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Factors Associated with Death in Children Hospitalized for Tuberculosis at Treichville University Hospital: A Retrospective Study from January 2015 to December 2025

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Abstract

Introduction: Pediatric tuberculosis remains a significant cause of preventable mortality. Objective: To identify factors associated with death in children hospitalized for tuberculosis in the pediatric medical department of the Treichville University Hospital. Methods: A retrospective analytical study was conducted from January 1, 2015, to December 31, 2025. It included children aged 0 to 16 years diagnosed with active tuberculosis, either through biological confirmation (Xpert gene, histology, acid-fast bacilli) or based on a combination of factors (epidemiological, clinical, and paraclinical). Deaths were identified through a review of medical records and hospital and emergency department registers. Factors associated with death were investigated using univariate and then multivariate logistic regression (selection threshold $p < 0.20$ in univariate analysis), with a significance level set at 5%. Results: Two hundred and fifty-four patients met our criteria. The sex ratio was 1:1, with a mean age of 8.3 ± 4.5 years. During the study, more than one-third of the patients (34.3%) died. These were children aged 0 - 5 years and adolescents aged 10 - 16 years. TB-HIV coinfection was found in 20.7% of cases. Factors associated with death in multivariate analysis were poor general condition and the presence of a comorbidity other than HIV, while the presence of an atypical localization of tuberculosis (bone tuberculosis, peritoneal tuberculosis) was associated with a reduced risk. Conclusion: A poor general condition and the presence of comorbidities are factors associated with a high risk of death. Reducing mortality requires early diagnosis and management.

Keywords

Risk Factors, Death, Tuberculosis, Child, Ivory Coast

1. Introduction

Tuberculosis is a contagious infectious disease caused by *Mycobacterium tuberculosis*. It is a ubiquitous disease that is prevalent mainly in Southeast Asia, Africa, and the Pacific. Despite efforts by governments to reduce its incidence, it remains a major cause of morbidity and mortality, particularly among children. In 2022, according to the WHO report, more than 1.6 million children had active tuberculosis, representing approximately 11% of global tuberculosis cases [1]. This figure appears to be an underestimate due to diagnostic challenges. Indeed, healthcare workers' lack of knowledge, the absence of specific clinical features, and the paucibacillary nature of biological fluids are all factors that explain underdiagnosis and therefore a lack of treatment for these children. This lack of treatment led to more than 250,000 child deaths worldwide in 2024, particularly among children under five years of age [2]. These children, due to their immunological immaturity, are exposed to contagiousness from bacillus-infected adults and are likely to develop severe, sometimes fatal, forms.

The renewed interest in pediatric tuberculosis in recent years, which had long been neglected by control programs, has led to efforts to improve screening, diagnosis, and treatment in order to reduce its incidence in this population. However, despite these efforts, the number of deaths remains constant. In 2020, 225,000 children died, and in 2024, 250,000 deaths were projected, primarily among undiagnosed and untreated children under 5 years of age [2]. Achieving the goal of "zero tuberculosis-related deaths" requires understanding the factors associated with these deaths in order to identify at-risk populations and implement control measures to sustainably and effectively reduce these deaths. Few studies address this aspect of pediatric tuberculosis, hence the present study.

2. Methodology

2.1. Study Type, Setting, and Population

This was a retrospective and analytical study conducted in the pediatric department of the Treichville University Hospital Center, covering the period from January 1, 2015, to December 31, 2025. Our sample consisted of all the records of children aged 0 to 16 years hospitalized in this department, living or deceased, who presented with bacteriologically confirmed or clinically diagnosed tuberculosis during the study period.

2.2. Data Collection and Description of Variables

Data were collected from medical records and hospitalization and emergency de-

partment registers. The variable of interest was the occurrence of death during treatment. Explanatory variables included sociodemographic characteristics (age, sex, education level), medical history and environment (tuberculosis exposure, chronic cough in close contacts, overcrowding), clinical characteristics at admission (reason for consultation, general condition, respiratory distress, tachypnea, fever, abdominal distension, malnutrition), comorbidities, characteristics of tuberculosis (form, type), time to treatment initiation, and length of hospital stay. Variables reflecting a consequence of death or having a circular relationship with it (time to treatment initiation, death occurring before treatment initiation, length of hospital stay) were excluded a priori from the pool of explanatory variables to avoid reverse causality bias.

The deterioration in the patient's general condition was characterized by asthenia, anorexia, weight loss, and an "infectious" facial appearance.

Atypical localization of tuberculosis includes: bone tuberculosis, peritoneal tuberculosis.

2.3. Management of Missing Data

Missing data, which varied depending on the item, were processed using multiple imputation according to the MICE (Multivariate Imputation by Chained Equations) algorithm, under the assumption of random missing data (MAR). Twenty datasets were imputed over 20 iterations. All statistical analyses were performed separately on each imputed dataset, and then the estimates were grouped according to Rubin's rules [3].

2.4. Statistical Analysis

Patient characteristics were described by counts and percentages for categorical variables, and by means ± standard deviations for quantitative variables. Comparisons between living and deceased patients were made using Pearson's chi-squared test (or Fisher's exact test in cases of low expected counts) and the Wilcoxon-Mann-Whitney U test, respectively. The search for factors associated with death was conducted using univariate logistic regression on each of the explanatory variables. Variables associated with death with a p-value < 0.20 were selected as candidates for the multivariate model, following the approach described by Hosmer and Lemeshow [4]. All of these variables were then simultaneously included in a multivariate logistic regression model, fitted to each of the imputed datasets, and then grouped according to Rubin's rules. The absence of multicollinearity between the variables in the final model was verified by the variance inflation factor (VIF), averaged across all imputed datasets. The significance level was set at $p < 0.05$. All analyses were performed using R software version 4.5.1.

2.5. Ethical Considerations

Authorizations for the study were obtained from the Medical and Scientific Di-

rector (MSD) and the Head of the Pediatric Medical Department at the Treichville University Hospital. Anonymity of patient records and data confidentiality were maintained.

3. Results

During the study period, 30,394 patients were seen. Two hundred and fifty-four had active tuberculosis, representing a prevalence of 8.35 cases per 1000 patients, and 87 (34.3%) died.

3.1. Epidemiological Characteristics

The population was predominantly male, with a mean age of 8.3 ± 4.5 years (range: 1 month to 16 years). The 10 - 16 years age group was the most represented (43.7%, n = 111). The mean age did not differ significantly between children who died (9.0 ± 4.8 years) and survivors (8.0 ± 4.4 years; p = 0.076). One-third of the patients died during period of hospitalization (after diagnosis, before starting treatment). Death occurred in 16.8% of cases among people living with HIV (PLHIV). The mean time to consultation was earlier in PLHIV: 26 days compared to 38.5 days for non-HIV individuals. The diagnostic delay was 47 days in non-HIV individuals and 36 days in PLHIV individuals. The 0 - 5 year and 10 - 16 years' age groups were most affected by death (Table 1 and Table 2).

Table 1. Distribution of patients according to epidemiological characters.

Characters	Total N = 254	Alive n = 167	Death n = 87	p
Middle age (years) (m ± ET)	8.3 ± 4.5	8.0 ± 4.4	9.0 ± 4.8	0.076
Age range (years)				0.2
5 - 9	75 (29.5%)	54 (32.3%)	21 (24.1%)	
<5	68 (26.8%)	47 (28.1%)	21 (24.1%)	
10 - 16	111 (43.7%)	66 (39.5%)	45 (51.7%)	
Sex				0.050
Female	115 (45.3%)	83 (49.7%)	32 (36.8%)	
Male	139 (54.7%)	84 (50.3%)	55 (63.2%)	
Educational status				0.4
Not in school	79 (39.9%)	56 (41.8%)	23 (35.9%)	
Schooled	119 (60.1%)	78 (58.2%)	41 (64.1%)	

Table 2. Distribution of patients according to clinical characters.

Characteristics clinicals	Total N = 254	Alive n = 167	Death n = 87	p
Contage tuberculeux				0.14
No	151 (71.9%)	91 (68.4%)	60 (77.9%)	
Yes	59 (28.1%)	42 (31.6%)	17 (22.1%)	
Missing data	44	34	10	

Continued

Chronic cough				0.15
No	124 (60.5%)	75 (56.8%)	49 (67.1%)	
Yes	81 (39.5%)	57 (43.2%)	24 (32.9%)	
Missing data	49	35	14	
Promiscuity				0.3
No	36 (23.7%)	24 (26.4%)	12 (19.7%)	
Yes	116 (76.3%)	67 (73.6%)	49 (80.3%)	
Missing data	102	76	26	
Consultation period, dayss				0.7
<14	150 (83.3%)	86 (84.3%)	64 (82.1%)	
≥14	30 (16.7%)	16 (15.7%)	14 (17.9%)	
Missing data	74	65	9	
Fever	250 (98.4%)	164 (98.2%)	86 (98.9%)	>0.9
Respiratory distress	87 (34.3%)	47 (28.1%)	40 (46.0%)	**0.004**
Chronic cough	95 (39.6%)	54 (35.1%)	41 (47.7%)	0.055
Missing data	14	13	1	
Abdominal distension	33 (13.9%)	19 (12.6%)	14 (16.3%)	0.4
Missing data	17	16	1	
Others reasons for consultation	51 (21.9%)	41 (27.5%)	10 (11.9%)	**0.006**
Missing data	21	18	3	
General condition				**<0.001**
Preserved	64 (28.3%)	55 (37.9%)	9 (11.1%)	
Altered	162 (71.7%)	90 (62.1%)	72 (88.9%)	
Missing data	28	22	6	
Polypnea				**0.004**
No	127 (52.7%)	92 (59.7%)	35 (40.2%)	
Yes	114 (47.3%)	62 (40.3%)	52 (59.8%)	
Missing data	13	13	0	
Malnutrition				0.6
No	36 (18.2%)	24 (19.2%)	12 (16.4%)	
Yes	162 (81.8%)	101 (80.8%)	61 (83.6%)	
Missing data	56	42	14	
Comorbidities				**0.006**
No comorbidities	157 (64.3%)	113 (71.1%)	44 (51.8%)	
HIV coinfection	41 (16.8%)	24 (15.1%)	17 (20.0%)	
Other comorbidities	46 (18.9%)	22 (13.8%)	24 (28.2%)	
Missing data	10	8	2	

Continued

Kinds of Tuberculosis				0.2
TBC (bacillifère)	153 (60.2%)	105 (62.9%)	48 (55.2%)	
TCD	101 (39.8%)	62 (37.1%)	39 (44.8%)	
Forms of tuberculosis				**0.010**
Localized	159 (62.6%)	114 (68.3%)	45 (51.7%)	
Multifocal	95 (37.4%)	53 (31.7%)	42 (48.3%)	
Time to start treatment, days †				**<0.001**
<3	98 (63.2%)	73 (78.5%)	25 (40.3%)	
≥3	31 (20.0%)	20 (21.5%)	11 (17.7%)	
Death before treatment	26 (16.8%)	0 (0.0%)	26 (41.9%)	
Missing data	99	74	25	
Length of hospital stay. days (m ± ET)†	13.4 ± 13.2	14.8 ± 14.2	10.6 ± 10.5	**<0.001**
Missing data	33	21	12	

3.2. Clinical, Paraclinical, and Therapeutic Characteristics

Regarding medical history, overcrowding was noted in 76.3% of patients (116/152). A history of chronic cough and confirmed tuberculosis exposure in the immediate environment were reported in 39.5% (81/205) and 28.1% (59/210) of children, respectively, with no significant difference between the two groups.

On admission, fever was almost always present (98.4%, n = 250). The other main reasons for consultation were chronic cough (39.6%), respiratory distress (34.3%), and abdominal distension (13.9%). Malnutrition (81.8%, n = 162) and poor general condition (71.7%, n = 162) were the most frequent physical signs. Deterioration of general condition was significantly more prevalent in children who died than in survivors (88.9% vs. 62.1%; $p < 0.001$). Signs of respiratory distress and tachypnea were also significantly more frequent in the death group (46.0% vs. 28.1%, $p = 0.004$; and 59.8% vs. 40.3%, $p = 0.004$, respectively). Conversely, the presence of an atypical reason for consultation was significantly associated with survival (27.5% in survivors vs. 11.9% in those who died; $p = 0.006$).

Regarding comorbidities, 35.7% of patients (87/244) had at least one associated condition. HIV co-infection was present in 16.8% of children (41/244) and was more frequent among those who died (20.0% vs. 15.1%). Other comorbidities (cardiovascular, renal, hepatic diseases, malaria, etc.) were observed in 18.9% of patients (46/244) and were significantly more prevalent among children who died (28.2% vs. 13.8%; $p = 0.006$).

From a paraclinical perspective, 60.2% of cases (n = 153) presented with bacteriologically confirmed tuberculosis (BCTB) and 39.8% (n = 101) with clinically diagnosed tuberculosis (CDT), with no difference according to outcome ($p = 0.2$). However, the multifocal form was significantly more frequent in children who

died than in survivors (48.3% vs. 31.7%; p = 0.010).

Finally, regarding the care pathway, the majority (63.2%) had a delay in treatment initiation of less than 3 days. Conversely, 26 children (representing 16.8% of reported cases and 41.9% of all deaths) died before the initiation of antituberculosis treatment. The average length of hospital stay was 13.4 ± 13.2 days, with a range of 1 to 47 days.

3.3. Factors Associated with Death

In univariate analysis, male sex, respiratory distress, tachypnea, poor general condition, presence of non-HIV comorbidities, and multifocal form were significantly associated with death (p < 0.05). After adjustment, three independent factors remained significantly associated with the risk of death: poor general condition on admission (ORa = 3.93; 95% CI 1.58 - 9.74; p = 0.003), presence of non-HIV comorbidities (ORa = 2.95; 95% CI 1.33 - 6.54; p = 0.008), and, conversely, consultation for an atypical localization for tuberculosis, associated with a lower probability of death. (ORa = 0.37; 95% CI 0.15 - 0.92; p = 0.032). A child arriving with a poor general condition is nearly four times more likely to die compared to a child in good general condition. Associated pathologies other than HIV (cardiovascular disease, renal or hepatic failure, malaria, etc.) nearly triple the risk of death. Conversely, seeking medical attention for an atypical reason is a protective factor, reducing the risk of death by 63%. A borderline statistically significant association was observed for males (ORa = 1.85; 95% CI 0.98 - 3.48; p = 0.056) (Table 3).

Table 3. Associated factors according to univariate and multivariate analysis.

Variable	Univariate Analysis			Multivariate Analysis		
	OR	IC 95%	p	ORa	IC 95%	p
Age range (réf.5 - 9 ans)						
<5 years	1.15	0.56 - 2.37	0.706	1.87	0.77 - 4.49	0.164
10 - 16 years	1.75	0.93 - 3.30	0.082	1.63	0.77 - 3.46	0.204
Sex male (réf. female)	1.70	1.00 - 2.90	0.052	1.85	0.98 - 3.48	0.056
Contage tuberculeux, yes	0.65	0.34 - 1.25	0.198	0.62	0.18 - 2.16	0.453
Chronic cougher, yes	0.64	0.35 - 1.17	0.146	0.65	0.21 - 2.04	0.456
Promiscuité, yes	1.83	0.81 - 4.15	0.147	2.20	0.84 - 5.72	0.105
Respiratory distress, yes	2.17	1.26 - 3.74	**0.005**	1.19	0.54 - 2.62	0.673
Chronic cough, yes	1.68	0.98 - 2.88	0.059	1.31	0.65 - 2.64	0.448
Motif de consultation atypique, yes	0.34	0.16 - 0.72	**0.005**	0.37	0.15 - 0.92	**0.032**
État général altéré (réf. conservé)	4.84	2.23 - 10.51	**<0.001**	3.93	1.58 - 9.74	**0.003**
Polypnea yes	2.32	1.36 - 3.96	**0.002**	1.47	0.68 - 3.15	0.324
Comorbidities (réf. absent)						
HIV Co-infection	1.88	0.93 - 3.82	0.079	1.44	0.62 - 3.34	0.390
Others comorbidities	2.81	1.42 - 5.60	**0.003**	2.95	1.33 - 6.54	**0.008**
Multifocal form (réf. localized)	2.01	1.18 - 3.43	**0.011**	1.56	0.81 - 2.98	0.183

3.4. Study Limitations

Due to the retrospective nature of the study, some data could not be retrieved.

4. Discussion

Tuberculosis is one of the top ten causes of death worldwide. By 2024, 1.25 million people had died from it globally. Children account for 16% of deaths, particularly those under five years of age [5]. In our study, the mortality rate of 34.3% appears high compared to the African literature on pediatric tuberculosis, where reported mortality rates generally range from 6% to 15% depending on the context and population studied [6], but can reach significantly higher levels in cases of poorly controlled HIV co-infection, delayed access to care [7], or disseminated forms similar to that of Maryline Bonnet in Uganda (32.9%) [8]. Lower rates were reported by Ouédraogo in Burkina Faso: 8.2%, and Koolo Barry 5.41% at Donka Hospital, including 61.9% in children under 5 years old [9] [10]. This difference could be explained by the characteristics of hospital recruitment (referred severe cases).

The deaths primarily affected children under five (28.7%) and adolescents (53%). Deaths from tuberculosis mainly concern children under five due to their immature immune systems, which make them more susceptible to severe forms of the disease (meningitis, miliary tuberculosis), and the nonspecific nature of the clinical signs. Indeed, these signs can lead to diagnostic errors because they can be confused with those of other infectious diseases, thus delaying treatment. In adolescents, on the other hand, the signs of tuberculosis are well-defined and similar to those in adults, making diagnosis easier. However, the high mortality rate in this population could be explained by their relationship with their health. Adolescents often have a sense of invulnerability regarding their health, leading them to believe they are healthier than they actually are. When they become ill, seeking care from professionals is not their first course of action, which explains the long delay in seeking medical attention (more than a month). Mabiala, in his study, revealed that adolescents often waited more than a month after the onset of symptoms to seek medical help, and that this age group (11 - 15 years) was a significant factor associated with delayed consultation [11]. The need for autonomy and to prove their own abilities leads adolescents to seek solutions on their own, then turn to friends and trusted individuals before consulting their parents. This quest for autonomy does not facilitate early access to care. Consequently, they only seek help from healthcare professionals when their condition worsens or persists. Furthermore, certain illnesses can be considered discriminatory (HIV, Hepatitis, Tuberculosis) and therefore require confidentiality. This can strain the doctor-adolescent relationship, as adolescents prefer to consult a doctor they trust in order to open up more easily [12] [13].

Factors Associated with Death: The long delay in seeking consultation could be associated with the occurrence of death. This delay in seeking medical attention is described in the literature. It is multifactorial in origin and delays treatment,

with a risk of worsening injuries and death. According to Mabiala, the delay is due to the lack of awareness of contagion, which is very rare in children, the parents' wait-and-see attitude towards the child's symptoms, and the use of alternative medicines [11]. The duration of tuberculosis was longer in HIV-negative individuals. HIV/AIDS creates a favorable environment for tuberculosis, so testing for it is systematic and performed early in this population, unlike in HIV-negative individuals who present with misleading signs. Indeed, the problem with pediatric tuberculosis lies, on the one hand, in its lack of clinical specificity and the paucibacillary nature of biological fluids, making bacteriological confirmation difficult, and on the other hand, in healthcare professionals' lack of awareness of its existence in children. Therefore, they will not systematically consider it in a child who is HIV-negative. Our study also shows that the presence of a comorbidity increases the risk of death.

The presence of respiratory distress is also associated with a higher risk of death, as is delayed treatment. For Ouedraogo in Burkina Faso, malnutrition, male sex, and hospitalization were risk factors for death [9]. Impaired general condition upon admission emerged as the factor most strongly associated with death in our study. This result is consistent with several studies conducted in Africa and elsewhere, where overall clinical severity upon admission constitutes a major prognostic determinant of tuberculosis mortality, including in children. Drobac *et al.*, in their study of children hospitalized for tuberculosis, notably identified clinical severity upon admission as an independent predictor of in-hospital mortality [14]. The presence of comorbidities other than HIV infection was also associated with an increased risk of death in this study. This finding is consistent with a body of converging data from the African continent, where a systematic review conducted in South Africa identified comorbidities, along with HIV infection, as consistent risk factors for tuberculosis-related mortality across all age groups [15]. Notably, HIV coinfection itself did not reach statistical significance in the multivariate model of the present study (ORa = 1.44; p = 0.390), which contrasts with several African pediatric studies that have reported marked excess mortality in children coinfected with tuberculosis and HIV. This discrepancy could be explained by a lack of statistical power due to the small number of coinfected children in this sample (41/254, or 16.8%), rather than by a true absence of association.

The association between an atypical location for consultation and a reduced risk of death is a less commonly reported finding in the literature and warrants cautious interpretation. A plausible hypothesis is that these children are diagnosed earlier or more incidentally (screened during another reason for consultation), at a less advanced stage of the disease, as opposed to children presenting with the classic clinical signs of advanced tuberculosis. However, this hypothesis cannot be confirmed in the absence of precise data on the time to diagnosis in the final model and would benefit from further investigation in future studies with prospective data collection on the time between symptom onset and diagnosis.

Variables significantly associated with death in bivariate analysis but not retain-

ing their significance after adjustment (respiratory distress, tachypnea, multifocal form) suggest a probable confounding effect with overall clinical severity (general condition), these different variables likely being correlated as markers of the same severity phenomenon.

5. Conclusion

Despite scientific progress, tuberculosis continues to wreak havoc worldwide, leaving countless families bereaved. In this study, poor general condition upon admission and the presence of associated comorbidities were the main determinants of death among children treated for tuberculosis at the Treichville University Hospital. These results underscore the importance of early screening and rigorous clinical assessment upon admission, particularly in children with comorbidities, to guide treatment priorities and reduce preventable mortality from pediatric tuberculosis.

Conflicts of Interest

The authors declare no conflict of interest.

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