

Clinical Characteristics of SARS-CoV-2 Infection in the Pediatric Patients: A Retrospective Cohort Study at the Tertiary Pediatric Hospital in Tbilisi, Georgia

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Abstract

Objective: This study aimed to analyze the clinical characteristics, demographic profile, and outcomes of pediatric patients hospitalized with SARS-CoV-2 infection at M. Iashvili Children's Central Hospital between March 2023 and March 2024.

Methods: A retrospective cohort analysis was conducted for the period from March 9, 2023, to March 2024. The study included patients aged 0-18 years with confirmed SARS-CoV-2 infection by RT-PCR or antigen testing. Data on demographics, clinical symptoms, comorbidities, length of hospitalization, and outcomes were examined.

Results: The cohort included 168 patients (103 male, 65 female). Of these, 86 (53.7%) were under 1 year of age, and 51 (31.9%) were aged 1-3 years. Fever was the most common symptom (165 patients, 98%), followed by cough (129 cases, 77%) and rhinorrhea (75 cases, 41%). Gastrointestinal symptoms (vomiting, diarrhea) were observed in 43 patients (26.9%). Comorbidities were present in 18 cases (11.3%) and were associated with a 44% increase in length of stay (LOS) (OR = 1.44, 95% CI: 1.20-1.72, $p < 0.001$). Disease severity was linked to a 36% increase in LOS (OR = 1.36, 95% CI: 1.18-1.56, $p < 0.001$). Intensive care was required for 8 patients (5.0%), all of whom were neonates (0-30 days old).

Conclusion: SARS-CoV-2 infection in pediatric patients is primarily characterized by mild respiratory symptoms, with gastrointestinal manifestations occurring frequently. Infants under 1 year, especially neonates, represent a particularly vulnerable group requiring intensive care.

Keywords: SARS-CoV-2; COVID-19; Children; Georgia; Retrospective Study

Introduction

In the fourth year since the declaration of the COVID-19 pandemic (March 2020), the study of SARS-CoV-2 infection in the pediatric population remains relevant [1]. According to World Health Organization data from April 2023, more than 39 million children worldwide have been infected with SARS-CoV-2, demonstrating the significant spread of this infection in the pediatric population [2].

Throughout the pandemic, the primary concern of healthcare systems was child safety, which manifested in the form of school closures, mandatory mask-wearing, and vaccination campaigns [3,4]. Against the backdrop of emerging new variants of coronavirus disease and changing vaccination policies, it is important to study the clinical characteristics of COVID-19 in pediatric patients during the post-pandemic period [5].

Clinical characteristics of pediatric COVID-19

According to international studies, the pediatric population is characterized by milder clinical course compared to adults, although children are not immune to severe disease [6,7]. According to data from the American Academy of Pediatrics, the hospitalization rate for children among all confirmed COVID-19 cases ranges from 0.1 - 1.5% [8].

Meta-analysis has shown that COVID-19 in children often presents with atypical symptoms, which complicate timely diagnosis [9,10]. According to a large-scale study by Chen., *et al.* the most common symptoms of COVID-19 in children are fever (65.1%), cough (51.8%), and rhinorrhea (38.1%) [11].

According to a systematic review by Zimmermann., *et al.* the clinical presentation of COVID-19 in pediatric patients differs significantly from adults-gastrointestinal symptoms (nausea, vomiting, diarrhea) are more common in children, while respiratory complications are less frequent [12].

Gastrointestinal symptoms in the pediatric population, sometimes even without respiratory manifestations, may be the only manifestation of COVID-19 [13,15]. An epidemiological analysis by Dong., *et al.* (2,143 children in China) showed that gastrointestinal symptoms were registered in 8.1% of cases [14], while in a New York pediatric cohort (50 children), gastrointestinal manifestations were documented in 26% of cases [16].

A study by Lu., *et al.* showed that in children under 5 years of age, COVID-19 may present only with mild febrile episodes or skin rashes, which often leads parents and physicians to suspect other infections [17].

According to data from a prospective study by Brookman., *et al.* asymptomatic COVID-19 course in children is 40% more common compared to adolescents, which significantly complicates epidemiological surveillance and contact identification [18].

A multicenter study by Wang., *et al.* also confirmed that neurological symptoms of COVID-19 in the pediatric population (headache, vertigo, impaired concentration) constitute a significant proportion of overall symptomatology and often precede classic respiratory manifestations [19].

In the adolescent age cohort, serious clinical manifestations have been documented, particularly an elevated risk of developing MIS-C (Multisystem Inflammatory Syndrome in Children), which manifests in 0.01-0.6% of confirmed SARS-CoV-2 cases [20].

It should also be noted that children, despite mild clinical course, may shed the virus for prolonged periods, which represents a significant epidemiological challenge [21].

Despite the global scale of the COVID-19 pandemic, clinical studies on pediatric COVID-19 in Georgia are limited. Existing publications are mainly based on national statistical data and do not provide a detailed clinical picture.

Due to low COVID-19 vaccination coverage in the pediatric population in Georgia, there is insufficient data on the impact of vaccination on hospitalization and clinical outcomes.

Aim of the Study

The aim of this retrospective cohort study was to analyze the clinical characteristics, demographic profile, and outcomes of pediatric patients hospitalized with SARS-CoV-2 infection at M. Iashvili Children's Central Hospital, as the country's leading pediatric institution, from March 2023 to March 2024.

Study Objectives

1. Clinical spectrum characterization - To study the symptomatic manifestations, severity, and length of hospitalization of COVID-19 in children hospitalized during the study period.
2. Age vulnerability identification - To determine risk groups by age categories and analyze factors predicting severe outcomes.
3. Assessment of the role of comorbidities - To determine the impact of comorbid conditions on length of hospitalization and clinical outcomes.
4. Resource utilization analysis - To assess intensive care needs, length of hospitalization, and complications for optimization of healthcare system resources.

Study Materials and Methods

The study was conducted at M. Iashvili Children's Central Hospital. The hospital has 225 beds and represents Georgia's largest multidisciplinary, referral pediatric hospital.

A retrospective cohort study was conducted for the period from March 2023 to March 2024.

All pediatric patients (0-18 years) with confirmed SARS-CoV-2 infection by rapid antigen test (SARS-CoV-2 Rapid Antigen Test) or RT-PCR test (Reverse Transcription Polymerase Chain Reaction) at hospital admission or after hospitalization were retrospectively studied.

The complete cohort comprised 168 patients, of whom 159 (94.6%) were hospitalized, while 9 (5.4%) patients were discharged directly from the emergency department upon confirmation of diagnosis.

Sampling method

A total sampling method was used, whereby all patients who met the inclusion criteria during the specified period were included in the study. This approach ensures maximum representativeness and reduces selection bias.

SARS-CoV-2 testing protocol

According to local regulations, all patients admitted to the clinic were tested for coronavirus in the Emergency Department using nasopharyngeal swab rapid antigen testing (SARS-CoV-2 Rapid Antigen Test) following standard procedures.

In case of a positive result, the patient was placed in an isolated ward with a COVID-19 diagnosis.

Patients who had:

- A negative antigen test result and clinical symptoms typical for COVID-19

OR

- Hospitalized patients with other diagnoses but with signs characteristic of COVID-19 underwent secondary testing on day 2 of hospitalization at the Richard Lugar Center for Public Health Research using RT-PCR test (Reverse Transcription Polymerase Chain Reaction).

Data collection procedure

Data collection was carried out based on open data, with complete protection of patient identity. A coded identifier was created for each patient (Patient ID: COV-001, COV-002, etc.). Due to the retrospective nature of the study, individual informed consent was not required.

The following parameters were studied:

- Demographic data (age, sex)
- Seasonality
- Clinical signs and symptoms
- Comorbidities
- Length of hospitalization
- Outcomes and complications

Statistical methods

We applied a chi-square goodness-of-fit test to assess whether the distribution of cases differed across seasons (spring, summer, autumn, winter).

Clinical symptoms were categorized into four groups: respiratory, gastrointestinal, both, and none, with fever excluded from the classification since nearly all patients (except two) presented with fever. Rare symptoms that did not fit these categories were classified as other. According to the small sample sizes in some categories, associations between categorical variables (symptom type, age group, comorbidity status) and disease severity were evaluated using Fisher's exact test.

For comorbidity analysis, the strength of association with severity was further quantified using odds ratios (ORs) with 95% confidence intervals (CIs). A p-value < 0.05 was considered statistically significant.

We used logistic regression with bias-reduced estimation to assess the influence of age, comorbidities, disease severity, sex, and symptom categories on the probability of intensive care admission. Odds ratios (OR) and 95% confidence intervals (CI) were reported. Bias-reduced estimation was applied to address small sample size and separation issues, which can lead to unstable estimates in conventional logistic regression.

Hospital length of stay (LOS) was right-skewed, so we applied a natural logarithm transformation to approximate a normal distribution and meet linear regression assumptions. We then used linear regression to assess the influence of age (in months), comorbidities, disease severity, sex, and symptom categories on LOS. Exponentiated regression coefficients were reported to indicate multiplicative effects on LOS. Missing values were excluded from the analysis.

Results

Descriptive statistics

From March 2023 to February 2024 inclusive-during the study period-SARS-CoV-2 infection was confirmed in 168 pediatric patients at the clinic. Of these, 127 (76%) patients were brought to the clinic by emergency medical service, while 41 (24%) presented to the clinic independently (Figure 1).

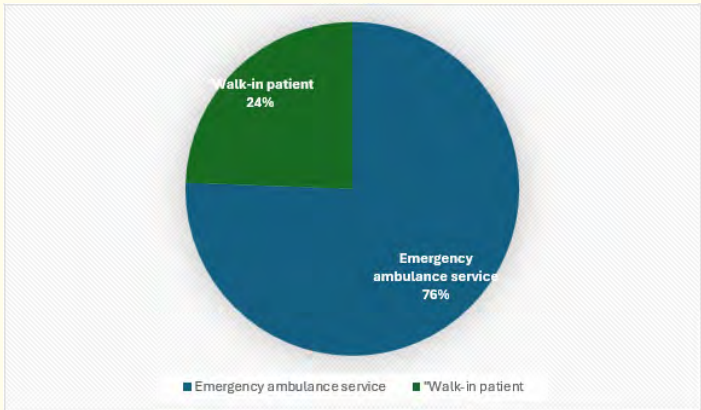


Figure 1: Distribution of patients by mode of presentation to the clinic.

In the Emergency Department, COVID-19 was confirmed by rapid antigen test in 120 patients, and 14 patients were brought with already confirmed diagnosis. Of these, 11 patients were transferred from other medical institutions with confirmed COVID-19 diagnosis for further treatment, while 3 patients presented to the clinic independently based on outpatient testing due to severely expressed symptoms. Thirty-three patients were admitted to the clinic with other respiratory symptoms; a negative result was recorded by SARS-CoV-2 rapid test at hospitalization, while COVID-19 was confirmed by PCR testing on the third day of hospitalization.

One patient was being treated for a surgical diagnosis and COVID-19 diagnosis was confirmed 5 days after hospitalization.

During the study period, of the 120 patients who had COVID-19 confirmed in the Emergency Department, 9 patients (7.5%) were discharged home, which indicates that a relatively small proportion of patients required only symptomatic treatment due to mild clinical course.

The gender distribution of the 168 patients included in the study (Figure 2) shows a statistically significant prevalence of male sex: 103 male patients (61%) and 65 female patients (39%).

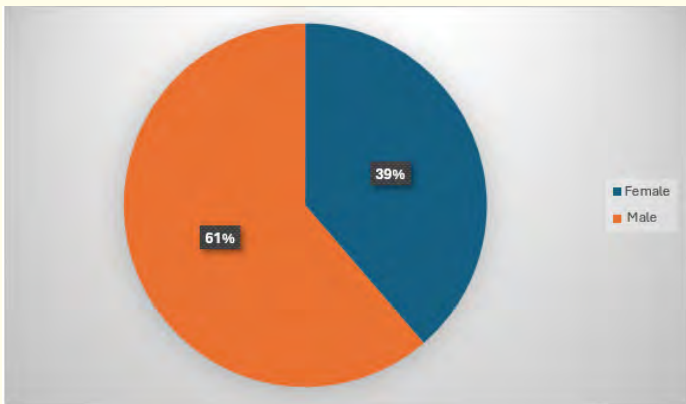


Figure 2: Distribution of patients by gender.

Age analysis of patients reveals significant characteristics of COVID development in pediatric age, specifically a pronounced excess of patients at early age, in the under-3-year group-80%, which indicates high vulnerability to SARS-CoV-2 infection in this age group (Figure 3).

Patient age ranged from 0 to 204 months (mean 23.1 ± 34.2 months, median 12 months).

The main age groups were distributed as follows:

- 0-6 months: 49 patients (30.6%)
- 6-12 months: 37 patients (23.1%)
- 12-36 months (1-3 years): 51 patients (31.9%)
- 37-72 months (3-6 years): 10 patients (6.3%)
- 72 months (over 6 years): 13 patients (8.1%).

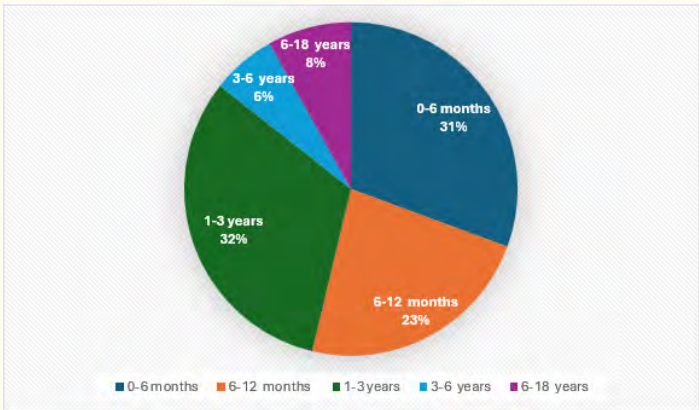


Figure 3: Distribution of patients by age.

Seasonal distribution

The seasonal distribution of cases was significantly uneven ($\chi^2 = 103.4$, $df = 3$, $p < 0.001$), with the majority occurring in autumn (58%), followed by summer (19%), spring (14%), and winter (8%). Seasonal distribution of patients is shown in table 1.

Season	Period	n (%)
Spring	March-May	24 (14%)
Summer	June-August	32 (20%)
Autumn	September-November	98 (58%)
Winter	December-February	14 (8%)

Table 1: Seasonal distribution of patients.

Clinical manifestations

Analysis of 168 symptomatic patients showed that the majority of patients presented to the clinic due to respiratory symptoms.

The reason for presentation in 165 patients (98%) was high fever; 129 (77%) patients had cough accompanying fever; 75 (45%) cases had rhinorrhea; 1 patient presented with hypothermia (0.6%); 2 (1.2%) with abdominal pain; 6 (3.5%) patients with rash; 25 (14.9%) with diarrhea; 20 (11.9%) with vomiting; 2 (1.2%) with nausea; 5 (3%) with appetite loss; shortness of breath in 2 (1.2%).

From the study group, in 129 (76%) and among hospitalized patients in 116 cases (76%), the main symptom was cough; in 68 (41%) cases, fever, cough, and rhinorrhea were pronounced.

Among hospitalized patients, 9 (6%) patients had severely pronounced vomiting and diarrhea. Only diarrhea was present in 14 patients (9%), while vomiting in 20 patients (13.2%). All patients with gastrointestinal complaints had pronounced abdominal pain.

In 5 (3%) patients, rash was pronounced against the background of respiratory symptoms.

In 13 patients who had convulsions during high fever and epilepsy as comorbid diagnoses, neurological manifestation-headache- was pronounced.

Information collection on loss of smell and taste could not be accomplished due to the age group.

Statistical analysis

Symptoms were categorized into two main types: respiratory and gastrointestinal, excluding fever, since nearly all patients (except two) had fever. Patients with both types of symptoms were classified as ‘both’; those with only fever were classified as ‘none’; and any other rare symptoms were classified as ‘other’. We tested whether symptom type was associated with severity using Fisher’s exact test. No significant association was found ($p = 0.854$), indicating that the proportion of severe and non-severe cases was similar across the different symptom categories (Figure 4).

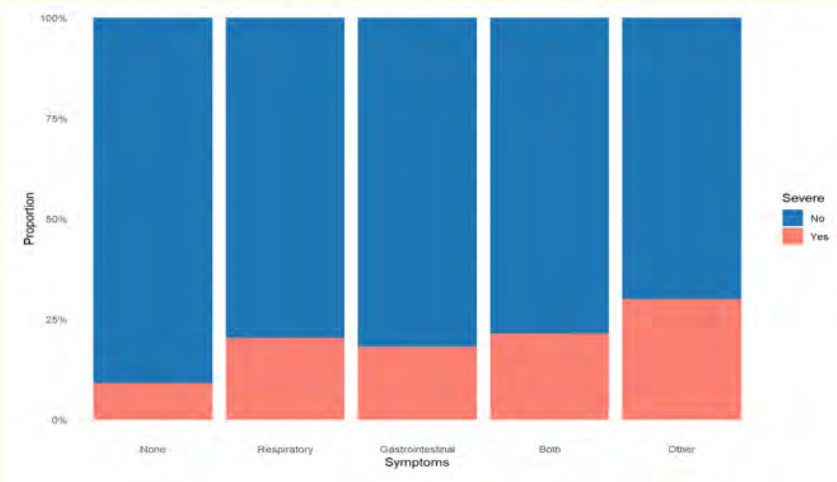


Figure 4: Relationship of symptom type to severity.

There was a significant association between age group and disease severity (Fisher’s Exact Test, $p < 0.001$). Toddlers (1-5 years) had the highest severe cases, while infants and older children had lower proportions (Figure 5).

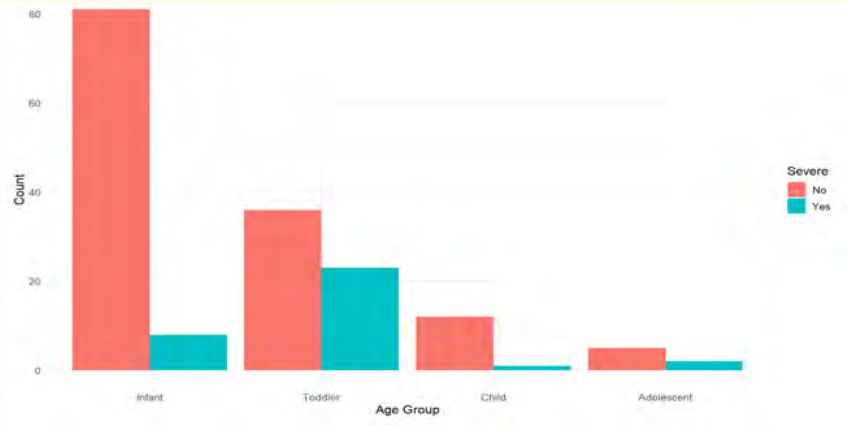


Figure 5: Relationship between age group and disease severity.

There was no statistically significant association between the presence of comorbidities and disease severity (Fisher’s Exact Test, $p = 0.25$, $OR = 0.38$, 95% CI 0.04-1.71). A small sample size in the comorbidity group limits the ability to detect a difference.

None of the predictors reached statistical significance in relation to intensive care admission. Age showed an OR of 1.01 (95% CI: 0.99-1.03), suggesting no meaningful effect. The presence of comorbidities ($OR = 2.11$, 95% CI: 0.27-16.57) and higher severity ($OR = 1.68$, 95% CI: 0.26-10.83) were associated with increased odds of ICU admission, while male sex was also associated with higher odds ($OR = 2.42$, 95% CI: 0.29-20.18). Symptom categories produced highly uncertain estimates with wide confidence intervals; for example, gastrointestinal symptoms ($OR = 2.54$, 95% CI: 0.08-84.14) and “other” symptoms ($OR = 10.68$, 95% CI: 0.58-196.56) suggested higher odds, but results were imprecise due to small sample sizes.

Although some predictors, such as comorbidities and symptom categories, showed trends toward increased ICU risk, none reached statistical significance. The wide confidence intervals reflect limited statistical power and sparse data in certain categories. Larger sample sizes or simplified categorization of symptoms may be needed to clarify these associations.

We used a linear regression model on log-transformed hospital length of stay (LOS) to examine which factors influenced the duration of hospitalization. The model was statistically significant ($F = 4.29$, $p < 0.001$), explaining approximately 14% of the variance in LOS (adjusted $R^2 = 0.14$).

- Comorbidities were associated with a 44% longer LOS ($OR = 1.44$, 95% CI: 1.20-1.72, $p < 0.001$).
- Higher disease severity was associated with a 36% longer LOS ($OR = 1.36$, 95% CI: 1.18-1.56, $p < 0.001$).
- Age in months ($OR = 1.000$, 95% CI: 0.999-1.002), sex (male vs. female; $OR = 1.06$, 95% CI: 0.94-1.20), and symptom categories (gastrointestinal, none, other, respiratory) were not significantly associated with LOS.

This indicates that patients with comorbidities or more severe disease tended to stay longer in the hospital, whereas age, sex, and symptom type did not have a meaningful effect. The effect sizes for comorbidities and severity are clinically relevant, suggesting these are key drivers of hospital resource use in this population. Other factors may also contribute to LOS, but were not captured in this analysis.

Discussion

The presented retrospective study, based on clinical data from 168 pediatric patients, reveals significant epidemiological and clinical characteristics of COVID-19 infection in the pediatric population. Analysis of the results indicates several important patterns.

The study revealed a statistically significant prevalence of male sex (61% vs 39%, $p < 0.05$), which corresponds to international pediatric data. An epidemiological analysis by Dong, *et al.* (2,143 children in China) [22] and an Italian cohort study (3,836 children) [23] also confirmed a slight prevalence of male sex (51.4%). This phenomenon is presumably determined by gender differences in the immune system and heterogeneity in ACE2 receptor expression [24].

Particularly noteworthy is the age distribution—80% of the study group were children under 3 years of age, including 30.6% in the 0-6-month group, 23.1% in the 6-12-month group, and 31.9% in the 1-3-year group. This distribution indicates high vulnerability of early-age children to SARS-CoV-2 infection, which corresponds to data studied by Zimmermann and Curtiss (2021) [25].

Our study documented pronounced seasonality: 61.3% of cases were concentrated in the autumn period (September–November), which differs statistically significantly from the winter (3.8%), spring (15.0%), and summer (20.0%) periods.

The incidence rate in the autumn period was 4.1 times higher compared to spring and 3.1 times higher compared to summer, indicating markedly pronounced seasonality.

In the post-pandemic era (2023–2024), US data reveal dual seasonality [26]—with recurring winter and summer peaks, while European studies [27,28] mainly indicate winter dominance. According to CDC analysis, SARS-CoV-2 is not characterized by a uniform seasonal pattern, unlike seasonal influenza [26].

The identified seasonal profile—with absolute autumn prevalence and minimal winter representation—may be determined by several interacting factors:

- The opening of schools at the beginning of September, which coincides with the circulation of these high-transmission variants, creates ideal conditions for rapid viral spread.
- Close contact with children in educational institutions, combined with high contagiousness of new variants, may be the main driving force of this unusual seasonal peak.
- Georgia's autumn climatic conditions—mild temperature, increasing relative humidity, and decreasing day length—facilitate the transmission of respiratory viruses. Additionally, the population spends more time indoors, which increases the risk of airborne infections.

The clinical part of the study indicates absolute dominance of fever (in 98% of cases), which corresponds to international literature on pediatric COVID-19. According to a multicenter study conducted by Götzinger, *et al.* (2020) in 25 European countries, fever was also the most frequent symptom (in 65% of cases).

A multicenter study by Götzinger, *et al.* (25 European countries, 582 children) showed that fever was the most frequent symptom (in 65% of cases) [29].

Respiratory symptoms, specifically cough (76% of hospitalized patients), rhinorrhea (41% of cases), and their combination, indicate classic respiratory syndrome. These indicators correspond to international data-in a European multicenter study (25 countries), fever was noted in 65% of cases, and cough showed similar frequency [30]. In a Chinese study (2,143 children), cough was the second most frequent symptom (48.5%) after fever [31].

Particularly significant is that in 41% of cases, the classic triad of fever, cough, and rhinorrhea was expressed, which is similar to Italian data where upper respiratory tract symptoms dominated in pediatric age [32].

Gastrointestinal manifestations were relatively rare-only 6% of patients had severely pronounced vomiting and diarrhea, while 9% had only diarrhea. These indicators are consistent with international literature-in a Chinese meta-analysis, GI symptoms were noted in 8.1% of cases [33], while according to US CDC data, diarrhea was recorded in 13.6% of hospitalized children [34].

In our study, all patients with gastrointestinal complaints had pronounced abdominal pain-the excess of abdominal pain may represent a local clinical characteristic.

Statistical analysis of the study shows significant correlation between age group and disease severity (Fisher's Exact Test, $p < 0.001$).

Our study revealed the highest rate of severe COVID-19 course in the 1-5-year age group ($p < 0.001$), which corresponds to the age vulnerability pattern frequently described in international literature.

In international studies, the risk of severe COVID-19 is highest in young (<1 year) children. Meta-analysis showed that critical COVID-19 course was recorded in 20% of infants less than 1 month old, and in 10% of those <1 year old [35].

According to CDC COVID-NET data, infants less than 6 months old had the highest rate of COVID-19-associated hospitalization among pediatric age groups [36].

An Italian national study of 3,836 pediatric patients showed that severe COVID-19 course was recorded in 4.3% of cases, particularly in children ≤ 6 years, where this indicator was 10.8% [37].

Thus, according to international study results, the risk of severe COVID-19 courses in young children, particularly in the <1 year and ≤ 6 -year age groups, is indeed higher than in older children, which corresponds to the results found in our study.

It is important to note that no statistically significant association was found between the presence of comorbidities and severity ($p = 0.25$).

International studies reveal different results regarding the role of comorbid pathologies. According to a systematic review, the presence of one comorbid pathology increases the risk of critical COVID-19 by 3.95 times (OR 3.95; 95% CI, 2.78-5.63), while ≥ 2 comorbid pathologies increase it by 9.51 times (OR 9.51; 95% CI, 5.62-16.06) [38].

In an Italian study (3,836 children), comorbid pathologies increased the risk of severe course by 2.80 times (OR = 2.80; 95% CI = 1.74-4.48) [39]. In a Polish study (1,405 patients), comorbid pathology was more frequent in children >5 years (42.3%) [40].

The divergence of our data from this international trend may be explained by both sample size limitations and population characteristics or differences in the spectrum of comorbid pathologies in Georgia.

The high hospitalization rate (92%) indicates that the majority of patients included in the study were characterized by severe or moderately severe clinical course. This may reflect both clear criteria for hospitalization indications and increased parental anxiety during the pandemic period.

Despite certain limitations, the study provides significant information about pediatric COVID-19 characteristics in Georgia and can be used for planning epidemiological studies.

Intensive care need was recorded in 8 patients in the study (5.3%, 95% CI: 1.7%-8.9%), which corresponds to international data. In an Italian study (3,836 children), ICU placement was necessary for 3.5% of hospitalized patients [41], while in a Chinese cohort (2,143 children), critical course was noted in 5.9% of cases [42].

An important clinical detail was that all patients required oxygen therapy, but none required mechanical ventilation, indicating prevalence of moderate severity respiratory complications. This corresponds to Polish data, where only 2% of infants and 5% of older children required oxygen therapy [43].

All NICU patients fully recovered during an average NICU stay of 5 days (3-23 days), which corresponds to the generally favorable prognosis of pediatric COVID-19.

Length of hospitalization (LOS) is critical both for optimizing clinical management and for effective allocation of healthcare resources.

Linear regression analysis (logarithmically transformed LOS) revealed a statistically significant model ($F = 4.29$, $p < 0.001$), which explains approximately 14% of LOS variation (adjusted $R^2 = 0.14$).

The presence of comorbid pathologies was identified as the most significant factor, associated with a 44% prolongation of LOS (OR = 1.44, 95% CI: 1.20-1.72, $p < 0.001$). This finding correlates with international literature-in a Malaysian study (1,713 children), comorbid diseases significantly increased length of hospitalization [44], while in an Italian cohort, the LOS of comorbid patients was on average 1.5 times longer [45].

Severe disease course was identified as the second statistically significant factor, associated with a 36% prolongation of LOS (OR = 1.36, 95% CI: 1.18-1.56, $p < 0.001$). This corresponds to Chinese data, where severe/critical COVID-19 was associated with 2-3 times prolonged hospitalization [46].

Based on these findings, it is recommended to:

- Early identification and intensive monitoring of children with comorbid pathologies.
- Implementation of risk-stratification algorithms.
- Proactive allocation of healthcare resources for high-risk groups.

All patients participating in the study were discharged from the clinic in improved condition.

It is noteworthy that none of the patients were vaccinated.

Conclusion

Based on 2023-2024 data, SARS-CoV-2 infection in the pediatric population in Georgia is primarily characterized by respiratory symptomatology with accompanying gastrointestinal manifestations. Children aged 1-5 years remain a particularly vulnerable group, which requires special attention toward them.

Analysis of clinical course and outcomes shows that SARS-CoV-2 infection continues to represent a significant challenge for the pediatric healthcare system in Georgia. It is important to note that the study was conducted in 2023-2024, during the period of Omicron variant circulation, which were characterized by high transmissibility, but relatively mild clinical course compared to the original Wuhan strain and Alpha/Delta variants.

Particularly significant is that all patients included in the study were unvaccinated, which limits the ability to assess the impact of vaccination on clinical outcomes. The 80% ICU risk in the neonatal population and concentration of severe course in the 1-5-year age group indicate the need for special clinical care for these age groups and the importance of risk stratification.

Based on these findings, development of an integrated clinical approach is recommended, which will take into account local epidemiological characteristics and will be oriented toward optimal management of risk groups.

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