

Original Research Article

Prevalence and factors influencing the circulation of pulmonary tuberculosis in patients followed at the National Tuberculosis Control Program in N'Djamena, Chad

ABSTRACT

Prevalence and factors influencing the circulation of pulmonary tuberculosis in patients followed at the National Tuberculosis Control Program (PNT) in N'Djamena at Chad.

Tuberculosis an infectious disease caused by a bacillus called *Mycobacterium tuberculosis*. Pulmonary involvement is the most common location and represents the usual source of transmission.

This was a prospective study 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

Comment [H1]: Writing style

- 1) Background of study
- 2) Research aim

Or remove background of study

tobacco consumption (20%) and alcohol (12.73%). Tuberculosis 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 zoonotic 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), between 2023 and 2027, 38.6 million people will be affected by tuberculosis, 3.32 million will be children and 1.7 million people will be affected by tuberculosis. Will develop resistance to Rifampicin or multidrug resistance [3]. For the World Health Organization (WHO), tuberculosis is far from the objective 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 are estimated at 302 patients, of whom 113 were completely cured 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% (WHO, 2021). Chad is one of the countries which is paying a heavy price for the tuberculosis epidemic. 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 HIV+ patients may possibly be based on their

Comment [H2]: organize references according to their sequence

Comment [H3]: Use "contagious infection" or specify "human infection" to avoid confusion.

Comment [H4]: Clearly separate these statistics. For instance, "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."

Comment [H5]: Provide a clear reference or context for the WHO's target, and check if this target is still current or has been updated.

Comment [H6]: Provide context or compare this number to global or regional totals for better clarity.

Comment [H7]: References arrange according to serial. Example [1],[2],[3],[4],.....

Comment [H8]: Unclear and may mislead- Rephrase to clarify

Comment [H9]: Remove semicolon and put comma

Comment [H10]: Avoid semicolon put in comma

Comment [H11]: Verify and provide the most recent data available from WHO or other credible sources.

Comment [H12]: Provide specific examples of how HIV affects TB presentation and management, especially in Chad

immunity [7]. Factors influencing the circulation of tuberculosis are linked to under nutrition, HIV/AIDS, smoking, alcohol use disorders and diabetes sugar. 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 a fully automated Real-Time PCR testing device that integrates sputum processing, DNA extraction and amplification as well as semiquantitative *M. tuberculosis* diagnosis and resistance detection. Rifampicin [8].

Comment [H13]: Use "diabetes" or "diabetes mellitus."

Comment [H14]: References arrange according to serial. Example [1],[2],[3],[4].....

Comment [H15]: Fragmented and lacks clarity- Rephrase for clarity

2. MATERIAL AND METHODS

2.1. Type and study area

This was a prospective study 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 Farchaneighborhood in first district. It covers an area of 180 meter square. 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.

Comment [H16]: Remove – and put full stop

Comment [H17]: Ensure consistency in measurement units

Comment [H18]: Consistently use proper capitalization and punctuation. Ensure clarity in describing boundaries.

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 Bacteriology laboratory department. Among them, 453 patients had agreed to sign the informed consent to participate in this study but 47 had refused to sign the consent and therefore were not included in the study.

Comment [H19]: Correct the phrasing to "the Bacteriology Laboratory Department at the PNT"

Comment [H20]: Add a comma for clarity and streamline the description.

2.3. Study population

The study population consisted mainly of patients of both sexes aged between eight months and 70 years admitted to the bacteriology laboratory department of the PNT with a sputum examination bulletin for pulmonary tuberculosis screening meeting the inclusion criteria and

Comment [H21]: Break this sentence into more manageable parts for clarity and ensure proper grammar.

above all consenting to participate in this study. Informed consent was read and approved by each participant. Sputum from patients was received from 6:00 a.m. to 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, profession 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 viral 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 [9].

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 [9].

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 [9].

2.5.3. Sample preparation

Comment [H22]: Slightly refine for clarity- "Informed consent was obtained from each participant after it was read and explained."

Comment [H23]: Adjust the phrasing to clearly indicate the time frame for sputum collection- "Sputum samples were collected from patients between 6:00 a.m. and 9:00 a.m."

Comment [H24]: Remove – and put full stop

Comment [H25]: The term "viral genome" might be a bit confusing if you are testing for tuberculosis, which is bacterial. If the test is indeed for bacteria, it should be specified.

The GeneXpert molecular technique was used. Collect 4 mL of reagent (diluent or bead) and add 2 mL of sputum sample. Mix well and vortex. Incubate for 15 minutes. After 15 minutes of incubation, shake the solution again on the vortex and incubate at room temperature for five minutes so that the solution is perfectly fluid and liquefies well 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 [8; 9].

Comment [H26]: molecular technique

Comment [H27]: Clarify and avoid repetition.

Comment [H28]: Avoid semicolon put in comma

2.5-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 circulation 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

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%.

Comment [H29]: Avoid repetition- already mention data collection method

Comment [H30]: Avoid redundancy for conciseness.

3.1. Distribution of patients according to socio-demographic characteristics

The average age in this study was 28.26 years. The extremes were 08 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).

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

3.2. Factors influencing the circulation of tuberculosis in this study

Certain factors had influenced the circulation of tuberculosis in this study. The prevalence was 100% linked to the registration of a case of tuberculosis within the family and a

Comment [H31]: Remove zero

prevalence of 77.77% linked 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's show a very significant variation with a $P = 0.001$ (Table 2).

Comment [H32]: Correct grammar and clarify the statistical significance.

Table 2: Factors influencing the circulation of tuberculosis

Influencing factors	N	TB+	Prevalence	CI at 95%	P	Interpretation
TB within the family	Yes	03	03	100	[-104.28 ; 95.72]	0.001 Very Significant
	No	450	102	22.66	[-23.11 ; 22.21]	
TB in neighbourhood	Yes	09	07	77.77	[-80.70 ; 74.84]	
	No	444	98	22.07	[-22.51 ; 21.64]	
Active smoking patients	Yes	100	20	20	[-20.37;19.63]	
	No	353	85	24.10	[-1.42 ; 1.43]	
Alcoholism	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 $P < 0.001$ in the Fisher Exact and Chi-square Test, the factors are very significant

3.3. Clinical variables of the study

Figure 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 $P = 0.68$.

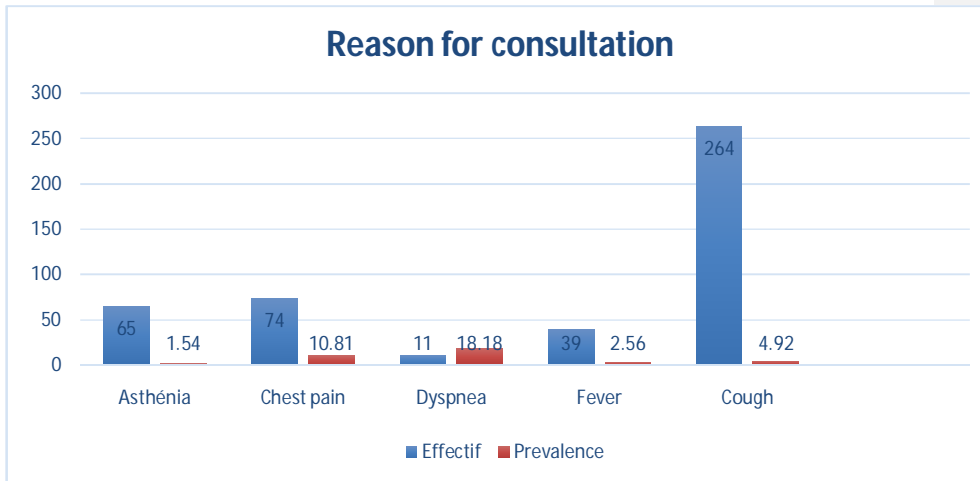


Figure 1: Reason of consultation

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 4.64%, 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 ($P = 0.06$).

Comment [H33]: Correct the prevalence value. The prevalence should be calculated as $(21/105) \times 100 = 20\%$, not 4.64%.

Table 3: Repair of patients according to HIV status

Co-infection HIV-TB	N	TB+	Prevalence	CI at 95%	P	Interpretation
HIV Positive	105	21	16.19	[-17.33 ; 15.05]	0.05	Significant

status	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 Significant
	In shape	240	38	15,83	[-16,31 ; 15,35]		

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 $P= 0.01$.

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]		

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	Very Significant
MTB+RIF R	03	0.66	[-0.65 ; 0.66]		

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

3.4. 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 students, 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 $P = 0.007$.

Comment [H34]: There is a repetition of "students" in the original passage; this should be corrected to accurately reflect different groups.

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]	0.009	Very Significant
11 years à 21 years	63	02	3.17	[-3.19 ; 3.15]		
22 years à 32 years	128	50	39.06	[-43.50 ; 34.62]		
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]	0.05	Significant
Student	66	12	18.18	[-19.55 ; 16.81]		
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	Very Significant
Secondary	82	19	23.17	[-25.16 ; 21.21]		
Upper	93	20	21.50	[-22.21 ; 20.81]		

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 [10] at the Point G University Hospital of Bamako in Mali.

3.1. Distribution of patients according to socio-demographic characteristics

The average age in this study was 28.26 years. The extremes were 08 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 rate of 24.28%. These results are lower than those of 35.33% in the age group of 30 years to 44 years published by [11] 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 [10] 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

Comment [H35]: Remove zero

Comment [H36]: Replace word 'a prevalence'

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 [10], 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 [11]. 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.

3.2. Factors influencing the circulation 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% linked to the registration of a case of tuberculosis within the family and a prevalence of 77.77% linked to the presence of a case of tuberculosis in the

Comment [H37]: among

Comment [H38]: among

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 [12] 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 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].

3.3. 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 4.64%. Our results are lower than those of 11.47% published by [10] 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, that to say a prevalence of 3.53%, and five patients lived with HIV-2, that means a prevalence of 1.12 %. 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 [13], 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.

3.4. The biological variables of the study

Comment [H39]: write more clear sentence, example "that increase the risk of pulmonary tuberculosis"

Comment [H40]: Ensure this reflects the actual data

Comment [H41]: which corresponds to"

Comment [H42]: which corresponds to"

Comment [H43]: "1.10%" (Standardize formatting to avoid confusion.)

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. 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.

Comment [H44]: Gramatic error

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 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%. Our results are higher than those of 83.03% resistance to Rifampicin published by [14] in Niger. On the other hand, our results are approximate to those of 0.7% of resistance to Rifampicin obtained by [15] 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 [16; 17].

Comment [H45]: ?

Comment [H46]: Avoid semicolon put in comma

3.4. 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 [11]. 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 [10] 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 [11], 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 circulation 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%. The average age in this study was 28.26 years. The extremes were 08 months and 70 years. The age groups aged 22 years to 32 years and those aged 33 years to 43 years were the most contaminated by *Mycobacterium tuberculosis*, that means a prevalence of 39% for these two age groups. Traders were more

Comment [H47]: This might imply overlapping groups or confusion.

contaminated by *Mycobacterium tuberculosis* (39.41%). 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's 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.

CONSENT

In this study, informed verbal consent from each patient admitted to the National Tuberculosis Control Program was obtained from these patients after explaining to each participant the importance and purpose of this research.

ETHICAL APPROVAL (WHEREEVER APPLICABLE)

The study was authorized by note Number 33/PNT/2023.

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Comment [H48]: The statement that traders had a prevalence of 39.41% might be confusing without context.

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