

Original Research Article

<https://doi.org/10.20546/ijcmas.2024.1304.012>

Prevalence of Pulmonary Tuberculosis among Patients Seen at the National Public Health Laboratory in Libreville, Gabon: A Three Years Observational Retrospective Study

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ABSTRACT

Tuberculosis remains a major public health problem worldwide. In Sub-Saharan African countries, screening methods and strategies for this disease are weak. This study assesses the prevalence of pulmonary tuberculosis among patients seen at the national public health laboratory in Libreville, Gabon, between January 2020 and December 2022. This is a retrospective observational study conducted from August 1 to October 11, 2023, based on pulmonary tuberculosis diagnostic results obtained between January 2020 and December 2022, in patients presumed to have tuberculosis, at the national public health laboratory in Libreville. Sputum samples from each patient were diagnosed using the MTB/RIF Xpert test. In order to establish correlations between the prevalence of pulmonary tuberculosis and variables such as age, sex, HIV infection and history of tuberculosis, data were entered into an excel 2016 spreadsheet, and exported to R software version 4.0.3, for statistical analysis of trends over time. Within a 95% confidence interval, results were considered significant at $p \leq 0, 05$. In total, data from 2369 patients were collected for the present study. With a sex ratio of 1.21 and a mean age of 51.85 ± 17.45 years, men predominated ($n=1296$) over women ($n=1073$). The overall prevalence of pulmonary tuberculosis was reported to be 20.60% ($n=488$) (95% CI: (0.19- 0.23)) in the present study. In the present study, 29 (5.94%) patients were resistant to rifampicin and 297/1027 (28.92%) patients were co-infected with HIV. Male gender (OR= 2.47, 95% CI 1.19-5.13), age groups between 21 and 40 years (OR= 2.47, 95% CI 1.19-5.13) and between 61 and 80 years (OR= 2.47, 95% CI 1.19-5.13), HIV infection (OR =2.47, 95% CI 1.19-5.13), were significantly associated with the prevalence of pulmonary tuberculosis. The overall prevalence of pulmonary tuberculosis between January 2020 and December 2022 obtained in the present study indicates that this disease persists in Gabon. Effective prevention and control strategies would be appropriate to control this burden.

Keywords

Pulmonary tuberculosis, MTB/RIF Xpert test, Libreville, Gabon

Article Info

Received:
28 February 2024
Accepted:
30 March 2024
Available Online:
10 April 2024

Introduction

Tuberculosis (TB) remains a major public health problem to this day. Until the advent of the COVID-19 pandemic, tuberculosis was the world's leading cause of death, ahead of HIV/AIDS, attributable to *Mycobacterium tuberculosis*, the infectious agent of this disease (WHO, 2023). In terms of tuberculosis (TB) treatment and control, one of the world's priorities is to improve conditions for early detection and identification of cases, particularly those co-infected with the human immunodeficiency virus (HIV), smear-negative TB in young people, and finally, to improve diagnostic options for multidrug-resistant tuberculosis (MDR-TB) (Torpey *et al.*, 2020).

Unfortunately, the limitations of traditional diagnostic techniques mean that TB/HIV co-infection is often misdiagnosed, particularly in resource-limited countries with high HIV prevalence, where TB diagnostic methods rely essentially on microscopic examination of smears and culture (gold standard) for rapid diagnosis. (Lupande *et al.*, 2017; WHO, 2023). With this in mind, in December 2010 the WHO approved the use of a new tuberculosis diagnostic tool, the Xpert MTB/RIF test.

This latest-generation molecular biology technique uses automated DNA-based platforms (real-time PCR), and has the capacity to detect not only tuberculosis, but also rifampicin resistance in less than 2 hours (Goosen *et al.*, 2020). In Gabon, despite the implementation of a National Tuberculosis Control Program (NTCP) including tuberculosis centers (TC) and diagnostic and treatment centers (DTC), which are first-line care centers, tuberculosis figures are still alarming in this country, which ranks 4th among African states and territories in terms of tuberculosis incidence (Elise Ghitman, 2020). Moreover, the World Health Atlas has indicated a tuberculosis incidence of 521/100,000 for Gabon in 2019 (Mba *et al.*, 2023). Faced with the resurgence in the prevalence of HIV/AIDS, in Gabon, people living with this disease are sometimes declared negative at microscopic diagnosis, even though they have tuberculosis. As a result, a co-infection rate of 55.4% has been reported among people infected with both TB and HIV (Mouinga-Ondeme *et al.*, 2024). The aim of the present study was to determine the prevalence of pulmonary tuberculosis in patients seen at the national public health laboratory in Libreville, Gabon, between January 2020 and December 2022.

Data and Methods

Study setting and location

The present study was carried out at the National Public Health Laboratory, in the Mycobacteriology Unit.

Type and period study

This is a retrospective observational study conducted from August 1 to October 11, 2023, based on the results of diagnosis of pulmonary tuberculosis by the Xpert MTB/RIF test, obtained between January 2020 and December 2022, in patients suspected of having tuberculosis, at the National Public Health Laboratory in Libreville.

Study population

The study population consisted of all individuals, children, adolescents and adults, regardless of age or sex.

Inclusion and exclusion criteria

All results from patients with suspected pulmonary tuberculosis who underwent Xpert MTB/RIF testing were included in the present study. On the other hand, results from patients who had only received microscopic diagnosis and those with information or diagnostic results that could not be used were not included.

Sampling

A purposive sampling was carried out to collect data from the archive registers of the Mycobacteria Unit of the the National Public Health Laboratory in Libreville (NPHL), based on a socio-demographic information sheet for each patient, providing information on age, sex, HIV infection and previous tuberculosis treatment.

XPRT MTB/RIF test

Principle

The Xpert MTB/RIF test is an automated in vitro diagnostic real-time nested PCR test designed for the qualitative detection of MTB complex and rifampin resistance. The test's primers amplify a fragment of the *rpoB* gene, containing the 81-base-pair core region. The probes are designed to differentiate the conserved wild-

type sequence from mutations in the core region, which are associated with rifampicin resistance. This test can be performed on Cepheid® GeneXpert instrument systems.

XPERT MTB/RIF test procedure

Pre-analytical

The pre-analytical procedure consists of sample reception, registration and transport of the various samples received.

Analytical

The analytical part consists of preparing the Xpert MTB/RIF test cartridge and starting up the computerized procedure.

Post-analytical

The post-analytical phase consists of viewing, interpreting, recording and reporting the results of the test performed.

Statistical analysis

Entered in Microsoft Excel 2016 format, the data were then analyzed using R software version 3.6.1, including the measurement of rates to determine risk factors associated with the prevalence of pulmonary tuberculosis. A 95% confidence interval was estimated, and a $p \leq 0.05$ value was considered statistically significant. Crude odds ratios (COR), and 95% confidence intervals (95% CI) were calculated for each variable. Values $p \leq 0.05$ were considered statistically significant.

Ethical considerations

The data received did not include patients' identity or personal information.

Results and Discussion

Overall prevalence of pulmonary tuberculosis as a function of year among participants in this study

Data from 2369 patients were collected for the present study. With a sex ratio of 1, 21 and a mean age of $51.85 \pm$

17.45 years, men predominated (1296) over women (1073). It was reported that, 488 results were positive for pulmonary tuberculosis, indicating an overall prevalence of the disease at 20.60% (95% CI: (0.19- 0.23)).

This prevalence varied annually from January 2020 to December 2022. While the lowest prevalence was observed in 2020 with 17.86% (95% CI: (0.16- 0.21)), followed by 21.49% (95% CI: (0.09- 0.12)) in 2021, the highest was observed in 2022 with 22.87% (95% CI: (0.26- 0.34)). The number of positive pulmonary tuberculosis cases rose steadily between January 2020 and December 2022 with 150/840 and 182/1847 cases respectively, before increasing significantly to 156/526 in 2022, Figure 1.

Pulmonary tuberculosis prevalence by age and sex of study participants

An univariate analysis of pulmonary tuberculosis prevalence as a function of sex and age of study participants showed that male gender (COR = 0.05; 95% CI: (0.03; 0.07) $p \leq 0.001^*$), age groups 21 - 40 years (COR = 1.68; 95% CI: (1.38; 2.05) $p \leq 0.001^*$) and 61-80 years (COR = 0.21; 95% CI: (0.1; 0.43) $p \leq 0.001^*$), were risk factors associated with pulmonary tuberculosis (Table 1).

Prevalence of pulmonary tuberculosis according to HIV infection and Previous tuberculosis treatment among study participants

In a univariate analysis of the prevalence of pulmonary tuberculosis according to HIV infection and previous tuberculosis treatment among study participants, Table 2 shows that HIV (OR = 2.45; 95% CI: (2.03; 2.45), $p \leq 0.001$) was associated with the prevalence of pulmonary tuberculosis among study patients (Table 2).

Despite numerous efforts by global health authorities to combat this burden, the WHO's goal of a world free of tuberculosis is far from being achieved, even by 2050 (Chakaya *et al.*, 2020). Confirming Gabon's ranking in the zone of countries with 300 or more cases of tuberculosis per 100,000 inhabitants worldwide (Mba *et al.*, 2023), a global tuberculosis prevalence of 20.60% was reported between 2020 and 2022 in the present study. Significantly lower than those obtained in previous studies carried out in other African countries such as Congo (79.1% (Farra *et al.*, 2019)) and Togo (57%

(Dagnra *et al.*, 2015)), this result is close to the 26.8% found in Ethiopia (Diriba *et al.*, 2022), the 23.1% also found in Ethiopia (Mulu *et al.*, 2017) and the 22.9% found in Nigeria (Tahiri *et al.*, 2014). On the other hand, it is much higher than those found in the Central African Republic 10.99% (Tékpa *et al.*, 2019), Eastern Amhara, Ethiopia: 2015-2019 which was 11% (Wasihun *et al.*, 2021), South Africa 13% (Nicol *et al.*, 2014), and Uganda 5.5% (Kim *et al.*, 2015).

These results, which vary from one study to another, could be justified not only by the different techniques for diagnosing pulmonary tuberculosis used in each study, but also by the quality of the participants in the different studies, the study period, sample size, environmental conditions and the different methods and practices put in place to combat tuberculosis in each region or country. The prevalence of tuberculosis in the present study corroborates with the implementation of multiple screening awareness campaigns advocated by the National Tuberculosis Control Program (NTCP) in Gabon (Mba *et al.*, 2023). Most of the participants in the 2108 study (88.98%) were newly infected patients (who had never taken anti-tuberculosis treatment). In contrast to a study conducted in Papua New Guinea, in which the authors recorded a high number of female sex workers positive for pulmonary tuberculosis (Willie *et al.*, 2021), the present study indicated a 0.05-fold prevalence of pulmonary tuberculosis, more associated with male sex.

This finding is in line with one from the Philippines, which found a similar result (Know *et al.*, 2018), and another, in which a male predominance has been described by numerous tuberculosis studies (Peer *et al.*, 2023). This result confirms the fact that, despite numerous efforts made by countries around the world in recent decades to improve access to healthcare, men have lagged behind women in various health indicators (GHDE, 2019). Moreover, in contemporary African societies, women's maternal fiber means that they are most often targeted in family planning and reproductive health research and policy programs (Ouedraogo *et al.*, 2021).

Finally, it should also be noted that in rural areas, most women are committed to housework, which exposes them less than men to the difficult working conditions outside the family home that the latter face (Njenga *et al.*, 2021). Contrary to the results obtained in a study which showed no association between tuberculosis and age (Abebe *et al.*, 2012), or which reported a higher

prevalence of the disease in the 16 to 34 age bracket (Hordofa and Adela, 2015); (Adane *et al.*, 2015). Univariate analysis of the results obtained in the present study respectively indicated a 1.6-fold and 0.21-fold higher prevalence of pulmonary tuberculosis in patients in the 21-40 and 61-80 age brackets. This result is not far from that found elsewhere, which indicated that the age groups most affected by pulmonary tuberculosis were those aged 21-30 and 31-40 (Dong *et al.*, 2022). This is in line with studies carried out in developing countries, which revealed a predominance of tuberculosis in young adults and the very elderly (de Figueiredo *et al.*, 2022). This may be justified by the fact that, with an average age of 51.85 ± 17.45 years, the population in the present study was made up of young adults and senior citizens, and thus represented periods of human life that are unfortunately conducive to multiple infections, including by *Mycobacterium tuberculosis*, the cause of tuberculosis (Olmo-Fontáñez and Turner, 2022). Similar to a study conducted elsewhere (Mulugeta *et al.*, 2021), it was reported that HIV infection was significantly associated with pulmonary tuberculosis in the study patients, and presented an increased risk of active tuberculosis. This finding is consistent with the literature, according to which HIV infection is accompanied by an immune deficiency that favours the occurrence of numerous opportunistic infections, including tuberculosis (Justiz Vaillant and Naik, 2023).

Study Limitations

Despite the important information they provide, and having been obtained solely in a hospital setting, the results of this study have certain limitations, and may not be generalizable. Firstly, the single use of the Xpert MTB/RIF test may present a reduced clinical efficacy, due to circumstances related to sample and result handling. Microspikes and chest X-rays, as complementary diagnostic tools for all suspected cases, would have been appropriate and would have avoided missing some positive cases of tuberculosis. In addition, the culture technique and CD4 assay for HIV/TB co-infected individuals were not performed due to limited laboratory facilities,

The results of the present study indicated an upward trend in the prevalence of pulmonary tuberculosis in Libreville between January 2020 and December 2022. This was associated not only with HIV/AIDS infection, but also with male gender, and with the age groups 21 to 40 and 61 to 80, respectively.

Table.1 A univariate analysis of pulmonary tuberculosis prevalence as a function of sex and age of study participants

Variables	Total number of people diagnosed N (%)	Prevalence of pulmonary tuberculosis		Univariate analysis	
		Positive N (%)	Negative N (%)	Crude OR 95% CI	p
Gender					
Male	1296 (54.71)	289 (22.30)	1007 (77.7)	0.05 [0.03 ; 0.07]	≤0.001*
Female	1073 (45.29)	199 (18.55)	35 (81.45)	Reference	-
Age groups (years)					
≤ 20	453 (19.12)	82 (18.10)	371 (61.19)	Reference	-
21 - 40	1034 (43.65)	263 (25.44)	771 (74.56)	1.68 [1.38 ; 2.05]	≤0.001*
41- 60	716 (30.22)	134 (30.22)	582 (69.78)	0.84 [0.68 ; 1.05]	0.13
61- 80	148 (6.25)	8 (0.34)	140 (99.66)	0.21 [0.1 ; 0.43]	≤0.001*
≥ 81	18 (0.76)	1 (7.69)	17 (92.31)	0.023 [0.03 ; 1.73]	0.11

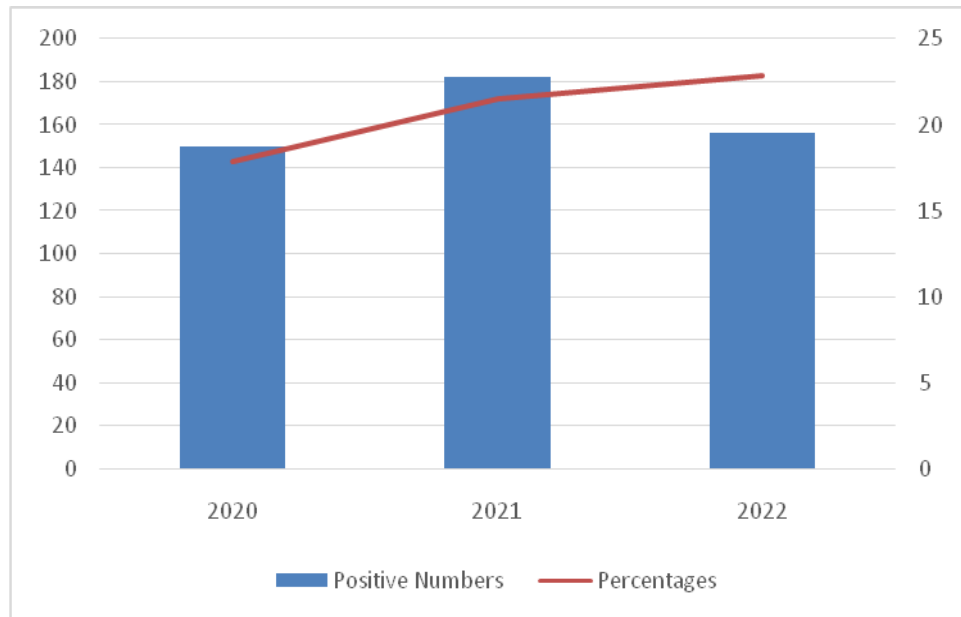
OR = odds ratio; CI= confidence interval; * = significant test

Table.2 Univariate analyses of the prevalence of pulmonary tuberculosis, according to HIV infection and previous tuberculosis treatment among study participants (N=2369).

Variables	Total number of people diagnosed N (%)	Prevalence of pulmonary tuberculosis		Univariate analysis	
		Positive N (%)	Negative N (%)	Crude OR 95% CI	p
HIV infection					
Positive	1027 (43.35)	297 (28.92)	730 (71.08)	2.45 [2.03 ; 2.45]	≤0.001*
Negative	1342 (56.65)	191 (14.23)	1151 (85.77)	Référence	-
Previous tuberculosis treatment					
Yes	261 (11.02)	64 (24.52)	197 (75.48)	1.29 [0.95 ; 1.74]	0.097
No	2108 (88.98)	424 (20.11)	1684 (79.89)	Reference	-

OR = odds ratio; CI= confidence interval; * = significant test

Figure.1 Overall prevalence of pulmonary tuberculosis as a function of year among study participants.



On the one hand, this suggests possible shortcomings in symptom-based case-finding, which should be addressed in similar contexts. On the other hand, TB treatment costs remain exorbitant, and some patients do not complete their treatment. Therefore, TB screening of HIV-positive patients, public awareness and community mobilization, and lower TB drug costs should be encouraged.

Recommendation and outlook

Large-scale studies on strategies for managing tuberculosis in children and trends in tuberculosis/HIV co-infection, as well as associated factors, should also be carried out throughout the country. This will enable us to combat this disease effectively.

Acknowledgements

We would like to thank the National Public Health Laboratory (NPHL) staff in Libreville, for collecting and making available to us all the results of the Xpert MTB/RIF test for *Mycobacterium tuberculosis*.

Data and code availability

The data reported in this document, and any additional information required to re-analyze the data reported in this document, are available from the corresponding author on request.

Author Contribution

The data reported in the study were available to the authors, who contributed equally to the preparation and drafting of this manuscript.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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How to cite this article:

Thiéry Ndong Mba, Allogho privat, Cédric Sima Obiang, Joseph Privat Ondo, Aurel N'Djimbi Mackanga, Armel Mintsas and Louis clément Obame Engonga. 2024. Prevalence of Pulmonary Tuberculosis among Patients Seen at The National Public Health Laboratory in Libreville, Gabon: A Three Years Observational Retrospective Study. *Int.J.Curr.Microbiol.App.Sci*. 13(4): 107-114. doi: <https://doi.org/10.20546/ijcmas.2024.1304.012>