

High prevalence and associated factors of *Mycoplasma pneumoniae* infection in children aged from 2 to 59 months with atypical pneumonia from June 2023 to May 2024

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Keywords

Atypical pneumonia • *M. pneumoniae* • Risk factors

Summary

Objectives. To identify the prevalence of *Mycoplasma pneumoniae* infection and association with age and gender among children aged from 2 to 59 months, hospitalized with atypical pneumonia in Vietnam from June 2023 to May 2024.

Methods. A retrospective descriptive study was performed using data collected from the electronic medical records. *M. pneumoniae* infection was determined by the IgM serology test.

Results. 1,296 patients aged from 2 to 59 months hospitalized with atypical pneumonia were included. The majority of patients were aged 12 months or older, with only 3.6% of cases being under 12 months of age. Male patients accounted for 58.7% of the cases. Prevalence of *M. pneumoniae* infection was 47.3%.

Compared to children under 12 months of age, those aged 12 to under 36 months had a 10 times higher risk of *M. pneumoniae* infection, with OR = 9.44, 95% CI = [2.90-30.77]. Compared to children under 12 months of age, those aged 36 months to under 5 years had a 20 times higher risk of *M. pneumoniae* infection, with OR = 20.19, 95% CI = [6.20-65.69]. Compared to female children, male children had nearly twice the lower risk of *M. pneumoniae* infection, with OR = 0.62, 95% CI = [0.50-0.78].

Conclusion. Our study provides additional evidence on the role of *M. pneumoniae* in atypical pneumonia in children aged from 2 to 59 months, while also highlighting significant risk factors for *M. pneumoniae* infection.

Introduction

Atypical pneumonia is a common condition, particularly in children, and plays a significant role in contributing to the burden of illness and mortality, especially in developing countries like Vietnam [1, 2]. The disease not only affects children health, but also poses the risk of leading to serious complications if not diagnosed and treated in a timely manner [1]. Children, with their underdeveloped immune systems, are a vulnerable group to various pathogens, among which atypical pneumonia is one of the leading threats.

Mycoplasma pneumoniae is considered one of the most common and concerning pathogens of atypical pneumonia [3]. *M. pneumoniae* is a small bacterium with no cell wall and a simple structure, but it has the ability to cause complex and diverse clinical manifestations. This creates significant challenges in diagnosis as the clinical symptoms are often non-specific and can easily be mistaken for other respiratory diseases. Furthermore, due to its lack of a cell wall, *M. pneumoniae* is not affected by many antibiotics commonly used to treat pneumonia, further complicating disease management and treatment [3].

In Vietnam, although pneumonia is a serious public health issue, the specific epidemiological situation

related to *M. pneumoniae* in children has not been extensively studied [1, 4]. Currently, data on infection rates and specific risk factors for *M. pneumoniae* infection remain quite limited. This highlights an urgent need for more detailed research to clarify the risk factors associated with *M. pneumoniae* infection.

Identifying these risk factors is not only scientifically valuable but also highly practical. It helps improve early diagnostic capabilities, thereby enhancing treatment efficacy and reducing the risk of dangerous complications. Furthermore, recognizing risk factors plays a crucial role in establishing prevention strategies, especially for high-risk children. This will contribute to reducing the incidence and mortality from pneumonia, thereby improving the quality of pediatric healthcare in Vietnam.

Therefore, this study was conducted to identify the prevalence and risk factors of *M. pneumoniae* infection in children aged from 2 to 59 months with atypical pneumonia from June 2023 to May 2024 in Thai Binh, a densely populated province with a young population structure in Vietnam. The findings will help provide essential information for the development of medical interventions aimed at reducing the burden of pneumonia-related diseases in children.

Methods

STUDY DESIGN AND POPULATION

This was a retrospective descriptive study conducted on all patients aged from 2 to 59 months, hospitalized for atypical pneumonia at the Thai Binh Pediatric Hospital from June 1, 2023, to May 31, 2024, located in Thai Binh province, before merging provinces and cities in Vietnam.

Thai Binh is a predominantly rural region in northern Vietnam. This province has a population of approximately 1.9 million, with a population density of around 1,100 persons per square kilometer. Most of population live in rural areas and 15.5% of the population aged from 0 to 9 years [5].

Atypical pneumonia was clinically diagnosed when children presented with pneumonia along with the following suggestive clinical symptoms: a high and persistent fever $> 39\text{--}40^{\circ}\text{C}$, cough, sputum production, dyspnea, tachypnea, hypoxia, extrapulmonary manifestations such as pleuritis, hepatosplenomegaly, or myocarditis. Chest x-ray findings in atypical pneumonia include patchy infiltrates, sometimes bilateral in distribution, and interstitial patterns.

M. pneumoniae infection was determined by serological testing, as molecular testing for *M. pneumoniae* was not available at the hospital. The serum samples were quantitatively analyzed for IgM antibodies against *M. pneumoniae* using the Virion/Serion ELISA kit (GmbH Germany, catalog number ESR127M). The antibody levels were expressed in units per milliliter (U/ml). According to the manufacturer's guidelines, the interpretation criteria for *M. pneumoniae* IgM were as follows: positive (> 17 U/ml), negative (< 13 U/ml), and borderline (13–17 U/ml). All ELISA assays were carried out strictly following the instructions provided by the manufacturer.

DATA COLLECTION

Data were extracted from the electronic medical records of hospital in Microsoft Excel format, including socio-demographic characteristics, clinical findings and laboratory testing. We then filtered out duplicate data, which included pediatric patients who underwent serological testing multiple times during the same treatment period. To eliminate duplication, we relied on the patient unique identification (for all subsequent hospitalizations if any). If a child underwent multiple tests during a single treatment period, we used the result from the most recent positive test (in cases where all tests were positive or where there were both positive and negative results) or the earliest negative result (in cases where all results were negative). If the child was hospitalized several times, data were collected corresponding to each separate treatment period.

DATA ANALYSIS

After data cleaning, R (version 4.5.0) software for was used for statistical analysis. Age was categorized into the

following groups: 2 to < 12 months, 12 to < 36 months, and 36 to < 60 months. Qualitative variables were presented as counts and percentages. The primary variable was the proportion of children with pneumonia and positive for IgM anti-*M. pneumoniae*. The Chi-squared test was used to assess differences in proportions. Logistic regression was used to evaluate the association between age and gender with *M. pneumoniae* infection. The results were presented and OR and 95% CI. Statistical significance was defined as $p < 0.05$.

Results

A total of 1296 children aged from 2 to 59 months were eligible and included. The Figure 1 showed the distribution of patients with and without *M. pneumoniae* over the period time of study (Fig. 1). Time analysis showed no sustained increase or decrease in *M. pneumoniae*-associated atypical pneumonia over the study year. A monthly logistic-regression model that treated calendar time as a continuous index showed no evidence of a monotonic trend in *M. pneumoniae* IgM positivity (OR = 0.99, 95% CI 0.96–1.03; $p = 0.70$). Weekly analyses also confirmed the absence of a linear trend. Only two spline components reached nominal significance ($p < 0.05$), indicating modest, non-monotonic week-to-week fluctuations. However, the terminal spline coefficient was not significant ($p = 0.46$), suggesting a return to baseline levels.

Most children (1249, 96.4%) with atypical pneumonia were aged 12 months and older, of whom 46.7% (605/1296) were aged 12–36 months and 49.7% (644/1296) were aged 36–59 months. Only 47 (3.6%) of children were under 12 months. Male gender accounted for 58.7% (761/1296), with a male/female sex ratio of 1.4 (Tab. I).

613 children (47.3%) with atypical pneumonia were infected with *M. pneumoniae*.

Compared to children aged from 2 to < 12 months, children aged 12 to under 36 months have a 10 times higher risk of *M. pneumoniae* infection, with OR = 9.44, 95% CI = [2.90–30.77]. Children aged 36 months to under 5 years have a 20 times higher risk of *M. pneumoniae* infection, with OR = 20.19, 95% CI = [6.20–65.69]. Compared to female children, male children have nearly twice the lower risk of *M. pneumoniae* infection, with OR = 0.62, 95% CI = [0.50–0.78] (Tab. I).

Discussion

Our study found that *M. pneumoniae* is a common cause of atypical pneumonia in children aged from 2 to 59 months in Thai Binh from June 2023 to May 2024, with the infection rate of *M. pneumoniae* accounting for 47.3% of cases. This high rate reflects the prevalence of *M. pneumoniae* in the pediatric population and is higher than previous studies in Vietnam and other Southeast Asian countries [1, 2, 5].

Fig. 1. Monthly (A) and weekly (B) distribution of children aged from 2 to 59 months, hospitalized with atypical pneumonia in Thai Binh from June 2023 to May 2024.



Previous studies in Vietnam have reported *M. pneumoniae* infection rates generally below 20%, which is significantly lower than our findings [1, 6] *Chlamydia pneumoniae*, and *Legionella pneumophila* are increasingly recognized as important causes of community acquired pneumonia (CAP). Notably,

in a study by Tran et al., conducted at the same location as our study, the *M. pneumoniae* infection rate was only 3.2% [7]. This discrepancy may be explained by the fact that their study focused on children with pneumonia in general, while ours specifically investigated children with atypical pneumonia. Moreover, previous studies

Tab. I. Associated factors of *Mycoplasma pneumoniae* pneumonia in children aged 2 to 59 months from June 2023 to May 2024.

Associated factors	IgM <i>M. pneumoniae</i> negative	IgM <i>M. pneumoniae</i> positive	OR [95% CI]	p-value
	n (%)	n (%)		
Age				
2 - < 12 months	44 (6.4)	3 (0.5)	Reference	
12 - < 36 months	368 (53.9)	237 (38.7)	9.44 [2.90-30.77]	0.0001
36 - 59 months	271 39.7)	373 (60.8)	20.19 [6.20-65.69]	0.0001
Gender				
Female	245 (35.9)	290 (47.3)	Reference	
Male	438 (64.1)	323 (52.7)	0.62 [0.50-0.78]	0.0001

have commonly used PCR testing to diagnose *M. pneumoniae*, whereas in Thai Binh, this method is not available for routine diagnosis. Therefore, we relied on serological test results, which likely explains the higher infection rate observed in our study.

Studies in Southeast Asian countries have reported *M. pneumoniae* infection rates in children with atypical pneumonia ranging from 3% to 26% [1, 2, 6-8]. These figures highlight *M. pneumoniae* as a common and important pathogen to be considered in the diagnosis and treatment of pneumonia in children, not only in Vietnam but across the geographical area.

The clinical significance of this finding is important, as *M. pneumoniae* is often not detected by conventional microbiological diagnostic methods, leading to missed or delayed diagnoses [3]. This can result in inappropriate treatment, prolonged illness, and increased risk of complications. Therefore, the use of accurate diagnostic methods such as PCR for the detection of *M. pneumoniae* should be encouraged, especially in healthcare settings where this technology is available [9].

Additionally, understanding the role of *M. pneumoniae* in atypical pneumonia can help improve antibiotic treatment guidelines, reduce antibiotic resistance, and improve treatment outcomes. The use of specific antibiotics such as macrolides, which are highly effective in treating *M. pneumoniae*, should be prioritized in suspected or confirmed cases of this infection [10].

A noteworthy finding in this study series is the age and gender distribution of *M. pneumoniae* infection rates. Children aged of 12 months or older were at higher risk of *M. pneumoniae* infection than those aged from 2 to 12 months. This could be explained by the development of the immune system and greater environmental exposure as children grow older, creating favorable conditions for *M. pneumoniae* infection. Previous studies have also shown that older children tend to be more frequently infected with *M. pneumoniae*, which aligns with our results [1, 10, 11].

In addition, our study found that male gender had a lower risk of *M. pneumoniae* infection compared to girls. This is a notable finding, as previous studies have generally not reported a significant gender difference in *M. pneumoniae* infection rates [1, 10, 11]. It could

be explained that behavioral, physiological, and exposure differences to risk factors may contribute to this variation, but further research is needed to better understand the biological mechanisms underlying this gender discrepancy.

Our study has several limitations. First, despite its relatively large sample size, this is a monocentric retrospective study, which limits the generalizability of the results to other regions of Vietnam. Second, by enrolling only hospitalized children with clinically suspected atypical pneumonia, we may have introduced selection bias, omitting milder outpatient cases and episodes of typical bacterial pneumonia. Third, routine multiplex PCR testing for respiratory pathogens was not available in our hospital. Consequently, potential viral or bacterial co-infections which are common in pediatric pneumonia could not be assessed and are likely under-represented in our dataset.

In conclusion, despite several limitations, our study provides additional evidence on the role of *M. pneumoniae* with high prevalence in atypical pneumonia in children aged from 2 to 59 months and highlights important risk factors such as age and gender. These findings can assist clinicians in identifying high-risk children for *M. pneumoniae* infection, thereby improving diagnostic and treatment strategies, and contributing to the reduction of disease incidence and healthcare burden in the community.

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Ethical approval

The protocol was approved by Thai Binh University of

Medicine and Pharmacy (approval date: 04 February 2025; reference number: SV.2025.02). The study was performed according to the good clinical practices recommended by the Declaration of Helsinki and its amendments. This was a retrospective study, informed consent was waived.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, [VTH], upon reasonable request.

Conflict of Interest statement

The authors declare that they have no conflict of interest.

Authors' contributions (Use CRediT terms)

Conceptualization: VTH. Data curation: MMT, KDL, VND. Formal analysis: MMT, VTH. Investigation: MMT, KDL, VND, VTH. Methodology: MMT, VTH. Software: VTH. Validation: MMT, KDL, VND, VTH. Visualization: MMT, VTH. Writing - original draft: MMT, VTH. Writing - review & editing: MMT, KDL, VND, VTH. KDL and MMT contributed equally to this work.

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