



ORIGINAL ARTICLE

Epidemiological dynamics at the peak of the COVID-19 pandemic among children in Rio Grande do Sul, Brazil

Dinâmica epidemiológica no pico da pandemia de COVID-19 entre crianças no Rio Grande do Sul, Brasil

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Abstract

Objective: to describe the profile of children infected by SARS-CoV-2 in Rio Grande do Sul, Brazil, between March 1, 2020, and April 30, 2021, comparing infection rates and disease evolution stratified by age group.

Methods: this cross-sectional study used data from COVID-19-confirmed cases from a public state database in children aged zero–nine.

Results: the study sample comprised 35,131 children. We found the highest infection rate in the age group of zero–four years old, 3.8% (95%CI:3.3%-4.3%). Of the patients, 3.8% (n = 1,323) had comorbidities, the most prevalent being respiratory tract disease (56.2%, n=829). 450 (1.3%) children developed Severe Acute Respiratory Syndrome (SARS), with a lethality rate of 0.05% (95%CI:0.02%-0.08%). However, we found that both outcomes decreased when age increased; thus, a PR of 8.68 (CI95%:6.86-10.99) was estimated for SARS and PR=5.52 (CI95%:1.26-24.09) for death in the presence of respiratory comorbidity.

Discussion: this study revealed a low mortality rate in this population. The presence of respiratory comorbidities increases the risk of SARS and death. Both outcomes increased in younger age groups.

Keywords: COVID-19, SARS-CoV-2, children, severe acute respiratory syndrome, epidemiology, descriptive.

Resumo

Objetivo: descrever o perfil das crianças infectadas pelo SARS-CoV-2 no Rio Grande do Sul, Brasil, entre 1º de março de 2020 e 30 de abril de 2021, comparando as taxas de infecção e a evolução da doença estratificada por grupo etário.

Métodos: este estudo transversal utilizou dados de casos confirmados de COVID-19 de um banco de dados estadual público em crianças de zero a nove anos.

Resultados: a amostra do estudo compreendeu 35.131 crianças. Encontramos a maior taxa de infecção no grupo etário de zero a quatro anos, 3,8% (IC95%:3,3%-4,3%). Dos pacientes, 3,8% (n = 1.323) tinham comorbidades, sendo a doença do trato respiratório a mais prevalente (56,2%, n=829). 450 (1,3%) crianças desenvolveram Síndrome Respiratória Aguda Grave (SARS), com uma taxa de letalidade de 0,05% (IC95%:0,02%-0,08%). No entanto, verificou-se que ambos os resultados diminuíram com o aumento da idade; assim, estimou-se um RP de 8,68 (IC95%:6,86-10,99) para SARS e RP=5,52 (IC95%:1,26-24,09) para óbito na presença de comorbidade respiratória.

Discussão: este estudo revelou uma baixa taxa de mortalidade nesta população. A presença de comorbidades respiratórias aumenta o risco de SARS e morte. Ambos os resultados aumentaram nos grupos etários mais jovens.

Palavras-chave: COVID-19, SARS-CoV-2, crianças, síndrome respiratória aguda grave, epidemiologia descritiva.



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Introduction

The evolution of the COVID-19 pandemic has allowed us to observe the infection of children by SARS-CoV-2; however, because they have a lower risk of exposure and most cases are asymptomatic, they may have been less tested than adults (1, 2), giving a perception of not having been infected with the same frequency as adults and the elderly. However, some authors have suggested that children have similar COVID-19 infection rates to those of adults (2, 3, 4). When they occur, the most frequently reported clinical manifestations are fever and cough, with a predominance of systemic respiratory symptoms (2, 3, 5).

The epidemiological profile of COVID-19 in children is not very clear in the literature, either because of underreporting or the small number of studies in this age group, which makes it difficult to monitor the disease and its aggravation. The incipience of morbidity and mortality data makes it difficult to align health strategies and decisions with better results, resource optimization, and positive impacts on healthcare. Children with COVID-19 have milder clinical manifestations than adults, possibly resulting in lower hospitalization and mortality rates (3, 6, 7).

Considering that children represent a portion of the population that has been sparingly tested, culminating in the scarcity of clinical and epidemiological information, the objective of this study was to describe the profile of children infected with SARS-CoV-2 in the State of Rio Grande do Sul (RS), Brazil, from the beginning of the COVID-19 pandemic (March, 1st, 2020) until April 30, 2021, comparing infection rates and the evolution of the disease according to the age groups of children under one year old, from one to four years old and from five to nine years old. This information can help public health institutions establish targeted interventions to prevent the spread of SARS-CoV-2 and reduce the damage caused by COVID-19 among pediatric patients.

Methods

We conducted a cross-sectional study using secondary public data on people infected with

COVID-19 from the epidemiological bulletin of RS (8). The data collection period was March 2020 to April 2021. This period was chosen to evaluate the profile of the pediatric population infected by SARS-CoV-2 at the beginning of the pandemic in RS; before widespread vaccine coverage was available. The RS Government reported the first official cases of this infection in March 2020. It is important to note that COVID-19 vaccines had not yet been introduced to children in this State during this period. The vaccine was introduced in the State in January 2022 for children aged five to 11 years and in November 2022 for children aged six months to two years (9).

This study did not require the approval of the Research Ethics Committee due to compliance with Resolution No. 510 of April 7, 2016, of the National Health Council (10) on the use of publicly accessible and shared domain information, which ensures the recognition of freedom, autonomy, and defense of human rights.

The State of RS, located in the southern region of Brazil, has an estimated population of 11,466,630 inhabitants and 497 municipalities (11) organized into 21 COVID-19 Health Regions (12). The sample was of the population type, with the total number of confirmed cases of COVID-19 in the RS. As an inclusion criterion, we set the age group from zero to nine years in the period delimited by the study. We considered any variable with unreported data to be missing; thus, they were not accounted for in the statistical analyses.

Confirmation of positive cases of SARS-CoV-2 infection, as reported in the Coronavirus RS Panel Bulletin created by the State Health Department of RS, presents the main epidemiological data of COVID-19 in the state. It uses as sources the two official notification systems of the Ministry of Health for disease monitoring: e-SUS Notifica and the Influenza Epidemiological Surveillance Information System (Sivep-Gripe). Confirmed cases of COVID-19 were and continue to be identified daily by the State Health Department of RS and published in this panel. The following confirmation criteria are used according to current protocols: laboratory, clinical-epidemiological, clinical-imaging, and clinical (12).

The variables available in the database were categorical or descriptive. The demographic variables used were "age group" stratified into the categories less than or equal to one year, from one to four years, and five to nine years; "sex", female and male; and parent-reported "race", considered as skin color, with white, black, brown, yellow, and indigenous responses. The clinical variables used were "health conditions", "SARS", and "evolution". The data "health conditions" was available in a descriptive way, and, from them, we created a dichotomous variable respiratory comorbidity, where the records of respiratory diseases, chronic respiratory diseases, decompensated chronic respiratory disease, asthma, and chronic lung disease were found and considered. Regarding the variable symptoms, the database included the following symptoms with "yes" or "no" responses: fever, cough, sore throat, dyspnea, and others. For our analyses, we considered the presence of symptoms to be dichotomous, requiring at least one of these five symptoms. The outcome variable "SARS", a dichotomous categorical one with yes or no answers, and the variable "evolution", used to determine death, were dichotomized into death and non-death categories (including responses in progress and recovery).

For the selection of variables, processing, and statistical analysis, we downloaded the database in a comma-separated values (CSV) file, transformed it into a Microsoft Excel® program file and imported it into the Statistical Package for the Social Sciences (SPSS) version 24.0, commercially available. Descriptive statistics are shown as absolute numbers and percentages, infection and fatality rates with their respective 95% confidence intervals (95% CI). The researchers performed analytical statistics for proportion comparisons using chi-square and Fisher's exact tests. Risk estimation was conducted using Poisson Robusta regression with the respective 95% CI, and for all analyses, an alpha lower than or equal to 5% was considered statistically significant.

To calculate the SARS-CoV-2 infection rates, a population projection for 2020 was used based on the census of the Brazilian Institute of Geography and Statistics (IBGE) for the years 1950, 1960, 1970, 1980, 1991, 2000, and 2010 (13), using polynomial equations for the age groups zero to four years and five to nine years. Subsequently, the number of infected individuals was divided by the projected population, according to these two age groups. We employed these two age groups to calculate the infection rates, as they are the strata available in the IBGE census.

Results

The time frame of this study was the beginning of the COVID-19 pandemic in RS, Brazil, from March 1, 2020, to April 30, 2021. Populational projections for 2020 estimated that children aged zero to four years old were 500,023 and that children aged five to nine were 569,792 in RS. During this period, 35,131 children were registered, from zero to nine years of age, among the confirmed cases of COVID-19, of which 5,632 (16%) were under one year of age, 13,421 (38.2%) were between one and four years, and 16,078 (45.8%) were between five and nine years old (**Table 1**).

The demographic and clinical characteristics of patients are shown in Table 1. It was observed that the frequency of symptoms, SARS, and mortality was higher in younger age groups of children. The overall infection rate found in children in this study for COVID-19 was 3.3% (95% CI: 3.0% to 4.3%) and 3.8% (95% CI: 3.3% to 4.3%) in the stratum from zero to four years and 2.8% (95% CI: 2.4% to 3.2%) in the stratum from five to nine years old.

Among the symptoms recorded in the Coronavirus RS Panel Bulletin, fever occurred in 12,099 (34.4%) children, cough in 9,545 (27.2%), sore throat in 6,640 (18.9%), and dyspnea in 1,383 (4.0%).

TABLE 1 – Demographic and clinical profile of confirmed COVID-19 cases in children in Rio Grande do Sul, Brazil, between 2020 and 2021, by age strata.

	Total 0 to 9 years old (n=35,131)	< 1 years old (n=5,632)	Age group 1 to 4 years old (n=13,421)	5 to 9 years old (n=16,078)	p*
Sex					
Female	17,359 (49.4)	2,879 (16.6)	6,500 (37.4)	7,980 (46.0)	
Male	17,772 (50.6)	2,753 (15.5)	6,921 (38.9)	8,098 (45.6)	0.002
Skin Color					
White	17,920 (91.2)	4,307 (91.7)	10,531 (91.2)	3,082 (90.2)	
Black	505 (2.6)	123 (2.6)	295 (2.6)	87 (2.5)	
Mixed	1,075 (5.5)	242 (5.2)	615 (5.3%)	218 (6.4)	
Asian	35 (0.2)	6 (0.1)	19 (0.2)	10 (0.3)	
Indigenous	122 (0.6)	20 (0.4)	82 (0.7)	20 (0.6)	0.064
Respiratory comorbidity	829 (2.4)	66 (1.2)	250 (1.9)	513 (3.2)	≤0.001
Symptomatic disease	25,396 (73.0)	4,352 (78.6)	9,651 (72.7)	11,393 (71.2)	≤0.001
SARS	450 (1.3)	192 (3.4)	161 (1.2)	91 (0.6)	≤0.001
Death	17 (0.05)	7 (0.12)	7 (0.05)	3 (0.02)	0.008

SARS, Severe Acute Respiratory Syndrome. *Chi-square test.

Note: The n (total absolute number of cases) varies according to the variable owing to missing data in the database (missing).

Comorbidities were present in 1,323 (3.8%) cases, with the most frequent group being respiratory diseases, with 829 cases (56.2%), followed by heart diseases, 181 cases (12.3%), and immunodeficiencies, with 129 cases (8.7%). SARS occurrence

and death outcomes in the presence of respiratory comorbidities were significantly associated with risk estimates with an increasing profile as the age group increased, as shown in **Table 2**.

TABLE 2 – Prevalence ratio (95% CI) of the association of respiratory comorbidity with SARS and death, by age strata, in children infected with SARS-Cov-2, in the State of Rio Grande do Sul between 2020 and 2021.

	Total 0 to 9 years old (n=35,131)	< 1 years old (n=5,632)	Age group 1 to 4 YO (n=13,421)	5 to 9 years old (n=16,078)
Respirador comorbidity X SARS	8.68 (6.86 – 10.99)	4.63 (2.57 – 8.35)	12.07 (8.28 – 17.58)	20.79 (13.81 – 31.29)
Respiratory comorbidity X Death	5.52 (1.26 – 24.09)	14.05 (1.72 – 115.11)	*	15.17 (1.38 – 167.04)

* Zero deaths in the group without comorbidities.

Severe acute respiratory syndrome occurred in 450 (1.3%) individuals, being more frequent in the age group of children under one year, with 195 (3.5%) cases, followed by the stratum of one to four years, with 63 (1.2%) cases and five to nine years, with 91 (0.6%) cases ($p \leq 0.001$).

Among the total population, there were 17 deaths, seven among children under one year of age, seven among children aged between zero and four years, and three among children aged between five and nine years. The total lethality rate was 0.05% (95% CI: 0.02%-0.08%), and when comparing the age strata, these indicators decreased as the age group increased, with 0.121% (95% CI: 0.118%-0.125%) in children under one year, 0.05% (95% CI: 0.047%-0.053%) between one and four years and 0.02% (95% CI: 0.019%-0.022%) between five and nine years ($p=0.008$).

Discussion

In our study, the infection rate in children aged zero to nine was 3.3%, totaling 35,131 cases from a universe of 1,069,815 children. The younger the age group, the higher the rates of infection, presence of symptoms, and outcomes of SARS and death. The presence of diseases or respiratory tract alterations in children with COVID-19 has increased the occurrence of these outcomes. The most frequent symptoms were fever and coughing. This information is especially relevant in contexts where information on infections among the elderly and adults is predominant. However, underreporting is a factor that should be considered in this population (2, 3), which can be attributed to the fact that the family does not want to expose the child to some tests or because the child is usually asymptomatic or has mild symptoms. Thus, the difficulty in identifying pediatric patients positive for COVID-19 may have hampered access to accurate epidemiological information and the recognition of a proper picture of community-acquired infections.

By advocating for continuous monitoring and analysis of notifiable diseases and conditions to

make effective, efficient, and resolute decisions, health surveillance in Brazil challenges managers in the public and private spheres (14). During the COVID-19 pandemic, this process had to take place in real-time through the availability of public domain data, which enabled the monitoring of the global panorama and the updating of the epidemiological scenario in the face of this infection.

The COVID-19 infection rate recorded for the children we identified corroborates data from an integrative review conducted from January to June 2020, which reported an infection frequency of 1% to 2% in the pediatric population (15). Another study on children affected by the coronavirus describes an infection rate, from January and May 2020, of 0.3% in Brazil among individuals aged zero to 18 years, 1.6% in England among the population aged zero to 19 years, 0.6% in Spain among individuals aged zero to 14 years, and 4.3% in Portugal among the population aged zero to 19 years. It also referred to data from the Chinese Center for Disease Control, which reported an infection rate of 2% in children under 20 years of age during the same period (16). In our findings, the infection rate was higher in the zero to four age group when compared to five to nine years old, which may be a warning for the infection of other age groups, especially the elderly, who live with small children (17), because of the estimation that family transmission is the most common form of infection in the pediatric population (2,13,14).

In Brazil, regional analyses of this population of children and adolescents have revealed lower infection rates in younger age groups. In Ceará, from March to July 2020, the COVID-19 infection rate was 10.5% among newborns and infants, 10.7% in preschool-aged children, 21.2% in school-aged children, and 57.7% in adolescents (23). In Taubaté, São Paulo, from March to November 2020, 677 COVID-19 cases were reported among individuals aged zero to 19, representing 10.1% of the municipality's population (24). In Espírito Santo, between May and June 2020, the infection rate was 6.1% among individuals aged two to 22 years (25).

In addition to having mild manifestations or being asymptomatic, children may transmit the disease for a longer time, as suggested by Su et al. (18), who analyzed the clinical, laboratory, and radiological findings of nine children and their families hospitalized in China, in which the period of PCR positivity in children's feces was longer than that in their relatives. Another study conducted in New York followed families with children aged zero to 17 years who underwent weekly molecular tests for asymptomatic and symptomatic infections. The authors concluded that infection incidence rates were similar between children and adults, with a higher fraction of infections in children being asymptomatic, which would likely go undetected without diagnostic tests (3).

Regarding the presence of symptoms, the proportions were clinically similar across the three age groups analyzed in our study, with the frequency progressively decreasing as the child's age increased. An American study, which compared symptom frequency between children (zero to 17 years) and adults (≥ 18 years), also found similar proportions within the pediatric age groups. However, adults had a higher frequency of symptoms compared to children (3). Similar results have been reported in Brazilian studies (22, 24, 25). In the state of Espírito Santo, a study using data from 2020 reported that younger children exhibited milder clinical manifestations. In this study, among the population aged zero to 22 years, the most frequent symptoms were cough (40.4%), anosmia (33.7%), fever (26%), and myalgia (24%) (25). A study in Taubaté, São Paulo, found that in children aged zero to four years, the presence of symptoms was more frequent than in those aged five to nine years. The most common symptom was fever, with frequencies of 32.4% and 18.5%, followed by cough at 18.3% and 8.9%, respectively, for the age groups zero to four years and five to nine years (24). In a retrospective Brazilian cohort of hospitalized children and adolescents from March to August 2020, the most frequent signs and symptoms among those infected with SARS who died were dyspnea (70%) and fever (67.8%) (22).

Regarding skin color, a higher prevalence of white was observed, as reported by the parents of the sample children, to the detriment of others. This is probably because in RS, more than 82% of the population self-declared themselves as white (19). Blanco et al. (20) point out that several publications on COVID-19 do not address socio-demographic characteristics, but recognize that the demographic profile, like skin color, schooling, and socioeconomic conditions could interfere with the way of life and, consequently, population health. Cestari et al. reported a possible influence of social vulnerability on the incidence of COVID-19 (21).

The frequency of children with COVID-19 and associated comorbidities was 3.8%, with a higher prevalence of chronic respiratory comorbidities, followed by heart disease and immunodeficiency. A historical cohort study of children and adolescents hospitalized for COVID-19 (22) reported immunopathy as a significant factor associated with death, and that the presence of heart and/or kidney diseases as the underlying disease increased the risk of death. These authors identified heart disease and diabetes mellitus as the most frequent comorbidities in the pediatric population. Cavalcante et al. (23) analyzed confirmed cases of COVID-19 in children and adolescents in Ceará, from March to June 2020, and identified neurological alteration and asthma as the most frequent comorbidities.

The presence of comorbidities appears to be a risk factor for more severe COVID-19 cases in children (16, 17, 23). Prata-Barbosa et al. (26) conducted a prospective multicenter study in Brazil with pediatric patients with COVID-19 admitted to Intensive Care Units (ICU), in which 50% to 80% of hospitalizations were of children with pre-existing comorbidities and with greater need for oxygen therapy (56% vs. 31%) and invasive mechanical ventilation (31% vs. 9%) compared to children without comorbidities. Cavalcante et al. (23) identified a 57.6 (95% CI: 49.2-78.8) times greater probability of hospitalization in children and adolescents from Ceará with associated comorbidities, especially congenital heart and

lung diseases. In another study carried out with the same population and time frame, the authors compared severe outcomes between children with and without comorbidities and found a prevalence of 14.9% versus 0.7% ($p \leq 0.001$) for SARS and 0.8% versus 0.02% for death (26).

In contrast to other reports, the high frequency of respiratory comorbidities in our population may be due to the climatic conditions of the State of RS, with low environmental temperatures that possibly represent an increased risk for severe disease and, therefore, worse outcomes, as COVID-19 mainly affects the respiratory tract (17, 20). A cohort study conducted in RS evaluated the effects of climatic conditions in the trimester of birth, whether in winter or summer, on asthma and pneumonia in childhood and adulthood and found a higher risk of hospitalization for asthma, bronchitis, and/or pneumonia in children who lived in their first six months of life in cities with cooler environmental temperatures (28). Another possibility is the underreporting of comorbidities other than respiratory comorbidities, as this variable in the database was descriptive and fragile, which is one of the limitations of this study.

When calculating the association between developing SARS and progressing to death in the presence of respiratory comorbidity, we found that children aged zero to nine years had an estimated risk 8.68 times higher for SARS and 5.52 times greater for death, with increasing risk behavior as the age group increased. Gomes *et al.* (22) identified asthma as an underlying respiratory disease in children, which reduces the risk of death, thus contradicting our results. The authors argued for the possibility that these children had controlled asthma at the time they were infected with SARS-Cov-2, that they received differentiated treatment during hospitalization, or that they could have been on corticosteroid treatment before becoming infected, positively influencing the outcomes.

The Brazilian Ministry of Health has incorporated testing for the SARS-CoV-2 virus with mandatory notification as a strategy for monitoring hospitalized cases of COVID-19 and surveillance

of severe acute respiratory syndrome (SARS) (29). In our analyses, in children aged zero to nine years, the frequency of SARS was 1.3%, which was higher in those under one year of age (3.4%) and progressively decreasing in age groups. From one to four years (1.2%) and five to nine years (0.6%), a similar profile was observed in the study by Niquini *et al.* (30), which included patients up to the 21st epidemiological week of 2020, and the proportion of children with SARS aged zero to four years was 0.8%. Five to nine years was 0.1%.

A positive aspect of the results was the low fatality rate in this population (0.05%), whereas for the general population of RS during the same period, it was 2.5% (8). During the period analyzed in our study, 17 deaths due to SARS-Cov-2 were registered.

Similar to SARS, a higher rate was observed in children under one year (0.12%), decreasing in the range of one to four years (0.05%) and five to nine years (0.02%).

Bhopal *et al.* (31) evaluated COVID-19 case fatality rates from official sources in the United States, United Kingdom, Italy, Germany, Spain, France, and Korea for children and adolescents from the beginning of the pandemic until May 2020. In the United States, the case fatality rate for the zero to four age groups was 0.03/100,000, and in the five to 14 age group, it was 0.02/100,000. In other countries, the age groups from zero to nine years in the United Kingdom were 0.02/100,000; in Italy, 0.08/100,000; in Germany, 0.01/100,000; in Spain, 0.05/100,000; in France, 0.04/100,000; and in Korea, 0.00/100,000. Our findings, in addition to the scientific literature, show that mortality from COVID-19 is rare in children (6,15,16,27, 29,30).

One of the limitations of this study is that we collected data from a secondary database, which may have influenced reliability. In addition, descriptive data generated discrepancies in the standardization of responses, especially in the "comorbidities" variable, as well as the statistical limitation imposed by all data being categorical and lacking some relevant information, such as the patient's social conditions. Another limitation is the possibility that children, even symptomatic

children, are less tested than adults. For any age group, asymptomatic cases may not be diagnosed by not performing the tests; therefore, this official data source did not consider them.

The mortality rate of COVID-19 is low in children between zero and nine years old. The presence of respiratory comorbidities in children increased the risk of developing SARS and progressing to death, and both SARS and death were more frequent in the younger age groups.

It is important to identify the COVID-19 scenario in children because their health may be compromised, in addition to the possibility of them being vectors for infection in other age groups, interfering with integral development, socialization, performance in physical activities, school performance, and vaccination decisions.

Notes

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Conflicts of interest disclosure

The authors declare no competing interests relevant to the content of this study.

Authors' contributions

All the authors declare to have made substantial contributions to the conception, or design, or acquisition, or analysis, or interpretation of data; and drafting the work or revising it critically for important intellectual content; and to approve the version to be published.

Availability of data and responsibility for the results

All the authors declare to have had full access to the available data and they assume full responsibility for the integrity of these results.

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