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Epidemiological Characteristics and Hematological Profiles of Pediatric Influenza: A Real-World Hospital-Based Study in Shanghai

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Abstract

Objects

This study aimed to analyze the epidemiological patterns of influenza and the hematological profiles in children under 14 years old in Shanghai.

Method

This study is a retrospective observational cohort study base on the real-world data from March 1st 2023 to March 31st 2024 of the hospital. All ambulant patients' data and blood routine test results were collected. The epidemiological character of monthly change of patient and the percentages of pediatric patients whose age were under 14 years old were presented. The pediatric population were divided into four groups for the subgroup analysis.

Results

127,500 patients conducted with influenza antigen quick tests and blood routine test during the period, which included 49,397(38.74%) patients younger than 14 years old.

33,378 patients' influenza antigen tests were positive, and 17,265 (51.72%) of those patients were pediatric patients. 14,139 children were demonstrated suffered from influenza A infections, which accounted for 81.89%. From November to March is the main infectious season of influenza in Shanghai. For the subgroup analysis, fever, and respiratory tract infection symptoms were the main symptoms for the admission reasons. The main symptoms to the admission varied among the groups and was related to the age.

Conclusion

Pediatric patients who were under 14 years old are still the major influenza infected population in this area. Influenza A was the main infectious agent. Fever and respiratory tract infection symptoms were the main symptoms for the admission symptoms.

Introduction

Influenza is still remaining its unneglectable role as a long-standing viral pathogen in human history, with recurrent seasonal epidemics and periodic pandemics that attest to its enduring presence. It is especially significant among the pediatric populations, not only because of the children's easy susceptibility to the infection but also playing the key role in sustaining community transmission. What is the fact about the influenza to the global health burden and economic burden: millions of influenza cases occur in children annually, many requiring medical attention, hospitalization, or intensive care.

Epidemiological data from different countries demonstrated the magnitude of this problem. In Italy, over ten influenza seasons, more than 1.4 million children aged 0–14 years generated nearly 89,000 influenza

diagnoses annually, with hundreds of emergency visits and hospital admissions[1]. In the United States, pediatric influenza leads to thousands of hospitalizations yearly, and severe outcomes are not rare [2]. Furthermore, influenza viruses persist through antigenic drift, and both influenza A and B lineages continue to co-circulate globally, reinforcing their permanent establishment in human populations [3].

For children, the implications of influenza extend beyond acute respiratory illness. Neurological complications are increasingly recognized: seizures, encephalopathy, and encephalitis have been reported in 7–17% of hospitalized pediatric cases, with higher prevalence in younger children and those with underlying neurologic disorders[4–6]. Although most children recover, severe cases can result in prolonged hospitalization, higher healthcare costs, and, rarely, long-term deficits [7]. There is body of evidence also suggests that influenza during critical developmental windows may influence long-term growth and cognition. In a longitudinal birth cohort, early influenza infection was associated with lower cognitive scores in toddlers, independent of sociodemographic confounders [8]. Reviews of pediatric viral infections further highlight how repeated or severe viral illnesses may alter neurodevelopmental and immunologic trajectories [9]. Given that growth and cognitive development are most vulnerable in early life, recurrent influenza episodes may subtly affect educational and developmental outcomes.

We retrospectively collected the ambulant data and routine blood test results from a high-volume center in China to present the epidemiological character of influenza in children under 14 years old and their routine blood test results, which will provide the exact data to show the prevalence of pediatric Influenza in this aera.

Methodology

Study design and data resource

The study was a retrospective observational cohort study base on the real-world data from March 1st 2023 to March 31st 2024 in a high-volume general hospital. The real-world database included all the ambulant patient data in this period. The demographic data and the routine bleed test data were collected and analyzed, which included age, sex, main symptom, influenza antigen test, the degree of influenza antigen test. The anonymization of the database was finished with the building of database at the mean time. This study was designed, implemented and presented in accordance with applicable local laws and regulations and the ethic principles laid down in the Declaration of Helsinki. The study was approved by the ethic committee of the Shanghai General Hospital Institutional Review Board (Ethic approval number: No. 20260306034816726).

Study population and subgroup analysis

The patients with age of 0–14 years old whose admission was between January 1st 2023 and March 31st 2024 were enrolled into this study. The excluded criteria are following:1) combined with severe chronic disease, e.g. severe congenital heart diseases, malignant tumor. 2) combined with anemia or

other hematological disease 3) undergoing the therapy with immunoinhibitory drug. For the influenza antigen test results, there are four results in clinical practice: positive, weakly positive, mini-positive and negative. In terms of our study, positive and weakly positive patients were regarded as Influenza-infected patients, and others were not regarded. To the subgroup analysis, the patients are divided into four groups (Group A, B, C, and D) based on the difference of age, which are Group A:0–1 years old; Group B:1–3 years old; Group C:3–7 years old and Group D:7–14 years old.

Statistical analysis

All statistical analyses were performed using R 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria). Data were checked for outliers and normality using normal Q–Q plots. Categorical variables are presented as frequency, and continuous variables as mean with standard deviation or median with interquartile range (IQR). Pearson's $\chi 2$ test (or Fisher's exact test) was used to compare categorical variables, and the Kruskal–Wallis test was used for continuous variables. P-values < 0.05 were considered statistically significant.

Results

Admission data and seasonal change of infected patients

Between 01.03.2023 and 31.03.2024 there are 127,500 patients conducted with influenza antigen quick tests in this high-volume medical center. Among all these patients, children whose age are between 0 and 14 years old are 49,397, which accounted for 38.74%. 33,378 patients were diagnosed as Influenza infected, and 17,265 in these patients are children under 14 years old, which accounted for 51.72% of all infected patients. In terms of the subtype of Influenza infection, 25,281 patients were tested as Influenza A positive and 8,097 patients were Influenza B positive. To the targeted children, 14,139 children were demonstrated as Influenza A positive and 3,486 children were Influenza B positive. The Table 1 and Fig. 1 showed the monthly changes of prevalence and percentage of children.

Table 1
The monthly changes of prevalence and percentage of children.

Months	Patient number	Pediatric patient number and percentage
03.2023	7335	5173(70.52%)
04.2023	1396	752(53.87%)
05.2023	47	4(8.51%)
06.2023	5	5(100%)
07.2023	9	0(0%)
08.2023	265	10(3.77%)
09.2023	902	367(40.69%)
10.2023	904	434(48.01%)
11.2023	3421	1616(47.24%)
12.2023	10075	4987(49.50%)
01.2024	5995	2649(44.19%)
02.2024	1883	792(42.06%)
03.2024	945	476(50.37%)

Subgroup analysis

Based on the study design, all the infected pediatric patients under 14 years old were divided into four groups for the subgroup analysis. The number of each subgroup patient were: Group A 759 patients; Group B 2120 patients; Group C 7579 patients and Group D 6807 patients. Table 2 presented the relative baseline data, which included sex, infected influenza subtype and main symptoms when admission. The results showed the significant differences in infected influenza subtype, which influenza A accounted for the main infectious agent. The significant differences of the main presenting symptoms were demonstrated in the febrile seizure, lower respiratory infection symptoms, relative allergic presences and subclinical symptoms. Figure 2 illustrated the exact distribution of main presented symptoms of four groups.

Table 2
Subgroup analysis of pediatric patients under 14 years old

Variables	Group A (n = 759)	Group B (n = 2120)	Group C (n = 7579)	Group D (n = 6807)	p Value
Sex(female)	225	962	3576	3068	< 0.001
Infectious agent					< 0.001
Influenza A	486	1783	5933	4977	
Influenza B	273	337	1646	1830	
Main symptom					
Fever	83	243	806	782	0.391
Febrile seizure	3	4	12	1	0.005
URI	541	1435	5240	4641	0.181
LRI	85	301	1001	766	< 0.001
GI symptoms	3	11	46	20	0.17
Urinary symptoms	0	2	2	0	0.09
Asthma	0	0	2	2	0.11
Allergy	0	0	3	11	0.0002
Headache	0	0	2	7	0.019
Subclinical symptoms	44	124	465	577	< 0.001
GI: Gastrointestinal; LRI: Lower Respiratory Infection; URI: Upper Respiratory Infection					

Routine blood test results and other laboratory parameter

We collected all the patients' blood routine test and C-reaction protein (CRP) test results. Table 3.1 showed the white blood cell (WBC)–related complete blood count and CRP results, which demonstrated the significant differences in the percentage of lymphocyte, monocyte and neutrophil and the meaningful difference in CRP. Group D patients had a higher CRP level compared to the other three groups, which may highly relate to the age differences. Table 3.2 presented the results of the red blood cell (RBC) and platelet–related complete blood count (CBC) tests. Several statistical meaningful differences were demonstrated among the four groups, nevertheless it seems these differences may not represent the crucial clinical meanings, considering the physical differences among the four groups because of the age. Figure 3 illustrated the exact results and distributions of blood test results in RBC, WBC, PLT, hemoglobin, hematocrit and CRP.

Discussion

This study provides a comprehensive overview of the epidemiological characteristics of influenza in Shanghai from 2023 to early 2024. Influenza outbreaks primarily occurred during the winter and spring seasons, specifically from November to March of the following year. Consistent with the epidemiological patterns reported in other studies[10–12], our findings further demonstrate that children under 14 years of age remain the main population affected by influenza. This is closely related to children's lifestyle characteristics, the ongoing development of their immune systems, and their relatively limited resistance to influenza viruses.

In this study, patients were divided into four subgroups according to age for subgroup analyses. The results clearly illustrated the epidemiological characteristics of influenza across different age strata. The findings showed that the main presenting symptoms at the time of admission varied by age. Febrile seizures occurred predominantly in infants and young children, whereas the proportion of patients with subclinical symptoms increased progressively with age. Although symptoms of upper respiratory tract infection remained the predominant clinical manifestations, symptoms of lower respiratory tract infection differed across age subgroups. For example, infants and young children most commonly presented with fever at the time of admission, and the infection had often not progressed to the lower respiratory tract. With increasing age, as the immune system continues to mature, the viral load at the early stage of infection may be insufficient to elicit noticeable symptoms. When the infection progresses to involve the lower respiratory tract, the resulting physical discomfort may prompt families to seek medical care, which often leads to the eventual identification of lower respiratory tract infection. This finding is highly consistent with findings from other studies that have examined age-stratified patterns of lower respiratory tract infection symptoms in children with influenza. [13–15] Because this study could not provide detailed biological information on specific influenza virus strains, it was not possible to determine whether the differences in lower respiratory tract infection symptoms among subgroups were associated with the biological characteristics of different influenza strains. This question warrants further investigation in future studies.

This study found that influenza infection did not cause marked abnormalities in routine blood test results in pediatric patients. Neither leukocyte parameters reflecting the inflammatory response nor other laboratory indices indicative of hematopoietic or coagulation function showed substantial deviations. Although the analysis demonstrated an age-related increase in CRP levels, overall CRP concentrations remained at a relatively low level. These findings are also consistent with the long-standing medical understanding of changes in routine blood parameters and C-reactive protein levels in children with influenza infection. [16–18]

Limitations

This retrospective cohort study has several unavoidable limitations. Although it is based on real-world data, information on influenza vaccination status among patients with these infections was not available. In addition, data on subsequent treatments and clinical outcomes for all patients were lacking.

Due to data limitations, important details such as whether pediatric patients progressed to severe disease or whether any deaths occurred could not be comprehensively captured.

Conclusion

Pediatric patients who were under 14 years old are still the major influenza infected population in this area. Influenza A was the main infectious agent, which accounted for 75.74% of all patients and 81.89% of all infected pediatric patients. The infected patient number presented a strong seasonal character. Fever and respiratory tract infection symptoms were the main symptoms for the admission symptoms. The main presented symptoms were mildly change between different age periods.

Declarations

Author Contribution Statement

Yangwei Cao was responsible for the overall study, including study conception, data acquisition, data management, statistical analysis, interpretation of the results, and manuscript preparation. Rulin Zhang contributed primarily to data acquisition and database establishment. Qiong Liao was responsible for statistical analysis. Chunmei Huang contributed to the methodological design and manuscript writing. Pengyu Zhang supervised and guided the study throughout the research process and critically reviewed the manuscript. All authors reviewed and approved the final version of the manuscript.

Ethics, Consent to Participate, and Consent to Publish Declarations

The study was approved by the ethic committee of the Shanghai General Hospital Institutional Review Board (Ethic approval number: No. 20260306034816726).

The Ethics, Consent to Participate, and Consent to Publish declarations were all confirmed and approved during the committee's ethical review process. For patients under 18 years of age, informed consent was obtained from their parents or legal guardians. The patient's parents or legal guardians provided explicit consent to participate in the study, and consent was also obtained for the use of the data for publication. The study was reviewed and defended before the committee in accordance with established ethical principles.

Clinical Trial Number

Clinical trial number: not applicable. This study is not a clinical trial.

Funding

Declaration

This study was supported by the Shanghai Initiative for Advancing Clinical Specialty Capacity Project (Grant No. SHDC22024317).

Author Contribution

Author contribution statementYangwei Cao was responsible for the overall study, including study conception, data acquisition, data management, statistical analysis, interpretation of the results, and manuscript preparation. Rulin Zhang contributed primarily to data acquisition and database establishment. Qiong Liao was responsible for statistical analysis. Chunmei Huang contributed to the methodological design and manuscript writing. Pengyu Zhang supervised and guided the study throughout the research process and critically reviewed the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data Availability Statement

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

Tables

Table 3.1 & 3.2 are available in the Supplementary Files section.

References

1. Bersani G, Barbieri M, Camilloni B, et al. Ten influenza seasons in Italian children: incidence and outcomes. Ital J Pediatr. 2023;49(1):121.
2. Willis DE, Bryant K, Carroll J, et al. Influenza-like illness in children: burden and epidemiology. J Pediatr Infect Dis Soc. 2018;7(3):e172–9.
3. Bedford T, Riley S, Barr IG, et al. Global circulation patterns of seasonal influenza viruses vary with antigenic drift. Proc Natl Acad Sci USA. 2020;117(37):22793–801.
4. Newland JG, Dawood FS, Azziz-Baumgartner E, et al. Neurologic complications in children hospitalized with influenza. Pediatrics. 2021;148(2):e2021050514.

5. Kumar DS, Odom JS, Pickens A, et al. Burden of neurologic complications in pediatric influenza hospitalizations. J Pediatr Infect Dis Soc. 2021;10(10):915–23.
6. Parikh DS, Campbell A, Rogovik A, et al. Neurological manifestations of influenza in hospitalized children. J Child Neurol. 2022;37(5):397–405.
7. Yokota S, Imagawa T, Miyamae T, et al. Influenza-associated acute necrotizing encephalopathy in children. Brain Dev. 2017;39(8):632–8.
8. Liu J, Qiu H, He M, et al. Early influenza infection and cognitive outcomes in toddlers: evidence from a birth cohort. Front Pediatr. 2022;10:826498.
9. Luchsinger J, Villaverde S, Alarcón A, et al. Long-term sequelae of viral infections in children: an overview. Viruses. 2022;14(3):622.
10. Kondratiuk K, Hallmann E, Łuniewska K, et al. Influenza and Influenza-Like Virus Infection in Children Under 14 Years of Age: An Investigation of 725 Cases in the 2021/2022 Influenza Epidemic Season in Poland. Med Sci Monit. 2023;29:e940368.
11. Shan J, Yang X, Wang T. Epidemiology of influenza from 2017 to 2022 in a national children's regional medical center. BMC Pediatr. 2025;25(1):240.
12. Barbieri E, Porcu G, Dona D, et al. Epidemiology and Burden of Influenza in Children 0–14 Years Over Ten Consecutive Seasons in Italy. Pediatr Infect Dis J. 2023;42(12):e440–6.
13. Taylor S, Lopez P, Weckx L, et al. Respiratory viruses and influenza-like illness: Epidemiology and outcomes in children aged 6 months to 10 years in a multi-country population sample. J Infect. 2017;74(1):29–41.
14. MacIntyre CR, Ridda I, Seale H, et al. Respiratory viruses transmission from children to adults within a household. Vaccine. 2012;30(19):3009–14.
15. Ruf BR, Knuf M. The burden of seasonal and pandemic influenza in infants and children. Eur J Pediatr. 2014;173(3):265–76.
16. Zhu R, Chen C, Wang Q, Zhang X, Lu C, Sun Y. Routine blood parameters are helpful for early identification of influenza infection in children. BMC Infect Dis. 2020;20(1):864.
17. Chen H, Cui P, Jin H, Guo Y, Huang Y, Jiao F, Yang X, Wang Y, Luo Y. The highly accuracy of lymphocyte count in diagnosing influenza A in children during the influenza A season. Front Pediatr. 2025;13:1609822.
18. Hoenigl M, Prattes J, Drescher M, et al. Comparison of clinical presentation and laboratory values at admission between PCR-confirmed influenza A H1N1 infection and influenza-like disease. South-East Austria Infect. 2014;42(2):317–24.

Figures

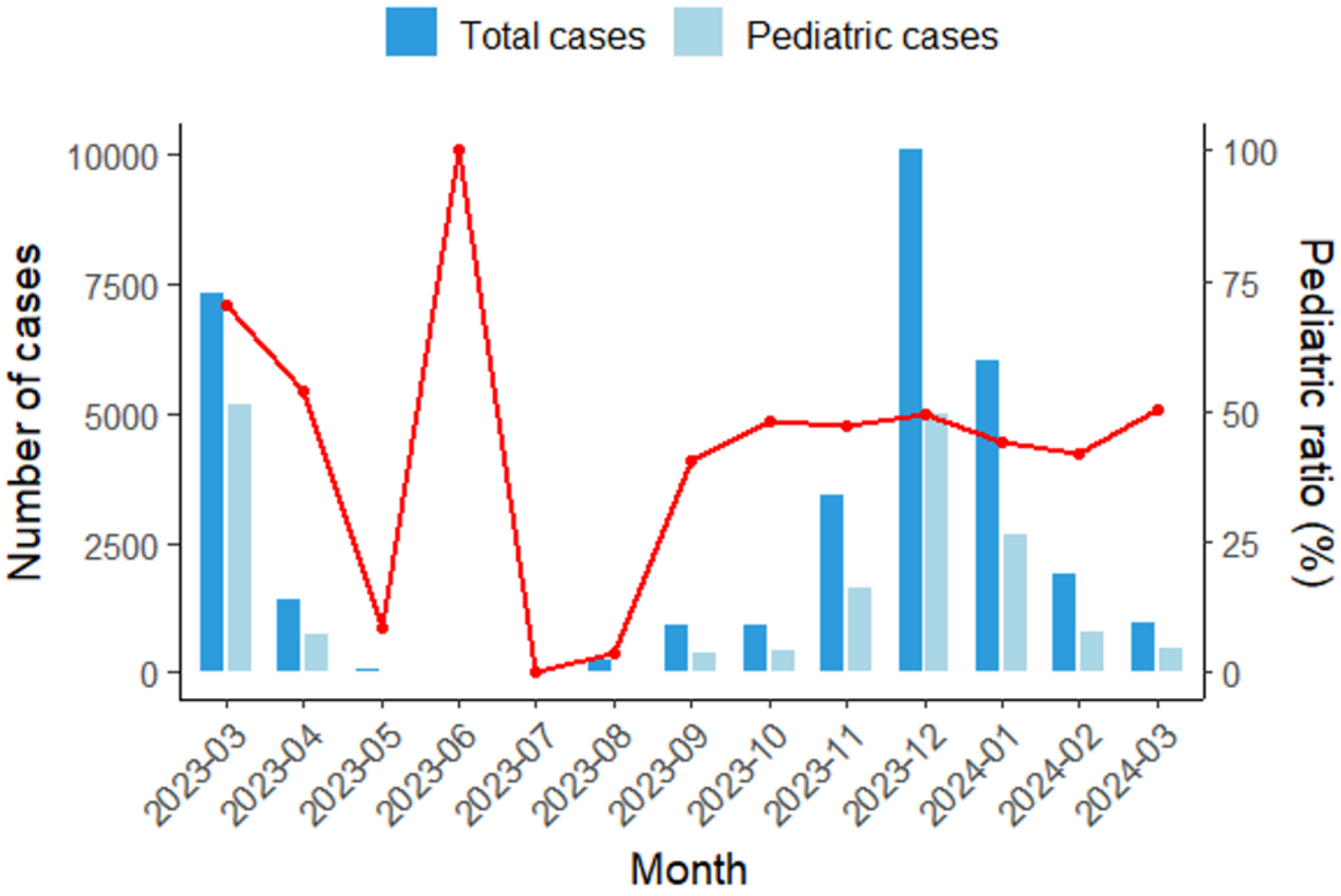


Figure 1

The monthly changes of prevalence and percentage of children.

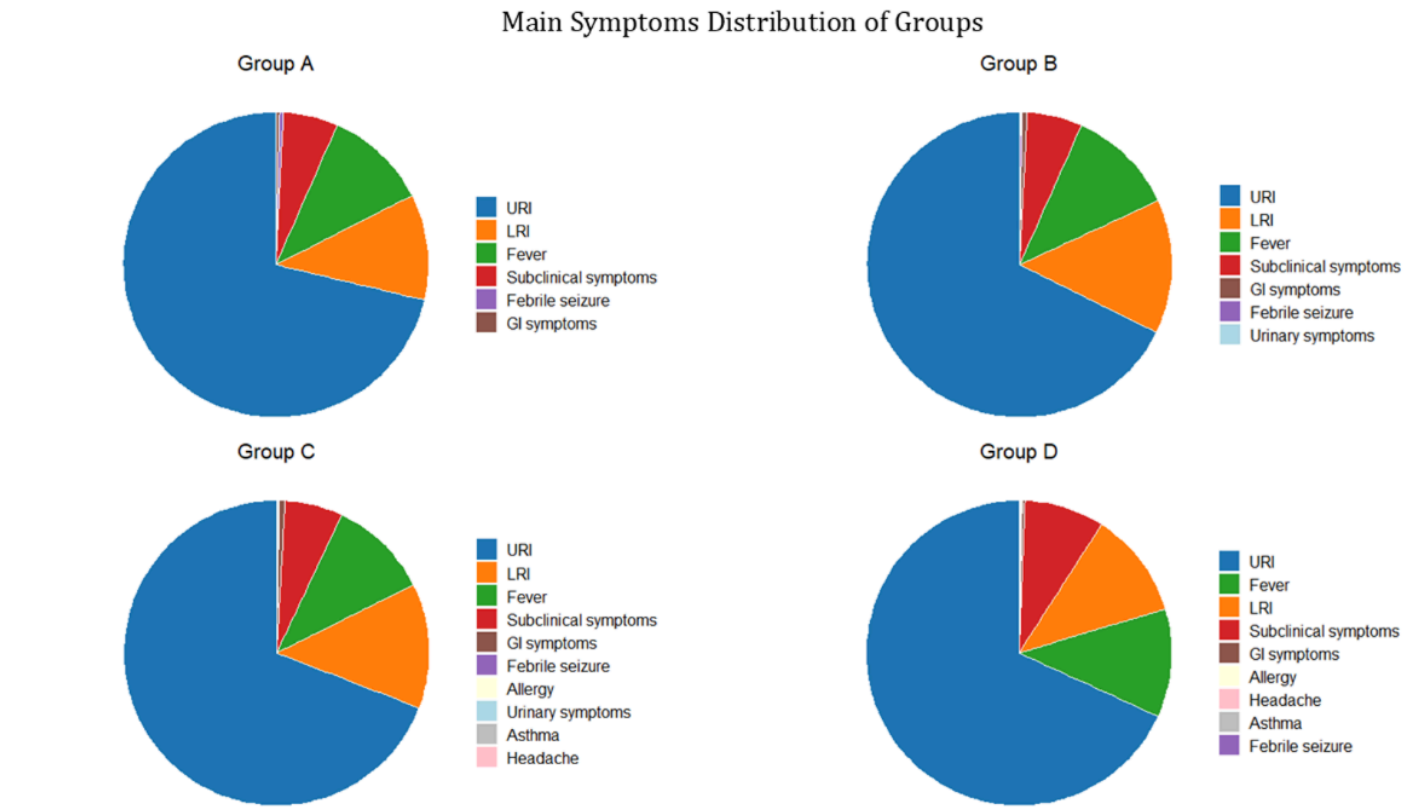


Figure 2

Subgroup analysis of main symptoms.

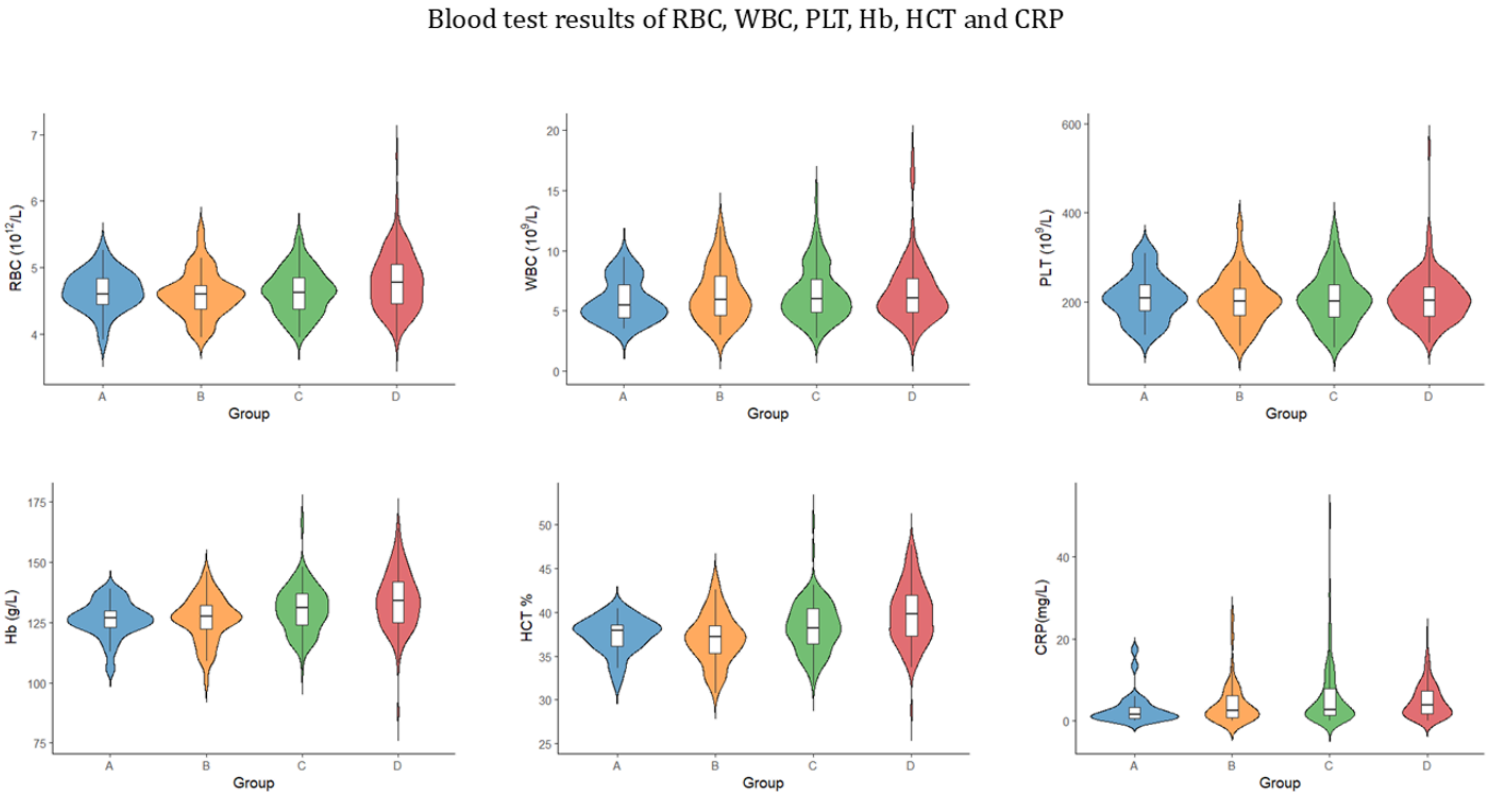


Figure 3

Hematological profiles of RBC, WBC, PLT, Hb, HCT and CRP.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tables3.13.2.docx