

## Assessment of the causes of infant morbidity and mortality in Brazil

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### Abstract

Child health is one of the world's priorities, and to give attention to the health of this population, health actions have been enlisted to guarantee integral childcare. Therefore, this study aimed to investigate the major causes of hospitalization and infant mortality and their correlation with care indicators. This is an ecological study of a temporal trend, with a spatial analysis, in which data collection was performed at the Department of Informatics of the Unified Health System, where a descriptive analysis was performed in the Statistical Package for the Social Sciences and a spatial analysis in TerraView and GeoDa programs. The results revealed that there was a reduction over the period studied in the indicators of illness and death; however, it also showed that the main causes are due to conditions related to Primary Health Care, namely: diseases of the respiratory system and some conditions originating in the perinatal period. In the spatial analysis, a high autocorrelation was observed in the Midwest, Southeast and Southern regions of the aforementioned causes. When correlated with the variables of Primary Care coverage and childcare consultations, a high correlation was also observed in the Midwest, Southeast, and Southern regions. It is concluded that Primary Health Care needs to advance and be strengthened, but there is still a need to reduce factors of child morbidity and mortality and analyze social factors in the occurrence of preventable diseases in Primary Health Care.

**Keywords:** Child Health. Causality. Morbidity. Mortality.

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### INTRODUCTION

Child health is one of the world's priorities, and in order to prevent health problems and damage to this population by reducing inequalities, several Health Policies were created in Brazil. Among them, we highlight the Commitment Plan for Comprehensive Child Health and Reduction of Child Mortality<sup>1</sup>, and the National Policy for Comprehensive Child Health Care<sup>2</sup>, among others. Within these policies, strategic actions were created to achieve the aforementioned objectives. However, in addition to these actions, it is

necessary to consider the praxis of each professional inserted in the different services that constitute the Child Care Network.

Thus, in addition to issues related to the quality of care provided in the children's health-disease process, as well as other life cycles influenced by social factors, it is necessary to understand the characteristics of the individual, their lifestyle, social networks, and living and working conditions. Some studies show that maternal education and socioeconomic conditions are factors that negatively influence

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DOI: 10.15343/0104-7809.202145152161

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child health<sup>3-5</sup>.

Bearing in mind that the child's growth and development is influenced by intrinsic (genetic) and extrinsic (environmental) factors, comprehensive monitoring during the child's first two years of life contributes to the prevention of diseases, reducing the indicators of infant morbidity and mortality<sup>6</sup>.

One of the actions performed by professionals working in the Family Health Units is the Childcare consultation, where at least seven consultations must be carried out in the first year of each child's life. Such consultations are held in order to monitor their growth and development, in addition to providing guidance to parents on accident prevention, breastfeeding, and vaccination<sup>7</sup>.

Araújo, Figueiredo, and Silva<sup>8</sup> state that the quality of healthcare can be assessed by infant mortality from preventable causes. Deaths from preventable causes are those that are understood to be totally preventable if the population receives adequate care. Among the factors that contribute to reducing these values and, consequently, improving health care, are family income, fertility level, mothers' education, and environmental conditions.

Thus, it is expected that the greater the coverage is of Primary Care and the greater the number of consultations is for children under two years of age, the lower the indicators of illness and death of children under two years from preventable causes in Primary Care. With that, this study sought to answer the following question: What are the main causes of hospitalization and infant death in Brazil?

Thus, this study aimed to ascertain what are the major causes of hospitalization and infant mortality and its correlation with care factors, namely, Primary Care coverage and childcare consultations for children less than one year old, in Brazil, in the period from 2000 to 2015.

## METHODOLOGY

An ecological study of a temporal trend with spatial analysis carried out in Brazil. The regional division of the Intermediate Regions of Urban Articulation (RIAU) composed of 161 regions was used<sup>9</sup>.

For data collection, data from the DATASUS database of the Hospital Information System (HIS)<sup>10</sup> were used, from which data on the cause of hospitalization of children less than one year old were obtained. The Mortality Information System (MIS)<sup>11</sup> collects the causes of mortality of children less than one year old. From both systems, in the period from 2000 to 2015, data were collected according to their group of causes defined in the ICD-10 Chapters. As a dependent variable, there was the prevalence of each cause chapter and mortality rate. Therefore, the hospitalization rate per thousand children was calculated with the population of the last IBGE census carried out in 2010<sup>12</sup>, and the mortality rate of children less than one year old per thousand live births per year.

As an independent variable, the coverage of Primary Care and the average childcare consultations of children less than one year old by live births were used. Data were collected in the Department of Primary Care (DPC) for data on the History of Primary Care Coverage<sup>13</sup> and in DATASUS for childcare consultations<sup>10</sup>.

For data analysis, the software Statistical Package for the Social Sciences (SPSS), version 22 with serial number 10101141047 was used. The municipalities were grouped from 5,565 to 161 Intermediate Regions Joined to Urban Centers (Regiões Intermediárias de Articulação Urbana (RIAU)), calculation of annual prevalence and an analysis based on in descriptive statistics, where mean, median, standard deviation, and Student's t test were

performed for comparisons between means. The use of the Student t test was for testing whether the hypothesis was true, in this way the sample distribution was investigated in which a normal distribution was identified based on the degree of freedom of the distribution table. In the analysis of variance performed with the ANOVA test, homoscedasticity of the data was not identified, considering that the variables were used in a double way (dependent variable with independent variable), thus, the Student's t test was the choice for the parametric test of the hypothesis in the present study. When investigating the major causes of both child morbidity and mortality, it was decided to organize the data in five-year intervals to better visualize them.

It is worth mentioning that when assessing the causes quantitatively, the groups of causes according to the ICD-10 chapter, it was decided to specialize the greatest cause of hospitalization and the greatest cause of mortality of the studied population, which then incorporates the chapters referring to "diseases of the respiratory system" (chapter 10) and "some conditions originating in the perinatal period" (chapter 16), respectively.

For the spatial analysis, Terra View 4.2.2 software was used to construct thematic maps, spatial distribution of the infant morbidity rate due to diseases of the respiratory system, and the formation of clusters, as well as spatial statistics to obtain the Moran Index and significance<sup>14</sup>. In GeoDa, spatial correlation was performed to ascertain the Clusters<sup>15</sup>.

## RESULTS

Table 1 shows the prevalence of the five major chapters of causes of hospitalizations, and the major cause of hospitalization was of diseases of the respiratory system. Still in this figure, it is possible to observe that there was an increase in the average prevalence of hospitalizations in the causes reported in ICD-

The map was constructed with the prevalence of infant morbidity due to diseases of the respiratory system and infant mortality rate due to some diseases of the perinatal period, both in 5 equal parts with the highest values located in the darkest regions. The reason for this choice was due to the fact that it was the primary cause of hospitalization and mortality.

For the evaluation of spatial autocorrelation, the global Moran Index was used to verify spatial dependence, which can have positive values indicating a direct correlation where similar values tend to exist between neighbors, as well as negative values indicating an inverse correlation where the high values are surrounded by neighbors with low inverse values.

The bivariate spatial correlation of the dependent variable with the independent variables was also used. In the bivariate spatial correlation, the spatial dependence could be direct and inverse, as well as used to evaluate the correlation of the variables by area, thus being: High-High (high values of the dependent variable and high values of the independent variable), Low-Low (low values of the dependent variable and low values of the independent variable), High-Low (high values of the dependent variable and low values of the independent variable), or Low-High (low values of the dependent variable and high values of the independent variable).

For this study, approval for the Ethics and Research Committee (CEP) was not required since data was appropriated from the public domain.

10 chapter 16, referring to some conditions originating in the perinatal period, from the second to the third five-year period, as well as in ICD-10 chapter 11, referring to diseases of the digestive system for the third five-year period. Still in this table, in the third five-year period, the average prevalence of ICD-10 chapter 04

causes (endocrine, nutritional, and metabolic diseases) decreased, and the fifth major cause became ICD-10 Chapter 17, which concerns congenital malformations, deformations, and chromosomal abnormalities.

When assessing the major causes of infant mortality from 2000 to 2015, Table 2 describes the five major causes of infant mortality, with Chapter 16 referring to some conditions originating in the perinatal period being the greatest cause of mortality in the period studied.

Continuing in table 2, it is possible to observe that the average of deaths from some conditions originating in the perinatal period increased from the second to the third five-year period, as well as the average of deaths from congenital malformations, deformations, and chromosomal abnormalities.

When the spatial analysis was performed, it was decided to map according to the chapters with the greatest cause of hospitalization and infant mortality. Figure 1 shows the spatialization and BoxMap of the major cause of infant morbidity and mortality in the period. In figure 1a, the spatialization of the major cause of hospitalization is by diseases of the respiratory system, and the highest prevalence is located in the states of Minas Gerais and Rio Grande do Sul.

In figure 1b, a heterogeneous distribution and a weak and non-significant autocorrelation can be observed. The results also showed that the most hospitalizations due to this cause are present in greater numbers in the Northeast, Southeast, Midwest and South. The high rates of diseases of the respiratory system are concentrated in the South and Southeastern regions, which may be associated with the climatic characteristics of this region.

Still in figure 1 (part c and d), there is the spatialization and BoxMap, respectively, of deaths from diseases originating in the perinatal period. In this figure, there is a heterogeneous

distribution and a weak and non-significant autocorrelation. In figure 1c, in the state of Minas Gerais, the main causes of mortality are found for this group of causes. When verifying the autocorrelation, in figure 1d, a high autocorrelation was observed in the North, Northeast, Midwest, and Southeast regions.

Figure 2 shows the correlation between the two chapters, Chapters 10 and 16 with coverage of Primary Care and childcare consultations. These indicators were chosen as dependent variables because they are the main indicators that influence one of the attributes of primary health care, which is the longitudinality of care. In figure 2a, there is an inverse and negative correlation with the Primary Care Coverage with Chapter 10, with a high correlation in the Southeast, Midwest, and Southern regions.

Figure 2b, on the other hand, shows a direct and positive correlation of Chapter 10 of morbidity with Childcare Consultations in children less than one year old, with a high correlation in the Southeast, Midwest, and Southern regions.

Image 2c shows a direct and positive correlation of Chapter 16 mortality with the coverage of Primary Care, with a high correlation in the Northeast, Midwest, and Southeast regions. Regarding the correlation of Chapter 16 with Childcare Consultations (2d), there was an inverse, negative, and high correlation in the Northeast, Southeast, and Midwest regions.

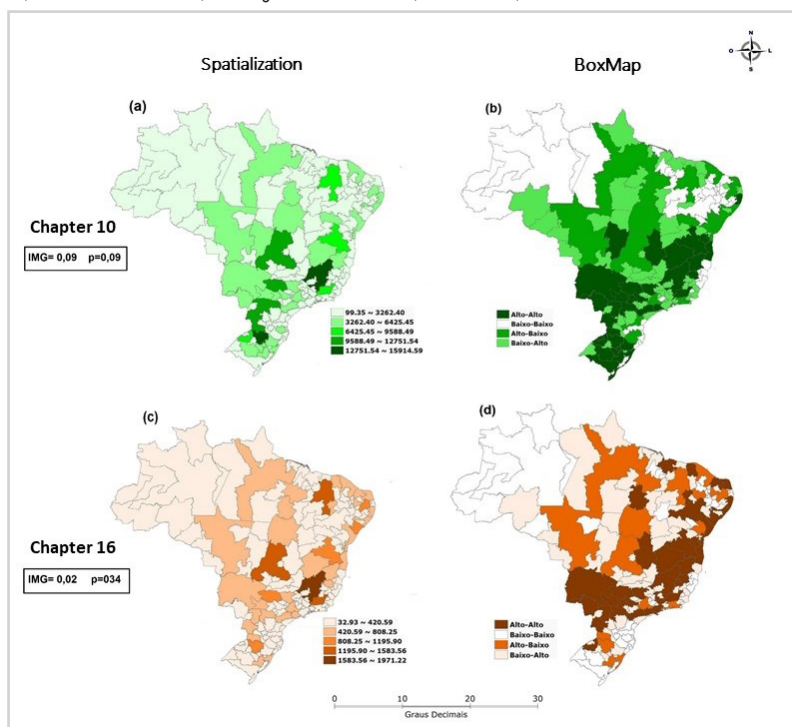
Ecological studies using spatial analyses have biases in ecological fallacies, also known as aggregation biases. However, to prevent this type of bias from occurring, the proximity matrix was performed before the spatial analysis of the data and the urban division that divides the region was used. Brazil can be divided by regions that are articulated by municipal centers that offer goods and services and concentrate activities of public and private management and logistics to better serve the area.

**Table 1** – Distribution of the five major causes of hospitalization per five-year period in Brazil from 2000 to 2015. Natal, RN, 2020.

| ICD Chapters -10 <sup>1</sup>                      | N   | Average | SD     | CI      |         | p     |
|--|-----|---------|--------|---------|---------|-------|
|  |     |         |        | Minimum | Maximum |       |
| <b>1<sup>st</sup> Five-Year Period (2000-2004)</b> |     |         |        |         |         |       |
| Chapter 10   | 161 | 505.87  | 206.72 | 473.69  | 538.04  | <0.01 |
| Chapter 01   | 161 | 337.23  | 188.33 | 307.92  | 366.54  | <0.01 |
| Chapter 16   | 161 | 325.29  | 176.32 | 297.84  | 352.73  | <0.01 |
| Chapter 11   | 161 | 58.72   | 54.58  | 50.22   | 67.21   | <0.01 |
| Chapter 04   | 161 | 43.53   | 25.80  | 39.52   | 47.55   | <0.01 |
| <b>2<sup>nd</sup> Five-Year Period (2005-2009)</b> |     |         |        |         |         |       |
| Chapter 10   | 161 | 418.31  | 175.33 | 391.02  | 445.60  | <0.01 |
| Chapter 16   | 161 | 284.20  | 124.13 | 264.88  | 303.52  | <0.01 |
| Chapter 01   | 161 | 223.46  | 113.35 | 205.82  | 241.10  | <0.01 |
| Chapter 11   | 161 | 37.67   | 29.28  | 33.11   | 42.22   | <0.01 |
| Chapter 04   | 161 | 26.93   | 13.56  | 24.82   | 29.04   | <0.01 |
| <b>3<sup>rd</sup> Five-Year Period (2010-2015)</b> |     |         |        |         |         |       |
| Chapter 16   | 161 | 412.83  | 177.78 | 385.16  | 440.50  | <0.01 |
| Chapter 10   | 161 | 392.10  | 167.74 | 365.99  | 418.21  | <0.01 |
| Chapter 01   | 161 | 185.02  | 79.69  | 172.62  | 197.43  | <0.01 |
| Chapter 11   | 161 | 38.39   | 18.80  | 35.47   | 41.32   | <0.01 |
| Chapter 17   | 161 | 33.29   | 13.42  | 31.20   | 35.38   | <0.01 |

\*Prevalence of the causes of hospital admissions in children less than one year of age.

<sup>1</sup>10-Diseases of the respiratory system; 01-Some infectious and parasitic diseases; 16-Some conditions originating in the perinatal period; 11-Diseases of the digestive system; 04-Endocrine, nutritional, and metabolic diseases; 17-Congenital malformations, deformations, and chromosomal abnormalities.

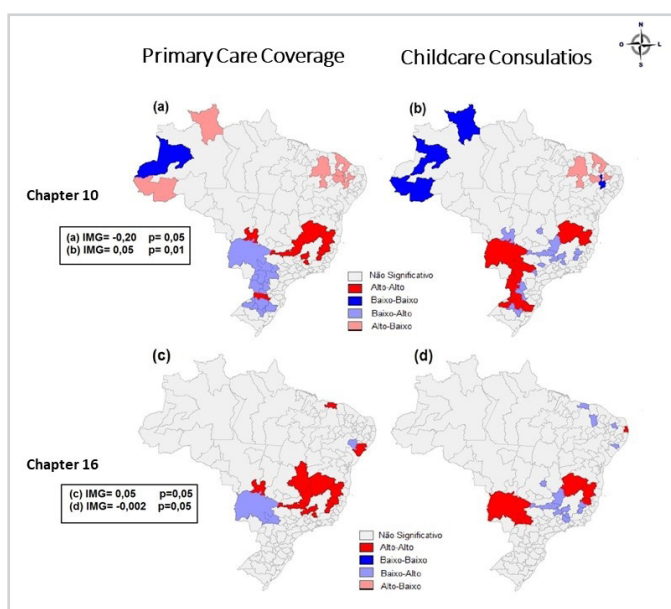


**Figure 1** – Spatialization (a, c) and BoxMap (b, d) of Chapter 10 (morbidity) and Chapter 16 (mortality), respectively, from 2000 to 2015 in Brazil. Natal, RN, 2020.

**Table 2** – Distribution of the five major causes of infant mortality per five-year period in Brazil from 2000 to 2015. Natal, RN, 2020.

| ICD Chapters -10 <sup>1</sup>                      | N   | Average | SD     | CI      |         | p     |
|--|-----|---------|--------|---------|---------|-------|
|  |     |         |        | Minimum | Maximum |       |
| <b>1<sup>st</sup> Five-Year Period (2000-2004)</b> |     |         |        |         |         |       |
| Chapter 16   | 161 | 29.77   | 160.52 | 25.55   | 33.98   | <0.01 |
| Chapter 17   | 161 | 6.97    | 46.37  | 5.75    | 8.19    | <0.01 |
| Chapter 18   | 161 | 5.08    | 15.00  | 4.68    | 5.47    | <0.01 |
| Chapter 01   | 161 | 4.06    | 17.92  | 3.59    | 4.53    | <0.01 |
| Chapter 10   | 161 | 3.56    | 21.61  | 2.99    | 4.13    | <0.01 |
| <b>2<sup>nd</sup> Five-Year Period (2005-2009)</b> |     |         |        |         |         |       |
| Chapter 16   | 161 | 24.30   | 120.00 | 21.14   | 27.45   | <0.01 |
| Chapter 17   | 161 | 7.05    | 42.05  | 5.95    | 8.16    | <0.01 |
| Chapter 01   | 161 | 2.51    | 11.29  | 2.21    | 2.80    | <0.01 |
| Chapter 10   | 161 | 2.42    | 13.61  | 2.06    | 2.78    | <0.01 |
| Chapter 18   | 161 | 1.81    | 7.18   | 1.62    | 1.99    | <0.01 |
| <b>3<sup>rd</sup> Five-Year Period (2010-2015)</b> |     |         |        |         |         |       |
| Chapter 16   | 161 | 24.56   | 127.88 | 21.20   | 27.92   | <0.01 |
| Chapter 17   | 161 | 8.69    | 52.09  | 7.32    | 10.06   | <0.01 |
| Chapter 10   | 161 | 2.11    | 12.97  | 1.77    | 2.46    | <0.01 |
| Chapter 01   | 161 | 1.91    | 9.68   | 1.66    | 2.16    | <0.01 |
| Chapter 18   | 161 | 1.22    | 5.64   | 1.07    | 1.37    | <0.01 |

16- Some conditions originating in the perinatal period; 17-Congenital malformations, deformations, and chromosomal abnormalities; 01-Some infectious and parasitic diseases; 18-Symptoms, signs, and abnormal findings of clinical and laboratory exams, not elsewhere classified; 10-Diseases of the respiratory system.



**Figure 2** – Correlation of Chapter 10 on morbidity and Chapter 16 on mortality with Primary Care coverage (a, c) and childcare consultations (b, d), respectively, from 2000 to 2015 in Brazil. Natal, RN, 2020.

## DISCUSSION

The results of this study show a reduction in the amount of child morbidity and mortality in Brazil in the period studied here, which was from 2000 to 2015. This demonstrates effectiveness in the actions carried out to comply with that established by Brazilian legislation, Law 8.080/90, the Pact for Health, in child health policies that aim to reduce the injuries and damages that may be caused to the population.

However, when investigating the main causes per group gathered by ICD-10 chapters, it was observed that the main causes are for conditions considered relevant to Primary Care, as described by the Ministry of Health in Mandate/MS no. 221 of April 17, 2008<sup>16</sup>. In the meantime, perinatal causes responsible for neonatal mortality and respiratory conditions deserve to be highlighted, which are reasons for the greater search for assistance in Childcare consultations, in which such consultations are carried out at the first level of health care, Primary Care.

Thus, Primary Care is responsible for preventing diseases and health problems and promoting and recovering the health of individuals at all stages of life<sup>7</sup>. Nevertheless, a study shows that Family Health Units contribute to reducing inequalities and health problems for the population<sup>17</sup>.

Moreover, although we know that Primary Care and the Family Health Unit, where childcare consultations are held, are important in reducing diseases listed as delicate by the Ministry of Health, however, the pathologies identified here as major causes of hospitalization and death of children less than one year old are included in this list, revealing the fragility of the attributes of Primary Health Care. These attributes are Longitudinality and Comprehensiveness of

care<sup>18</sup> which implies a discontinued care is occurring in the health care not only of the child, but also of the assisted population.

Even with the efforts made by the Ministry of Health in seeking to reduce indicators of child morbidity and mortality through the creation of various policies and actions aimed at this public, they continue to intensely demonstrate the fragility of Primary Health Care.

The high rates of diseases of the respiratory system are found in the South and Southeast regions, a fact that can be explained by the climatic characteristics of the place. Brazil is a country that has climatic variations by region since each region has its own characteristics. However, the south and southeast regions have similar characteristics throughout the year and are characterized by a tropical and subtropical climate. In the study by Beber *et al.*<sup>19</sup>, the authors refer to the factors associated with the occurrence of respiratory diseases in children which are air pollution and climatic conditions. The regions with the highest incidence of hospitalization for respiratory diseases identified in this study are regions where the largest industrial centers and the greatest climatic variations are found, with very hot or very cold periods, thus influencing the occurrence of greater respiratory infections in children, such as those diagnosed in the results presented herein.

When associated with the coverage of Primary Care (Figure 2a), this correlation was shown to be strong in the Southeast region, as well as when correlated with Childcare consultations (figure 2b); however, the latter was still strong in the Midwest and Southern regions.

Moreover, it was also observed that the Midwest and Southern regions, although with a good indicator of childcare consultations,

have a low coverage of Primary Care. This factor needs to be analyzed by the Ministry of Health, because, in Brazil, there is a financial incentive to fund the implementation of new Primary Care Teams, that is, the territories without coverage of professional care need to be reduced, as the purpose of this Ministry is to ensure that all Brazilian territory has professional assistance in Primary Care.

The study by Awasthi *et al.*<sup>20</sup> revealed that care provided to children in Primary Health Care in northern India contributed to the early diagnosis of respiratory diseases.

Thus, it can be inferred that health professionals responsible for comprehensive and longitudinal care need not only to register people, but to accompany registered users, among which are the children, in order to identify the morbid conditions early, treat them and reduce the cases of mortality.

Brazil is a country that has diverse socioeconomic factors, places of residence, access to health services, among other factors that directly influence child health. Thus, the attention given to this population must comply with their individual needs, seeking to contemplate the attributes of primary care so that the Brazilian population will have adequate assistance and, consequently, there will be a reduction in deaths from preventable causes in primary care<sup>21</sup>.

With the objective of reducing such inequalities and ensuring that the population obtains comprehensive care in a way that results in the reduction of factors, some strategies were created. Among these strategies, and in concomitance with the period studied here, the Humanization in Prenatal and Birth Program was created in 2000, which concentrated efforts to reduce the high rates of maternal and perinatal morbidity and mortality<sup>22</sup>. In 2001, the First Comprehensive Health Week was created, so that, in the first week of life, the child would be welcomed by the professionals of the Basic Health Unit which should be attentive

to any changes in the mother and changes that the newborn may display, advise them on breastfeeding, as well as general care<sup>1</sup>.

However, the results presented here show that, after 16 years of creating this program, perinatal causes are still the main cause of death among children less than one year old, even when prenatal care in primary care has been an open to receive pregnant women who would be entitled to consultations. However, caring for quantities is not enough, but rather we must start from an understanding of the quality of actions, guidelines, health education proposed by professionals working at this level of care.

A study carried out in Memphis, Tennessee, found that home visits by nurses, both to the mother and the child, in the prenatal and puerperium period, were conducive to reducing maternal and child mortality; especially when it comes to awaiting the first child and living in highly disadvantaged environments<sup>23</sup>.

The study by Reichert *et al.*<sup>24</sup>, carried out in the city of João Pessoa, PB in 2011, says that there are lacks in the home visits of professionals in the Primary Health Care service as to the care of the mother-child binomial, compromising the completeness of care.

However, the results presented here show that, even if there is a reduction in infant morbidity and mortality, the coverage of Primary Care and childcare consultations did not influence the reduction of hospitalizations due to diseases of the respiratory system as well as deaths due to diseases originated in the perinatal period. This shows the need for strategic and quality planning in the Primary Care network and in the care lines in the healthcare network, as well as hospitals with pediatric beds, laboratories, and other health services in each municipality and state of Brazil.

The realization of this study allowed us to identify that the low coverage of Primary



Care alone is not the only factor that can influence the high rates of child morbidity and mortality, it is also important to investigate

other social factors and set up strategies that can contribute to the improvement of the indicators studied here.

## CONCLUSION

When assessing the major causes of hospitalization and infant mortality, it was observed that these were due to Conditions Relevant to Primary Health Care. When spatializing the major cause of morbidity and mortality, it was observed that they presented a similar pattern of autocorrelation. When correlated with Primary Care Coverage and Childcare Consultations, they demonstrated an influence on child health in the Southeast, Midwest, and Southern regions. Moreover, this concept of coverage should be improved not only in quantity, but above all in the quality of care provided to the users.

The limitations of the study may be linked to the Health Information Systems of the Ministry of Health, which has been an assessment tool and the development of goals proposed each year for the health of the child. Thus, an ecological study with a spatial approach allows for local-regional observations of the health situation and is extremely important for

the elaboration of specific strategies for each reality.

Thus, this study reveals that, although there are health policies aimed at child healthcare in Primary Care, with a reduction in these indicators of illness and mortality, the need is clear for an evaluation by the Ministry of Health to strengthen this level of healthcare in Brazil and improve childcare for the development of healthy cities. This starts from small subjects who received quality health actions and who will become increasingly healthy children, reducing inequality between regions in Brazil.

The study brings the need to reflect on the data on infant morbidity and mortality and the findings should encourage municipal and state health managers to act on the local peculiarities of the region, as well as guide financial investments in Primary Health Care and better orientation of childcare lines throughout the healthcare network within the scope of the Unified Health System.

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Received in July 2020.

Accepted in February 2021.