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# Effect of the COVID-19 pandemic on malnutrition in socially vulnerable children in Brazil

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**Abstract** *This article aims to evaluate the effect of the COVID-19 pandemic on malnutrition among children under two years of age enrolled in the Bolsa Família Program (BFP). Ecological study of interrupted time series (ITS), with low weight for age, stunting, and overweight as time-dependent variables of malnutrition, extracted monthly (Jan/2008 to June/2021) from the Food and Nutrition Surveillance System. The COVID-19 pandemic was the exposure, dichotomized into pre-pandemic and pandemic. In RStudio, the trend was obtained by Prais-Winsten regression, and the effect of the pandemic on the time-dependent variables was determined by SARIMA modeling, estimating the regression coefficients (RC) adjusted for trend and seasonality (α = 5%). The pandemic was associated with an increase in: i) low weight for age in the South (RC = 0.94; p < 0.001) and Southeast (RC = 1.97; p < 0.001); ii) height deficit in the Midwest (RC = 2.4; p = 0.01), South (RC = 2.15; p < 0.001) and Southeast (RC = 2.96; p < 0.001); and iii) and overweight in the North (RC = 1.51; p = 0.04), Midwest (RC = 2.29; p = 0.01), South (RC = 2.83; p < 0.001), and Southeast (RC = 0.72; p = 0.04). The pandemic increased underweight in the South and Southeast, and the double burden of malnutrition in the Midwest, South, and Southeast. In the Northeast and North, higher rates of malnutrition still persist.*

**Key words** *COVID-19, Malnutrition, Overweight, Children*

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## Introduction

The social, economic, and health changes generated by the COVID-19 pandemic have brought global concern about its indirect effects on child nutrition[1], due to the increase in Food and Nutrition Insecurity (*Insegurança Alimentar e Nutricional* – InSAN)[2]. In this scenario, an increase in all forms of child malnutrition[3], expressed both in the form of malnutrition and excess weight[4], is expected to increase, thereby compromising the achievement of international goals regarding the elimination of malnutrition by 2030[5].

In Brazil, the health crisis was compounded by the economic and political crisis, which began in 2015, resulting in the freezing of public health spending and budget cuts for the implementation of Food and Nutrition Security (*Segurança Alimentar e Nutricional* – SAN) policies in the country[6]. In this context of recession and setbacks, the isolation measures, necessary to contain COVID-19, catalyzed unemployment, hunger[6], and difficulty in accessing health services[7], thus increasing InSAN[8].

In a more unfavorable socioeconomic context, children are more vulnerable to the double burden of nutrition problems[9,10], especially those from poor and socially vulnerable families, whose effects of the COVID-19 pandemic can be more intense[2]. Here, children enrolled in the *Bolsa Família* Program (PBF) stand out, especially those who live in poverty and extreme poverty (income between R$ 89.01 and R$ 178.00), whose difficulty in accessing the Human Right to Adequate Food (Direito Humano a Alimentação Adequada – DHAA) intensified after the pandemic, even at the beginning of life[8].

The PBF was established in 2004, and the program's contributions to reducing poverty and inequalities are well described, expanding access to food, education, and health through compliance with conditions imposed by the program in these sectors, including Food Surveillance and Nutrition (Vigilância Alimentar e Nutricional – VAN) of children in Primary Health Care (PHC), with a reduction in malnutrition1[1] and child mortality over the years[12].

Regarding the nutritional epidemiology of children under two years of age included in this program, in the pre-pandemic period, there was a reduction in excess weight in the five Brazilian macro-regions, between 2008 and 2018[13]. In relation to the decrease in malnutrition, the evidence also shows a significant reduction in stunting among children under five years of age[9,14]. However, there is still a gap regarding the trend of this indicator for children under two years of age enrolled in the program.

No studies were identified that measured children's nutritional status after the COVID-19 pandemic in Brazil. There is evidence of changes in the nutrition and lifestyle habits of children and adolescents, mostly from high- or middle-income countries, pointing to an increase in excess weight[15-17]. In Brazil, it is well-known that, in addition to the increase in hunger and InSAN[8], there are also records of changes in food systems and environments[18], with a high consumption of ultra-processed foods (UPF) by children in the PBF[8], unavailability of healthy foods in the outskirts of major cities[19] and a decline in time for physical activity among Brazilian children[20].

Malnutrition has a unique effect on children at the most critical stages of development, such as the first 1,000 days of life[1]. There are intergenerational consequences throughout the life cycle, with a greater probability for Noncommunicable Diseases (NCDs), cognitive deficits, and compromised human capital, constituting a high burden on public health[10].

Our hypothesis is that the COVID-19 pandemic has changed the scenario of the nutritional epidemiology of child populations in conditions of social and biological vulnerability, such as those in the first 1,000 days of life. The PBF reaches more than 90% of poor and socioeconomically vulnerable families in Brazil. Poor nutrition in this group perpetuates a cycle of poverty and illness, in turn strengthening social inequality. Therefore, it is important to identify the consequences of the pandemic on the nutrition of this population, thus impacting the advances achieved for more than 13.2 million Brazilian families using the PBF, in turn subsidizing public interventions to guarantee full child development. Therefore, this work aimed to evaluate the effect, by Brazilian macro-region, of the COVID-19 pandemic on indicators of malnutrition among children under two years of age and enrolled in the PBF.

## Methods

### Study type and location

Ecological interrupted time series (ITS) study, ideal for evaluating the effect of interventions/exposures on outcomes at the community level[21]. The units of analysis were the five mac-

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ro-regions of Brazil, a middle-income country with the largest territorial extension in Latin America, with 211 million inhabitants. The country is organized politically and administratively into five macro-regions that include 26 states and the Federal District. The North (N), Northeast (NE), and Midwest (MW) regions are less populous and poorer, with a lower Gross Domestic Product (GDP), while in the Southeast (SE) and South (S) regions, there is greater density population and GDP, in addition to more organized health services[22].

**Study population and data source**

All children under two years of age, enrolled in the PBF and with monitoring records for the anthropometric indices Weight for Age (W/A), Height for Age (H/A), and Weight for Height (W/H) were studied, from January 2008 to July 2021, in SISVAN - https://sisaps.saude.gov.br/sisvan/, a public domain database that brings together anthropometric information and food consumption of the Brazilian population, measured in the PHC.

The extraction of information from SISVAN was performed by issuing monthly reports on children's nutritional status and filtered by: year, month, geographic unit, type of monitoring (*Bolsa Família* Program Management System – DATASUS), age group (0-2 years), and anthropometric index, considering W/A, H/A, and W/H. The data were tabulated in an Excel spreadsheet (2017) by the responsible researchers.

Considering that one of the PBF conditionalities for income transfer is the monitoring of child nutrition in Brazilian PHC services, these data have census characteristics for this population[13].

**Study variables**

The exposure variable was the beginning of the COVID-19 pandemic in February 2020, the month corresponding to the first notification of the disease in Brazil. The time-dependent variables were deviations from malnutrition in the form of malnutrition (proportions of underweight and stunting) and excess weight (proportion of overweight/obesity).

Using the W/A index, the proportion of underweight was obtained, considering the relationship between the total number of children with a z score < -2 and the total number of children evaluated. The proportion of height deficit was given by the H/A index, the relationship between the total number of children with a z score < -2 and the total number of children evaluated. The proportion of overweight children was obtained using the W/H index, considering the relationship between the total number of children with a z score > +2 and the total number of children assessed[23]. The proportions were calculated by month and region for each indicator.

**Statistical analysis**

Statistical analyses were performed using the R Studio Pro statistical software (2022). The descriptive analysis was based on the presentation of average rates for the pre-pandemic (Jan/2019 to Jan/2020) and pandemic (Feb/2020 to Jun/2021) periods, as well as the graph presentation of the time series (TS) and of its decompositions into trend curve, seasonality pattern, and error.

Prais-Winsten regression was applied to data from 2008 to 2021 and its product was used to calculate the monthly percentage change (MPV). The series were considered increasing or decreasing when the values were positive or negative, respectively, and p < 0.0524.

The effect of the pandemic on the study variables was measured using Autoregressive, Integrated, and Moving Average modeling for series with seasonality - Seasonal Autoregressive Integrated Moving Average (SARIMA), described in Box and Jekins (1970) and adapted by Hyndman and Athanasopoulos (2018)[25].

The analysis has advantages over other ITS analyses, as it more precisely captures and models the elements of seasonality, trend, and self-correlation that make up the series. Such elements can lead to spurious associations and misinterpretations of the effect of a given exposure on a set of data over time. For example, differences between the pre- and post-intervention data set may simply be due to the existence of a trend prior to exposure, or sudden variations due to seasonality[21]. The analysis was organized into two stages, as described below.

**First step: model identification for each TS**

The automated method was applied, using the *auto.arima* function, to estimate the terms p, d, q, P, D, and Q of the ARIMA(p,d,q) and/or SARIMA(p,d,q)(P) models, which best reflected the TS of each time-dependent malnutrition indicator. The terms were identified considering the assumption of parsimony (lowest term values) and the lowest values of the Akaike information criterion (AIC)[25].

The absence of correlation between model residuals was assessed through: i) analysis of the graphs of the autocorrelation function (ACF), considering up to two significant autoregressive terms in cases of series with seasonality; and ii) Lung Jung Box test values with p > 0.0525. For models with residual autocorrelation (Lung Jung Box < 0.05), the identification of an adjusted model was performed using the interactive method, as described in Hyndman and Athanasopoulos (2008)[25].

**Second stage: intervention models with ARIMA/SARIMA**

The exposure – the COVID-19 pandemic – was taken as a dummy variable, to which the value "zero" was assigned in the pre-pandemic period (January/2008-January/2020) and the value "one" in the pandemic period (February/2020-June/2021). The insertion of the exposure variable in the ARIMA/SARIMA models, identified in the previous stage, made it possible to evaluate whether there was a change in the level or slope of the series[21] of low W/A; stunting and excess weight of children under two years of age, after the onset of the pandemic; and whether the change was maintained during the period under study (until June 2021).

Significant increases or decreases (p<0.05) were considered when the regression coefficient (RC) was positive or negative, respectively. The residue assessment by ACF and the Lung Jong Box test > 0.05 attested to the quality of the model with exposure[21].

**Ethical Issues**

This study used data from freely accessible public reports from SISVAN. Therefore, it was exempt from consideration by the Research Ethics Committee, considering Resolution No. 674/2022, of the National Health Council.

## Results

The present study used anthropometric data from 24,532,241 assessments of children under two years of age, registered in SISVAN from January 2008 to June 2021.

In the pre-pandemic and pandemic periods, stunting and excess weight were the nutritional deviations with the highest average rates in the study population. Before the pandemic, the N region presented higher average rates of underweight for age (4.63% ± 1.62) and stunting (24.43% ± 5.21%), while overweight reached its highest average rate in the NE region (20.70% ± 2.01%). With the onset of the pandemic, higher average rates of underweight by age were recorded in the SE (5.30% ± 1.62) and MW (5.19% ± 1.19) regions, while the N and NE regions remained with higher averages for stunting (24.54% ± 3.34) and excess weight (19.29% ± 2.52), respectively (Table 1).

After breaking down the data, all analyzed series showed seasonality and trends in some period of the series (Figures 1, 2, and 3). The graph analysis showed an increase in underweight rates in Brazilian regions, with an inflection of the curve from 2014 onwards, except in SE, where an increase occurred in mid-2013 (Figure 1). In relation to excess weight, a decline was observed until mid-2019, with a resumption of growth from this year onwards, in all regions of Brazil (Figure 2), as was the case with stunting in the N and NE regions. However, in the MW and SE regions, this problem grew continuously throughout the series (Figure 3).

Significant increasing trends were observed for low weight for age in the CO (MPV = 3.46%; p < 0.001), SE (MPV = 4.16%; p < 0.001), and S (MPV = 1.45%; p < 0.001) regions. Stunting rates increased in the MW (MPV = 8.53%, p < 0.001) and SE (MPV = 8.14%, p < 0.001) regions, but in the NE region there was a reduction of 4.35% (p = 0.02) between 2008 and 2021. In the NE (VPM = -4.53; p < 0.001), CO (VPM = -5.69; p < 0.001) and SE (VPM = -2.99; p = 0.03) regions, there was a decline in excess weight among children under two years of age enrolled in the PBF (Table 1).

The models identified for each TS are described in Table 2. The pandemic was associated with an increase in low weight for age in the SE (CR = 1.97; p < 0.001) and S (CR = 0.94; p < 0.001) regions, as well as stunting in regions the CO (CR = 2.4; p = 0.01), SE (CR = 2.96; p < 0.001) and S (CR = 2.15; p < 0.001) regions. Excess weight increased significantly in the NO (CR = 1.51; p = 0.04), MW (CR = 2.29; p = 0.01), SE (CR = 0.72; p = 0 .04), and S (CR = 2.83; p < 0.001) regions after the onset of the pandemic (Table 2).

## Discussion

The present study investigated the effect of the COVID-19 pandemic on malnutrition in children under two years of age, who were enrolled

**Table 1.** Average rates. monthly percentage variation (MPV). and trend of malnutrition in socially vulnerable children under two years of age. by Brazilian macro-region. between 2008 and 2021.

| Region | Indicador | Average % ± SD % (Jan/2008 to Jan/2020) | Average % ± SD % (Fev/2020 to Jun/2021) | VPM | p-value | Tendency |
|---|---|---|---|---|---|---|
| **Northeast** | Low Weight for Age | 3.35 ± 1.18 | 4.07 ± 1.51 | 0.79 | 0.16 | Stationary |
| | Height deficit | 19.44 ± 4.32 | 18.83 ± 6.10 | -4.35 | 0.02 | Descending |
| | Overweight | 20.70 ± 2.01 | 19.29 ± 2.52 | -4.53 | <0.001 | Descending |
| **North** | Low Weight for Age | 4.63 ± 1.62 | 4.68 ± 2.34 | 0.40 | 0.57 | Stationary |
| | Height deficit | 24.43 ± 5.21 | 24.54 ± 5.34 | -3.80 | 0.10 | Stationary |
| | Overweight | 17.73 ± 1.71 | 18.28 ± 5.35 | -1.39 | 0.12 | Stationary |
| **Midwest Low** | Low Weight for Age | 3.94 ± 1.26 | 5.16 ± 1.19 | 3.46 | <0.001 | Growing |
| | Height deficit | 15.69 ± 2.56 | 22.33 ± 2.64 | 8.53 | <0.001 | Growing |
| | Overweight | 15.69 ± 3.65 | 14.92 ± 3.30 | -5.69 | <0.001 | Descending |
| **Southeast** | Low Weight for Age | 3.76 ± 1.60 | 5.30 ± 1.62 | 4.16 | <0.001 | Growing |
| | Height deficit | 16.02 ± 3.73 | 19.33 ± 5.17 | 8.14 | <0.001 | Growing |
| | Overweight | 16.14 ± 2.00 | 15.56 ± 1.79 | -2.99 | 0.03 | Descending |
| **South** | Low Weight for Age | 2.82± 0.71 | 3.86 ± 0.98 | 1.45 | <0.001 | Growing |
| | Height deficit | 14.77 ± 3.18 | 17.27 ± 4.66 | 2.40 | 0.13 | Stationary |
| | Overweight | 15.86 ± 2.44 | 16.77 ± 2.94 | -1.94 | 0.23 | Stationary |

Source: SISVAN.

in the BPF from 2008 to 2021. Predictions of an increase in various forms of child malnutrition[1,3] were confirmed for the low W/A in the SE and S regions; for stunting in the MW, SE, and S regions, as well as for excess weight in all Brazilian regions, except in the NE regions, but which still maintained high rates of nutritional deviations.

The pandemic intensified the growth trends of low W/A in the SE and S regions, which had already been occurring since 2013/14, as well as stunting in the MW and SE regions, increasing since 2019. In the overweight series, whose Prais-Winsten analyses showed a decline (NE, CO, SE) or stability (N, S) up to 2021, there were changes at the level of the curve, according to SARIMA modeling, even though the trend of the TS did not change at the end of the period. Thus, there was a resumption of growth in excess weight in Brazilian regions – except in the NE, although in absolute terms the most recent rates are lower than in years prior to the COVID-19 pandemic. Likewise, there was an increase in stunting in the S region, whose series increased after the pandemic but remained stationary for the period.

Stunting in the first 1,000 days of life is the product of the interaction between intrauterine exposures, inadequate infant nutrition. and frequent infections[10,26]. It is a permanent public health problem for vulnerable Brazilian children, reaching moderate (10-19.9%) and high average rates (20-29.9%) at a population level[23], when compared to children of other ages and social scenarios, whose prevalence varies from 3.3% to 7.0%[27]. In the N region, higher rates are justified by broad geographic distances, poor service structures, and low PHC coverage, which makes access to health services difficult[28].

Excess weight also affects a high population level (> 15%)23, with average rates close to stunting in all regions of the country and above the global rate[29]. Higher rates of excess weight in the N and NE regions have already been described in children who are being monitored in a PHC[29], as a result of increased sedentary lifestyle and access to less nutritious foods by poorer populations[14].

Although poor nutrition, especially obesity, is well defined as a risk factor for severe manifestations of COVID-19, including in children[17,30], there is still a lack of studies[31] analyzing the effect

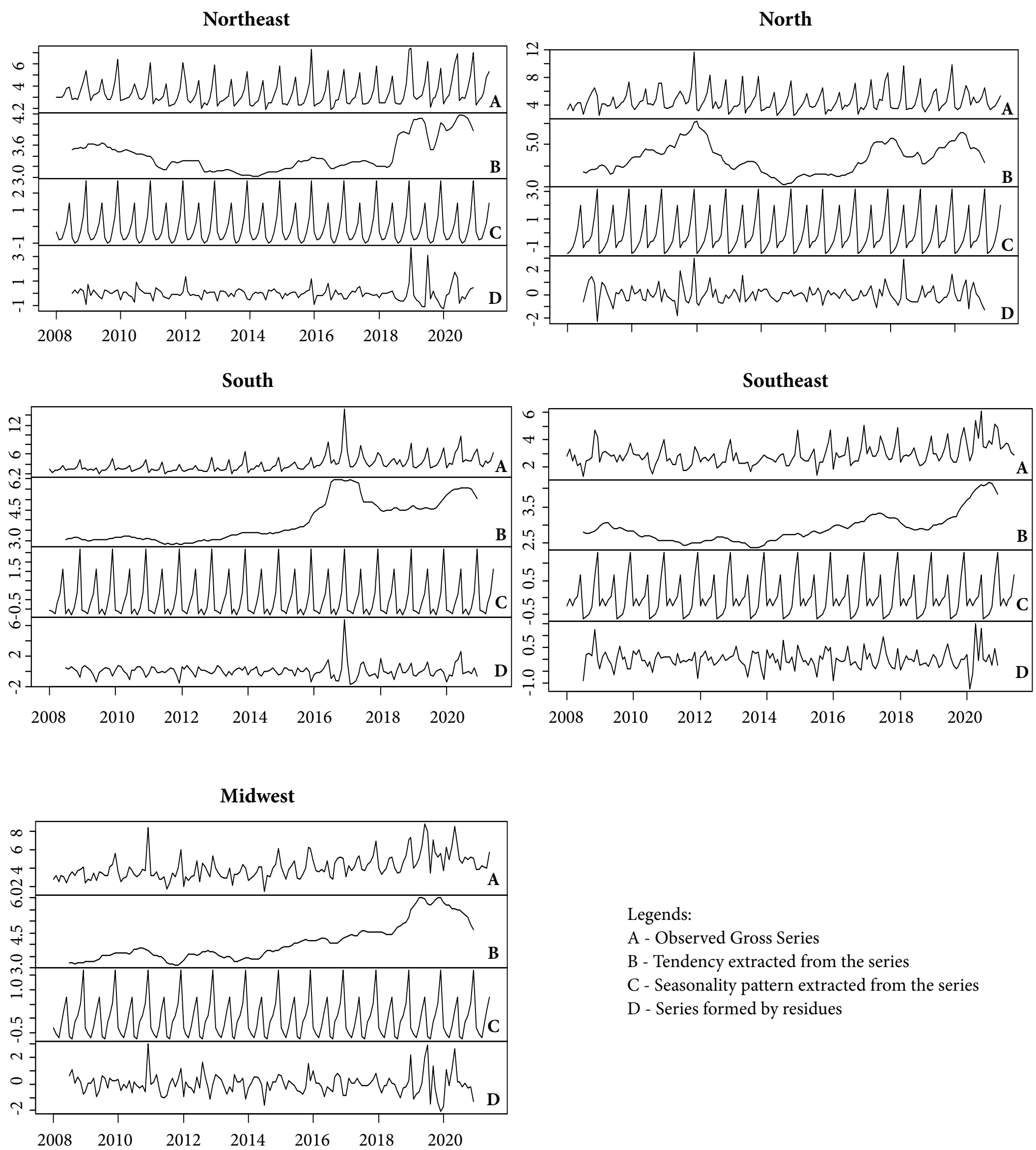


**Figure 1.** Breakdown of the time series (2008-2021) of low weight by age among children under two year of age in social vulnerability, by Brazilian macro-region.

Source: SISVAN.

of the pandemic on malnutrition indicators, considering the type of aggregate analysis, the age group (under two years of age), and the context of social vulnerability of the population under study.

Unlike our results, one longitudinal study with underprivileged children in Sri Lanka (Asia) showed an increase in the mean z-score of the H/A index. However, as occurred in Brazil's N, MW, S, and SE regions, there was an increase in the average W/H index, justified by the income transfer and the reduction in the level of children's physical activity, after six months of lockdown due to the pandemic[31]. In Bangladesh, there were no changes in the proportion of stunting and underweight in low-income populations, between the pre-pandemic and post-pandemic periods, as was also the case in the Brazilian NE

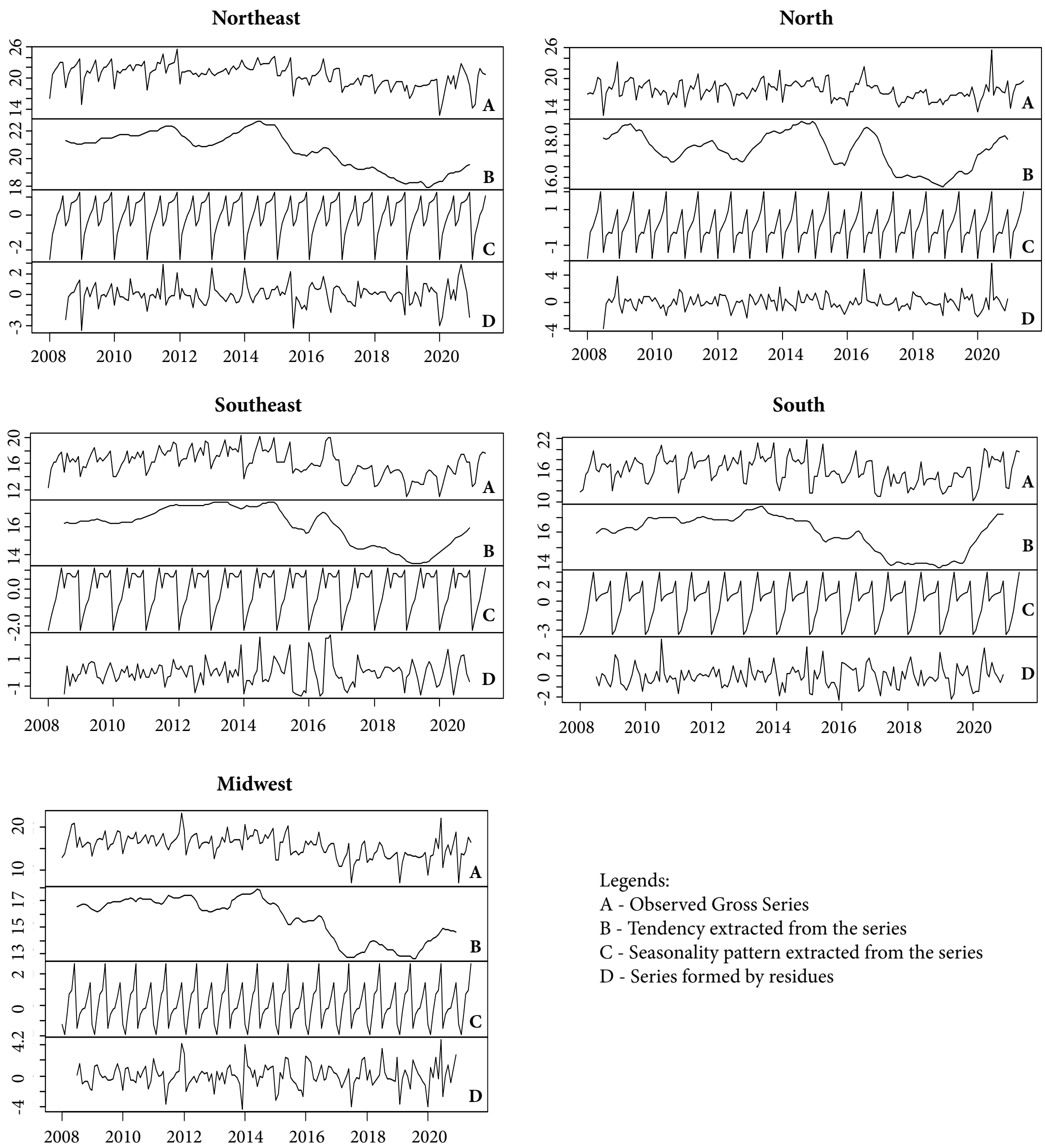


**Figure 2.** Breakdown of the time series (2008-2021) of excess weight among children of two years of age in social vulnerability, by Brazilian macro-region.

Source: SISVAN, Brazil.

region[32,33]. The studies cited above[31-33] included children under five years of age, an age group for which height impairment is less frequent, as compared to children up to two years of age[34].

The distinct effects of the pandemic on malnutrition in Brazilian macro-regions reflect the historical and socioeconomic differences and the differences in coping with the pandemic throughout the country[35]. Larger increases in nutritional deviations were projected in areas with lower baseline rates prior to COVID-19. In areas where rates were already high, they continued to be relatively high[36], as occurred in the N and NE regions.

The implementation of Emergency Aid (EA), especially in the N and NE regions, increased the average monthly income of beneficiary families (R$600.00), purchasing power, and access to food, possibly hindering the effect on the low W/A and stunting. However, in richer regions,

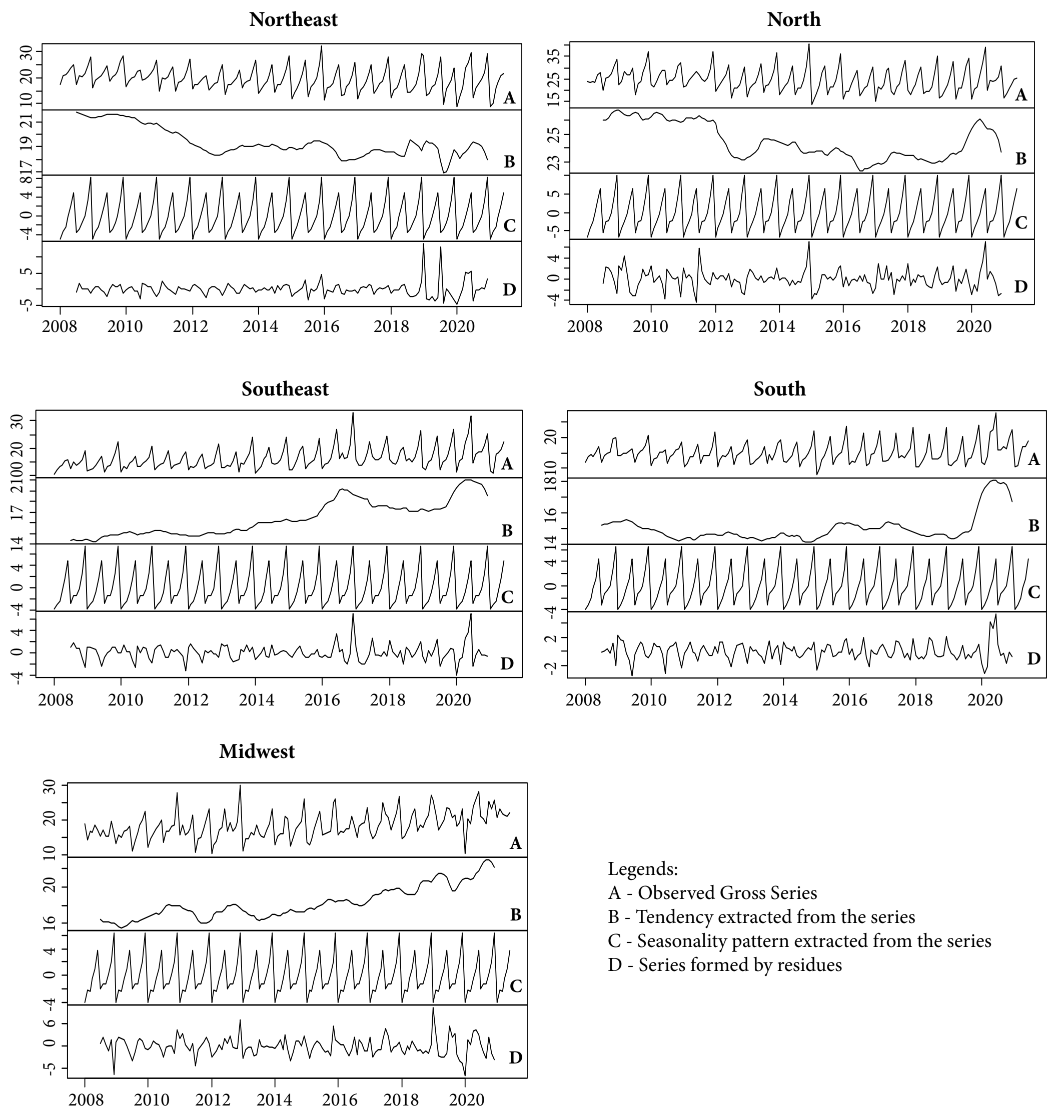


**Figure 3.** Breakdown of the time series (2008-2021) of height deficit among children of two years of age in social vulnerability, by Brazilian macro-region.

Source: SISVAN.

such as the S and SE regions, higher values would be needed to achieve the same effect[37]. Furthermore, in the NE, there are records of a greater support and solidarity network from organized civil society provided for vulnerable populations, such as food donations[38], in turn minimizing the side effects of the pandemic[39].

The increase in low W/A and stunting in the MW, SE, and S regions, which already existed even prior to the pandemic, resulted from the economic recession, with fiscal austerity measures, implemented in 2017[11], and reduced efforts to control InSAN[40]. The growth of low W/A does generate concern, as it is an acute condition, which is more sensitive to environmental changes and precedes stunting in this population[32,33]. For low-income groups, there is a complex capacity to face the problem by reproducing a cycle of poverty and illness[34].

The tendency to reduce excess child weight in this population has already been explored[13], and was found to be antagonistic to the increase

**Table 2.** Effect of the COVID-19 pandemic on malnutrition in socially vulnerable children under two years of age, by Brazilian macro-region, between 2008 and 2021.

| Region/indicador | Identification and parameters of adjustment [a] | | | Regression coefficient (RC) and parameters of adjustment of the model with intervention | | | |
|---|---|---|---|---|---|---|---|
| | Model[b] | AIC | Box Test | RC | p-value | White noise | Box Test |
| **NorthEast** | | | | | | | |
| Low Weight for Age | $(2.1.3)(2.1.2)_{12}$ | 337.66 | 0.05 | 0.55 | 0.06 | YES | 0.80 |
| Height deficit | $(1.0.0)(0.1.1)_{12}$ | 733.93 | 0.00 | 0.28 | 0.76 | NO[c] | 0.00 |
| Overweight | $(1.1.1)(2.0.0)_{12}$ | 581.99 | 0.89 | 1.44 | 0.05 | YES | 0.77 |
| **North** | | | | | | | |
| Low Weight for Age | $(0.0.1)(2.1.0)_{12}$ | 427.02 | 0.26 | -0.11 | 0.74 | YES | 0.22 |
| Height deficit | $(1.0.0)(0.1.2)_{12}$ | 672.99 | 0.47 | 0.15 | 0.89 | YES | 0.32 |
| Overweight | $(1.0.1)(2.0.0)_{12}$ | 598.32 | 0.69 | 1.51 | 0.04 | YES | 0.51 |
| **Midwest** | | | | | | | |
| Low Weight for Age | $(1.1.1)(2.0.0)_{12}$ | 454.74 | 0.60 | -0.55 | 0.26 | YES | 0.59 |
| Height deficit | $(2.0.2)(1.1.1)_{12}$ | 711.47 | 0.06 | 2.40 | 0.01 | YES | 0.06 |
| Overweight | $(0.1.1)(2.0.0)_{12}$ | 708.8 | 0.60 | 2.29 | 0.01 | YES | 0.59 |
| **Southeast** | | | | | | | |
| Low Weight for Age | $(3.1.2)(2.1.2)_{12}$ | 440.37 | 0.06 | 1.97 | < 0.001 | YES | 0.13 |
| Height deficit | $(2.1.6)(1.1.1)_{12}$ | 604 | 0.13 | 2.96 | < 0.001 | YES | 0.19 |
| Overweight | $(1.1.1)(1.0.1)_{12}$ | 460.59 | 0.16 | 0.72 | 0.04 | NO[c] | 0.17 |
| **South** | | | | | | | |
| Low Weight for Age | $(1.0.1)(0.1.1)_{12}$ | 245.81 | 0.08 | 0.94 | < 0.001 | YES | 0.07 |
| Height deficit | $(1.0.0)(0.1.1)_{12}$ | 534.38 | 0.27 | 2.15 | < 0.001 | YES | 0.14 |
| Overweight | $(3.1.3)(1.1.2)_{12}$ | 524.34 | 0.82 | 2.83 | < 0.001 | YES | 0.67 |

[a] The identification of the SARIMA model, in a non-automated way, based on the interactive proposal of Hyndman and Athanasopoulos[25], occurred for the low weight-for-age series in the Northeast and Southeast, for chronic malnutrition in the Midwest and Southeast and for excess weight in the South region. [b] SARIMA models are represented by the notation (p,d,q) (P,D,Q) m, where we use uppercase notation for the seasonal parts and lowercase notation for the non-seasonal parts of the model, being: p = order of the autoregressive part; d = degree of differentiations involved; q = order of moving average part; m = seasonal period; [c] Model not adjusted.

Source: SISVAN.

in this condition in children under five years of age[13,14], which can be justified by the expansion of access to PHC and guidance on adequate child nutrition[13,41]. However, our results suggest that, in the MW and SE regions, the decline in excess weight in the pre-pandemic period can be explained by the increase in poverty and worsening of living conditions[6], resulting in an increase in manifestations of underweight and stunting in this population.

With the onset of the pandemic, the resumption of growth in excess weight, concomitant with stunting, signals an increase in Double Burden of Malnutrition (DBM) at the population level, marked by the coexistence of these conditions above 10% and 20%, respectively[10]. This scenario is common in middle-income and low-income countries that have not overcome stunting and are experiencing a widespread increase in overweight and obesity, increasing the burden and public health costs of NCDs[4,10].

There is a consensus that chronic malnutrition and excess weight in young children have some common causes and perpetuates DBM, such as high consumption of UPFs which have high caloric density, thus contributing to excess weight and NCDs[10]. Simultaneously, this is related to height deficit due to insufficient nutritional support for bone growth, immunological protection, adequate hormonal signaling, and stabilization of the intestinal microbiome[10,42,43].

In 2021, the pandemic year, UPF consumption reached 72% of Brazilian children under two years of age, justified by its low cost and high palatability[8]. Furthermore, the decline in mobility and access to healthy foods[18,44], the reduction in PHC services[7], and the decrease in breastfeeding practices in middle and low-income countries after the COVID-19 pandemic[30] are factors that influenced this scenario.

This study has some limitations, such as the possibility of ecological fallacy, making it impossible to infer the results at the individual level. Data were available until June 2021 and the analysis of aggregated data by region eliminates state and municipal specificities, which can be contrasting. Furthermore, secondary data may have problems related to the quality of collection and the adequate entry of data into information systems. With the start of the pandemic and contingency measures, some municipalities did not conduct anthropometric monitoring actions. Therefore, the monthly rates at the beginning of 2020, referring to the first term, may be overestimated, considering the reduction in coverage for VAN shares.

Regarding its potential, this study is one of the first of its kind to record the effect of the COVID-19 pandemic on malnutrition among Brazilian children in scenarios of social vulnerability and included in the chronological period of the first 1,000 days of life. The use of the ARIMA/SARIMA analysis in an automated way, and based on the simultaneous interpretation of multiple tests, it was thus possible to select the best representative TS models and attribute the effect to an external event, such as the COVID-19 pandemic. Furthermore, it was possible to isolate the strong seasonal component of the data used, most likely related to the pattern of insertion of anthropometric information in the system up to June (1st period) and December (2nd period). This appears in the peaks (higher rates) in the subsequent months, considering the deadline for consolidation and release of reports by the Ministry of Health. By using SISVAN data, we reinforce the importance of this tool in supporting VAN in order to subsidize actions that improve the eating habits and nutrition of the Brazilian population.

## Conclusion

The emergence of the COVID-19 pandemic affected the nutritional epidemiology of Brazilian children under two years of age and in social vulnerability. There was a resumption of growth in low weight for age in the S and SE regions, which are historically richer, suggesting a worsening of living conditions in these places. Furthermore, the increase in excess weight and stunting, simultaneously, signals the advancement of BDM in the MW, S, and SE regions. However, in the NE and N regions, traditionally poorer regions, despite the stability of malnutrition indicators during the pandemic period, with the exception of the increase in excess weight in the N region, higher rates of malnutrition still persist.

This scenario complicates actions that guarantee DHAA, considering the coexistence of deficiency and excess manifestations in this population. Therefore, it is our hope that these results will support the formulation of actions, programs, and public policies to guarantee Food and Nutrition Security for poor families and young children who a heavily impacted by the global health crisis, given their importance for human health throughout the entire life cycle.

## Collaborations

ESM Rodrigues and EBAF Thomaz participated equally in the conception of the article; ESM Rodrigues, EM Costa, FBP Araújo and MSB Lopes performed the data analyses; ESMR, EMC, FSS, and EBAFT interpreted the results, wrote and critically reviewed the article.

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