

# Résurgence de la coqueluche au Burkina Faso: investigation d'une épidémie de toux persistant dans un district sanitaire rural

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## Résumé

### Introduction

Ces dernières années, des épidémies de coqueluche ont été rapportées dans les pays à revenu élevé, mais peu d'informations sont disponibles pour l'Afrique subsaharienne. Cette étude avait pour but d'évaluer la prévalence de la coqueluche au cours d'une poussée épidémique de toux persistante chez des écoliers au Burkina Faso.

### Méthode

Une enquête transversale a été menée entre 2024 et 2025 dans une école primaire du district sanitaire de Sapouy. Les données sociodémographiques et cliniques de patients présentant des épisodes de toux ont été recueillies et des prélèvements nasopharyngés ont été effectués pour le diagnostic étiologique par rT-PCR multiplexe.

### Résultat

Sur 116 cas suspects de coqueluche, 17,24 % (20/116) étaient confirmés par PCR. Après ajustement par analyses multivariées, la présence de fièvre ou d'antécédents de fièvre au cours des dernières 24 heures était le seul facteur indépendamment associé aux cas confirmés d'infection à *Bordetella pertussis* (OR ajusté (aOR) = 3,1, [IC à 95 % : 1,1 – 9,0], p = 0,03). Une tendance à une association positive a également été rapportée pour les patients présentant un essoufflement (aOR = 2,8, [IC à 95 % : 0,9 – 8,9], p = 0,09) ou un mal de gorge (aOR = 2,3, [IC à 95 % : 0,8 – 6,9], p = 0,09), sans toutefois être statistiquement significative.

### Conclusions

Cette étude a mis en évidence une résurgence de la coqueluche au Burkina Faso, suggérant ainsi une baisse de l'immunité post vaccinale. Une vaccination de rappel pour les groupes à haut risque pourrait s'avérer bénéfique.

**Mots clés :** Coqueluche, *Bordetella pertussis*, Afrique subsaharienne.

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# **Pertussis resurgence in Burkina Faso: an outbreak investigation among schoolchildren in a rural health setting**

## **Abstract**

### **Background**

In recent years, large scale outbreaks of pertussis have occurred in high-income countries, with however little information available in sub-Saharan Africa. This study reports findings from an investigation of a pertussis outbreak among schoolchildren in Burkina Faso.

### **Methods**

A cross-sectional survey which enrolled patients with coughing episodes at a primary school in the Sapouy health district was conducted between November 2024 and March 2025. Included subjects sociodemographic and clinical data were collected via direct interview and their nasopharyngeal swabs were also collected for etiological analysis by multiplex rT-PCR using the commercially available Fast Track Diagnostic (FTD®) Respiratory Pathogens 33 multiplex test.

### **Results**

Of 116 pertussis suspected cases, 17.24% (20/116) were laboratory confirmed with *Bordetella pertussis* infection. After adjustment with the sociodemographic and clinical characteristics the presence of fever or history of fever in the last 24 hours in patients with coughing episodes was the only factor independently associated with laboratory confirmed cases of *Bordetella pertussis* infection (adjusted OR = 3.1, [95% CI: 1.1 – 9.0], p=0.03). A positive association trend was also reported for patients with shortness of breath (aOR = 2.8, [95% CI: 0.9 – 8.9], p=0.09) and those with sore throat (aOR = 2.3, [95% CI: 0.8 – 6.9], p=0.09) without being statistically significant.

### **Conclusions**

These data provide evidence of *Bordetella pertussis* resurgence among school children in Burkina Faso despite the high vaccination coverage, implying that immunity from childhood vaccination may not be lifelong. Booster vaccination for high-risk groups may be beneficial as a control strategy.

**Keywords :** Whooping cough, *Bordetella pertussis*, Sub-Saharan Africa.

## **Introduction**

Pertussis, also known as whooping cough, is a highly contagious acute respiratory infection caused by the bacterium *Bordetella pertussis* and is one of the most important causes of infant deaths worldwide (1). In the pre-vaccine era, the disease burden was high around the world, with more than 300 million children dying from pertussis each year (2). The global morbidity and mortality of pertussis however decreased remarkably after the World Health Organization (WHO) initiated the Expanded Program on Immunization (EPI) and improved coverage of the pertussis vaccination (3). Since the middle of the twentieth century, the incidence of pertussis has remained very low globally (4,5). However, from the late 1990s, the incidence has started increasing steadily due to several factors including waning immunity, declining

vaccination rates, and recently the impact of relaxed COVID-19 measures leading to large scale outbreaks in the high-income nations especially among infants and vulnerable populations (6–11). The WHO estimates that pertussis still causes millions of cases globally and over 160,000 deaths in children under 5 each year, highlighting its continuing role as a leading cause of vaccine-preventable deaths in young children (12). In Africa, despite that the surveillance of pertussis remains limited due to the weaknesses of the surveillance systems, the difficulties of accessing etiological diagnosis tools, and the poor clinical recognition of the cases, especially among adults, the reported burden of the disease remains high among children despite good vaccination coverage (13,14). Continued efforts are therefore necessary to redefine strategies to limit the resurgence of the disease in low- and middle-income countries (LMIC), but the lack of sufficient epidemiological information represents a major drawback to support decision making. In Burkina Faso, pertussis is a targeted EPI disease and the vaccination is part of the Pentavalent vaccine (DTP-HBV-HIB). Recent data shows significant variations with DTP3 (full vaccination) coverage at 64.75% in 2021, while it was about 90% in 2017 among infants aged 12-23 months (15–17). Factors like region, distance to health facilities, and maternal education are reported to influence the coverage rates, and recent data suggests increased regional disparities (15,18). Pertussis remains a nationally notifiable disease under surveillance in Burkina Faso, and its status as a significant cause of acute respiratory infections (ARIs) necessitates continuous monitoring and interventions. Surveillance systems in the country are crucial for detecting outbreaks, assessing the disease burden, and evaluating the effectiveness of the existing immunization programs to prevent waning immunity and protect vulnerable populations, especially infants. Pertussis outbreak was reported in two schools of the Sabou health district in 2019 and 16.6% (15/92) of symptomatic patients were confirmed in the laboratory for carrying *Bordetella spp* (19). The current study, conducted in the COVID-19 post pandemic era, aimed to investigate the prevalence of *Bordetella spp* in a cluster of coughing fits that occurred among schoolchildren in the Sapouy health district, in the Center west region of the country. The study results could inform adequate decision making for the surveillance of pertussis in Burkina Faso.

## **I. Methods**

### **Setting, design, and period**

This was a cross-sectional study conducted between 2024 and 2025. The study was conducted in the Sapouy health district in the Nando region, Centre-West part of Burkina Faso, at about 90 km from Ouagadougou, the capital city. This is a rural municipality of three neighboring villages and a public primary school. Nétiao health facility is one of 35 health facilities in the Sapouy district, with a total population of 274,653 in 2024.

### **Study participants and case definition**

All schoolchildren enrolled in the primary school at the time of the study were eligible. Participants were included if they presented coughing episodes and were willing to participate by providing assent. Informed consents were subsequently sought from caregivers prior to any study related procedures. Participants were systematically included if they fulfilled all inclusion/exclusion criteria. We used case definitions as follows:

- A suspected case was defined as any schoolchild who presented with a cough illness of any duration, with or without paroxysm with no prior biological confirmation during the outbreak under investigation.
- A laboratory-confirmed case met the suspected case definition with laboratory confirmation by rRT-PCR.

### **Data source and collection procedures**

Structured questionnaires (case notification forms) were administered to each patient through individual interviews by trained staff. Variables such as the socio-demographic (age, sex) clinical symptoms (cough, sore throat, difficult breathing, ongoing fever or history of fever in the last 24 hours, diarrhea, headache, anosmia, ageusia, convulsion, shortness breathing, conjunctival hyperemia, abdominal pain, and sneezing) and history of pertussis vaccination were collected. Age was subsequently grouped in 3-8 years, 9-11 years, and 12-15 years. Information that was not available at the time of the interview was collected from the consultation registries of the local health center. In addition, for each patient, nasopharyngeal (NP) specimens were collected and placed into a tube of Universal Transport Media (Copan Diagnostics). Specimens were immediately refrigerated at 2–8°C for temporary storage and subsequently shipped to the National Influenza Reference Laboratory (NIRL) within 72 h after collection, aliquoted for testing or long-term storage in minus 80°C freezers (20). PCR results were also extracted for analysis. The dependent variable was the result of the PCR test grouped into negative or positive.

### **Laboratory testing**

Total nucleic acid (TNA) was extracted from 200 µL of Universal Transport Media containing the specimens and which was eluted into 50 µL using the KingFisher Flex Purification system 96 Instrument with the MagMAX™ Viral/Pathogen kit (Thermo Fisher Scientific, USA) according to the manufacturer's instructions. The extracts were screened for the detection of respiratory pathogens using the commercially available Fast Track Diagnostics 33 (FTD-33) reverse-transcriptase real-time polymerase chain reactions (rRT-PCR) kits for the detection of Bordetella species (*excluding Bordetella Para pertussis*). All assays were conducted using the Applied Biosystems 7500 Real-Time PCR Instrument (Thermo Fisher Scientific) (20).

### **Data processing and analysis**

Data were collected on notification forms and entered on an Excel spreadsheet, and transferred onto R (R Core Team, 2020) and RStudio (RStudio Team, 2020) for cleaning and analysis using the 'tidyverse' package. Descriptive analyses were conducted and included the calculation of frequencies and proportions for categorical variables. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated by univariable logistic regression. Adjusted OR (aOR) were derived by backward multivariable logistic regression of factors whose p-values were  $\leq 0.1$  at univariable analysis and keeping those with p-values  $< 0.1$  in the final model. The significance level was set at 0.05 and differences were considered statistically significant for p values  $< 0.05$  (two-sided p-value)

### **Ethical considerations, consent to participate**

Ethical and administrative approval was not required as the investigations are part of the missions assigned to the National Influenza Reference Laboratory (NIRL) by the Ministry of Health (Law No. 23/94/ADP on the public health code and ARRETE No 2023–83/MSHP/ CAB/PM/MSHP). However, permission to use data was sought from the national ethics committee of health science research in Burkina Faso (clearance certificate number 2025-10-473). In addition, consents were requested from the caregiver before any study related data were collected. For personal data protection, all entries were anonymized before analysis and therefore, individual consent for publication was not required.

## **II. Results**

### **Study participants' sociodemographic and clinical characteristics**

Considering all the 327 schoolchildren at risk during the outbreak period, 116 schoolchildren were suspected of pertussis based on clinical symptoms and were enrolled in this study. The median age of included patients was 10 years (interquartile range IQR, 8-12 years). The majority of included suspected cases were aged 9 to 12 years (42.86%, 42/98) and female patients were most represented (59.48% , 69/116) . Clinically, in addition to the cough which was present in all included subjects, 23.28% had fever or history of fever in the past 24 hours. The other common symptoms were sore throat (36.21%), shortness of breath (18.97%), and post-tussive vomiting (32.76%) (Table I). All participants were treated with a macrolide antibiotic (erythromycin), and no severe case that required hospitalization was observed and no fatal outcome was noted.

**Table I.** Characteristics of 116 patients included in the pertussis outbreak investigation study in Burkina Faso, 2024

Characteristics	Categories	Total	Percentage
Age (years)	3-8	29	29.59
	9 - 11	42	42.86
	12 - 15	27	27.55
	Missing*	18	-
Sex	Female	69	59.48
	Male	47	40.52
Fever or history of fever	No	89	76.72
	Yes	27	23.28
Sore throat	No	74	63.79
	Yes	42	36.21
Shortness of breath	No	94	81.03
	Yes	22	18.97
Diarrhea	No	109	93.97
	Yes	7	6.03
Vomiting	No	78	67.24
	Yes	38	32.76
Convulsion	No	115	99.14
	Yes	1	0.86
Ageusia	No	113	97.41
	Yes	3	2.59
Anosmia	No	96	82.76
	Yes	20	17.24

\*Missing data were presented as numbers and were not included in calculation

## Prevalence and factors associated with pertussis.

Of the 327 schoolchildren at risk, the overall attack rate of suspected cases was 35.50% (116/327), and the laboratory confirmed attack rate was 6.1% (20/327).

Of the 116 patients suspected cases enrolled in the study, 17.24% (20/116) were laboratory confirmed with *Bordetella pertussis* infection. The prevalence did not differ according to patients' sociodemographic characteristics ( $p>0.05$ ). However substantial differences were observed according to the clinical manifestations. Indeed, the multivariable logistic regression analysis reported that the presence of fever or history of fever in patients with coughing episodes as an independent associated factor of laboratory confirmed *Bordetella pertussis* infections (adjusted odd ratio (aOR) =3.1, [95% confident interval: 1.1 – 9.0]). A positive association trend was also observed among patients with shortness of breathing and those with sore throat but without being statistically significant (Table II).

**Table II.** Laboratory confirmed pertussis cases and factors associated among schoolchildren in Burkina Faso

Characteristics	% (n/N)	OR [95% CI]	p-value	aOR [95%CI]	p-value
Age (years)					
3-8	6.90 (2/29)	1.0 [Ref]	-		-
9 - 11	23.81 (10/42)	4.2 [1.0-29.0]	0.07*		
12 - 15	18.52 (5/27)	3.1 [0.6-22.9]	0.20		
Sex					
Female	15.94 (11/69)	1.0 [Ref.]	-		-
Male	19.15 (9/47)	3.5 [0.5-3.3]	0.65		
Fever or History of fever					
No	12.26 (11/89)	1.0 [Ref.]	-	1.0 [Ref.]	0.03**
Yes	33.33 (9/27)	3.5 [1.3- 9.8]	0.01**	3.1 [1.1 – 9.0]	
Sore throat					
No	10.81 (8/74)	1.0 [Ref.]	-	1.0 [Ref.]	0.09*
Yes	28.57 (12/42)	3.3 [1.2 – 9.2]	0.02**	2.3 [0.8 – 6.9]	
Shortness breath					
No	12.77 (12/94)	1.0 [Ref.]	-	1.0 [Ref.]	0.07*
Yes	36.36 (8/22)	3.9 [1.3-11.2]	0.01**	2.8 [0.9 – 8.9]	
Diarrhea					
No	17.43 (19/109)	1.0 [Ref.]	-		-
Yes	14.29 (1/7)	0.8 [0.1 – 5.0]	0.83		
Vomiting					
No	12.16 (9/74)	1.0 [Ref.]	-		-
Yes	26.19 (11/42)	2.5 [0.9 – 6.9]	0.05*		
Ageusia					
No	16.81 (19/113)	1.0 [Ref.]	-		-
Yes	33.33 (1/)	2.4 [0.1-27.1]	0.47		

**OR:** odds ratio, **aOR:** adjusted **OR**, 95%**CI**: ninety-five percent confident interval, \* : <0.1, \*\* : <0.05

### III. Discussion

This study investigated a pertussis outbreak in a primary school with the primary aim to assess the magnitude of laboratory confirmed cases and identified potential factors that could substantiate increased transmission patterns and to suggest proper control measures implementations. The investigation collected data from a total of 116 patients with coughing episodes in the designated primary school and showed that 17.24% of suspected cases were confirmed for *Bordetella pertussis* infection in the laboratory. Similar to our study, another recent study conducted in two primary schools of the Sabou health district in the pre-pandemic era in Burkina Faso, reported a prevalence of 16.6% among suspected cases (19). In sub-Saharan, other findings showed evidence of increased circulation of *B. pertussis*, and a study conducted in the Gambia reported a seroprevalence of 6% (21), despite high vaccination coverage (22,23). These data provide evidence of increasing *B. pertussis* circulation in sub-Saharan Africa despite high pertussis vaccination coverage.

In contrast to what is commonly known about the distribution of the pertussis disease across age groups and which identified infants and young children below 5 years of age as the most vulnerable age group for pertussis infection, this study did not show any differences in prevalence due to patients age (24). The shift in the age of peak onset of pertussis in southern China has been reported and indicates that the peak onset of pertussis shifted from infancy to adolescence and could be explained by waning immunity and reinforce the idea that surveillance and preventive measures should be widened to all age groups particularly to adolescents who increasingly bear the peak burden of the disease (25). Thus, including booster pertussis vaccination to schoolchildren in areas of increased transmission risk could be beneficial for national control programs.

In this study, the presence of fever was independently associated with biological confirmed cases of pertussis in suspected cases with coughing fits. In addition, a positive association trend was observed in patients with shortness of breath and sore throat. This observed symptomatology aligns with the typical description of pertussis which includes low grade fever, cough, coryza and apnea (26). This symptom when observed in schoolchildren may trigger investigation of pertussis particularly in the rural area where overcrowding in classrooms is common with the aim to limit the spread of the infection to other school mates and reduce school absenteeism.

All cases recovered and no fatal outcome was observed. The administration of antibiotics to all suspected cases may have impacted on the natural progression of the infection towards the development of severe cases and from deaths. This implies that *Bordetella pertussis* macrolide-resistance has not yet reached the country as described elsewhere, and wise use of effective antibiotics should be recommended given the increased trend of pertussis resurgence and thus to preserve its efficacy for future usages (27). This also showed that a large proportion of the study population was prescribed antibiotics when there was no confirmation of the need, prompting unnecessary use of antibiotics. The development of point of care tests may be useful for the management of such an outbreak and reduce the risk of antimicrobial resistance development.

### **Study limitations**

The study acknowledges certain limitations, particularly the absence of information regarding the vaccination coverage for the targeted age-group, the short study duration which do not allow the assessment of the transmission seasonality as well as the absence of data regarding the school neighborhoods. While data on the coverage for the initial three vaccine shots is available at country level, this information was missing for the studied population and then conclusions were drawn using the overall coverage rates.

### **Conclusion**

The study data provides evidence of the resurgence of *Bordetella pertussis* infection in Burkina Faso with no age patterns among school children in a context of high vaccination rates. These findings imply that immunity from childhood vaccination may not be lifelong and suggest that booster vaccination may be beneficial for vulnerable groups in high-risk settings as a preventive strategy.

### **List of abbreviations**

WHO: World Health Organization, OR: odds ratios, aOR: adjusted odds ratios, EPI: Expanded Program on Immunization, DTP: diphtheria, tetanus and pertussis, HBV: hepatitis B vaccination, HiB: *Hemophilus influenzae* Type B, NIRL: National Influenza Reference Laboratory

### **Ethics approval and consent to participate**

See ‘Ethics approval and consent to participate’ in the section methodology of the manuscript.

## **Consent for publication**

Not applicable.

## **Availability of data and materials**

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

## **Competing interests**

The authors declare that they have no competing interests.

## **Funding**

No funding was necessary for this study.

## **Authors' contributions**

ZT has conceptualized the study and its methodology. AC, AT, and AW conducted the field investigation. ML performed the statistics, and wrote the first draft. HSP has made important comments to the manuscript. All authors read and approved the final manuscript.

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