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PERTUSSIS SURVEILLANCE SYSTEM IN PERNAMBUCO, 2013 - 2022

SISTEMA DE VIGILÂNCIA DA COQUELUCHE EM PERNAMBUCO, 2013 A 2022

SISTEMA DE VIGILANCIA DE TOS FERINA EN PERNAMBUCO, 2013 A 2022

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ABSTRACT
Objective: to evaluate the quality (completeness and consistency) and representativeness of the pertussis epidemiological surveillance system in the state of Pernambuco between 2013 and 2022. **Methods:** evaluative study, based on the analysis of reported pertussis cases among Pernambuco residents, following the guidelines of the *Centers for Diseases Control and Prevention* (CDC), which propose evaluating surveillance systems using qualitative and quantitative attributes. **Results:** the system demonstrated moderate completeness (71.69%) for the variables analyzed, moderate consistency (89.06%), and proved representative when compared to the Hospital Information System (SIH), enabling characterization by time, person and place. **Conclusion:** weaknesses were observed in the completeness and consistency of some variables, underscoring the importance of periodic evaluations of the surveillance system to monitor data quality and detect changes in disease patterns.
Keywords: *Whooping Cough; Epidemiology; Health Information Systems.*

RESUMO
Objetivo: avaliar a qualidade dos dados (completitude e consistência) e a representatividade do sistema de vigilância epidemiológica da coqueluche no estado de Pernambuco entre 2013 e 2022. **Métodos:** trata-se de um estudo avaliativo, a partir da análise dos casos notificados de coqueluche de residentes de Pernambuco, com base nas diretrizes do *Centers for Diseases Control and Prevention* (CDC), que propõem a avaliação do sistema de vigilância a partir de atributos qualitativos e quantitativos. **Resultados:** o sistema apresentou completitude regular (71,69%) de preenchimento das variavés analisadas, consistência regular (89,06%) e mostrou-se representativo quando comparado ao Sistema de Informações Hospitalares (SIH), possibilitando a caracterização quanto a tempo, pessoa e lugar. **Conclusão:** foram observadas fragilidades na completitude e consistência de algumas variáveis, ressaltando a importância de avaliações periódicas do sistema de vigilância, essenciais para monitorar a qualidade das informações registradas e detectar alterações no padrão da doença.
Descritores: *Coqueluche; Epidemiologia; Sistemas de Informação em Saúde.*

RESUMEN
Objetivo: evaluar la calidad de los datos (completitud y consistencia) y la representatividad del sistema de vigilancia epidemiológica de la tos ferina en el estado de Pernambuco entre 2013 y 2022. **Métodos:** se trata de un estudio evaluativo, basado en el análisis de los casos notificados de tos ferina en residentes de Pernambuco, siguiendo las directrices de los *Centers for Disease Control and Prevention* (CDC), que proponen la evaluación del sistema de vigilancia a partir de atributos cualitativos y cuantitativos. **Resultados:** el sistema presentó una completitud regular (71,69%) en el llenado de las variables analizadas, una consistencia regular (89,06%) y demostró ser representativo al compararse con el Sistema de Informaciones Hospitalares (SIH), lo que permitió caracterizar la enfermedad en cuanto a tiempo, persona y lugar**. Conclusión:** se observaron deficiencias en la completitud y consistencia de algunas variables, lo que resalta la importancia de realizar evaluaciones periódicas del sistema de vigilancia, fundamentales para monitorear la calidad de la periódicas del sistema de vigilancia, esenciales para monitorear la calidad de la información registrada y detectar cambios en el patrón de la enfermedad.
Descriptores: *Tos Ferina; Epidemiología; Sistemas de Información en Salud.*

INTRODUCTION

Pertussis is an acute infectious disease caused by the bacterium *Bordetella pertussis*. It is highly contagious, has a global distribution, and humans are its only known natural reservoir. The disease specifically affects the respiratory tract (trachea

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and bronchi) and is characterized by paroxysms of dry coughing. Transmission occurs through droplets of oropharyngeal secretions expelled during speaking, coughing, or sneezing. The incubation period averages 5 to 10 days but can range from 4 to 21 days and, rarely, up to 42 days [1].

The average duration of pertussis is 6 to 12 weeks, progressing through three phases. The first, catarrhal phase (the most transmissible), lasts 7 to 14 days and presents symptoms similar to the common cold. The second, paroxysmal phase, lasts 2 to 8 weeks, with worsening symptoms, including frequent and intense coughing fits, inspiratory whooping, post-tussive vomiting, and cyanosis. The third, convalescent phase, lasts 1 to 2 weeks on average, marked by gradual reduction in paroxysms and overall clinical improvement[2,3].

Laboratory diagnosis of pertussis includes nasopharyngeal culture, considered the "gold standard" due to its high specificity. Other methods, such as Direct Fluorescent Antibody (DFA) testing and Real-Time Polymerase Chain Reaction (RT-PCR), are also used. Notably, RT-PCR can detect both live and dead bacteria, so clinical symptoms must be considered when requesting this test[4].

Most pertussis cases respond well to treatment and progress to recovery. Antibiotics such as azithromycin, clarithromycin, erythromycin, and trimethoprim-sulfamethoxazole are prescribed for treatment[5,6].

The primary prevention strategy is vaccination of children under 1 year of age, with booster doses at 15 months and 4 years, as well as vaccination of pregnant women, postpartum women, and healthcare workers[7]. Although pertussis can occur at any age, unimmunized or partially immunized infants are epidemiologically more vulnerable due to the absence of specific immunity and a higher risk of severe disease, which may lead to hospitalization and often death[8].

From 2010 to 2019, the global annual average of reported pertussis cases was 170,000, dropping to 53,940 during the COVID-19 pandemic. However, in 2023, the World Health Organization (WHO) European Region reported 32,037 cases, with a significant increase in early 2024[9].

In Brazil, from 2013 to 2022, 25,980 cases were confirmed in the Notifiable Diseases Information System (SINAN). The Northeast region accounted for 46% of cases, with Pernambuco reporting the highest number in the region. In 2013, Pernambuco confirmed 174 pertussis cases, while in 2022 (post-COVID-19 pandemic), 86 cases were confirmed[10].

Pertussis is a mandatory notifiable disease in Brazil since its inclusion in the national list of compulsory notifiable diseases[11]. In Pernambuco, upon detection of a suspected case, healthcare professionals or facilities must immediately notify (within 24 hours) the Municipal Health Secretariat (SMS) and the State Health Secretariat's Strategic Health Surveillance Information Center (CIEVS). Notification data must be entered into SINAN within seven days, and case closure must occur within 60 days of notification[12].

Evaluating the pertussis surveillance system is critical, as it is a highly contagious disease with significant morbidity and mortality impacts, particularly among infants under one year who have not completed vaccination. System evaluation helps

identify potential gaps in case detection, investigation, and monitoring, which may compromise disease control efforts.

In Pernambuco, where studies like this are scarce, system evaluation not only improves data quality but also strengthens epidemiological surveillance, ensuring more effective interventions for pertussis control.

This study aimed to evaluate the pertussis surveillance system in Pernambuco from 2013 to 2022 by assessing the "data quality" attribute (completeness and consistency) and the "representativeness" attribute, proposing recommendations for system improvement.

METHODS

This was an evaluative study based on guidelines proposed by the Centers for Disease Control and Prevention (CDC), which recommends assessing surveillance systems through qualitative and quantitative attributes. The study was conducted in Pernambuco state, located in Northeast Brazil, encompassing its 184 municipalities and Fernando de Noronha Island. The study population consisted of suspected pertussis cases reported in the Notifiable Diseases Information System (SINAN) among Pernambuco residents from 2013 to 2022.

Secondary data from SINAN and the Hospital Information System (SIH) were used, obtained from the Unified Health System Department of Informatics (DATASUS) and extracted in August and October 2024, respectively.

The SINAN pertussis investigation form contains 64 fields, classified according to the system's data dictionary: (i) mandatory fields, where missing data prevents case notification or investigation entry into the system; and (ii) essential fields, which are non-mandatory but whose absence may compromise case investigation or the calculation of epidemiological and operational indicators.

For hospitalization data extraction, cases were selected by: residence location, hospital admissions, ICD-10 morbidity list (Pertussis), study period (2013-2022). Fields included sex, age group 1, race/ethnicity, municipality, and year of care. Data analysis used Epi Info (version 7.2.6) and Microsoft Office Excel 2010. The qualitative attribute "data quality" was evaluated through field completeness and consistency of information in the notification form.

Completeness was assessed for: mandatory fields ("Sex" and "Culture Result"), and essential fields ("Race/Ethnicity", "Contact With Suspected/Confirmed Pertussis Case", "Number of DTaP (Diphtheria-Tetanus-Pertussis) or Tetravalent (DTaP + Hib) vaccine doses", "Antibiotic Use", "Nasopharyngeal Swab Collection", "Identification of Close Contacts", "Prevention/Control Measures", and "Outcome"). Completeness was calculated as the percentage (%) of completed fields relative to total reported cases (blank/missing fields were considered incomplete). The results were categorized based on the study by Ribeiro *et al.*[13]: Excellent (≥90.0%), Good (80.0-89.9%), Moderate (70.0-79.9%), Poor (<70.0%).

Consistency was evaluated for hospital admissions (frequency of cases with "Yes" and recorded admission date), culture-positive cases (laboratory-confirmed cases), and fatal outcomes (frequency of deaths with recorded date). Regarding the

degree of variable consistency, the following parameters were adopted: Excellent (≥90.0%), Moderate (70.0-89.0%), Low (<70.0%)[14].

Overall data quality was calculated as the average of completeness and consistency percentages, classified using the parameters: Excellent (≥90.0%), Moderate (70.0-89.0%), Low (<70.0%).

The quantitative attribute "representativeness" evaluated the system's capacity to characterize pertussis cases by person, time, and place. A comparison was made between hospitalized cases (reported/confirmed in SINAN) and pertussis hospitalizations recorded in SIH during the same period, assessing the surveillance system's ability to describe disease-related hospitalizations over time in Pernambuco.

As the study used publicly available databases, ethics committee approval was waived per National Health Council Resolution No. 674 (May 6, 2022).

RESULTS

From 2013 to 2022, 7,697 pertussis cases were reported in Pernambuco state, with peak notification and confirmation rates occurring in 2014 and 2019. Notably, 2014 saw intensified pertussis surveillance through adoption of a more sensitive case definition, resulting in increased case detection.

For the assessment of data completeness, ten fields from the pertussis investigation form were evaluated (two mandatory and eight essential). Only the "Sex" variable achieved an excellent classification (99.88%). Among the essential variables, four showed poor completion rates: "Culture Result" (33.34%), "Contact With Suspected/Confirmed Pertussis Case" (66.35%), "Number of DTaP (Diphtheria-Tetanus-Pertussis) or Tetravalent (DTaP + Hib) vaccine doses" (56.49%), "Prevention/Control Measures" (53.07%). The overall completeness rate across all variables was 71.69%, classifying the pertussis surveillance system's completeness as moderate (Table 1).

Table 1 - Data quality attribute assessment: Completeness of variables in reported pertussis cases, Pernambuco 2013-2022 (N=7,697)

Variables	n	%	Classification
Mandatory			
Sex	7,688	99.88%	Excellent
Culture Result	2,566	33.34%	Poor
Essential			
Race/Ethnicity	5,748	74.68%	Moderate
Contact With Suspected/Confirmed Pertussis Case	5,107	66.35%	Poor
Number of DTaP (Diphtheria-Pertussis-Tetanus) or Tetravalent (DTaP + Hib) vaccine doses	4,348	56.49%	Poor
Antibiotic use	6,568	85.33%	Good
Nasopharyngeal swab collection	6,729	87.42%	Good
Identification of Close Contacts	5,725	74.38%	Moderate
Prevention/Control Measures	4,085	53.07%	Poor
Outcome	6,623	86.05%	Good

Mean percentage	**71.69%**	**Moderate**

Source: DATASUS/ SINAN/ MS. Data extracted August 2024.

The consistency assessment revealed that: 98.43% of hospitalized cases had documented admission dates, 93.77% of culture-positive cases were laboratory-confirmed, and 75% of fatal cases (whether from pertussis or other causes) contained recorded death dates. Based on these results, we conclude that Pernambuco's pertussis surveillance system demonstrates moderate data consistency (Table 2).

Table 2 - Data quality attribute assessment: Consistency of variable combinations in reported pertussis cases, Pernambuco 2013-2022

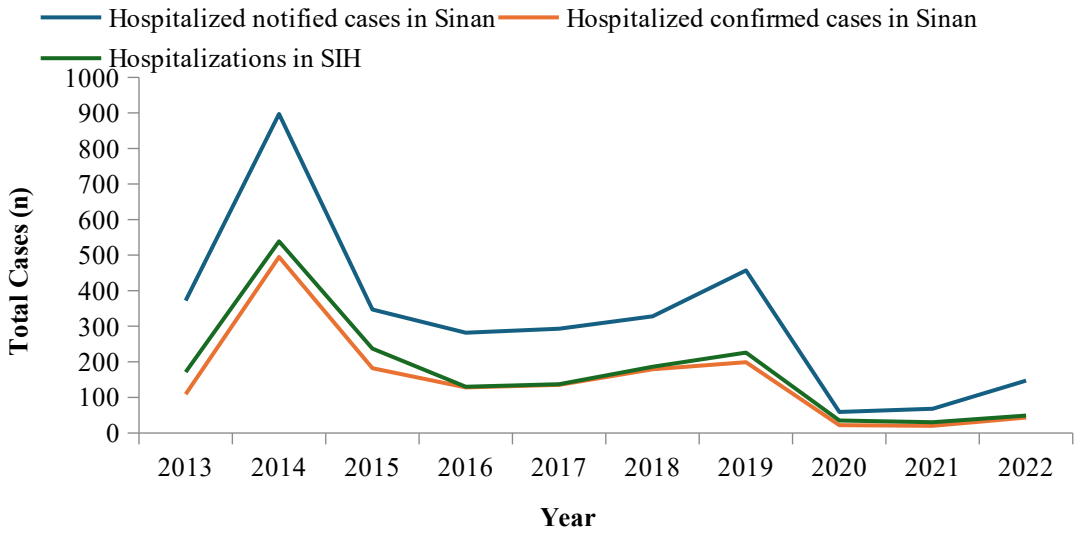
Variable consistency	N	n	%	Classification
Hospitalization "Yes"/Admission date "Yes"	3,250	3,199	98.43%	Excellent
Culture "Positive"/Lab confirmation	273	256	93.77%	Excellent
Fatal outcome/Death date	41	31	75.00%	Moderate
Mean percentage			89.06%	Moderate

Source: DATASUS/ SINAN/ MS. Data extracted August 2024.

Based on the mean percentages of data completeness and consistency, an overall data quality score of 80.37% was observed, classifying Pernambuco's pertussis surveillance system as moderate.

A comparison of hospitalized confirmed pertussis cases reported in SINAN with pertussis hospitalizations recorded in SIH revealed similar temporal distributions. The analysis demonstrated parallel trends, with increases in hospitalization records in SINAN corresponding to proportional increases in SIH (Figure 1).

Figure 1 - Hospitalized notified and confirmed pertussis cases in SINAN *versus* pertussis hospitalizations in SIH, by notification year. Pernambuco, 2013-2022



Source: DATASUS/ SINAN/ SIH/ MS. Data extracted August 2024 (SINAN) and October 2024 (SIH).

The demographic distributions (sex, race/ethnicity, and age group) were similar between SINAN and SIH databases (Table 3). Females were most affected (55.3% in SINAN; 52.4% in SIH); both systems showed similar patterns, with infants <1 year representing 88.5% of cases. The higher disease burden among infants reflects their incomplete primary vaccination series during early life. The racial/ethnic characterization revealed predominance of Mixed-race individuals (*Pardos*, 54.6%) in SINAN and higher proportion of Black individuals (*Pretos*, 34%) in SIH.

Table 3 - Representativeness of pertussis cases in SINAN and SIH systems, Pernambuco 2013-2022

Person-related variables	SINAN (Hospitalized Confirmed Pertussis Cases)		SIH (Hospitalized Pertussis Cases)	
	n	%	n	%
Sex (Total)	1,512	100.0	1,740	100.0
Male	675	44.7	829	47.6
Female	835	55.2	911	52.4
Unknown	2	0.1	0	0.0
Age Group (Total)	1,512	100.0	1,740	100.0
<1 year	1,338	88.5	1,540	88.5
1-4 years	113	7.5	158	9.1
5-9 years	26	1.7	21	1.2
10-14 years	11	0.7	7	0.4
15-19 years	4	0.3	0	0.0
20-29 years	5	0.3	1	0.1
≥30 years	15	1.0	13	0.7
Race/Ethnicity (Total)	1,512	100.0	1,740	100.0
White	354	23.4	90	5.2
Mixed-race (*Pardo*)*	826	54.6	6	0.3
Black (Preto)	43	2.8	591	34.0
Indigenous	3	0.2	2	0.1
Asian (Amarela)	3	0.2	0	0.0
Unknown	283	18.7	1,051	60.4

**"Parda"* was translated as "Mixed-race" following IBGE standards for international audiences.
Source: DATASUS/ SINAN/ SIH/ MS. Data extracted August 2024 (SINAN) and October 2024 (SIH).

In terms of representation by location, it was found through the ranking of the state's Health Regions that the geographic distribution was also similar, with the four main regions concentrating the highest percentages of cases in both systems (Table 4).

The findings demonstrate that despite operational differences, both SINAN and SIH systems exhibit comparable patterns in representing pertussis epidemiology across Pernambuco over time. We therefore conclude that the pertussis surveillance system demonstrates adequate representativeness.

Table 4 - Ranking of hospitalized pertussis cases in SINAN and SIH by Health Region, Pernambuco 2013-2022

Health Region	Hospitalized Cases - SINAN		Health Region	Hospitalized Cases - SIH	
	n	%		n	%
I - Recife	1,115	73.7	I - Recife	1,068	61.4
VIII - Petrolina	86	5.7	VIII - Petrolina	167	9.6
IV - Caruaru	76	5.0	IV - Caruaru	114	6.6
II - Limoeiro	55	3.6	II - Limoeiro	112	6.4
V - Garanhuns	51	3.4	III - Palmares	107	6.1
III - Palmares	44	2.9	VI - Arcoverde	53	3.0
X - Afogados da Ingazeira	25	1.7	V - Garanhuns	30	1.7
XII - Goiana	21	1.4	XII - Goiana	27	1.6
VI - Arcoverde	18	1.2	VII - Salgueiro	21	1.2
IX - Ouricuri	10	0.7	IX - Ouricuri	17	1.0
VII - Salgueiro	7	0.5	XI - Serra Talhada	13	0.7
XI - Serra Talhada	4	0.3	X - Afogados da Ingazeira	11	0.6
Total:	1,512	100.0		1,740	100.0

Source: DATASUS/ SINAN/ SIH/ MS. Data extracted August 2024 (SINAN) and October 2024 (SIH).

DISCUSSION

This study revealed an increase in pertussis notifications and confirmed cases in Pernambuco in 2014 and 2019, followed by a decline in subsequent years and during the COVID-19 pandemic. Pertussis exhibits cyclical patterns, with peaks occurring every three to five years, as demonstrated in a Brazilian time-series analysis of pertussis from 2010 to 2019. The reduction in cases may be attributed to the introduction of the Tdap vaccine for pregnant women in 2014 and enhanced chemoprophylaxis measures for contacts of suspected cases.

Despite advancements in health information systems, challenges persist in the quality of notification form completion, as observed in this study—likely due to healthcare professionals' limited awareness or training regarding the importance of these data for decision-making. Variables with the lowest completeness rates included: culture results (33.34%, mandatory field); prevention/control measures (53.07%, essential field); and number of DTaP or DTaP+Hib vaccine doses (56.49%, essential field)

The low completion rate for "Culture Result" suggests inadequate biological sample collection in suspected cases, possibly due to reliance on clinical diagnosis. Similarly, incomplete "Prevention/Control Measures" data indicate reporting deficiencies, undermining the evaluation of control and prophylaxis actions to containment disease.

Poor documentation of vaccination history reflects weaknesses in case investigation data, compromising epidemiological control. Comparable findings were reported in a study evaluating pertussis forms in two São Paulo municipalities[16]. Although pertussis immunization relies on pentavalent and DTaP vaccines, studies indicate waning protection 5–10 years post-vaccination, leaving populations vulnerable[1].

The control of vaccine-preventable diseases like pertussis depends on adequate

immunization coverage to disrupt pathogen transmission. The National Immunization Program (PNI), in collaboration with state and municipal health departments, routinely monitors vaccination rates[17].

Scientific evidence confirms that pertussis-related respiratory hospitalizations predominantly affect infants under one year old, who face severe clinical outcomes[18,19]. This study corroborates those findings, with 88.5% of hospitalized cases occurring in this age group across both SINAN and SIH systems (2013–2022). Infants' heightened susceptibility stems from incomplete vaccination schedules and developing immune systems[20].

Females accounted for most confirmed hospitalized cases, aligning with national data showing higher pertussis prevalence among females (55%)[21]. This gender disparity may reflect behavioral or biological factors.

Divergent racial/ethnic distributions emerged between systems: SINAN reported higher mixed-race (*pardo*) cases, whereas SIH recorded more Black (*Preto*) individuals. Both systems showed significant missing data (>60% in SIH), consistent with a national study where mixed-race individuals comprised 42.1% of pertussis hospitalizations[22].

Based on study findings, we propose the following interventions: (i) to the Ministry of Health: Implement system integration across health information platforms to streamline notification form completion, and enhance data quality and reliability; (ii) Surveillance Form enhancements: expand diagnostic documentation to include alternative laboratory methods (beyond culture), and maternal Tdap vaccination status (recommended since 2014); (iii) for State/Municipal Health Departments: conduct targeted training programs for healthcare professionals to emphasize complete/accurate reporting protocols; strengthen immunization efforts through pentavalent vaccine administration for infants <1 year, and timely booster dose delivery; ensure standardized nasopharyngeal sample collection.

State and municipal health departments need health education actions to train professionals on the importance of filling out records completely and accurately, as well as encouraging the vaccination of children under 1 year of age with the pentavalent vaccine and booster doses, in addition to carrying out the timely collection of nasopharyngeal material.

CONCLUSION

Pernambuco's pertussis surveillance system demonstrates moderate data quality (completeness and consistency) and adequate representativeness. Key weaknesses include incomplete epidemiological variables, such as contact with suspected/confirmed cases, and DTaP/Tetravalent vaccine doses; and control measures, such as identification of close contacts and prevention/control measures.

Periodic system evaluations are critical to monitor data quality and detect epidemiological shifts. Further studies—currently scarce—are essential to advance pertussis surveillance in Brazil.

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