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Epidemiology of Tuberculosis in Children at Centre Hospitalier Universitaire Pédiatrique Charles De Gaulle

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A B S T R A C T

Tuberculosis, a disease caused by *Mycobacterium tuberculosis*, is prevalent in developing countries such as Burkina Faso. It is in this context that we conducted this study, which aimed to investigate the epidemiological aspects of tuberculosis in children aged 0 to 14 years at the Charles De Gaulle Pediatric University Hospital Center (CHUP-CDG). This was a descriptive cross-sectional study conducted between 2010 and 2020. Data was collected from laboratory records and infectious disease departments using a completed questionnaire. From 2010 to 2020, the Charles De Gaulle Pediatric University Hospital Center recorded 93 cases of tuberculosis. The average age of children with tuberculosis was 8.4 years, and the (0-5 year) age group was the most represented, accounting for 38.71% of cases. Progressive cough was the most common reason for consultation. Tuberculosis/HIV co-infection accounted for 18.35% of cases. The prevalence of tuberculosis from 2010 to 2020 was 4.04%. Tuberculosis remains a reality among children at CHUP-CDG. Therefore, appropriate preventive measures must be taken to eradicate tuberculosis in Burkina Faso.

Introduction

Tuberculosis is a contagious infectious disease of an endemic-epidemic nature, caused by *Mycobacterium tuberculosis* and transmitted mainly between humans (1). Although tuberculosis is preventable and curable, it continues to be a major public health problem and cause of death among children in areas where it is endemic (2). According to the WHO, there were an estimated 10.4 million new cases of tuberculosis worldwide in 2019, including 5.9 million (56%) in men, 3.5 million (34%) in women, and 1 million (10%) in children (3). In 2021, according to the CNLAT, 3,200 children were infected with tuberculosis (4). An estimated 10.6 million people contracted tuberculosis in 2018, compared to 10.1 million in 2019, and 1.6 million people died from tuberculosis in 2019 (including 187,000 people living with HIV), compared to 1.5 million in 2020 (including 214,000 HIV+ people). Thus, the incidence rate of tuberculosis increased by 3.6% in 2018 compared to 2020, suggesting a reversal of the trend of nearly 2% decline per year over the past two decades (5).

In the United States in 2019, the incidence of tuberculosis partially rebounded (to 2.4), but remained significantly lower than in pre-pandemic years, raising concerns. In 2020, the 50 US states and the District of Columbia provisionally reported 8,300 cases of tuberculosis to the National Tuberculosis Surveillance System (6). In 2012, out of an increase to 530,000 in the number of tuberculosis cases in children (aged < 15 years), representing 6% of all reported cases, the majority of cases were reported in Asia (58%) and sub-Saharan Africa (27%) (7). According to the WHO, in 2020, approximately 25% of tuberculosis cases worldwide occurred in Africa (8). The Kingdom of Lesotho has one of the highest tuberculosis rates in the world, with a past incidence of 827 per 100,000 in 2000, peaking at 1,240 per 100,000 cases in 2008 (9). Nigeria had the fourth highest tuberculosis rate in the world, with an incidence of 0.37 to 0.55 million in 2008, and also has the highest number of new tuberculosis cases in Africa, with around 300,000 cases recorded each year, resulting in around 30,000 deaths per year (10). In Burkina Faso, tuberculosis was designated a priority public health issue in 1995, with an estimated incidence of 46 cases per 100,000 inhabitants and a mortality rate of 9.7 cases per 100,000 inhabitants in 2015 (11). However, according to data from the National Tuberculosis Control Program (PNT), the notification rate is extremely low among children, and the WHO emphasizes that childhood tuberculosis has long been neglected, making ending the tuberculosis epidemic by 2035 a goal assigned to the Sustainable development goals (12). To achieve this, there needs to be a 95% reduction in the number of deaths by 2035 and a 90% reduction in the incidence rate of tuberculosis compared to 2015 (13). To reduce the incidence of tuberculosis in children, we have undertaken this study, which aimed to contribute to a better understanding of the epidemiology of tuberculosis at Centre Hospitalier Universitaire Charles de Gaulle.

Materials and Methods

This study was conducted at CHUP-CDG, in the medical department, which is organized into eight care units, including the Infectious Diseases (ID) unit, where tuberculosis patients were hospitalized. This was a descriptive cross-sectional study conducted between 2010 and 2020, including all children hospitalized at the CHUP-CDG for tuberculosis. The population consisted of all children aged 0 to 14 years diagnosed with tuberculosis. All children hospitalized at the hospital for tuberculosis during the study period and whose complete medical records were found were included. Also included were children who received treatment for tuberculosis according to current recommendations. However, children with medical histories that could affect the study results, such as chronic diseases or immune disorders, were not included. The same applies to children who received non-standard treatment for tuberculosis and those whose records were empty or incomplete.

A comprehensive survey was conducted among patients who had requested a diagnosis of tuberculosis. Sociodemographic variables included age, gender, educational level, family income, health insurance status, and place of residence based on geographical location. Clinical variables included the date of tuberculosis diagnosis, type of tuberculosis, diagnostic test results, treatment received, outcome after treatment, treatment effects, and comorbidities.

The technique consisted of listing all the department's files, classifying them by period, then reporting all tuberculosis cases using an individual data collection form designed for the study, and finally presenting them in Excel tables. The data were extracted from the registers for the period 2010-2020 for tuberculosis cases. KoboCollect software was used to create the database

for tuberculosis cases, which was presented in Excel format and then analyzed using Epi Info software version 7.2.6. Authorization and approval of the protocol were obtained from the hospital administration. Anonymity and confidentiality were respected in the data collection process.

Results and Discussion

Sociodemographic characteristics: From 2010 to 2020, we included 2,301 patients recorded for 93 cases of tuberculosis at the Charles de Gaulle Pediatric University Hospital Center.

In this study, the target population was aged between 0 and 14 years. Table 1 showed the distribution of tuberculosis patients by age group.

Age	N = 93	%
(0, 5)	36	38.71
) 5, 10)	32	34.41
) 10, 14)	25	26.88

The average age was 8.4 years. The age group (0, 5) was the most represented with 38.71%.

Of the 93 cases of tuberculosis, 53 were male and 40 were female, giving a sex ratio of 1.32 in favor of males.

Distribution according the clinical forms of tuberculosis: The main clinical forms of tuberculosis were pulmonary tuberculosis and extrapulmonary tuberculosis. Table 2 showed the distribution by age according to the clinical forms of tuberculosis.

Age	Pulmonary tuberculosis	Extra-pulmonary tuberculosis	Total
(0,5)	23	13	36
) 5,10)	23	9	32
) 10,14)	19	6	25
Total	65	28	93

The age groups (0, 5) and (5, 10) were the most represented, with 23 cases of pulmonary tuberculosis, which remains predominant compared to extrapulmonary tuberculosis.

Distribution by gender according to clinical forms: Table 3 showed the distribution of clinical forms of tuberculosis by gender.

Gender	Pulmonary tuberculosis (%)	Extra-pulmonary tuberculosis (%)	Total
Female	30(32.25)	10(10.75)	40(43.01)
Male	35(37.63)	18(19.35)	53(56.98)

Males were the most represented group, with 35 cases of pulmonary tuberculosis (37.63%) and 18 cases of extrapulmonary tuberculosis (19.35%) compared to females.

Distribution of tuberculosis cases by location: Table 4 showed the distribution of tuberculosis cases according to the place of residence of tuberculosis patients.

Place of residence	Frequencies	Percentage (%)
Rural	15	16.13
Urban	78	83.87
Total	93	100

Tuberculosis patients from urban areas accounted for the largest proportion, at 83.87%.

Distribution of cases according to descriptive epidemiology by year: From 2010 to 2020, pediatrics recorded 93 cases of tuberculosis. Table 5 showed the distribution of tuberculosis cases by year.

Years	Frequencies (n=93)
2010	03
2011	04
2012	04
2013	05
2014	07
2015	10
2016	13
2017	09
2018	20
2019	12
2020	06

Low numbers of cases were recorded in 2010 and 2011, with three and four cases of tuberculosis respectively. From 2012 to 2018, pediatrics recorded an increase in confirmed cases of tuberculosis, peaking in 2018 with 20 confirmed cases.

Description of tuberculosis cases according to parents' occupation: Table 6 showed tuberculosis cases according to the father's occupation.

Father's occupation	Frequencies (n=93)	Percentage (%)
Couturier	4	4.30
Traders	22	23.66
Farmers	46	49.46
Eleveur	2	2.15
Teachers	3	3.23
Mécanicien	6	6.45
Forces armées	1	1.08
Sans emploi	9	9.68

Distribution of cases according to the mother's occupation: Table 7 gave the occupations of the mothers of tuberculosis patients.

Mother's occupation	Frequencies (n=93)	Percentage (%)
Shopkeeper	1	1.08
Seamstress	5	5.38
Housewife	81	87.10
Teacher	6	6.45

Children of stay-at-home mothers were the most represented, accounting for 87.10% of cases.

Clinical aspects and arguments of tuberculosis: Table 8 showed the distribution by age group according to BCG scar

BCG scar	Yes	No
(0,5)	3	2
) 5, 10)	3	6
) 10, 14)	1	4
Total	5	12

A total of five children with tuberculosis had visible BCG scars, compared with 12 who were not vaccinated.

Clinical background of children infected with tuberculosis: The patient's history or background was fundamental to their care. Table 9 showed cases of tuberculosis in HIV-positive patients.

Age groups	Frequencies	Percentage (%)
) 0 - 5)	10	10.75
) 5 - 10)	5	0.05
) 10 -14)	3	3.22

Eighteen (18) children with tuberculosis were HIV-positive in this study, representing a co-infection rate of 19.35%. The 0-5 age group was the most represented, with 10 cases of tuberculosis-HIV+ co-infection.

Reason for consultation: Table 10 showed the reasons of consultation of children infected with tuberculosis

Reason for consultation	F	%	*P-value*
Cough lasting for two weeks	62	34.83	*0.014*
Fever	56	31.46	*0.05*
Asthenia/weight loss	22	12.35	*0.08*
Abdominal pain	12	6.74	*0.26*
Increased abdominal volume	15	8.42	*0.145*
Body aches, vomiting	11	6.17	*0.248*

Tuberculosis was associated with a cough that had been developing for more than two weeks. Other reasons for consultation included fever, abdominal pain, body aches, and asthenia.

Confirmatory tests: The confirmatory tests were mainly BAAR microscopy and MTB/XPERT. Microscopy was performed in 50 cases, of which 34 were positive and 16 negative. MTB/XPERT was performed in 26 cases, of which 16 were positive and 10 negative.

Discharge status: Discharge status was important, highlighting optimal, efficient, and effective care. From 2010 to 2020, out of a total of 93 tuberculosis cases, we recorded 4 deaths, 72 improvements, and 17 recoveries.

Tuberculosis prevalence: Out of 2,301 patients recorded, the pediatric department recorded 93 cases of tuberculosis. The prevalence of tuberculosis at CHUP-CDG from 2010 to 2020 is estimated at 4.04% (95% CI: 3.31%-4.93).

In this study, the age group (0-5 years) was the most represented with 38.71%. This result is consistent with data from the literature by Dieng *et al.,* in Dakar in 2013, who found a percentage of 36.89% of children in the same age group (12). Higher proportions were observed by Barry and colleagues, with 55.93% for the 1-4 age group (13). This significant representation of the (0-5 years) age group could explain the cases of vaccination failure. Indeed, several factors could be responsible for vaccination failure. This may be linked to problems in maintaining the cold chain due to unexpected power cuts

or during the transport of vaccines. It could also be related to the quality of the vaccine upon delivery. Similarly, it could be related to an immune system deficiency preventing a response. Males were the most represented, accounting for 56.93% of cases. Similar data were reported by Alido *et al.,* in Mali (58.62% in 2011) and by Chaboule *et al.,* in Morocco (60.08% in 2020) (16, 17). However, higher figures than ours were observed by Hamidou's team in Niger, specifically in the Zinder area from 2020 to 2022, with 77%. This high result could be explained by the fact that they included 36 cases of tuberculosis/HIV co-infection. This high proportion of boys could be explained by their high mobility and increased contact outside the family through playgrounds, leisure activities, school, and the neighborhood. All of these factors could contribute to an increased risk of exposure to tuberculosis. Of the 93 cases of tuberculosis, 65 cases (69.89%, 65/93) were pulmonary and 30.10% (28/93) were extrapulmonary.

Cases of pulmonary tuberculosis were predominant. Other authors had already made the same observation. Indeed, Olinga and Yombi found 62% of tuberculosis cases in Cameroon in 2019 to be pulmonary (18). Similarly, Dabo and his colleagues observed 89% of cases in Mali in 2017 to be pulmonary (19). This can be explained by the fact that their work focused on cases of pulmonary tuberculosis. According to the WHO, the pulmonary form is the most prevalent type of tuberculosis. M. tuberculosis is strictly aerobic. This is why it prefers to lodge in the upper part of the lungs, as this area is hyperventilated.

Cases of tuberculosis in urban areas accounted for 83.87%. Previous studies conducted by Amadou in Niger in 2020 and Ben Amar in Tunisia in 2017 reported 70.5% and 73.9%, respectively (20, 21). Several hypotheses can be put forward. Indeed, this high urban concentration could be justified by the fact that urban areas offer more facilities for consultation, diagnosis, and treatment of detected cases. Thus, many cases in rural areas, especially severe cases, are transferred to urban areas, which would contribute to inflating the urban proportions. Similarly, overcrowding and high urban concentration could contribute to the spread of M. tuberculosis within the population.

From 2010 to 2014, there were 3 and 7 cases of tuberculosis per year, respectively. The highest number of cases was recorded in 2018 with 20 cases. These data corroborate existing data stating that tuberculosis remains present in Burkina Faso (22). This result differs from that of Maïga *et al.,* who reported 225 cases of tuberculosis in 2018 in the city of Ouahigouya in northern Burkina Faso (23). This difference can be explained by the fact that the two studies did not have the same site or the same target. Indeed, the capital Ouagadougou is one of the best-protected cities in Burkina Faso compared to Ouahigouya, which is severely affected by insecurity, leading to large population displacements of people suffering from physical insecurity and food insecurity, which can weaken the immune system and create a breeding ground for tuberculosis.

In this study, nearly half had a father who was a farmer; 87.10% had a mother who was a housewife. These results may indicate, to some extent, a lack of awareness or understanding of hygiene and protective measures, suggesting that children infected with tuberculosis come from disadvantaged backgrounds (25). This result is similar to the work of Lowys, who stated that three-quarters of tuberculosis patients came from economically disadvantaged backgrounds (26). A lifestyle linked to precarious conditions, poor hygiene, and lack of sanitation are all factors that contribute to the spread of tuberculosis. This has led some to conclude that tuberculosis is linked to poverty. However, this result is high compared to that of Ouédraogo *et al.,* who found that nearly one-third of farmers, 64.2% of housewives, and 5.2% of unemployed people had children with tuberculosis (27). In the absence of a universal health insurance system, people living in poverty face enormous barriers to accessing health centers. Indeed, payment methods in health facilities, such as direct payment and fee-for-service, assume that in the event of illness, the patient or their relatives have the financial means to pay for treatment.

In our series, 12 children (12.90%) had no visible BCG scar and 5 (5.3%) were vaccinated. This result differs from that reported by Nagalo *et al.,* in 2016 in Burkina Faso, who reported that 42.55% of infected children were vaccinated against tuberculosis in the same hospital (28). The benefits of BCG vaccination are well known; it protects children against disseminated forms of tuberculosis. In 2002, 100 million doses prevented 1,000 cases of miliary tuberculosis and 30,000 cases of meningitis. Thus, while vaccination does not prevent tuberculosis infection, it does reduce its severity (29).
HIV-tuberculosis co-infection was found in 19.35% of our patients. Indeed, as the saying goes, “every cloud has

a silver lining"; tuberculosis provided an opportunity to screen for HIV infection. Cardenat in Côte d'Ivoire in 2019 and Segbedji in Togo in 2018 noted a rate of tuberculosis-HIV co-infection of 24.5% and 15% among their patients (30). Adonis-Koffi in Côte d'Ivoire in 2004 and Enoghan in Libreville in 2006 observed HIV and tuberculosis co-infection in 16% and 4.4% of their patients, respectively (31).

In 2009 in Congo, M'pemba found that more than a third of the population he studied was co-infected (32). The rate of co-infection depends on the prevalence of HIV infection in the country; it is known that HIV infection promotes the progression of tuberculosis infection to tuberculosis disease and that tuberculosis disease in turn leads to HIV replication, resulting in an increase in viral load and a decrease in the number of CD4+ cells. This is a comorbidity that worsens the prognosis for each of these infections (33).

According to the WHO, individuals infected with Koch's bacillus who also have HIV are 20 to 30 times more likely to develop active tuberculosis (34).

The reason for consultation was chronic cough (34.83%) lasting at least two weeks, associated with fever, asthenia, and weight loss. Mabiala-Babela in Cameroon in 2020 found that the main reasons for consultation were persistent cough, fever (87.2%), malnutrition (69.2%), and dyspnea (30.8%) (35, 36).

The symptoms of tuberculosis in children are non-specific and can be indicative of several diseases. This clinical non-specificity is often responsible for delayed diagnosis.

Bacilloscopy was positive in 68% of cases. Ouédraogo *et al.,* in 2011 found 57% of bacilloscopy to be positive for tuberculosis in children at the CHU-SS (37). In children, it is difficult to obtain good-quality sputum samples, hence the importance of combining Xpert/MTB.

MTB/Xpert was performed in 26 cases, of which 16 were positive and 10 negative. Due to its recent introduction in 2013, several cases of tuberculosis were confirmed only by smear microscopy. As for prevalence, it is estimated at 4.04% (95% CI: 3.31%–4.93%) from 2010 to 2020 at CHUP-CDG. In Burkina Faso, other authors reported a prevalence of 7.08% (38). In Côte d'Ivoire and the Democratic Republic of Congo in 2014, Cardenat and Ngama noted prevalences of 7.14% and 4.5%, respectively (39, 40).

The aim of our study was to investigate the epidemiological aspects of tuberculosis in children aged 0-14 years at the Charles de Gaulle Pediatric University Hospital Center.

To achieve our objectives, we conducted a descriptive cross-sectional study covering the period 2010-2020.

Sociodemographic characteristics indicated that children in the (0–5 years) age group accounted for more than one-third of cases. Similarly, males predominated, accounting for more than half of tuberculosis cases. In addition, more than half of cases came from urban areas.

Similarly, the pulmonary form was the most common, accounting for 69.89% of cases. Tuberculosis-HIV co-infection accounted for 19.35% of tuberculosis cases. Progressive cough was the main reason for consultation. Microscopy was the main confirmatory test.

Despite the low prevalence of 4.04% of tuberculosis at the CHUP-CDG from 2010 to 2020 among children aged 0 to 14, this disease remains a reality and a public health problem in Burkina Faso.

Therefore, in order to achieve its effective eradication, it would be wise to break the chain of transmission of tuberculosis among children, who remain the most vulnerable group likely to transmit the disease, thus renewing the cycle of tuberculosis transmission.

Our study on the epidemiology of tuberculosis had some limitations due to the lack of information in patient records, namely the level of education of the children; the absence of a dedicated tuberculosis registry, which meant that all patient records had to be searched thoroughly; and incomplete archiving and filing of records, which led to the loss of sociodemographic and clinical data.

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Authors Contributions

Conceptualization: KD, OTR, SM

Data curation: KD, KBGB, TI, TM

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Investigation: KD, TI, TM, KDS, OTR, SM

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Supervision: KD, OO, TI, TM, KDS, OTR, SM

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Writing ± original draft: KBGB, KD

Writing ± review & editing: KD, OO, KBGB, TI, TM, KDS, PJES, KMSO, DSC, KB, ZA, ZAA, SRST, CTR, ST, ZC, SA, ON, OWHG, OTR, SM

Conflicts of Interest

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

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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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