The sample to be analyzed is sputum or another biological fluid (gastric tube contents, urine, stool, pus, ascites puncture, pleural puncture, lymph node puncture, cerebrospinal fluid, etc.). The DNA of the bacteria is extracted from the samples using the Quiagen Kit according to the manufacturer's recommendations. TaqMan™ Master Mix is used for real-time PCR. Each 25 µl of reaction mix will contain 0.4 µM of each primer, 0.3 µM of probe, and 5µl of DNA. Amplification is performed on Applied Biosystems 7500 Fast. After collection and labeling of the samples, the sputum samples are stored in a fume hood (Type II Microbiological Safety Cabinet) for testing. A mixture of 2 ml of sputum and 4 ml of sample reagent is prepared in a 15 ml tube. The mixture obtained is closed and gently shaken for a few seconds, then left to stand for 10 minutes at room temperature. The mixture is shaken again, then left to stand once more for 5 minutes at room temperature, for a total of 15 minutes. The GeneXpert cartridge is removed from its packaging, labeled, and the cap opened. Using a Pasteur pipette, 2 ml of samples are taken and transferred to the cartridge chamber. The test is performed within 30 minutes by inserting the prepared cartridge into the device, and the result is available in 90 minutes. The result is displayed in real time on the machine via an exponential curve generated in the form of a graph with the words "Negative" or "Positive". For a positive result, the bacterial load is estimated based on the degree of positivity given by the test (very low, low, medium, or high). GeneXpert also detects rifampicin resistance in these samples.

2.6. Data Processing and Analysis

The collected data were entered into an Excel spreadsheet. This Excel spreadsheet was also used to generate the figures. Data analysis was performed using Epi Info version 7 software from CDC-Atlanta. We determined the number and frequency of each variable in the study with a 95% confidence interval. The incidence expressed in person-months was determined as the number of new cases divided by the product of the population at risk and the duration. For tuberculosis, the incidence is determined per 100,000 inhabitants. The population of the districts is that of the 2021 mapping by the Central African Institute of Statistics and Economic and Social Studies (ICASEES). The Chi-square test at a 5% threshold was used to highlight the association between tuberculosis and the study variables. The degree of association was measured by determining the odds ratio (OR). The search for variables associated with risk was carried out at two levels, namely simple bivariate or multivariate analysis or multivariate analysis using logistic regression.

3. Results

3.1. Sociodemographic Characteristics of Patients

According to **Table 1**, 12,112 patients aged 4 months to 100 years were registered

in 32 of the 35 districts of the CAR. The median age was 35 ± 18 years, and the most common age was 40 years. The male-to-female ratio was 1.8. The most represented age group was 15 to 49 years old, with a rate of 62.23%.

Table 1. Distribution of patients according to sociodemographic characteristics.

Features	Sample size	Percentage
Age group		
≤14 years	1899	15.68
15 - 49 years	7536	62.22
≥50 years	2677	22.10
Gender		
Female	5303	43.78
Male	6809	56.22
Health Region		
Health Region 1	2362	19.51
Health Region 2	2554	21.09
Health Region 3	1298	10.71
Health Region 4	530	4.38
Health Region 5	287	2.36
Health Region 6	471	3.88
Health Region 7	4610	38.08
Type of sample		
Expectoration	11,090	91.56
Cerebrospinal fluid	145	1.20
Joint aspiration	5	0.05
Ascites puncture	51	0.43
Lymph node biopsy	7	0.05
Pleural puncture	35	0.29
Pus	9	0.08
Stools	175	1.45
Gastric tube	450	3.72
Urine	135	1.12
Total	12,112	100

3.2. Distribution of Patients by Place of Residence

By place of residence, Bangui District 1 was predominant (20.87%). **Figure 1** shows the distribution of patients by place of residence.

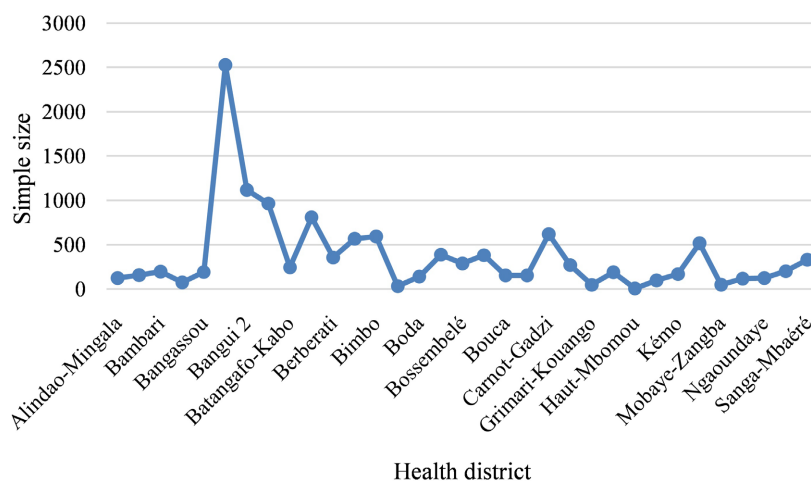


Figure 1. Distribution of patients by place of residence.

3.3. Incidence of Tuberculosis

Of the 12,112 tests performed with GeneXpert, 2862 were positive for tuberculosis in a total population of 6,289,798 inhabitants. The overall incidence of tuberculosis was 45.50 per 100,000 person-months. Incidental cases of tuberculosis were more common among patients aged 15 to 49 ($n = 2142$), males ($n = 1791$), and in Health Region 7 (1143). The 15 - 49 age group was the most prevalent (2142). The highest incidence was among patients aged 50 and over (323.50/100,000 person-months), men (57.99/100,000 person-months), and patients residing in Health Region 7 (127.46/100,000 person-months). **Table 2** shows the distribution of incidence according to the sociodemographic characteristics of the patients.

Table 2. Distribution of incident tuberculosis according to sociodemographic characteristics.

Features	Population Inhabitants	GeneXpert TB incident	Incidence
Age group			
≤14 years	2,559,948	252	9.84/1,000,000 person-semester
15 - 49 years	3,585,185	2142	59.74/1,000,000 person-semester
≥50 years	144,665	468	323.50/1,000,000 person-semester
Gender			
Female	3,201,507	1071	33.45/1,000,000 person-semester
Male	3,088,291	1791	57.99/1,000,000 person-semester
Place of residence			
Health Region 1	1,354,245	572	42.23/100,000 person-semester
Health Region 2	1,125,017	516	45.86/100,000 person-semester
Health Region 3	1,190,085	326	27.39/100,000 person-semester
Health Region 4	926,007	140	15.11/100,000 person-semester

Continued

Health Region 5	232,298	65	27.99/100,000 person-semester
Health Region 6	656,033	97	14.78/100,000 person-semester
Health Region 7	896,745	1143	127.46/100,000 person-semester
Total	6,289,798	2862	45.50/100,000 person-semester

Population = Population at risk for tuberculosis.

3.4. Distribution of Tuberculosis Cases by Health District

New tuberculosis cases were most frequently reported by the districts of Bangui (609/2862, or 21.27%), followed by the district of Bangui 2 (313/2862, or 10.93%). The districts of Vakaga, Ouango-Gambo, and Nangha Boguila were the three districts for which tuberculosis data were not fully available during the study period. **Figure 2** shows the distribution of tuberculosis cases by district in the Central African Republic.

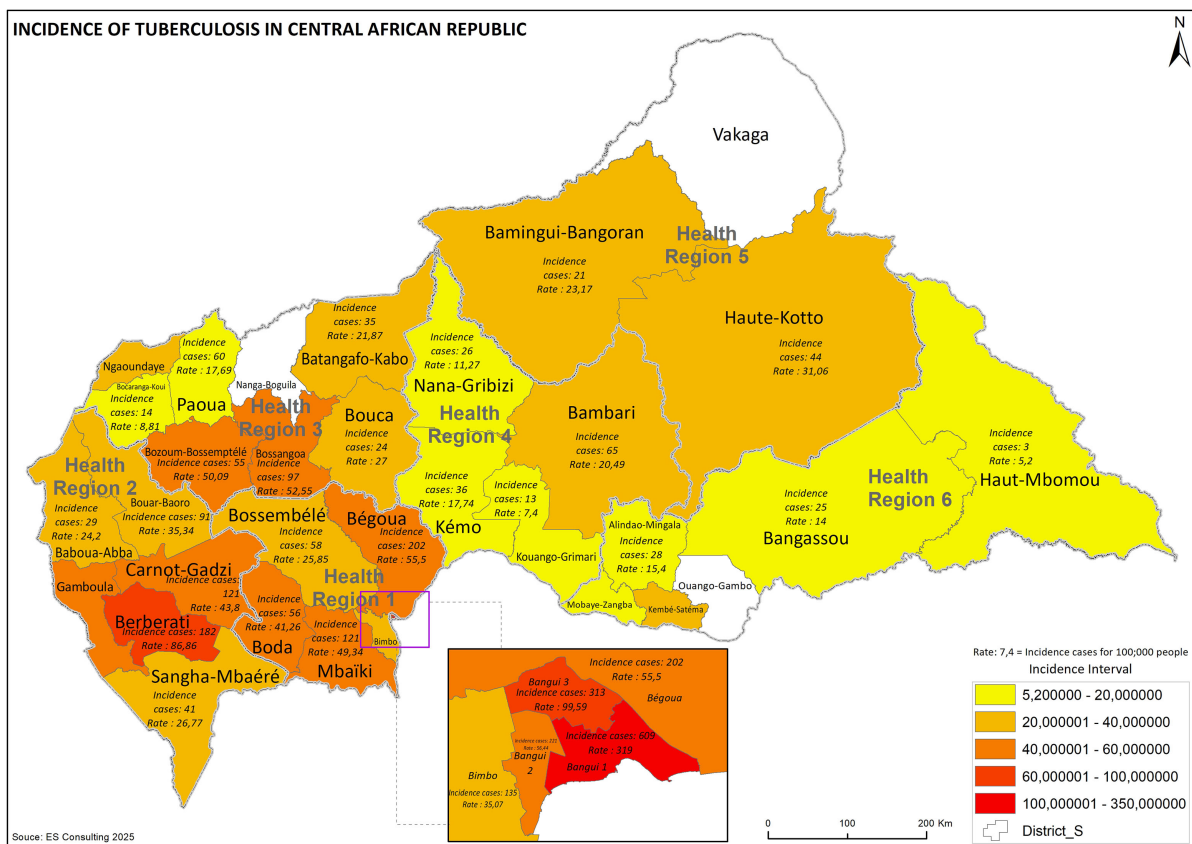


Figure 2. Representation of incidence cases by health district in CAR.

3.5. Incidence Cases of Tuberculosis by Location

Pulmonary tuberculosis accounted for 93.22% of tuberculosis cases. The remaining cases were extrapulmonary (6.78%). No cases of tuberculosis were found in pus. These data are presented in **Table 3**.

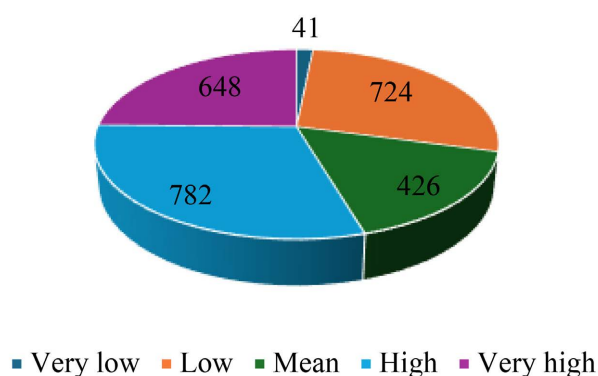
Table 3. Distribution of tuberculosis cases by location.

Sample type	Total patients N	Tuberculosis cases N (Proportion)
Expectoration	11090	2668 (93.22%)
Cerebrospinal fluid	145	23 (0.80%)
Joint aspiration	5	1 (0.03%)
Ascites puncture	51	6 (0.21%)
Lymph node biopsy	7	2 (0.07%)
Pleural puncture	35	5 (0.18%)
Pus	9	0 (0%)
Stools	175	32 (1.11%)
Gastric tube	450	90 (3.15%)
Urine	135	35 (1.23%)
Total	12112	2862 (100)

3.6. Bacterial Load

The high bacterial load was 27.32%, followed by the low bacterial load (25.29%).

Figure 3 shows the distribution of tuberculosis cases according to bacterial load.

**Figure 3.** Distribution of tuberculosis cases according to bacterial load.

3.7. Variables Associated with the Risk of Incident Tuberculosis

Male gender ($p = 0.0004$, $ORa = 1.30$ [1.12 - 1.52]) and place of residence ($p < 0.0001$) were the variables significantly associated with the occurrence of tuberculosis. In terms of proportion, younger patients (≤ 45 years) were more affected by tuberculosis (2282/7426; 30.72%) than older patients (580/4680 = 12.39%). Advanced age provided a protective effect ($ORa = 0.67$, $IC = [0.57 - 0.80]$). This protective effect is significant ($p < 0.0001$). **Table 4** presents the variables associated with tuberculosis in multivariate analysis by logistic regression.

Table 4. Variables associated with tuberculosis.

Features	GeneXpert		Bivariate analysis		Multivariate analysis	
	Test-	Test+	OR (IC)	p-value	ORa (IC)	p-value
Age group						
≤45 years	5144	2282	1	<0.0001	1	<0.0001
>45 years	4100	580	0.65 [0.51 - 0.77]		0.67 [0.57 - 0.80]	
Gender						
Female	4232	1071	1	0.0004	1	0.0004
Male	5018	1791	1.29 [1.10 - 1.50]		1.30 [1.12 - 1.52]	
Health Region						
HR1	1790	572	-		-	
HR2	2038	516	-		-	
HR3	972	326	-		-	
HR4	390	140	-	<0.0001	-	<0.0001
HR5	222	65	-		-	
HR6	374	97	-		-	
HR7	3467	1143	-		-	
Location						
Pulmonary	8422	2668				
Extrapulmonary	822	194				
Total	9244	2862				

4. Discussion

Biological diagnosis of tuberculosis, chemotherapy, and vaccination for infants are free in the CAR, but the disease is far from eradicated. This can be explained by certain factors such as antibiotic resistance, poor public health policy (vaccination, communication), and management by the PNLT. The problem of tuberculosis management by the program in charge and poor public health policy has already been raised by some authors [7] in the Central African Republic. During the first half of 2025, the 32 health districts out of the 35 districts in the seven health regions of the CAR recorded 12,112 samples from patients suspected of having tuberculosis. The age of patients at screening ranged from 4 months to 100 years, with a median age of 35 years (standard deviation \pm 18 years). The incidence of tuberculosis reported in our study was 45.50 per 100,000 person-semester. Studies conducted elsewhere have reported higher incidence rates than ours. These are studies conducted in Algeria, which reported an average incidence of 56.02 per 100,000 inhabitants and an average incidence of 63.81 cases per 100,000 inhabitants for all forms of tuberculosis combined [13] [14]. The discrepancy between these incidence data can be explained by the sample size. Our study covered data from one semester, whereas the two studies conducted in Algeria covered a period

of five years (2015 to 2020). The incidence of tuberculosis is not negligible. However, it should also be noted that tuberculosis can affect all age groups. The Central African population is characterized by its youth in demographic terms. Taking into account the size of the age groups screened, these districts recorded 2142 cases of tuberculosis among people aged 15 to 49, with a proportion of 17.68%, which is the highest among the age groups. This age group accounted for 74.85% of detected tuberculosis cases. In the CAR, the 15 - 45 age group represents the most productive age group in the population. There is therefore a risk of economic and social loss. The predominance of our data among patients aged 15 to 49 is consistent with that observed among people aged 15 to 45 in Algeria (60.39%) and in developing countries, where it accounts for 75% of cases [14] [15]. The highest incidence of tuberculosis is among people aged 50 and over (323.50/100,000 person-semesters). This is explained by the low denominator, which is the at-risk population for this age group. In this study, the incidence of tuberculosis increases with age. This incidence is consistent with that of a study conducted in Europe [16]. The risk of developing tuberculosis increases with age and is most often the result of endogenous reactivation of dormant bacilli, which become pathogenic when the body is weakened either by age or by immunosuppression. Incident cases of tuberculosis were more common in men. This observation is consistent with studies conducted in the Central African Republic, Mali, and Chad [7] [17] [18]. This predominance of tuberculosis in men could be explained by exposure to risk factors such as a history of smoking, occupational respiratory diseases, alcoholism, and drug use [19]. In contrast, some previous studies have shown a high proportion of tuberculosis in women, particularly in Algeria, with 67.84% of cases and 44.81 cases per 100,000 inhabitants [14] [20]. Malnutrition and biological changes that can disrupt the immune system, as well as acute or chronic diseases, are factors that may explain the occurrence of tuberculosis in women [21]. Incidental cases of pulmonary tuberculosis are the main source of infection and, consequently, transmission of the disease. The pulmonary form was predominant in our study (96.43%). This is consistent with studies conducted in the Central African Republic [9]. In contrast, the predominance of extrapulmonary forms has been described by some authors in Algeria and Korea [20] [22]. Pulmonary tuberculosis can be attributed to many factors. These include poverty, sociodemographic characteristics (age, gender, place of residence) related to the disease, personal data (smoking, alcohol consumption), vaccination coverage, availability of anti-tuberculosis drugs, the concept of contagion, and the policy of the national tuberculosis control program. The predominance of pulmonary tuberculosis over extrapulmonary tuberculosis can be explained by the fact that extrapulmonary tuberculosis is very difficult to diagnose using microscopy because it is paucibacillary.

Fluids and biopsies from internal sites in the body are very low in bacilli because microorganisms cannot multiply easily in deep organs due to a lack of oxygen. The concentration of mycobacteria is minimal in samples [21]. *Mycobacterium tuberculosis* has a high capacity to infect several tissues in the body. This has led

to the emergence of new forms of tuberculosis that are difficult to diagnose and known as extrapulmonary tuberculosis [23]. The task has been made easier today with the advent of GeneXpert, which, unlike microscopy, detects tuberculosis regardless of its location. In addition, tuberculosis can be detected in patients with a low bacterial load (very low and low), which accounts for 26.72% of cases. The present study did not report any clear variation between months. In the Central African Republic, the first quarter of the year corresponds to the dry season. However, some studies have reported that the incidence of tuberculosis is seasonal and that the disease predominates in spring and summer [14]. Certain factors such as sun exposure, indoor activity, and seasonal changes in immune function promote the emergence of tuberculosis [21]. Tuberculosis transmission is more likely in winter due to the decrease in natural ultraviolet light. Depending on the place of residence, the number of tuberculosis cases, and even the incidence of the disease, were higher among patients from the Bangui 3 district. This district is one of the three districts of the city of Bangui, which is Health Region No. 7. It ranks fifth among the thirty-two districts in the study in terms of its at-risk population, but with a negligible difference compared to the top four districts. The predominance of tuberculosis cases in this district can be explained by several factors, such as the urban environment with a high population density, the availability of qualified personnel (clinicians and laboratory technicians), and adequate technical facilities for laboratory screening. Unlike the data from Bangui 3 District, which is located in an urban area, the districts often face certain difficulties in screening for tuberculosis. Sometimes tuberculosis is diagnosed at the health facility by a clinician or in a local laboratory, which often has limited technical facilities and qualified personnel. Patients suspected of having pulmonary tuberculosis are referred to the district hospital laboratory. The distance to the district hospital is a handicap for the diagnosis and treatment of tuberculosis in rural areas of the CAR.

5. Limitation

Admittedly, this study has its limitations. HIV data are not documented for patients who test positive for tuberculosis. This contravenes the recommendations of the National Tuberculosis Control Program (PNLT) in the CAR, which stipulate that all patients who test positive for tuberculosis must be screened for HIV. This would ensure better management of tuberculosis/HIV co-infection. Added to this are socio-economic status and malnutrition due to lack of questioning.

6. Conclusion

Tuberculosis remains a major public health problem in CAR today, due to its morbidity and mortality rates. Given the results obtained in this study, the incidence of tuberculosis remains higher in CAR. The overall incidence was 45.50 per 100,000 person-months. Incidental cases were more common among young patients, males, and in health region 7. Pulmonary tuberculosis was the most common form. In this study, the incidence of extrapulmonary tuberculosis was lower than that of

pulmonary tuberculosis, because Mycobacteria are paucibacillary and rare. GeneXpert has greatly contributed to tuberculosis screening by identifying cases of tuberculosis with rare bacilli, different locations of the disease, and finally, the detection of resistance to anti-tuberculosis drugs. This test has aided diagnosis in various health districts in the CAR. It would be better for the NLT to revitalize HIV screening among patients who test positive for tuberculosis in order to ensure better management of the disease and review the control strategy, with an emphasis on staff training and public awareness.

Conflicts of Interest

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

References

- [1] Chakaya, J., Petersen, E., Nantanda, R., Mungai, B., Migliori, G.B., Amanullah, F., *et al.* (2022) The WHO Global Tuberculosis 2021 Report—Not So Good News and Turning the Tide Back to End TB. *International Journal of Infectious Diseases*, **124**, S26-S29. <https://doi.org/10.1016/j.ijid.2022.03.011>
- [2] Massenet, D. and Djemadji, O.N. (1994) Chad: Bibliographic Review of Reported Cases. *Tropical Medicine*, **54**, 179-188.
- [3] Kallenius, G., Koivula, T., Ghebremichael, S., Hoffner, S.E., Norberg, R., Svensson, E., *et al.* (1999) Evolution and Clonal Traits of *Mycobacterium tuberculosis* Complex in Guinea-Bissau. *Journal of Clinical Microbiology*, **37**, 3872-3878. <https://doi.org/10.1128/jcm.37.12.3872-3878.1999>
- [4] Heyderman, R.S., Goyal, M., Roberts, P., Ushewokunze, S., Zizhou, S., Marshall, B.G., *et al.* (1998) Pulmonary Tuberculosis in Harare, Zimbabwe: Analysis by Spoligotyping. *Thorax*, **53**, 346-350. <https://doi.org/10.1136/thx.53.5.346>
- [5] Lockman, S., Sheppard, J.D., Braden, C.R., Mwasekaga, M.J., Woodley, C.L., Kenyon, T.A., *et al.* (2001) Molecular and Conventional Epidemiology of *Mycobacterium tuberculosis* in Botswana: A Population-Based Prospective Study of 301 Pulmonary Tuberculosis Patients. *Journal of Clinical Microbiology*, **39**, 1042-1047. <https://doi.org/10.1128/jcm.39.3.1042-1047.2001>
- [6] (2021) World Health Organization Global Tuberculosis Report 2021: Executive Summary. World Health Organization, Geneva, 57 p.
- [7] Laoulet Kerepelet, T., Mossoro-Kpindé, C.D. and Pamatika, C.M. (2021) Systematic HIV Screening in Patients Suspected of Pulmonary Tuberculosis at the Malimaka Urban Health Center in Bangui. *Black African Medicine*, **5**, 12-15.
- [8] Tékpá, G., Fikouma, V., Marada Téngothi, R.M., Longo, J.D.D., Amakadé Woyengba, A.P. and Koffi, B. (2019) Aspects épidémiologiques et cliniques de la tuberculose en milieu hospitalier à Bangui. *Pan African Medical Journal*, **33**, Article 31. <https://doi.org/10.11604/pamj.2019.33.31.13442>
- [9] Ngbangbagai, E., Pamatika, C.M., Tekpa, G., Diemer, H.C.S., Wilkoé, P. and Longo, J.D.D. (2022) Incidence of Tuberculosis among People Living with HIV Followed at the National Reference Center for Sexually Transmitted Infections and Antiretroviral Therapy in Bangui. *Black African Medicine*, **65**, 270-274.
- [10] Farra, A., Jolly, B., Ngaya, G., Gando, H., Komamgoya Nzonzon, A.D. and Manirakiza, A. (2021) Primary and Secondary Resistance to First-Line Anti-Tuberculosis Medications at the Institute Pasteur Bangui, Central African Republic. *African Jour-*

nal of Medical and Health Sciences, **20**, 34-40.

- [11] Farra, A., Koula, K., Jolly, B.L., Gando, H.G., Ouarandji, L.M., Mossoro-Kpinde, C.D., *et al.* (2023) Effectiveness of Xpert MTB/RIF and the Line Probe Assay Tests for the Rapid Detection of Drug-Resistant Tuberculosis in the Central African Republic. *PLoS Global Public Health*, **3**, e0001847. <https://doi.org/10.1371/journal.pgph.0001847>
- [12] Minime-Lingoupou, F., Manirakiza, A., Yango, F., Zandanga, G., Le Faou, A. and Rigouts, L. (2011) Relatively Low Primary Resistance to Anti-Tuberculosis Drugs in Bangui and Bimbo, Central African Republic. *The International Journal of Tuberculosis and Lung Disease*, **15**, 657-661. <https://doi.org/10.5588/ijtld.10.0292>
- [13] Alihalassa, S. (2016) Tuberculosis in 2015. World Tuberculosis Day. *Poster*, **18**, 29-30.
- [14] Debbabi, R., Slamati, S. and Tifourak, A. (2021) Pulmonary and Extrapulmonary Tuberculosis: Epidemiological Situation in the Wilaya of Guelma. Master's Thesis, University of Guelma, 146 p.
- [15] Zehani, D. (2016) The Resurgence of Tuberculosis Worldwide. Diagnosis of the Disease by Microscopic Examination of Sputum Using Ziehl-Neelsen Staining. Mentouri Brothers University, Constantine, 15 p.
- [16] Souidi, L. (2014) The Prevalence of Pulmonary Tuberculosis in Oujda-Anggad between 2008 and 2012. Doctoral Thesis, Mohammed V University, 4-15.
- [17] Dabo, G., Bourama, K., Traoré, A.M., Mariko, M., Diabaté, K., Diarra, I.M., Diallo, K., Diallo, Y. and Minta, D.K. (2022) Epidemioclinical Study of Pulmonary Tuberculosis in People Living with HIV in the Kolokani Health District. *Health Science Say*, **23**, 57-60.
- [18] Walbang Ossoga, G., Ban-Bo Bebanto, A., Bakarnga-Via, I., Abderamane, M., Yanda Mberkissam, D. and Daneumbé, G. (2022) Clinicoradiographic Diagnosis of Pulmonary Tuberculosis and Resistance to Rifampicin in Chad. *Health Science Say*, **23**, 23-28.
- [19] Nacer, L. and Lakhel, N. (2018) Microbiological Diagnosis of Pulmonary Tuberculosis at the Hygiene Laboratory of the Wilaya of Constantine. Master's Thesis, University of Constantine 1, 10-14.
- [20] Mahamat, A. and Traore, A. (2016) Tuberculosis in the Guelma Region. Epidemiological Situation and Screening Methods. Master's Thesis, University of Guelma, 3-21.
- [21] Behnas, H. and Salem, A. (2018) Pulmonary and Extrapulmonary Tuberculosis at the BK Unit of the Microbiology Laboratory in Constantine: A Three-Year Retrospective Study. Master's Thesis, Mentouri Brothers University Constantine, 14-15.
- [22] Go, U., Park, M., Kim, U., Lee, S., Han, S., Lee, J., *et al.* (2018) Tuberculosis Prevention and Care in Korea: Evolution of Policy and Practice. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, **11**, 28-36. <https://doi.org/10.1016/j.jctube.2018.04.006>
- [23] Boulahbal, F. and Chaulet, P. (2004) Tuberculosis in Africa: Epidemiology and Control Measures. *Tropical Medicine*, **64**, 224-228. <https://doi.org/10.4236/jcc.2025.136011>