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Original Article

A cross-sectional study to assess the impact of the re-emergence of pertussis in children in a tertiary care hospital.

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Abstract

Background

Despite decades of vaccine implementation, pertussis remains a significant global threat, particularly among infants and young children. This study was designed to evaluate the clinical spectrum, immunisation status, and diagnostic confirmation of pertussis in a pediatric cohort at a tertiary care hospital in India.

Methods

An observational cross-sectional study was conducted over a two-month period (Nov–Dec 2023) at a government tertiary hospital in Hyderabad. Children aged ≤12 years presenting with prolonged cough suggestive of pertussis were enrolled consecutively. Clinical assessment, immunisation history, and laboratory investigations, including culture, real-time polymerase chain reaction (PCR), and anti-pertussis toxin IgG serology, were performed to confirm the diagnosis. Descriptive statistics and categorical analyses were used to interpret demographic, clinical, and diagnostic data.

Results

A total of 32 children were clinically diagnosed with suspected pertussis, with 93.8% being under five years of age. The most common symptom was paroxysmal cough (81.25%). Immunisation gaps were evident, with 90.6% partially vaccinated and 9.4% unvaccinated. Laboratory confirmation was limited, with culture positivity at 9.4%, PCR positivity at 6.25%, and serology confirming 6.25% of cases. Additionally, 90.6% of cases exhibited elevated white blood cell (WBC) counts, and 53.1% had raised C-reactive protein (CRP) levels. These findings underscore both the vulnerability of incompletely vaccinated children and the diagnostic constraints in real-world settings.

Conclusion

The resurgence of pertussis in partially or unvaccinated children reflects critical lapses in immunisation coverage and underutilization of confirmatory diagnostics. Low sensitivity of standard tests and atypical clinical presentations complicate early recognition. This study highlights the urgent need to reinforce booster strategies, consider maternal immunisation, and enhance diagnostic infrastructure in tertiary care settings to support effective disease surveillance and timely management of paediatric pertussis in India.

Recommendations

Strengthen childhood and maternal pertussis immunisation, improve booster uptake, and expand PCR-based diagnostics for early detection.

Keywords: *Pertussis, Re-emergence, Paediatric infectious diseases, Vaccination gaps, Laboratory diagnosis, Bordetella pertussis.*
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Introduction

Pertussis, also known as whooping cough, is a highly transmissible and acute respiratory tract infection caused by *Bordetella pertussis*, an obligate human pathogen classified as a fastidious Gram-negative coccobacillus. The disease has long been recognised as a major public health challenge, particularly affecting children, with the highest morbidity and mortality observed in infants. Despite the availability of efficacious vaccines, pertussis continues to exert a significant burden globally, especially in regions with limited healthcare infrastructure and immunisation coverage. According to global estimates reported by the World Health Organisation (WHO), pertussis accounts for approximately 30 to 50 million cases annually, contributing to more than 300,000 deaths. Alarmingly, the majority of these fatalities occur in infants under the age of one year, underscoring the disproportionate vulnerability of this age group and the gaps in immunological protection during early infancy [1].

The clinical presentation of pertussis typically evolves sequentially, often beginning with an initial catarrhal phase that may be indistinguishable from other upper respiratory tract infections. This early stage is generally marked by mild and nonspecific symptoms, including low-grade fever, nasal congestion, sneezing, malaise, and a dry, intermittent cough. As the illness progresses, it transitions into the paroxysmal stage, which is pathognomonic of pertussis and characterised by recurrent episodes of intense and spasmodic coughing. These coughing bouts are often followed by an inspiratory whoop, post-tussive vomiting, and in some cases, episodes of apnoea or transient cyanosis, particularly in young infants. The convalescent phase may last for several weeks, with a gradual decrease in the frequency and severity of coughing episodes. These prolonged and evolving symptoms often resemble other paediatric respiratory conditions such as bronchiolitis, pneumonia, or viral upper respiratory infections, which may result in diagnostic delays or misdiagnoses, particularly in primary and secondary care settings lacking access to specialised testing [2].

Despite the implementation of routine immunisation programs targeting pertussis, a concerning resurgence of the disease has been observed globally over the past two decades. Specifically, this re-emergence is not limited to countries with historically low vaccination coverage but has also been documented in high-income settings with established immunisation infrastructure and relatively high vaccine uptake [3]. In India, the national immunisation schedule includes pertussis vaccination as part of the diphtheria-pertussis-tetanus (DPT) combination, which is later integrated into the pentavalent vaccine administered at 6, 10, and 14 weeks of age. However, the real-world effectiveness of these vaccination efforts may be undermined by factors such as incomplete immunisation, delays in vaccine administration, absence of booster doses, and the general lack of maternal immunisation during pregnancy. The resurgence of pertussis in both developed and developing nations is widely recognised to be multifactorial in origin. Several interrelated factors have been proposed, including the phenomenon of waning immunity over time in both vaccinated individuals and those who have recovered from natural infection, genetic variation and adaptation in circulating *B. pertussis* strains, increased awareness and improved diagnostic methods, and the existence of under-vaccinated or vaccine-hesitant subpopulations [4].

The evolutionary adaptation of the pertussis pathogen has raised significant concerns regarding the long-term efficacy of currently used vaccines, particularly acellular pertussis (aP) vaccines. Studies have demonstrated that *B. pertussis* has undergone antigenic divergence, particularly in genes encoding pertactin and pertussis toxin, which may result in strains that partially evade vaccine-induced immunity. Furthermore, acellular vaccines, though associated with fewer adverse reactions, have been shown to induce shorter-lived immunity compared to traditional whole-cell pertussis (wP) vaccines. These immunological limitations have prompted renewed interest in optimising immunisation strategies, including the consideration of booster schedules, maternal immunisation during pregnancy, and the development of next-generation vaccines that can confer more durable and comprehensive protection [1,4].

India, like several other low- and middle-income countries (LMICs), continues to face challenges in accurately diagnosing pertussis due to a confluence of systemic limitations. These include limited clinical suspicion among healthcare providers, variability in case definitions, and inadequate access to sensitive laboratory diagnostic tools such as real-time polymerase chain reaction (PCR) and serological assays. In many healthcare facilities, pertussis diagnosis remains reliant on clinical judgment or basic laboratory parameters, with minimal microbiological confirmation. A comprehensive review by Muloiwa R et al. (2020), focusing on LMICs, emphasised that pertussis remains a highly under-recognised condition due to insufficient laboratory infrastructure, inconsistent reporting systems, and a lack of routine diagnostic testing capabilities. The study highlighted that even in countries with existing vaccination programs, the diagnostic burden of pertussis remains substantial and likely underestimated, further obscuring the true epidemiological landscape [5].

This underdiagnosis has critical implications for public health planning and resource allocation. Pertussis surveillance that is reliant solely on clinical criteria without microbiological confirmation risks both underreporting and misclassification, particularly when children present with atypical or modified symptoms due to partial immunity from prior vaccinations. Furthermore, the failure to detect and report pertussis cases undermines efforts to evaluate vaccine performance, track emerging strain variants, and implement appropriate outbreak control measures. The limitations in diagnostic infrastructure also hinder early case identification, delay isolation and treatment, and increase the likelihood of ongoing transmission in both community and healthcare settings [6].

Compounding this issue is the reality that children, especially those below six months of age who are not yet fully immunised, are particularly susceptible to severe disease and its complications. These include pneumonia, hypoxic seizures, apnoea, leukocytosis with lymphocytosis, and rarely, encephalopathy. Moreover, in this age group, pertussis can present atypically, often lacking the classic whoop, which further complicates timely diagnosis. Studies from tertiary centres across Asia have reported high case fatality rates among hospitalised infants, particularly those requiring intensive care or ventilatory support [1,7].

Given the observed resurgence of pertussis despite widespread immunisation coverage, there is an urgent need to enhance diagnostic vigilance and clinical recognition, particularly in tertiary care institutions. These centres function as referral hubs for complex paediatric cases and are uniquely positioned to produce laboratory-confirmed data that not only reflects actual disease prevalence but also informs regional and national surveillance frameworks. Strengthening diagnostic capacities at such settings is essential, especially considering the under-recognition of pertussis in partially vaccinated or unvaccinated infants due to limited access to confirmatory tests like PCR or anti-PT IgG assays. Furthermore, targeted investigations in tertiary institutions offer critical opportunities to delineate the clinical profiles, immune status, and disease burden among affected children. These data are indispensable for refining immunisation schedules, especially in vulnerable populations under one year of age. The present study was therefore conceived with three focused objectives: (1) to study the clinical and laboratory-confirmed effects of pertussis in children, (2) to evaluate the epidemiological impact of its re-emergence in a contemporary paediatric cohort, and (3) to confirm the diagnosis of pertussis through appropriate laboratory methods including culture, real-time PCR, and serology. By fulfilling these aims, the study contributes vital real-world evidence for improving early recognition, guiding booster vaccination policies, and optimising paediatric infectious disease management in India.

Materials and Methods

Study Design

This study was designed as an observational cross-sectional study to evaluate the clinical spectrum and laboratory-confirmed diagnosis of pertussis among children in a tertiary care setting. The study was conducted from November 1 to December 31, 2023. The objective was to assess the re-emergence and diagnostic confirmation of *Bordetella pertussis* infection in children presenting with prolonged cough illness. The study population comprised children aged ≤12 years who fulfilled clinical criteria suggestive of pertussis. All eligible cases presenting during the study period and meeting the inclusion criteria were enrolled consecutively. No fixed sample size was determined a priori; instead, all consecutive suspected pertussis cases presenting to the hospital during the defined study period were included.

Study Setting

The study was conducted at Osmania Medical College and its affiliated government tertiary care hospital in Hyderabad, Telangana, India. Osmania Medical College is a major public medical teaching institution that supports undergraduate and postgraduate medical education, specialist clinical services, and hospital-based research. The affiliated tertiary care hospital provides high-volume outpatient, inpatient, emergency, intensive care, paediatric, microbiology, and laboratory services, and receives referrals from Hyderabad and surrounding districts. Its paediatric services include evaluation and management of acute respiratory infections, infectious diseases, immunisation-related conditions, and paediatric emergencies, with support from microbiology and clinical laboratory facilities.

Informed Consent

Written informed consent was obtained from the parent or legal guardian of each enrolled child after explaining the study purpose, procedures, sample collection requirements, expected benefits, and absence of additional therapeutic risk. Participation was voluntary, and confidentiality was maintained by anonymising patient identifiers during data entry, analysis, and reporting.

Inclusion and Exclusion Criteria

Children were included in the study if they met all of the following criteria: (1) age ≤12 years; (2) presence of an afebrile or minimally febrile cough illness lasting more than 14 days, with at least one characteristic feature such as paroxysmal coughing, inspiratory whoop, post-tussive vomiting, or apnea; or cough illness of any duration that was clinically suspected to be pertussis by the pediatrician; and (3) unvaccinated or partially vaccinated children who had not received any booster doses. Children were excluded from participation if they had any known chronic illnesses, including cardiac disorders or gastroesophageal reflux disease, if they had chronic lung diseases such as asthma, or if the parents/guardians refused to give written informed consent for study participation.

Clinical Evaluation and History

For each recruited child, a comprehensive demographic and clinical assessment was performed. A detailed medical history was recorded, including prior illnesses, pertussis vaccination status, receipt of booster doses (if any), and the route of administration. All children underwent clinical examination by a qualified paediatrician.

Specimen Collection and Laboratory Testing

Two bilateral posterior nasopharyngeal swabs (NPS) were collected from each participant using a standard technique. Additionally, venous blood samples were drawn for the estimation of the complete blood count (CBC), C-reactive protein (CRP), and anti-pertussis toxin IgG levels. All sample processing, culture incubation, PCR amplification, and serological analysis were

conducted in accordance with established Standard Operating Procedures (SOPs) of the institutional laboratory. Internal quality control measures were followed to maintain testing accuracy and reproducibility.

Culture: Each NPS sample was immediately inoculated onto a specialised transport medium and incubated at 35–37°C. Colonies with morphological resemblance to *Bordetella pertussis* were subjected to slide agglutination testing using *B. pertussis* and *B. parapertussis* antisera. Confirmed colonies were then sub-cultured and preserved for further strain characterisation.

PCR: For molecular confirmation, a real-time PCR assay targeting the promoter region of the pertussis toxin S1 subunit gene (ptxA) and the IS481 insertion element was performed on the pooled NPS samples. A specimen was deemed PCR-positive when the ptxA gene target was amplified.

Serology: Peripheral blood samples were also tested for anti-pertussis toxin (anti-PT) IgG using a quantitative assay. Patients who had not received a pertussis vaccine in the past 12 months and had anti-PT IgG titers ≥62.5 IU/mL were considered to have probable pertussis infection.

Case Definitions

A child was diagnosed with definite pertussis if the culture or PCR result for *B. pertussis* was positive. Those with negative culture/PCR but anti-PT IgG ≥62.5 IU/mL without recent vaccination history were categorised as probable cases.

Data Management and Statistical Analysis

Data were compiled in Microsoft Excel and cleaned before analysis. Descriptive statistics were used to summarise demographic characteristics, clinical features, immunisation status, and laboratory findings. Categorical distributions were analysed using Chi-square goodness-of-fit tests, and Chi-square tests were applied where cross-tabulated comparisons were appropriate. A p-value <0.05 was considered statistically significant. Because the number of laboratory-confirmed cases was small, association testing between specific clinical features and individual diagnostic outcomes was interpreted cautiously. Results are presented as frequencies, percentages, Chi-square values, degrees of freedom, and p-values.

Bias

Potential sources of selection, information, recall, and measurement bias were addressed during study conduct. Selection bias was minimised by consecutive enrolment of all eligible children presenting during the defined study period. Information bias was reduced by using a structured clinical proforma, uniform case definitions, and paediatrician-led clinical assessment. Recall bias related to immunisation history was minimised by verifying available vaccination records whenever possible and by recording parental recall only when documentary evidence was unavailable. Measurement bias was reduced by standardised nasopharyngeal swab collection, institutional laboratory standard operating procedures, and internal quality control during culture, PCR, serology, complete blood count, and CRP testing.

Ethical Approval

The study was conducted after obtaining formal approval from the Institutional Ethics Committee, Osmania Medical College, Hyderabad, India (Ref. No.: IEC-BHR/OMC/M.NO (03)/P-35; dated 27.09.2023).

Results

Demographic Characteristics

During the study period from November to December 2023, a total of 32 pediatric patients were clinically diagnosed with suspected Bordetella pertussis infection at the tertiary care hospital. Age-wise distribution revealed that 8 patients (25%) were in the 0–3 months age group, 7 patients (21.9%) were between 3–6 months, and another 7 patients (21.9%) were aged 6–12 months. Additionally, 9 children (28.1%) belonged to the 1–5 years age category, while only 1 child (3.1%) was between 5–12 years. These findings highlight that 93.8% (30/32) of the clinically suspected pertussis cases occurred in children under the age of five years. This clustering of cases in the younger age groups suggests a potential association with incomplete vaccination status or lack of booster immunisation, particularly in infants too young to have received the full primary vaccination schedule. The sex distribution of clinically diagnosed pertussis cases revealed that males accounted for 19 cases (59.37%), while females comprised 13 cases (40.62%), totalling 32 cases overall (Table 1).

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Table 1. Age Distribution of Clinically Diagnosed Pertussis Cases

Age Group	Number of Cases
0–3 months	8
3–6 months	7
6–12 months	7
1–5 years	9
5–12 years	1
Total	**32**

Clinical Characteristics

A detailed clinical history was elicited from all 32 enrolled subjects presenting with prolonged cough. Among them, the predominant associated symptom was paroxysms of cough, reported in 26 cases (81.25%). Additional symptom clusters were also observed: post-tussive vomiting was present in 2 cases (6.25%), post-tussive vomiting with whooping in 2 cases (6.25%), paroxysms of cough with post-tussive vomiting in 1 case (3.12%), and apneic spells in 1 case (3.12%). These findings are detailed in the following Table 2. These symptom combinations reaffirm the diagnostic variability of pertussis presentations and highlight the importance of comprehensive history-taking to distinguish classical features from atypical or overlapping respiratory symptoms.

Table 2: Distribution of Associated Symptoms Among Clinically Diagnosed Pertussis Cases (n = 32)

Associated Symptom	Number of Cases (n=32)	Percentage (%)
Paroxysms of cough	26	81.25%
Post-tussive vomiting	2	6.25%
Post-tussive vomiting with whooping	2	6.25%
Paroxysms of cough with post-tussive vomiting	1	3.12%
Apnoeic spells	1	3.12%

Immunization History

Assessment of immunisation status revealed a significant gap in complete vaccination coverage among children clinically diagnosed with pertussis. Out of the 32 study participants, 29 children (90.6%) were found to be partially vaccinated, indicating that either they had not received the full three doses of the DPT vaccine or had missed the booster doses. In contrast, 3 children (9.4%) were completely unvaccinated at the time of presentation. These findings underscore a critical vulnerability among children with incomplete immunisation, which may contribute substantially to the observed resurgence of pertussis cases. The data are summarised in the following Table 3:

Table 3: Immunization Status of Children Clinically Diagnosed with Pertussis (n = 32)

Immunization Status	Number of Cases (n=32)	Percentage (%)
Partially Vaccinated	29	90.6%
Unvaccinated	3	9.4%

This distribution pattern suggests that the majority of pertussis cases occurred in children who had not completed the primary immunisation schedule, further emphasising the need for public health reinforcement of vaccine compliance and timely booster administration.

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Laboratory Findings

Out of the 32 clinically suspected pertussis cases, white blood cell (WBC) counts revealed notable patterns. Only 3 patients (9.4%) had WBC counts within the normal range, defined as less than 11,000 cells/cmm. A total of 8 patients (25%) had moderately elevated WBC counts, ranging from 11,000 to 15,900 cells/cmm. The majority, 12 patients (37.5%), showed further elevation within the 16,000–20,900 cells/cmm range. An additional 5 patients (15.6%) exhibited leukocytosis in the range of 21,000–25,000 cells/cmm. Finally, 4 patients (12.5%) demonstrated markedly elevated counts exceeding 25,000 cells/cmm.These findings suggest that a significant proportion of children clinically suspected of pertussis exhibited raised WBC counts, which is consistent with the leukocytosis typically associated with pertussis infection. The distribution of these WBC levels is summarised in Table 4 below.

Table 4: Distribution of Total White Blood Cell (WBC) Counts Among Clinically Suspected Pertussis Cases (n = 32)

WBC Count Range (cells/cmm)	Number of Cases	Percentage (%)
<11,000	3	9.4%
11,000–15,900	8	25.0%
16,000–20,900	12	37.5%
21,000–25,000	5	15.6%
>25,000	4	12.5%
Total	32	100%

In addition to white blood cell analysis, C-reactive protein (CRP) testing was performed to assess the acute phase response in all 32 clinically suspected pertussis patients. Among these, 17 patients (53.1%) exhibited elevated CRP levels greater than 6 mg/L, indicating a systemic inflammatory response. The remaining 15 patients (46.9%) had CRP values below this threshold, considered within the negative or normal range. These findings suggest that more than half of the suspected pertussis cases demonstrated biochemical evidence of active inflammation, although CRP alone may not be diagnostic in isolation. The distribution of CRP positivity is summarised in Table 5 below.

Table 5: Distribution of C-Reactive Protein (CRP) Levels Among Clinically Suspected Pertussis Cases (n = 32)

CRP Result	Number of Cases	Percentage (%)
Positive (>6 mg/L)	17	53.1%
Negative (≤6 mg/L)	15	46.9%
Total	**32**	**100%**

A total of 32 nasopharyngeal swab samples were processed for *Bordetella pertussis* culture to confirm microbiological diagnosis. Among them, only 3 patients (9.4%) demonstrated culture positivity, while 29 patients (90.6%) showed no growth of *B. pertussis*. The low culture positivity rate may be attributed to prior antibiotic exposure, sample collection timing, or the inherently low sensitivity of culture methods, especially in resource-constrained clinical settings. Despite its low yield, culture remains the gold standard for confirmation and facilitates strain preservation for further epidemiological tracking. The culture outcomes are detailed in Table 6.

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Table 6: Culture Results for *Bordetella pertussis* Among Clinically Suspected Cases (n = 32)

Culture Result	Number of Cases	Percentage (%)
Positive	3	9.4%
Negative	29	90.6%
Total	**32**	**100%**

PCR testing was conducted on nasopharyngeal specimens from all 32 clinically suspected pertussis cases. PCR yielded a positive result in 2 patients (6.25%), a negative result in 29 patients (90.6%), and was deemed indeterminate or "suspected" in 1 patient (3.1%). Although PCR is a highly sensitive and specific tool for early detection of *B. pertussis* DNA, its diagnostic utility may vary depending on the timing of sample collection, quality of specimen, and presence of inhibitory substances. In this study, the relatively low PCR positivity might reflect delayed presentation, partially treated illness, or technical limitations. The distribution of PCR results is presented in **Table 7**.

Table 7: PCR Results for *Bordetella pertussis* Detection (n = 32)

PCR Result	Number of Cases	Percentage (%)
Positive	2	6.25%
Negative	29	90.6%
Suspected	1	3.1%
Total	**32**	**100%**

Serological testing for anti-pertussis toxin (anti-PT) IgG antibodies was performed in all 32 clinically suspected cases to evaluate humoral immune response. Among them, 2 patients (6.25%) had significantly elevated IgG titers consistent with recent or active *Bordetella pertussis* infection, while 30 patients (93.75%) showed negative results. The low positivity may be attributed to early sampling before antibody production, immunization status, or limitations in the sensitivity of IgG assays in pediatric populations. These findings suggest that IgG serology, though useful in retrospective diagnosis, may have limited utility as a standalone diagnostic tool in acute clinical scenarios. The results are summarised in **Table 8**.

Table 8: IgG Antibody Results in Suspected Pertussis Cases (n = 32)

IgG Antibody Result	Number of Cases	Percentage (%)
Positive	2	6.25%
Negative	30	93.75%
Total	**32**	**100%**

Chi-square Analysis

Chi-square goodness-of-fit analysis showed significant predominance of paroxysmal cough among symptom categories (χ^2=75.19, df=4, p<0.001) and significant clustering of cases among partially vaccinated children (χ^2=21.13, df=1, p<0.001). Diagnostic outcome distributions also showed significantly low laboratory positivity for culture (χ^2=21.13, df=1, p<0.001), PCR (χ^2=47.31, df=2, p<0.001), and anti-pertussis toxin IgG serology (χ^2=24.50, df=1, p<0.001). Age-group distribution (χ^2=6.13, df=4, p=0.190), sex distribution (χ^2=1.13, df=1, p=0.289), WBC distribution (χ^2=8.31, df=4, p=0.081), and CRP distribution (χ^2=0.13, df=1, p=0.724) were not statistically significant. These results were interpreted descriptively because the small number of laboratory-confirmed cases limited robust cross-tabulated association testing between individual clinical features and each diagnostic modality.

Discussion

The resurgence of pertussis, despite established vaccination protocols, represents a growing public health challenge, particularly in low- and middle-income countries like India. This observational study contributes meaningful insight into the clinical manifestations, immunisation gaps, and laboratory confirmation of pertussis in paediatric patients aged ≤12 years. Anchored on three primary objectives, namely evaluating clinical-laboratory profiles, assessing the epidemiological impact of re-emergence, and confirming diagnosis through culture, PCR, and serology, this study offers practical relevance for paediatric infectious disease surveillance and vaccine policy refinement.

Clinical Presentation in the Contemporary Paediatric Context

The predominant burden in this study was observed among children under five years (93.8%), with a significant subset below one year. This age clustering is consistent with prior literature, which identifies infants as the most vulnerable due to their immature immunity and incomplete primary vaccination schedules [8]. The high prevalence of paroxysmal cough (81.25%) aligns with classical pertussis symptomatology, as outlined in Mi et al. (2024) [9], though other features such as post-tussive vomiting (6.25%) and apnoeic spells (3.12%) reflect the spectrum of atypical presentations, particularly in partially immune hosts [10]. The clinical heterogeneity underscores the diagnostic complexity in resource-limited settings, particularly where molecular tools are not readily accessible. This complexity necessitates vigilant clinical recognition supported by suggestive histories, as also emphasised by similar studies [1,10].

Evidence of Re-Emergence and Immunisation Gaps

The findings indicate critical lapses in immunisation, with 90.6% of cases being partially vaccinated and 9.4% remaining unvaccinated. This mirrors trends observed globally and regionally, where incomplete vaccination and waning immunity have been repeatedly linked to pertussis resurgence. Reports of similar immunisation gaps in South Asian paediatric populations further support the argument that re-emergence is closely related to structural delays in vaccine delivery and booster implementation [11–13]. Moreover, the WHO has emphasised that booster dose coverage remains inadequate in several developing nations, thereby prolonging vulnerability. The findings support this position and indicate the need to re-evaluate the timing and accessibility of DPT boosters. The situation is aggravated in infants too young to have completed primary immunisation, a finding echoed in the recent analysis by Irulappan et al. (2025), which calls for targeted maternal and cocooning vaccination strategies [14].

Diagnostic Utility of Laboratory Methods

While culture remains the gold standard for pertussis diagnosis, its sensitivity is limited in real-world settings. In this study, culture was positive in only 9.4% of cases, consistent with the literature, which suggests a poor yield beyond the early catarrhal stage or after antibiotic initiation. PCR testing, although more sensitive, yielded a positivity rate of only 6.25%, possibly due to the timing of sample collection or partial treatment, a limitation also noted by previous studies [15,16]. Serological testing for anti-pertussis toxin IgG was positive in only 6.25% of patients, reinforcing previous findings that serology may have limited sensitivity in acute paediatric scenarios. While useful for retrospective diagnosis, IgG testing is not a suitable standalone tool in acute presentations, particularly in unvaccinated children [17]. Further, 90.6% of patients had elevated WBC counts, a surrogate marker often associated with pertussis, as validated by existing literature. More than half of the children (53.1%) had raised CRP levels, although this marker remains non-specific. These findings echo those of Wang et al. (2021), who noted that laboratory support should be contextualised with clinical data rather than relied upon in isolation [8].

Broader Implications and Future Directions

This study confirms that pertussis continues to pose diagnostic and immunological challenges in paediatric populations. The constellation of clinical suspicion, incomplete vaccination, and suboptimal laboratory confirmation underscores the need for revised diagnostic algorithms and surveillance strategies. As argued in a recent publication, the real-time integration of

epidemiological and diagnostic data from tertiary institutions can help forecast outbreaks, inform vaccine policy, and enhance the responsiveness of the health system [14].

Additionally, the findings advocate for strengthening booster coverage, implementing maternal immunisation, and promoting early referral for prolonged cough illnesses. As recommended by WHO and reinforced by recent Asian surveillance reports [7,14], sustained surveillance and public health messaging are imperative to counteract pertussis re-emergence in the post-COVID landscape. By correlating clinical findings with laboratory data and immunisation histories, this study contributes real-world evidence toward early diagnosis, outbreak detection, and immunisation reform. The re-emergence of pertussis, especially in under-immunised infants, highlights persistent gaps in primary healthcare infrastructure. Integration of high-sensitivity diagnostics and robust immunisation tracking systems is essential for future containment [5,13,18].

Generalizability

The findings may be generalizable to similar tertiary care hospitals managing paediatric respiratory infections in India. However, the small sample size, short study duration, and single-centre design limit broader applicability to community settings or different geographic regions.

Conclusion

The study highlights the continuing burden and diagnostic challenges of pertussis among children in a tertiary care setting, despite the availability of national immunisation programmes. The predominance of cases among infants and young children, particularly those who were partially vaccinated or unvaccinated, emphasises the need for timely completion of primary immunisation, improved booster coverage, and consideration of maternal pertussis vaccination.

Low positivity rates with culture, PCR, and serological testing reflect the practical limitations of routine diagnostic methods, including delayed presentation, prior antibiotic exposure, and variable test sensitivity. These limitations may contribute to delayed recognition, underreporting, and weakened disease surveillance. By combining clinical features, immunisation status, and laboratory findings, this study supports the need for heightened clinical suspicion, strengthened diagnostic infrastructure, and improved tertiary care-based surveillance. These measures may help improve early detection, guide public health interventions, and support better prevention of paediatric pertussis in India.

Limitations

This study has several limitations. Being cross-sectional, it could not assess disease progression or outcomes. The small sample size and single-centre setting limit generalizability. Laboratory confirmation was affected by delayed presentation, prior antibiotic use, and limited test sensitivity, resulting in low culture and PCR positivity. Some immunisation histories relied on parental recall, introducing potential bias. Despite these constraints, the study provides valuable insights into the clinical and diagnostic landscape of paediatric pertussis in a tertiary care setting.

Recommendations

Routine pertussis surveillance should be strengthened in tertiary care hospitals, particularly for infants and children presenting with prolonged paroxysmal cough. Timely completion of primary immunisation and scheduled booster doses must be ensured through active counselling of caregivers and follow-up of partially vaccinated children. Maternal pertussis immunisation during pregnancy may be considered to protect young infants before completion of vaccination. Diagnostic capacity should be improved by wider availability of real-time PCR, culture facilities, and standardised serological testing. Clinicians should maintain high suspicion even in atypical cases. Public health programmes should focus on reducing immunisation gaps, improving reporting, and supporting early treatment.

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Abbreviations

PCR-Polymerase Chain Reaction;
IgG-Immunoglobulin G;
WBC-White Blood Cell;
CRP-C-Reactive Protein;
WHO-World Health Organization;
DPT-Diphtheria–Pertussis–Tetanus;
aP-Acellular Pertussis;
Wp-Whole-cell Pertussis;
LMICs-Low- and Middle-Income Countries;
NPS-Nasopharyngeal Swab;

CBC- Complete Blood Count;

Source of funding

The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author Contributions

Dr. Bunga Harshita contributed to study concept support, data collection, clinical data compilation, literature review, and preparation of the initial manuscript draft.

Dr. Bunga Babu Ratnakar contributed to study design, clinical supervision, diagnosis and management guidance, interpretation of findings, manuscript revision, and overall academic coordination.

Dr. Prathyusha Yellamelli contributed to clinical evaluation, data verification, analysis of paediatric findings, review of scientific content, and critical revision of the manuscript.

Dr. Shilpa Nandru contributed to patient screening support, clinical documentation, coordination of laboratory investigations, data organization, and final manuscript review.

Data availability

Data available on request

Author Biography

Dr. Bunga Harshita is an Internee in the Department of General Medicine at Osmania Medical College, Hyderabad, Telangana, India. She has a developing academic interest in clinical medicine, paediatric infectious diseases, and hospital-based observational research. Her involvement in this study reflects her interest in clinical data collection, disease surveillance, and evidence-based medical writing.

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Dr. Prathyusha Yellamelli is an Assistant Professor in the Department of Pediatrics at Government Medical College, Khammam, Telangana, India. Her professional interests include paediatric clinical care, infectious disease evaluation, immunisation practices, and child health research. She is involved in undergraduate and postgraduate teaching, patient care, and academic contribution in paediatrics.

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