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Original Article

Epidemiologic characteristics of immunoglobulin M antibodies in lower respiratory tract infection pathogens of children: association with severe pneumonia in Chengdu city from 2019 to 2023

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Abstract: Objective: To analyze the epidemiologic characteristics of serum immunoglobulin M (IgM) antibody aming six pathogens in children with acute lower respiratory tract infections (LRTI) and its association with severe pneumonia, thereby providing a basis for clinical diagnosis and treatment. Methods: A total of 25,693 children with lower respiratory tract infections who were hospitalized in the Department of Respiratory Medicine at Chengdu Women's and Children's Central Hospital from 2019 to 2023 were included and retrospectively analyzed in the study. The epidemiologic characteristics of serum IgM antibodies for six LRTI pathogens in the enrolled children were analyzed. Logistic regression analysis was conducted to identify risk factors for severe pneumonia. Results: The IgM positive detection rate among the six pathogens was 30.26%. In addition, the IgM positive detention rates among Mycoplasma pneumoniae (MP), Parainfluenza virus (PVI) and Influenza B virus (IFV-B) of female children were higher than those of male children ($P < 0.05$); Children who were younger than 1 year oldshowed the lowest IgM positive detention rates of MP and IFV-B ($P < 0.05$). The positivity rates of IgM antibodies for MP, IFV-B, PIV, and Respiratory syncytial virus (RSV) markedly varied across different lower respiratory tract infections ($P < 0.001$; $P = 0.007$; $P = 0.004$; $P < 0.001$). The IgM positive detection rate of two or more pathogens before COVID-19 pandemic were higher in comparison to those post COVID-19 ($P < 0.05$). Compared to the non-severe group, children with severe pneumonia showed a relatively lower detection rate of MP but a significantly higher detection rate of RSV. The results of multiple logistic regression analysis suggested that age and gender were independent influencing factors for severe pneumonia, with an area under the Receiver Operating Characteristics curve of 0.727. Conclusion: In Chengdu city, the positivity rates of IgM antibodies for LRTI pathogens in children exhibited seasonal, age-related, and diagnostic category characteristics-related variations. Severe pneumonia cases were characterized by RSV infection and younger age. Clinicians should take epidemiologic features into consideration to optimize their diagnostic and therapeutic strategies.

Keywords: Children, lower respiratory tract infection, pathogens, IgM antibodies, severe pneumonia

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Introduction

Respiratory infections are one of the most common infectious diseases in children, with symptoms including fever, runny nose, cough, and nasal congestion. Pediatric respiratory infections are recurrent and frequent, making them one of the leading causes of death in children under the age of five. Therefore, early diagnosis of respiratory infection pathogens enables precise treatment and reduces disease burden [1-3]. Studies have shown that Respiratory Syncytial Virus (RSV), Influenza viruses (IFV), Parainfluenza viruses (PIV), and Adenoviruses (ADV) are the major viruses responsible for lower respiratory tract infections (LRTI) in children. Following the COVID-19 pandemic, increasing attention has been paid to various viral infections and Mycoplasma pneumoniae (MP), though related literature remains scarce. However, the epidemiologic characteristics of respiratory tract pathogens are associated with factors such as region, environment, and age, with reports varying especially across different regions [4, 5]. Chengdu city, as a major first-tier megacity in Southwest China, has a population exceeding 20 million and over 80% of its area is urbanized. With its large and dense population, great cross-regional population mobility, and topography-induced air pollution, the pediatric respiratory tract pathogens readily disseminate in this area. This causes a high frequency of respiratory tract infections. In addition, as a consequence of the COVID-19 pandemic, the pathogen monitoring system has undergone structural shifts, resulting in more attention to the changing epidemiologic characteristics of pathogens in clinical settings. Studies have demonstrated that the occurrence rate of pneumonia in children under 5 years old is up to 25% in developing countries, among which 7%-13% are hospitalized for severe pneumonia. This significantly complicates clinical management extra burdens the healthcare system [6]. Currently, research on the long-term changes in pathogen spectrum and predictions of severe pneumonia risk in Chengdu city following the COVID-19 pandemic remains scarce. Therefore, this study aimed to collect the IgM profiles of six pathogens in 25,693 children with acute LRTI in Chengdu city between 2019 and 2023 for the analysis of the epidemiologic characteristics of common pediatric pathogens in this region and their association with severe pneumonia. The study not only provides detailed information about LRTI pathogens to assist clinicians in implementing treatment regimens, but also offers scientific evidence to public health authorities for developing targeted prevention and control strategies, thereby effectively reducing the incidence of respiratory tact infections and their associated mortality.

Data and methods

Patient selection

This is a retrospective study conducted at Chengdu Women's and Children's Central Hospital, a national Grade A tertiary hospital. In 2023, the hospital recorded 2.82 million patient visits and had a total of 1840 approved beds. Therefore, because it represents the region well, the data collected here should hold significant clinical value. A total of 25,693 children hospitalized in the Department of Respiratory Medicine of Chengdu Women's and Children's Central Hospital for acute LRTI between 2019 and 2023 were enrolled and divided into a severe pneumonia group (n = 6,093) and a non-severe pneumonia group (n = 19,600) based on their clinical conditions. The study was approved by the Chengdu Women's and Children's Central Hospital's Ethics Committee (Approval No.: Scientific Research Ethics Review 2025(41)). The flow chart is illustrated in **Figure 1**.

Inclusion and exclusion criteria: (1) Inclusion Criteria: Children were eligible for the study if they met the diagnostic criteria for LRTI as defined in the *Zhu Futang's Practical Pediatrics* (8^{th} Edition) [7]; their age ≥ 28 days but < 18 years; they were hospitalized in the Department of Respiratory Medicine of Chengdu Women's and Children's Central Hospital between Jan. 2019 and Dec. 2023; their fasting venous blood were collected and IgM antibody tests were completed within 24 hours after hospitalization; their demographic data, clinical records and laboratory reports were complete and obtainable. (2) Exclusion Criteria: Children were excluded from the study if their medical records were incomplete; their respiratory tract samples were not collected; they had a history of Crohn's disease, congenital heart disease, or immunodeficiency requiring long-term immunosuppressive therapy, which could interfere with IgM antibody detection results; or they were discharged or transferred to another department or hospital within 24 hours after hospitalization. It was worth noting that only the first medical record was kept for analysis if an

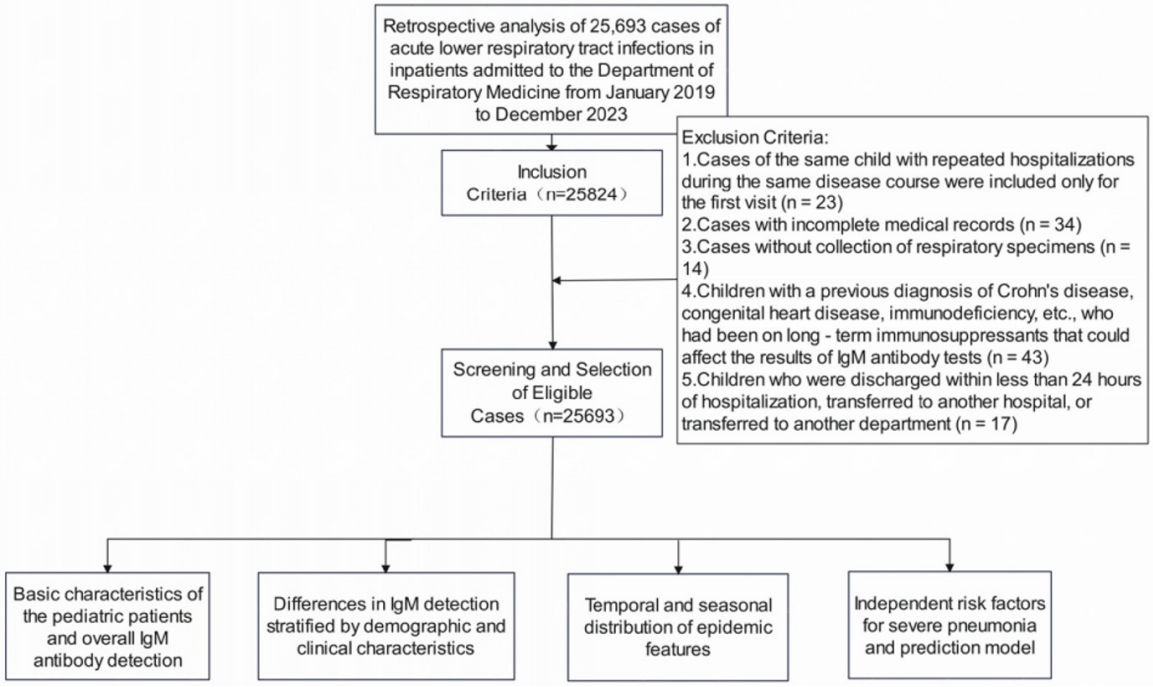

Figure 1. The flow chart of the study.

enrolled child had multiple medical records for the same disease course due to repeated hospital visits.

Data retrieval method: The Jiangsu Mandala Electronic Medical Record System (Version No.: 2023SR0407610) was employed to retrieve data of children who were hospitalized at the Department of Respiratory Medicine of Chengdu Women's and Children's Central Hospital between 2019 and 2023. Children with acute LRTI, defined by the International Classification of Diseases (10th Revision) (ICD-10) codes, were screened for the study.

Data collection

Patients' demographic data (gender, age, length of hospital stay, year of admission and season of admission), clinical diagnostic data and laboratory data [the IgM detection results for MP, influenza A virus (IFV-A), influenza B virus (IFV-B), RSV, parainfluenza virus (PIV), adenovirus (ADV)] were collected.

The IgM antibody detection kits were purchased from Zhengzhou Autobio Biotechnology Co., Ltd. (Approval No.: CFDA Imported Medical Device Registration No. 2010-3400365). The value threshold specified in instructions on the kit was used to determine IgM positive results. The data collected were checked separately by two researchers. Patients' age, length of hospital stay, and other variables were checked to verify that they met the inclusion criteria. Patients who did not fall into the inclusion range were excluded, or for those whose relevant data were missing, their original medical records were consulted to supplement the information.

Outcome measures

Primary outcome measures: (1) The IgM antibody positive detection results in children. (2) Comparison of IgM positive detection rate of a single pathogen and co-detection rates of multiple pathogens across different clinical characteristics (e.g., gender, age, diagnostic results). (3) Comparison of IgM positive detection rate of a single pathogen and co-detection rates of multiple pathogens across different years and seasons. (4) Comparison of IgM positive detection rate of a single pathogen and co-detection rates of multiple pathogens before and after the COVID-19 pandemic. (5) Comparison of clinical characteristics and IgM positive detection rates of different pathogens between the severe pneumonia group and the non-severe pneumonia group.

Secondary outcome measures: (1) Basic demographic and clinical data of the hospitalized children. (2) Independent risk factors for severe

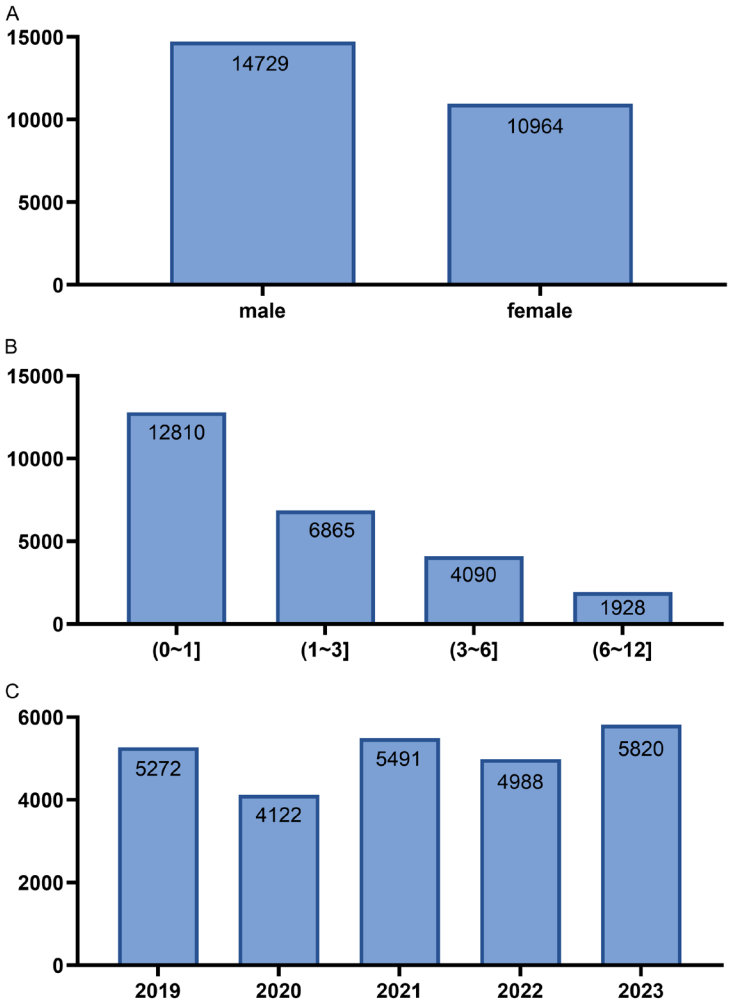

Figure 2. Basic information of hospitalized children seeking medical treatment. A: The number of hospital visiting children of different gender; B: The number of children seeking medical treatment of different ages; C: The number of children seeking medical treatment in different years.

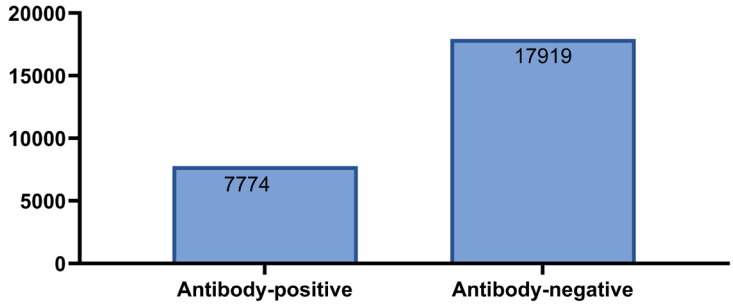

Figure 3. Overall IgM positive detection rates of pathogens.

pneumonia and the construction of a predictive model, which was evaluated using the Area Under the Receiver Operating Characteristics Curve (AUC).

Statistical analysis

Data were processed using SPSS 22.0 software. Counted data were presented as (n, %). Between-group comparisons were performed using the chi-square (χ^2) test. Pairwise comparisons of the counted data among multiple groups were conducted using the Bonferroni-corrected chi-square test. Measured data were expressed as mean ± standard deviation ($\bar{x}$ ± s). Between-group comparisons were performed using the t-test. Analysis of influencing factors for severe pneumonia was performed using binary logistic regression method. The predictive performance of the model was evaluated using the ROC curve. A *P*-value < 0.05 was considered significant.

Results

Basic information of the enrolled children

A total of 25,693 children were included in this study, with males accounting for 57.3% and females accounting for 42.7%. When grouped by age, the highest proportions were observed in the ≤ 1 year group (49.9%), followed by the 1 to ≤ 3 years group (26.7%). When grouped by the year of admission, 20.5% of the cases were from 2019, 16.0% from 2020, 21.4% from 2021, 19.4% from 2022, and 22.7% from 2023. See **Figure 2**.

Overall IgM positive detection rates of LRTI pathogens in children

A total of 7,774 children were found positive for IgM antibodies for LRTI pathogens, with a positivity rate of 30.26%. Among them, 7,492 cases (96.37%) tested positive for IgM antibodies to a single pathogen, while 282 cases (3.63%) tested for two or more pathogens. See **Figure 3**.

Comparison of IgM positive detection rates of LRTI pathogens across different clinical characteristics

Female children exhibited higher IgM antibody positive rates for MP, PIV, IFV-B, as well as for a single pathogen and for the combination of two or more pathogens compared to male children (all $P < 0.05$). The IgM antibody positive rates for MP, IFV-B, PIV, and RSV exhibited significant differences across different age groups. Notably, the IgM antibody positive rate for MP increased with age (all $P < 0.05$). In addition, the IgM positive detection rates of MP, IFV-B, and the co-detection rate for two or more pathogens were lowest in children who were under 1 year old (all $P < 0.05$). Rates for MP, IFV-B, PIV, and RSV also varied markedly across different LRTI. Children diagnosed with bronchitis exhibited the highest MP positivity rate; those diagnosed with bronchiolitis exhibited the highest co-detection rate for two or more pathogens (all $P < 0.05$). See **Table 1**.

Comparison of IgM positive detection rates for a single and multiple pathogens across different years and seasons

The IgM antibody positive rates for a single pathogen, multiple pathogens as well as MP were significantly different across different years (all $P < 0.05$). The highest positive rates for MP and a single pathogen were observed in 2023 (all $P < 0.05$). Moreover, the differences in IgM positive detection rates for a single pathogen were statistically significant across different seasons, with the highest detection rates observed in both autumn and winter (all $P < 0.05$). See **Table 2** and **Figure 4**.

Comparison of IgM positive detection rates of a single pathogen and multiple pathogens before and after the COVID-19 pandemic

The IgM positive rates detected for a single pathogen and for two or more pathogens were higher before the COVID-19 pandemic compared to after ($P < 0.05$). See **Figure 5**.

Comparison of IgM positive detection rates of LRTI pathogens before and after the COVID-19 pandemic

The IgM positive rates of MP, IFV-A, IFV-B, PIV, ADV, and RSV were all higher before the COVID-19 pandemic compared to after, with varied reduction observed in the IgM antibody positive rates for all six pathogens after the COVID-19 pandemic (all $P < 0.05$). See **Table 3**.

Comparison of clinical characteristics and IgM antibody positive rates of various LRTI pathogens between the severe pneumonia group and the non-severe pneumonia group

The severe pneumonia group showed a younger mean age and longer hospitalization duration than the non-severe pneumonia group. The IgM positive detection rate of MP was lower while that of RSV was higher in the severe pneumonia group in comparison to the non-severe pneumonia group. Moreover, the IgM-positive detection rate of a single pathogen was higher in the severe pneumonia group than that of the non-severe pneumonia group. Ratios of comorbid asthma and rhinitis cases were markedly lower when the same two groups were compared. The case distribution by year and season showed significant differences between the two groups (all $P < 0.05$). No statistically significant differences were observed in other pathogens or co-infection rates (all $P > 0.05$). See **Table 4**.

Independent risk factors for severe pneumonia by multiple logistic regression analysis

Logistic regression analysis was performed with the occurrence of severe pneumonia as the dependent variable and year, season, length of hospital stay, comorbid asthma, comorbid rhinitis, age, positive detection of MP and RSV, as well as any single pathogen as independent variables. The results revealed that age, gender, comorbid rhinitis and asthma, season, year, and length of hospital stay were independent influencing factors for the occurrence of severe pneumonia, with an AUC of 0.727 ($P < 0.05$). See **Table 5** and **Figure 6**.

Discussion

The study results showed that a total of 7,774 cases tested positive for LRTI pathogen IgM antibodies among the 25,693 enrolled children, yielding an overall positivity rate of 30.26%. The IgM positive rate for MP was 28.34%, for IFV-A was 0.12%, for IFV-B was 1.33%, for ADV was 0.24%, and for RSV was

Table 1. Comparison of IgM positive detection rates of pathogens between different clinical characteristics

Classification	Number of cases	Pathogen type						Positive cases of pathogen superimposed detection	
		Mycoplasma pneumoniae	Influenza A virus	Influenza B virus	Parainfluenza virus	Adenovirus	Respiratory syncytial virus	Single pathogen	Superposition of two or more pathogens
Gender									
Male	10964	3537 (32.26)	15 (0.14)	187 (1.71)	103 (0.94)	29 (0.26)	68 (0.62)	3631 (33.12)	145 (1.32)
Female	14729	3745 (25.42)	16 (0.11)	155 (1.05)	95 (0.64)	33 (0.22)	105 (0.71)	3861 (26.21)	137 (0.93)
χ^2		144.209	0.214	19.933	6.752	0.284	0.675	144.692	8.562
P		< 0.001	0.644	< 0.001	0.009	0.599	0.412	< 0.001	0.003
Age									
≤ 1 year group	12810	2167 (16.92)	13 (0.10)	99 (0.77)	82 (0.64)	25 (0.20)	161 (1.26)	2311 (18.04)	114 (0.89)
1~≤ 3 year group	6865	2463 (35.88)	8 (0.11)	130 (1.89)	76 (1.11)	24 (0.34)	7 (0.10)	2515 (36.64)	90 (1.31)
3~≤ 6 year group	4090	1675 (40.95)	9 (0.22)	82 (2.00)	29 (0.71)	10 (0.24)	3 (0.07)	1684 (41.17)	58 (1.42)
> 6 year group	1928	977 (50.67)	1 (0.05)	31 (1.61)	11 (0.57)	3 (0.16)	2 (0.10)	982 (50.93)	20(1.04)
χ^2		1809.707	4.211	62.201	14.234	5.071	130.095	1680.701	11.934
P		< 0.001	0.211	< 0.001	0.003	0.167	< 0.001	< 0.001	0.008
Classification									
Community-acquired pneumonia	23877	6761 (28.32)	30 (0.12)	303 (1.27)	174 (0.73)	59 (0.25)	153 (0.64)	6955 (29.13)	249 (1.04)
Bronchitis	1423	438 (30.78)	1 (0.07)	31 (2.18)	16 (1.12)	3 (0.21)	4 (0.28)	448 (31.48)	21 (1.48)
Bronchiolitis	393	83 (21.12)	0 (0.00)	8 (2.04)	8 (2.04)	0 (0.00)	16 (4.07)	89 (22.65)	12 (3.05)
χ^2		14.275	0.82	9.972	11.101	1.042	71.504	11.80	16.38
P		0.001	0.662	0.007	0.004	0.595	< 0.001	0.003	< 0.001
Total	25693	7282 (28.34)	31 (0.12)	342 (1.33)	198 (0.77)	62 (0.24)	173 (0.67)	7492 (29.16)	282 (1.10)

Note: The criterion for a IgM positive test of Mycoplasma pneumoniae was a serum antibody titer > 1:160; IgM positive detection rate of a single pathogen = (Number of IgM positive cases for a single pathogen/Total number of cases) × 100%; IgM positive co-detection rate of two or more pathogens = (Number of IgM antibody positive cases for two or more pathogens/Total number of cases) × 100%.

Table 2. Comparison of IgM positive detection rate of a single pathogen and of multiple pathogens across different years and seasons (n, %)

Classification	Case number	IgM positive detection rates of a single pathogen	IgM positive detection rates of two or more pathogens
Year			
2019	5272	1953 (37.04)	219 (4.15)
2020	4122	851 (20.65)	30 (0.73)
2021	5491	995 (18.12)	23 (0.42)
2022	4988	1241 (24.88)	9 (0.18)
2023	5820	2452 (42.13)	1 (0.02)
χ^2		1145.535	583.429
P		< 0.001	< 0.001
Season			
Spring	6540	1692 (25.87)	87 (1.33)
Summer	6362	1710 (26.88)	91 (1.43)
Autumn	6426	2173 (33.82)	59 (0.92)
Winter	6365	1917 (30.12)	45 (0.71)
χ^2		120.994	20.60
P		< 0.001	< 0.001

Note: From March to May was defined as Spring, June to August as Summer, September to November as Autumn, and December to February as Winder in accordance with meteorological changes.

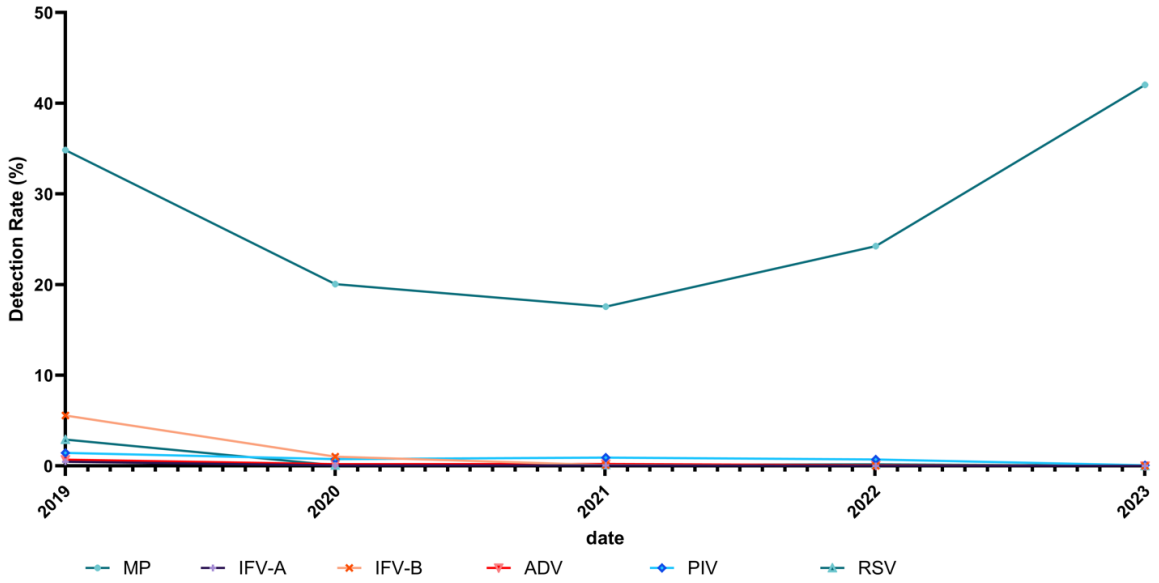

Figure 4. Changing trend of IgM positive rates of various pathogens in children in different years. Note: RSV: Respiratory Syncytial virus; ADV: Adenovirus; PIV: Parainfluenza virus; IFV-B: Influenza B virus; IFV-A: Influenza A virus; MP: Mycoplasma Pneumoniae.

0.67%. These positive detection rates were all lower than those reported by Jun-e Ma et al. and Guo et al. [8, 9]. Variations in geography, research period, subject selection, as well as the detection methods used might be the causes of this difference. Evidently, climate, population density, and distribution of medical resources in Chengdu city differ from other regions, affecting the MP transmission and its infection rates. Additionally, variations in research period and in the subject selected for various studies may also have influenced the

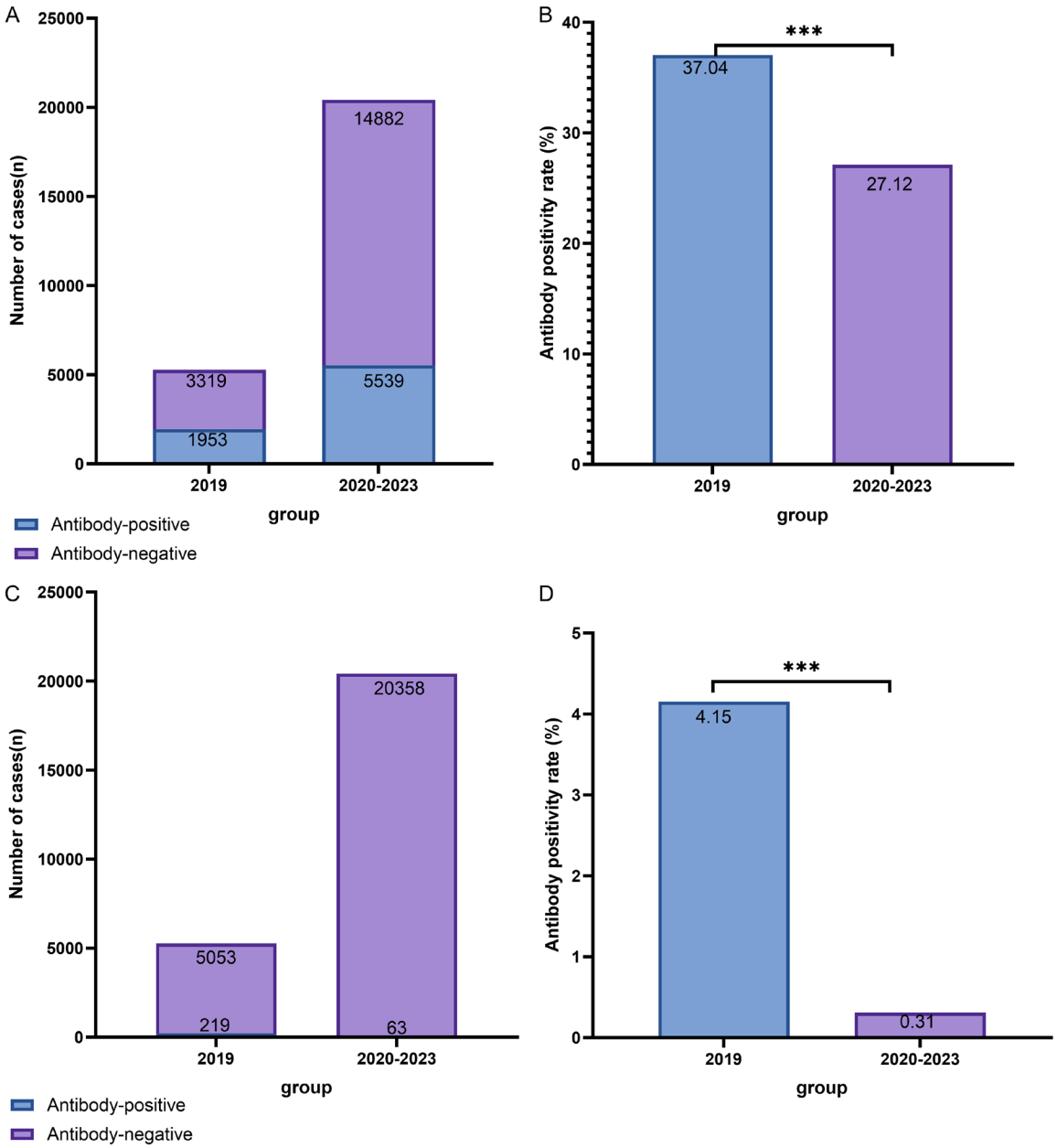

Figure 5. The superimposed IgM detection results of a single pathogen and multiple pathogens before and after COVID-19. A: IgM positive detection cases of a single pathogen before and after COVID-19; B: IgM positive rates of a single pathogen before and after COVID-19; C: IgM positive detection cases of two or more pathogens before and after COVID-19; D: IgM positive detection rate of two or more pathogens before and after COVID-19. Comparison between the two groups, $^{***}P < 0.001$.

virus detection rates. Furthermore, differences in the detection methods and standards used in studies may have led to variations in results [10, 11].

The high IgM positive detection rate for MP, IFV-B, and the high IgM positive co-detection rate of two or more pathogen in females compared to males contradicts the findings of Peer et al., but aligns with the results of Mai and Wang [12-14]. This gender difference in IgM antibody positivity rates may be in association with strong immune responses and the distinct regulatory effects of estrogen and androgen on immune responses in females [15, 16]. Moreover, genetic susceptibility and anatomical dif-

Table 3. Comparison of IgM positive detection rates of pathogens before and after COVID-19 pandemic

Year	Case number	MP	IFV-A	IFV-B	PIV	ADV	Respiratory syncytial virus
Before the COVID-19 pandemic (2019)	5272	1836 (34.83)	24 (0.46)	293 (5.56)	76 (1.44)	37 (0.70)	154 (2.92)
After COVID-19 (2020-2023)	20421	5446 (26.67)	7 (0.03)	49 (0.24)	122 (0.60)	25 (0.12)	19 (0.09)
χ^2		137.273	61.615	902.185	39.047	58.433	501.089
P		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Note: MP: Mycoplasma pneumoniae; IFV-A: Influenza A virus; IFV-B: Influenza B virus; PIV: Parainfluenza virus; ADV: Adenovirus.

Table 4. Comparison of clinical characteristics and IgM positive detection rates of different pathogens between the severe pneumonia group and none-severe pneumonia group

Index	Severe pneumonia group (n = 6093)	Non-severe pneumonia group (n = 19600)	t/χ^2	*P*
Ages (Years)	1.88 ± 2.60	2.51 ± 2.56	9.817	< 0.001
Sex			1.333	0.248
Male	3454	11275		
Female	2639	8325		
Years			367.327	< 0.001
2019	1497	3775		
2020	1271	2851		
2021	1209	4282		
2022	1170	3818		
2023	946	4874		
Season			55.071	< 0.001
Spring	1486	5054		
Summer	1541	4821		
Autumn	1370	5056		
Winter	1696	4669		
Length of hospital stay	7.06 ± 1.54	6.02 ± 1.37	46.316	< 0.001
Pathogen detection type				
MP	1560	5722	29.508	< 0.001
IFV-A	12	19	3.858	0.050
IFV-B	69	273	2.400	0.123
PIV	36	162	3.376	0.066
ADV	13	49	0.259	0.611
RSV	60	113	11.581	0.001
Infection with a single pathogen			24.996	< 0.001
Yes	1687	6087		
No	4406	13513		
Co-infection with 2 or more pathogens	58	224	1.562	0.212
Comorbid asthma				
Yes	463	2501	121.329	< 0.001
No	5630	17099		
Comorbid rhinitis				
Yes	107	1007	128.147	< 0.001
No	5986	18593		

Note: MP: Mycoplasma pneumoniae; IFV-A: Influenza A virus; IFV-B: Influenza B virus; PIV: Parainfluenza virus; ADV: Adenovirus; RSV: Respiratory Syncytial Virus.

Table 5. Influencing factors for the occurrence of severe pneumonia by logistic regression analysis

Variables	B	S.E	Wald	P	Exp (B)	95% CI lower limit	95% CI upper limit
Sex	-1.03	0.37	7.86	0.005	0.903	0.84	0.97
Length of hospital stay	0.514	0.013	1452.102	0.000	1.673	1.629	1.717
Comorbid asthma	-0.507	0.068	55.231	< 0.001	0.603	0.527	0.689
Comorbid rhinitis	-1.093	0.13	70.97	< 0.001	0.335	0.26	0.432
Age	-0.099	0.008	138.776	< 0.001	0.905	0.891	0.921
Year_2020	-0.331	0.044	57.297	< 0.001	0.718	0.659	0.782
Season_Summer	-0.083	0.02	17.878	< 0.001	0.921	0.886	0.957
Constants	-3.721	1.03	1302.245	< 0.001	0.024		

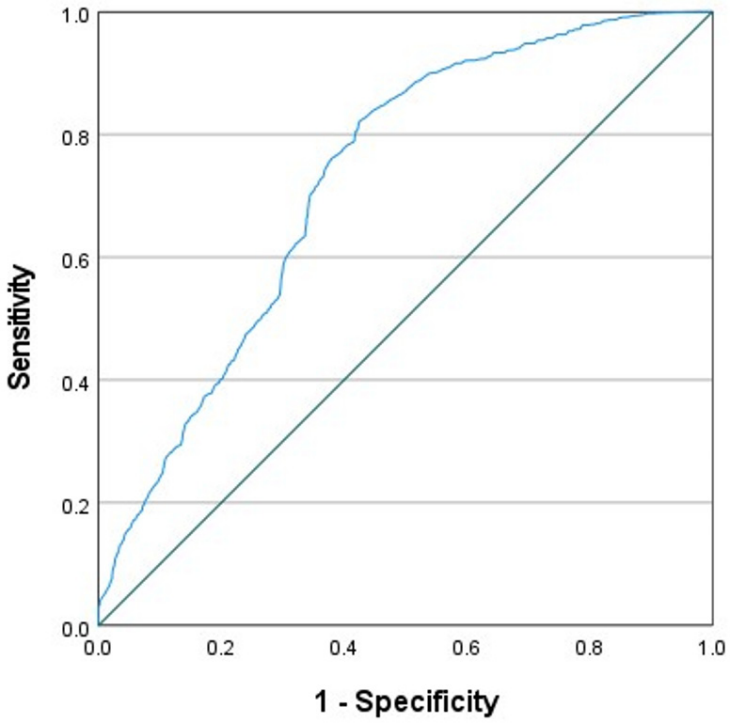

Figure 6. The ROC curve.

ferences could make female children more vulnerable to get infected by certain pathogens in comparison to male children.

The high IgM positive detection rates of MP in older groups, with the lowest detection rate in children who were no older than 1 year, was consistent with the findings of Choo et al. [17]. In contrast, the IgM positive detection rate of RSV was the highest in the same aforementioned age group, which aligned with the results of Suss et al. [18] and Bechini et al. [19]. This age-related contrast in the positivity rates might be attributed to various factors, including pathogen characteristics, immune system development, social behavior, and environmental exposure [20, 21]. MP primarily spreads through respiratory droplets and human contact. Children over 3 years old, who undergo frequent interactions in collective settings such as a daycare center or school, are susceptible to pathogen infection, leading to a high infection rate. In addition, RSV is highly contagious. Children under 1 year old, whose immune systems are still developing, are more susceptible to infection upon first exposure. From a clinical treatment perspective, the age-related differences in pathogen distribution have important implications for the formulation of diagnostic and treatment strategies. For older children, the high IgM positive detection rate of MP suggests that clinicians should prioritize considering MP infection when evaluating children manifesting LRTI symptoms. Early targeted tests (such as IgM antibody test or PCR) should be conducted to initiate appropriate treatment with macrolide antibiotics in a timely manner. For children under 1 year old, the high IgM positive detection rate of RSV indicates that clinicians should be vigilant for the possibility of bronchiolitis, especially during winter when RSV is prevalent. Our study also found that the IgM positive detection rate of RSV was higher in the severe pneumonia group compared to the non-severe pneumonia group, suggesting that children infected with RSV were more likely to progress to severe conditions, which aligns with the results reported by

Treston et al [22]. Therefore, clinicians should identify high-risk populations for severe conditions and rationalize medical resource allocation to reduce the incidence of severe cases and mortality [22].

Since 2019, the IgM positive detection rates of MP, RSV, ADV, IFV-A and a single pathogen infection have decreased, with MP showing the lowest IgM positive detection rate between 2020 and 2022. However, in 2023, it rebounded to the highest level, even surpassing the rate of 2019. This phenomenon may be attributed to multiple factors. Firstly, the strict public health measures implemented during the COVID-19 pandemic, such as wearing masks, social distancing, and reduced social interactions, not only suppressed the transmission of the SARS-CoV-2 virus but also significantly curtailed the spread of other respiratory tract pathogens. Moreover, while medical resources and clinical practices were primarily allocated to the detection of COVID-19 virus, less attention was paid to the detection of other respiratory tract pathogens. However, as pandemic control measures were relaxed and life returned to normal, certain populations, having been largely isolated from pathogens for an extended period, developed an “immune gap”. This enabled pathogens to spread easily when they reemerged.

Among different seasons, the IgM positive detection rate of a single pathogen was higher in autumn and winter compared to spring and summer. Different pathogens exhibit varied seasonality features. In winter, the climate gets cold and dry, therefore it creates a suitable environment for viruses to grow and spread. Moreover, people tend to stay indoors due to the coldness, resulting in more close human contact and, consequently, the risk of respiratory tract pathogen infection. The impact of the flu season may also contribute to high IgM positive detection rates of other pathogens, particularly in cases of occurrence of co-infection related to influenza.

The IgM positive detection rates of MP, IFV-B, PIV and RSV differed markedly among various LRTI, indicating that different pathogens may be associated with distinct types of LRTI. RSV is the primary pathogen in bronchiolitis, while MP is commonly found in bronchitis. This finding has significant implications for clinical diagnosis and treatment. From a clinical perspective, understanding the association between pathogens and infection type can help optimize treatment strategies. For children with bronchiolitis caused by RSV, clinicians should focus on supportive therapies, such as oxygen therapy, nebulized bronchodilators, and, when necessary, corticosteroids. For critically ill children, antiviral medications may be considered, especially in immunocompromised patients. In the case of bronchitis caused by MP infection, early diagnosis and prompt initiation of macrolide antibiotics are crucial to reduce complications and shorten disease course. Further analysis revealed that gender, age, time period before or after COVID-19, and the LRTI types were all independent factors influencing the IgM positive detection rate of a single pathogen.

The study further analyzed the clinical characteristics and IgM positivity rates of different pathogens in children with severe pneumonia. In this study, 25.6% of patients with severe pneumonia were MP positive, significantly lower than the 29.2% in the non-severe group, suggesting that while MP infection is highly contagious, it is less likely to progress to a severe condition. The RSV positive rate was markedly higher in the severe group than that of the non-severe group, reflecting the propensity of RSV infection for severe outcomes and heightened risk for younger children. This heightened severe RSV pneumonia susceptibility for younger patients can be attributed to their immature immune systems. As children grow older, their exposure to various pathogens increases, leading to the formation of immune response memory, and as a result, improved tolerance to treatment and reduced occurrence of severe conditions. This result underscored the need for heightened clinical vigilance for LRTI children under 1 year old, particularly during RSV transmission seasons. From 2019 to 2023, the severe pneumonia group showed a consistent declining trend, while the non-severe pneumonia group rebounded significantly after 2020 (the peak pandemic year) and reached its zenith in 2023. This phenomenon may stem from the effects of COVID-19 public health interventions (e.g., wearing masks and social distancing) on the transmission of respiratory tract pathogens. The results of logistic regression analysis revealed that children who had asthma presented a reduced risk of severe

pneumonia. This may be attributed to a protective mechanism in specific asthma phenotypes in response to pulmonary infections or possibly related to better home management and increased attention given to asthmatic children, leading them to receive prompt medical care when they develop LRTI [23].

In summary, the IgM positive detection rates of LRTI pathogens in children in Chengdu city exhibited seasonal, age and infection type-related differences. The characteristics of certain pathogen IgM antibodies may be associated with specific infection types. Clinicians should combine epidemiologic data with patient symptoms to select appropriate diagnostic tests, thereby optimizing treatment plans and improving therapeutic outcomes.

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Disclosure of conflict of interest

None.

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