J Bras Pneumol. 2023;49(5):e20230151
https://dx.doi.org/10.36416/1806-3756/e20230151

ORIGINAL ARTICLE

One-year follow-up of children hospitalized with COVID-19: a prospective cohort study

Caroline Jacoby Schmidt[1], Giovana Morin Casassola[2], Guilherme Hoff Affeldt[1], Debora Sana Morais[3], Letícia Krás Borges Alvarenga[4], Cristina Miller[5], Bruna Ziegler[1]

1. Programa de Pós-Graduação em Ciências Pneumológicas, Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.
2. Residente Multiprofissional em Saúde da Criança, Hospital de Clínicas de Porto Alegre – HCPA – Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.
3. Programa de Pós-Graduação em Pesquisa Clínica, Departamento de Fisioterapia, Hospital de Clínicas de Porto Alegre – HCPA – Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.
4. Departamento de Fisioterapia, Hospital de Clínicas de Porto Alegre – HCPA – Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.
5. Programa de Pós-Graduação em Saúde da Criança e do Adolescente, Departamento de Fisioterapia, Hospital de Clínicas de Porto Alegre – HCPA – Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.

Submitted: 26 April 2023.
Accepted: 12 September 2023.

Study carried out at the Hospital de Clínicas de Porto Alegre – HCPA – Universidade Federal do Rio Grande do Sul – UFRGS – Porto Alegre (RS) Brasil.

ABSTRACT

Objective: Currently, little is known about the long-term outcomes of COVID-19 in the pediatric population. The aim of this study was to investigate the long-term clinical outcomes of pediatric patients hospitalized with COVID-19. **Methods:** This was a prospective cohort study involving unvaccinated children and adolescents admitted to a tertiary hospital in southern Brazil with a COVID-19 diagnosis. Data were collected from electronic medical records for one year after the diagnosis. **Results:** A total of 66 children were included: the median age was 2.9 years; 63.6% were male; and 48.5% were under 2 years of age. Over 70% had at least one comorbidity prior to the COVID-19 diagnosis. During the one-year follow-up period, 59.1% of the children revisited the emergency department, 50% required readmission, and 15.2% died. Younger children with longer hospital stays were found to be at greater risk of readmission. Having cancer and impaired functionality were found to increase the risk of death within one year. **Conclusions:** Our findings indicate that most children hospitalized with COVID-19 have comorbidities. Younger age at admission and a longer hospital stay seem to be risk factors for readmission. In addition, the presence of cancer and impaired functionality are apparently associated with the poor outcome of death within the first year after the diagnosis of COVID-19.

Keywords: COVID-19; Pediatrics; Physical functional performance.

INTRODUCTION

The new coronavirus was first identified in November 2019 in the city of Wuhan, China, after a series of unspecified pneumonia cases occurred in the city. Since then, SARS-CoV-2 infection, which can lead to COVID-19, has been widely studied worldwide.[1]

It is known that the rates of contamination are lower and the symptoms of COVID-19 are milder in the pediatric population than in the adult population.[2,3] In addition, the rates of hospitalization for COVID-19 are lower in the pediatric population,[4] and most children hospitalized for COVID-19, on wards or in ICUs, have had preexisting comorbidities.[2,3]

Because of the milder presentation of the disease and lower hospitalization rates, COVID-19-related mortality is also significantly lower in the pediatric population.[5] In a multicenter study, conducted mostly in the United States, mortality rates of approximately 1.8% were reported.[6] A study conducted with a Brazilian national COVID-19 database showed that 7.6% of children hospitalized for COVID-19 died during their hospital stay.[7] Among pediatric patients, mortality rates are higher for those under 2 years of age and for those between 12 and 19 years, as well as for those with preexisting comorbidities.[6,7]

After hospital discharge, adult and pediatric patients may still have COVID-19 symptoms, a phenomenon known as long COVID or post-acute sequelae of COVID-19.[8] Studies show that, among children and adolescents with COVID-19, requiring ICU admission and having more comorbidities are associated with presenting more symptoms in the long term, the most common symptoms being fatigue, exercise intolerance, and dyspnea.[9,10] However, few studies have addressed the long-term clinical outcomes in children who were hospitalized with COVID-19.

A recent multicenter study conducted in the United States showed that 11% of pediatric patients hospitalized with COVID-19 were readmitted to the hospital within four months after discharge.[10] However, there have been few studies evaluating readmissions and late mortality

Correspondence to:
Bruna Ziegler. Rua Ramiro Barcelos 2350, Serviço de Fisioterapia, Santa Cecília, CEP 90035-903, Porto Alegre, RS, Brasil.
Tel.: 55 51 3359-8000. Email: brunaziegler@yahoo.com.br
Financial support: This study received financial support from the *Fundo de Incentivo à Pesquisa* (FIPE, Research Incentive Fund) of the Hospital de Clínicas de Porto Alegre (Protocol no. 2022-0122).

among pediatric patients hospitalized with a diagnosis of COVID-19. Therefore, the aim of this study was to investigate the long-term clinical outcomes of pediatric patients hospitalized with COVID-19.

METHODS

This was a prospective cohort study involving unvaccinated children diagnosed with COVID-19 and admitted to the *Hospital de Clínicas de Porto Alegre* (HCPA) between March 2020 and July 2021. Patients were followed by monitoring of their electronic medical records for one year after the diagnosis. This research was approved by the HCPA Research Ethics Committee (Reference no. 57286822000005327), and the study protocol was in accordance with the ethical precepts on research involving humans outlined in Brazilian National Health Council Resolution no. 466/2012.

Sociodemographic data and laboratory test results were collected from electronic medical records. Data regarding hospital admission, including the date of admission, nutritional status, prematurity, signs and symptoms of the disease, and presence of comorbidities, were collected, as were the results of laboratory tests, such as arterial blood gases and C-reactive protein. During hospitalization, the need for ventilatory support—such as oxygen therapy, high-flow nasal cannula use, and noninvasive/invasive ventilation—and for admission to the pediatric ICU (PICU) were recorded. After hospital discharge, follow-up was carried out by reviewing electronic medical records, and information on emergency room visits, hospital admissions, and death was recorded for one year after the diagnosis of COVID-19. All patients admitted to the HCPA Department of Pediatrics with a diagnosis of COVID-19, as confirmed by a positive RT-PCR for SARS-CoV-2,[11,12] were included in the study.

For each of the children included in the study, the level of functionality was assessed in the first 24 h after hospital admission by applying the Functional Status Scale (FSS), which has been translated and validated for use in the pediatric population of Brazil.[13] The FSS assesses six domains of functionality, and the total score ranges from 6 to 30 points, a higher score indicating worse functionality.[13-15] The individuals were stratified into two groups for analysis: those with an FSS score ≤ 9 (preserved functioning or mild dysfunction); and those with an FSS score ≥ 10 points (moderate, severe, or very severe dysfunction).

Variables are expressed as absolute values and percentages or as medians and interquartile ranges. To assess the normality of continuous variables, the Shapiro-Wilk test was used. Univariate and multivariate Cox regression analyses were performed, the dependent variable being death within the first year after diagnosis. We also performed univariate and multivariate Poisson regression analyses with robust variance, in which the dependent variable was hospital readmission within one year. Data were stored in Microsoft Office Excel and analyzed with the Predictive Analytics Software package, version 18.0 (SPSS Inc., Chicago, IL, USA). The level of statistical significance adopted was 5% ($p < 0.05$).

RESULTS

The study included 66 unvaccinated children diagnosed with COVID-19: 42 (63.6%) were male; 32 (48.5%) were under 2 years of age; and the median age was 2.9 years (IQR, 0.4-9.5 years). The most common symptoms were fever (in 75.8%), cough (in 50.0%), hypoxemia (in 40.9%), rhinorrhea (in 37.9%), and diarrhea (in 25.8%). Of the 66 children evaluated, 48 (72.7%) had at least one comorbidity prior to being diagnosed with COVID-19. The most common comorbidities were cancer (in 21.2%) and respiratory disease (in 19.7%). More than 18% of the children in the sample had been born prematurely. The median length of hospital stay was 10 days (IQR, 6.0-24.5 days). Ventilatory support was required for 27 patients (40.9%), and 23 patients (34.8%) were admitted to the PICU. Table 1 shows the characteristics of the patients.

Premature birth was significantly more common among the patients under 2 years of age ($p = 0.008$). However, C-reactive protein levels were significantly higher among the patients over 2 years of age ($p = 0.000$), who also had significantly more comorbidities ($p = 0.004$), mainly cancer.

By the end of the one-year follow-up period, 39 (59.1%) of the children had revisited the HCPA Emergency Department and 33 (50.0%) had been readmitted to the hospital. Of the 33 readmissions, 4 (12.1%) were caused by a new SARS-CoV-2 infection and 27 (81.8%) were caused by complications of an underlying disease (preexisting comorbidity): cancer, in 36%; metabolic disorders, in 18%; neurological disorders, in 18%; respiratory diseases, in 15%; cardiovascular diseases, in 9%; and gastrointestinal disorders, in 6%. Of the 33 children who required readmission, only 6 (18.2%) were previously healthy. Of those 6 children, 4 were readmitted for respiratory problems, due to acute viral bronchiolitis in all four cases. One child was readmitted eight times during the one-year follow-up period because of sequelae and respiratory complications, requiring mechanical ventilation and failing ventilator weaning repeatedly, which led to the need for a tracheostomy during the fourth hospital stay. Readmission for nonrespiratory causes was identified in two children: one had a urinary tract infection, and the other had gastrointestinal symptoms.

By the end of the one-year follow-up period, 10 (15.2%) of the children had died. All of the deaths were in children who had had at least one preexisting comorbidity at the initial hospital admission, the most common comorbidity being cancer, which was present in 8 of those 10. Two deaths (20%) were due to acute respiratory distress syndrome caused by COVID-19, and seven (70%) were due to progression of the underlying disease: four due to ventilatory failure

Table 1. Characteristics of children hospitalized with COVID-19, overall and by age.[a]

Characteristic	Total (N = 66)	< 2 years of age (n = 32)	≥ 2 years of age (n = 34)	p
Male	42 (63.6)	20 (62.5)	22 (64.7)	0.835
White	56 (84.8)	27 (84.4)	29 (85.3)	0.918
Age (years)	2.9 [0.4-9.5]	0.4 [0.2-1.2]	9.2 [6.0-11.2]	0.000
Hospital stay (days)	10.0 [6.0-24.7]	8.0 [5.0-31.0]	12.5 [7.0-25.2]	0.277
Comorbidities	48 (72.7)	18 (56.2)	30 (88.2)	0.004
Respiratory disease	13 (19.7)	4(12.5))	9 (26.5)	0.157
Cancer	14 (21.2)	4 (12.5)	10 (29.4)	0.96
Prematurity	12 (18.2)	10 (31.2)	2 (5.9)	0.008
Asymptomatic	6 (9.1)	3 (9.7)	3 (9.7)	0.968
Fever	50 (75.8)	23 (71.9)	27 (79.4)	0.479
Cough	33 (50.0)	16 (50.0)	17 (50.0)	1.000
Hypoxemia	27 (40.9)	10 (33.3)	17 (56.7)	0.072
Rhinorrhea	25 (37.9)	13 (40.6)	12 (35.3)	0.658
Diarrhea	17 (25.8)	10 (31.2)	7 (20.6)	0.326
C-reactive protein (mg/L)	23.5 (3.5-77.8)	2 (1-17)	63 (28-139)	0.000
Ventilatory support required	27 (40.9)	14 (43.8)	13 (38.2)	0.651
PICU admission	23 (34.8)	8 (25)	15 (44.1)	0.106
IMV required	12 (18.2)	5 (15.6)	7 (20.6)	0.604
FSS score	8 (6-10)	7 (6-10)	8 (6.2-10)	0.922
Adequate functionality	46 (69.7)	22 (68.8)	24 (70.6)	0.872
Death during first hospitalization	5 (7.5)	2 (3.0)	3 (4.5)	0.97
Readmission	33 (50.0)	19 (59.4)	14 (41.2)	0.143
Death within one year	10 (15.2)	2 (6.2)	8 (23.5)	0.052

PICU: pediatric ICU; IMV: invasive mechanical ventilation; and FSS: Functional Status Scale. [a]Values expressed as n (%) or as median [IQR].

and three due to septic shock. One death (10%) was associated with septic shock after bone marrow transplantation. Five deaths (50%) occurred during the first hospitalization after the COVID-19 diagnosis (3 children had cancer, 1 had a respiratory disease, and 1 had a metabolic disorder). The five other deaths occurred during readmissions (4 children had cancer, and 1 had a metabolic disorder).

Table 2 shows the results of the univariate and multivariate linear regression analyses in which the dependent variable was readmission within one year. In the multivariate analysis, the dependent variable was found to be significantly associated with age ($\beta = 0.589$; $p = 0.036$) and with the length of hospital stay during the first admission ($\beta = 1.004$; $p = 0.007$).

Table 3 shows the results of the univariate and multivariate linear regression analyses in which the dependent variable was death within the first year after diagnosis. In the multivariate analysis, the dependent variable was found to be significantly associated with the FSS score ($\beta = 1.235$, $p = 0.001$) and with a diagnosis of cancer ($\beta = 33.516$, $p < 0.001$).

DISCUSSION

In the present study, pediatric patients hospitalized with COVID-19 were evaluated and over 70% were found to have had at least one comorbidity, cancer having been the most common. During the one-year follow-up period after the diagnosis of COVID-19, approximately 59% of the children revisited the pediatric emergency room and 50% required readmission. In addition, approximately 15% of the children died during that period, and all of those children had at least one comorbidity prior to being diagnosed with COVID-19. We demonstrated that the younger children and those with longer hospital stays were at a higher risk for readmission during the first year after a COVID-19 diagnosis, as well as that children with cancer and children with impaired functionality were at a higher risk of death within one year after the diagnosis.

A multicenter study conducted in the United States showed lower rates of hospital readmission than those found in the present study. Maddux et al. observed that 11% of patients were readmitted within a period of 2-4 months after the initial discharge, and only one patient was healthy before prior to COVID-19 diagnosis. In their study, readmissions were associated with exacerbations of underlying diseases.[10] In our study, most patients requiring readmission had at least one preexisting comorbidity. Therefore, we can assume that the readmissions of our patients were also associated with exacerbations of the underlying diseases. These data corroborate previous findings in the literature.

In the present study, the risk of readmission within one year after the diagnosis of COVID-19 was found to be higher among the younger patients. We believe that to be a novel finding. However, it is known that

Table 2. Univariate and multivariate Poisson regression analyses with robust variance with readmission within one year as the dependent variable.

Characteristic	Univariate analysis			Multivariate analysis		
	PR	95% CI	p	PR	95% CI	p
Age (years)	0.664	0.498-0.885	0.30	0.589	0.892-0.996	0.036
Length of hospital stay	1.005	1.002-1.008	0.001	1.004	1.001-1.007	0.007
Prematurity	1.687	1.084-2.626	0.020	-	-	-

PR: prevalence ratio.

Table 3. Univariate and multivariate Cox regression analyses with death within one year as the dependent variable.

Characteristic	Univariate analysis			Multivariate analysis		
	HR	95% CI	p	HR	95% CI	p
FSS score	1.133	1.022-1.257	0.017	1.235	1.095-1.391	0.001
Cancer	16.749	3.536-79.332	0.000	33.516	5.747-195.456	< 0.001
Age (years	1.183	1.042-1.343	0.009	-	-	-
C-reactive protein	1.007	1.002-1.013	0.005	-	-	-
PICU admission	4.847	1.252-18.770	0.022	-	-	-

HR: hazard ratio; FSS: Functional Status Scale; and PICU: pediatric ICU.

the disease is more severe in infants, and being under one month of age is considered an important risk factor for admission to the PICU.[5,16] Being under 2 years of age has also been identified as a risk factor for death from COVID-19.[7,17,18]

The results of our analyses also indicate that a longer hospital stay after admission for COVID-19 increases the risk of a second hospitalization within one year after the first. The median length of hospital stay observed in our study was 10 days, considerably longer than the 3-6 days reported in previous studies.[10,17,19,20] That difference may be related to the heterogeneity of the studies and the different levels of complexity of the children included in the study samples.

To date, there have been few follow-up and mortality studies in the pediatric population with COVID-19.[6] In our study sample, the one-year mortality rate was 15.2%, which is considerably higher than the rates reported elsewhere. In a multicenter study that evaluated a sample of children hospitalized with COVID-19, Bhalala et al. demonstrated a 0.3% mortality rate at 28 days after discharge.[6] However, the median age was higher in their sample than in ours and the rates of preexisting comorbidities were lower in their sample, both of which could have influenced the differences between the results of the two studies. Notably, none of our patients had been immunized against COVID-19 and only two died from acute respiratory distress syndrome caused by COVID-19; all of the other deaths were associated with exacerbation of the underlying disease, which may have been related to COVID-19 sequelae.

Approximately 7.5% of the children in our sample died during hospitalization, which is similar to the outcome reported by Oliveira et al.[7] However, studies conducted in high-income countries have reported lower mortality rates.[5,6,11,19] In a systematic review involving a collective sample of approximately 3,800 children who died from COVID-19, Kitano et al. demonstrated that the mortality rates were higher in low- and middle-income countries than in high-income countries, the former group accounting for over 90% of the deaths from COVID-19 in the pediatric population.[18] Notably, the hospital where the present study was carried out is a referral center for the treatment of highly complex chronic diseases in southern Brazil and regularly receives critically ill patients, a fact that could explain the higher mortality rate in our sample.

In our study sample, the risk of death within one year after the diagnosis of COVID-19 was found to be higher among the children with cancer. Previous studies have shown that the rates of COVID-19-related mortality are higher for children with cancer than for healthy children or even for children with other comorbidities.[21-24] However, to our knowledge, there have been no studies evaluating the association between cancer and death within one year after the diagnosis of COVID-19 in pediatric patients. Despite the fact that patients with cancer are at a greater risk of developing the more severe forms of COVID-19,[22] Węcławek-Tompol et al. observed that children with cancer have a 97.3% probability of survival to 100 days after a diagnosis of COVID-19.[25]

In the present study, impaired functionality at hospital admission was also identified as a risk factor for death within one year after the diagnosis of COVID-19. Casassola et al. demonstrated that over half of children hospitalized with COVID-19 have impaired functionality, which they found to be associated with a longer hospital stay and a greater likelihood of requiring ventilatory support.[26] Their findings suggest that pediatric patients with reduced functionality tend to develop the more severe forms of COVID-19 and that one-year mortality rates would therefore be higher among such patients, thus corroborating our findings.

The study conducted by Maddux et al.[10] also underscored the importance of assessing the functionality of pediatric patients with COVID-19 during hospitalization. The authors found that 9% of their patients presented a deterioration in functionality

by the end of the hospital stay and that 3% had an even worse FSS score at the end of the follow-up, demonstrating that the functionality of pediatric patients may change even up to four months after discharge.[10] On the basis of these findings, we can assume that pediatric patients will continue to develop post-COVID-19 sequelae in the long term, resulting in a loss of functionality, which may be associated with death within one year after diagnosis.

Finally, over 70% of the patients in our study sample had at least one preexisting comorbidity and all of the patients who died during the one-year follow-up period were in that group. Similar data can be found in the literature.[17,26] Most of the children hospitalized with COVID-19 have preexisting comorbidities.[7,10,11] The presence of comorbidities is considered a risk factor for the development of more severe COVID-19 and for unfavorable outcomes such as death.[2,5,7,10,17]

Our study has some limitations. The data were obtained from local electronic medical records, which made it impossible to monitor readmissions at other health facilities. In addition, our study sample was heterogeneous, including patients with a variety of preexisting comorbidities, which could have influenced the mortality rates. Furthermore, only severe cases (those requiring hospitalization) were included, so our findings cannot be extrapolated to the pediatric population at large. Moreover, this was a single-center study and the sample size was small. Despite these limitations, our study has the longest follow-up of pediatric patients with COVID-19 to date.

We reiterate that most of the children diagnosed with COVID-19 had comorbidities, and that this characteristic was present in all of the cases with a fatal outcome. Younger age and longer hospital stays appear to be related to a higher risk of readmission. The presence of cancer and impaired functionality were associated with a greater risk of death within the first year after the diagnosis of COVID-19. Currently, little is known about the long-term consequences of COVID-19 in the pediatric population, which underscores the importance of our results. Our study adds to the literature some important risk factors to be monitored and emphasizes the importance of long-term follow-up, especially in pediatric patients who require hospitalization for COVID-19.

ACKNOWLEDGMENTS

The authors would like to thank all study collaborators and participants.

AUTHOR CONTRIBUTIONS

CJS, GMC, GHA, DSM, LKBA, CM, and BZ: literature search.

CJS, GMC, GHA, and BZ: data collection.

CJS, GMC, DSM, LKBA, CM, and BZ: study design.

CJS, GMC, and BZ: analysis of data.

CJS, GMC, GHA, DSM, LKBA, CM, and BZ: manuscript preparation.

DSM, LKBA, CM, and BZ: manuscript revision.

All of the authors read and approved the final version of the manuscript.

CONFLICTS OF INTEREST

None declared.

REFERENCES

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020;382(8):727-733. https://doi.org/10.1056/NEJMoa2001017
2. Bailey LC, Razzaghi H, Burrows EK, Bunnell HT, Camacho PEF, Christakis DA, et al. Assessment of 135 794 Pediatric Patients Tested for Severe Acute Respiratory Syndrome Coronavirus 2 Across the United States. JAMA Pediatr. 2021;175(2):176-184. https://doi.org/10.1001/jamapediatrics.2020.5052
3. Shekerdemian LS, Mahmood NR, Wolfe KK, Riggs BJ, Ross CE, McKiernan CA, et al. Characteristics and Outcomes of Children With Coronavirus Disease 2019 (COVID-19) Infection Admitted to US and Canadian Pediatric Intensive Care Units. JAMA Pediatr. 2020;174(9):868-873. https://doi.org/10.1001/jamapediatrics.2020.1948
4. Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. Acta Paediatr. 2020;109(6):1088-1095. https://doi.org/10.1111/apa.15270
5. Swann OV, Holden KA, Turtle L, Pollock L, Fairfield CJ, Drake TM, et al. Clinical characteristics of children and young people admitted to hospital with covid-19 in United Kingdom: prospective multicentre observational cohort study. BMJ. 2020;370:m3249. https://doi.org/10.1136/bmj.m3249
6. Bhalala US, Gist KM, Tripathi S, Boman K, Kumar VK, Retford L, et al. Characterization and Outcomes of Hospitalized Children With Coronavirus Disease 2019: A Report From a Multicenter, Viral Infection and Respiratory Illness Universal Study (Coronavirus Disease 2019) Registry. Crit Care Med. 2022;50(1):e40-e51. https://doi.org/10.1097/CCM.0000000000005232
7. Oliveira EA, Colosimo EA, Simões e Silva AC, Mak RH, Martelli DB, Silva LR, et al. Clinical characteristics and risk factors for death among hospitalised children and adolescents with COVID-19 in Brazil: an analysis of a nationwide database. Lancet Child Adolesc Health. 2021;5(8):559-568. https://doi.org/10.1016/S2352-4642(21)00134-6
8. Raveendran AV. Long COVID-19: Challenges in the diagnosis and proposed diagnostic criteria. Diabetes Metab Syndr. 2021;15(1):145-146. https://doi.org/10.1016/j.dsx.2020.12.025
9. Asadi-Pooya AA, Nemati H, Shahisavandi M, Akbari A, Emami A, Lotfi M, et al. Long COVID in children and adolescents [published correction appears in World J Pediatr. 2022 Jul 3;:]. World J Pediatr. 2021;17(5):495-499. https://doi.org/10.1007/s12519-021-00457-6
10. Maddux AB, Berbert L, Young CC, Feldstein LR, Zambrano LD, Kucukak S, et al. Health Impairments in Children and Adolescents After Hospitalization for Acute COVID-19 or MIS-C. Pediatrics. 2022;150(3):e2022057798. https://doi.org/10.1542/peds.2022-057798
11. Badal S, Thapa Bajgain K, Badal S, Thapa R, Bajgain BB, Santana MJ. Prevalence, clinical characteristics, and outcomes of pediatric COVID-19: A systematic review and meta-analysis. J Clin Virol. 2021;135:104715. https://doi.org/10.1016/j.jcv.2020.104715
12. Wölfel R, Corman VM, Guggemos W, Seilmaier M, Zange S, Müller MA, et al. Virological assessment of hospitalized patients with COVID-2019 [published correction appears in Nature. 2020 Dec;588(7839):E35]. Nature. 2020;581(7809):465-469. https://doi.org/10.1038/s41586-020-2196-x

13. Bastos VCS, Carneiro AAL, Barbosa MDSR, Andrade LB. Brazilian version of the Pediatric Functional Status Scale: translation and cross-cultural adaptation. Rev Bras Ter Intensiva. 2018;30(3):301-307. https://doi.org/10.5935/0103-507X.20180043
14. Pereira GA, Schaan CW, Ferrari RS, Normann TC, Rosa NV, Ricachinevsky CP, et al. Functional Status Scale: Cross-Cultural Adaptation and Validation in Brazil. Pediatr Crit Care Med. 2019;20(10):e457-e463. https://doi.org/10.1097/PCC.0000000000002051
15. Pollack MM, Holubkov R, Glass P, Dean JM, Meert KL, Zimmerman J, et al. Functional Status Scale: new pediatric outcome measure. Pediatrics. 2009;124(1):e18-e28. https://doi.org/10.1542/peds.2008-1987
16. Oualha M, Bendavid M, Berteloot L, Corsia A, Lesage F, Vedrenne M, et al. Severe and fatal forms of COVID-19 in children. Arch Pediatr. 2020;27(5):235-238. https://doi.org/10.1016/j.arcped.2020.05.010
17. Sharma AG, Kumar V, Sodani R, Sapre A, Singh P, Saha A, et al. Predictors of mortality in children admitted with SARS-CoV-2 infection to a tertiary care hospital in North India. J Paediatr Child Health. 2022;58(3):432-439. https://doi.org/10.1111/jpc.15737
18. Kitano T, Kitano M, Krueger C, Jamal H, Al Rawahi H, Lee-Krueger R, et al. The differential impact of pediatric COVID-19 between high-income countries and low- and middle-income countries: A systematic review of fatality and ICU admission in children worldwide. PLoS One. 2021;16(1):e0246326. https://doi.org/10.1371/journal.pone.0246326
19. Marks KJ, Whitaker M, Anglin O, Milucky J, Patel K, Pham H, et al. Hospitalizations of Children and Adolescents with Laboratory-Confirmed COVID-19 - COVID-NET, 14 States, July 2021-January 2022. MMWR Morb Mortal Wkly Rep. 2022;71(7):271-278. https://doi.org/10.15585/mmwr.mm7107e4
20. Shi DS, Whitaker M, Marks KJ, Anglin O, Milucky J, Patel K, et al. Hospitalizations of Children Aged 5-11 Years with Laboratory-Confirmed COVID-19 - COVID-NET, 14 States, March 2020-February 2022. MMWR Morb Mortal Wkly Rep. 2022;71(16):574-581. https://doi.org/10.15585/mmwr.mm7116e1
21. Corso MCM, Soares VJ, Amorim AMP, Cipolotti R, Magalhães IMQ, Lins MM, et al. SARS-CoV-2 in children with cancer in Brazil: Results of a multicenter national registry. Pediatr Blood Cancer. 2021;68(12):e29223. https://doi.org/10.1002/pbc.29223
22. Schlage S, Lehrnbecher T, Berner R, Simon A, Toepfner N. SARS-CoV-2 in pediatric cancer: a systematic review. Eur J Pediatr. 2022 Apr;181(4):1413-1427. https://doi.org/10.1007/s00431-021-04338-y
23. Madhusoodhan PP, Pierro J, Musante J, Kothari P, Gampel B, Appel B, et al. Characterization of COVID-19 disease in pediatric oncology patients: The New York-New Jersey regional experience. Pediatr Blood Cancer. 2021;68(3):e28843. https://doi.org/10.1002/pbc.28843
24. Mukkada S, Bhakta N, Chantada GL, Chen Y, Vedaraju Y, Faughnan L, et al. Global characteristics and outcomes of SARS-CoV-2 infection in children and adolescents with cancer (GRCCC): a cohort study. Lancet Oncol. 2021;22(10):1416-1426. https://doi.org/10.1016/S1470-2045(21)00454-X
25. Węcławek-Tompol J, Zakrzewska Z, Gryniewicz-Kwiatkowska O, Pierlejewski F, Bień E, Zaucha-Prażmo A, et al. COVID-19 in pediatric cancer patients is associated with treatment interruptions but not with short-term mortality: a Polish national study [published correction appears in J Hematol Oncol. 2022 May 31;15(1):71]. J Hematol Oncol. 2021;14(1):163. https://doi.org/10.1186/s13045-021-01181-4
26. Casassola GM, Schmidt CJ, Affeldt GH, Morais DS, Alvarenga LKB, Miller C, et al. Functional status of hospitalized pediatric patients with COVID-19 in southern Brazil: a prospective cohort study. J Bras Pneumol. 2023;48(6):e20220153. https://doi.org/10.36416/1806-3756/e20220153