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ORIGINAL ARTICLE

Sociodemographic and environmental factors in infants under one year of age hospitalized for acute bronchiolitis: case-control study

Factores sociodemográficos y ambientales en lactantes menores de un año hospitalizados por bronquiolitis aguda: estudio de casos y controles

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What do we know about the subject matter of this study?

In developed countries, severe forms of bronchiolitis are associated with the presence of comorbidities. In developing countries, sociodemographic and environmental factors also contribute are added as risk elements for the disease. The objective was to analyze these factors in hospitalized infants under 1 year of age diagnosed with acute bronchiolitis.

What does this study contribute to what is already known?

The research addressed a gap in knowledge regarding on the relevance of environmental and sociodemographic factors in infants hospitalized due to bronchiolitis, compared to those hospitalized for other pathologies. In the adjusted analysis, an association was found with modifiable factors such as the lack of exclusive breastfeeding whose prevalence is notably low at the national level and exposure to tobacco smoke, as well as other factors related to family environment conditions.

Abstract

Inequity in access to healthcare and environmental conditions are factors that affect health. **Objective:** To analyze sociodemographic and environmental factors in infants under 1 year of age admitted due to acute bronchiolitis. **Patients and Method:** Retrospective case-control study conducted in a public pediatric hospital. Cases were infants under 1 year of age hospitalized due to bronchiolitis and controls were infants of the same age hospitalized due to non-respiratory pathologies, matched by origin and date of consultation. Incomplete medical records were excluded, as well as cases in which parents could not be contacted by telephone. The variables analyzed were age, gender, comorbidities, nutritional status, exclusive breastfeeding, socioeconomic level, exposure to environmental and tobacco smoke, living less than 100 meters from a high-traffic area, and living with siblings under 10

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years. Data were analyzed with SPSS, using descriptive and inferential statistics. **Results:** A total of 200 cases and 200 controls were included. In the multivariate analysis, factors associated with hospitalization were the lack of exclusive breastfeeding at 3 months of age (OR = 2 [1.1-3.8]), exposure to tobacco (OR = 1.8 [1.2-3]), age less than 6 months(OR = 2 [1.3-3.2]), and living with siblings under 10 years of age (OR = 1.7 [95% CI 1.2-2.6]). **Conclusions:** The absence of exclusive breastfeeding in the first 3 months of life, living with smokers, age less than 6 months and living with siblings under 10 years of age were the sociodemographic and environmental risk factors independently associated with hospitalization due to bronchiolitis.

Introduction

Acute bronchiolitis is the leading cause of viral lower respiratory tract infection¬s and hospitalization in infants under 12 months of age[1]. Respiratory syncytial virus (RSV) the predominant etiological agent[2]. The illness typically begins with symptoms such as rhinitis, nasal congestion, and cough. Although most cases follow a mild to moderate course, it can escalate to tachypnea, wheezing, and use of accessory muscles, ultimately resulting in respiratory distress and the development of severe condition that may require admission to the pediatric intensive care unit (PICU)[3-5].

Pre-existing conditions in infants, such as chronic lung disease, congenital heart disease, immunodeficiencies, neuromuscular disorders, and a history of prematurity, are recognized risk factors for severe forms of acute bronchiolitis[6]. Aditional contributors to the increased incidence of respiratory illness in children include exposure to tobacco smoke[7], environmental and household air pollution, overcrowding, and reduce lexposure to sunlight[8,9,10].

Similarly, inequity in access to health services, driven by socioeconomic disparities limited educational opportunities, and adverse environmental conditions affect the health of the general population and, particularly, that of children in developing countries[11]. The United Nations (UN) Sustainable Development Goals address these global challenges including poverty, inequity, climate change, and environmental degradation[12].

A previous study conducted at the same hospital, demostrated that low socioeconomic status, comorbidities, and the lack of exclusive breastfeeding up to 6 months of age were independent risk factors associated with admission to the PICU in children under 2 years of age diagnosed with severe bronchiolitis[13]. In separed r study, the admission of neonates with acute bronchiolitis to the Pediatric Emergency Department (PED) of the same hospital was linked in 45% of cases to social risk factors such as young mothers experiencing challenges in providing adequate comfort care and exposure to tobacco smoke within the home environment[14].

The primary objective of this study was to analyze sociodemographic and environmental factors in infants under 1 year of age who were hospitalized due to acute bronchiolitis. As a secondary objective, the study aimed to identify } underlying chronic conditions, such as congenital heart disease, chronic lung disease, neurological pathologies, and history of prematurity.

Patients and Method

Design and population

A retrospective case-control study was conducted in the PED of the *Hospital Pediátrico Niños de Acosta Ñu*, in Paraguay, between March and August 2022. This tertiary university hospital is the only institution in Paraguay dedicated exclusively to pediatric care , registering approximately 120,000 annual consultations in the PED. Cases included infants under 1 year of age hospitalized with a diagnosis of the first episode of acute bronchiolitis. Controls were infants under 1 year of age admitted for non-acute respiratory pathologies, matched by geographic origin cities within the central department and date of consultation (same day). Eligibility criteria required that the clinical record include a telephone number allow communication with the parents,to obtain informed consent, validation of clinical record, and verification of socio-environmental information. Cases participants were selected by consecutive sampling and controls participants were selected using systematic sampling (calculated as the quotient between the number of clinical records and the desired sample size). Based on this approach every third elegible record was included, until a 1:1 case to control ratio was achived .

Variables

Data were collected using a Google Form specifically designed to capture hospitalization details medical history, and information from telephone interviews with parents. These interviews were conducted 6 to 7 months after discharge, alternating a case and a

control from a coded list provided to the interviewer, who was blinded to e each infants' case or control status.

The following was obtained from the medical records: date of hospitalization from the PED, age, sex, presence of comorbidities, history of hospitalization during the immediate neonatal period, nutritional status according to WHO percentiles, bronchiolitis severity classified using the modified Tal score[15], disposition (discharge, admission to PICU), and exclusive breastfeeding up to 3 months of age. Additionally PCR test results were performed on nasopharyngeal swab collected upon admission to the PED using the Allplex™ Respiratory Panel-RT-PCR assay,(Seegene, USA), which detects 26 respiratory pathogens, including 16 viruses with their subtypes and 7 bacteria, alonside relevant laboratory finding

The telephone interview gathered maternal demographic data: including educational level, occupation, marital status (categorized as "in a relationship" and "single"), and socioeconomic status based on the modified Graffar Méndez Castellano scale[16], which classifies individuals into five levels: high, upper-middle, lower-middle, working class, and marginal. Given the specific characteristics of the study population, socioeconomic status was dichotomized into two categories: lower-middle and working class. Socio-environmental variables included: overcrowding (calculated as the ratio of household members to bedrooms, presence of cohabiting siblings aged ≤ 10 years attendance at daycare, exposure to biomass smoke use for cooking, household waste disposal practices specifically burning, proximity of the residence to high-traffic roads (< 100 meters), and exposure to tobacco smoke in the home (defined as living with one or more smokers).

Statistical aspects

Sample size

To calculate of the sample size, the proportion of younger siblings was considered a risk factor for bronchiolitis (0.75) as reported in the literature[9]. Using the GRANMO calculator and assuming an alpha risk of 0.05 and a beta risk of < 0.2 in a bilateral contrast, we determined the need to include 190 cases and 190 controls to detect a minimum odds ratio (OR) of 2.2.

Data analysis

The data were analyzed with SPSS version 21 (IBM, New York, USA). Quantitative variables were expressed as medians with their respective quartiles given their non-normal distribution. Qualitative variables were expressed as percentages. Association between qualitative variables were evaluated using a contingency tables and chi-square test. Variables that showed statistical significance in the bivariate analysis were subjected to logistic regression, using both by the stepwise method and the intro method. A p-value < 0.05 was considered statistically significant.

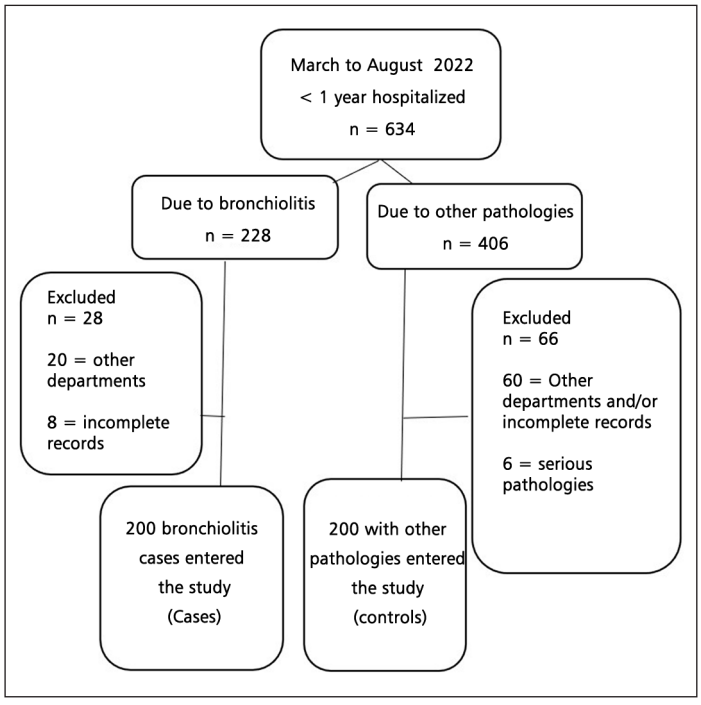

Figure 1. Patients flowchart.

Results

During the study period, 634 patients under 1 year of age were hospitalized, Of these 36% (228/634) corresponded to acute bronchiolitis (cases) while 64% (406/634) presented with other pathologies (controls). From the cases group, 28 patients were excluded: 20 for not residing in the central department and 8 due to incomplete clinical history and inability to contact their parents. From the control group, 66 patients were excluded: 25 for being from other departments, 12 for incomplete medical records and inability to contact their parents, and 29 due to acute decompensation of pre-existing pathologies. Using systematic sampling, 200 controls were included (figure 1).

Acute bronchiolitis cases were significantly younger than controls [median (p25-p75): 2 months (1-5) vs. 4 months (1-8), respectively; p = 0.01]. At admission the distribution of the modified Tal scale in cases was mild in10.5% (21/299), moderate in 73% (146/200), and severe in 16.5% (33/200). Of the mild cases, 11out of 21 were neonates admitted due to social risk, while

no patients in the control group were admitted for this reason. The viral agent was identified by RT-PCR) of nasopharingeal swab in 65% (130/200) of the bronchiolitis, with the following distribution: 60% RSV, 17.7% SARS-CoV-2, 15.4% metapneumovirus, 3.8% influenza A, and 3.1% adenovirus. Oxygen therapy was required in 89.5% of cases. Admission to PICU occurred in 10 patients (5%) in the case group (8 RSV and 2 SARS-CoV-2) and 16 (8%) in the control group (p = 0.31). One death was recorded in each group: one case patient with bronchopulmonary dysplasia and RSV infection, and one control patient with congenital heart disease and sepsis.

No patients in either group attended daycare. No significant differences were found betwen the groups in term of sex,distribution nutritional status, or the overall presence of comorbidity. However, neurological pathologies were less frequent in the case group than in the control group [2.5% vs. 7.5%; OR = 0.3 (0.11-0.88); p = 0.02]. No significant differences were observed in other comorbidities (table 1).

Regarding sociodemographic factors, a higher prevalence of single mothers was observed in the case group compared to the control group [32.5% vs. 22.5%, OR = 1.6 (1.1-2.5); p = 0.02] Neonatal hospitalization was also more frequent amongs cases [32% vs. 22%; OR = 1.6 (1.1-2.6); p = 0.02], with respiratory distress and suspected sepsis being the most common causes. The absence of exclusive breastfeeding for up to 3 months was more prevalent in the case group [16% vs. 8%; OR = 2.1 (1.1-4.1); p = 0.01]. Cases had a higher proportion of cohabiting siblings under 10 years of age [50.5% vs. 40.5%; OR= 1.4 (1-2.2); p = 0.04] and greater exposure to tobacco smoke at home [21.5% vs. 12%; OR = 2 (1.1-3.4); p = 0.01]. No differences were found between the groups in biomass use, waste burning, exposure to high-traffic roads, and socioeconomic status (table 2).

In the logistic regression analysis, adjusted for maternal marital status and history of neonatal hospitalization, the socio-environmental risk factors independently associated with hospitalization for acute bronchiolitis were cohabitation with siblings, lack of exclusive breastfeeding up to 3 months, presence of smokers at home, and younger age (table 3).

Discussion

The results of this study highlight the predominance of socio-environmental risk factors such as absence of exclusive breastfeeding during the first three months of life exposure to tobacco smoke in the home, and cohabitation with younger siblings as significant contributos to hospitalization for to acute bronchiolitis in infants under one year of age, compared to infants hospitalized for other pathologies within the same age group.

Table 1. Characteristics of patients under 1 year of age, hospitalized for bronchiolitis (cases) and for other pathologies (controls), General Pediatric Hospital Niños de Acosta Ñu, n= 400

Variables	Cases n = 200		Controls n = 200		OR (CI 95%)	p-value
Age (month) Median [Q1-Q3]	2 [1-5]		4 [1-8]			0.01[a]
	n	%	n	%		
Gender						
Female	91	45.5	92	46	1 (0.6-1.5)	0.92[b]
Male	109	54.5	108	54		
Nutritional status						
Eutrophic	148	79.6	153	80.1	1 (0.6-1.7)	0.89[b]
Malnourished	38	20.4	38	19.9		
Comorbidities	56	28	51	25.5	1 (0.7-1.7)	0.57[b]
Types od comorbidities						
Neurological Pathology	5	2.5	15	7.5	0.3 (0.1-0.8)	0.02[b]
Prematurity	34	17	23	11.5	1.5 (0.8-2.7)	0.11[b]
Bronchopulmonary dysplasia	5	2.5	2	1	2.5 (0.4-13)	0.25[b]

[a]U Mann Whitney; [b]χ^2.

Table 2. Analysis of sociodemographic and environmental factors in children under 1 year of age hospitalized for bronchiolitis vs. other pathologies at the General Pediatric Hospital Niños de Acosta Ñu, n = 400

Variables	Cases n = 200	Controls n = 200	OR (CI 95%)	P
Maternal data				
Age (years)	26 (22-33)	26 (22-31)		1[a]
Marital status:				
In relantionship	65 (32.5)	45 (22.5)	1.6 (1.1 – 2.6)	0.02[b]
Single	135 (57.5)	155 (77.5)		
Schooling:				
≤ 9 years	25 (12.5)	22 (11)	1.1 (0.6 – 2.1)	0.64[b]
> 9 years	175 (87.5)	178 (89)		
Occupation:				
House wife	122 (63)	130 (65)	0.8 (0.5 -1.2)	0.40[b]
Job	78 (37)	70 (35)		
Infant data				
Hospitalization in the neonatal period				
Yes	64 (32)	44 (22)	1.6 (1.1 – 2.6)	0.02[b]
Absence of EBF for 3 months				
Yes	32 (16)	16 (8)	2.2 (1.2 – 4.1)	0.02[b]
Younger siblings				
Yes	101 (50.5)	81 (40.5)	1.4 (1.2 – 2.2)	0.04[b]
Exposure to tobacco				
Yes	43 (21.5)	24 (12)	2 (1.1 – 3.4)	0.0[b]
Use of biomass for cooking				
Yes	15 (7.5)	21 (10.5)	0.6 (0.3 – 2.7)	0.29[b]
Burning of waste				
Yes	20 (10)	15 (7.5)	1.3 (0.6 -2.7)	0.37[b]
Overcrowding				
Yes	103 (51.5)	98 (49)	1.1 (0.7 – 1.6)	0.6[b]
High vehicular traffic				
Yes	114 (57)	99 (49.5)	1.3 (0.9 – 2)	0.13[b]
Socioeconomic level				
Medium- low	113 (56.5)	119 (59.5)	1.1 (0.7 – 1.6)	0.54[b]
Worker	87 (43.5)	81 (40.5)		

Figures are expressed as number (%) or median [25th–75th percentile], as appropriate. [a]Mann-Whitney U, [b]χ^2; EBF: exclusive breast feeding.

The lack of exclusive breastfeeding during the first three months of life was twice as frequent in the case group, and emerged as the most important independent risk factor in this study. The protective effects of exclusive breastfeeding are well supported by previous research. A cohort study conducted in Italy identified breastfeeding as the main protective factor against hospitalization due to bronchiolitis[17]. In the United States, a case-control studyfound that exclusive breastfeeding during the first Three months reduced the risk of hospitalization due to bronchiolitis by 58%[18]. Likewise, a multicenter study in England reported that breast-

Table 3. Logistic regression of socio-environmental risk factors in infants with bronchiolitis, adjusted for marital status (with or without a partner and history of neonatal hospitalization)

Variables	OR (IC 95%)	p value
Age < 6 month	2 (1.3 – 3.2)	0.02
Absence of EBF	2 (1.1 - 3.8)	0.03
Smokers in the house	1.8 (1.2 – 3)	0.02
Siblings < 10 years in the house	1.7 (1.2- 2.6)	0.01

EBF: Exclusive breast feeding.

feeding for up to six months decreased the likelihood of acute bronchiolitis by 45%[19]. The inmmunologic benefits of breast milk, particularly the transfer of maternal IgG likely plays a key role in preventing bronchiolitis[20]. Consequently,the promotion of exclusive breastfeeding for three to six months may represent a critical preventive measure[21].

Tobacco exposure from living with smokers in the household was identified as another significant environmental risk factor. An Italian study found that parents of infants hospitalized for bronchiolitis smoked at twice the rate of those in the control group[17]. Postnatal tobacco exposure is linked to an increased frequency and severity of respiratory illnesses particulary bronchiolitis, and a high risk of hospitalization in infants[22,23]. Tobacco smoke may activate immunologic mechanisms that alter the host response to RSV, which is the predominant etiologic agent of bronchiolitis[24]. Exposure to smoke in general and to tobacco specifically has adverse health effects at any age. Children specifically with smokers become passive smokers and are consequently a greater risk for lower respiratory infections otitis media, and the development of asthma[25].

Cohabitation with younger siblings emerged as the third socio-environmental risk factor for bronchiolitis in this series, This association can be attributed to interpersonal transmission from with older siblings attending kindergarten or school, a link that as been previously in several studies[9,10,19].

Most of the infants in this study, both cases and controls, belonged to low socioeconomic strata, a condition often linked to unhealthy living environment such as overcrowding[26], which was observed in approximately half of the patients,. Environment degradation and pollution, largely driven by human activity, have negatively impacted health particularly in urban areas of developing countries[27]. Most of the participants resided in densely populated urban areas of the central departament, characterized by with chaotic traffic and proximity to high-traffic roads,a factors associated with environmental pollution[19,28], These shared exposures may account for the absence of differences in these covariates between the studied groups .

The air quality index near the patients´homes could not be measured.Furthermore,other contributors to environmental risk, such as industrial activity and the processing of fertilizers and insecticides in the central department, were not include as study variables A systematic review reported an association between exposure to pesticides and respiratory symptoms in children aged 2 to 12 years[29]. Additionally a study conducted in Chile found a correlation between a higher concentration of particulate matter (PM) 2.5 and hospitalization due to bronchiolitis[8].

Nosignificant differences were observed in the frequency of comorbidities, chronic conditions, or history of prematurity between the groups. These factors have previously been linked to a higher risk of acute bronchiolitis in more developed countries[6]. The rates of PICU admissions and mortality were comparable across both groups. Hospitalization of mild cases of bronchiolitis due to social risk has been documented in prior studies[30]. In our study, the percentage of admissions for social risk was low (5%) in the bronchiolitis cases, with no such admissions in the control group.

Regarding etiology, although a viral studywere not conducted in all patients, RSV was identified in 60% of cases, consistent with finding from other reports[31,32]. Thisstudy, conducted in the post-COVID-19 pandemic period, found SARS-CoV-2 to be the second most frequently detected agent after RSV, surpassing other viruses commonly observed during the pre-pandemic period. These finding highlight the importance of immunization against both viruses.

Infants diagnosed with bronchiolitis were significantly younger than those in control group, with the majority under six months of age This aligns with previous studies reporting a higher incidence of bronchiolitis in this age group[32].

The study presents limitations inherent to retrospective designs. The main limitation was the use of hospital-based controls, which was justified by the difficulty in recruiting community-based participants within the target age group. This approach was deemed relevant for assessing socio-environmental risk factors in infants hospitalized for non-respiratoryconditions . To minimized bias, consultation dates and place of origin, , were matched and blinded interviews were conducted with parents within 6 months after hospitalization.

Additional limitations include the absence of direct measurement of outdoor environmental pollution , considered indirectly via proximity to vehicular traffic,the lack of data regarding family history of asthma or atopy, and missing information on exposure to fertilizer and insecticide processing sites.

Strengths of the study include the validation of incomplete clinical data through follow-up telephone interview with parents, and the confirmation of previously identified association between bronchiolitis and socio-environmental factors found in our hospital population across different age groups.

Conclusions

Among hospitalized children under one year of age, sociodemographic and environmental risk factors such as lack of exclusive breastfeeding for less than 3 months, exposure to tobacco smoke, and cohabitation

with siblings were significantly associated with hospitalization due to acute bronchiolitis, These factors demostred higher prevalence than comorbidities and chronic medical conditions. Notably Some of these sociodemographic and environmental risks factors, particularly limited to exclusive breastfeeding and exposure to tobacco smoke, are potentially modifiable through public policies aimed at promoting preventive care and health education

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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