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COVID-19 CHARACTERIZATION IN A PEDIATRIC ONCOLOGY SERVICE: CROSS-SECTIONAL STUDY

CARACTERIZAÇÃO DA COVID-19 EM UM SERVIÇO DE ONCOLOGIA INFANTO-JUVENIL: ESTUDO TRANSVERSAL

CARACTERIZACIÓN DE LA COVID-19 EN UN SERVICIO DE ONCOLOGÍA INFANTOJUVENIL: ESTUDIO TRANSVERSAL

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Abstract: Children and teenagers with cancer who contract COVID-19 have increased risks compared to the general pediatric population. However, there is a scarcity of information about this specific group in our regional context. The objective of this study was to describe the clinical characteristics of COVID-19 in children and adolescents treated at a reference children's hospital for cancer treatment. This was a cross-sectional study, based on the analysis of medical records of patients treated between March 2020 and May 2021, with SARS-CoV-2 infection. Fifteen patients were diagnosed with COVID-19, aged between 2 and 20 years; 73.3% were male. Eleven required hospitalizations. The most frequent symptoms were cough, runny nose, fever, dyspnea, headache, and gastrointestinal manifestations; four patients remained asymptomatic. Regarding the oncological diagnosis, seven had leukemia, five had central nervous system (CNS) tumors, and three had solid tumors. Laboratory tests revealed leukopenia with neutropenia. Radiological findings included diffuse pulmonary infiltrate, consolidation, and a pattern suggestive of Acute Respiratory Distress Syndrome (ARDS). Two patients developed severe conditions and required mechanical ventilation; both had CNS tumors and were classified as obese and overweight. We observed a higher frequency of hospitalization among symptomatic patients and those who used a higher number of medications. All patients recovered and were discharged. We conclude that, despite the high hospitalization rate, the clinical evolution in this series was favorable. The data reinforce the importance of continuous surveillance, testing and isolation protocols, as well as specialized clinical support and preventive strategies to ensure the continuity of cancer treatment and better clinical outcomes.
Keywords: Cancer; child; adolescent; COVID-19; SARS-CoV-2.

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Resumo: Crianças e adolescentes com câncer que contraem COVID-19 apresentam riscos aumentados em comparação à população pediátrica geral. No entanto, há escassez de informações sobre esse grupo específico em nosso contexto regional. O objetivo desse trabalho foi descrever as características clínicas da COVID-19 em crianças e adolescentes atendidos em um hospital infantojuvenil de referência no tratamento oncológico. Este foi um estudo transversal, baseado na análise de prontuários de pacientes atendidos entre março de 2020 e maio de 2021, com infecção por SARS-CoV-2. Foram diagnosticados 15 pacientes com COVID-19, com idades entre 2 e 20 anos; 73,3% do sexo masculino. Onze necessitaram de internação. Os sintomas mais frequentes foram tosse, coriza, febre, dispneia, cefaleia e manifestações gastrointestinais; quatro pacientes permaneceram assintomáticos. Quanto ao diagnóstico oncológico, sete tinham leucemia, cinco tumor de sistema nervoso central (SNC) e três tumores sólidos. Exames laboratoriais evidenciaram leucopenia com neutropenia. Achados radiológicos incluíram infiltrado pulmonar difuso consolidação e padrão sugestivo de Síndrome de Desconforto Respiratório Agudo (SDRA). Dois pacientes evoluíram com quadros graves e necessitaram de ventilação mecânica; ambos apresentavam tumores de SNC e estavam classificados como obeso e sobrepeso. Observamos maior frequência de hospitalização entre os pacientes sintomáticos e os que utilizaram um número mais elevado de medicamentos. Todos os pacientes se recuperaram e receberam alta. Concluímos que, apesar da alta taxa de internação, a evolução clínica nesta série foi favorável. Os dados reforçam a importância da vigilância contínua, de protocolos de testagem e isolamento, bem como do suporte clínico especializado e de estratégias preventivas a fim de garantir a continuidade do tratamento oncológico e melhores desfechos clínicos.
Palavras-chave: Câncer, criança, adolescente, COVID-19, SARS-CoV-2

Resumen: Los niños y adolescentes con cáncer que contraen COVID-19 tienen mayores riesgos en comparación con la población pediátrica general. Sin embargo, hay escasez de información sobre este grupo específico en nuestro contexto regional. El objetivo de este estudio fue describir las características clínicas de la COVID-19 en niños y adolescentes tratados en un hospital infantil de referencia para el tratamiento del cáncer. Este fue un estudio transversal, basado en el análisis de los registros médicos de pacientes tratados entre marzo de 2020 y mayo de 2021, con infección por SARS-CoV-2. Quince pacientes fueron diagnosticados con COVID-19, de entre 2 y 20 años; el 73,3% eran varones. Once requirieron hospitalización. Los síntomas más frecuentes fueron tos, rinorrea, fiebre, disnea, dolor de cabeza y manifestaciones gastrointestinales; cuatro pacientes permanecieron asintomáticos. Con respecto al diagnóstico oncológico, siete tenían leucemia, cinco tenían tumores del sistema nervioso central (SNC) y tres tenían tumores sólidos. Las pruebas de laboratorio revelaron leucopenia con neutropenia. Los hallazgos radiológicos incluyeron infiltrado pulmonar difuso, consolidación y un patrón sugestivo de síndrome de dificultad respiratoria aguda (SDRA). Dos pacientes desarrollaron afecciones graves y requirieron ventilación mecánica; ambos presentaban tumores del SNC y estaban clasificados como obesos y con sobrepeso. Observamos una mayor frecuencia de hospitalización entre los pacientes sintomáticos y aquellos que utilizaban un mayor número de medicamentos. Todos los pacientes se recuperaron y fueron dados de alta. Concluimos que, a pesar de la alta tasa de hospitalización, la evolución clínica en esta serie fue favorable. Los datos refuerzan la importancia de la vigilancia continua, los protocolos de pruebas y aislamiento, así como el apoyo

clínico especializado y las estrategias preventivas para garantizar la continuidad del tratamiento oncológico y mejores resultados clínicos.
Palabras clave: Cáncer; niño; adolescente; COVID-19; SARS-CoV-2.

1 INTRODUCTION

Infection with SARS-CoV-2 in the pediatric population is less frequent and typically less severe than in adults and the elderly. Children and adolescents account for less than 2% of symptomatic cases, with hospitalization rates ranging from 0.6% to 20% and mortality between 0% and 4%—substantially lower than in adults (Pan American Health Organization [PAHO], 2024; Ministério da Saúde, 2021). In most cases, pediatric patients present with mild respiratory symptoms, fever, fatigue, or remain asymptomatic (Lu et al., 2020; Castagnoli et al., 2020; Santos et al., 2022). However, a subset of children may experience severe complications, requiring intensive care unit (ICU) admission due to acute respiratory illness or multisystem inflammatory syndrome in children (MIS-C) associated with COVID-19. MIS-C is characterized by fever, hypotension, gastrointestinal symptoms, cardiac dysfunction, and laboratory evidence of cytokine storm occurring several weeks after primary infection. Known risk factors for severe disease progression include obesity, pulmonary disease, gastrointestinal disorders, and neurological comorbidities (Radia et al., 2021).

Information regarding the impact of COVID-19 on pediatric cancer patients remains limited. Early reports suggested that severe disease was rare in this population (Millen et al., 2021), although subsequent data indicate a higher prevalence of severe outcomes compared to the general pediatric population (Madhusoodhan et al., 2021). More recent studies have identified increased risks in this group, including higher rates of hospitalization, ICU admission, and mortality. Additional concerns have arisen regarding delays in cancer diagnosis and interruptions in treatment schedules, which are critical given the aggressive nature and short latency of most pediatric malignancies. Chemotherapy regimens are often prolonged, and data on the long-term impact of SARS-CoV-2—including potential direct toxicity to target organs—are still scarce (Kotecha, 2020; Meena et al., 2021; Kahn et al., 2022).

The Global COVID-19 and Childhood Cancer Registry, coordinated by St. Jude Children's Research Hospital, is among the largest longitudinal datasets on this topic, primarily documenting cases from South America, Africa, and Asia. As of March 2024, the registry reported 1,514 pediatric cancer patients with COVID-19 across 51 countries (St. Jude Global, 2024). A parallel study in the United States reported 2,239 pediatric oncology cases as of April 2023 (Johnston et al., 2020). In Brazil, there is currently no unified national registry specific to COVID-19 in pediatric cancer patients.

Brazil has experienced one of the highest pediatric COVID-19 mortality rates globally, with 23 deaths per million inhabitants, compared to fewer than 2 per million in the United States—a discrepancy largely attributed to socioeconomic vulnerabilities (Sousa et al., 2022). An analysis of national data revealed that 82,055 children and adolescents were hospitalized with COVID-19, with disparities in healthcare access, poverty, and comorbidities contributing to increased vulnerability and worse outcomes compared to high-income countries (Oliveira et al., 2021). In the Vale do Paraíba region of São Paulo State, a descriptive study in the municipality of

Taubaté reported 677 pediatric cases of SARS-CoV-2 infection from March to November 2020, representing 10.1% of total cases in the municipality during that period (Santos et al., 2022).

The CTFM-GACC Hospital (Center for Pediatric Treatment Fabiana Macedo de Moraes – Support Group for Children with Cancer), located in São José dos Campos, São Paulo, is accredited by the UNACON (High Complexity Assistance Unit in Pediatric Oncology) as a center of excellence in pediatric oncology, serving patients from the Vale do Paraíba, North Coast, and Mantiqueira Mountains regions.
Given the lack of national studies on COVID-19 in pediatric oncology patients in Brazil, this study aims to describe the epidemiological, clinical, laboratory, and radiological characteristics, as well as the treatments and clinical outcomes, of children and adolescents diagnosed with COVID-19 and treated at the CTFM-GACC Hospital.

2 MATERIALS AND METHODS

This cross-sectional study included patients aged 0 to 21 years with a confirmed diagnosis of cancer, either undergoing active treatment or in outpatient follow-up after chemotherapy, radiotherapy, and/or surgery. All patients were treated at the CTFM-GACC Hospital (Center for Pediatric Treatment Fabiana Macedo de Moraes – Support Group for Children with Cancer), located in São José dos Campos, São Paulo, between March 2020 and May 2021.

Patients who exhibited signs and symptoms consistent with COVID-19 and tested positive by real-time reverse transcription polymerase chain reaction (RT-PCR) and/or serological rapid test (positive IgG and/or IgM) were included in the study. Informed consent was obtained from all participants or their legal guardians, in accordance with the protocol approved by the Research Ethics Committee of the University of Taubaté (Approval No. 6,308,484).

Clinical data were extracted from medical records, including age, sex, nutritional status, type of malignancy, COVID-19-related signs and symptoms, laboratory parameters (complete blood count, D-dimer, coagulation profile, fibrinogen), and chest radiography findings. Information on the type of care provided was also recorded, including the need for hospitalization, medications administered, oxygen therapy, and clinical outcomes.

Nutritional classification was determined using anthropometric data collected on the day of hospitalization and analyzed using the WHO Anthro and WHO Anthro Plus software tools (Pan American Health Organization [PAHO], 2025).
Descriptive statistics were reported as absolute and relative frequencies for categorical variables and medians with interquartile ranges (IQRs) for continuous variables. The primary outcome was hospitalization during the study period, recorded as a binary variable (yes/no).

Associations between categorical variables and hospitalization status were assessed using Pearson's chi-square test or Fisher's exact test, depending on the distribution of expected cell counts. Fisher's exact test was used when any expected value was <5. For continuous variables with non-normal distribution (e.g., age), the Mann–Whitney U test was employed to compare medians between hospitalized and non-hospitalized patients.

Statistical significance was defined as $p < 0.05$. Due to the small sample size, certain comparisons could not be tested statistically when all patients within a

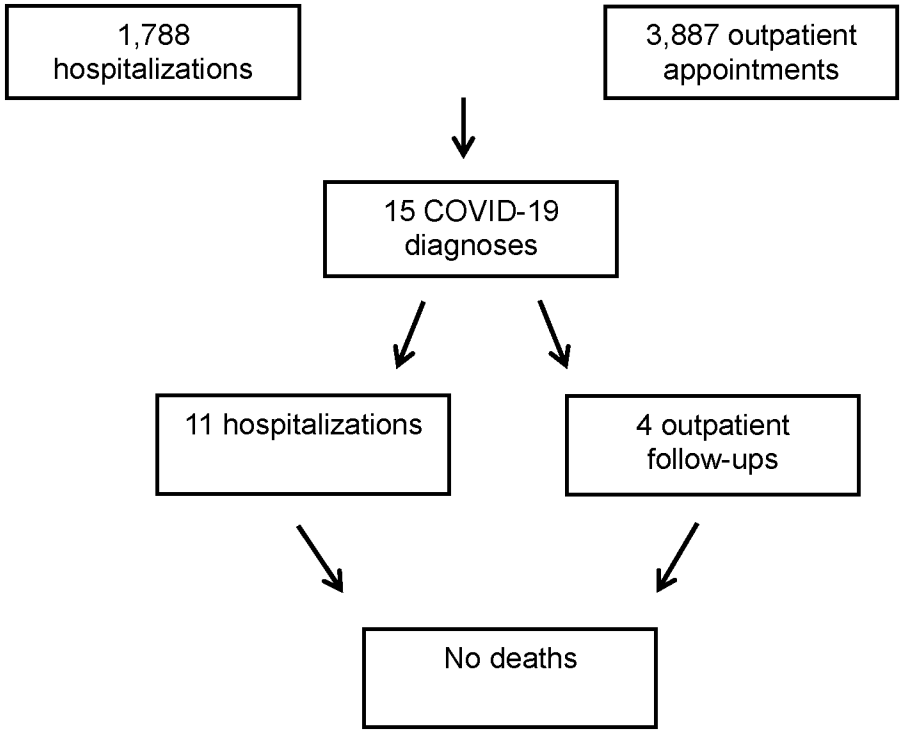
category shared the same outcome. All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA).

3 RESULTS

Between March 2020 and May 2021, a total of 1,788 hospital admissions and 3,887 outpatient consultations for children and adolescents with cancer were recorded at the CTFM-GACC Hospital. During this period, 15 patients were diagnosed with COVID-19, of whom 14 tested positive by RT-PCR and one by serological testing (IgG/IgM).

Among the confirmed cases, 11 patients (73.3%) required hospitalization, while 4 (26.7%) were managed in outpatient care. All patients recovered and were discharged, with no deaths reported (according to Flowchart 1).

Flowchart 1. - Follow-up of children and adolescents with cancer diagnosed with COVID-19 at CTFM-GACC Hospital (March 2020 to May 2021).



Source: Prepared by the authors.

Table 1 presents the epidemiological, clinical, laboratory, and radiological characteristics, along with the treatments administered and clinical outcomes of the 15 pediatric cancer patients diagnosed with COVID-19 at the CTFM-GACC Hospital.

Table 1 – Characteristics of patients with cancer and Covid-19

Patient	Age	Gender	Nutritional assessment	Previous oncological pathology	Symptoms	Hemoglobin (g/dL)	Hematocrit (%)	Leukocytes (m³)	Neutrophils (%)	Lymphocytes (%)	D-dimer	TP (")	aPTT (")	Fibrinogen (mg/dL)	Chest x-ray	Oxygen therapy	Follow-up	Treatment
1	2	M	Risk of overweight	Acute lymphoid leukemia	Fever Rhinorrhea Headache	9,2	27	2.600	5	94	0,67	12	26,5	254	No abnormalities	No	Hospitalization	Symptomatic relief and antibiotics
2	2	M	Obesity	High-grade glioma in the posterior fossa	Fever Cough	8,7	25,9	1.500	67,2	10,7	1,11	12	27,6	300	Acute Respiratory Distress Syndrome	Mechanically ventilated	Hospitalization	Symptomatic relief, antibiotics, corticosteroids, and oxygen
3	3	M	Eutrophic	Acute myeloid leukemia	Fever Cough	8,9	24,7	400	NA	NA	1,56	14,3	32,9	NA	Diffuse infiltrate	No	Hospitalization	Symptomatic relief and antibiotics
4	4	M	Eutrophic	Acute lymphoid leukemia	Diarrhea Rhinorrhea	12	33,4	5.400	86,5	10,5	NA	NA	NA	NA	No abnormalities	No	Hospitalization	Symptomatic relief and antibiotics
5	4	F	Severely underweight	Posterior fossa medulloblastoma	Asymptomatic	10,5	31,7	2.500	54	43	NA	NA	NA	NA	NA	No	Outpatient follow-up	Symptomatic relief
6	4	M	Risk of overweight	Acute lymphoid leukemia	Asymptomatic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No	Outpatient follow-up	Did not take any medication
7	5	M	Eutrophic	Neuroblastoma	Fever Cough	10,8	33,1	9.900	58,4	29,1	3,5	13,9	35,4	431	Consolidation	Nasal catheter	Hospitalization	Symptomatic relief, antibiotics, corticosteroids, and oxygen
8	6	M	Severely underweight	Pilocytic astrocytoma	Asymptomatic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	No	Hospitalization	Symptomatic relief
9	8	M	Overweight	Primitive neuroectodermal tumor	Fever	10,3	30,4	7.100	78,7	15,7	2,91	12	26,4	NR	Diffuse infiltrate	Mechanically ventilated	Hospitalization	Symptomatic relief, antibiotics, corticosteroids, and oxygen
10	13	M	Eutrophic	Lymphoblastic lymphoma	Fever Cough	12,7	37	1.600	38	58	NA	NA	NA	NA	Consolidation	No	Hospitalization	Symptomatic relief and antibiotics
11	14	F	Eutrophic	Medulloblastoma Grade IV	Cough Rhinorrhea Dyspnea Nausea	11,5	32,9	2.100	79,3	8,8	NA	NA	NA	NA	NA	No	Outpatient follow-up	Symptomatic relief
12	15	F	Severely underweight	Acute lymphoid leukemia	Fever Cough Dyspnea	10	28,1	3.000	96	3	NA	NA	NA	NA	No abnormalities	Nasal catheter	Hospitalization	Symptomatic relief, antibiotics, and oxygen therapy
13	16	M	Obesity	Diffuse large B-cell lymphoma	Fever Rhinorrhea	8,3	24,9	1.100	17	70	0,44	12,9	29,7	NA	No abnormalities	No	Hospitalization	Symptomatic relief and antibiotics
14	17	M	Eutrophic	Acute lymphoid leukemia	Asymptomatic	14,3	40,6	2.400	65,8	22,2	0,1	NA	NA	NA	NA	No	Outpatient follow-up	Symptomatic relief
15	20	F	Eutrophic	Acute myeloid leukemia	Fever Cough Rhinorrhea Headache	12,3	37,8	6.500	76,2	19,5	0,38	13	31,5	NA	Consolidation	Non-rebreather mask	Hospitalization	Symptomatic relief, antibiotics, corticosteroids, and oxygen

Source: Prepared by the authors.
Note: M = male; F = female; NA = not available; aPTT = activated partial thromboplastin time; TP = prothrombin time

The ages of the patients ranged from 2 to 20 years. Of the 15 patients, 11 (73.3%) were male and 4 (26.7%) were female. Regarding healthcare coverage, 13 patients (86.7%) received treatment exclusively through the Brazilian Unified Health System (SUS), while 2 patients (13.3%) had supplementary private insurance.
Patients were categorized based on their underlying oncological diagnosis: seven had leukemia (five acute lymphoblastic leukemia and two acute myeloid leukemia), five had central nervous system (CNS) tumors (including high-grade glioma of the posterior fossa, medulloblastoma grade IV, posterior fossa medulloblastoma, pilocytic astrocytoma, and primitive neuroectodermal tumor), and three had solid tumors (neuroblastoma, lymphoblastic lymphoma, and diffuse large B-cell lymphoma).

Symptom analysis revealed that 10 patients (66.6%) experienced cough and rhinorrhea, 9 (60%) had fever, 2 (13.3%) presented with dyspnea, 2 (13.3%) reported headache, and 2 (13.3%) exhibited gastrointestinal symptoms, such as nausea and diarrhea. Four patients (26.6%) remained asymptomatic throughout the course of infection.

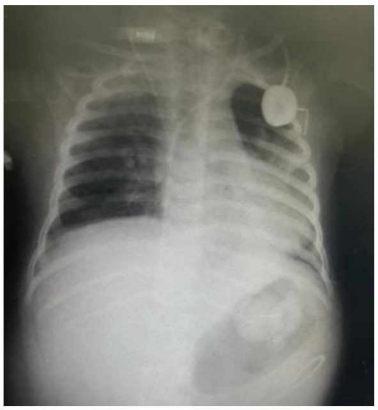
Nutritional assessment showed that 7 patients (46.7%) were classified as eutrophic, 3 (20.0%) as severely underweight, 2 (13.3%) as at risk of overweight, 2 (13.3%) as obese, and 1 (6.7%) as overweight. Among those who developed a severe clinical course, one patient was classified as obese and the other as overweight.

Regarding laboratory evaluations, abnormal values were observed in hemoglobin (4/13; 30.7%), hematocrit (4/13; 30.7%), total leukocytes (9/13; 69.2%), neutrophils (9/12; 75%), and lymphocytes (8/12; 66.6%). Among coagulation markers, D-dimer was elevated in 4 of 8 patients (50%), activated partial thromboplastin time (aPTT) was altered in 3 of 7 (42.8%), and fibrinogen levels were elevated in all 3 patients tested (100%). No abnormalities were found in prothrombin time (PT) results (0/7; 0%).

With regard to imaging, only plain chest radiographs were performed; no computed tomography (CT) scans were indicated during follow-up. Chest X-rays showed no abnormalities in 4 patients, diffuse pulmonary infiltrates in 2, parenchymal consolidation in 3, and findings suggestive of acute respiratory distress syndrome (ARDS) in 1 patient. In 5 cases, no imaging was performed due to lack of clinical indication.

Figures 1 and 2 illustrate the chest radiographic findings of the two patients who developed severe clinical courses requiring invasive mechanical ventilation. Figure 1 shows the chest X-ray of Patient 2, a 2-year-old obese male diagnosed with a high-grade glioma of the posterior fossa, presenting an image compatible with ARDS. Figure 2 shows the chest X-ray of Patient 9, an 8-year-old overweight male with a diagnosis of primitive neuroectodermal tumor, revealing bilateral pulmonary infiltrates, with predominant hypotransparency in the left lung base (Gasparetti & Patto, 2020).

Figure 1 - Chest X-ray revealing



Source: Prepared by the authors.

ARDS

Figure 2 - Chest X-ray demonstrating bilateral pulmonary infiltrate, with predominant hypotransparency at the left base

Source: Prepared by the authors.

Five patients required oxygen therapy, two of whom underwent invasive mechanical ventilation (intubation), one used a non-rebreathing mask and two received oxygen supplementation via a nasal catheter. The two patients who progressed to severe clinical conditions and required mechanical ventilation had CNS tumors and were classified as obese and overweight.

Among the total number of patients followed up, one did not receive any medication, four were treated exclusively with symptomatic drugs, one received symptomatic drugs, antibiotics and oxygen therapy, four were treated with a combination of symptomatic drugs, antibiotics, corticosteroids and oxygen, and five received only symptomatic drugs and antibiotics.

Statistical analyses were conducted based on the clinical follow-up outcome (hospitalized vs. non-hospitalized), as this variable demonstrated the greatest discriminatory capacity between groups (Table 2). It was observed that symptomatic patients had a higher frequency of hospitalization ($p = 0.033$), as did those who used a greater number of medications during treatment ($p = 0.004$). None of the other variables analyzed showed a statistically significant association with the hospitalization outcome.

Table 2 - Association between clinical characteristics and hospitalization during follow-up of cancer patients (n = 15)

(Continued)

Variable	Total (n=15)	Follow-up Hospitalization (n=11)	Outpatient follow-up (n=4)	p-value[1]
Sex				0.218
Male	11 (73.3)	9 (81.8)	2 (18.2)	
Female	4 (26.7)	2 (50.0)	2 (50.0)	
Age (median, IQR)	6.0 (4-15)	6.0 (3-15)	9.0 (4-16.3)	0.753‡
Previous oncological pathology				0.495
Leukemia	7 (46.7)	5 (71.4)	2 (28.6)	
CNS tumor	5 (33.3)	3 (60.0)	2 (40.0)	
Solid tumor	3 (20.0)	3 (100.0)	0 (0)	
Symptoms				**0.033**
Asymptomatic	4 (26.7)	1 (25.0)	3 (75.0)	
Symptomatic	11 (73.3)	10 (90.9)	1 (9.1)	
Oxygen therapy				0.231
Yes	5 (33.3)	5 (100.0)	0 (0)	
No	10 (66.7)	6 (60.0)	4 (40.0)	
Treatment				**0.004**
None/ Symptomatic relief	5 (33.3)	1 (20.0)	4 (80.0)	
Symptomatic and other relief	10 (66.7)	10 (100.0)	0 (0)	
Nutritional assessment				0.831
Severely underweight	3 (20.0)	2 (66.7)	1 (33.3)	
Eutrophic	7 (46.7)	5 (71.4)	2 (28.6)	
Overweight/in risk	3 (20.0)	2 (66.7)	1 (33.3)	
Obesity	2 (13.3)	2 (100.0)	0 (0)	
Altered hemoglobin (n=13)				0.294
Yes	4 (30.8)	4 (100.0)	0 (0)	
No	9 (69.2)	6 (66.7)	3 (33.3)	
Altered hematocrit (n=13)				0.294
Yes	4 (30.8)	4 (100.0)	0 (0)	
No	9 (69.2)	6 (66.7)	3 (33.3)	

Source: Prepared by the authors.

Table 2 - Association between clinical characteristics and hospitalization during follow-up of cancer patients (n = 15)

(Conclusion)

Variable	Total (n=15)	Follow-up Hospitalization (n=11)	Outpatient follow-up (n=4)	p-value[1]
Altered leukocytes (n=15)				0.242
Yes	11 (73.3)	7 (63.6)	4 (36.4)	
No	4 (26.7)	4 (100.0)	0 (0)	
Altered neutrophils (n=12)				0.255
Yes	8 (66.7)	5 (62.5)	3 (37.5)	
No	4 (33.3)	4 (100.0)	0 (0)	
Altered lymphocytes (n=12)				0.636
Yes	7 (58.3)	5 (71.4)	2 (28.6)	
No	5 (41.7)	4 (80.0)	1 (20.0)	
Altered D-dimer (n=8)				0.500
Yes	4 (50.0)	4 (100.0)	0 (0)	
No	4 (50.0)	3 (75.0)	1 (25.0)	
Altered fibrinogen (n=3)				*
Yes	3 (100)	3 (100)	0 (0)	
No	0 (0)	0 (0)	0 (0)	
Altered aPTT (n=7)				*
Yes	3 (42.9)	3 (100)	0 (0)	
No	4 (57.1)	4 (100)	0 (0)	
Altered TP (n=7)				*
Yes	0 (0)	0 (0)	0 (0)	
No	7 (100)			
Altered X-ray (n=10)				*
Yes	6 (60.0)	6 (100)	0 (0)	
No	4 (40.0)	4 (100)	0 (0)	

Source: Prepared by the authors.

[1]Fisher's exact test or Pearson's chi-square test.
‡Mann-Whitney non-parametric test.
*Not applicable due to lack of variability in outcome.
Bold: Statistically significant at the 95% level.

4 DISCUSSION

This study identified 15 confirmed cases of COVID-19 among children and adolescents with cancer out of 5,675 oncology-related encounters at the CTFM-GACC Hospital between March 2020 and May 2021, including 1,788 hospitalizations and 3,887 outpatient visits. Among these cases, 11 patients (73.3%) required hospitalization, and no deaths were reported.

These findings differ from those of a national multicenter study involving 179 pediatric oncology patients across 21 centers, which reported higher hospitalization and mortality rates: 19% ICU admissions, 60.9% general ward admissions, and a 12.3% overall mortality rate. The higher mortality was attributed to disease severity and nutritional status during SARS-CoV-2 infection (Corso et al., 2021). Differences in outcomes may stem from our smaller sample size, which limits statistical comparisons with larger cohorts.

Our results are comparable to a study from Recife, Brazil, in which 72.9% of 48 pediatric oncology patients required hospitalization. However, 10.5% died within 30 days of COVID-19 diagnosis and 16.6% within 60 days (Lima et al., 2021). In a later expansion to 62 patients, that cohort reported a 66.1% hospitalization rate and a 29% case fatality rate (de Andrade-Lima et al., 2023). It is important to note that our study did not include post-discharge follow-up, limiting comparisons with long-term outcomes reported in other studies.

Two additional Brazilian studies emphasized the significant impact of onco-hematological comorbidities on COVID-19 severity. A multicenter prospective study across 19 pediatric ICUs identified comorbidities, particularly hematologic malignancies, as predictors of severe disease (Prata-Barbosa et al., 2020). Another hospital-based cohort study reported a 15.2% fatality rate and higher mortality among children with cancer (Schmidt et al., 2023). Although no deaths occurred in our cohort, this may be due to the limited sample size and shorter follow-up duration.
International meta-analyses have estimated COVID-19-related mortality rates among pediatric cancer patients between 4% and 9.8%, significantly higher than in healthy pediatric populations (Vijenthira et al., 2020; Meena et al., 2021; Dorantes-Acosta et al., 2021). One review with over 1,000 pediatric cases found the fatality rate to be at least ten times higher than in children without comorbidities (Schlage et al., 2022).

A U.S. cohort study including 2,035 pediatric oncology patients with COVID-19 reported a 1.2% MIS-C rate—twice that of the general pediatric population (Martin et al., 2023). No MIS-C cases were observed in our cohort, likely due to the small sample size or the data collection timeframe.

Symptomatic patients in our study were more likely to be hospitalized, consistent with other reports suggesting that early in the pandemic, symptomatic children with cancer were often admitted due to uncertainty about disease progression (Millen et al., 2021).

Leukemia was the most common malignancy in our cohort (46.6%), aligning with findings from previous studies, which consistently report leukemia as the most frequent cancer in pediatric COVID-19 cases, followed by CNS and solid tumors (de Andrade-Lima et al., 2023; Schlage et al., 2022; Corso et al., 2021; Mukkada et al., 2021).

Over half of the patients presented with fever and/or respiratory symptoms, while approximately 25% were asymptomatic. These findings are consistent with a meta-analysis of 1,003 pediatric cancer patients, which reported 27.8% asymptomatic cases and fever in nearly 60% (Schlage et al., 2022). Pediatric cancer

patients, similar to healthy children, tend to experience milder COVID-19 courses compared to adults with cancer (Madhusoodhan et al., 2021; Millen et al., 2021). While 4–9% of pediatric cancer patients develop severe forms of COVID-19, this rate reaches up to 55% in adult oncology patients (Kahn et al., 2022).

Obesity is a recognized risk factor for severe COVID-19. In our cohort, 5 of 15 patients (33.3%) were classified as overweight or obese—two of whom developed severe symptoms. This finding aligns with Brazilian studies demonstrating a worse prognosis in overweight pediatric patients (Corso et al., 2021; James et al., 2021; La Fauci et al., 2022). Interestingly, the two severely underweight patients in our study recovered without major complications, but this observation must be interpreted cautiously due to the small sample.

Among patients evaluated with complete blood count, anemia was observed in 30.7%, while leukopenia, neutropenia, and lymphopenia occurred in 62.2%, 75%, and 66.6% of cases, respectively—rates higher than those found in a Brazilian general hospital cohort (Bain et al., 2024). These findings likely reflect the combined effect of oncologic disease, chemotherapy, and viral infection.

Laboratory abnormalities in coagulation markers were also present: elevated D-dimer in 50% (4/8), increased fibrinogen in all patients tested (3/3), and altered aPTT in 42.8% (3/7). These findings are in line with studies in adult oncology patients but are less consistent in children. Evidence in pediatric oncology remains scarce and inconclusive (ElGohary et al., 2022; Bain et al., 2024; Corso et al., 2021).

Radiological abnormalities were noted in 60% (6/10) of chest X-rays in our cohort, compared to 29% in a national study of 62 pediatric oncology patients with COVID-19 (de Andrade-Lima et al., 2023). Most therapeutic decisions, however, remain based on clinical presentation.

One-third (33.3%) of patients required oxygen therapy, and two (13.3%) needed invasive mechanical ventilation. Both patients had CNS tumors and were either overweight or obese. These figures are within the range reported in Brazilian studies, which document rates of 6–18% for invasive ventilation in this population (Corso et al., 2021; Lima et al., 2021; de Andrade-Lima et al., 2023; Schmidt et al., 2023).

Treatment was primarily symptomatic, followed by antibiotics and corticosteroids. One patient required no pharmacological intervention, while four were treated exclusively with symptomatic medications. Patients requiring multiple medications were more frequently hospitalized, reflecting more severe presentations and the cautious approach adopted early in the pandemic. Previous studies have reported the use of antifungals, antivirals, hydroxychloroquine, ivermectin, heparin, and biologics in pediatric oncology COVID-19 cases (Meena et al., 2021; de Andrade-Lima et al., 2023; St. Jude Global, 2024), highlighting therapeutic variability across institutions and timeframes.

4.1 LIMITATIONS

This study has several limitations. First, the small sample size (n = 15) restricts generalizability and statistical inference. The single-center design reflects the specific protocols and practices of CTFM-GACC and may not represent broader national conditions. Additionally, heterogeneity in patient characteristics—such as cancer type, treatment stage, and comorbidities—may confound results.

No control group was included (e.g., pediatric cancer patients without COVID-19 or healthy children with COVID-19), and race/ethnicity was not analyzed,

preventing assessment of structural health disparities. International literature suggests that non-White children may face higher risks of severe outcomes, often linked to socioeconomic rather than biological factors (Harman et al., 2020; White et al., 2021).

The underreporting of asymptomatic or mildly symptomatic cases, especially in outpatient settings, may have led to underestimation of COVID-19 prevalence. Incomplete laboratory and imaging data also limited detailed analysis of prognostic markers.

No long-term follow-up was conducted, preventing evaluation of post-acute outcomes, including MIS-C and potential treatment delays. The study period coincided with a peak in pediatric COVID-19 mortality in Brazil, providing insight into the health system's response during a critical time (Ministério da Saúde, 2021a; Silva et al., 2023).

4.2 VACCIONATION CONTEXT

Pediatric COVID-19 vaccination in Brazil began after the study period. Immunization for adolescents (12–17 years) started in August 2021, with younger children vaccinated progressively in 2022 (Ministério da Saúde, 2021b). Vaccination has been shown to reduce hospitalizations by 93%, MIS-C by 91%, and long COVID risk in children (Kuehn, 2021; Zambrano et al., 2022; Razzaghi et al., 2024). In Brazil, CoronaVac® demonstrated 59.2% effectiveness against hospital admissions and 39.8% against symptomatic illness in children (Florentino et al., 2022).

Vaccination is particularly critical for pediatric oncology patients, reducing hospitalizations and treatment interruptions. Studies confirm that this population can mount a significant immune response with a favorable safety profile, justifying their prioritization in vaccination campaigns (World Health Organization [WHO], 2020; Centers for Disease Control and Prevention [CDC], 2025; Ministério da Saúde, 2021b).

5 CONCLUSION

Our findings suggest that in healthcare centers equipped for early diagnosis and high-quality clinical care, COVID-19 infection in pediatric oncology patients may be associated with low mortality. Additionally, our results—aligned with existing literature—highlight the significant impact of excess weight, particularly obesity, as a potential risk factor for adverse clinical outcomes.

Although a higher hospitalization rate was observed in this case series, overall clinical progression was favorable. These results underscore the importance of close monitoring, systematic triage, specialized multidisciplinary care, and targeted prevention strategies—especially vaccination and nutritional assessment—to support continuity of oncological treatment and improve clinical outcomes.

Further multicenter, prospective studies with larger sample sizes are needed to identify independent prognostic factors, including vaccination coverage and its potential protective effect. Long-term follow-up is also essential to evaluate delayed complications of SARS-CoV-2 infection. Finally, more comprehensive laboratory-based research is warranted to identify reliable biomarkers of disease severity in pediatric oncology patients affected by COVID-19.

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