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Prevalence and Factors Influencing the Transmission of Pulmonary Tuberculosis in Patients Followed at the National Tuberculosis Control Program in N'Djamena, Chad

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NKA and NBNR wrote and revised the protocol. Authors DV, EA, HO and AG carried out the manipulations. Authors B-BBA and OA-H supervised the work. Author NKA carried out the statistical analyses. Authors NKA and NBNR interpreted the results. All authors contributed to the production of this document. All authors read and approved the final manuscript.

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ABSTRACT

Prevalence and factors influencing the transmission of pulmonary tuberculosis in patients followed at the National Tuberculosis Control Program (PNT) in N'Djamena at Chad. Tuberculosis is an infectious disease caused by a bacillus called *Mycobacterium tuberculosis*.
This was a study prospective with analytical purposes carried out from December 2023 to January 2024 in patients of both sexes received at the laboratory of the PNT. The diagnosis of pulmonary tuberculosis was made by GeneXpert or Xpert.
Total of 453 patients were enrolled. Among them, 105 patients detected positive for *Mycobacterium tuberculosis* by GeneXpert, either prevalence of 23.18%. The average age in this study was 28.26% years. The age groups from 22 years to 32 years and those from 33 years to 43 years were the most infected with *Mycobacterium tuberculosis*, either prevalence of 39% in these two age groups. Traders were more contaminated by *Mycobacterium tuberculosis* (39.41%). One hundred strains of *Mycobacterium tuberculosis* had high sensitivity to Rifampicin, either prevalence of 22.05%, two strains of *Mycobacterium tuberculosis* had low sensitivity to Rifampicin, either prevalence of 0.44%, and three strains of *Mycobacterium tuberculosis* were resistant to Rifampicin. Either prevalence of 0.66%. The factors influencing the circulation of the lung and its maintenance in this study were linked to the detection of a case of illness in the neighborhood (77.77%), within the family (100%), to tobacco consumption (20%) and alcohol (12.73%). Tuberculosis is far from being controlled by public health authorities.

Keywords: Prevalence; influencing factors; pulmonary tuberculosis; patients; N'Djamena.

1. INTRODUCTION

Pulmonary tuberculosis is a slowly progressive, contagious infection infection caused by mycobacteria belonging to the *Mycobacterium tuberculosis* Complex [1]. People diagnosed with tuberculosis for the first time reached 7.5 million worldwide in 2022 due to COVID-19. In 2022, tuberculosis was the second leading cause of death globally after COVID-19. The COVID-19 pandemic has delayed its diagnosis and treatment as well as access to health services [2]. According to estimates from the Stop TB Partnership (PHT), it is projected that 38.6 million people will be affected by tuberculosis between 2023 and 2027. Among these, 1.7 million are expected to develop Rifampicin resistance or multidrug resistance [3]. For the World Health Organization (WHO), tuberculosis is far from the objective fixed of a 50% reduction by 2025 set in its strategy. It remains high in thirty countries with 87% of cases worldwide in 2022, two thirds of which occurred in Asia and sub-Saharan Africa. The number of people on anti-tuberculosis drugs was 175.650 in 2022 [2]. In Africa, tuberculosis remains the second leading cause of mortality due to a single infectious agent, surpassing the toll from HIV/AIDS [4]. In 2020, the incidence of tuberculosis in Chad, all forms, new cases and relapses was estimated at 142 cases per 100.000 inhabitants. The number of cases diagnosed and confirmed by the laboratory was 6610 cases, of which 3904 were completely cured of the disease. Cases of therapeutic failure were estimated at 302 patients among which 113 were completely warlike of tuberculosis and 47 patients were lost to follow-up [5,6]. The prevalence of drug-resistant tuberculosis in Chad

is estimated at 2.5% [5,6]. Chad is one of the countries which is paying a heavy price for the tuberculosis epidemic. HIV weakens patients' immune systems by significantly reducing T-cells. According to the Global Fund, in 2021, 81% of HIV-infected patients tested positive for tuberculosis. Of these patients infected with HIV and tuberculosis, 99% are on antiretroviral treatment [7,8]. The HIV pandemic has modified the clinical and radiological epidemiological characteristics of TB, which represents the first opportunistic HIV disease in Chad. The particularity of the radiological signs of TB in patients infected HIV may possibly be based on their immunity [9]. Factors influencing the circulation of tuberculosis are linked to under nutrition, HIV/AIDS, smoking, alcohol use disorders and diabetes mellitus. As well as social factors such as poverty, poor living conditions, stigma and discrimination [3]. Since 2010, the WHO has approved the use of a new diagnostic tool, essentially molecular biology (the Xpert/MTB/RIF or GeneXpert test). The Xpert MTB/RIF is an ultra-automated Real-Time PCR device integrating sputum processing, DNA extraction and amplification as well as semi-quantitative diagnosis of *M. tuberculosis* and detection of susceptibility and resistance of Rifampicin [10].

2. MATERIALS AND METHODS

2.1 Type and Study Area

This was a study prospective with an analytical aim ranging from December 2023 to January 2024 at the National Tuberculosis Control Program **(**PNT). The PNT is located in the city of N'Djamena in the Farcha neighborhood in first district. It covers an area of 180 square meter. It is limited to the North by the National Directorate of Meteorological Services, to the South by the National Research Center for Development, to the East by the International Business Center under construction and to the West by the International Airport HASSAN Djamous from N'Djamena. It is a public administrative and scientific establishment which is placed under the supervision of the Ministry of Public Health of Chad.

2.2 Sampling

The sampling was non-probabilistic and carried out on a voluntary way. It began with an interview of 500 patients who came to the PNT is the Bacteriology laboratory department. Among them, 453 patients had agreed to participate in this study but 47 had refused to participate and were therefore not included in the study. Patients of both sexes admitted to the PNT who did not consent to participate in the study were not included in the study.

2.3 Study Population

The study population consisted mainly of patients of both sexes aged eight months to 70 years admitted to the bacteriology laboratory department of the PNT for pulmonary tuberculosis screening. After reading and explaining the study to each participant, written consent was obtained from each patient for their participation in this study. Sputum samples from patients were received between 6:00 a.m. and 9:00 a.m.

2.4 Data Collection Method

Data collection and sputum samples were carried out from December 2023 to January 2024. For each sputum sample, several pieces of information were collected in a data collection sheet designed for this purpose. These data were: sociodemographic characteristics of patients (age, sex, marital status, occupation and level of education), reason for consultation, factors influencing the circulation of tuberculosis (cases of tuberculosis within the family, in the neighborhood, active smoking patients, alcoholism and the serological status of HIV patients) and their physical states at the time of sampling.

2.5 Sputum Analysis Technical: GeneXpert Cepheid® Molecular Technique

The bacterial genome was demonstrated using a polymerase chain reaction (PCR) test according to the protocol recommended by GeneXpert Cepheid®**.** Bacterial DNA extraction and amplification is automated [11].

2.5.1 Principle of the GeneXpert Cepheid® technical

The principle is as follows: the primers specific to the DNA region of interest are fluorolabelled. During the elongation phase, the fluorescence emitted by the primers is measured by the GeneXpert automated system. The PCR + fluorescence combination makes it possible to quickly detect the presence of *Mycobacterium tuberculosis* DNA [11].

2.5.2. Overview of GeneXpert Cepheid®

Each module is independent and processes a sample then manages the entire analysis. A module is made up of four elements, namely: a valve motor which rotates the body of the valve of the cartridge in order to reach the different chambers of the cartridge. A syringe piston motor which distributes the liquids into the different chambers of the cartridge and an ultrasound emitter which lyses the sample (if applicable) and finally an I-CORE® module which carries out PCR amplification and detection [11].

2.5.3 Sample preparation

The GeneXpert molecular technique was used. Collect 4 mL of reagent (diluent or bead) and add 2 mL of sputum sample. Make the sample and the reagent homogeneous and then agitate with the vortex. Then incubate for 15 minutes. After incubation, shake the solution again with a vortex and then incubate at room temperature for five minutes so that the solution is perfectly fluid and liquefying (but above all without visible aggregates in the sputum). Open the lid of the GeneXpert MTB/RIF cartridge provided by the company and pipette 2 mL of solution then add to the GeneXpert MTB/RIF cartridge then close the cartridge lid securely. The GeneXpert cartridge Contains PCR buffer, specific primers, DNA polymerase, internal quality controls (primers and cellular). Scan the barcode and click start test. The results are interpreted by the presence of crossing of the fluorescence curve with the threshold line. *Mycobacterium tuberculosis* is detected on the FAM channel (green) and IC DNA on the JOE (Yellow)/HEX/Cy3 channel. The GeneXpert test detects the presence or absence of *Mycobacterium tuberculosis* DNA and detects the sensitivity and resistance of the *Mycobacterium tuberculosis* strain to Rifampicin [10,11].

2.6 Data Processing and Analysis

The data from the interviews as well as the sputum results tested were entered into a Microsoft Office 2010 Excel spreadsheet then converted to CSV and then exported to R Studio software version 4.0.4.2021 for analyses. Concerning the analytical statistics, the Chi-square test and the Fisher Exact test were used to determine the prevalence of tuberculosis and the factors influencing the transmission of *Mycobacterium tuberculosis* as well as for their significance. The significance threshold was set at 0.05 and the p-value calculated using Fisher Exact Test.

At the end of the laboratory analyses, the results below were obtained.

3. RESULTS AND DISCUSSION

During this study period, we enrolled 453 patients. Among these patients, 105 patients tested positive for *Mycobacterium tuberculosis*, representing a prevalence of 23.18%.

3.1 Distribution of Patients According to Socio-demographic Characteristics

The average age in this study was 28.26 years. The extremes were 8 months and 70 years. The age group of 22 years to 32 years (n = 128) was the most represented with a percentage of 28.26% followed by that of 33 years to 43 years (n = 110) with a rate of 24.28% (Table 1).

In this study, male patients accounted for 69.98% and 30.02% of patients were female.

Table 1 shows that married people are more represented, with a rate of 61.15% followed by single people with a rate of 31.12%. According to the profession of the patients, the unemployed represented 41.94%, followed by students with a rate of 18.32% and traders and students with a rate of 14.57% grouped in Table 1. Uneducated patients were the majority in this study with a rate of 58.94%, 20.53% had a higher level of education and 18.10% had a secondary level of education (Table 1).

3.2 Factors Influencing the Transmission of Tuberculosis in this Study

Certain factors had influenced the transmission of tuberculosis in this study. The prevalence was 100% among to the registration of a case of tuberculosis within the family and a prevalence of 77.77% among to the presence of a case of tuberculosis in the neighborhood (Table 2).

The prevalence of *Mycobacterium tuberculosis* was 20% among active smokers and a prevalence of 12.73% among those who regularly consumed alcohol. According to the Chi-square test and the Fisher Exact test, this prevalence is show a very significant variation with a $P = 0.001$ (Table 2).

Table 1. Distribution of patients according to marital status

Variable	Effective (N)	Percentage
Marital status		
Unmarried	141	31.12
Married	277	61.15
Divorced	15	3.31
Children	20	4.41
According to profession		
Trader	66	14.57
Pupil	83	18.32
Student	66	14.57
Functionary	26	5.74
SDF	10	2.21
Homemaker	12	1.,00
Unemployed or Emptiest	190	41.94
Educational level		
Uneducated	267	58.94
Primary	10	2.21
Secondary	82	18.10
Upper	93	20.53

Table 2. Factors influencing the transmission of tuberculosis

Influencing factors		N	TB+	Prevalence	CI at 95%	P	Interpretation
TB within the	Yes	03	03	100	[-104.28 ; 95.72]		
family	No	450	102	22.66	[-23.11 ; 22.21]		
TB in	Yes	09	07	77.77	[-80.70 ; 74.84]		
neighbourhood	No	444	98	22.07	[-22.51 ; 21.64]	0.001	Highly
Active smoking	Yes	100	20	20	[-20.37;19.63]		Significant
patients	No	353	85	24.10	[-1.42 ; 1.43]		
Alcohlism	Yes	110	15	13.63	[-13.83 ; 13.43]		
	No	343	11	90	[-93.65 ; 86.34]		

Legend: If P >0.05 in the Fisher Exact and Chi-square Test, the factors are not significant.
If P < 0.05 in the Fisher Exact and Chi-square Test, the significant factors
If P < 0.00 in the Fisher Exact and Chi-square Test, the factors are very significant

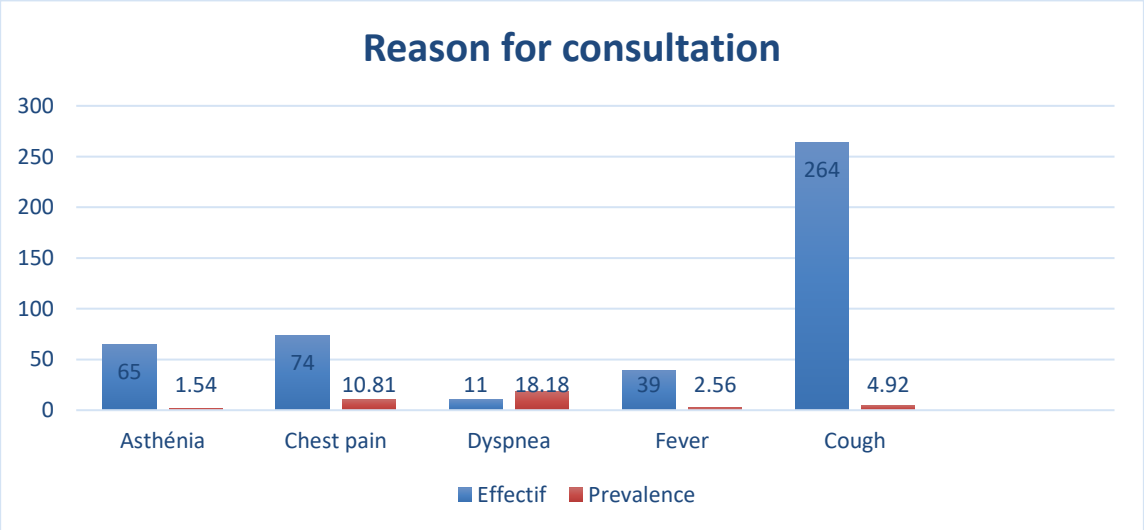

Fig. 1. Reason of consultation

Table 3. Repair of patients according to HIV status

Co-infection HIV-TB		N	TB+	Prevalence	CI at 95%	*P*	Interpretation
HIV status	Positive	105	21	16.19	[-17.33 ; 15.05]	0.05	Significant
	Negative	348	88	25.29	[-25.98 ; 24.60]		
Types of HIV	HIV-1	16	14	87.50	[-91 ; 83 ;99]	0.04	Significant
	HIV-2	05	03	60	[-61.98 ; 58.02]		
Patients condition	Cachexic	213	67	31.45	[-33.02 ; 30.01]	0.06	Not
	In shape	240	38	15,83	[-16,31 ; 15,35]		Significant

Table 4. macroscopic aspects of sputum

Macroscopic aspects	N	TB +	Prevalence	CI at 95%	*P*	Interpretation
Mucous	193	74	38.34	[-40.69 ; 35.99]		
Purulent	38	28	73.68	[-105.86 ; 41.5]	0.01	Significant
Salivary	219	00	00			
Bloody	03	03	100	[-746.80 ; 546.8]		

3.3 Clinical variables of the study

Fig. 1 presents the reasons for consultation of patients enrolled in this study. Cough is the first reason with a prevalence of 28.41%, 18.92% complain of chest pain and 18% of patients have dyspnea and fever. The Chi-square test and Fisher Exact test, the results of which are presented below, do not show any significant variation with a $P = 0.68$.

In relation to HIV status, out of 105 patients detected positive for *Mycobacterium tuberculosis* in this study, 21 patients were HIV positive, representing a prevalence of 20%, and 432 were HIV negative. The Chi-square test and Fisher Exact test, the results of which are presented below, show a significant variation ($P = 0.05$).

According to the type of HIV, out of a total of 453 patients who were included in this study, 16 patients were infected with HIV-1, that to say a prevalence of 3.53%, and five patients were infected with HIV-2, that to say a prevalence of 1.12%. Out of 105 patients diagnosed positive for tuberculosis, the prevalence of HIV-1 and tuberculosis coinfection was 87.50% and that of HIV-2 and tuberculosis was 60%. According to the Chi-square test and Fisher Exact test, these results present significant variations and are grouped in Table 3 ($P = 0.04$).

During this study, the prevalence of pulmonary tuberculosis due to *Mycobacterium tuberculosis* was 5.16% in cachexic patients and 5.83% in non-cachexic patients. The Chi-square test and Fisher Exact test, the results of which are presented in Table 3, show that there is not significant variation ($P = 0.06$).

3.4 The Biological Variables of the Study

In this cohort, the macroscopic appearance of sputum before performing GeneXpert molecular examinations was multivariate. A prevalence of 100% obtained in sputum with a bloody appearance, 73.68% obtained in purulent sputum and 38.34% were mucous (Table 4). The Chi-square test and Fisher Exact test, the results of which are presented below, show a significant variation with a $P = 0.01$.

The GeneXpert test detects *Mycobacterium tuberculosis* and the sensitivity or resistance of this strain to Rifampicin. One hundred strains of *Mycobacterium tuberculosis* had high sensitivity to Rifampicin, that means a prevalence of 22.05%, two strains of *Mycobacterium tuberculosis* had low or low sensitivity to Rifampicin, that means a prevalence of 0.44%, and three strains of *Mycobacterium tuberculosis* were resistant to Rifampicin, a prevalence of 0.66%. The Chi-square test and Fisher Exact test, the results of which are presented below, show a very significant variation with a $P = 0.004$ (Table 5).

Table 5. Sensitivity of anti-tuberculosis drugs

Sensitivity of anti-tuberculosis drugs	N	Prevalence	CI at 95%	*P*	Interpretation
MTB+RIF HS	100	22.05	[-23.89 : 20.21]		
MTB+RIF LS	02	0.44	[-0.43 ; 0.45]	0.004	Highly
MTB+RIF R	03	0.66	[-0.65 ; 0.66]		Significant

Legend: MTB+RIF HS: *Mycobacterium tuberculosis* very high sensitivity to Rifampicin;
MTB+RIF LS: *Mycobacterium tuberculosis* low sensitivity to Rifampicin
MTB+RIF R: *Mycobacterium tuberculosis* resistant to Rifampicin

Table 6. The prevalence of TB by age groups of patients

Variables	N	TB +	Prevalence	CI at 95%	P	Interpretation
Prevalence of TB by age group of patients						
08 month à 10 years	19	02	10.53	[-10.66 ; 10.39]		
11 years à 21 years	63	02	3.17	[-3.19 ; 3.15]	0.009	Highly
22 years à 32 years	128	50	39.06	[-43.50 ; 34.62]		Significant
33 years à 43 years	110	43	39.10	[-44.82 ; 36.65]		
44 years à 54 years	56	03	6.52	[-6.58 ; 6.46]		
55 years à 65 years	46	03	6.52	[-6.58 ; 6.46]		
+ 65 years	31	02	6.45	[-6.51 ; 6.39]		
Prevalence of TB according to profession of enrolled patients						
Trader	66	27	39.41	[-43.91 ; 34.91]		
Pupil	83	22	26.51	[-28.96 ; 24.06]		
Student	66	12	18.18	[-19.55 ; 16.81]	0.05	Significant
Functionary	26	06	23.01	[-24.99 ; 21.04]		
SDF	10	02	20	[-21.58 ; 18.41]		
Homemaker	12	01	8.33	[-8.72 ; 7.93]		
Unemployed or Emptiest	190	35	18.42	[-19.81 ; 17.02]		
Prevalence of TB according to the level of education of enrolled patients						
Uneducated	267	64	24	[-24.82 ; 23.17]		
Primary	10	02	20	[-21.58 ; 18.41]	0.007	Highly
Secondary	82	19	23.17	[-25.16 ; 21.21]		Significant
Upper	93	20	21.50	[-22.21 ; 20.81]		

3.5 The Prevalence of Sputum Due to *Mycobacterium tuberculosis*

The prevalence of *Mycobacterium tuberculosis* pulmonary tuberculosis was 26% in male patients and 17% in female patients. The Chi-square test and Fisher Exact test, the results of which are presented below, do not show any significant variation with a *P* = 0.06. Groups aged 22 years to 32 years and those aged 33 years to 43 years were more contaminated by *Mycobacterium tuberculosis*, with a prevalence of 39%. According to the Chi-square test and Fisher Exact test, the results of which are presented below show a very significant variation with a *P* = 0.009 (Table 6).

Table 6 shows the prevalence of tuberculosis according to the profession of the patients. The prevalence due to *Mycobacterium tuberculosis* is 39.41% among traders, 26.51% among pupil, 23.01% among people working in the public service (civil servants), 20% among the Security Defense Force (SDF) and 18.18% among students. The Chi-square test and Fisher Exact test, the results of which are presented in Table

6, show a significant variation (*P* = 0.05160). In relation to the level of education, Table 6 shows the prevalence due to *Mycobacterium tuberculosis* which is 24% in uneducated patients and 23.17% in patients with a secondary level of education. The Chi-square test and Fisher Exact test, the results of which are presented in Table 6, show a very significant variation with a *P* = 0.007.

Our study took place from December 2023 to January 2024. During this study period, we enrolled 453 patients. Among these patients, 105 patients tested positive for *Mycobacterium tuberculosis*, representing a prevalence of 23.18%. This prevalence is much higher than that of 3.72% published by [12] at the Point G University Hospital of Bamako in Mali.

3.6 Distribution of Patients According to Socio-demographic Characteristics

The average age in this study was 28.26 years. The extremes were 8 months and 70 years. The age group of 22 years to 32 years (n = 128) was more represented with a percentage of 28.26% followed by that of 33 years to 43 years (n = 110) with a prevalence of 24.28%. These results are lower than those of 35.33% in the age group of 30 years to 44 years published by [13] at the Bongor Provincial Hospital in Chad. But our results are sensitive to those of 29.5% in the age group of 28 years to 37 years obtained by [12] at the Point G University Hospital of Bamako in Mali. These results can be explained by the fact that this is the most active age group and therefore more exposed to pulmonary tuberculosis. In this study, male patients accounted for 69.98% (n = 317) and 30.02% (n = 136) of patients were female. Our results are contrary to those obtained by [12], who found a female predominance with a number of 33 female patients or 54.1%. This difference could be explained by the fact that in our study most of the patients enrolled were male.

Married people were the most represented, with a rate of 61.15%, followed by singles with a rate of 31.12%. These results can be explained by the fact that the bride and groom were running from left to right in search of daily bread and above all constantly on the move to meet family needs. This approach makes these groups of individuals increasingly vulnerable to pulmonary tuberculosis.

According to the profession of patients, the unemployed represented 41.94%, students with a rate of 18.32%, traders and students with a rate of 14.57%. These results are consistent with the Chadian reality. The unemployment rate being very high, the unemployed who participated in this study go looking for work every day. This continual search for employment forces them to work alongside several individuals with unknown health conditions and are constantly exposed to respiratory infections such as tuberculosis.

Uneducated patients were the majority in this study with a rate of 58.94%, 20.53% had a higher level of education and 18.10% had a secondary level of education. The results of this study are significantly lower than those of 83.47% in uneducated patients obtained at the Bongor Provincial Hospital in Chad by [13]. These results can be explained by the lack of knowledge of hygiene practices and ignorance about the concept of hygiene among these groups of individuals due to the simple fact that they are not educated. During interviews with the latter, the vast majority do not apply basic personal hygiene.

3.7 Factors Influencing the Transmission of Tuberculosis in this Study

Some factors had influenced the circulation of pulmonary tuberculosis due to *Mycobacterium tuberculosis* in this study.

The prevalence was 100% among to the registration of a case of tuberculosis within the family and a prevalence of 77.77% among to the presence of a case of tuberculosis in the neighborhood. These results can be explained by the promiscuity which is at the origin of this increase in the prevalence of *Mycobacterium tuberculosis* in our context. Therefore, the patients who participated in this study had close contact with people who tested positive for tuberculosis. Some even claimed to share meals and dormitories with them. Which could certainly explain this increase in prevalence in this study.

The prevalence of *Mycobacterium tuberculosis* was 20% among active smokers and a prevalence of 12.73% among patients who regularly consumed alcohol. These results are higher than those of 54% among smokers and significantly higher than those of 64% among heavy drinkers obtained by [14] in Canada. According to [3], tobacco constitutes a high risk factor for the development of tuberculosis. Tobacco consumption and alcohol are among

the underlying conditions thus that increase the risk of pulmonary tuberculosis favoring the contamination of pulmonary tuberculosis. Tobacco and alcohol users constitute a risk group simply because of their addictions to alcohol and tobacco. These results are in agreement with these statements from the WHO [3].

3.8 Clinical Variables of the Study

In relation to HIV status, out of 105 patients detected positive for *Mycobacterium tuberculosis* in this study, 21 patients were positive for HIV, representing a prevalence of 20%. Our results are lower than those of 11.47% published by [12] at Point G University Hospital in Bamako, Mali in 2013. According to the type of HIV, out of a total of 453 patients who were included in this study, 16 patients lived with HIV-1, which corresponds to say a prevalence of 3.53%, and five patients lived with HIV-2, which corresponds a prevalence of 1.10 %. The prevalence of HIV-1 and tuberculosis co-infection was 16.24% and that of HIV-2 and tuberculosis was 4.76%. Our results are higher than those of 1.64% obtained by [7], in 2013 in Bamako, Mali in patients co-infected with HIV and Tuberculosis. These results can be explained by the fact that HIV and its immunosuppression constitute an important factor in the acquisition and progression of tuberculosis. People living with HIV due to their immunodeficiency frequently develop tuberculosis.

3.9 The Biological Variables of the Study

In this cohort, the macroscopic appearance of sputum before performing GeneXpert molecular examinations was multivariate. The prevalence of 100% obtained in sputum with a bloody appearance, 73.68% obtained in purulent sputum and 38.34% were mucous. Two reasons could explain these results. Firstly, the patients admitted to the PNT bacteriology laboratory were largely referred by the different hospital structures in the city of N'Djamena. Most of these patients arrived with complications related to their illnesses. Secondly, being a reference laboratory in tuberculosis research, these aspects reflect the good orientation on the part of laboratory technicians in the quality of samples taken by patients.

The GeneXpert test detects *Mycobacterium tuberculosis* and the sensitivity or resistance of this strain to Rifampicin. One hundred strains of *Mycobacterium tuberculosis* had high sensitivity to Rifampicin, that to say a prevalence of 22.05%, two strains of *Mycobacterium tuberculosis* had low sensitivity to Rifampicin, that means a prevalence of 0.44%, and three strains of *Mycobacterium tuberculosis* were resistant to Rifampicin, a prevalence of 0.66%. Our results are higher than those of 83.03% resistance to Rifampicin published by [15] in Niger. On the other hand, our results are approximate to those of 0.7% of resistance to Rifampicin obtained by [16] in the Republic of Guinea. These results can be explained by the fact that according to the WHO, the new cases of tuberculosis diagnosed are resistant to Rifampicin. Tuberculosis therefore constitutes a major public health problem of concern due to the resistance of *Mycobacterium tuberculosis* to other anti-tuberculosis drugs. As a result, the WHO considers that the plan to eradicate tuberculosis by 2025 is not possible [17,8].

3.10 The Prevalence of Sputum Due to *Mycobacterium tuberculosis*

A total of 453 patients were included in the study, the GeneXpert molecular test detected positive *Mycobacterium tuberculosis* in 105 sputum samples, representing a prevalence of 23.18%. These results are highly significant at the 5% level (P-value = 0.000987). Our results are higher than those of 16.53% obtained in a cohort in Bongor in Chad by [13]. These results show that tuberculosis still remains a public health problem in Chad.

The age groups aged 22 to 32 and those aged 33 to 43 were the most contaminated by *Mycobacterium tuberculosis*, that means a prevalence of 39% in these two age groups. These results can be explained by the fact that most of the patients in this age group who participated in this study were in activities and therefore in direct contact with tuberculosis-positive individuals. Of which most were of vulnerable layer. During the interview, many said they did not have the means of transport to get to a hospital facility.

The prevalence due to *Mycobacterium tuberculosis* was 39.41% among traders, 26.51% among students, 23.01% among people working in the public service (civil servants), 20% among Security Defense Forces (SDF) and 18.18% among students. These results are different from those obtained by [12] at Point G University Hospital in Bamako in Mali with a prevalence of

13.1% among traders and 6.6% among students. This high prevalence among traders is explained by their negligence. Because some said they did not have time to go to a hospital for a consultation. Some only happen when the cough persists.

In relation to the level of education, the prevalence due to *Mycobacterium tuberculosis* was 24% in uneducated patients and a prevalence of 23.17% in patients with a secondary level of education. According to the studies of [13], it obtained at the Bongor Provincial Hospital in Chad a very high prevalence than that obtained in our study. It obtained a prevalence of 83.47% among patients without schooling and 4.96% among patients with a secondary level of education.

4. CONCLUSION

At the end of this study on the prevalence and factors influencing the transmission of pulmonary tuberculosis due to *Mycobacterium tuberculosis*, we enrolled 453 patients. Among these patients, 105 patients detected positive for *Mycobacterium tuberculosis* by GeneXpert, representing a prevalence of 23.18%. In relation to the level of education, the prevalence due to *Mycobacterium tuberculosis* which is 24% in uneducated patients and 23.17% in patients with a secondary level of education. Some factors had influenced the transmission of *Mycobacterium tuberculosis* in this study. The factors influencing TB transmission were 100% related to a family case of TB and 77.77% were related to the presence of TB in the vicinity. The *Mycobacterium tuberculosis* strain constitutes a major public health problem, hence the need to test its sensitivity to Rifampicin before proposing a treatment regimen. One hundred strains of *Mycobacterium tuberculosis* had a high sensitivity to Rifampicin, that is to say a prevalence of 22.05%, two strains of *Mycobacterium tuberculosis* had a low sensitivity to Rifampicin, that means a prevalence of 0.44%, and three strains of *Mycobacterium tuberculosis* were resistant to Rifampin, a prevalence of 0.66%. Tuberculosis is far from being controlled by public health authorities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s). (33/PNT/2023.).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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