

## Breastfeeding can prevent hospitalization for pneumonia among children under 1 year old

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### Abstract

**Objective:** To evaluate the relationship between breastfeeding and hospitalization for pneumonia among children under 1 year old.

**Methods:** Ecological study using secondary data of hospitalizations for pneumonia (outcome) and breastfeeding prevalence data (exposure) among children under 1 year old living in the Brazilian state capital cities and the Federal District in 2008. A negative binomial model of hospitalization was used to estimate the rate ratio (95% confidence interval), adjusted according to the Gini Index, and the prevalence rates of smokers in the general population and low birth weight individuals in the population investigated.

**Results:** Breastfeeding prevalence among children between 9 and 12 months old and exclusive breastfeeding prevalence among children under 6 months old were associated with a lower rate ratio of hospitalization for pneumonia (RR = 0.62; 95%CI 0.51-0.74 and RR = 0.52; 95%CI 0.39-0.69, respectively).

**Conclusion:** Increased prevalence rates of breastfeeding during the first year of life and exclusive breastfeeding during the first 6 months of life can reduce the number of hospitalizations for pneumonia.

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### Introduction

It is estimated that breastfeeding may be responsible for the reduction of 9.1% of the infant mortality coefficient according to a study conducted in the Metropolitan Area of São Paulo.<sup>1</sup> Breastfeeding can prevent more than 600,000 deaths from acute lower respiratory infections worldwide, which represents about 30% of the postneonatal mortality and 50% of the preventable neonatal mortality from acute respiratory infections in Latin America.<sup>2</sup>

The rates of hospitalizations for pneumonia among children under 1 year old remained stable between 1998 and 2008 (3.7 and 3.6/100 children per year, respectively).<sup>3</sup> Pneumonia is the leading cause of hospitalization and postneonatal death according to a study conducted in municipalities of the state of São Paulo.<sup>1</sup>

In the first years of life, breastfeeding can reduce hospitalizations for acute lower respiratory infections.<sup>4</sup>

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Exclusive breastfeeding also has a protective effect on hospitalization for pneumonia, particularly in the first 3 months of life according to a study conducted in southern Brazil.<sup>5</sup>

On the other hand, the prevalence of breastfeeding and exclusive breastfeeding among children younger than 6 months old have increased significantly in the Brazilian state capital cities in recent decades. However, there are still important differences between the cities studied.<sup>6</sup>

Given the differences in breastfeeding patterns between the capital cities and the importance of reducing child morbidity and mortality due to preventable causes, it is essential to investigate the relationship between breastfeeding and hospitalizations for pneumonia in these cities. Based on our findings, we expect to help identify and measure the mean effect caused by the breastfeeding practices seen in the capital cities and the Federal District on the mean rates of hospitalization for pneumonia in the population of children under 1 year old from these cities and, thus, contribute to strengthen actions that promote public health.

## Method

This is an ecological study using secondary data. The population investigated included children under 1 year old living in the Brazilian capital cities and the Federal District in 2008. Data were obtained from the Information Department of the Brazilian Unified Health System (DATASUS)<sup>3</sup> and were aggregated by municipality.

Outcomes were cases of hospitalization for pneumonia occurred in 2008 and registered in the Brazilian hospital information system (SIH) according to the list of morbidities of the International Classification of Diseases (ICD-10 from J15.0 to J15.9) among children under 1 year old (by place of residence).<sup>3</sup> The lowest level of aggregation for this variable was individual, without the possibility of identifying the subject.

The proportion of newborns with low birth weight (below 2,500 g) in 2008 was considered an explanatory variable aggregated by municipality. Data were obtained from DATASUS.<sup>3</sup> The Gini index was obtained from the Brazilian Institute of Geography and Statistics (IBGE, [www.ibge.gov.br](http://www.ibge.gov.br)), however, we multiplied the index by 100 in order to improve its interpretation in the coefficients expressed in the statistical models. The Gini index measures the degree of inequality in the distribution of individuals according to *per capita* household income and its value ranges from zero (when there is no inequality) to one (when there is maximum inequality).

The prevalence of smokers was obtained from the national survey Telephone-Based Surveillance of Risk and Protective Factors for Chronic Diseases (VIGITEL).<sup>7</sup>

Information related to breastfeeding among children under 1 year old were obtained from the 2nd Research on Prevalence of Breastfeeding in Brazilian Capital Cities and the Federal District, conducted in 2008,<sup>6</sup> with the municipalities being the lowest level of aggregation. We used the mean prevalence of exclusive breastfeeding among children under 6 months old and the mean prevalence of breastfeeding in children between 9 and 12 months of age in each capital city.

The choice of factors associated with hospitalizations for respiratory diseases for the present study was based both on the risk factors identified in the literature and the availability of secondary data for public consultation. As a consequence of the small sample size (27 cities), it was not possible to include all the factors available in the secondary databases because of the risk of saturating the statistical models.

Therefore, we included the following factors: breastfeeding, smoking, birth weight, and income inequality (Gini index). In addition, because of the lack of secondary data, we could not assess other factors related to hospitalizations for respiratory diseases, such as level of air pollutants, temperature, and air relative humidity.<sup>8,9</sup>

A bivariate analysis was performed by correlating each of the explanatory variables with the outcome, maintaining in the statistical model those variables that had a p-value lower than 0.20 (Wald test) in order to avoid residual confounding. Next, the independence of the explanatory variables was tested (variance inflation factor), as well as the correlation between the variables (Spearman correlation, 95% confidence interval [95%CI]).

The regression model was estimated considering 95%CI and assuming the Poisson distribution and the negative binomial link function, which provides the estimated rate ratio (RR) of each of the cofactors studied.<sup>10</sup>

The variables were estimated jointly, and those variables that did not reach statistical significance were removed from the model one by one. Finally, we tested all possible interactions among the variables. The statistically significant interactions that improved the model fit remained in the final model.<sup>10,11</sup>

A chi-square goodness of fit test was used to assess the quality of the models' fit under the null hypothesis that the model has a good fit (at 5% significance level).<sup>11</sup>

Standardized residuals (vs. linear predictors) and normality of the residual likelihood were graphically observed in the estimated final model.<sup>10,11</sup> The computer program *R* (version 2.9.2) was used to perform the statistical analysis.

## Results

The population of 642,792 children living in the 26 Brazilian capital cities and the Federal District who were born

in 2008 were considered for the present study. According to the SIH records, there were 139,075 hospitalizations in 2008 in the above mentioned cities, of which 24,437 were hospitalization for pneumonia.

Hospitalizations for pneumonia accounted for about 1/5 of all hospitalizations among children under 1 year old, and the median rate of hospitalizations for pneumonia was 3.96 (95%CI 3.23-4.69)/100 children per year (Table 1).

According to the statistical model, the practice of exclusive breastfeeding among children under 6 months old and breastfeeding among children between 9 and 12 months old in the Brazilian state capitals and the Federal District were responsible for decreasing by nearly 40 and 50%, respectively, the expected mean rates of hospitalizations for pneumonia. According to the same model, the higher the income inequalities between the

cities studied (Gini index) and the prevalence of smokers in the population, the higher the rates of hospitalization for pneumonia (Table 2).

The prevalence of low birth weight was excluded from the statistical model because it showed no statistically significant association.

There was a statistically significant interaction between the variables exclusive breastfeeding among children under 6 months old and breastfeeding among children between 9 and 12 months old. That is, in the cities with high prevalence of exclusive breastfeeding but low prevalence of breastfeeding, or vice versa, there was a slight but significant increase in the rates of hospitalization for pneumonia, which may indicate that a population should have higher prevalence rates of both breastfeeding practices in order to be protected (Table 2).

**Table 1 -** Prevalence of hospitalizations for pneumonia according to the total number of hospitalizations and rate of hospitalization for pneumonia among children under 1 year old living in the Brazilian capital cities and the Federal District in 2008

<b>Municipality</b>	<b>Hospitalizations for pneumonia according to the total number of hospitalizations (%)</b>	<b>Rate of hospitalization for pneumonia (100 children/year)</b>
Aracaju	19.84	1.79
Belém	17.07	6.10
Belo Horizonte	16.61	3.86
Boa Vista	24.60	4.44
Brasília	15.71	3.79
Campo Grande	22.33	4.47
Cuiabá	12.32	2.36
Curitiba	14.34	3.02
Florianópolis	11.05	1.82
Fortaleza	16.42	3.91
Goiânia	19.63	5.42
João Pessoa	36.24	8.68
Macapá	36.34	3.63
Maceió	35.57	7.42
Manaus	10.96	2.86
Natal	28.29	4.74
Palmas	13.29	3.46
Porto Alegre	6.13	2.33
Porto Velho	16.30	1.90
Recife	14.94	4.64
Rio Branco	22.44	3.75
Rio de Janeiro	14.79	2.13
Salvador	15.12	2.54
São Luís	28.53	4.77
São Paulo	19.01	4.27
Teresina	8.82	1.46
Vitória	31.31	7.44
Mean	19.56	3.96

Source: Hospital Information System (SIH)/DATASUS, 2008.

**Table 2** - Effect of breastfeeding on the rate ratio of hospitalizations for pneumonia among children under 1 year old in the capital cities and the Federal District, 2008

Factors	RR	95%CI
Breastfeeding (9 to 12 months old)	0.618	0.514-0.744
Exclusive breastfeeding (under 6 months old)	0.522	0.393-0.694
Gini index (%)	1.110	1.012-1.218
Prevalence of smokers	1.125	1.034-1.225
Interaction BF:EBF	1.010	1.006-1.015

95%CI = 95% confidence interval; BF = breastfeeding; EBF = exclusive breastfeeding; RR = rate ratio.

The Poisson model with negative binomial link function<sup>10</sup> showed a good fit of data, which was observed in both the quality of fit of the residuals and the model fit test.

## Discussion

The increase in the prevalence of breastfeeding was related to reduced rates of hospitalization for pneumonia among children under 1 year old living in the Brazilian capital cities and the Federal District in 2008.

On the other hand, the prevalence of smokers in the general population and the degree of income inequality between the cities (measured by the Gini index) were negatively associated with the rates of hospitalization for pneumonia.

The protective effect of breastfeeding for respiratory morbidity and mortality among children has been well established in many observational studies,<sup>1,5,12-14</sup> which is in agreement with the findings of the present study. However, few studies have assessed children under 1 year old.<sup>5</sup>

A systematic review on the effects of breastfeeding on maternal and child health in developing countries concluded that breastfeeding reduces the children's risk of developing asthma and severe infections of the lower respiratory tract<sup>13</sup> and it may also reduce by 17 times the chance of hospitalization for pneumonia among children under 1 year old compared to children who were not being breastfed.<sup>5</sup>

Bachrach et al.<sup>15</sup> found results that show breastfeeding as a protective factor in a meta-analysis of studies conducted in developed countries. Such meta-analysis concluded that exclusive breastfeeding for over 4 months can reduce in 70% the risk of hospitalization for respiratory diseases (pooled RR = 0.28, 95%CI 0.14-0.54). These findings are similar to those of the present study.

One of the mechanisms of protection provided by breast milk to infants can be the transference of modulating factors

from the mother's immune system to the baby, such as cells, cytokines, and other immunological agents.<sup>16</sup> One example was the identification of secretory immunoglobulin-A specific for the respiratory syncytial virus (one of the causes of community-acquired pneumonia) in the milk of lactating women living in communities where the virus circulates.<sup>17</sup>

The risk of hospitalizations for acute respiratory infections are higher among children of mothers who have little education and smokers,<sup>4,18</sup> children with a history of early weaning, use of pacifiers and previous wheezing, and among male<sup>4</sup> children younger than 6 months, with low birth weight<sup>12</sup> and exposure to secondhand smoking.<sup>19</sup>

Childhood pneumonia may be associated with low birth weight, breastfeeding, parity, and BCG vaccination.<sup>14</sup> On the other hand, hospitalizations for pneumonia seem to be associated with the children's dietary patterns, with breastfeeding playing an essential protective role,<sup>5</sup> whereas maternal low educational level and low social class may be risk factors.<sup>20</sup>

In the city of São Paulo, a similar proportion as that of the present study regarding hospitalizations for pneumonia was found in two observational studies: 22<sup>1</sup> and 20%.<sup>12</sup> Our rates of hospitalizations were similar to those found in Pelotas, state of Rio Grande do Sul, where 2.9% of the children were hospitalized for pneumonia.<sup>20</sup>

A study conducted in the city of Rio de Janeiro showed that the higher the inequality of income distribution, the worst the health indicators, such as infant mortality and life expectancy,<sup>21</sup> highlighting the role played by social inequalities in health outcomes such as rates of hospitalization for diarrhea.

The prevalence of smokers in the general population was evaluated in our study because there were no specific secondary data on the prevalence of smoking mothers; however, Carvalho & Pereira<sup>19</sup> found that children exposed

to secondhand smoking could be twice as likely to have respiratory diseases, which justifies the use of this ecological variable in the present study.

A possible limitation of the use of the prevalence of smokers is that this indicator was obtained from VIGITEL, a telephone-based observational survey: since the coverage of the fixed telephone network is not uniform throughout Brazil, there is the possibility of selection bias. However, this bias was mitigated by the researchers of the VIGITEL, who incorporated post-stratification weights in the analysis of indicators.<sup>7</sup>

Ecological studies, besides being inexpensive and quickly conducted, are useful for evaluating the mean effect of an intervention or exposure on a given outcome in the population; therefore, their findings should be interpreted differently from those of individual studies,<sup>22</sup> provided that potential errors and biases inherent to this study design are taken into consideration.<sup>23</sup>

Thus, the use of secondary data generated by the Brazilian Unified Health System (SUS) can be useful for performing a continuous evaluation of the impacts that public health policies have on the population.

In the present study, we were not able to identify how many hospitalizations were rehospitalizations, which may create a non-differential bias in the model estimates, since rehospitalization may occur both among the subjects exposed to breastfeeding and the unexposed subjects.

An example of the magnitude of rehospitalizations can be drawn from a study conducted in the state of Rio de Janeiro that evaluated another outcome (hospitalizations for diarrhea): of the total number of hospitalizations for infectious diarrhea among children under 1 year old registered in the SIH, 3.9% were rehospitalizations.<sup>24</sup>

The SIH of SUS is a source of data used in several scientific manuscripts, and it is coherent and consistent with existing knowledge. However, some negative aspects should be considered, such as the possibility of fraud in the system<sup>24</sup> and the fact that approximately 1/4 of the Brazilian population uses private health plans.<sup>25</sup>

It is worth mentioning another important source of bias: part of the population that uses private health plans may not have had the cases of hospitalization for pneumonia included in the present study, since we only considered the cases of hospitalizations within the context of SUS, but these children were included in the total study population and have higher prevalence rates of exclusive breastfeeding.<sup>6</sup> Therefore, there may have been an overestimation of the effects of breastfeeding on hospitalizations for pneumonia.

On the other hand, the effect estimates for the Gini index may not be affected by this bias, since the whole population of a city is "exposed" to inequalities and their consequences.

A very interesting fact was that all the factors considered in the present study had the same direction of association (protective or risk) as other observational studies investigating both hospitalizations for pneumonia and hospitalizations for acute respiratory diseases, which is a positive aspect of the use of the ecological approach as an inexpensive and efficient alternative to evaluate the effect of breastfeeding prevalence on child health.

It is worth noting that poor feeding practices and inadequate food consumption by infants can lead to inadequate intake of micronutrients, such as zinc and iron, enhancing the development of diseases.<sup>26</sup>

Finally, the present study sought to demonstrate how much the differences in breastfeeding patterns between the capital cities can have an influence on the patterns of hospitalization for pneumonia among children under 1 year old. Therefore, it is possible to conclude that the promotion of breastfeeding and the increased prevalence of breastfeeding may result in reduced number of hospitalizations and decreased costs of public health in the context of SUS.

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