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Original Article

Incidence and mortality rates in children and the relationship with family income

Coeficientes de incidência e mortalidade em crianças e a relação com a renda familiar

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ABSTRACT
Objective: to analyze children's COVID-19 incidence and mortality rates and their relationship with family income. **Methods:** this ecological study looks at COVID-19 cases and outcomes in children aged up to 11 years, 11 months, and 29 days. Data were collected from the State Data Analysis System and the Brazilian Institute of Geography and Statistics. They analyzed using the Bivariate Global Moran's Index and a join point regression model based on Poisson regression. **Results:** 88,913 cases of COVID-19 in children and 335 deaths were recorded in the period analyzed. There was a weak negative spatial correlation between the COVID-19 incidence coefficient among children and the rate in families with an income of up to half the minimum wage *per capita* and families with an income above two minimum wages *per capita*. **Conclusion:** the clusters with the highest incidence coefficients were found in favored regions, while the mortality coefficient was higher in disadvantaged and vulnerable areas. **Contributions to practice:** these results contribute to a more equitable nursing and health practice, focused on the reality of the different social and economic contexts faced by families in other regions.
Descriptors: COVID-19; Epidemiology; Child; Incidence; Economic Indexes.

RESUMO
Objetivo: analisar os coeficientes de incidência e mortalidade por COVID-19 em crianças e sua relação com a renda familiar. **Métodos:** trata-se de um estudo ecológico, considerando os casos e desfechos da COVID-19 em crianças de até 11 anos, 11 meses e 29 dias. Os dados foram coletados do Sistema Estadual de Análise de Dados e do Instituto Brasileiro de Geografia e Estatística e analisados por meio do Índice de Moran Global Bivariado e modelo de regressão *joinpoint*, baseado na regressão de Poisson. **Resultados:** foram registrados 88.913 casos da COVID-19 em crianças e 335 óbitos no período analisado. Verificou-se uma correlação espacial negativa fraca em relação ao coeficiente de incidência da COVID-19 entre crianças e taxa de famílias com rendimento de até meio salário mínimo per capita, bem como em famílias com rendimento acima de dois salários mínimos per capita. **Conclusão:** os aglomerados com maiores coeficientes de incidência foram encontrados em regiões favorecidas, enquanto o coeficiente mortalidade foi maior em regiões desfavorecidas e vulneráveis. **Contribuições para a prática:** esses resultados contribuem para uma prática de enfermagem e saúde mais equitativa e focada na realidade dos diferentes contextos sociais e econômicos enfrentados pelas famílias nas diferentes regiões.
Descritores: COVID-19; Epidemiologia; Criança; Incidência; Indicadores Econômicos.

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Introduction

The COVID-19 pandemic has been considered the greatest global public health emergency in recent decades. It is a global phenomenon of historic magnitude that has transcended geographical borders and profoundly impacted not only public health but also the economy, education, social dynamics, and even political structures[1].

During the most severe period of the pandemic, economic inequalities around the world widened considerably. This worsening resulted from the generalized economic decline, rising unemployment, and worsening income distribution. These conditions directly affected the population, especially low-income families, already facing socio-economic difficulties that intensified during the critical period[2].

The population of all ages has been susceptible to COVID-19. However, at the beginning of the pandemic, the infection was not common in children, and these cases were not given much attention due to the high prevalence of severe cases in adults[3]. The highest mortality rates from the disease were recorded in children from low—and middle-income countries[4]. Thus, it should be noted that the adverse outcomes of the disease in children may be linked to the influence of income distribution[5].

The loss of family income is one factor contributing to the worsening of social inequalities, which in turn reflects the action of allocating resources in a society. COVID-19 mortality levels among Brazilian residents varied according to the city in which they lived, and the highest coefficients of the disease were concentrated in urban centers with greater income inequality and segregation[6].

In addition, the social inequality exacerbated by the pandemic has had direct implications for health disparities among children, especially in urban areas where income segregation is more evident. The impact of COVID-19 on the child population has been variably described, and despite low mortality compared to adults, it still has a high multifactorial morbidity. The phenomenon of child mortality from the disease in Brazil is complex and cannot be attributed to a single explanation, with social inequalities being one of the main factors[6]. In this context, it should be noted that between April 1, 2020, and August 31, 2022, COVID-19 was one of the leading causes of death in children and young people aged between 0 and 19[7].

Still, four years after the start of the pandemic and even after the availability of vaccines against COVID-19 aimed at children as young as six months, an average of three children or adolescents up to the age of 14 die every four days in Brazil. The persistence of mortality may be associated with low vaccination coverage rates since 23% of children between three and four years old have had two doses of the vaccine, and only 7% have a complete vaccination schedule with three doses[8].

Analysis of the initial period of the pandemic shows that Brazil led the ranking of countries with the highest mortality rates in children due to COVID-19 in the world[4]. Although children develop less severe forms[9], these outcomes may be related to low—and middle-income regions[10], reinforcing the need to identify factors associated with unsatisfactory results. It is, therefore, necessary to understand the distribution of cases and deaths in children due to the disease and how these data correlate with family income.

Therefore, this study aimed to analyze children's COVID-19 incidence and mortality rates and their relationship with family income.

Methods

This is an ecological time trend study characterized by analyzing a population or a group of people who generally belong to a defined geographical area[11], using data referring to the 16 Administrative Regions of the State of São Paulo. The epidemiological data (confirmed cases and deaths resulting from COVID-19 in children aged 0 to 11 years, 11 months, and 29 days) were collected in May 2023 by the researcher on the official website of the State Data Analysis System. They corresponded to the period from February 25, 2020, referring to the date of the first confirmation of the disease in the State of São Paulo, to February 25, 2023. Data were collected from the Brazilian Institute of Geography and Statistics database to analyze the economic variable, per capita family income, and the study population.

The data collected were exported to Excel spreadsheets, and descriptive analyses were carried out. The Bivariate Global Moran's Index was calculated to assess the spatial autocorrelations of the variables of interest, and the formation of clusters was assessed using the Bivariate Moran's Index analysis[(12)].

The incidence coefficient was calculated using the ratio between the number of new cases in each period and the number of children exposed in the same period multiplied by 1,000. In turn, the infant mortality coefficient for COVID-19 was calculated using the ratio between the number of deaths in this population group and the infant population living in the same place multiplied by 1,000[(13)]. Advanced software tools like GeoDa 1.20.0.10 were used to calculate the indices[(12)], and QGIS 3.26.0 was used to draw up the maps and frequency distributions[(14)].

The GeoDa 1.20.0.10 software was also used in the bivariate analysis to assess the spatial correlation between the dependent variable (incidence coefficient) and the independent variables (per capita family income). This analysis calculated the Local Moran's Index and generated spatial correlation maps. In the bivariate spatial correlation, the clusters were interpreted into five categories: non-significant, for regions that did not fit into any cluster; high-high, indicating regions with a high frequency of the variable of interest and a high frequency of mortality; low-low, for areas with a low frequency of the variable of interest and a low frequency of mortality; low-high: for areas with a low frequency of the variable of interest and a high frequency of mortality; high-low: for regions with a high frequency of the variable of interest and a low frequency of mortality.

The correlation values produced by the Global Moran's Index (GMI) and Local Moran's Index (LMI) were pivotal in our research. These values were evaluated as positive or negative and classified as weak (<0.3), moderate (0.3-0.7), or strong (>0.7), following the same methodology used to assess Pearson's correlation[(12)].

Variations in the monthly disease incidence coefficients between 2020 and 2023 were analyzed using a joint point regression model. Based on a Poisson regression, the positions of the inflection points and the regression coefficients were estimated. In contrast, the ideal number of join points was determined using a Monte Carlo permutation test, with a maximum of 6 points. Monthly percentage changes (MPCs) were calculated for each line segment, and the 95% confidence interval was used to facilitate interpretation. The analyses were carried out using the JoinPoint Regression software version 4.9.1.0, adopting a significance level of 5% for all analyses. A significance level of 5% was adopted for all analyses. Concerning the children mortality coefficients, as the number of children was small, it was impossible to see any change in the death rate trend.

Results

In the state of São Paulo, there were 88,913 confirmed cases of COVID-19 in children and 335 deaths during the study period. Between February 2020 and February 2023, the São José do Rio Preto administrative region recorded the highest incidence rate of COVID-19 cases per 1,000 inhabitants, and the Registro administrative region recorded the highest mortality rate (Table 1).

Table 1 – Distribution of COVID-19 incidence and mortality coefficients in children in the state and the different regions of São Paulo, 2020-2023. São Carlos, SP, Brazil, 2024

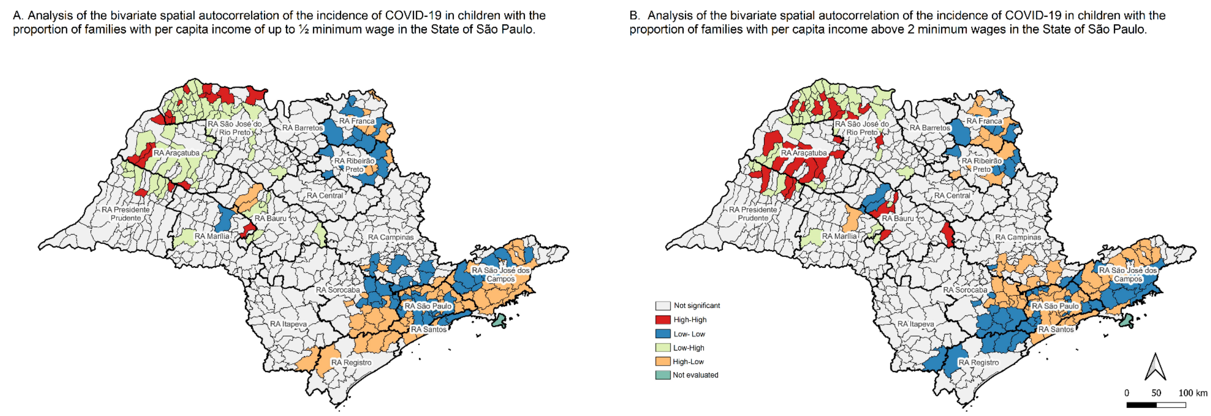
Region	Incidence rate per 1,000 inhabitants/year		Mortality rate per 1,000 inhabitants	
	Rate	95% CI	Rate	95% CI
Araçatuba	37.4	36.8 – 38.1	0.057	0.021– 0.125
Barretos	22.2	21.5 – 22.9	0.034	0.004 –0.122
Bauru	26.6	26.2 – 27.1	0.032	0.010 – 0.074
Campinas	18.9	18.8 – 19.1	0.032	0.022 – 0.045
Central	30.3	29.8 – 30.8	0.014	0.002 – 0.051
Franca	10.9	10.6 – 11.3	0.044	0.014 – 0.103
Itapeva	30.1	29.4 – 30.8	0.023	0.003– 0.082
Marília	34.1	33.6 – 34.7	0.043	0.016 – 0.094
Presidente Prudente	31.4	30.8 – 32.0	0.052	0.019 – 0.113
Registro	16.0	15.3 – 16.7	0.108	0.035 – 0.251
Ribeirão Preto	14.4	14.1– 14.7	0.064	0.034 – 0.110
Santos	8.2	8.1 – 8.4	0.089	0.058 – 0.131
Sorocaba	20.2	19.9 – 20.4	0.046	0.028 – 0.073
São José do Rio Preto	44.9	44.3 – 45.4	0.046	0.021 – 0.086
São José dos Campos	13.1	12.9– 13.3	0.064	0.042 – 0.095
São Paulo	7.0	6.9 – 7.0	0.051	0.044 – 0.059
State of São Paulo	14.1	14.1 – 14.2	0.049	0.044 – 0.055

Source: Brazilian Institute of Geography and Statistics/State Data Analysis System; CI: Confidence Interval

The results showed a weak negative spatial correlation between the COVID-19 incidence coefficient and the rate of families with a per-person income of up to half the minimum wage. Municipalities with higher incidence rates of the disease among children had a lower proportion of families with per capita income in this range (Moran's Index: -0.141; p-value < 0.01). There was also a weak negative spatial correlation between the incidence coefficient and the rate of families earning more than two minimum wages per capita. Municipalities with high COVID-19 incidence coefficients among children generally had a lower rate of families with per capita income above two minimum wages (Moran's Index: -0.112; p < 0.01).

The analysis of the local Moran's Index revealed a spatial autocorrelation of the proportion of families with per-person income of up to half a minimum wage in the state of São Paulo, highlighting the formation of high-high clusters in municipalities in the administrative regions of Marília, Presidente Prudente, Araçatuba and São José do Rio Preto. These regions had a high COVID-19 incidence rate among children and a high proportion of families in this income bracket, also observed in neighboring municipalities. On the other hand, the formation of low-low clusters was identified in municipalities in the administrative regions of Santos, São Paulo, São José dos Campos, Campinas, Sorocaba, Ribeirão Preto, and Franca, which showed a low incidence coefficient of the disease in children and a low proportion of families with a per capita income of up to half a minimum wage (Figure 1A).

In addition, there was spatial autocorrelation in the proportion of families with a per capita income of up to two minimum wages in the state of São Paulo, with the formation of high-high clusters in municipalities in the administrative regions of: Presidente Prudente, Araçatuba, São José do Rio Preto and Bauru. These areas also showed a high incidence rate of COVID-19 in children and a high proportion of families with a per capita income of up to two minimum wages, as well as in the surrounding municipalities. In contrast, the formation of low-low clusters was observed in municipalities in the administrative regions of Itapeva, Registro, Sorocaba, Santos, São Paulo, São José dos Campos, Campinas, Bauru, Franca, and Ribeirão Preto, which showed both a low COVID-19 incidence coefficient among children and a low proportion of families with a per capita income of up to two minimum wages (Figure 1B).

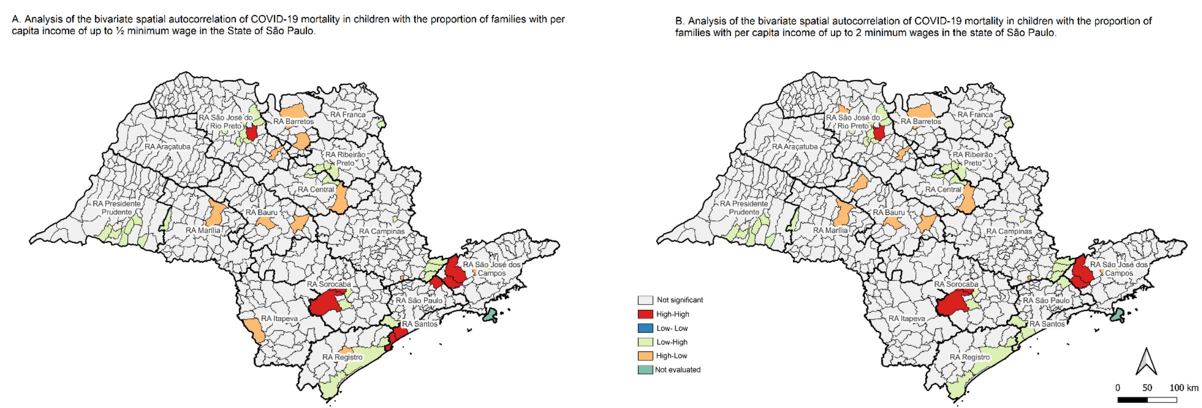


Source: Brazilian Institute of Geography and Statistics/State Data Analysis System

Figure 1 – Analysis of the bivariate spatial autocorrelation of the COVID-19 incidence coefficient in children with the proportion of families with per capita income in the state. São Carlos, SP, Brazil, 2024

Regarding the COVID-19 child mortality coefficient in the state of São Paulo, high-high clusters were found in municipalities in the administrative regions of São José do Rio Preto, Sorocaba, Santos, São Paulo, and São José dos Campos. These administrative regions had municipalities with a high mortality rate and a high proportion of families with a per capita income of up to half the minimum wage (Figure 2A).

High-high clusters were found in municipalities in the administrative regions of São José do Rio Preto, Sorocaba, and São José dos Campos, with a high mortality rate and a high proportion of families with a per capita income of more than two minimum wages, as well as in the surrounding areas (Figure 2B).



Source: Brazilian Institute of Geography and Statistics/State Data Analysis System

Figure 2 – Analysis of the bivariate spatial autocorrelation of the COVID-19 mortality coefficient in children with the proportion of families with per capita income in the state. São Carlos, SP, Brazil, 2024

When analyzing the points of change in the COVID-19 incidence coefficients in children in the state of São Paulo during the study period, the administrative regions of Santos and São Paulo showed no change. The administrative areas of Franca and Registro showed two points of change in the incidence coefficients of the disease during the period analyzed. The administrative regions that registered three points of change in the COVID-19 incidence coefficients in children were Araçatuba, Barretos, Bauru, Campinas, Central, Itapeva, Marília, Presidente Prudente, Ribeirão Preto, São José do Rio Preto, São José dos Campos, Sorocaba and the State of São Paulo (Table 2).

Table 2 – Time trend estimates of COVID-19 incidence coefficients in children in São Paulo analyzed using Join-Point analysis. São Carlos, SP, Brazil, 2024

Incidence rate (1,000 inhabitants/year)	Period	MPC (CI 95%)	MAPC (CI 95%)
2 JoinPoint			
Franca	04/20 to 05/21	20.0 (9.5 ; 31.5)*	-1.9 (-6.2 ; 2.6)
	05/21 to 02/23	-13.4 (-17.5 ; -9)*	
Registro	04/20 to 01/22	13.1 (4.9 ; 22.1)*	2.3 (-3.6 ; 8.5)
	01/22 to 02/23	-13.0 (-21.7 ; -3.4)*	
3 JoinPoint			
Estado de São Paulo	04/20 to 06/21	13.4 (6 ; 21.5)*	-2.4 (-27 ; 30.3)
	06/21 to 10/21	-50.5 (-79.3; 18.7)	
	10/21 to 01/22	210.6 (-87.5; 7628.6)	
	01/22 to 02/23	-21.8 (-28.7 ; -14.3)*	
Araçatuba	04/20 to 06/21	20.6 (10.3 ; 31.8)*	-0.8 (-31.6 ; 43.9)
	06/21 to 10/21	-56.4 (-84.5; 22.9)	
	10/21 to 01/22	298.9 (-93.9; 26003)	
	01/22 to 02/23	-24.8 (-31.1 ; -18)*	
Barretos	04/20 to 06/21	11.3 (2.3 ; 21.1)*	-1.9 (-43.2 ; 69.6)
	06/21 to 10/21	-57 (-87.5; 48)	
	10/21 to 01/22	290.7 (-99.3; 211117.8)	
	01/22 to 02/23	-19.7 (-27.1 ; -11.5)*	
Bauru	04/20 to 06/21	12.7 (2.8 ; 23.5)*	-0.1 (-36.2 ; 56.3)
	06/21 to 10/21	-61.9 (-91.2; 65.5)	
	10/21 to 01/22	392.6 (-96.5; 69038.2)	
	01/22 to 02/23	-18.4 (-25.2 ; -10.9)*	
Campinas	04/20 to 07/21	10.3 (2.9 ; 18.2)*	-2.5 (-29 – 34)
	07/21 to 10/21	-61 (-94.8; 192)	
	10/21 to 01/22	247.9 (-85.4; 8167.1)	
	01/22 to 02/23	-22.0 (-29.1 ; -14.3)*	
Central	04/20 to 06/21	22.3 (12 ; 33.6)*	-0.8 (-32; 44.9)
	06/21 to 10/21	-64.1 (-90.7; 38.8)	
	10/21 to 01/22	400.4 (-91.7; 30110.6)	
	01/22 to 02/23	-25.4 (-32 ; -18.3)*	
Itapeva	04/20 to 06/21	22.9 (10.8 ; 36.2)*	0 (-39.2 ; 64.5)
	06/21 to 10/21	-67.3 (-92.9; 51.5)	
	10/21 to 01/22	472.3 (-97.8; 146214.2)	
	01/22 to 02/23	-24.4 (-30.7 ; -17.5)*	
Marília	04/20 to 06/21	25.0 (16.2 ; 34.5)*	-1 (-24.4 ; 29.6)
	06/21 to 10/21	-54.9 (-77.9 ; -8.1)*	
	10/21 to 01/22	208 (-85.1; 6267.2)	
	01/22 to 02/23	-24.5 (-30.8 ; -17.6)*	
Presidente Prudente	04/20 to 06/21	24.8 (13.3 ; 37.5)*	1.1 (-28.5 ; 42.8)
	06/21 to 10/21	-56 (-84.8; 27.3)	
	10/21 to 01/22	261.6 (-92.2; 16572.2)	
	01/22 to 02/23	-22.5 (-28.5 ; -16.1)*	
Ribeirão Preto	04/20 to 06/21	13.0 (5.7 ; 20.8)*	-5.5 (-28.1 ; 24)
	06/21 to 10/21	-45.4 (-75.6; 22.1)	
	10/21 to 01/22	151 (-87.7; 5013)	
	01/22 to 02/23	-26.4 (-34.4 ; -17.5)*	
São José do Rio Preto	04/20 to 07/21	12.3 (3.8 ; 21.6)*	-1.8 (-41 ; 63.3)
	07/21 to 10/21	-73.1 (-98.6; 411.5)	
	10/21 to 01/22	398.9 (-97.4; 97475.3)	
	01/22 to 02/23	-22.1 (-29.6 ; -13.8)*	
São José dos Campos	04/20 to 06/21	15.0 (6.3 ; 24.4)*	-0.8 (-26 ; 32.9)
	06/21 to 10/21	-55.5 (-84.9; 30.8)	
	10/21 to 01/22	218.4 (-86; 7148)	
	01/22 to 02/23	-17.3 (-25.9 ; -7.8)*	
Sorocaba	04/20 to 06/21	21.4 (12.1 ; 31.4)*	-0.4 (-38.4; 61.1)
	06/21 to 10/21	-61.2 (-86.9; 15.1)	
	10/21 to 01/22	296.4 (-98.4; 99433.2)	
	01/22 to 02/23	-21.7 (-28.2 ; -14.6)*	

*Statistically significant changes; MPC: Monthly percentage change; MAPC: Mean annual percentage change; CI: Confidence Interval

Discussion

The evolution of the COVID-19 incidence rate among children in São Paulo showed an upward trajectory with remarkable peaks between May 2021 and January 2022. The number of deaths among children up to the age of 11 was exceptionally high in 2022. In addition, municipalities with the highest incidence rates of the disease among children tend to have a lower proportion of families with a per capita income of less than half the minimum wage and a reduced rate of families with an income above two minimum wages.

It can be inferred that the lower incidence of COVID-19 in children from families with a per capita income below half the minimum wage is related to barriers to accessing health services, the lack of diagnostic resources, and even the underreporting of these cases. On the other hand, the lower prevalence of the disease in children from families with better financial conditions can be attributed to a more robust prevention network, in addition to the roles played by family members during the critical periods of the pandemic. It is important to note that people with higher incomes have been able to adapt more quickly to remote working, which may have contributed to reduced exposure to the virus.

Families with lower incomes may have suffered more significant exposure to the virus. In comparison, families with higher incomes may have benefited from the physical isolation policies adopted during the critical periods of the pandemic. From this perspective, the experiences of the H1N1 and Zika pandemics have already shown that some social groups are more affected than others, especially low-income individuals[15].

The conditions surrounding people's lives, such as those associated with the health system, are influenced by the distribution of income, power, and infrastructure in the regions, which are mediated by public policies. Thus, health disparities partially manifest through social determinants, affecting health indicators[16].

It should be noted that the individual and collective capacity to protect themselves against health crises, as occurred during the COVID-19 pandemic, varies significantly between different social classes[17]. This shows the influence of geographical inequalities, as the coefficients of mortality, lethality, incidence and prevalence of the disease are higher in more impoverished areas, which concentrate more socially vulnerable people[6].

Thus, people and locations have not been uniformly affected by COVID-19 in terms of speed and intensity[18]. The control measures implemented during the critical phase of the pandemic have influenced variations in trends in incidence coefficients. Due to the lack of federal coordination, each state and municipality implemented measures at different times and with varying degrees of rigor. They had various mechanisms for monitoring, evaluating, and relaxing physical isolation guidelines[19].

COVID-19 incidence and mortality rates, especially among children, have been influenced by regional differences related to healthcare access and coverage, the distribution of human resources, and the structure of the health network[20]. These factors may explain the differences observed in incidence and mortality rates in the administrative region of São José do Rio Preto, recognized as one of the most prosperous in São Paulo. Although this region had a high incidence rate, mortality was relatively low. In contrast, the administrative area of Registro, one of the poorest in the state, recorded a lower incidence rate but a significantly high mortality rate among this population group.

Regionality, as well as socioeconomic development, can be considered risk factors for mortality in children, with municipalities with greater inequality, social vulnerability, and worse socioeconomic indicators tending to have higher mortality from COVID-19 in this population group[6].

High COVID-19 incidence and mortality rates in the general population were recorded in May and July 2020 and March to April 2021 in the São Paulo state[21]. These periods coincide with the highest levels of incidence in the child population, allowing us to infer that in this period, the disease was advancing uncontrollably, concurrent with the emergence and spread of new variants, in addition to the start of vaccination in January 2021, but for specific groups of adults and older adults.

The number of cases of COVID-19 in children was distributed heterogeneously in the state of São Paulo, with a high incidence of the disease in the populations of São José do Rio Preto and Araçatuba[21]; it can be understood that the child population was also affected, as these were the administrative regions with the highest incidence rates among children.

This disparity in the geographical distribution of cases may be linked to factors such as adherence to physical insulation measures during the critical phase of the pandemic, distribution, access to tests for early disease detection[10], and demographic characteristics. This indicates that the distribution of cases was not random, as they were concentrated in areas with higher population density, economic development, and access to health services[15].

Despite this, the vaccination of adults has protected even the unvaccinated population, impacting the incidence of the disease in children, who until then could not benefit from the available immunizers[22]. In addition, the complete vaccination of adults has contributed to the concentration of severe cases of COVID-19 in unvaccinated groups. This situation has led to a proportional increase in cases among the child population, causing an increase in hospitalizations and deaths in this age group[23].

From 2020 to 2021 in Brazil, there was an exponential increase in cases in children and adolescents, especially in December 2021, when 80% of the Brazilian population was vaccinated and the third wave of COVID-19 began[24]. This wave was caused by the Omicron variant, which showed mechanisms of escape from the immune system and greater capacity for dissemination, up to three times greater than the Gamma and Delta variants[25], and directly impacted the trends in the incidence coefficient in children. Even though children were not vaccinated during this period, there was a high percentage of coverage among the adult population, which undoubtedly led to a natural shift in the individuals affected. This led to an increase in cases of the disease among children, which led to a rise in the number of hospitalizations and deaths in this age group[24].

The fluctuations in COVID-19 incidence and mortality rates in children reflect the different epidemic waves and municipalities' actions to control the pandemic. In addition, during the pandemic period, due to the lack of a national guideline, the São Paulo State Government drew up the São Paulo Plan, which defined measures to control the spread of the disease according to indicators such as ICU bed occupancy rate, number of new hospitalizations and, consequently, the number of deaths, creating criteria for flexibility and resumption of non-essential services[26]. However, the implementation of the restriction and relaxation measures occurred heterogeneously in the different regions of the state, implying different COVID-19 incidence and mortality coefficients, especially in children, which were also related to socioeconomic, cultural, and health indicators of each administrative region, and even ideological and political issues.

In addition to the factors that influenced the changes in the trend of incidence coefficients, the capacity for infection associated with COVID-19, linked to a population occupying heterogeneous territories regarding living conditions, shows a differentiated increased risk for the disease[27]. To understand the trajectory of the spread of SARS-CoV-2s, it is essential to analyze urban inequalities since COVID-19 has shown how the disease has strengthened while circulating through unequal urban contexts. The combination of the pandemic and social deprivation has made this scenario critical, exposing more people to additional risks of acquiring the disease[2].

Regarding the child population, the invisibility of children in situations of social vulnerability may be associated with socioeconomic factors beyond biological and individual aspects[28]. The pandemic has disproportionately affected children from certain vulnerable groups, such as low income, structural inequalities related to color or race, and those in developing and underdeveloped countries, such as Brazil[10,21].

Multiple factors may be associated with these inequalities, suggesting a COVID-19 syndemic. This syndemic strongly interacts with the virus, chronic diseases, and socioeconomic vulnerabilities, potentiating these conditions and adverse health outcomes[29].

The social disparities structurally rooted in Brazil can be related to social indicators, influencing the incidence coefficients and the number of deaths from COVID-19 in children[20]. In this scenario, social vulnerability has become an influential factor in increasing incidence and mortality in the child population[6,19].

The more significant impact of COVID-19 mortality in children in low—and middle-income countries compared to high-income countries may be related to the lower capacity or quality of the health system in general[4]. Child mortality has been linked to geopolitically disadvantaged regions[6,24].

Based on the analyses above, it is possible to conclude that children in social vulnerability face additional challenges related to access to healthcare, the quality of housing and precarious living conditions during the critical phase of the COVID-19 pandemic. These factors have probably contributed to an increase in the incidence and mortality of the disease in this population group.

Study limitations

The limitation of an ecological study is the use of secondary data, which may be subject to underreporting and incomplete information. It is also important to note that the analysis of per-capita family income was based on data available from the Brazilian Institute of Geography and Statistics, according to an analysis of the latest 2010 census, available during the periods of data collection and analysis; however, these limitations did not impact on the results of this study, as they provide evidence of the effects of geographical and regional inequities and poverty on the incidence and mortality coefficients of COVID-19 in the child population.

Contributions to practice

It is essential to discuss and strengthen the literature on the epidemiological findings of COVID-19 in children, considering that the economic context stands out among the various facets that can influence unfavorable outcomes. Understanding the relationship between the two phenomena has affected children's health during the critical phase of the pandemic, providing valuable information for improving public health policies. In addition, it has contributed to preventive health planning and actions, emphasizing regions with greater vulnerability and social inequalities.

Conclusion

COVID-19 incidence and mortality rates among children in the state of São Paulo have shown significant variations over time and between different regions. Among the factors intertwined to explain this complex situation, regional economic disparities stand out, which may have significantly affected the outcomes of the disease in children.

It is therefore concluded that the most socially vulnerable regions in the state of São Paulo have had a disproportionate influence on COVID-19 incidence and mortality rates in children. This underscores the urgent need to combat socioeconomic inequalities in public health strategies, the importance of continuous case surveillance, constant monitoring of vaccination coverage, and the adaptation of public health policies as the epidemiological scenario evolves.

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Authors' contributions

Conception and design or analysis and interpretation; writing of the work and relevant critical revision of the intellectual content; final approval of the version to be published; and responsibility for all aspects of the manuscript: Silva BC, Uehara SCSA.

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