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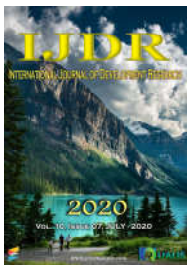

RESEARCH ARTICLE OPEN ACCESS

CHILDHOOD PNEUMONIA AND FACTORS ASSOCIATED WITH THE CAUSES OF HOSPITAL READMISSION

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ABSTRACT

Objective: To identify factors associated with the causes of previous hospitalization of children with pneumonia. ***Methods***: Cross-sectional, quantitative, analytical study, realized in a pediatric hospital in Ponta Grossa, Paraná, Brazil. Children between zero and 12 years old, hospitalized for pneumonia in the months of May to September 2015 were investigated about previous hospitalizations. ***Results***: 221 children were hospitalized for pneumonia, 46.6% were in the age group of children under 1 year old, 52.5% were male, 70.6% had never been hospitalized previously and 29.4% had already been hospitalized at least once in their lives, of these, 72.3% previous hospitalizations were for respiratory causes and 27.7% for other causes. Among the factors associated with rehospitalization for respiratory causes, the low weight at birth, attending school or daycare and age group over 1 year, obtained statistical significance ($P \leq 0.05$). ***Conclusion***: In this study, the children with pneumonia that previously hospitalized for respiratory causes, hadss low birth weight, attend school and are over 1 year old, had more chances of hospitalization for respiratory causes when compared to other hospitalization causes, therefore, it is important to accompany children on an outpatient basis after hospital discharge to prevent new hospitalizations.

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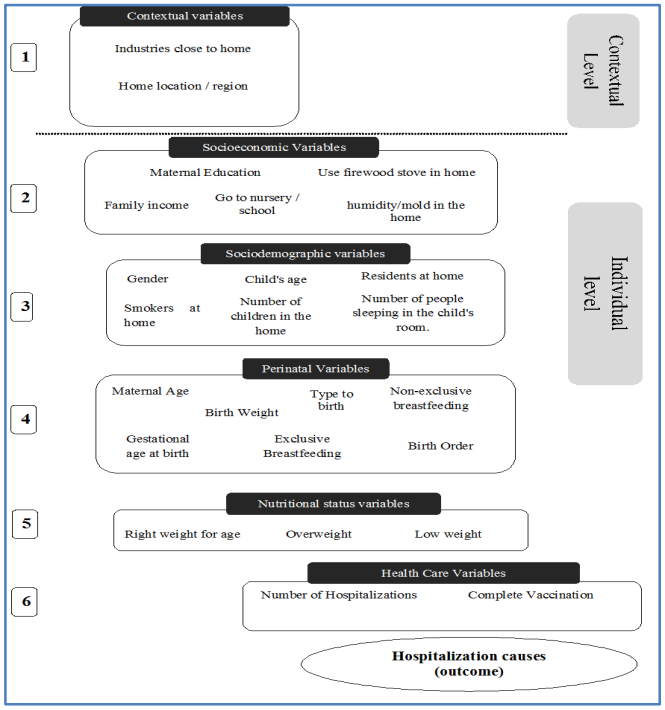
INTRODUCTION

The hospitalizations, morbidity and mortality from pneumonia in childhood are topics of worldwide concern in the health sector, because, despite the existence of vaccines, the number of children affected by the disease is high, being one of the main causes of death in children under five years old. (Hatisuka, 2015; Nascimento-Carvalho, 2020). Pneumonia is a disease characterized by inflammation accompanied oflower respiratory tract infection, progressing to consolidation of the alveoli or infiltration of the pulmonary parenchyma, cause important changes in the ventilation/ perfusion ratio and respiratory mechanics, preventing an effective breathing pattern (Neuman *et al.,* 2011). Viruses, bacteria, fungi, protozoa, larvae, helminths, in addition to chemical and physical agents, can cause it but viruses and bacteria are the main etiological agents of this pathology (Souza, 2010). Among the types of pneumonia, community-acquired pneumonia is the most common and responsible for high rates of pediatric hospitalization. It affects previously healthy people, being acquired outside the hospital environment (Souza, 2010), it corresponds to the most severe and frequent form of acute respiratory infection, being responsible for about 80% of the deaths of children affected by respiratory tract infections (Williams, 2002; Amorin, 2012). The estimated incidence by the World Health Organization (WHO) is 156 million episodes of pneumonia per year in children under 5 years old. In developed countries the estimated annual incidence is 33 for every 10,000 children under 5 years old and 14.5 for every 10,000 children under 16 years old. In 2012, approximately 6.6 million deaths occurred among children under five years old; 15% of these losses were for pneumonia (UNICEF, 2014). In developing countries, childhood pneumonias are more common and more severe, with increased morbidity and mortality when they affect children under 5 years old. In Brazil, the group of diseases of the respiratory system represents the first cause hospitalization and the third cause of childhood death, the pneumonia is the most prevalent in this group (Brasil - Datasus, 2020). In 2019, Brazil registered 1,172,607 hospital admissions of children under five years old, 358,394 cases occurred due to respiratory diseases, of these cases, 54% (193,941) were due to pneumonia. In relation to infant mortality, in the same year and

in the same age group, 2,090 deaths from respiratory disease were registered, 1,023 deaths occurred from pneumonia (Brasil - Datasus, 2020). Many factors contribute to the increased incidence of pneumonia and its severity in childhood. They can be of socioeconomic origin (low income and parental education); environmental (home smoking, environmental pollution, without sanitation, humidity and mold on home); nutritional and perinatal (prematurity, low and extreme low birth weight, comorbidities during pregnancy and birth, absence breastfeeding or early weaning) (Paiva *et al.,* 1998). For Theodoratou *et al.* (2010), studies have shown that children with previous episodes of respiratory disease are more chances to contract pneumonia. Previous hospitalization for pneumonia can increase the risk of a subsequent episode in three times compared to previous hospitalization for other causes. The heterogeneity of the factors involved makes it difficult to reduce hospitalization rates for respiratory diseases in childhood. High hospitalization rates increase health care costs. Readmissions for the same cause in a short period indicate low quality in health services and little planning in disease prevention actions. Readmissions may be the result of premature hospital discharge, influencing the child's worsening at home, so it is important to plan discharge carefully, considering the various factors involved in the child's family life. Studies about factors associated with the occurrence of diseases and hospitalization in childhood are of crucial importance for the healthy population development and contribute to the planning of health services, once the costs of hospitalizations that could be avoided, increase each year. In this sense, the objective this study was to identify factors associated with the causes of previous hospitalization of children with pneumonia in a pediatric hospital in the city of Ponta Grossa, Paraná, Brazil.

MATERIALS AND METHODS

This is an analytical, quantitative and cross-sectional study, developed in a public pediatric hospital, that provide care children from zero to 12 years old, located in Ponta Grossa city, Paraná State, Brazil. Is a city that has a high human development index (HDI) of 0.763, estimated population is 351,736 inhabitants and 20% are children between 0 to 12 years old (IBGE, 2019). The participants in the study were children from zero to 12 years old, hospitalized for pneumonia, represented by their parents and/or legal guardians. All children hospitalized for pneumonia from May to September/ 2015 were investigated, which totaled 221 children. The inclusion criteria were children from zero to 12 years old, hospitalized for pneumonia and the exclusion criteria were surgical patients and/or other pathologies not considered as a pneumonic process or if there was no consent and no signature of the Informed Consent Form (ICF) by the child's guardian. The Research Ethics Committee of the State University of Ponta Grossa/PR, Brazil (Protocol No. 1,085,344) approved the research project. To collect data, four tools were used: TASY system (electronic medical record and institution's management tool) to search for information about previous hospitalizations of children with pneumonia; the physical and printed medical record with the current information of the hospitalized child; Child follow-up card in primary health care to collect information on birth weight, gestational age at birth and vaccination; finally, a structured questionnaire containing closed questions on socioeconomic, perinatal and environmental aspects, applied to the person responsible for the child. The dependent variable used in the study was cause of previous hospitalization, it was divided into three categories: (0) "none" (for no previous hospitalization); (1) "other causes" (previous hospitalization for any health problem except for respiratory problems) and (2) "respiratory causes" (for previous hospitalizations for respiratory problems). The independent variables used in the study were of contextual origin (industries close to the home, region where the home is located) and individual origin (socioeconomic, socio-demographic, perinatal and health care variables). These variables were projected in a six levels hierarchical model, which were associated with the dependent variable and compared with each other, at the same level or level above (Fig. 1).



Source: Adapted from De Moraes et al., 2015.

Figure 1. Hierarchical model in six levels

The six levels developed in the hierarchical model are: 1) contextual variables; 2) socioeconomic variables; 3) socio demographic variables; 4) perinatal variables; 5) nutritional status; and 6) health care variables. In this model, the variables were controlled by a variable at the same level or above. For a variable to be kept in the model, the level of significance was established at $P<0.20$. The Wald test was used for to check heterogeneity and the level of significance (alpha of 5%) of the categorized variables. The linear tendency was used for the ordinal categorical variables (Victora *et al.,* 1997; De Moraes *et al.,* 2014; De Moraes *et al.,* 2015). Data analysis was performed using the Stata 13.0 software (STATA Corp., College Station, TX, USA). Initially, the proportion and their respective 95% confidence intervals (95% CI) of the causes of hospitalization were analyzed according to the independent variables. Adjusted analyzes were performed using Poisson multinomial regression with robust adjustment of variance to estimate the odds ratio (OR) and their respective confidence intervals. Poisson regression is recommended when the prevalence of the outcome is greater than 10%. The category "no hospitalization" was used as a reference category, being considered as an unexposed group.

RESULTS

In 2015, 554 children were hospitalized for pneumonia, of these, 221 occurred between May and September 2015, the

period with the highest prevalence of hospitalization for pneumonia at the study site. Of the 221 children hospitalized for pneumonia, there was a prevalence of 46.6% in the age group of children under 1 year, 52.5% were male. Investigating the records of previous hospitalizations, 156 (70.6%) cases were recorded that never occurred internally and 65 (29.4%) cases of children who had already been hospitalized at least once, in these, 47 (72.3%) respiratory and 18 (27.7%) were due to other diseases. Table 1 shows the distribution of the causes of previous hospitalization according to sociodemographic and perinatal variables of the studied population.

Among the important issues in the health-disease binomial discussion are those related to socioeconomic contexts, housing conditions, education and pollution, in this sense, some variables were more present in the population studied and are distributed in table 2: Table 3 shows the adjusted prevalence ratios for cases of previous hospitalization for other causes compared to previous hospitalization for respiratory causes. In This table, only the independent variables with P< 0.2 were included and variables withsignificance P≤0.05 were contrasted in bold. With the statistical adjustments, it was possible to find the three most significant variables in the study: low and extremely low birth weight, going to

Table 1. Distribution of causes of previous hospitalization according to sociodemographic and perinatal variables in children from 0 to 12 years old hospitalized for pneumonia

		Previous hospitalization causes (%; CI 95%)		
Variables	**Total cases (n= 221)**	**No previous hospitalization (n= 156)**	**Others causes (n= 18)**	**Respiratory causes (n= 47)**
Age				
< 1 year	103	53,3 (45,3-61,0)	61,1 (37,1-80,7)	19,1 (10,2-33,1)
1 a 5 years	97	42,9 (35,3-50,9)	33,4 (15,3-57,9)	51,1 (36,8-65,1)
6 a 12 years	21	3,8 (1,7-8,3)	5,5 (0,7-32,1)	29,8 (18,3-44,5)
Gender				
Female	105	46,2 (38,4-54,1)	50,0 (27,8-72,2)	51,1 (36,8-65,1)
Male	116	53,8 (45,9-61,6)	50,0 (27,8-72,2)	48,9 (34,9-63,1)
Gestational age				
37 a 41 weeks	175	85,3 (78,7-90,0)	61,1 (37,1-80,7)	66,0 (51,2-78,1)
≥ 42 weeks	3	1,3 (0,3-5,0)	0,0	2,1 (0,3-14,0)
≤ 36 weeks	43	13,4 (8,9-19,8)	38,9 (19,3-62,9)	31,9 (20,1-46,6)
Birth weight				
≥ 2,5 kg	175	82,7 (75,9-87,9)	72,2 (47,2-88,3)	70,2 (55,5-81,6)
1,5 a 2,49 kg	40	16,7 (11,6-23,4)	16,7 (5,2-41,9)	23,4 (13,3-37,8)
≤ 1,5 kg	6	0,6 (0,09-4,5)	11,1 (2,7-36,4)	6,4 (2,0-18,3)
Breastfeeding exclusive until 6 months				
Yes	93	42,3 (34,7-50,2)	27,8 (11,7-52,8)	46,8 (33,0-61,2)
No	128	57,7 (49,7-65,3)	72,2 (47,2-88,3)	53,2 (38,8-67,0)
Maternal age				
20 a 34 years	147	71,2 (63,5-77,8)	61,1 (37,1-80,7)	53,2 (38,8-67,0)
≤ 19 years	31	14,7 (10,0-21,3)	22,2 (8,3-47,4)	8,5 (3,2-20,9)
≥ 35 years	43	14,1 (9,4-20,5)	16,7 (5,2-41,9)	38,3 (25,4-53,0)

Source: The authors, 2020.

Table 2. Distribution of causes of previous hospitalization according to sociodemographic and perinatal variables in children from 0 to 12 years old hospitalized for pneumonia

		Previous hospitalization causes (%; CI 95%)		
Variables	**Total cases (n= 221)**	**No previous hospitalization (n= 156)**	**Others causes (n= 18)**	**Respiratory causes (n= 47)**
Family income				
≥ 5 salaries	1	0,6 (0,09-4,5)	0,0	0,0
> 2,5 a 4 salaries	30	15,4 (10,5-22,0)	16,7 (5,2-41,9)	6,4 (2,0-18,3)
> 1 a 2,5 salaries	160	69,9 (62,2-76,6)	72,2 (47,2-88,3)	80,8 (66,9-89,8)
≤ 1 salary	30	14,1 (9,4-20,5)	11,1 (2,7-36,4)	12,8 (5,8-25,9)
Maternal education				
≥ 9 years	48	20,5 (14,8-27,6)	33,3 (15,3-57,9)	21,3 (11,7-35,5)
5 a 8 years	133	61,6 (53,6-68,9)	55,6 (32,3-76,6)	57,4 (42,9-70,8)
1 a 4 years	40	17,9 (12,6-25,8)	11,1 (2,7-36,4)	21,3 (11,7-35,5)
Go to day care/school				
No	161	81,4 (75,3-87,6)	66,7 (44,1-89,2)	46,8 (32,3-61,3)
Yes	60	18,5 (12,4-24,7)	33,3(10,8- 55,9)	53,2 (38,7-67,7)
Humidity/mold in the home				
No	176	82,1 (75,2-87,3)	61,1 (37,1-80,7)	78,7 (64,5-88,3)
Yes	45	17,9 (12,6-24,8)	38,9 (19,3-62,9)	21,3 (11,7-35,5)
Used firewood stove in home				
No	195	89,1 (83,1-93,1)	88,9 (63,6-97,3)	85,1 (71,6-92,8)
Yes	26	10,9 (6,8-16,9)	11,1 (2,7-36,4)	14,9 (7,2-28,4)
Smokers in home				
No	134	62,2 (54,2-69,5)	50,0 (27,8-72,2)	59,6 (44,9-72,7)
Yes	87	37,8 (30,5-45,7)	50,0 (27,8-72,2)	40,4 (27,3-55,1)
Industries close to home				
No	212	97,4 (93,3-99,0)	94,4 (67,8-99,3)	91,5 (79,1-96,8)
Yes	9	2,6 (0,9-6,7)	5,6 (0,7-32,1)	8,5 (3,2-20,9)

Source: The authors, 2020.

Table 3. Prevalence ratios (PR) adjusted for cases of previous hospitalization for other causes compared to previous hospitalization for respiratory causes according to independent variables

Level in hierarchical model	Variables	Previous hospitalization Others causes (PR; IC95%)	Previous hospitalization Respiratory causes (PR; IC95%)
1	Industries close to home †		
	No	ref	ref
	Yes	2,23 (0,24-21,16)	3,53 (0,85-14,72)
2	Go to day care/school †		
	No	Ref	ref
	Yes	2,10 (0,68-6,45)	**4,76 (2,30-9.84)**
	Humidity/mold in home †		
	No	ref	ref
	Yes	2,83 (1,00-8,02)	3,43 (0,81-14,49)
3	Child's age range ‡		
	< 1 year	ref	ref
	1 a 5 years	0,49 (0,16-1,57)	**2,70 (1,14-6,43)**
	6 a 12 years	0,62 (0,05-7,23)	**12,95 (3,30-50,83)**
4	Birth weight		
	≥ 2,5 kg	ref	ref
	1,5 a 2,49 kg	1,15 (0,28-4,78)	**2,76 (1,05-7,22)**
	≤ 1,5 kg	**22,3 (1,72-301,89)**	12,69 (1,00-161,59)
	Breast-feeding		
	Yes	ref	ref
	No	1,22 (0,34-4,42)	1,70 (0,66-4,37)
	Maternal age		
	20 a 34 years	ref	ref
	≤ 19 years	2,08 (0,57-7,63)	0,98 (0,28-3,38)
	≥ 35 years	1,04 (0,23-4,74)	1,76 (0,70-4,39)
4	Weight for age		
	Ideal weight	ref	ref
	Overweight	1,16 (0,11-12,23)	1,01 (0,22-4,55)
	Underweight	1,05 (0,20-5,37)	2,16 (0,79-5,90)

Source: The authors, 2020. No hospitalization is the reference category for the outcome; † Wald test for heterogeneity; ‡ Wald test for linear trend. The effect of each variable on the result is adjusted by other variables of the same or higher level in the hierarchical model; Variables with P>0.2 were excluded from the model. In bold are variables with P≤0.05.

daycare/school and age ≥ 1 year. As shown in Table 3, both low weight and extreme low birth weight influenced hospitalizations for respiratory diseases. Children hospitalized for pneumonia who had low birth weight were (2.76) more likely to be hospitalized for respiratory causes than children weighing ≥ 2.5 kg. Those who were born with extremely low birth weight were more likely to be hospitalized for other causes when compared to the respiratory ones, one explanation for this is that, extremely low birth weight children in general are extremely premature with severe development problems related. Children aged ≥ 1 year, attending daycare or school, were 4.76 times more likely to be rehospitalized for respiratory causes when they have already been hospitalized for respiratory problems at least once in their lives.

DISCUSSION

Regarding the sociodemographic characteristics, it was observed in this study that of 221 children hospitalized for pneumonia, 103 (53.2%) belonged to the age group of children under 1 year old and 97 (42.9%) cases were between 1 and 5 years old. Similar results were found in studies by Barsam, et. al. 2013, demonstrated that in children over 5 years old, the age was a protective factor against the occurrence of pneumonia. Other authors say that respiratory problems are more severe in newborns than in older children, a justification is a high mortality rate in this phase. (Rodrigues *et al.,* 2004; Ferreira and Britto, 2003). The presence of previous hospitalizations for respiratory diseases is reported in the literature as a risk factor for severe pneumonia and new episodes of hospitalization for respiratory causes. Recurrences can involve several factors, such as deficiencies in the immune system, birth defects or sequels of the previous disease (Scott, 2008; Galvão, 2007). In this sense, our study showed that older children, specifically those aged 6 to 12 years, had 12.95 more chances of rehospitalizations for respiratory causes when compared to younger children, we justify this result in the study because older children are more time exposure to etiologic agents. Some studies explain that attendance at day care centers, closed places, crowds and child malnutrition are risk factors for pneumonia in children in school (Veríssimo, 2001; Nesti, 2007; Toloni, 2009). The attendance at the daycare / school was a factor of great relevance in our study, more than half of the children who attended daycare or school had previous hospitalization for respiratory diseases and 4.76 times more likely to readmissions for respiratory causes than those who did not attend (p <0.05). Vico *et al.* (2004), affirm that children who use day care centers are more likely to acquire and develop infections, especially those of repetition, such as those of respiratory. Our study corroborates with Veríssimo (2015), who stated that daycare assistance favors the exposure of children to infectious agents through confinement and agglomeration, emphasizing that young children have habits that facilitate the spread of diseases, such as putting their hands in the mouth, have proximity interpersonal contact, lack of hand hygiene practices and other hygiene habits. As for gender, some studies show a higher prevalence of respiratory diseases in male children (Rodrigues *et al.,* 2004; Ferreira an Britto, 2003; Paiva *et al.,* 1998), in our study there were no significant differences in relation to gender of children in general hospitalizations. Among the perinatal factors associated with hospitalization for respiratory causes, we highlight the birth weight, it´s exerts great influence both on the health of children and on individuals in

adulthood. According to Viana *et al.* (2013), low birth weight has a strong relationship with the risk of death in the first year of life. With the statistical adjustments (table 3), it was possible to detect that children with low birth weight (<2.5 kg) have of 2.76 times more likely rehospitalization for respiratory causes ($p<0.05$). The children with extreme low weight (≤ 1.5 kg) the chances increase to 12.69 times in rehospitalizations for respiratory causes and 22.3 times for other causes, such as complications due to prematurity, for example. Rover *et al.* (2016), in a study carried out with extremely low birth weight neonates, showed that the main cause of rehospitalization was due to respiratory problems, with pneumonia being the most frequent. A study by Barros (2011), concluded that prematurity and low birth weight are determining factors for the increase in hospitalization rates, greater propensity for growth retardation, postnatal neuropsychological deficit and poor school performance. Another study, developed at the Pediatrics Service of the University Hospital of Taubaté - SP from May to December 2001, showed, among other nutritional variables, that low birth weight tripled the chances of hospitalization of children (Nascimento, 2004). Exclusive breastfeeding up to the 6th month of age has a protective effect on children's health. A systematic review by Boccolini *et al*. (2015) on the effects of breastfeeding on maternal and child health in developing countries concluded that breastfeeding reduces the risk of children developing asthma and respiratory infections. In our study, 128 (57.9%) mothers answered that they were unable to continue breastfeeding exclusively until the 6th month, they breastfed less time, breastfeeded with supplementation or never breastfed with breast milk. Children who did not have exclusive breastfeeding until the 6th month of age represented the rates of 53.2% in rehospitalizations for "respiratory causes" and 72.2% in rehospitalizations for "other causes". WHO recommends exclusive breastfeeding up to six months of age, and complementary breastfeeding up to two years of age or older. Children who were breastfed for less than this period had a higher risk of developing infections of the respiratory tract, such as pneumonia, sinusitis and otitis (Lopes, *et al.* 2014).

In this study, the causes of interruption or low adherence to exclusive breastfeeding in the first 6 months of the child's life weren´t investigated, however, according to the author Boccolini *et al.* (2015), maternal education is a factor widely discussed in Brazilian epidemiological studies, almost half of these studies have observed an association between low maternal education and the interruption of exclusive breastfeeding. Regarding the influence of maternal education on the occurrence of rehospitalizations in childhood, there was not statistical significance in our study, but some studies mention that the low socioeconomic level contributes to the increase in the incidence of pneumonia in children.The severity of the disease is greater in developing countries and that the low educational level of parents, particularly mothers, has been shown to be a risk factor for hospitalizations and death from childhood pneumonia (Paiva, 1998; Victora, 2011). According to Aranha *et al.* (2011) the fact that most mothers have not completed high school prevents better professional training and, consequently, insertion in the labor market, reflecting low purchasing power, which limits decisions and actions in relation to care with child health.

One of the risk factors for respiratory diseases is air pollution, represented mainly by inhalation of chemicals and home smoking. In a systematic review study and meta-analysis developed by Dherani et al. (2008) about relationship between air pollution and pneumonia in children, they observed that children exposed to air polluted with solid fuel residues are 1.8 times more likely to acquire the disease. Coelho *et al.* (2012), considers that children from 0 to 5 years of age exposed to passive smoking, have a higher risk of developing respiratory diseases.Other studies such as those by Prietsch *et al.* (2008) and Barsam *et al.* (2013), corroborate by showing that there association with the smoking habit of parents and people who smoke in the child's home with the incidence of pneumonia and hospitalization. The authors concluded that non-smoking mothers and the absence of smokers at home are factors that protect children from respiratory disease. In the studied population, there was no statistical significance in relation to environmental variables and smoking, however, the deleterious effects of these agents on people's health are already known, requiring more studies with larger populations to detect the correlations.

CONCLUSION

Children with exposure to previous hospitalization for respiratory diseases,who were born underweight, attend day care/school and was over 1 year old, were more likely of hospitalization for respiratory causes when compared to children who were never hospitalized or who were hospitalized for other causes. We highlight the importance of performing prenatal care to reduce the occurrence of prematurity and low birth weight, in addition the follow-up the child after hospital discharge, which can be in the pediatric outpatient clinic or by the family health strategy teams (FHS) to prevent new hospitalizations. In relation to children attending daycare / school, it is important that health promotion actions be carried out daily in schools. It is necessary to have an environment with adequate ventilation, avoid crowds in closed rooms, cleaning in the place, motivate and to assist children in their personal hygiene and especially to take care of hand hygiene, as they are fundamental actions for blocking diseases transmitted by contact and by the respiratory route.

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