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# Étude multicentrique sur la bronchiolite en Algérie : épidémiologie, facteurs de risque, évolution et prise en charge thérapeutique.

## *Multicenter Study on Bronchiolitis in Algeria: Epidemiology, Risk Factors, Evolution, and Therapeutic Management*

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## Résumé

La bronchiolite, une maladie virale obstructive des voies respiratoires, survient généralement au cours des deux premières années de vie. Ses caractéristiques épidémiologiques, cliniques, évolutives ainsi que les facteurs de risque contribuant à l'aggravation de l'infection et aux récidives varient selon les pays. Il est essentiel de définir ces aspects et ces facteurs de risque pour la population pédiatrique algérienne.
À l'aide d'un questionnaire destiné aux parents, nous avons mené une étude épidémiologique, rétrospective et observationnelle chez des enfants de moins de deux ans ayant reçu un diagnostic de bronchiolite entre 2017 et 2020. L'étude a inclus 215 nourrissons, avec un pic de fréquence notable en janvier (28,4 %). L'âge moyen était de huit mois. Quarante-quatre pour cent des cas ont nécessité une hospitalisation d'une durée moyenne de 8 jours, influencée par des facteurs tels que le jeune âge, la prématurité, des antécédents pulmonaires ou cardiaques, et l'absence d'allaitement maternel. Une proportion significative de 79,1 % des nourrissons a présenté des récidives, influencées par la prématurité, la présence d'atopies, l'âge et la sévérité de l'épisode initial de bronchiolite. Les traitements administrés étaient en contradiction avec les recommandations internationales, et les infections bactériennes secondaires étaient fréquentes. Cette étude met en évidence les cas à risque accru de bronchiolite précoce, de nécessité d'hospitalisation, de récidive, ainsi que de développement d'un asthme du nourrisson, permettant ainsi d'évaluer le fardeau de la bronchiolite en Algérie.

**MOTS CLES:** Bronchiolite, maladies respiratoires pédiatriques, épidémiologie, nourrissons algériens, infections virales respiratoires, hospitalisation et traitement, facteurs de risque de la bronchiolite, récidive des affections respiratoires.

## ABSTRACT

Bronchiolitis, a viral obstructive respiratory disease, typically emerges in the first two years of life. Its epidemiological, clinical, and developmental traits and risk factors contributing to infection aggravation and recurrence vary across countries. It is crucial to outline these aspects and risk factors for the Algerian pediatric populace. Utilizing a parent questionnaire, we executed an epidemiological, retrospective, observational study on children under two diagnosed with bronchiolitis between 2017 and 2020. The study encompassed 215 infants, with a

notable frequency peak in January (28.4%). The average age was eight months. Forty-four per cent of cases required an average 8-day hospital stay, influenced by factors like young age, prematurity, pulmonary or cardiac conditions, and breastfeeding absence. A significant 79.1% of infants faced recurrences, swayed by prematurity, atopies presence, age, and the severity of the initial bronchiolitis episode. The applied treatments contradicted international guidelines, with secondary bacterial infections being common. This study delineates cases at higher risk for early-onset bronchiolitis, hospitalization necessity, recurrence presentation, and infant asthma development, hence assessing the burden of infant bronchiolitis in Algeria.

**KEYWORDS:** Bronchiolitis, viral respiratory infections, risk factors for bronchiolitis.

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## Introduction

Bronchiolitis is a viral infection, very common during the first two years of life, characterized by inflammation and obstruction of the lower respiratory tract [1] (**figure 01**). It is one of the world's leading causes of infant hospitalisation and is generally associated with the Syncytial Respiratory Virus (RSV) but may also be caused by other respiratory viruses [2,3].

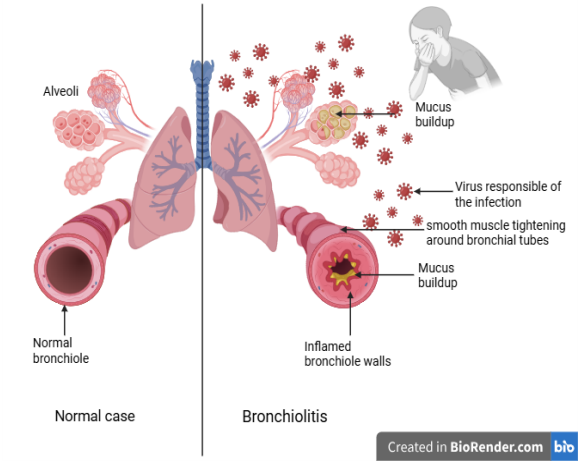


**Figure 01 : Description of the inflammation and obstruction of the lower respiratory tract in bronchiolitis (Created with BioRender.com)**

The inaugural research on the viral origins of respiratory infections in Algeria pinpointed the Respiratory syncytial virus, human rhinovirus, and human metapneumovirus as primary culprits for acute respiratory infections in Algerian infants below two years [4]. Interestingly, while the specific virus isn't a definitive indicator of infection severity, clinical symptoms provide a more accurate gauge [5]. The main symptoms are : nasopharyngitis, cough, dyspnea, wheezing, crackling and moderate fever [6].

To date no treatment has actually proven its effectiveness against this infection [7]. Bronchiolitis may occur in a benign manner and be treated at home or may be severe and require hospital management [1]. The treatment differs from one hospital to another and from a country to another [8].

In a 2017 review, the authors highlighted the differences in the definitions of bronchiolitis, age groups, auscultatory characteristics, and the risk factors of gravity and recurrence [7].

Various studies around the world have defined the epidemiological characteristics, clinical and evolutionary as well as risk factors specific to each region[9-17]. Clinical patient data were shown to be more predictive of risk of severity than the viral entity involved in bronchiolitis [5].

Given the limited research on bronchiolitis within Algeria and Africa, our study aims to delineate the epidemiological and clinical profiles, as well as the risk factors, outcomes, and recurrence rates of bronchiolitis in the Algerian paediatric population. Our goals are to enhance prevention, diagnosis, and treatment strategies, identify children at risk of severe outcomes including asthma, and contribute to a global consensus on the definition and monitoring of bronchiolitis.

## Materials and Methods

### Type of Study

This is an observational retrospective study conducted on children requiring medical consultation for bronchiolitis from January 2017 to December 2020 in various cities across Algeria.
Framework of the Study: The study utilized a questionnaire distributed to parents of children who required consultation for bronchiolitis, supplemented by interviews with parents to gain deeper insights

into each case and medical information extracted from health records. This combined approach enabled a comprehensive collection of data.

Inclusion Criteria: All infants under two years of age diagnosed with acute bronchiolitis during the study period were included.

### Data Collection

Information was gathered using a detailed data collection sheet, which included 56 elements across several categories:

Socio-demographic Parameters: Sex, age, residence, proximity to the sea, and humidity in the dwelling.

### Neonatal and Early Childhood Analysis

Birth routes, gestational age, fetal suffering, respiratory distress at birth, month of birth, birth weight, type of pregnancy, type of breastfeeding, parental age, number of previous pregnancies, gastroesophageal reflux, passive smoking, existing respiratory or cardiac pathology, age of food diversification, number of siblings, type of childcare, and exposure to air conditioning.

Personal and Family Medical History: History of asthma and allergies.

Clinical Parameters: Month of consultation, need and reasons for hospitalization, general condition, body temperature, refusal to eat, and type of breathing.

Therapeutic and Evolutionary Parameters: Administered treatments, recurrence of symptoms, and diagnosis of infant asthma.
Infectious Parameters: Occurrence of secondary bacterial infections.

### Statistical Analysis

Data were presented as means and standard deviations for normally distributed
variables, and medians with interquartile ranges for continuous variables. Qualitative variables were expressed in numbers and percentages. Linear regression and ANOVA tests were utilized to assess the influence of various factors on the severity of the illness, need for and length of hospitalization, recurrence, age at first episode, and the future diagnosis of asthma.

### Explanation of Linear Regression Analysis

Linear regression was specifically used to identify relationships between various independent variables (e.g., socio-demographic and clinical parameters) and dependent outcomes such as severity of bronchiolitis and length of hospitalization. Each variable was examined for its predictive power while controlling for potential confounders. The regression model provided coefficients that estimated the change in the dependent variable for a one-unit change in the predictor variable, while holding other factors constant. Assumptions of linear regression, including linearity, independence, homoscedasticity, and normal distribution of errors, were systematically tested to ensure the validity of the model outcomes. Statistical analyses were conducted using Jamovi software, with a significance threshold set at $p<0.05$.

## Results

Between January and March 2021, we collected data from 215 parents in Algeria whose children had bronchiolitis consultations from 2017 to 2020. The data, representing 23 northern and central Algerian cities, revealed that out of 215 cases, 96 (44.7%) were severe enough to require hospitalization. Boys were more affected than girls, with a sex ratio of 1.4. The average age at infection onset was 8 months, with most infants (76.3%) aged 1 to 12 months. Hospitalized infants had an average age of 5.8 months, with over half (56.3%) under 6 months old, including 25% under 2 months.

**Table 01** summarizes the epidemiological and personal information of the patients.

Bronchiolitis cases occurred throughout the year, peaking from November to March (87.9%), especially in January (28.4%) and February (27%) (see **figure 2**). Most children (70.2%) lived in northern Algeria, with 32.6% residing within 10 kilometers of the coast. Over half of the cases (53.4%) reported high humidity levels in their homes.

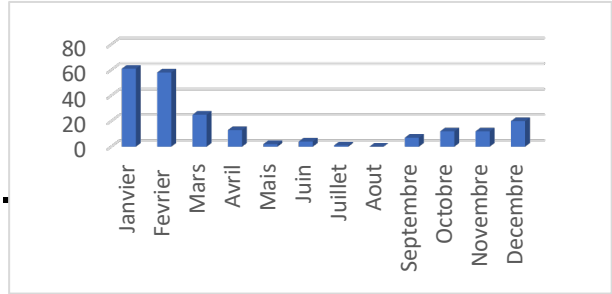


**Figure 02 : Rate and percentage of bronchiolitis visits per month in Algeria from 2017 to 2020**

In our study, 59.5% of bronchiolitis cases had a history of asthma or allergies. Prematurity was noted in 18.6% of cases, with none receiving the palivizumab vaccine, and about 30% required neonatal hospitalization. The median birth weight was 3kg300, and 46.5% of infants were delivered via caesarean section, more than half of which were planned.

A respiratory or heart condition was present in 19.5% of the infants, and 61.9% were not breastfed. Among breastfed infants, 34.5% were breastfed for less than 6 months, and 70.6% for less than 12 months. Gastroesophageal reflux was reported in 44.2% of cases, and 54.4% were exposed to passive smoking. Allergies were noted in 17.2%, atopic dermatitis in 38.6%, and 40.5% were diagnosed with infant asthma, mainly after a second bronchiolitis episode. Food diversification commonly occurred between 4 and 6 months (51.6%). Additionally, 58.1% had at least one sibling, 26% attended a nursery, and 28.4% were cared for by a nanny with other children. Over half (51.7%) had been exposed to air conditioning.

In our study on bronchiolitis episodes, 90% of infants experienced recurrences: 11.8% had one episode, 36.3% had two, and 52.1% had three or more. The median consultation weight was 8.45 kg (IQR 6.20 to 9.90 kg), and 44.7% required hospitalization. The average hospital stay was 8 days, with a median of 7 days (IQR 4 to 10 days).

**Table 01 : Epidemiological and personal patient information**

| Variables | Values |
|---|---|
| **Sample size** | 215 patients |
| **Sex (male/female)** | 126 (58.6%) / 89 (41.4%) |
| **Age *** | 7 months (iqr 3.5-12 months) |
| **Age **** | 5 months (iqr 2.75-9 months) |
| **Consultation weight *** | 8kg45 (iqr 6.20-9.90kg) |
| **Birth weight *** | 3kg300 (iqr 3,100-3,700 kg) |
| **Neonatal hospitalization** | 64 (29.8%) |
| **Allimentary diversification between 4 et 6 months** | 111 (51.6%) |
| **Presence of siblings** | 125 (58.1%) |
| **Community custody** | 117 (54.4%) |
| **Hospitalization time *‘**** | 7 days (iqr 4-10 days) |
| **Recurrence** | 170 (79.1%) |

The clinical and paraclinical data indicated that high temperatures above 39° led to hospitalization in 58.1% of cases. Coughing occurred in 60% of the cases, and nasal discharge was present in 89.8%.

The **table 02** resumes the different factor with the different variables of the study.

In our study, 84.7% of bronchiolitis patients were diagnosed with rhinopharyngitis. Over half of the infants (54.9%) experienced difficulty breathing, often accompanied by rapid breathing (52.1%), wheezing (91.6%), and abdominal breathing (59.5%). Nose flapping was seen in 27.4% of cases, and 17.2% presented with dehydration. Oxygen saturation was below 95% in 89.3% of infants tested. Chest X-rays were performed in 68.8% of cases. The most common treatments included saline serum nebulization (82.2%), a combination of saline serum and salbutamol nebulization (74.1%), and corticosteroids (72.4%). Inhaled bronchodilators were prescribed to 42.3%, and antibiotics, predominantly amoxicillin, were given to 82.3% of infants.

**Table 02 : demographic characteristic of bronchiolitis consultations**

| | **Cases of bronchiolitis** ***(n=215)*** | **Cases not requiring hospitalization (n=119)** | **Serious cases requiring hospitalization** ***(N=96)*** | **cases of recidives** ***(N=171)*** |
|---|---|---|---|---|
| **prematurity** | 40 (18.6%) | 14 (11.8%) | 26 (27.1%) | 30 (17.5%) |
| **family asthma field** | 128 (59.5%) | 49 (41.1%) | 39 (40.6%) | 75 (43.8%) |
| **cesarean birth** | 100 (46.5%) | 63 (52.9%) | 37 (38.5%) | 78 (45.6%) |
| **fetal suffering** | 37 (17.2%) | 18 (15.1%) | 19 (19.8%) | 29 (17%) |
| **respiratory of cardiac pathologies** | 42 (19.5%) | 7 (5.9%) | 35 (36.5%) | 36 (21.1%) |
| **lack of breastfeeding** | 133 (61.9%) | 49 (41.2%) | 47 (49%) | 76 (44.4%) |
| **gastroesophageal reflux** | 95 (44.2%) | 55 (46.2%) | 40 (41.7%) | 80 (46.8%) |
| **passive smoking** | 117 (54.4%) | 64 (53.8%) | 53 (55.2%) | 91 (53.2%) |
| **food allergies** | 36 (17.2%) | 22 (18.4%) | 15 (15.6%) | 32 (18.7%) |
| **atopic dermatitis** | 83 (38.6%) | 46 (37.8%) | 38 (39.6%) | 76 (44.5%) |
| **Exposure to air conditioning** | 128 (59.6%) | 71 (59.6%) | 57 (59.4%) | 102 (59.7%) |

Nasopharyngeal disinfection was the leading non-pharmaceutical treatment (85.1%), while only 17.7% received respiratory physiotherapy. Secondary bacterial infections were found in 40.5% of the cases.

Our linear regression analysis identified several factors significantly associated with hospitalization risk in bronchiolitis cases. The **table 03** resumes all the linear regression analysis findings. These include age at consultation, delivery method, neonatal respiratory distress, respiratory or cardiac pathologies, lack of breastfeeding, gestational age, pregnancy type, and consultation weight, along with chest X-ray and symptoms like fever, decreased oxygen saturation, and breathing difficulties.

Hospital stay length was influenced by prenatal corticosteroid therapy, fetal pain, neonatal respiratory distress, lack of breastfeeding, respiratory or cardiac conditions, having siblings, childcare type, consultation month and weight, and age at the first episode. Symptoms like fever, breathing difficulty, rapid breathing, and dehydration also affected stay duration, as did undergoing a chest X-ray.

**Table 03 : Summarizing the linear regressions performed on the studied factors and their influences. *not significant**

| Factors | Need for hospitalization | Length of hospitalization | Age of first episode | Reccurence | Infent asthma diagnosis |
|---|---|---|---|---|---|
| **Prenatal corticosteroids** | * | p=0.003 | p=0.004 | * | p=0.045 |
| **Fetal pain** | * | p=0.038 | * | * | * |
| **Childbirth mode** | p = 0.035 | * | * | * | * |
| **Type of pregnancy** | p = 0.050 | * | p=0.057 | * | p=0.009 |
| **Neonatal repiratory distress** | **p<0.001** | **p<0.001** | **p<0.001** | * | * |
| **Respiratory or cardiac disease** | **p<0.001** | p=0.032 | p=0.031 | * | * |
| **Lack of breastfiding** | **p<0.001** | **p<0.001** | **p<0.001** | * | * |
| **Gastroesophageal reflux** | * | * | **p<0.001** | * | **p<0.001** |
| **Gestational age** | p = 0.017 | * | p=0.016 | p=0.033 | * |
| **Age at consultation** | **p<0.001** | **p<0.001** | **-** | p=0.027 | * |
| **The hight humidity** | * | * | * | * | p=0.033 |
| **Atopic dermatitis** | * | * | * | **p=0.001** | **p<0.001** |
| **Consultation weight** | **p<0.001** | p=0.03 | * | * | * |
| **Number of siblings** | * | p=0.003 | * | * | * |
| **Custody type** | * | p=0.036 | **p<0.001** | * | * |
| **Hospitalisation first episode** | **-** | **-** | **-** | p=0.002 | **p<0.001** |
| **Presence of allergy** | * | * | * | * | **p<0.001** |
| **Fever** | **p<0.001** | **p<0.001** | **-** | * | * |
| **Decrease in O2 saturation** | **p<0.001** | * | **-** | * | * |
| **Respiratory difficulty** | **p<0.001** | **p<0.001** | **-** | **p<0.001** | **p<0.001** |
| **Rapid breathing** | **p<0.001** | **p<0.001** | **-** | **p<0.001** | p=0.002 |
| **Flapping nose wings** | **p<0.001** | **p<0.001** | **-** | * | * |
| **Abdominal breathing** | **p<0.001** | **p<0.001** | **-** | **p<0.001** | **p<0.001** |
| **Decreased diet** | **p<0.001** | **p<0.001** | **-** | p=0.033 | * |
| **Dehydratation** | **p<0.001** | **p<0.001** | **-** | * | * |
| **Secondary bacterial infection** | **p<0.001** | p=0.039 | **-** | **p<0.001** | * |

The age at first bronchiolitis episode was significantly influenced by prenatal corticosteroid use, gestational age, pregnancy type, neonatal respiratory distress, lack of breastfeeding, gastroesophageal reflux, respiratory/cardiac conditions, childcare type, air conditioning exposure, and consultation month.

Recurrent bronchiolitis was significantly affected by gestational age at birth, presence of atopic dermatitis, age at the first episode, hospitalization during the first episode, and symptoms like difficulty breathing and rapid breathing. Treatments like saline serum nebulization, combined nebulization, inhaled bronchodilators, corticosteroid, and antibiotic therapy also increased recurrence risk.

Asthma development in infants was linked to factors like high humidity, prenatal corticosteroid use, pregnancy type, gastroesophageal reflux, allergies, atopic dermatitis, air conditioning exposure, hospitalization for the first episode, and recurrent episodes. Symptoms like difficulty breathing, rapid breathing, and abdominal breathing, as well as treatments like nebulization, bronchodilators, corticosteroids, and physiotherapy, were associated with a higher asthma risk. Secondary bacterial infections during the first episode also increased asthma risk.

The various therapeutic approaches adopted for both hospitalized and outpatient infants with bronchiolitis are summarized in **Table 04**.

The **table 05** presents a detailed analysis of how initial treatment strategies affected various aspects of our research outcomes. The age at first bronchiolitis episode was significantly influenced by prenatal corticosteroid use, gestational age, pregnancy type, neonatal respiratory distress, lack of breastfeeding, gastroesophageal reflux, respiratory/cardiac conditions, childcare type, air conditioning exposure, and consultation month.

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**Table 04 : Treatments introduced for hospitalized and outpatient infants**

| Treatments | **Total number** (N=215) | Hospitalized infants (N=96) | Infant not hospitalized (N=119) | *p* |
|---|---|---|---|---|
| Serum nebulization | 175 (82.2%) | 90 (93.8%) | 85 (72.6%) | p<0.001 |
| Serum nebulization + asthalin | 157 (74.1%) | 88 (91.7%) | 69 (59.5%) | **p<0.001** |
| Inhaled bronchodilators | 91 (42.3%) | 44 (45.8%) | 47 (39.5%) | 0.352 |
| Oral corticosteroids | 155 (72.1%) | 74 (77.9%) | 81 (68.1%) | 0.144 |
| Antibiotic therapy | 181 (84.2%) | 96 (100%) | 85 (71.4%) | **p<0.001** |
| Nasopharyngeal disinfection | 183 (85.1%) | 82 (85.4%) | 101 (84.9%) | 0.912 |
| Respiratory physiotherapy | 38 (17.7%) | 16 (16.7%) | 22 (18.5%) | 0.729 |

**Table 05 : Impact of treatments instituted at the first episode of bronchiolitis on different elements study. (*not significant)**

| **Factors** / **Treatements** | **Length of hospitalization** | **Récurrences** | **Diagnostic d'asthme** |
|---|---|---|---|
| **Serum nebulization** | * | **p<0.001** | p=0.003 |
| **Serum nebulization + asthalin** | **p<0.001** | **p<0.001** | p=0.001 |
| **Inhaled bronchodilators** | * | **p<0.001** | **p<0.001** |
| **Oral corticosteroids** | p=0.016 | p=0.016 | p=0.05 |
| **Antibiotic therapy** | **p<0.001** | p=0.027 | * |
| **Nasopharyngeal disinfection** | * | * | * |
| **Respiratory physiotherapy** | * | * | p=0.034 |

## Discussion

Bronchiolitis, a significant respiratory condition affecting infants, remains a pressing public health challenge globally, especially in under-researched regions like Algeria and Africa. Our study marks an important contribution in this field, offering a thorough examination of bronchiolitis epidemiology, risk factors, and hospitalization trends in these areas. It also explores factors influencing hospital stay duration, age of infection onset, and the potential development of asthma post-bronchiolitis. This research not only enriches the global understanding of bronchiolitis but also guides future healthcare strategies in underrepresented regions.

Shahnaz et al. [18] note that about one-third of infants under one year develop symptomatic bronchiolitis, with 3% needing hospitalization. Identifying factors influencing infection severity is crucial. Brandt et al. [19]observed regional variations in epidemic onset. Outbreak frequency and duration differ worldwide [20], with climate playing a role. Epidemics often start in the rainy season and increase in colder months when respiratory viruses thrive [21,22]. In temperate climates, bronchiolitis peaks in winter [3,18,23-29]; our study confirms this with 87.9% of cases from November to March. In tropical regions, epidemic patterns vary [17,30-32]. The diagnosis month affects hospitalization length and age at first bronchiolitis consultation. Winter indoor stays may increase pathogen exposure, especially with older siblings present, facilitating viral transmission [22].

Infants born just before or during the early epidemic season face a higher risk of severe illness due to their age and immature immune systems.
Winter indoor stays may increase pathogen exposure, especially with older siblings present, facilitating viral transmission [22].
bronchiolitis onset age [42]. Esper et al. [43] reported a case of in utero VRS transmission causing fetal pain and neonatal respiratory distress, which our study corroborates. However, we found no direct link between fetal pain and hospitalization, though it did affect hospitalization duration.

Infants with bronchiolitis often have comorbidities like respiratory or cardiac issues, and are exposed to passive smoking. In our study, 19.5% of bronchiolitic infants had such pathologies, affecting hospitalization need, stay length, and age at first episode onset, consistent with other findings [44-46]. Passive smoking reduces lung function and raises serious infection risks in children [47], and prenatal smoking

Boys, found to be more prevalent in our study, might be more susceptible due to factors like sensitivity to aeroallergens [33], lung development differences, and genetics [3,34]. However, sex showed no significant impact on infection severity, hospitalization needs, recurrence, hospital stay length, age at first episode, or asthma diagnosis. While American guidelines define bronchiolitis in children under two [7], European guidelines limit it to those under one year. Our findings revealed 23.7% of bronchiolitis cases in infants over one year, with the oldest at 21 months and an average onset age of 8 months, slightly higher than other studies' 3-9 months range [17]. Our study aligns with another [14] in showing a 93.8% hospitalization rate among under-one-year-olds, underscoring young age as a key predictor for infection severity and hospitalization (p 0.001) [18,35]. This increased risk in early months could be linked to developing immune systems and the presence of neonatal regulator B lymphocytes in the respiratory tract, which are targeted by Respiratory Syncytial Virus (RSV) [36] - the primary bronchiolitis cause globally [27] and in Algeria [4].

Studies show that low birth weight (less than 2500g) may raise the risk of bronchiolitis and its severity [35,37,38]. However, in our study, 14.6% of infants with low birth weight didn't show increased symptoms or hospitalization risk. The impact of prematurity on bronchiolitis is debated (39,40). Our study observed that 18.6% of bronchiolitis cases were in premature infants, with 12% hospitalized.

Prematurity influenced bronchiolitis recurrence and age at first episode but not hospitalization duration, aligning with Sala et al. [41]. This might be due to premature infants' underdeveloped lungs and immune systems. Additionally, respiratory distress in newborns was identified as a risk factor for hospitalization, affecting hospital stay length and

is linked to bronchiolitis [48], though our study found no significant impact, possibly due to lower smoking rates among women in Algeria.

Factors like caesarean birth and multiple pregnancies also influence bronchiolitis severity and hospitalization. Multiple pregnancies increase infection risk [49], and caesarean births are linked to more severe cases [50,51]. Hypotheses include the 'hygienist hypothesis', suggesting caesarean births alter intestinal flora and immune responses [52,53], and differences in immune markers like IGE, leukocytes, neutrophils, and serum cortisol in caesarean-born babies [54]. Our study, however,

found no link between caesarean conditions (emergency or planned) and severe bronchiolitis.

Research indicates that breastfeeding plays a key role in preventing bronchiolitis and lessening its severity [55], with breastfed infants having stronger immune systems than non-breastfed ones [56]. Our study aligns with these findings, showing that not breastfeeding affects the age of first bronchiolitis episode, as well as hospitalization duration and need. Similar results were observed in a Korean study [57].

For infants born in summer, early exposure to air conditioning is linked to bronchiolitis onset and an increased risk of developing infant asthma. This differs from Nenna et al. [22], who couldn't analyze data based on birth months. The lack of ventilation from air conditioning might contribute to this, as Leung et al. [58] suggest. Additionally, infants with smoking parents and constant air conditioning at home face higher exposure to air pollutants, raising their bronchiolitis risk.

Bozaykut et al. [59] suggest that factors like gestational age, atopy presence, and age at first bronchiolitis episode can heighten the risk of recurrent infections. Contrarily, our study indicates that the severity of the initial episode may predispose to relapses. This discrepancy could be due to various strains causing repeated infections and the fact that acute bronchiolitis can temporarily alter the respiratory tract's anatomy and histology, increasing susceptibility to new infections [60]. Studies show that up to 80% of infants hospitalized for their first episode develop bronchial hyperactivity, leading to recurrences and potentially "infant asthma" [61,62].

Our findings align closely with Atay et al. [25], who reported that 23% of infants had no relapses, 45% had fewer than three, and 31% had three or more. We observed 21% without relapses, 38.1% with fewer than three, and 41% with three or more.

Our aim was to identify the symptoms displayed by infants during their initial bronchiolitis episode, which would help in recognizing severe cases and determining the need for hospitalization as well as the likelihood of recurrence and asthma development. A scoring system that showed satisfactory diagnostic accuracy was created by incorporating the risk factors for hospital admission, which were identified through a previous study [63].

In the absence of standardized hospitalization criteria in Algerian hospitals, certain symptoms are commonly deemed necessary for hospitalization. These include fever over 39 degrees Celsius, breathing difficulties, low oxygen saturation, rapid breathing, flapping nose wings, abdominal breathing, refusal to feed, and dehydration.

Notably, a fever above 39 degrees Celsius was the primary reason for consultation. Midulla et al. [64] emphasize the importance of dehydration in bronchiolitis management. In our research, 17.2% of bronchiolitic infants experienced dehydration, impacting hospitalization need and duration. While oxygen saturation wasn't systematically measured in our study, it was identified as a hospitalization predictor.
Our study discovered that refusal to eat and bacterial superinfection were key predictors for hospitalization in bronchiolitis cases, affecting the duration, similar to Ramos-Fernandez et al. [13]. Additional predictors included difficulty breathing, rapid breathing, abdominal breathing, and hospitalization during the first episode, which also indicated a higher risk of recurrence. Following a second bronchiolitis episode, 69.7% of cases were diagnosed with infant asthma.

The connection between bronchiolitis and asthma remains unclear, with no definitive cause-effect relationship established [65]. It's uncertain whether bronchiolitis causes lung damage leading to wheezing later on, or if certain infants have a predisposition to wheezing due to innate immune or airway issues [3]. Our study found no link between asthma development and factors like age at first bronchiolitis episode, prematurity, fetal distress, neonatal respiratory distress, or respiratory/cardiac pathology. This indicates that airway dysfunction isn't a predictive factor for asthma. Instead, the severity of the first bronchiolitis episode emerged as a significant factor, hinting at a role for dysfunctional immune response in asthma development. This suggests an immunological predisposition may be involved.

Our research identified a significant link between gastroesophageal reflux and future asthma diagnosis, a connection also noted in previous studies [66]. Dupont et al. [67] suggest that while reflux might not cause asthma, it can exacerbate it. The study also focused on factors influencing hospitalization decisions and treatments during the first bronchiolitis episode, noting that treatments primarily ease symptoms without being curative [64].

For bronchiolitis diagnosis and treatment, history and physical examination are key, as recommended by the American Academy of Pediatrics [68]. Routine chest radiography is not advised. In our study, 68.8%

of 148 infants underwent a chest X-ray, influencing hospitalization needs and duration (p 0.001). This rate is comparable to Seck et al. [17] at 65.5%, higher than Arnoux et al. [69] at 59.3%, but lower than Rosolen et al. [70] at 77%.

The management of bronchiolitis remains a debated topic. While the importance of rhinopharyngeal deobstruction for clearing false nasal blockage is widely accepted [17], there's no consensus on the effectiveness of bronchodilators, corticosteroids, antibiotics, and respiratory physiotherapy [71].
Our study shows that Algerian pediatricians often prescribe treatments not recommended by current research. Notably, rhinopharyngeal deobstruction, a non-medicinal therapy, was used nearly as frequently as saline serum nebulization, with rates of 85.1% and 82.2% respectively. Recommended by Western University Hospitals (HUGO) [71], this method aids in keeping upper airways clear, preventing superinfection, maintaining ventilation, reducing congestion, and is usually performed before meals. Although not all infants responded to this treatment, its usage rate in our study was much higher than Seck et al. [17], who reported a rate of 47.9%.

In Algeria, nebulized saline serum is commonly used by pediatricians for bronchiolitis, supported by literature for its benefits in reducing inflammation and clearing mucus [21]. Often, this treatment doesn't require hospitalization, with 93.8% of infants treated outside hospitals. A 2017 Cochrane review suggested it might reduce hospital stays and improve bronchiolitis scores [72], but our study found no significant impact.

Additionally, a common prescription is saline serum nebulization combined with asthalin (salbutamol), a bronchodilator, used by 91.7% of hospitalized and 59.5% of non-hospitalized infants in our study. However, the efficacy of bronchodilators in bronchiolitis, especially for patients without a wheezing history, is debated [73,74].

Our study also showed widespread use of corticosteroids (72.1% of infants) and antibiotics (100% of hospitalized and 71.4% of outpatient infants), despite limited evidence of their efficacy in bronchiolitis and contrary to European [71] and American [68] guidelines. The high antibiotic use is likely due to factors like fever and chest X-ray results suggesting secondary infections [21], yet only 39% of infants on antibiotics had a secondary bacterial infection from bronchiolitis.

The study's retrospective nature posed challenges in data collection, especially in distributing questionnaires to parents.

## Conclusion

Our research has uncovered a multitude of factors that can influence the duration of hospitalization, the onset of bronchiolitis, and the likelihood of recurrence and asthma in Algerian infants. These factors are varied, but we found that certain ones are shared amongst hospitalization cases, such as respiratory distress in the neonatal period, respiratory or cardiac pathology, and lack of breastfeeding. Additionally, we observed that the occurrence of recurrence and diagnosis of asthma were linked to hospitalization at the first episode of bronchiolitis and the presence of atopy. Symptoms like difficulty breathing, rapid breathing, and abdominal breathing during the first episode of bronchiolitis can also be predictors of recurrence and asthma.

By gaining a deeper understanding of these factors, we can more effectively prevent, diagnose, and treat bronchiolitis. The ability to identify cases with a predisposition to worsening, recurrence, and asthma development can have a significant impact on the lives of affected infants and their families. Developing a diagnostic tool, such as a scoring system, can further aid in identifying high-risk cases.

In order to better understand the predictive model, we recommend a larger, prospective study to be conducted. By implementing new strategies and therapies, we can prevent and treat infants at high risk of bronchiolitis. Our research is an important step towards achieving these goals and improving the lives of infants and their families affected by bronchiolitis.

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