

ORIGINAL ARTICLE

Body mass index assessment of preschool children during the COVID-19 pandemic

Luciane Bresciani Salaroli^a, Jeressica Renally de Araújo Silva^b, Dixis Figueroa Pedraza^{a,b}



^aPostgraduate Program in Public Health, Federal University of Espírito Santo (UFES), Vitória, Espírito Santo, Brazil;

^bDepartment of Nursing, State University of Paraíba (UEPB), Campina Grande, Paraíba, Brazil.

Corresponding author
dixisfigueroa@gmail.com

Manuscript received: may 2023

Manuscript accepted: december 2023

Version of record online: march 2024

Abstract

Introduction: the COVID-19 pandemic has brought socioeconomic, behavioral and clinical losses that can compromise the nutritional status of children, and studies on the subject are essential.

Objective: to assess the Body Mass Index of preschool children during the COVID-19 pandemic.

Methods: the data in this study comes from a cohort of children created to prospectively investigate determinants of growth and development in the period from birth to 1,000 days of life in a municipality in the interior of Paraíba, Brazil. For this study, data were collected from children at 4 years of age examining repercussions of the COVID-19 pandemic on maternal and child life. Data on the children (biological characteristics, health conditions, food consumption, screen time, behaviors during the COVID-19 pandemic, satisfaction with school and home life) and their mothers (overweight/obesity, sociodemographic characteristics, childcare, attitudes and practices related to the COVID-19 pandemic) were included, and the Body Mass Index-for-age average (Z-score) was compared using hierarchical multiple linear regression.

Results: not breastfeeding in the first hour of life ($p = 0.046$) and regular consumption of filled cookies, sweets or candies ($p = 0.042$) were the characteristics of the children that represented the highest means of the outcome. Children whose mothers were diagnosed as overweight/obese ($p = 0.034$), who had not completed high school ($p = 0.042$), who had difficulty caring for the child and guiding them in health aspects ($p = 0.010$), as well as those whose mothers needed psychological care ($p = 0.047$) and mental health medication ($p = 0.036$) during the COVID-19 pandemic, also had higher mean scores.

Conclusion: maternal mental health (psychological care and use of medication) during the COVID-19 pandemic had an impact on the child's nutritional status.

Keywords: COVID-19, child, body mass index, nutrition, mental health.

Suggested citation: Salaroli LB, Silva JRA, Pedraza DF. Body mass index assessment of preschool children during the COVID-19 pandemic. *J Hum Growth Dev.* 2024; 34(1):174-185. DOI: <http://doi.org/10.36311/jhgd.v34.15749>

Authors summary

Why was this study done?

The COVID-19 pandemic brought socioeconomic, behavioral and clinical losses, with greater impacts on socially vulnerable children and families. Knowing the relation between the COVID-19 pandemic and the nutritional status of children is of critical importance for decision-making on arrangements that can be implemented to protect the health and nutritional status of the child population. Studies with this focus are still needed. The child's nutritional status is not only an important indicator of health, but also of resilience against destabilization processes such as caused by the COVID-19 pandemic.

What did the researchers do and find?

126 children aged 4 years old were analyzed, examining the repercussions of the COVID-19 pandemic on maternal and child life. Body Mass Index-for-age averages (Z-Score) of children were compared according to child and maternal characteristics using hierarchical multiple linear regression. The findings showed that children who were not breastfed in the first hour of life and who ate filled cookies, sweets or candies regularly had higher outcome means. Regarding maternal characteristics, similar results were found in children of mothers who were overweight/obese, who didn't complete high school, had difficulty caring for the child and who expressed mental health problems caused by the COVID-19 pandemic.

What do these findings mean?

The scientific evidence available showed that the nutritional status of children was influenced by repercussions of the COVID-19 pandemic on their mothers' mental health. Therefore, interventions to improve maternal health are essential to mitigate the negative effects of the pandemic and protect the child's nutritional status.

Highlights

The children's Body Mass Index was related to their mothers' need for psychological care and the use of mental health medications during the COVID-19 pandemic, concomitantly with other maternal factors such as overweight/obesity, lower education level and the difficulty in caring for the child.

Improving the mental health of mothers as a result of the repercussions of the COVID-19 pandemic should be encouraged to minimize the negative effects of the pandemic on maternal health and the nutritional status of their children.

INTRODUCTION

The COVID-19 pandemic has presented itself as one of the biggest health challenges around the world, especially in low- and middle-income countries like Brazil, which has become the epicenter of the pandemic¹. The disease represented a critical global humanitarian situation whose course, severity and consequences on the health, economic, social, political and cultural dynamics of the population made the need to contain the infection of new individuals and reduce the social burden of the disease and its mortality a priority^{1,2}. Thus, social isolation measures were adopted in many countries, however, with changes in people's lives and society in general¹⁻³.

In Brazil, progressive social distancing measures included raising awareness among the population to stay at home, closing schools, universities and workplaces, suspending some types of commerce, banning mass events and gatherings, restricting travel and public transport, limited access to recreational facilities and the prohibition of circulation on the streets, except for purchasing food and medicine or seeking health care. Some indicators suggest that there have been important reductions in the movement of people in parks and for recreation purposes, in commercial activities and at transport stations. In the state of Paraíba, acts of public authorities decreed social distancing measures related to the holding of events, in the area of education and the movement of people⁴.

Although scientific evidence suggests that measures of social distancing of the population, associated with the isolation of cases and the quarantine of contacts combined, had a positive impact on the expansion of the epidemic⁴, it is also recognized the possibility of losses in access to essential goods and services, with potential socioeconomic and behavioral repercussions and clinics, especially among socially vulnerable families³⁻⁵. Social distancing can result in reduced income and economic instability, adoption of

unhealthy lifestyles (decreased physical activity, sleep disorders, and greater consumption of unhealthy foods, alcoholic beverages and tobacco) and increased stress⁶⁻⁸. Additionally, lost opportunities due to interruptions in education, health, nutrition and social protection services limited preventive care and the receipt of school meals, accentuating vulnerability⁸⁻¹⁰.

Collectively, these changes can have a lasting impact on health³, with marked increases in the risk of mental illness, food and nutritional insecurity, all forms of malnutrition and maternal and child morbidity and mortality⁷⁻¹¹. The concern is of such magnitude that it is believed that there are possible intergenerational consequences for child growth and development, lifelong impacts on education, illness due to chronic diseases and human capital, and the risk of losing the progress made in the last decade on the child's nutritional status^{9,10}. According to estimates by the Food and Agriculture Organization of the United Nations, the number of undernourished people increased drastically from 82 to 132 million in 2020 due to the COVID-19 pandemic¹².

While topics such as socioeconomic consequences^{13,14}, lifestyles^{6,15}, mental health^{14,16} and food and nutritional security^{11,17} have been the target of interest among researchers concerned about the repercussions of COVID-19, studies focusing on nutritional status have not received attention^{6,9,10,14}. As it constitutes an important indicator of health¹⁸ and resilience against destabilization processes, such as that caused by the COVID-19 pandemic in which individual and community resilience emerged as the main defense resource⁷, knowing the relation between COVID-19 and nutritional status is of critical importance for decision-making on measures that can protect the post-COVID-19 population and mitigate negative effects of the disease.

Additionally, research on the effects of COVID-19 on children's lives and health behaviors is still limited^{3,6}. Families with children may be more impacted by COVID-19, with greater consequences on income, food security and poverty levels^{19,20}. Evidence suggests that children's absence from school and changes in routine, separation from loved ones and friends, and the worsening of family finances can cause changes in behavior and lifestyles, with unfavorable results in sleep quality, nutritional status and health in general^{6,21-23}. Social isolation, absence from school life and more time at home have been related to an increase in sedentary behaviors, a decrease in physical activity and the consumption of foods with high energy density, with impacts on children's overweight rates^{21,22}.

Therefore, the objective is to evaluate the Body Mass Index (BMI) of preschool children during the COVID-19 pandemic.

■ METHODS

Study design

The data in this study come from a cohort of children created to prospectively investigate factors determining growth and development in the period from birth to one thousand days of life²⁴. They were eligible to participate in the research children born in 2018 in Mamanguape General Hospital and residents of the county of Mamanguape, Paraíba, headquarters of said hospital, approximately 60 km from the city of João Pessoa, capital of the State. Of the total of 335 children eligible for the study, 95 were excluded (mother under 18 years of age, congenital malformation, twins, referred to the Neonatal Intensive Care Unit, neonatal death, birth before the 37th week of gestation, birth weight, birth weighing less than 2500g) and 35 mothers did not agree to participate in the research. Of the total number of children who began the study (n = 205), 61 were lost to follow-up and 144 were evaluated in the sixth month of life. Initially, the cohort intended assessments at birth, in the 1st, 2nd, 6th month and at one thousand days of the children's lives. However, monitoring at two years of age of the children had to be interrupted as a result of the pandemic installation of COVID-19.

To continue the cohort, the previous reference project²⁴ was reformulated with the purpose of examining implications of the pandemic of COVID-19 in growth and development of children. The data were collected in the five municipal schools in the county of Mamanguape with pre-school education, in which, in general, children born in the county study between 4 and 6 years of age. Collection was in August 2022, when the children in the cohort were 4 years old.

Data collect

For data collection, structured questionnaires were used. The first of these aimed to collect information regarding children. The second questionnaire referred to maternal characteristics. The first questionnaire included questions aimed at children, in addition to those aimed at mothers. The study focuses on the BMI of the children in the cohort, analyzing its relation with data about the

children (biological characteristics, health conditions, food consumption, screen time, behaviors during the COVID-19 pandemic, satisfaction with school and home life) and their mothers (BMI, sociodemographic characteristics, child care, attitudes and practices related to the COVID-19 pandemic).

The questionnaire applied to mothers to obtain data contained information about sex, race (self-reported), health problems at birth, hospital stay for 24 hours or more since birth and immunization with the pentavalent vaccine. Data on the child's vaccination were obtained from the Children's Health Record.

In the second block, the questionnaire addressed breastfeeding in the first hour of life, food consumption and the child's screen time. For food consumption, the Food Consumption Marker Form was used, following the guidelines of the Brazilian Ministry of Health for obtaining food consumption markers in primary care²⁵. The form includes questions related to the previous day of collection, including eating behaviors at risk for developing childhood obesity. Three applications were carried out, two for school days (Monday to Friday) and one for a weekend day. Regular consumption was considered when food intake was reported over two or three days. Two markers of healthy eating were used (consumption of fruit and consumption of vegetables and/or legumes) and two markers of unhealthy eating (consumption of hamburgers and/or sausages and consumption of stuffed biscuits, sweets or candy). Additionally, mothers were asked to report how much time their child spent in the last month watching television, using a computer, playing video games and using a cell phone/tablet on a normal weekday and on a normal weekend day²⁶. To calculate the total recreational screen time in a day, the minutes used for each of the activities mentioned were added and the average of the two reference moments (Monday to Friday and weekend) was determined. For categorization, screen use of up to one hour per day or more was considered, based on the guidelines for physical activity, sedentary behavior and sleep for children under 5 years of age from the World Health Organization²⁷.

The third block of the questionnaire referred to the child's behaviors during the COVID-19 pandemic, including aspects about general health care. We asked whether social isolation, wearing a mask and washing hands were common practices during the pandemic.

The children were asked about their satisfaction with school and family life (whether they liked being at school, school activities, being at home and the things they do at home, as well as whether they felt loved by their family). Furthermore, along with these questions, the mother was asked whether the child had ever rejected school.

The second questionnaire answered by the mothers collected sociodemographic data (age, education), child care (ability to care for the child and guide them in health aspects, do activities and play with the child) and about attitudes and practices related to the pandemic of COVID-19. In relation to the pandemic period, mothers should report how living with the child was like, adapting to remote learning, how worried they were about the

disease, and the need for psychological care and the use of mental health medications. In addition, they were asked whether they had taken the vaccine and whether they had contracted the disease.

Body measurements of children and their mothers were carried out by previously trained anthropometrists using standardized techniques²⁸. Weight was measured using a platform-type digital electronic scale with a capacity of 150 kg and graduated in 100 g (Tanita UM-080[®]). Height was measured using a stadiometer (WCS[®]) with a scale in millimeters. All measurements were taken twice with the individual barefoot, standing and wearing light clothing. The average of the two measurements was used for recording purposes.

Mothers' BMI was calculated as the ratio between weight (kg) and height (meters) squared, classifying them as overweight/obese when ≥ 25 ²⁹. In children, BMI-for-age Z-Scores were calculated using the WHO Anthro v.3 software, considering the population of the Multicentre Growth Reference Study²⁸ as a reference.

Data analysis

The independent variables of the children's profile used in the analyzes were: sex (male, female), race (white, other), health problems at birth (no, yes), hospital stay for 24 hours or more since birth (no, yes), immunization with the pentavalent vaccine (complete schedule, incomplete schedule), screening for NES (no, yes), breastfeeding in the first hour of life (yes, no), fruit consumption (regular, irregular), consumption of vegetables and/or vegetables (regular, irregular), consumption of hamburgers and/or sausages (irregular, regular), consumption of stuffed biscuits, sweets or candies (irregular, regular), recreational screen time (≤ 60 minutes, > 60 minutes), routine of wearing a mask during the COVID-19 pandemic (yes, no), routine of washing hands during the COVID-19 pandemic (yes, no), social isolation during the COVID-19 pandemic (yes, no), likes being at home (yes, no), likes the things you do at home (yes, no), feels loved by your family (yes, no), likes being at school (yes, no), likes the activities from school (yes, no), rejection of school (no, yes).

For the distribution according to maternal characteristics, the following were considered: BMI (adequate, overweight/obesity), age (≤ 34 years, > 34 years), education (complete/higher secondary, incomplete secondary or lower), ease of caring for the child and guidance. In health aspects (yes, no), routine of doing activities and playing with the child (yes, no), living with the child during the COVID-19 pandemic (good, fair/bad), difficulty adapting to the remote teaching during the COVID-19 pandemic (no, yes), concern about COVID-19 disease (no, yes), need for psychological care during the COVID-19 pandemic (no, yes), need to use medication to mental health during the COVID-19 pandemic (no, yes), vaccination against COVID-19 disease (yes, no), positive diagnosis of COVID-19 disease (no, yes).

The BMI-for-age average (Z-Score) of the preschool children were analyzed according to the characterization variables of the children and their mothers. In the bivariate analysis, the averages were compared using the Student's t-test. The correlation matrix did not

identify multicollinearity between the variables. Pearson's correlation coefficients were absolute values below 0.7. The variables that presented a p-value lower than 0.2 according to the Student's t-test were selected for multiple linear regression analysis with a hierarchical model. A modeling process was adopted in two blocks of variables, using the "enter" sequence method, so that BMI-for-age was initially adjusted by the children's characteristics and, in the second block, by maternal characteristics. The statistical significance criterion was established at $p < 0.05$. Analyzes were conducted using the Stata statistical package version 11.0.

Ethical aspects

The work was conducted under the guidelines of Resolution 466/2012 of the National Health Council. The children's mothers signed the Free and Informed Consent Form as a prior condition to participate in the study after being informed about the objectives, procedures and benefits of your participation. Research projects were approved by the Research Ethics Committee of the State University of Paraíba (CAAE 81216417.0.0000.5187, Opinion 2.447.509 and CAAE 53281421.8.0000.5187, Opinion 5.137.768).

RESULTS

The distribution according to their characteristics of the 126 preschool children that participated in the study is available in table 1. As can be seen, hospital admission for 24 hours or more since birth (38.9%) was the most common negative health condition. Regarding food, regular consumption of fruits was 73.2%, while vegetables and/or legumes were 41.1%. For unhealthy eating markers, regular consumption of stuffed biscuits, sweets or candies (56.3%) was higher than that of hamburgers and/or sausages (43.7%). With regard to recreational screen time, in 86.5% of children it was above 60 minutes. During the COVID-19 pandemic, 82.5% of children wore a mask in their routine, 78.6% were in the habit of washing their hands and 63.5% were in social isolation whenever/almost always when recommended. For the variables of satisfaction with home and school life, in all aspects, satisfaction was greater than 70%, except for the items liking being at home (47.4%) and not rejecting school (61.9%).

When characterizing mothers, proportions of overweight/obesity, age over 34 years and incomplete secondary education or less were observed at 66.7%, 34.1% and 57.9%, respectively. The majority of mothers responded positively to questions related to child care, while coexistence with the child during the COVID-19 pandemic was fair/poor in 38.1% of cases. The repercussions of the pandemic were visible, from the need to use mental health medications (13.5%) to concern about the disease (72.0%). Of the 126 mothers, 96.0% reported having been vaccinated against the disease and 19.0% having contracted it (table 2).

Not breastfeeding in the first hour of life ($p = 0.046$) and regular consumption of stuffed biscuits, sweets or candies ($p = 0.042$) were the characteristics of children that represented the highest BMI-for-age average (table 1). Children of overweight/obese mothers ($p = 0.034$), who

Table 1: Body Mass Index-for-age (Z-score) of preschoolers according to children's characteristics. Mamanguape, PB, 2022

Variables	n	%	Body Mass Index-for-age (0.150±1.245)		
			Average	Standard deviation	p-value
Biological characteristics					
Sex					0.412
Feminine	66	52.4	0.127	1,288	
Masculine	60	47.6	0.176	1,206	
Race					0.255
White	38	30.2	0.039	1,032	
Others	88	69.8	0.199	1,329	
Health conditions					
Health problems at birth					0.078
No	112	88.9	0.206	1,258	
Yes	14	11.1	-0.294	1,065	
Hospital stay for 24 hours or more since birth					0.473
No	77	61.1	0.144	1,246	
Yes	49	38.9	0.160	1,256	
Immunization with the pentavalent vaccine					0.103
Complete scheme	113	89.7	0.198	1,215	
Incomplete scheme	13	10.3	-0.264	1,248	
Food consumption and screen time					
Breastfeeding in the first hour of life					0.046
Yes	105	83.3	-0.223	1,229	
No	21	16.7	0.252	1,285	
Fruit consumption					0.214
Regular	82	73.2	0.232	1,303	
Irregular	30	26.8	0.003	1,192	
Consumption of vegetables and/or legumes					0.245
Regular	46	41.1	0.246	1,064	
Irregular	66	58.9	0.107	1,405	
Consumption of hamburgers and/or sausages					0.143
Irregular	63	56.3	0.030	1,290	
Regular	49	43.7	0.290	1,251	
Consumption of stuffed biscuits, sweets or candies					0.042
Irregular	49	43.7	-0.034	0.968	
Regular	63	56.3	0.439	1,455	
Recreational Screen Time (minutes)					0.366
≤ 60	17	13.5	0.126	1,551	
> 60	109	86.5	0.164	1,198	
Behaviors during the COVID-19 pandemic					
Mask wearing routine					0.088
Yes	104	82.5	0.081	1,190	
No	22	17.5	0.477	1,459	

Continuation - Table 1: Body Mass Index-for-age (Z-score) of preschoolers according to children's characteristics. Mamanguape, PB, 2022

Variables	n	%	Body Mass Index-for-age (0.150±1.245)		p-value
			Average	Standard deviation	
Hand washing routine					0.290
Yes	99	78.6	0.118	1,257	
No	27	21.4	0.269	1,212	
Social isolation always/almost always when recommended					0.409
Yes	80	63.5	0.131	1,179	
No	46	36.5	0.184	1,364	
Satisfaction with home and school life					
Likes being at home					0.348
Yes	46	47.4	0.020	1,122	
No	51	52.6	0.113	1,218	
Like the things you do at home					0.239
Yes	68	70.1	0.014	1,142	
No	29	29.9	0.198	1,239	
Feel loved by the family					0.257
Yes	80	82.5	0.105	1,216	
No	17	17.5	-0.100	0.926	
Likes being at school					0.347
Yes	70	72.2	0.098	1,157	
No	27	27.8	-0.007	1.215	
Enjoy school activities					0.454
Yes	72	74.2	0.060	1,141	
No	25	25.8	0.092	1,266	
School rejection					0.455
No	78	61.9	0.141	1.205	
Yes	48	38.1	0.166	1,320	

p-value: statistical significance value according to the t-test.

did not complete high school ($p = 0.042$), who expressed difficulty in caring for the child and guiding them in health aspects also had higher BMI-for-age average ($p = 0.010$), as well as those whose mothers needed psychological care ($p = 0.047$) and used mental health medications ($p = 0.036$) during the COVID-19 pandemic (table 2).

After adjustment, differences in the children's BMI-for-age average recorded through bivariate analyzes were confirmed. Not breastfeeding in the first hour of life, despite not having shown a significant difference in model 1 (adjusted for the children's characteristics), gained statistical significance in model 2. The explanatory power of the model was 31.3% (table 3).

Table 2: Body Mass Index-for-age (Z-score) of preschool children according to maternal characteristics. Mamanguape, PB, 2022

Variables	n	%	Body Mass Index-for-age (0.150±1.245)		p-value
			Average	Standard deviation	
Anthropometric					
Maternal Body Mass Index (kg/m ²)					0.034
Adequate	42	33.3	-0.110	1,096	
Overweight/obesity(≥ 25)	84	66.7	0.382	1,299	

Continuation - Table 2: Body Mass Index-for-age (Z-score) of preschool children according to maternal characteristics. Mamanguape, PB, 2022

Variables	n	%	Body Mass Index-for-age (0.150±1.245)		
			Average	Standard deviation	p-value
Sociodemographic					
Age (years)					0.404
≤ 34	83	65.9	0.131	1,182	
> 34	43	34.1	0.188	1,370	
Education					0.042
Full/upper middle	53	42.1	-0.010	1,283	
Incomplete or lower average	73	57.9	0.377	1,199	
Child care					
Ease of taking care of the child and guiding them in health aspects					0.010
Yes	102	81.0	0.030	1,142	
No	24	19.0	0.659	1,536	
Routine of doing activities and playing with the child					0.210
Yes	118	93.7	0.117	1,233	
No	8	6.3	0.450	1,394	
Attitudes and practices related to COVID-19 pandemic					
Living with the child					0.363
Good	78	61.9	0.101	1,206	
Fair/poor	48	38.1	0.181	1,317	
Difficulty adapting to remote teaching					0.322
No	60	55.6	0.127	1,337	
Yes	48	44.4	0.243	1,234	
Concern about illness					0.421
No	35	27.8	0.115	1,356	
Yes	91	72.2	0.164	1,207	
Need for psychological care					0.047
No	64	50.8	-0.020	1,229	
Yes	62	49.2	0.298	1,251	
Need use mental health medications					0.036
No	109	86.5	0.072	1,227	
Yes	17	13.5	0.632	1,292	
Vaccination against the disease					0.079
Yes	121	96.0	0.183	1,243	
No	5	4.0	-0.468	1,107	
Positive diagnosis of the disease					0.374
No	102	81.0	0.133	1,215	
Yes	24	19.0	0.224	1,388	

p-value: statistical significance value according to the t-test.

Table 3: Hierarchical multiple linear regression of the Body Mass Index-for-age (Z-score) of preschool children according to child and maternal characteristics. Mamanguape, PB, 2022

Variables	Model 1	Model 2	R ² (%)
	β	β	
Body Mass Index-for-age (Z-score)			31.3
Characteristics of children			
Health problems at birth	-0.234	-0.212	
Incomplete pentavalent vaccine vaccination schedule	-0.198	-0.186	
Not breastfed in the first hour of life	0.346	0.352*	
Regular consumption of hamburgers and/or sausages	0.196	0.216	
Regular consumption of stuffed biscuits, sweets or treats by the child	0.353*	0.358*	
Mask wearing routine	0.158	0.174	
Maternal characteristics			
Overweight/obesity (Body Mass Index ≥ 25 kg/m ²)		0.396*	
Education level mincomplete or lower grade		0.289*	
Difficulty caring for the child and guiding them in health aspects		0.435*	
Need for psychological care during the COVID-19 pandemic		0.273*	
Need to use mental health medications during the COVID-19 pandemic		0.488*	
Non-vaccination against COVID-19		-0.201	

* p < 0.05; Model 1: children's characteristics; Model 2: child and maternal characteristics; β: Regression Coefficient; R²: Coefficient of Determination.

DISCUSSION

The objective of the current study was to analyze differences in the BMI-for-age of preschoolers who grew up during the COVID-19 pandemic according to the characteristics of the children and their mothers. The findings showed that the nutritional status of children was mainly influenced by maternal factors such as the presence of overweight/obesity, lower education, difficulties in caring for the child and the repercussions of the pandemic on mental health.

Around the world, the COVID-19 outbreak has forced the implementation of social distancing measures and the need to reinforce individual health care such as hand hygiene and the use of face masks⁴. It is noteworthy that these measures are well evaluated for their functionality, safety and preventive nature, which justifies the good adherence shown among the participants in this study, as previously reported³⁰. The proportion of women who said they had been vaccinated (96.0%), in turn, reinforces acceptance and adherence to pandemic contingency measures. The finding converges with that obtained among residents of Rio Grande do Sul where the intention to be vaccinated against COVID-19 was 96.0% and favored by the acceptance of individual protection actions, including social distancing³¹. In this spectrum of data, another important result observed was the frequency of women who self-reported having contracted the disease (19.0%), which is also consistent with the profile observed in the Brazilian population³². These factors did not influence the average BMI-for-age of the children in the present study.

Other aspects of life that also underwent changes with the COVID-19 pandemic and the restrictions on its control were the social situation, routine, health behaviors and emotional well-being. Financial losses and concerns, food and nutritional insecurity, sedentary lifestyle,

unhealthy diet and stress were circumstances highlighted in the COVID-19 pandemic that can increase the risk of weight gain in children. Associated with the pandemic, the repercussions of these factors on weight are not restricted and isolated, but influenced by each other and by the parents habits.

This scope of knowledge resulting from literature reviews^{6,11,13-17,23,33-35} becomes visible in the results of this study, especially in the variety of problems reported in significant quantities by mothers, such as the need to use mental health medications (13.5%) and psychological care (49.2%), difficulty in living with the child (38.1%) and adapting to remote learning (44.4%), and concern about the disease (72.2%), with an emphasis on the repercussions on mental health that influenced children's BMI-for-age. Parental stress and anxiety caused by COVID-19 can hamper support for their children and can often be passed on to children, increasing the risk of childhood obesity³³. Considering special attention to mothers is pertinent, as women stand out for having been more emotionally affected during the pandemic¹⁶.

The association between mothers mental health and excess weight in their children has been suggested in the literature, namely the presence of depression. The mechanisms described for this relationship reinforce the role of parental practices that affect children's behaviors related to physical activity, eating and screen use^{36,37}. In Brazil, recent studies have also reported similar results^{38,39}. In a study developed with children treated at a pediatric endocrinology out patient clinic located in the city of Fortaleza, Ceará, researchers showed a bidirectional relationship between mothers' depression and children's obesity³⁸. In turn, data from a retrospective cohort of children from a hospital in the state of Minas Gerais revealed an association between maternal depression and a

composite indicator of maternal health and care, including information on BMI, breastfeeding, vaccination, iron deficiency anemia prophylaxis, illnesses and accidents³⁹.

The mother's difficulty in providing care to the child ($p = 0.010$) and lower education ($p = 0.042$) also contributed to higher BMI-for-age mean. This can be explained based on the importance of parents interaction with their offspring and their educational level in maintaining the child's weight, as highlighted in Chile in a study whose results were similar to those observed in our research³⁶. Parent-child interactions can affect children's behavior, such as food choices and those related to physical activity, which are fundamental pillars of healthy weight. On the other hand, school level is directly related to socioeconomic level, whose influence on weight is unquestionable⁴⁰.

Regarding the characteristics of the children, it was evident that not breastfeeding in the first hour of life ($p = 0.046$) and the consumption of stuffed biscuits, sweets or candies on a regular basis ($p = 0.042$) resulted in higher BMI-for-age average, reflecting the importance of food in the child's nutritional status^{15,41}. The differences in children's BMI-for-age according to breastfeeding immediately after birth reflect the importance of breastfeeding for the child's growth and development and are plausible in supporting an analogy with the greater risk of excess body weight in the second year of life in the absence of exclusive breastfeeding, according to a study developed in Joinville, Santa Catarina⁴². Despite this, another study found no association between breastfeeding in the first hour of life and overweight/obesity in children aged 2 to 6 years⁴³. In turn, the consumption of processed foods is one of the determining characteristics of obesity and is increasingly present in the diet of the Brazilian population, starting from childhood⁴¹. Healthy eating, on the other hand, reduces the risk of overweight and obesity in children, as shown in Chile⁴⁰. During the pandemic, behaviors that were harmful to health were exacerbated, such as greater consumption of unhealthy foods and less consumption of healthy foods^{3,6,15,22}.

Finally, it was shown that children of overweight/obese mothers had higher BMI-for-age than those whose mothers were of adequate weight. Along the same lines, other studies have shown that living with overweight mothers was associated with childhood obesity^{43,44}. In fact, for some researchers, this association can be explained by the child's susceptibility to obesity due to genetics, which greatly determines energy balance⁴³. However, in the view of other researchers, the determination of a child's excess weight due to the same condition in the mother is shaped by the influence of social and behavioral factors, namely eating and physical activity habits, in addition to biological determinants⁴⁴.

REFERENCES

1. Rede Brasileira de Pesquisa em Soberania e Segurança Alimentar e Nutricional. VIGISAN: Inquérito Nacional sobre Insegurança Alimentar no Contexto da Pandemia da Covid-19 no Brasil. Rio de Janeiro: Instituto Vox Populi; 2021.
2. Sarti TD, Lazarini WS, Fontenelle LF, Almeida APSC. Qual o papel da Atenção Primária à Saúde diante da pandemia provocada pela COVID-19?. *Epidemiol Serviços Saúde* 2020; 29(2): e2020166.

The closure of schools significantly influenced children's lifestyles with an increase in sedentary lifestyle, screen time and consumption of low-nutrient foods, factors that lead to excessive weight gain^{6,21,22,34,35,40}. This situation is compared to the vacation period when there is an increase in children's weight in relation to the school year, since the school environment favors healthier behaviors^{22,34}. Therefore, it is argued that the repercussions of social isolation on weight are more pronounced in children than in adults. In addition to the environment, greater energy needs and physical activity demands, as well as less autonomy, make children more susceptible to the consequences of the pandemic^{6,34,35,40}. In this sense, the findings of the present study revealed the role of mothers mental health during the pandemic on children's BMI-for-age, becoming relevant knowledge that reinforces how children are influenced by family stimuli⁴⁰.

CONCLUSION

Children's BMI-for-age mean were significantly higher when their mothers were overweight/obese, had a lower level of education and had difficulty caring for the child. Furthermore, children who were not breastfed in the first hour of life and who regularly consumed sandwich cookies, sweets or candies also contributed to higher BMI-for-age values. Examining the repercussions of the pandemic of COVID-19 in maternal and child life, it is highlighted that maternal mental health during the COVID-19 pandemic had an impact on the child's nutritional status.

Acknowledgements

This work was carried out with the support of the Research and Innovation Support Foundation of Espírito Santo (Fapes) Edital 05/2023.

Author contributions

Luciane Bresciani Salaroli, Jerssica Renally de Araújo Silva and Dixis Figueroa Pedraza participated in the analysis and interpretation of data, writing and final review of the article. Dixis Figueroa Pedraza participated in the design of the study and the conception of the article.

Interest conflicts

The authors declare that they have no conflicts of interest regarding the authorship and publication of this article.

Orcid authors

Luciane Bresciani Salaroli
<https://orcid.org/0000-0002-1881-0306>
 Jerssica Renally de Araújo Silva
<https://orcid.org/0000-0001-5150-5816>
 Dixis Figueroa Pedraza
<https://orcid.org/0000-0002-5394-828X>

3. Carroll N, Sadowski A, Laila A, Hruska V, Nixon M, Ma DW, Haines J, on behalf of the Guelph Family Health Study. The Impact of COVID-19 on Health Behavior, Stress, Financial and Food Security among Middle to High Income Canadian Families with Young Children. *Nutrients* 2020; 12(8): 2352.
4. Aquino EML, Silveira IH, Pescarini JM, Aquino R, Souza Filho JA, Rocha AS, et al. Medidas de distanciamento social no controle da pandemia de COVID-19: potenciais impactos e desafios no Brasil. *Ciênc Saúde Colet* 2020; 25(suppl 1): 2423-46.
5. Ribeiro-Silva RC, Pereira M, Campello T, Aragão E, Guimarães JMM, Ferreira AJF, et al. Implicações da pandemia COVID-19 para a segurança alimentar e nutricional no Brasil. *Ciênc Saúde Colet* 2020; 25(9): 3421-30.
6. Mogrovejo LGB, Bermúdez VJ. Childhood Obesity in the Age of COVID: The Epidemic within the Pandemic. *Revista Latinoamericana de Hipertensión* 2022; 17(2): 176-84.
7. Naja F, Hamadeh R. Nutrition amid the COVID-19 pandemic: a multi-level framework for action. *Eur J Clin Nutr* 2020; 74: 1117-21.
8. Philip T James, Zakari Ali, Andrew E Armitage, Ana Bonell, Carla Cerami, Hal Drakesmith, et al. The Role of Nutrition in COVID-19 Susceptibility and Severity of Disease: A Systematic Review. *J Nutr* 2021; 151: 1854-78.
9. Headey D, Heidkamp R, Osendarp S, Ruel M, Scott N, Black R, et al, on behalf of the Standing Together for Nutrition Consortium. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. *The Lancet* 2020; 396(22): 517.
10. Akseer N, Kandru G, Keats EC, Bhutta ZA. COVID-19 pandemic and mitigation strategies: implications for maternal and child health and nutrition. *Am J Clin Nutr* 2020; 112: 251-6.
11. Éliás BA, Jámbor A. Food Security and COVID-19: A Systematic Review of the First-Year Experience. *Sustainability* 2021; 13: 5294.
12. Food and Agriculture Organization, International Fund for Agricultural Development, United Nations Children's Fund, World Food Program, World Health Organization. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. Rome: FAO; 2020.
13. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, Agha M, Agha R. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *Int J Surg* 2020; 78: 185-93.
14. Yen-Hao Chu I, Alam P, Larson HJ, Lin L. Social consequences of mass quarantine during epidemics: a systematic review with implications for the COVID-19 response. *Journal of Travel Medicine* 2020; 27(7): taaa192.
15. Bennett G, Young E, Butler I, Coe S. The Impact of Lockdown During the COVID-19 Outbreak on Dietary Habits in Various Population Groups: A Scoping Review. *Front Nutr* 2021; 8: 626432.
16. Ma L, Mazidi M, Li K, Li Y, Chen S, Kirwan R, et al. Prevalence of mental health problems among children and adolescents during the COVID-19 pandemic: A systematic review and meta-analysis. *J Affect Disord* 2021; 293: 78–89.
17. Zago MAV. As implicações do cenário pandêmico do COVID-19 frente a Segurança Alimentar e Nutricional: uma revisão bibliográfica. *Segur Aliment* 2021; 28: e021008.
18. Hosseini SM, Maracy MR, Sarrafzade S, Kelishadi R. Child weight growth trajectory and its determinants in a sample of Iranian children from birth until 2 years of age. *Int J Prev Med* 2014; 5(3): 348-55.
19. IBOPE Inteligência. Impactos Primários e Secundários da COVID-19 em Crianças e Adolescentes. Relatório de análise: 1ª Onda. Rio de Janeiro: UNICEF; 2020.
20. Sinha IP, Lee A, Bennett D, McGeehan, Abrams EM, Mayell SJ, et al. The Child poverty, food insecurity, and respiratory health during the COVID-19 pandemic. *Lancet Respiratory Medicine* 2020; 8(8): 762-3.
21. Vogel M, Geserick M, Gausche R, Beger C, Poulaint T, Meigen C, et al. Age-and weight group-specific weight gain patterns in children and adolescents during the 15 years before and during the COVID-19 pandemic. *Int J Obes (Lond)* 2022; 46: 144-52.
22. Burkart S, Parker H, Weaver RG, Beets MW, Jones A, Adams EL, Chaput JP, Armstrong B. Impact of the COVID-19 pandemic on elementary schoolers' physical activity, sleep, screen time and diet: A quasi-experimental interrupted time series study. *Pediatr Obes* 2022; 17(1): e12846.
23. Browne NT, Snethen JA, Greenberg CS, Frenn M, Kilanowski JF, Gance-Cleveland B, et al. When Pandemics Collide: The Impact of COVID-19 on Childhood Obesity. *J Pediatr Nurs* 2021; 56: 90-8.
24. Lins ACL, Figueroa Pedraza D. Velocidade de crescimento de crianças de uma coorte até o sexto mês de vida. *Ciênc Saúde Colet* 2021; 26(11): 5777-92.

25. Brasil. Ministério da Saúde. Orientações para avaliação de marcadores de consumo alimentar na atenção básica. Brasília: Ministério da Saúde; 2015.
26. Goncalves WSF, Byrne R, Lira PIC, Viana MT, Trost SG. Psychometric properties of instruments to measure parenting practices and children's movement behaviors in low-income families from Brazil. *BMC Med Res Methodol* 2021; 21: 129.
27. World Health Organization. WHO guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. Genebra: WHO; 2019.
28. Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food Nutr Bull* 2004; 25(suppl 1): 15-27.
29. Brasil. Ministério da Saúde. Orientações para a coleta e análise de dados antropométricos em serviços de saúde: Norma Técnica do Sistema de Vigilância Alimentar e Nutricional – SISVAN. Brasília: Ministério da Saúde; 2011.
30. Fernandes SCS, Souza VH (Org.). Adesão e acesso às medidas preventivas à covid-19 na perspectiva da teoria da ação planejada [recurso eletrônico]. Maceió: EDUFAL; 2021.
31. Scherer JN, Martins PMD, Azevedo VA, Sperling LE, Veronese MV, Renck PGB. Intention to get vaccinated against COVID-19 and vaccine hesitation in Southern Brazil: Prevalence and associated factors. *Rev Bras Psicoter (Online)* 2022; 24(2): 61-73.
32. Silva LMC, Wickert DC, Ilha AG, Piccin C, Malheiros LCS, Santos TA, et al. Investigación en Enfermería: Imagen y Desarrollo 2022; 24.
33. Cena H, Fiechtner L, Vincenti A, Magenes VC, De Giuseppe R, Manuelli M, et al. COVID-19 Pandemic as Risk Factors for Excessive Weight Gain in Pediatrics: The Role of Changes in Nutrition Behavior: A Narrative Review. *Nutrients* 2021; 13(12): 4255.
34. Chang TH, Chen YC, Chen WY, Chen CY, Hsu WY, Chou Y, et al. Weight Gain Associated with COVID-19 Lockdown in Children and Adolescents: A Systematic Review and Meta-Analysis. *Nutrients* 2021; 13(10): 3668.
35. Bakaloudi DR, Barazzoni R, Bischoff SC, Breda L, Wickramasinghe K, Chourdakis M. Impact of the first COVID-19 lockdown on body weight: A combined systematic review and a meta-analysis. *Clin Nutr* 2021; 41(12): 3046-54.
36. Marco PL, Valério ID, Zanatti CL de M, Gonçalves H. Systematic review: Symptoms of parental depression and anxiety and offspring overweight. *Rev Saúde Pública* 2020; 54: 49.
37. Lampard AM, Franckle RL, Davison KK. Maternal depression and childhood obesity: a systematic review. *Prev Med* 2014; 59: 60-7.
38. Martins MIS, Vitoriano NAM, Martins CA, Carvalho EM, JucáRVBM, Alves JSM, Ferreira HS, Mont'Alverne DGB. Aspects of motor development and quality of life in the context of child obesity. *J Hum Growth Dev* 2021; 31(1): 58-65.
39. Scherrer IRS, Alves CRL. Association of maternal depression, family composition and poverty with maternal care and physical health of children in the first year of life. *J Hum Growth Dev* 2021; 31(1): 18-27.
40. Etchegaray-Armillo K, Fuentealba-Urra S, Bustos-Arriagada E. Factores de riesgo asociados al sobrepeso y obesidad en niños y adolescentes durante la pandemia por COVID-19 en Chile. *Rev Chil Nutr* 2023; 50(1): 56-65.
41. Canella DS, Duran AC, Claro RM. Malnutrition in all its forms and social inequalities in Brazil. *Public Health Nutr* 2020; 23(suppl 1): S29-38.
42. Contarato AAPF, Rocha EDM, Czarnobay SA, Mastroeni SSBS, Veugelers PJ, Mastroeni MF. Efeito independente do tipo de aleitamento no risco de excesso de peso e obesidade em crianças entre 12-24 meses de idade. *Cad Saúde Pública* 2016; 32(12): e00119015.
43. Rocha SGMO, Rocha HAL, Leite AJM, Machado MMT, Lindsay AC, Campos JS, et al. Environmental, Socioeconomic, Maternal, and Breastfeeding Factors Associated with Childhood Overweight and Obesity in Ceará, Brazil: A Population-Based Study. *Int. J. Environ Res Public Health* 2020; 17: 1557.
44. Oliveira MM, Santos EES, Bernardino IM, Figueroa Pedraza D. Fatores associados ao estado nutricional de crianças menores de 5 anos da Paraíba, Brasil. *Ciênc Saúde Colet* 2022; 27(2): 711-24

Resumo

Introdução: a pandemia da COVID-19 trouxe prejuízos socioeconômicos, comportamentais e clínicos que podem comprometer o estado nutricional das crianças, sendo essenciais estudos sobre a temática.

Objetivo: avaliar o Índice de Massa Corporal de crianças pré-escolares durante a pandemia da COVID-19.

Método: os dados deste estudo provêm de uma coorte de crianças criada para investigar prospectivamente fatores determinantes do crescimento e desenvolvimento no período do nascimento até os mil dias de vida em um município do interior da Paraíba, Brasil. Para este estudo, foram coletados dados das crianças aos 4 anos de idade examinando-se repercussões da pandemia da COVID-19 na vida materno-infantil. Incluíram-se dados sobre as crianças (características biológicas, condições de saúde, consumo alimentar, tempo de tela, comportamentos durante a pandemia da COVID-19, satisfação com a vida escolar e domiciliar) e suas mães (sobrepeso/obesidade, características sociodemográficas, cuidado da criança, atitudes e práticas relacionadas à pandemia da COVID-19), comparando-se as médias de Índice de Massa Corporal/Idade (Escore-Z) por meio de regressão linear múltipla hierarquizado.

Resultados: não amamentação na primeira hora de vida ($p = 0,046$) e consumo regular de biscoito recheado, doces ou guloseimas ($p = 0,042$) foram as características das crianças que representaram maiores médias do desfecho. Também apresentaram maiores médias as crianças de mães diagnosticadas com sobrepeso/obesidade ($p = 0,034$), que não completaram o ensino médio ($p = 0,042$), que tinham dificuldade de cuidar da criança e orientá-la em aspectos de saúde ($p = 0,010$), bem como aquelas cujas mães tiveram a necessidade de atendimento psicológico ($p = 0,047$) e de usar medicamentos para saúde mental ($p = 0,036$) durante a pandemia da COVID-19.

Conclusão: a saúde mental materna (atendimento psicológico e uso de medicamentos) durante a pandemia da COVID-19 repercutiu no estado nutricional da criança.

Palavras-chave: COVID-19, criança, índice de massa corporal, nutrição, saúde mental.

©The authors (2024), this article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.