Pediatr Pol 2026; 101 (2): 113-121
DOI: https://doi.org/10.5114/polp.2026.162932
Submitted: 04.12.2025, Accepted: 28.02.2026, Published: 30.06.2026

PEDIATRIA Polska
PISMO POLSKIEGO TOWARZYSTWA PEDIATRYCZNEGO
Polish Journal of PAEDIATRICS
OFFICIAL JOURNAL OF POLISH SOCIETY OF PAEDIATRICS

ORIGINAL PAPER

Epidemiology and clinical course of influenza in hospitalized children: a single-center retrospective study during one epidemic season

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ABSTRACT

Introduction: Influenza is exceedingly common in children worldwide and places a substantial burden on healthcare systems. We aimed to evaluate the epidemiology, clinical course, and laboratory characteristics of seasonal influenza in hospitalized children during a single infection season.

Material and methods: We analyzed data from children with laboratory-confirmed influenza hospitalized at a single center from September 2022 to August 2023. The clinical course was compared across three age groups (< 2, 2–7, and > 7 years) and by influenza type (A or B).

Results: Among 1,344 hospitalized children, 150 (11.2%) had laboratory-confirmed influenza. Ninety children (61.2%) were infected with influenza A and 57 (38.8%) with influenza B. Three patients with dual A/B infection were excluded, leaving 147 children for the final analysis. Their mean age was 3.7 ±3.3 years (range 1 month –14 years), and 81 (55.1%) were male. Most patients were < 7 years old (85.0%). Children with influenza A were younger (3.1 ±3.0 vs. 4.8 ±3.5 years, $p = 0.014$), had higher C-reactive protein and white blood cell counts ($p < 0.05$). Bronchiolitis occurred more often in children with influenza A (14.4% vs. 1.7%, $p = 0.011$). In contrast, children with influenza B more frequently experienced headaches (19.3% vs. 6.7%, $p = 0.020$), myositis (24.4% vs. 5.5%, $p < 0.001$) and laboratory abnormalities, including leukopenia (45.6% vs. 22.2%, $p = 0.005$), thrombocytopenia (22.8% vs. 2.2%, $p < 0.001$), and increased aspartate aminotransferase > 3× the upper reference limit (22.8% vs. 4.4%, $p < 0.001$). The most common complications were pneumonia (17.7%) and otitis media (16.3%), regardless of the type of influenza. Most children were unvaccinated (98.6%). The peak incidence occurred in December, with influenza A predominating from October to January and influenza B prevailing during the spring months ($p < 0.001$).

Conclusions: Influenza A and B had a broadly similar clinical course; however, the virus type and patient age shaped complication patterns, underscoring the importance of age-adapted clinical assessment and improved preventive strategies in children.

KEY WORDS:

children, pediatrics, seasonal influenza, influenza complications.

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INTRODUCTION

Influenza is an acute viral respiratory infection caused by influenza viruses that circulate worldwide. Infections with influenza types A and B are among the leading causes of morbidity, hospitalization, and mortality associated with seasonal influenza, particularly in the pediatric population [1]. Globally, approximately 2,224,000 hospitalizations each year (95% uncertainty interval 738,000–5,979,000) are attributable to influenza-associated lower respiratory tract infections in children younger than 5 years, with an estimated 28,000 deaths annually in the entire pediatric population [1, 2].

For most patients, influenza is a self-limiting infection, with symptoms resolving within several days. However, complications may occur in both previously healthy individuals and those with chronic illnesses, with the highest risk observed in younger children with comorbidities [3, 4]. It has been previously demonstrated that 41% of influenza-positive children experience some form of influenza-associated complications, of which primary viral or secondary bacterial pneumonia, seizures, other bacterial infections (sinusitis or otitis media), and exacerbation of existing respiratory conditions, such as asthma, were the most commonly observed [4–6].

Despite the availability of safe and effective vaccines as a preventive strategy, seasonal influenza epidemics remain a significant burden on healthcare systems worldwide, affecting both low- and high-income countries [7, 8]. Although data on influenza infections among children in Poland are available, studies focusing on the clinical course, complications, and laboratory findings during individual epidemic seasons remain relatively limited. Therefore, this study aimed to provide a detailed analysis of the epidemiology, clinical presentation, complications, and laboratory characteristics of seasonal influenza in children hospitalized during the 2022/2023 season at a single pediatric center in Poland.

MATERIAL AND METHODS

PATIENTS

This retrospective, single-center study included patients under 18 years of age hospitalized with laboratory-confirmed influenza at the Department of Pediatric Infectious Diseases in Cracow, Poland, between September 2022 and August 2023. Data were obtained from electronic medical records. For each patient, demographic data (age, sex), comorbidities, influenza vaccination status within the preceding year, clinical symptoms, seasonal distribution, length of hospitalization, treatment, and complications were recorded. Comorbidities included conditions associated with a higher risk of severe influenza (pulmonary, cardiac, neurologic, genetic disorders, immunodeficiencies, prematurity, low birth weight, and allergies). Complications were defined as new medical conditions developing during the course of influenza which deviated from the typical self-limited pattern. Pneumonia was defined as an acute lower respiratory tract infection diagnosed based on compatible clinical features and/or radiological findings. Otitis media was defined as an acute middle ear infection diagnosed clinically and confirmed by typical otoscopic findings. Hospitalization was also indicated in patients without documented complications due to young age, poor general condition, underlying comorbidities, or the need for close clinical monitoring or adverse social circumstances limiting adequate home care.

All children presenting with influenza-like illness (sudden fever, respiratory or gastrointestinal symptoms, headaches, muscle and joint pain) underwent rapid antigen testing for influenza A and B using a nasopharyngeal swab (Influenza A+B CerTest, BIOTEC, Saragossa, Spain). In clinically suggestive cases with a negative antigen test, influenza infection was verified with reverse-transcription polymerase chain reaction (Fast-Track Diagnostics, Châtel-Saint-Denis, Switzerland) performed on a nasopharyngeal swab.

In cases where the clinical condition suggested a possible coinfection, additional microbiological testing was performed. Group A Streptococcus (*Streptococcus pyogenes*; GAS) infection was assessed using a throat swab. *Mycoplasma pneumoniae* and *Chlamydia pneumoniae* infections were evaluated using serological IgM/IgG ELISA assays. Detection of other viral pathogens, including adenovirus, metapneumovirus, rhinovirus, respiratory syncytial virus, severe acute respiratory syndrome coronavirus 2, was performed using multiplex polymerase chain reaction testing with the BioFire® FilmArray® system (bioMérieux).

The exclusion criteria were as follows: simultaneous detection of influenza virus types A and B. The clinical course was compared across three age groups: < 2, 2–7, and > 7 years. The cut-off at 7 years reflects the beginning of formal school attendance in our healthcare setting and was additionally supported by the age distribution of the study population, which allowed for statistically balanced comparison groups. In a separate analysis, influenza A and B cases were compared.

LABORATORY INVESTIGATION

Upon admission, all patients underwent routine laboratory evaluation, including complete blood count, electrolytes, and renal and liver function tests. Liver function tests included alanine aminotransferase (ALT) and aspartate aminotransferase (AST). Additional tests included coagulation profile, C-reactive protein (CRP), procalcitonin, and creatine kinase (CK). Neutropenia was defined as an absolute neutrophil count < 1500/µl, thrombocytopenia as platelets count < 140 000/µl, and leukopenia

as a white blood cell count (WBC) below the reference range for age. Elevated liver enzymes were defined as ALT and/or AST ≥ 3 × the upper reference limit (URL), and elevated CK as ≥ 2 × the URL for age and sex.

STATISTICAL ANALYSIS

Categorical variables are presented as numbers (*n*) and percentages (%). Continuous variables are expressed as mean ± standard deviation or median with interquartile range (IQR), as appropriate. The distribution of variables was assessed using the Shapiro-Wilk test, and equality of variances with Levene's test. Differences between two groups were analyzed using the Student's *t*-test or Welch's *t*-test, depending on variance equality, or the Mann-Whitney *U* test, as appropriate. For multiple group comparisons, ANOVA or the Kruskal-Wallis test was applied according to data distribution. Nominal variables were compared using the Pearson χ^2 test or Fisher's exact test, as appropriate. A two-sided p-value < 0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

BASELINE CHARACTERISTICS

Baseline characteristics of the study group are presented in Table 1. A total of 1,344 children were hospitalized during the study period, of whom 150 (11.2%) were diagnosed with influenza. Three patients with simultaneous detection of influenza A and B were excluded, leaving 147 children for analysis. Influenza A was confirmed in 90 patients (61.2%) and influenza B in 57 patients (38.8%). Only 2 children (1.4%) had received influenza vaccination. The mean age of the study group was 3.7 ±3.3 years (range 1 month – 14 years), and 81 (55.1%) were male. At least one chronic medical condition was present in 56 children (38.1%), most commonly allergy (13.6%) and a history of low birth weight (12.2%). As shown in Table 2, the majority of patients (n = 125, 85.0%) were < 7 years of age. Influenza cases peaked in December (n = 46, 31.3%), with no cases recorded from June to September (Figure 1).

LABORATORY FINDINGS

The most frequent laboratory abnormalities were leukopenia (n = 46, 31.3%), elevated AST activity (n = 42, 28.6%), neutropenia (n = 34, 23.1%), elevated CK (n = 23, 15.6%), and thrombocytopenia (n = 15, 10.2%). Leukopenia, elevated AST, and elevated CK occurred significantly more often in children > 2 years of age (p < 0.05), while platelet counts were significantly lower in children > 7 years compared with those < 2 years (p = 0.028) (Table 2).

TABLE 1. Baseline characteristics of the study group

Parameters	All patients (N = 147)
Age [years]	3.7 ±3.3
Sex, *n* (%)	
Male	81 (55.1)
Female	66 (44.9)
Influenza type, *n* (%)	
A	90 (61.2)
B	57 (38.8)
Comorbidities, *n* (%)	56 (38.1)
Comorbidity type, *n* (%)	
Allergy	20 (13.6)
Atopic dermatitis	8 (5.4)
Allergic rhinitis	6 (4.1)
Cow's milk protein allergy	6 (4.1)
History of low birth weight	18 (12.2)
History of prematurity	11 (7.5)
Neurological diseases	10 (6.8)
Asthma	9 (6.1)
Genetic disorders	3 (2.0)
Down syndrome	1 (0.7)
Noonan syndrome	1 (0.7)
Coffin-Siris syndrome	1 (0.7)
Congenital heart defect	2 (1.4)
Immunodeficiencies	1 (0.7)

CLINICAL COURSE – SYMPTOMS

As shown in Table 2, the most common presenting symptoms were fever (93.3%), rhinitis (61.9%), and cough (60.5%). Gastrointestinal symptoms, including vomiting, diarrhea, and poor feeding, were also frequently reported (59.2%). Symptom distribution differed by age. A higher proportion of children < 2 years had conjunctivitis compared with those > 7 years (p = 0.049). In contrast, muscle and joint pain was significantly more common in older children (< 2 vs. 2–7 years, p = 0.016; < 2 vs. > 7 years, p < 0.001; 2–7 vs. > 7 years, p = 0.002). Sore throat was also more frequently reported in children > 2 years (< 2 vs. 2–7 years, p = 0.016; < 2 vs. > 7 years, p = 0.003). The least common symptom was headaches (11.6%), which were predominantly reported in children > 7 years (> 7 vs. < 2 years of age, p < 0.001; > 7 vs. 2–7 years, p < 0.001).

CLINICAL COURSE – COMPLICATIONS AND CO-INFECTIONS

Influenza-associated complications occurred in 103 children (70.7%). The most frequent complications, aside from dehydration (40.8%), were pneumonia (17.7%),

TABLE 2. Clinical course of influenza in relation to age groups

Parameters	All patients ($N = 147$)	< 2 years old ($n = 48$)	2–7 years old ($n = 77$)	> 7 years old ($n = 22$)	*p*-value
Symptoms, *n* (%)					
Fever	138 (93.3)	42 (87.5)	74 (96.1)	22 (100)	0.064
Rhinitis	91 (61.9)	27 (56.3)	53 (68.8)	11 (55.0)	0.170
Cough	89 (60.5)	30 (62.5)	49 (63.6)	10 (45.5)	0.289
Gastrointestinal disturbances	87 (59.2)	32 (66.7)	44 (57.1)	11 (55.0)	0.365
Vomiting	56 (38.1)	18 (37.5)	31 (40.3)	7 (31.8)	0.768
Diarrhea	34 (23.1)	15 (31.3)	14 (18.2)	5 (22.7)	0.241
Poor feeding	64 (43.5)	26 (54.2)	29 (37.7)	9 (40.9)	0.121
Muscle and joint pain	29 (19.7)	2 (4.2)	15 (19.5)[a]	12 (54.5)[b,c]	< 0.001
Conjunctivitis	26 (17.7)	13 (27.1)	12 (15.6)	1 (4.5)[b]	0.042
Sore throat	24 (16.3)	2 (4.2)	15 (19.5)[a]	7 (31.8)[b]	0.005
Headache	17 (11.6)	0 (0)	5 (6.5)	12 (54.5)[b,c]	< 0.001
Co-infections, *n* (%)	32 (21.8)	9 (18.8)	16 (20.8)	7 (31.8)	0.448
GAS pharyngitis	13 (40.6)	1 (11.1)	9 (56.2)	3 (42.8)	0.127
MP/CP pneumonia	5 (15.6)	0 (0.0)	2 (12.5)	3 (42.9)[b]	0.012
Viral pathogens*	14 (43.7)	8 (88.8)	5 (31.3)	1 (14.3)	0.117
Complications, *n* (%)	103 (70.7)	30 (62.5)	60 (77.9)	13 (59.1)	0.120
Pneumonia	26 (17.7)	6 (12.5)	18 (23.4)	2 (9.1)	0.145
Otitis media	24 (16.3)	7 (14.6)	17 (22.1)	0 (0)c	0.008
Seizures	20 (12.9)	5 (10.4)	12 (15.6)	3 (13.6)	0.707
Myositis	19 (12.9)	1 (2.1)	12 (16.5)[a]	6 (27.3)[b]	0.004
Bronchiolitis	14 (9.5)	12 (25.0)	2 (2.6)[a]	0 (0)[b]	< 0.001
Laryngitis	11 (7.5)	4 (8.3)	6 (7.8)	1 (4.5)	0.829
Sinusitis	6 (4.1)	1 (2.1)	4 (5.2)	1 (4.5)	0.660
Bronchitis	6 (4.1)	0 (0)	5 (6.5)	1 (4.5)	0.083
Dehydration	60 (40.8)	24 (50.0)	27 (35.1)	9 (40.9)	0.255
Treatment, *n* (%)					
Oseltamivir use	143 (97.3)	47 (97.9)	76 (98.7)	20 (90.9)	0.843
Antibiotic use	57 (38.8)	13 (27.1)	38 (49.4)[a]	6 (27.3)	0.022
Days of hospital stay	4.0 (4.0–5.5)	5.0 (4.0–6.0)	4.0 (4.0–5.5)	4.0 (3.0–5.0)	0.220
Laboratory results, *n* (%)					
Leukopenia	46 (31.3)	3 (6.3)	30 (39.0)[a]	13 (59.1)[b]	< 0.001
Neutropenia	34 (23.1)	11 (22.9)	15 (19.5)	8 (36.4)	0.259
Thrombocytopenia	15 (10.2)	2 (4.2)	8 (10.4)	5 (22.7)[b]	0.050
AST > URL	42 (28.6)	5 (10.4)	28 (36.4)[a]	9 (40.9)[b]	0.005
AST > 3 × URL	17 (11.6)	1 (2.1)	10 (13.0)[a]	6 (27.3)[b]	0.006
ALT > URL	19 (12.9)	5 (10.4)	8 (10.4)	6 (27.3)	0.122
ALT > 3 × URL	4 (2.7)	1 (2.1)	1 (1.3)	2 (9.1)	0.137
CK > 2 × URL	23 (15.6)	2 (4.2)	14 (18.2)[a]	7 (31.8)[b]	0.018
CRP [mg/l]	4.7 (1.3–19.8)	4.5 (1.4–15.8)	5.1 (1.9–31.2)	1.6 (0.6–6.5)	0.030
PLT [10^3/µl]	229 (184–303)	286 (229–349)	218 (178–268)	188 (165–223)	< 0.001

ALT – alanine aminotransferase, AST– aspartate aminotransferase, CK – creatine kinase, CRP – C-reactive protein, GAS – Group A Streptococcus, MP/CP – Mycoplasma/Chlamydia pneumoniae, PLT – platelet count, URL – upper reference limit

[a] $p < 0.05$ between < 2 and 2–7 years of age

[b] $p < 0.05$ between < 2 and > 7 years of age

[c] $p < 0.05$ between 2–7 and > 7 years of age

** Viral pathogens: adenovirus, metapneumovirus, rhinovirus, respiratory syncytial virus, severe acute respiratory syndrome coronavirus 2, varicella zoster virus*

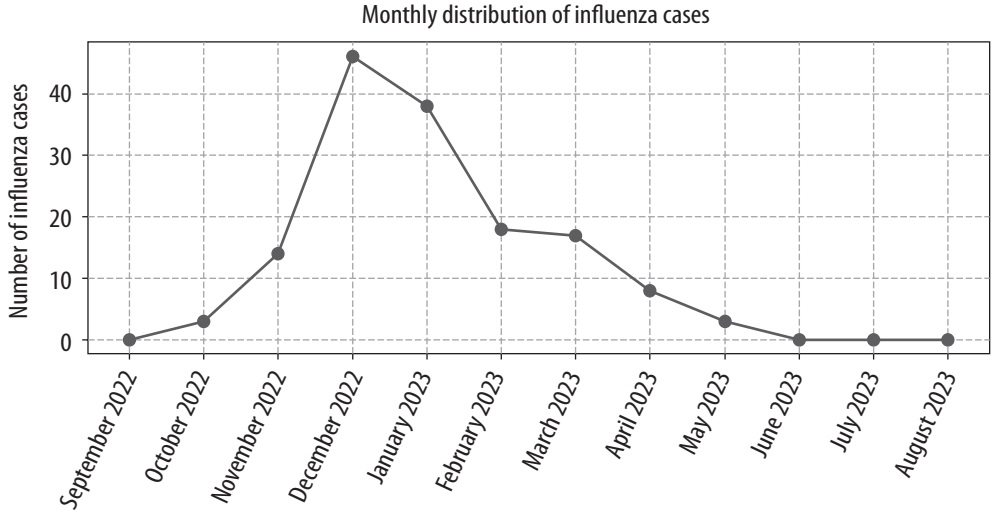

FIGURE 1. Monthly distribution of influenza cases

and otitis media (16.3%). Overall complication rates did not differ significantly between age groups ($p = 0.120$). However, the type of complication varied by age. Bronchiolitis was significantly more common in children < 2 years compared with those aged 2–7 and > 7 years ($p < 0.001$ and $p = 0.013$, respectively). Myositis occurred more often in children > 2 years (2–7 vs. < 2 years, $p = 0.016$; > 7 vs. < 2 years, $p = 0.003$). Otitis media was more frequent in children aged 2–7 years compared with the oldest group ($p = 0.015$). Co-infections were identified in 32 children (21.8%), most frequently GAS pharyngitis (8.8%). There was a trend toward more frequent complications in patients with co-infections (84.4% vs. 66.9%, $p = 0.055$).

CLINICAL COURSE – TREATMENT

Almost all hospitalized children ($n = 143$, 97.3%) received oseltamivir in accordance with hospital guidelines. Four patients (2.7%) did not receive antiviral therapy due to rapid spontaneous recovery. Antibiotic therapy was required in 57 children (38.8%). Empirical antibiotics were initiated mainly in cases of suspected or confirmed bacterial co-infection or in the presence of respiratory complications associated with influenza. Children with pneumonia, otitis media, and sinusitis, as well as those with bacterial or viral co-infections, significantly more often required antibiotic treatment ($p < 0.001$, $p < 0.001$, $p = 0.002$, and $p < 0.001$, respectively). Antibiotic use was also more frequent in patients with elevated inflammatory markers, including CRP, WBC count, and fibrinogen concentration ($p < 0.001$, $p = 0.047$, and $p < 0.001$, respectively). In addition, antibiotics were more commonly administered to children presenting with cough and to those without myositis ($p = 0.003$ and $p = 0.007$, respectively). Importantly, no association was observed between the presence of chronic medical conditions and the need for antibiotic therapy ($p = 0.650$).

The median length of hospital stay was 4.0 days (IQR 4.0–5.5). Length of stay was also prolonged in children with complications ($p = 0.050$) and in those with a co-infection ($p = 0.007$), but was not associated with age ($p = 0.220$) or comorbidities ($p = 0.969$). Oxygen therapy was required in 6 cases (4.1%) due to decreased oxygen saturation (< 90–92%) during bronchiolitis ($n = 4$, 2.7%) or pneumonia ($n = 2$, 1.4%). Hospitalization was significantly longer in children who received antibiotics than in those who did not (5.0 [IQR 4.0–6.5] vs. 4.0 [IQR 3.8–5.0], $p < 0.001$) (Table 2). No child required transfer to the Intensive Care Unit, mechanical ventilation, or died during hospitalization.

COMPARISON OF INFLUENZA A AND B

Characteristics of patients with influenza A and B are presented in Table 3. Children infected with influenza A were younger than those with influenza B (3.1 ±3.0 years vs. 4.8 ±3.5 years, $p = 0.014$). The age-related distribution of seasonal influenza caused by types A and B is shown in Figure 2.

Children with influenza A had higher CRP and WBC levels and more frequently developed bronchiolitis compared with those infected with influenza B (CRP: 30.4 [3.7–71.1] vs. 5.0 [0.6–54.3], $p = 0.047$; WBC: 8.6 [5.4–13.1] vs. 5.8 [3.9–8.6], $p = 0.026$; bronchiolitis: 14.4% vs. 1.7%, $p = 0.011$).

In contrast, influenza B was associated with a higher frequency of muscle and joint pain, headache, and myositis (36.8% vs. 8.9%, $p < 0.001$; 19.3% vs. 6.7%, $p = 0.020$; 24.4% vs. 5.5%, $p < 0.001$, respectively). Leukopenia, thrombocytopenia, elevated aminotransferases (AST > 3 × URL and ALT > URL), and elevated CK (> 2 × URL) were also significantly more common in influenza B cases (45.6% vs. 22.2%, $p = 0.005$; 22.8% vs. 2.2%, $p < 0.001$; 22.8% vs. 4.4%, $p < 0.001$; 21.1% vs. 7.8%, $p = 0.024$; 28.1% vs. 7.7%, $p = 0.002$, respectively).

Seasonal variation differed by virus type: influenza A predominated from October to January, whereas influenza B was more frequently detected during the spring months ($p < 0.001$) (Figure 3).

TABLE 3. Comparison of patient groups by influenza type

Parameters	Type A ($n = 90$)	Type B ($n = 57$)	p-value
Age [years]	3.1 ± 3.0	4.8 ±3.5	0.014
Male, *n* (%)	48 (53.3)	33 (57.9)	0.588
Symptoms, *n* (%)			
Fever	84 (93.3)	54 (94.7)	0.729
Rhinitis	56 (62.2)	35 (61.4)	0.921
Cough	56 (62.2)	33 (57.9)	0.601
Muscle and joint pain	8 (8.9)	21 (36.8)	< 0.001
Conjunctivitis	17 (18.9)	9 (15.8)	0.631
Sore throat	13 (14.4)	11 (19.3)	0.438
Headache	6 (6.7)	11 (19.3)	0.020
Vomiting	39 (43.3)	17 (29.8)	0.100
Diarrhea	23 (25.6)	11 (19.3)	0.381
Co-infections, *n* (%)	21 (23.3)	11 (19.3)	0.564
Complications, *n* (%)	82 (91.1)	53 (93.0)	0.696
Pneumonia	16 (17.8)	10 (17.5)	0.971
Otitis	17 (18.9)	7 (12.2)	0.291
Seizures	12 (13.3)	8 (14.0)	0.904
Myositis	5 (5.5)	14 (24.5)	< 0.001
Bronchiolitis	13 (14.4)	1 (1.7)	0.011
Laryngitis	7 (7.8)	4 (7.0)	0.864
Sinusitis	5 (5.5)	1 (1.7)	0.256
Bronchitis	3 (3.3)	3 (5.2)	0.565
Dehydration	41 (45.5)	19 (33.3)	0.142
Laboratory results, *n* (%)			
Leukopenia	20 (22.2)	26 (45.6)	0.005
Neutropenia	18 (20.0)	16 (28.1)	0.314
Thrombocytopenia	2 (2.2)	13 (22.8)	< 0.001
CK > 2 × URL	7 (7.7)	16 (28.1)	0.002
AST > URL	21 (23.3)	21 (36.8)	0.093
AST > 3 × URL	4 (4.4)	13 (22.8)	< 0.001
ALT > URL	7 (7.8)	12 (21.1)	0.024
ALT > 3 × URL	2 (2.2)	2 (3.5)	0.641
CRP [mg/l]	30.4 (3.7–71.1)	5.0 (0.6–54.3)	0.047
WBC [× 103/µl]	8.6 (5.4–13.1)	5.8 (3.9–8.6)	0.026
Treatment, *n* (%)			
Antibiotic use	38 (42.2)	19 (33.3)	0.281
Oseltamivir use	87 (96.7)	56 (98.2)	0.566
Days of hospital stay	5.0 (4.0–6.8)	4.0 (4.0–6.0)	0.831

ALT – alanine aminotransferase, AST – aspartate aminotransferase, CK – creatine kinase, CRP– C-reactive protein, PLT – platelet count, URL – upper reference limit

DISCUSSION

This study provides a detailed account of the frequency, clinical course, and laboratory features of laboratory-confirmed influenza A and B infections in children hospitalized in a temperate-climate setting during the 2022/2023 season. By analyzing three age groups and comparing the two major influenza types, we were able to highlight how both patient age and virus type shape the clinical presentation, complication profile, and laboratory abnormalities.

Hospitalizations predominantly involved previously healthy infants and young children under 7 years of age, who represented 85% of cases. These findings align with previous reports and reflect the recognized role of young children as key drivers of influenza transmission, attributable to their immature immune responses, high frequency of social contacts, and limited capacity to implement infection-control measures [5, 9–12]. Despite clear recommendations for annual influenza vaccination in children over six months of age [13], vaccination uptake remains very low in Poland. In our cohort, only 1.4% of influenza-positive children had received the vaccine, paralleling national figures of 2% among children aged 0–4 years and 1.9% among those aged 5–14 years during the 2023/2024 season [14]. Earlier data also show that this low coverage has been a persistent trend, with vaccination rates of 1–1.9% reported among children under five years of age in population-based studies before the pandemic [15]. This persistent gap between recommendations and real-world implementation likely contributes to the continued burden of influenza-related hospitalizations and highlights the need for intensified public health efforts to improve vaccination uptake.

The overall symptom profile observed in our cohort was consistent with the established clinical spectrum of pediatric influenza, dominated by fever and respiratory symptoms, with frequent gastrointestinal involvement [10, 16, 17]. Importantly, symptom presentation varied with age, highlighting the need for age-adjusted clinical assessment. Younger children more often presented with conjunctivitis and gastrointestinal symptoms, whereas older children more frequently reported headaches, myalgia, and sore throat. These differences likely reflect not only biological variation but also the limited ability of younger children, particularly those under two years of age, to verbalize subjective symptoms, a phenomenon previously described by Wolf and Antoon [17]. Gastrointestinal involvement frequently led to dehydration requiring intravenous rehydration, underscoring the systemic nature of influenza beyond the respiratory tract [14, 18].

The observed seasonal distribution of influenza types is consistent with surveillance data from temperate-climate regions. Specifically, influenza A predominated during the winter months, whereas influenza B was more frequently observed in spring, consistent with prior reports [12]. According to the European Centre for Disease Prevention and Control, influenza activity during the 2022/2023 season in European Union countries approached pre-pandemic levels and was characterized by an earlier onset of the seasonal epidemic and an earlier peak in test positivity compared with the preceding four seasons [19, 20]. Although influenza A(H3N2) was the predominant strain across

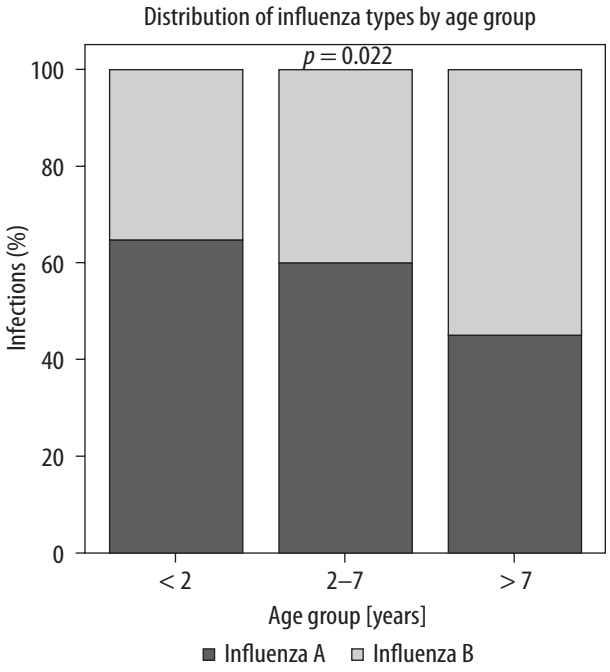

FIGURE 2. Distribution of influenza types by age group

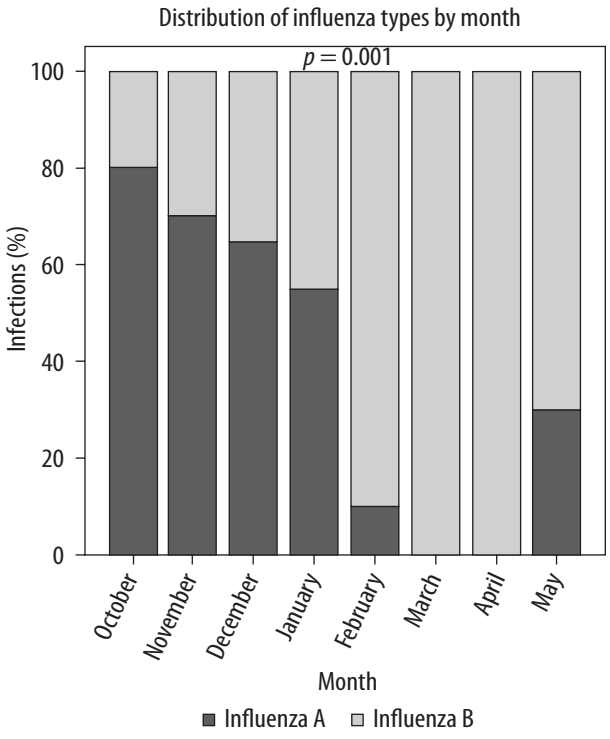

FIGURE 3. Distribution of influenza types by month

Europe, increased circulation of A(H1N1)pdm09 and influenza B viruses was also reported [19, 20]. Influenza B viruses accounted for approximately one third of detected cases at the European level, nearly all belonging to the B/Victoria lineage [19]. Similarly, in our study, influenza B represented a substantial proportion of cases. Although influenza A subtypes and influenza B lineages were not determined, this proportion was comparable to European reports, suggesting broader regional epidemiological trends rather than center-specific variation.

The proportion of complications observed in our cohort (70.7%) was markedly higher than the approximately 41% reported in broader pediatric populations [4–6]. This discrepancy likely reflects the hospitalized nature of the study population, which is inherently enriched for children with more severe disease, as well as potential seasonal variability in viral virulence. Pneumonia emerged as the most frequent complication, consistent with Dawood *et al.* [21]. Importantly, the type of complication varied with age: younger children were more likely to develop bronchiolitis and otitis media, whereas myositis predominated among older children, mirroring previous observations [5, 16]. Co-infections were relatively common and clinically relevant, most frequently manifesting as GAS pharyngitis, and were associated with longer hospitalization and more frequent antibiotic use, underscoring the clinical relevance of co-infections in pediatric influenza [21, 22].

From a therapeutic perspective, nearly all hospitalized children received antiviral treatment in accordance with current recommendations for hospitalized or high-risk pediatric patients [6, 20]. Antibiotic therapy was not administered routinely but was largely reserved for patients with suspected bacterial co-infection or influenza-related complications. The association between antibiotic use and prolonged hospitalization likely reflects greater disease severity rather than a direct effect of antibiotic treatment itself, consistent with earlier observations by Dawood *et al.* [21]. These findings reinforce current guidance advocating prompt antiviral therapy and judicious use of antibiotics in carefully selected cases [23].

The observed differences between influenza A and B likely reflect age-related immune responses and tissue tropism, helping to contextualize age-related patterns observed in pediatric influenza and providing insight into distinct host-virus interactions. Children with influenza A were younger, exhibited higher CRP and WBC levels, and more frequently developed bronchiolitis, consistent with the greater inflammatory response often linked to influenza A [24]. Conversely, influenza B was associated with a higher frequency of muscle and joint pain, headaches, and myositis, supporting previous evidence that type B infections disproportionately affect older children and more frequently lead to influenza-associated myositis [24–26]. Elevated AST, ALT, and CK levels in influenza B cases further suggest a potential tropism of this virus for muscle tissue, which may underlie the higher incidence of myositis [26, 27].

It should be emphasized that the laboratory parameters presented in this study are not specific to influenza and are commonly observed in various viral infections; however, they were included to facilitate comparison between influenza A and B and to illustrate age-related differences in laboratory profiles rather than to suggest diagnostic novelty.

Laboratory abnormalities such as thrombocytopenia and leukopenia were more prevalent in influenza B, although thrombocytopenia did not correlate with complications or antibiotic use in our cohort. Despite higher inflammatory markers in influenza A, there were no differences in complication rates, co-infection frequency, or antibiotic requirements. These findings refine our understanding of how the virus type modulates the clinical and laboratory presentation of pediatric influenza, while emphasizing that laboratory abnormalities should be interpreted in clinical context and do not, in isolation, reliably predict disease severity or therapeutic needs.

Overall, our findings indicate that patient age and virus type, together with basic clinical features, shape the clinical course of influenza in hospitalized children and underscore the importance of improving vaccination coverage and careful monitoring of high-risk patients to reduce disease burden.

LIMITATIONS

This study has several limitations. Firstly, this study was conducted at a single center in Poland using a retrospective design. The analysis was limited to hospitalized pediatric patients and covered only one influenza season in the post-COVID-19 period, which limits the generalizability of the findings. Nevertheless, the cohort size is comparable to that reported in other pediatric studies of hospitalized influenza cases. Influenza virus subtypes or lineages were not determined, and data on viral or bacterial coinfections were not systematically available. In addition, clinical decisions regarding hospitalization and antibiotic therapy were based on individual physician judgment rather than standardized protocols. Furthermore, assessment of clinical symptoms, particularly in children younger than 2 years of age, may have been influenced by their limited ability to verbalize subjective complaints, which could have affected the evaluation of age-related differences in clinical presentation. Finally, due to low influenza vaccination coverage in the study population, the impact of vaccination on disease course could not be evaluated.

CONCLUSIONS

Influenza A and B had a broadly similar clinical course; however, the type of virus and patient age significantly in-

fluenced the pattern of complications and laboratory abnormalities. The observed low vaccination coverage underscores the need for stronger population-level preventive efforts to improve influenza prevention in children. These findings may help clinicians and public health teams better prepare for seasonal influenza in children through age-adapted clinical assessment and preventive strategies.

DISCLOSURES

1. Institutional review board statement: This study was approved by the Research Ethics Committee of the Andrzej Frycz Modrzewski Cracow University (approval decision no. KBKA/5/O/2024, dated: 18.01.2024).
2. Assistance with the article: None.
3. Financial support and sponsorship: None.
4. Conflicts of interest: None.

REFERENCES

1. Iuliano AD, Roguski KM, Chang HH, Muscatello DJ, Palekar R, Tempia S, et al. Estimates of global seasonal influenza-associated respiratory mortality: a modelling study. Lancet 2018; 391: 1285-1300.
2. GBD 2017 Influenza Collaborators. Mortality, morbidity, and hospitalisations due to influenza lower respiratory tract infections, 2017: an analysis for the Global Burden of Disease Study 2017. Lancet Respir Med 2019; 7: 69-89.
3. Doyle JD, Campbell AP. Pediatric influenza and illness severity: what is known and what questions remain? Curr Opin Pediatr 2019; 31: 119-126.
4. Uyeki TM, Hui DS, Zambon M, Wentworth DE, Monto AS. Influenza. Lancet 2022; 400: 693-706.
5. Ruf BR, Knuf M. Burden of seasonal and pandemic influenza in infants and children. Eur J Pediatr 2014; 173: 265-276.
6. Uyeki TM, Bernstein HH, Bradley JS, Englund JA, File TM, Fry AM, et al. IDSA clinical practice guidelines: diagnosis & treatment of seasonal influenza. Clin Infect Dis 2019; 68: e1-e47.
7. Putri WCWS, Muscatello DJ, Stockwell MS, Newall AT. Economic burden of seasonal influenza in the United States. Vaccine 2018; 36: 3960-3966.
8. Xu ZW, Li ZJ, Hu WB. Global dynamic spatiotemporal pattern of seasonal influenza since the 2009 pandemic. Infect Dis Poverty 2020; 9: 2.
9. Wang X, Li Y, O'Brien KL, Madhi SA, Widdowson MA, Byass P, et al. Global burden of respiratory infections associated with influenza in children under 5 years in 2018. Lancet Glob Health 2020; 8: e497-e510.
10. Nayak J, Hoy G, Gordon A. Influenza in children. Cold Spring Harb Perspect Med 2021; 11: a038430.
11. Szymański K, Hallmann E, Łuniewska K, Kondratiuk K, Poznańska A, Brydak LB. Spread of influenza viruses in Poland and neighboring countries. Pathogens 2021; 10: 316.
12. Yildiz I, Gonullu E, Soysal, OnerCN, Karabocuoglu M. Epidemiology of influenza virus infection and group A streptococcal pharyngitis in children. Cureus 2023; 15: e33492.
13. Jackowska T, Wrotek A, Dembiński Ł, Mazur A, Szczepański T, Toporowska-Kowalska E, et al. Influenza vaccination of children and adolescents in the 2023–2024 season. Prz Pediatr 2023; 52: 16-22.
14. Angiel K, Stopyra L. Influenza in hospitalized pediatric patients in Poland: a retrospective single-center study of the 2023/2024 epidemic season. Arch Med Sci 2025; 21: 706-709.
15. Nitsch-Osuch A, Kuchar E, Zycinska K, Gyrczuk E, Wardyn K. Influenza vaccine coverage among children under 5 years in Poland during 2004–2008. Eur J Med Res 2010; 15: 102-104.
16. Hoy G, Kuan G, López R, Sánchez N, López B, Ojeda S, et al. The spectrum of influenza in children. Clin Infect Dis 2023; 76: e1012-e1020.
17. Wolf RM, Antoon JW. Influenza in children and adolescents: epidemiology, management, and prevention. Pediatr Rev 2023; 44: 605-617.
18. Ebell MH, Rahmatullah I, Hulme C, Buhr M, Kotnik JH, Geyer R, et al. Accuracy of individual signs and symptoms and case definitions for the diagnosis of influenza in different age groups: a systematic review with meta-analysis. BMJ Open 2025; 15: e067574.
19. European Centre for Disease Prevention and Control. Seasonal influenza. Annual epidemiological report 2022–2023.
20. Sybilski AJ, Mastalerz-Migas A, Jackowska T, Woroń J, Kuchar E, Doniec Z. Recommendations for influenza management in children – COMPAS INFLUENZA, update 2023/2024. Pediatr Fam Med 2023; 19: 273-283.
21. Dawood FS, Chaves SS, Pérez A, Reingold A, Meek J, Farley MM, et al. Complications and associated bacterial coinfections among children hospitalized with seasonal or pandemic influenza, United States, 2003–2010. J Infect Dis 2014; 209: 686-694.
22. Klein EY, Monteforte B, Gupta A, Jiang W, May L, Hsieh YH, et al. The frequency of influenza and bacterial coinfection: a systematic review and meta-analysis. Influenza Other Respir Viruses 2016; 10: 394-403.
23. Hamdan L, Probst V, Haddadin Z, Rahman H, Spieker AJ, Vandekar S, et al. Influenza clinical testing and oseltamivir treatment in hospitalized children with acute respiratory illness, 2015–2016. Influenza Other Respir Viruses 2022; 16: 289-297.
24. Oh YN, Kim S, Choi YB, Woo SI, Hahn YS, Lee JK. Clinical similarities between influenza A and B in children: a single-center study, 2017/18 season, Korea. BMC Pediatr 2019; 19: 472.
25. Jané M, Vidal MJ, Soldevila N, Romero A, Martínez A, Torner N, et al. Epidemiological and clinical characteristics of children hospitalized due to influenza A and B in southern Europe, 2010–2016. Sci Rep 2019; 9: 12853.
26. Yoon JW, Choi DY, Lee SH, Abeywardana S, Jayamaha CJS. Influenza B-associated myositis in children. Korean J Fam Med 2018; 39: 37-41.
27. Kamin W, Adams O, Kardos P, Matthys H, Meister N, Strassburg CP. Liver involvement in acute respiratory infections in children and adolescents. Front Pediatr 2022; 10: 840008.
28. Wrotek A, Wrotek O, Jackowska T. Platelet abnormalities in children with laboratory-confirmed influenza. Diagnostics 2023; 13: 634.
29. Shen CF, Huang SC, Wang SM, Wang JR, Liu CC. Laboratory findings of influenza virus infections in children. J Microbiol Immunol Infect 2008; 41: 294-300.
30. Shalabi RD, Kassis I, Cohen MS, Dabaja-Younis H. Predictors of unfavorable outcome in children hospitalized with influenza. J Clin Virol 2022; 157: 105298.