



Outcomes of COVID-19 Infections in children: A single-center retrospective study

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Abstract

The COVID-19 pandemic is an important cause of morbidity and mortality, which has had a negative impact worldwide. Our aim was to describe clinical findings and outcomes of severe acute respiratory syndrome (SARS)-CoV-2 viral infection and COVID-19 cared for at a large pediatric tertiary care hospital during the first year of the pandemic. Patients aged 1 month to 18 years who were diagnosed as having COVID-19 between March 2020 and April 2021 were included. The files of patients diagnosed with COVID-19 were reviewed retrospectively. Results: Four hundred sixty seven children were included in the study. There were 34 (7.3%) patients under 1 year of age, 111 (23.8%) between 1 and 5 years, 98 (30.4%) between 5 and 10 years, 142 (30.4%) between 11 and 15 years, and 82 (17.6%) age over 15 years. Fever (88.2%), vomiting (32.4%), and diarrhea (29.4%) in patients aged under 1 year, sore throat (36.6%) in patients aged 11–15 years, and dysgeusia (11%), anosmia (14.6%), headache (18.3%), malaise (40.8%), myalgia (28%), and shortness of breath (17.1%) in those aged over 15 years were found to be significantly more common in comparison with the other age groups ($p < 0.05$). Thirty-five (7.5%) patients were asymptomatic, 365 (78.1%) had mild disease, 35 (7.5%) were moderate, 27 (5.8%) were severe, and five (1.07%) were critical. Leukocyte count, erythrocyte sedimentation rate, ferritin, and C-reactive protein values were significantly higher in hospitalized patients. Three patients died during the study period (0.64%). While SARS-CoV-2 infection may be asymptomatic and COVID-19 usually has a mild clinical course, some children have severe disease or mortality.

KEYWORDS

children, COVID-19, pandemic

1 | INTRODUCTION

In February 2020, the World Health Organization (WHO) defined coronavirus disease 2019 (COVID-19) and declared it as a pandemic on March 11, 2020.¹

There must be a high level of clinical suspicion to diagnose children infected with COVID-19 because most children have mild

disease and asymptomatic children may carry the virus to other people. Although the prognosis in children is good, diagnosis is important in terms of isolation because this has an important place in the chain of transmission.²

This study aims to identify the epidemiological characteristics and outcomes in pediatric patients with SARS-CoV-2 infection in our clinic, which provided tertiary level care during the pandemic period.

2 | MATERIALS AND METHODS

Our study was a retrospective case series of all ambulatory and hospitalized pediatric patients (aged 1 month–18 years) with a positive test for SARS-CoV-2 viral infection between March 2020 and April 2021.

Our study was approved by the ethics committee of the Ministry of Health (decision number T09_42_13) and Necmettin Erbakan University Meram Faculty of Medicine (decision number 2021/3145).

Demographic data, epidemiologic history, symptoms, contact history, laboratory tests, and treatments were recorded. Fever is defined as a temperature above 100.4°F (38°C) from skin.³ Shortness of breath (dyspnea) is a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity.⁴ Diarrhea is defined from WHO as the passage of three or more loose or liquid stools per day.⁵ Chest X-rays were taken in patients with respiratory symptoms or findings on physical examination. The patients included in the study were divided into age groups as those aged under 1 year, 1–5 years, 6–10 years, 11–15 years, and patients aged over 15 years. The clinical status of the patients and whether they had an underlying disease were evaluated while making the decision to hospitalize the patients. Disease severity was classified as asymptomatic infection, mild, moderate, severe, or critical disease. The diagnostic criteria were as follows.⁶

(1) Asymptomatic infection: There was no clinical sign or symptom; the chest imaging results were normal, polymerase chain reaction (PCR) test was positive.

(2) Mild: There were symptoms of upper respiratory tract infection. Physical examination showed congestion of the pharynx and no auscultatory abnormalities.

(3) Moderate: Patients with pneumonia, frequent fever, and cough were included; some had wheezing or rales.

(4) Severe/critical: There was obvious hypoxemia and respiratory support (invasive or noninvasive) and intensive care are required.

There was no child vaccination in our country at the time of the study.

The diagnosis of asymptomatic infection was made by screening the children at the request of the family in the presence of a positive family member with SARS-Cov-2 infection.

The diagnosis of COVID-19 was made using PCR. During this period, combined nasal and throat swab samples were taken from the patients and transferred to the medical molecular laboratory of Meram Medical Faculty within 30 min in a viral transport medium. First, manual extraction was performed for all samples in the laboratory. Amplification was performed on the obtained extract using the COVID-19 quantitative (Q) reverse transcription-PCR kit (Bio-speedy). The amplification curves obtained using the rotor gene-q (Qiagen) device were monitored on the computer screen and evaluated according to the criteria suggested by the kit manufacturer. This kit provided rapid diagnosis using one-step real-time PCR targeting the RNA-dependent RNA polymerase gene fragment.

Statistical analysis was performed using the IBM SPSS 20.0 package program (IBM Corp.). The frequencies, rates, and mean and

standard deviations of the patients in terms of different variables are presented as descriptive statistics. Skewness and kurtosis values were examined to test the normality assumption before proceeding to the fundamental analysis and the numerical data were evaluated by using visual (histograms, probability plots) programs. Frequency and percentage (%) values are presented for categorical variables, and mean±standard deviation values are presented for continuous variables. χ^2 analysis was used to determine whether there was a difference between the distribution ratios of categorical variables and cross tables were added. In cases where the number of categories for each variable is above three, the groups with the least and most difference in percentages interpreted as different if statistically significant. The significance level for the analysis was determined as $p < 0.05$.

3 | RESULTS

Our study included 467 patients with COVID-19 aged between 1 month and 18 years. The median age of the patients was 5 years (1 month to 18 years), 48% were girls and 52% were boys. One hundred fourteen (24.4%) patients were hospitalized and 353 (75.6%) were followed up as outpatients. The median duration of hospitalization was 6.3 (range 1–65) days. There was no significant relation between sex and hospitalization ($p > 0.05$).

The most common symptoms in our study were fever (61%) and cough (47%). The distribution of patients' symptoms according to age groups was examined. There was no significant difference in terms of cough and runny nose symptoms between the age groups, but fever (88.2%), vomiting (32.4%), and diarrhea (29.4%) were significantly more common in children aged under 1 year; sore throat (36.6%) was significantly more common in those aged 11–15 years; and inability to taste (11%) and smell (14.6%), headache (18.3%), fatigue (40.8%), myalgia (28%), and shortness of breath (17.1%) were significantly more common in children aged over 15 years (Table 1).

In laboratory examinations according to age, under 1 year; leukopenia (30.3%), neutropenia (36.4%), and elevated aspartate aminotransferase (AST) (38.2%), 1–5 years of age; elevated lactate dehydrogenase (LDH) (46.7%), 6–10 years of age; leukocytosis (16.7%), over 15 years of age; lymphopenia (51.7%) and elevated C-reactive protein (CRP) (51.7%) were significantly more common than the other age groups. The laboratory findings of the patients are shown in Table 2.

The patients were graded as clinically asymptomatic, mild, moderate, severe, and critical according to the age groups (Table 3).

χ^2 analysis was performed to evaluate the relationship between patients with high CRP and hospitalization. It was observed that there was a significant relation between the hospitalization rates of patients and high CRP levels, $\chi^2(1) = 21.10$, $p > 0.001$.

In our study, chest X-rays were performed in 383 patients, lung findings were found in 133 (28.5%) patients. Thoracic computed tomography (CT) imaging was performed in 49 (10.5%) patients, significant positive findings for COVID-19 were obtained in 20

TABLE 1 Distribution of symptoms of patients by age groups

| Variables | | <1 year | 1–5 years | 6–10 years | 11–15 years | >15 years | Total | p |
|---------------|---|---------------|----------------|---------------|----------------|---------------|----------------|--------|
| Cough | – | 20 (58.8%) | 62 (55.9%) | 49 (50.5%) | 80 (56.3%) | 36 (43.9%) | 247 (53.0%) | 0.351 |
| | + | 14 (41.2%) | 49 (44.1%) | 48 (49.5%) | 62 (43.7%) | 46 (56.1%) | 219 (47.0%) | |
| Sore throat | – | 34 (100%) | 95 (85.6%) | 77 (78.6%) | 90 (63.4%) | 56 (68.3%) | 352 (75.4%) | <0.001 |
| | + | 0 (0%) | 16 (14.4%) | 21 (21.4%) | 52 (36.6%) | 26 (31.7%) | 115 (24.6%) | |
| Fever | – | 4 (11.8%) | 29 (26.1%) | 39 (39.8%) | 66 (46.5%) | 44 (53.7%) | 182 (39.0%) | <0.001 |
| | + | 30 (88.2%) | 82 (73.9%) | 59 (60.2%) | 76 (53.5%) | 38 (46.3%) | 285 (61.0%) | |
| Loss of smell | – | 34 (100%) | 111 (100%) | 97 (99.0%) | 125 (88.0%) | 70 (85.4%) | 436 (93.4%) | <0.001 |
| | + | 0 (0%) | 0 (0%) | 1 (1.0%) | 17 (12.0%) | 12 (14.6%) | 31 (6.6%) | |
| Loss of taste | – | 34 (100%) | 111 (100%) | 95 (96.9%) | 127 (89.4%) | 73 (89.0%) | 440 (94.2%) | <0.001 |
| | + | 0 (0%) | 0 (0.0%) | 3 (3.1%) | 15 (10.6%) | 9 (11.0%) | 27 (5.8%) | |
| Runny nose | – | 31 (91.2%) | 100 (90.1%) | 80 (81.6%) | 116 (81.7%) | 72 (87.8%) | 399 (85.4%) | 0.203 |
| | + | 3 (8.8%) | 11 (9.9%) | 18 (18.4%) | 26 (18.3%) | 10 (12.2%) | 68 (14.6%) | |
| Headache | – | 34 (100%) | 109 (98.2%) | 82 (83.7%) | 123 (86.6%) | 67 (81.7%) | 415 (88.9%) | <0.001 |
| | + | 0 (0%) | 2 (1.8%) | 16 (16.3%) | 19 (13.4%) | 15 (18.3%) | 52 (11.1%) | |
| Myalgia | – | 33 (97.1%) | 104 (93.7%) | 83 (84.7%) | 106 (74.6%) | 59 (72.0%) | 385 (82.4%) | <0.001 |
| | + | 1 (2.9%) | 7 (6.3%) | 15 (15.3%) | 36 (25.4%) | 23 (28.0%) | 82 (17.6%) | |
| Vomiting | – | 23 (67.6%) | 93 (83.8%) | 82 (83.7%) | 130 (91.5%) | 76 (92.7%) | 404 (86.5%) | 0.002 |
| | + | 11 (32.4%) | 18 (16.2%) | 16 (16.3%) | 12 (8.5%) | 6 (7.3%) | 63 (13.5%) | |
| Diarrhea | – | 24 (70.6%) | 93 (83.8%) | 86 (87.8%) | 129 (90.8%) | 77 (93.9%) | 409 (87.6%) | 0.005 |
| | + | 10 (30.4%) | 18 (16.2%) | 12 (12.2%) | 13 (9.2%) | 5 (6.1%) | 58 (12.4%) | |

(Continues)

TABLE 1 (Continued)

| Variables | | <1 year | 1–5 years | 6–10 years | 11–15 years | >15 years | Total | p |
|---------------------|---|---------|-----------|------------|-------------|-----------|---------|--------|
| | | (29.4%) | (16.2%) | (12.2%) | (9.2%) | (6.1%) | (12.4%) | |
| Shortness of breath | - | 34 | 109 | 94 | 134 | 68 | 439 | <0.001 |
| | | (100%) | (98.2%) | (95.9%) | (94.4%) | (82.9%) | (94.0%) | |
| | + | 0 | 2 | 4 | 8 | 14 | 28 | |
| | | (0.0%) | (1.8%) | (4.1%) | (5.6%) | (17.1%) | (6.0%) | |

(40.8%) patients. Lungs were affected bilaterally in 65% and unilaterally in 35% of patients. Ground-glass opacity was observed in 12 (60%) patients, consolidation in 5 (25%) patients, atelectasis in three (15%) patients, pleural effusion in three (15%) patients, subpleural nodules in one (5%) patient. No findings were in the chest X-ray of three patients in whom ground-glass opacities were seen in thorax CT. There was no relationship between radiological involvement and clinical findings ($p > 0.05$).

Reasons for hospitalization are respiratory distress (46 patients), feeding problem (22 patients), seizure (8 patients), underlying disease (immunodeficiency (16 patients), leukemia (15 patients), diabetes mellitus (4 patients), cerebral palsy (6 patients), cystic fibrosis (3 patients), asthma (1 patient)). Obesity rate was found 11.4% in hospitalized patients. Considering hospitalizations, high hospitalization rates were noted in patients with immunodeficiency (76.1%), leukemia (75%), and cerebral palsy (100%). We observed no complications in the follow-up of patients with immunodeficiency and leukemia. Eight patients were followed up in the intensive care unit. Five patients with cerebral palsy due to respiratory distress, two newly diagnosed diabetic patients with diabetic ketoacidosis and respiratory distress, and one obesity patient with Down syndrome due to respiratory distress were admitted to the intensive care unit. During the study period, we had six cerebral palsy patients, two of them died and tracheostomy was required in the follow-up of three patients.

Favipiravir treatment was given to 20 (17.5%) of 114 patients who were hospitalized. Apart from favipiravir, remdesivir treatment was given to one patient and one patient with anakinra (IL-1 reseptör antagonist) was given to one patient. Prophylactic low-molecular-weight heparin was given to 20 patients in the adolescent age group at risk for thrombosis. Low-dose corticosteroid was given to 30 patients. Thirty patients required oxygen support. In our study, respiratory support was provided to 30 patients. 20 patients received oxygen support by mask, three received high flow oxygen therapy, the rest received oxygen support by mask, 6 patients received mechanical ventilation support, three of them received noninvasive mechanical ventilation (bilevel positive airway pressure), and three received invasive mechanical ventilation support by endotracheal tube. Three patients (0.64%) died during the study period. Two patients with cerebral palsy and one patient with Down syndrome and obesity died of SARS-CoV-2 pneumonia.

4 | DISCUSSION

COVID-19 is mostly asymptomatic or causes a mild infection in children, but it is an important cause of morbidity and mortality with its complications. There is a need for more clinical experience and management schemes in the pandemic, which negatively affects life all over the world.

In a study with 1156 patients, the median age was 10.75 years, 49.7% were girls and 50.3% were boys.⁷ The median age of our study was lower and the sex distribution was similar. In our study, our youngest patient was a 1-month-old infant, which showed that children of all ages were susceptible to COVID-19 and there was no significant sex difference.

The symptoms were fever (61%) and cough (47%) with high rates. Similarly, in the literature, the most common reasons for admission were fever and cough.^{7,8} In a study consisting of 149 patients aged 10 to 19 years, loss of taste or smell was observed in 40 patients (28.4%).⁹ Taste-smell loss, which was at a low rate when all age groups were considered in our study, was found as 26.4% when patients aged over 10 years were evaluated separately. This result suggested that loss of taste and smell should be a warning symptom for COVID-19, especially in the adolescent age group.

When the symptoms at admission were examined by age groups, fever, vomiting, and diarrhea were more common in children aged under 1 year, sore throat and fatigue were more common in the 11–15 years age group, the loss of smell-taste, headache, myalgia, and shortness of breath were more common in the >15 years age group. In a multicenter study, fever was found to be significantly more frequent in the 0–3 years age group, cough in the 0–1 years and >15 years age groups, myalgia in the >15 years age group, and shortness of breath in the 1–3 years age group, with a significantly higher rate compared with other age groups.⁷ Patients aged over 15 years progress with clinical and laboratory findings similar to the young adult patient group.

In our study, leukocytosis (16.7%) was found at significantly higher rates in the 6–10 years age group; leukopenia, neutropenia, elevated AST level in the <1 year age group; lymphopenia and elevated CRP levels in the >15 years age group and elevated LDH levels in the 1–5 years age group compared with the other age groups. In another study, lymphopenia was found to be significantly more frequent in the >15 years age group and elevated AST levels

TABLE 2 Distribution of laboratory parameters of the patients by age groups

| Variables/number of patients | | <1 year | 1–5 years | 6–10 years | 11–15 years | >15 years | Total | p |
|--------------------------------|----------------------------------|---------------|---------------|---------------|---------------|---------------|----------------|------------------|
| Leukocyte | Leukocytosis (>10,000K/ μ l) | 0 (0%) | 8 (9.4%) | 13 (16.7%) | 9 (10.8%) | 8 (13.8%) | 38 (11.3%) | 0.004 |
| | Normal (4,000-10,000K/ μ l) | 23 (69.7%) | 57 (67.1%) | 57 (73.1%) | 68 (81.9%) | 44 (75.9%) | 249 (73.9%) | |
| | Leukopenia (<4000K/ μ l) | 10 (30.3%) | 20 (23.5%) | 8 (10.3%) | 6 (7.2%) | 6 (10.3%) | 50 (14.8%) | |
| Lymphopenia | +(<1500K/ μ l) | 0 (0%) | 21 (24.7%) | 29 (37.2%) | 38 (45.8%) | 30 (51.7%) | 118 (35.0%) | <0.001 |
| | -(>1500K/ μ l) | 33 (100%) | 64 (75.3%) | 49 (62.8%) | 45 (54.2%) | 28 (48.3%) | 219 (65.0%) | |
| Neutropenia | +(<1500K/ μ l) | 12 (36.4%) | 15 (17.6%) | 10 (12.8%) | 6 (7.2%) | 2 (3.4%) | 45 (13.4%) | <0.001 |
| | -(>1500K/ μ l) | 21 (63.6%) | 70 (82.4%) | 68 (87.2%) | 77 (92.8%) | 56 (96.6%) | 292 (86.6%) | |
| Thrombocytopenia | -(>150,000 K/ μ l) | 31 (93.9%) | 80 (94.1%) | 73 (93.6%) | 75 (90.4%) | 55 (94.8%) | 314 (93.2%) | 0.835 |
| | +(<150,000K/ μ l) | 2 (6.1%) | 5 (5.9%) | 5 (6.4%) | 8 (9.6%) | 3 (5.2%) | 23 (6.8%) | |
| C-reactive protein | Normal (<5 mg/L) | 30 (90.9%) | 50 (60.2%) | 55 (72.4%) | 58 (69.9%) | 28 (48.3%) | 221 (66.4%) | <0.001 |
| | High (>5 mg/L) | 3 (9.1%) | 33 (39.8%) | 21 (27.6%) | 25 (30.1%) | 30 (51.7%) | 112 (33.6%) | |
| Ferritin | Normal (30-400 μ g/L) | 14 (87.5%) | 38 (95.0%) | 50 (96.2%) | 64 (98.5%) | 42 (97.7%) | 208 (96.3%) | 0.314 |
| | High (>400 μ g/L) | 2 (12.5%) | 2 (5.0%) | 2 (3.8%) | 1 (1.5%) | 1 (2.3%) | 8 (3.7%) | |
| Lactate dehydrogenase | Normal | 11 (64.7%) | 24 (53.3%) | 38 (63.3%) | 61 (92.4%) | 38 (92.7%) | 172 (75.1%) | <0.001 |
| | High (>300 U/L) | 6 (35.3%) | 21 (46.7%) | 22 (36.7%) | 5 (7.6%) | 3 (7.3%) | 57 (24.9%) | |
| AST-Aspartate aminotransferase | Normal (0–46 U/L) | 21 (61.8%) | 66 (79.5%) | 73 (93.6%) | 79 (97.5%) | 54 (93.1%) | 293 (87.7%) | <0.001 |
| | High (>46 U/L) | 13 (38.2%) | 17 (20.5%) | 5 (6.4%) | 2 (2.5%) | 4 (6.9%) | 41 (12.3%) | |
| ALT-Alanine aminotransferase | Normal (0–45 U/L) | 31 (91.2%) | 73 (89.0%) | 76 (97.4%) | 77 (96.3%) | 54 (93.1%) | 311 (93.7%) | 0.189 |
| | High (>45 U/L) | 3 (8.8%) | 9 (11.0%) | 2 (2.6%) | 3 (3.8%) | 4 (6.9%) | 21 (6.3%) | |

TABLE 3 Distribution of clinical grading of the patients by age groups

| Clinical grading | <1 year | | 1–5 years | | 6–10 years | | 11–15 years | | >15 years | |
|------------------|---------|------|-----------|------|------------|------|-------------|------|-----------|------|
| | n | % | n | % | n | % | n | % | n | % |
| Asymptomatic | 1 | 2.9 | 8 | 7.2 | 10 | 10.2 | 12 | 8.5 | 4 | 4.9 |
| Mild | 25 | 73.5 | 87 | 78.4 | 79 | 80.6 | 116 | 82.3 | 59 | 72 |
| Moderate | 7 | 20.6 | 10 | 9 | 3 | 3.1 | 8 | 5.6 | 7 | 8.5 |
| Severe | 1 | 2.9 | 6 | 5.4 | 5 | 5.1 | 5 | 3.5 | 10 | 12.2 |
| Critical | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 1.3 | 2 | 2.4 |

were found as significantly higher rates in the 0–1 years age group compared with other age groups.⁷ This supports that the effect of COVID-19 on laboratory parameters in children is similar to other viral infections. In a comprehensive meta-analysis, it was found that under 1 year of age, elevated CRP levels were found in 42%, lymphopenia in 33%, elevated LDH levels in 50%, elevated AST levels in 33%, elevated alanine aminotransferase (ALT) levels in 47%, and elevated creatinine kinase (CK) levels in 88%.⁸ In our study, in patients aged under 1 year, elevated CRP levels were found in 9.1%, lymphopenia in 0%, elevated LDH levels in 35.3%, elevated AST levels in 38.2%, elevated ALT levels in 8.8%, and elevated CK levels in 6.3% of children. The rate of critically ill patients aged under 1 year was 14% in the meta-analysis, but we had no critically ill patients aged under 1 year in our study.

In our study, a significant correlation was found between high CRP levels and hospitalization. In another study, a significant correlation was shown between disease severity and lung involvement area and elevated CRP levels.⁹

The clinical severity of the majority of children is mild or asymptomatic, which has been attributed to the low number of angiotensin-converting enzyme-2 receptors in the nasal epithelium of children to which the virus binds, their anatomically shorter respiratory tract, and their immunity against previous common coronavirus infection.¹⁰ In a study conducted with 2135 patients, it was found that 94 (4.4%) were asymptomatic, 1088 (51%) had mild disease, and 826 (38.7%) had moderate disease.¹¹ In our study, 365 (78.1%) patients had mild disease and five (1.07%) were critically ill.

Since respiratory system involvement is common in COVID-19, radiologic evaluation is important in the diagnosis and follow-up. The fact that the rate of patients with findings on chest X-ray was lower than in other studies was attributed to the early admission of the patients to the hospital and the majority being asymptomatic or having mild and moderate disease. To protect children from radiation risk, thoracic CT should be performed only in selected patients and at low doses. In a meta-analysis, the rate of normal imaging was 41%, ground-glass opacity was 36%, bilateral patchy infiltration was 28%, local patchy infiltration was 26%, white lung was 2%, and pleural effusion was 2%.⁸ In our study, thorax CT imaging was performed in 49 (10.5%) patients. Significant findings in terms of COVID-19 were obtained in 20 (40.8%) of those patients. In our study and other pediatric studies, the incidence of lung involvement and ground-glass

opacity was lower than in adults. This situation is associated with the children's progress with mild clinical findings.

It is known that the mortality rate is high in patients with COVID-19 who have an underlying disease.¹² The most common underlying diseases in our study were immunodeficiency and leukemia. No complications developed in patients with these diseases.

Symptomatic and supportive treatments are important in COVID-19. Favipiravir treatment was given to 20 of 114 patients who we hospitalized. Our favipiravir-treated patients were in the adolescent group and their clinical grades were moderate, severe, and critical. Although recent evidence state that favipiravir is not effective on treatment, more clinical studies are needed to evaluate the efficacy and safety of favipiravir for COVID-19 treatment.¹³ Thromboembolic events in children are rare, but it should be known that children are at risk for thrombosis.¹⁴ No patients developed thromboembolism in our study. Prophylactic low-molecular-weight heparin was given to 20 patients in the adolescent age group who were at risk for thrombosis.

In selected patients, positive effects of corticosteroid use on morbidity and mortality were observed. Although dexamethasone is not recommended for use in mild and moderate disease, it is recommended for patients in need of oxygen.¹⁵ Low-dose steroid treatment was given to 30 patients who we followed in our clinic.

Two of our patients who died were diagnosed as having cerebral palsy, and one with Down syndrome and obesity. This showed us that the underlying cerebral palsy was an important cause of mortality in patients with COVID-19. The frequency of respiratory tract diseases and the risk of death in patients with Down syndrome are known.¹⁶ Increased adipose tissue, insulin resistance, dyslipidemia, high proinflammatory cytokine levels, and low intake of essential nutrients are factors that compromise the functioning of organs and systems in individuals with obesity.¹⁷

There is some limitations in our study. Our study was conducted for hospitalized children, but population based studies should be conducted to understand the general characteristics of COVID-19 in children.

As a result, based on the experience we gained during 1-year period after the COVID-19 pandemic, it can be concluded that COVID-19 often progresses asymptotically or mildly in children, but it rarely progresses severely, and patients may have different clinical presentations depending on age groups.

AUTHORS CONTRIBUTIONS

Mustafa Gençeli, Özge Metin Akcan collected the data and wrote the article; Özge Metin Akcan, Sevgi Pekcan, Ahmet Osman Kılıç and Abdullah Yazar collected the data; Özge Metin Akcan, Fatih Akin and Ahmet Osman Kılıç managed the diagnosis, and follow-up of the patients; Mehmet Özdemir made the statistical analysis; Özge Metin Akcan contributed in the study design and the discussion; Mustafa Gençeli, Özge Metin Akcan planned the study and supervised the whole manuscript. All authors approved the manuscript before submission for publication.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

- World Health Organization. *World Health Organisation director general announced pandemic*. 2020. Accessed March 11, 2020. Available at: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19>
- De Souza TH, Nadal JA, Nogueira RJ, Pereira RM, Brandão MBJPP. Clinical manifestations of children with COVID-19: a systematic review. *Pediatr Pulmonol*. 2020;55:1892-1899.
- Davies A. Fever in children. *Nurs Stand*. 2014;29(1):61.
- Bausewein C, Simon ST. Shortness of breath and cough in patients in palliative care. *Dtsch Arztebl Int*. 2013;110(33-34):563-571.
- World Health Organization. *Diarrhoea in the Western Pacific*. Available at: <https://www.who.int/westernpacific/health-topics/diarrhoea>
- Society of Pediatrics Chinese Medical Association; Editorial Board Chinese Journal of Pediatrics. Recommendations for the diagnosis, prevention, and control of the 2019 novel coronavirus infection in children (first interim edition). *Zhonghua Er Ke Za Zhi*. 2020;58:E004.
- Karbuş A, Akkoc G, Demirdag TB, et al. Epidemiological, clinical, and laboratory features of children with COVID-19 in Turkey. *Front Pediatr*. 2021;9:631547.
- Cui X, Zhao Z, Zhang T, et al. A systematic review and meta-analysis of children with coronavirus disease 2019 (COVID-19). *J Med Virol*. 2021;93:1057-1069.
- Wang L. C-reactive protein levels in the early stage of COVID-19. *Med Mal Infect*. 2020;50(4):332-334.
- Chatziparasidis G, Kantar A. COVID-9 in Children with Asthma. *Lung*. 2021;199(1):7-12.
- Dong Y, Mo X, Hu Y. Epidemiological characteristics of 2143 pediatric patients with 2019 coronavirus disease in China. *J Emerg Med*. 2020;145:e20200702.
- D'antiga LJLT. Coronaviruses and immunosuppressed patients: the facts during the third epidemic. *Liver Transpl*. 2020;26:832-834.
- Hassanipour S, Arab-Zozani M, Amani B, Heidarzad F, Fathalipour M, Martinez-de-Hoyo R. The efficacy and safety of Favipiravir in treatment of COVID-19: a systematic review and meta-analysis of clinical trials. *Sci Rep*. 2021;11(1):1-11.
- Joshi S, Parkar J, Ansari A, et al. Role of favipiravir in the treatment of COVID. *Int J Infect Dis*. 2021;102:501-508.
- Recovery Collaborative Group, Horby P, Lim WS, Emberson JR, et al. Dexamethasone in hospitalized patients with Covid-19. *N Engl J Med*. 2021;384(8):693-704.
- Colvin KL, Yeager ME. What people with Down Syndrome can teach us about cardiopulmonary disease. *Eur Respir Rev*. 2017;26:160098.
- Kumar L, Kahlon N, Jain A, Kaur J, Singh M, Pandey AJ. Loss of smell and taste in COVID-19 infection in adolescents. *Int J Pediatr Otorhinolaryngol*. 2021;142:110626.

How to cite this article: Gençeli M, Metin Akcan Ö, Pekcan S, et al. Outcomes of COVID-19 Infections in children: a single-center retrospective study. *Pediatric Pulmonology*. 2022;57:2533-2539. doi:10.1002/ppul.26070