A Descriptive Study on Children with COVID-19 Admitted at the Isolation Unit of Assiut University Children's Hospital

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Abstract:

Background: COVID-19 predominantly affected adults but also led to severe cases in children, including multisystem inflammatory syndrome (MIS-C).

Aims: This study analyzed the demographic, clinical, and laboratory factors associated with severe outcomes in pediatric COVID-19 patients.

Methods: A retrospective descriptive study was conducted between January 1st, 2021, and December 31st, 2022, at Assiut University Children's Hospital. The study involved 157 children (≤ 18 years) with RT-PCR-confirmed COVID-19. Of these, 78 had complete clinical data, which were analyzed to identify factors influencing survival.

Results: The cohort's mean age was 7.2 ± 5.27 years, with school-aged children (29.9%) most affected. The mortality rate was 22.9%. Non-survivors (n=27) had higher rates of comorbidities, including interstitial lung disease, chronic liver disease, and malnutrition. They also exhibited more severe clinical manifestations, such as cyanosis, altered consciousness, and anuria, along with higher rates of severe respiratory distress, elevated inflammatory markers, and multi-organ dysfunction. Radiological findings showed a greater prevalence of CO-RADS 5 in non-survivors, indicating more severe lung involvement.

Conclusion: Pediatric COVID-19 outcomes were influenced by age, comorbidities, and clinical severity. Infants, children with pre-existing comorbidities, and those with severe respiratory distress or multi-organ dysfunction faced higher risks of poor outcomes. Early identification and management of high-risk patients are crucial to improving survival rates.

Keywords: SARS-CoV-2; Pediatric COVID-19; MIS-C; Comorbidities; CO-RADS; Egypt.

Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in late 2019 in China [1]. Declared a pandemic by the WHO in March 2020 [2, 3]. By July 2020, the pandemic had caused over 15.6 million cases and 638,000 deaths globally, including 90,413 confirmed cases and 4,480 deaths in Egypt [4, 5].

Children typically experienced milder COVID-19 and lower mortality than adults [6]. However, the emergence of multisystem inflammatory syndrome (MIS-C), a rare post-COVID complication in children necessitates further investigation [7]. The Centers for Disease Control (CDC) defines MIS-C as a severe illness requiring hospitalization, presenting with fever (≥ 38°C for ≥ 24 hours), involvement of at least two organ systems, and laboratory evidence of inflammation (e.g., elevated CRP, ESR, etc.), along with evidence of SARS-CoV-2 infection [7].

Mild COVID-19 in children is managed with home isolation, paracetamol for fever, and hydration [8]. Severe cases require intensive care to maintain oxygen saturation (>92%) and hemodynamic stability, with empirical antibiotics for suspected sepsis [8].

The current study aims to describe the demographic and clinical characteristics of children with COVID-19 admitted to the isolation unit of Assiut University Children's Hospital, assess the risk factors for complications and poor prognosis, and evaluate their clinical outcomes.

Methodology:

This retrospective descriptive study was conducted from January 1st, 2021, to December 31st, 2022, at the isolation unit of Assiut University Children's Hospital. Ethical approval was obtained (IRB number 17101750), with consent waived due to the study's retrospective nature; patient confidentiality was maintained.

Inclusion Criteria: All children (up to 18 years) confirmed by RT-PCR to have COVID-19 and admitted to the isolation Unit of Assiut University Children's Hospital from January 1st, 2021, to December 31st, 2022.

Exclusion Criteria: Clinically suspected patients approved by CT chest and RT-PCR who are not infected with COVID-19.

Sample Size: The sample size for this study was determined using a total coverage sample technique. A total of 157 children were enrolled, representing all eligible cases during the two years. Demographic data, including age, gender, and residence, as well as the outcomes of their management, were analyzed for all 157 cases. However, complete clinical data were available for a subset of 78 cases within this cohort.

Data Collection: Data collection involved reviewing medical records for demographics, symptoms, comorbidities, nutritional history, Grades of respiratory distress (Grade 1: Tachypnea, Grade 2: Subcostal and intercostal retraction, Grade 3: Grunting, Grade 4: Cyanosis) [9], physical findings, laboratory results (CBC, coagulation profile, liver/renal function, LDH, serum ferritin, D-dimer, cardiac enzymes, CRP) and chest CT scans with CO-RADS classification. Data also included oxygen support requirements.

Statistical Analysis: Using IBM SPSS version 20 involved descriptive statistics (frequency, percentages, mean, and standard deviation) and inferential statistics (Chi-square test for categorical variables, Student's t-test for continuous variables). A 95% confidence interval and 5% margin of error were used; $p < 0.05$ was considered statistically significant.

Results:

The study included 157 children, with a mean age of 7.2 ± 5.27 years. School-aged children (29.9%) were most affected, and females slightly outnumbered males (53.5% vs. 46.5%). Most patients (63.7%) were from rural areas, and the mortality rate was 22.9% (Table 1).

Among the 78 children with complete clinical data, there were 51 survivors and 27 non-survivors. Infants were more common in non-survivors ($p = 0.041$), while adolescents were more frequent in survivors ($p = 0.011$). Non-survivors were more likely to be below the 3rd percentile for weight ($p = 0.002$) (Table 2).

Non-survivors had more comorbidities (81.5% vs. 58.8%, $p = 0.043$), with higher rates of interstitial lung disease (ILD), chronic liver disease (CLD), and malnutrition ($p = 0.015$, $p = 0.015$, $p = 0.049$, respectively) (Table 3).

Cyanosis ($p = 0.000$), disturbed consciousness ($p = 0.001$), anuria ($p = 0.001$), and bruising ($p = 0.045$) were also more common in non-survivors (Table 4).

Respiratory distress grades 1 and 2 were more frequent in survivors ($p = 0.001$, $p = 0.003$), while grades 3 and 4 were more common in non-survivors ($p = 0.001$, $p = 0.000$) (Table 4).

Gasping, ecchymosis, congestive heart failure, and shock were also more common in non-survivors ($p = 0.027$ for gasping, $p = 0.045$ for ecchymosis, $p = 0.012$ for congestive heart failure, $p = 0.000$ for shock) (Table 4).

Non-survivors had higher rates of absolute neutrophilia ($p = 0.001$),

monocytopenia (p = 0.018), increased prothrombin time (PT) (p = 0.001), decreased prothrombin concentration (PC) (p = 0.003), elevated international normalized ratio (INR) (p = 0.000), and elevated liver enzymes (ALT: p = 0.005, AST: p = 0.006). Additionally, non-survivors exhibited higher instances of hypernatremia (p = 0.000), hypokalemia (p = 0.012), and hypocalcemia (p = 0.042). Elevated cardiac enzymes were also more common in non-survivors (p = 0.009). (Table 5).

CO-RADS 4 was higher in survivors (p = 0.000), while CO-RADS 5 was more common in non-survivors (p = 0.000) (Table 6).

Nasal oxygen use was more frequent in survivors (p = 0.000), while non-rebreathing masks and invasive ventilation were more common in non-survivors (p = 0.004, p = 0.009) (Table 7).

Table 1: Demographic data and fate of Children with COVID-19 (n=157)

Characteristic	Frequency (%)
Age Group, n (%)	
Infants (2 months to 1 year)	26 (16.6%)
Toddlers (>1 to 2 years)	15 (9.6)
Preschoolers (>2 to 5 years)	31 (19.7%)
School-aged children (6 to 12 years)	47 (29.9%)
Adolescents (>12 to 18 years)	38 (24.2%)
Sex, n (%)	
Female	84 (53.5%)
Male	73 (46.5%)
Residence, n (%)	
Rural	100 (63.7%)
Urban	57 (36.3%)
Fate	
Recovery	80 (51.0%)
Death	36 (22.9%)
Transfer to another unit	23 (14.6%)
Discharge on Demand	18 (11.5%)

Table 2: Comparing survivors and non-survivors regarding age and body weight for age

	Non-survivor group (N=27)	Survivor group(N=51)	p-value*
Age groups			
Infants (up to 1 year)	9 (33.3%)	7 (13.7%)	0.041
Toddlers (> 1 to 2 years)	3 (11.1%)	4 (7.8%)	0.631
Preschoolers (> 2 to 5 years)	6 (22.2%)	7 (13.7%)	0.338
School-aged children (6 to 12 years)	7 (25.9%)	16 (31.4%)	0.616
Adolescents (> 12 to 18 years)	2 (7.4%)	17 (33.3%)	0.011
Weight for age < third percentile	14 (51.9%)	9 (17.6%)	0.002

*Chi-square test used

Table 3: Comparing survivors and non-survivors regarding comorbidities

	Non-survivor group (N=27)	Survivor group(N=51)	p-value*
Any comorbidity	22(81.5%)	30(58.8%)	0.043
Chronic kidney disease	7(25.9%)	11(21.6%)	0.665
Interstitial lung disease	3(11.1%)	0(0.0%)	0.015
Chronic liver disease	3(11.1%)	0(0.0%)	0.015
Malnutrition (marasmus)	2(7.4%)	0(0.0%)	0.049

*Chi-square test used

Table 4: Comparing survivors and non-survivors regarding clinical manifestations

Symptoms/signs	Non-survivor group (N=27)	Survivor group(N=51)	p-value*
General manifestations:			
Fever	20 (74.07%)	43 (84.31%)	0.275
Poor Oral Intake	7 (25.93%)	8 (15.69%)	0.275
Respiratory manifestations:			
Shortness of Breath	26 (96.30%)	44 (86.27%)	0.165
Dry Cough	20 (74.07%)	38 (74.51%)	0.967
Respiratory Distress (Grade 1)	1 (3.7%)	19 (37.3%)	0.001
Respiratory Distress (Grade 2)	2 (7.4%)	20 (39.2%)	0.003
Respiratory Distress (Grade 3)	9 (33.3%)	3 (5.9%)	0.001
Respiratory Distress (Grade 4)	14 (51.9%)	6 (11.8%)	0.000
Gasping	4 (14.8%)	1 (2.0%)	0.027
Crepitations	25 (92.6%)	44 (86.3%)	0.406
Stridor/Croupy Cough	0 (0.0%)	2 (3.9%)	0.297
Gastrointestinal manifestations:			
Vomiting	12 (44.44%)	14 (27.45%)	0.130
Abdominal Pain	5 (18.52%)	16 (31.37%)	0.223
Diarrhea	6 (22.22%)	7 (13.73%)	0.338
Hepatobiliary manifestations:			
Jaundice	2 (7.4%)	2 (3.9%)	0.506
Hepatomegaly	5 (18.5%)	4 (7.8%)	0.160
Neurological manifestations:			
Convulsions	9 (33.33%)	14 (27.45%)	0.588
Irritability	4 (14.81%)	4 (7.84%)	0.334
Disturbed Conscious Level	19 (70.37%)	15 (29.41%)	0.001
Flaccid Paralysis with lost gag reflex	0 (0.0%)	1(2.0%)	0.465
Hematological manifestations:			
Pallor	14 (51.85%)	27 (52.94%)	0.927
Ecchymosis	11 (40.74%)	10 (19.61%)	0.045
Renal manifestations:			
Oliguria	8 (29.63%)	6 (11.76%)	0.050
Anuria	7 (25.93%)	1 (1.96%)	0.001
Cardiovascular manifestations:			
Tachycardia	23 (85.2%)	39 (76.5%)	0.365
Congestive Heart Failure	14(51.9%)	12(23.5%)	0.012
Shock	15 (55.6%)	8 (15.7%)	0.000
Dermatological Manifestations:			
Maculopapular Rash	1 (1.3%)	0 (0.0%)	1(2.0%)

*Chi-square test used

Table 5: Comparing survivors and non-survivors regarding laboratory investigations

	Non-survivor group (N=27)	Survivor group(N=51)	p-value*
Anemia (decreased HB)	14 (51.9%)	30 (58.8%)	0.555
Leucopenia	2 (7.4%)	9 (17.6%)	0.216
Leucocytosis	9 (33.3%)	14 (27.5%)	0.588
Absolute neutrophilia	18 (66.7%)	14(27.5%)	**0.001**
Absolute lymphopenia	12 (44.4%)	24(47.1%)	0.826
Monocytopenia	10 (37.0%)	7(13.7%)	**0.018**
Thrombocytopenia	10 (37.0%)	16(31.4%)	0.614
Thrombocytosis	5 (18.5%)	10(19.6%)	0.906
Increased PT	14 (51.9%)	8(15.7%)	**0.001**
Decreased PC	13 (48.1%)	8(15.7%)	**0.003**
Increased INR	14 (51.9%)	7(13.7%)	**0.000**

	Non-survivor group (N=27)	Survivor group(N=51)	p-value*
Increased total bilirubin	5 (18.5%)	7(13.7%)	0.577
Increased ALT	15 (55.6%)	12(23.5%)	0.005
increased AST	16 (59.3%)	14(27.5%)	0.006
Hypoalbuminemia	17 (63.0%)	17(33.3%)	0.012
Raised serum creatinine	11 (40.7%)	16(31.4%)	0.408
Hypernatremia	11 (40.7%)	3(5.9%)	0.000
Hypokalemia	7 (25.9%)	3(5.9%)	0.012
Hypocalcemia	16 (59.3%)	18(35.3%)	0.042
Elevated LDH	18 (66.7%)	30(58.8%)	0.222
Elevated serum ferritin	18 (66.7%)	33(64.7%)	0.863
Elevated D-dimer	23 (85.2%)	45(88.2%)	0.635
Elevated CRP	24 (88.9%)	42(82.4%)	0.559
Elevated cardiac enzymes	5 (18.5%)	1 (2.0%)	0.009

*Chi-square test used

Table 6: Comparing survivors and non-survivors regarding CORADS classification

	Non-survivor group (N=27)*	Survivor group(N=51) *	p-value*
CORADs 2	1(5.9%)	0(0.0%)	0.147
CORADs 3	0(0.0%)	6(17.1%)	0.070
CORADs 4	1(5.9%)	23(65.7%)	0.000
CORADs 5	15(88.2%)	6(17.1%)	0.000

**Chi-square test used; CT chest was not done for (16 cases) * in the recovery group and (10 cases)• in the death group.

Table 7: Comparing survivors and non-survivors regarding oxygen support at admission

	Non-survivor group (N=27)*	Survivor group(N=51)	p-value*
Nasal O2	5(18.5%)	32(62.7%)	0.000
O2 Mask	10(37.0%)	10(19.6%)	0.093
Non-rebreathing Mask	7(25.9%)	2(3.9%)	0.004
Mechanical ventilation	5(18.5%)	1(2.0%)	0.009

Discussion

This study examines the demographic, clinical, and laboratory data of children with COVID-19 admitted to the Assiut University Children's Hospital isolation unit from January 1, 2021, to December 31, 2022. A total of 157 children were included, with 78 having complete clinical data, selected based on the availability of full medical records.

Our study found that most affected children were school-aged (29.9%), followed by adolescents (24.2%), with a slight female predominance (male-to-female ratio of 0.87). Rural residents were more affected (63.7%). The age distribution aligns with other studies, such as Göktuğ et al. (2021) [10], which reported 67.6% of cases in the 6-18 age group, and Sanders et al. (2022) [11], with 61.1% of cases in children over 6 years of age. These trends suggest higher COVID-19 prevalence among older children due to more social contact. However, our slight female predominance contrasts with studies like Göktuğ et al. (2021) [10] and Ibrahim et al. (2023) [12], which reported male predominance. Noman et al. (2021) [13] found a similar female predominance (male-to-female ratio of 0.49). This difference may reflect local factors or methodological variations. Our finding of higher infection rates in rural

communities is consistent with Leatherby (2020) [14] and Sun and Monnat (2022) [15], who highlighted lower vaccination rates in rural areas.

Among the 78 children with complete clinical data, we observed significant differences between survivors (51 patients) and non-survivors (27 patients):

We found that Infants were more prevalent among non-survivors (p=0.041), while adolescents (12-18 years) were more common among survivors (p=0.011). This suggests that a very young age may be a risk factor for poor outcomes in pediatric COVID-19. Additionally, children below the 3rd percentile for weight-for-age were significantly overrepresented in the non-survivor group (p=0.002), indicating that failure to thrive may contribute to increased mortality risk.

When comparing our findings with other studies (Alfraij et al., 2021 [16]; Abdelaziz et al., 2023 [17]; and Maheshwari et al., 2022 [18]), there were both similarities and differences. Alfraij et al. (2020) [16] reported a trend toward higher median age in non-survivors (10.3 years) compared to survivors (2.13 years). Maheshwari et al. (2022) [18] also noted a trend toward older age in non-survivors. This contrasts with our findings, suggesting a complex relationship between age and mortality in pediatric COVID-19. Our observation of failure to thrive as a risk factor appears unique, highlighting a potential area for further clinical attention and research.

In our research, non-survivors had a significantly higher prevalence of at least one comorbidity (p=0.043), particularly ILD, CLD, and malnutrition (p=0.015, p=0.015, and p=0.049, respectively). Alfraij et al. (2020) [16] reported higher rates of neurological disease and complex conditions in non-survivors, while Maheshwari et al. (2022) [18] noted higher rates of organ dysfunction. These findings underscore the importance of carefully managing and monitoring patients with pre-existing comorbidities.

In the current study, non-survivors presented more frequently with cyanosis, disturbed consciousness, anuria, and bruising ($p < 0.001$, p=0.001, p=0.001, p=0.045). Respiratory distress was a key differentiator, with non-survivors showing higher rates of grades 3 and 4 distress (p=0.001 and $p < 0.001$). At admission, non-survivors were more likely to require non-rebreathing masks (p=0.004) and invasive mechanical ventilation (p=0.009). These clinical findings align with other studies, including Maheshwari et al. (2022) [18] and Abdelaziz et al. (2023) [17], which reported higher rates of shock, respiratory symptoms, and need for mechanical ventilation in non-survivors.

Our investigations revealed that non-survivors showed higher rates of neutrophilia, monocytopenia, coagulation abnormalities, liver function derangements, electrolyte imbalances, and elevated cardiac enzymes. These findings suggest multi-organ involvement and a more severe systemic response in fatal cases. These laboratory abnormalities were similar to those observed in comparative studies, including Maheshwari et al. (2022) [18] and Abdelaziz et al. (2023) [17], which reported elevated inflammatory markers and organ dysfunction in non-survivors. Alfraij et al. (2020) [16] noted lower platelet and lymphocyte counts in non-survivors, while Maheshwari et al. [18] found raised CPK-MB levels, similar to our study. However, Maheshwari et al. noted significant differences in D-dimer levels, which were not the case in our study, indicating variability in clinical presentations and laboratory findings across different populations.

We found that CO-RADS 5 was significantly more common in non-survivors ($p<0.001$), indicating more severe lung involvement. This radiological finding, especially the higher prevalence of CO-RADS 5 in non-survivors, provides valuable prognostic information, which has not been extensively explored in other studies.

In our study, 51% of patients were discharged after complete recovery, while

22.9% experienced mortality. Additionally, 14.6% were transferred for further management of associated medical issues, and 11.5% were discharged on family request. Our mortality rate (22.9%) aligns with Maheshwari et al. (2022) [18] at 27.6% and Abdelaziz et al. (2023) [17] at 33.3% for MIS-C patients. However, it exceeds rates reported by Ahmed et al. (2021) [19] at 14.8% and Alfraij et al. (2020) [16] at 16%, highlighting differences across settings and populations. Factors contributing to our higher mortality include the high prevalence of comorbidities (66.7%) and the focus on severe cases admitted to tertiary care.

The main limitations of this study include the small sample size, single-hospital setting, and potential selection bias, as it only included hospitalized children, which may over-represent severe cases. As a retrospective study, it relies on incomplete medical records. Additionally, CT chest scans were not performed on all patients due to financial and clinical constraints, limiting lung involvement assessment. The absence of a control group also restricts comparisons with non-infected populations.

Conclusion

In conclusion, COVID-19 affected children across various age groups, with school-aged children and adolescents being the most impacted. A slight female predominance was observed, and rural children were more affected. Comorbidities, particularly chronic kidney disease, were common. Symptoms ranged from mild to severe, with fever, dry cough, and shortness of breath being the most frequent. Laboratory findings included anemia, leucocytosis, lymphopenia, neutrophilia, impaired coagulation, elevated liver/ renal chemistry, electrolyte disturbances, elevated inflammatory markers, and cardiac enzymes. Most patients had CO-RADS 4 or 5 on the CT chest. Six out of the 78 children required mechanical ventilation upon admission; COVID-19 was more severe in infants, especially with failure to thrive, comorbidities, severe clinical signs (shock, desaturation, cyanosis, DCL, anuria, and bruising), higher respiratory distress grades, need for higher O2 support, mechanical ventilation, laboratory abnormalities (neutrophilia, monocytopenia, impaired coagulation, raised liver enzymes, electrolyte disturbances, and elevated cardiac enzymes), and CORADS 5 on CT chest. The mortality rate was (22.9%).

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