

Increased Asthma Risk and Impaired Quality of Life After Bronchiolitis or Pneumonia in Infancy

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Summary. Background: Recent studies have revealed that adulthood asthma has its origin in early childhood. Aim: The aim of the present study was to evaluate the prevalence of asthma and respiratory health-related quality of life in adults 30 years after hospitalization for bronchiolitis or pneumonia in infancy. Methods: Patients who were hospitalized for bronchiolitis or pneumonia at age under 24 months in 1981–1982 have been followed in repeated visits. In 2010, 48 of the 83 former patients with bronchiolitis (57.8%), 22 of the 44 former patients with pneumonia (50.0%), and 138 matched controls participated in the clinical study at the age of 28–31 years. The participants completed a structured questionnaire on respiratory symptoms, the Saint George's Respiratory Questionnaire (SGRQ), and underwent 2-week peak expiratory flow (PEF) monitoring. Asthma was defined as doctor-diagnosed and self-reported asthma based on doctor-prescribed medication for asthma, the presence of asthma-presumptive symptoms, and the results of home PEF monitoring. Results: Both doctor-diagnosed asthma (31.3% vs. 10.9% adjusted $P = 0.002$) and self-reported asthma (35.4% vs. 14.5% 0.003), as well as repeated on-demand use of bronchodilators (35.4% vs. 14.5% 0.002), and regular use of inhaled corticosteroids (20.8% vs. 8.7% 0.023) were more common in former bronchiolitis patients than in controls. Former bronchiolitis and pneumonia patients had higher total SGRQ scores than controls. The median scores were 5.4 (IQR_{25–75} 0.0–14.7, $P < 0.001$) in bronchiolitis group, 4.9 (1.3–14.8, 0.012) in pneumonia group compared to controls 1.5 (0.0–6.0). Conclusion: Hospitalization for bronchiolitis in infancy is associated with an increased risk of asthma, and an increased use of asthma medication in adulthood at the age of 28–31 years. Impaired respiratory health-related quality of life in adulthood as measured by the SGRQ is present after bronchiolitis and pneumonia in infancy. **Pediatr Pulmonol.** © 2013 Wiley Periodicals, Inc.

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INTRODUCTION

The link between early childhood respiratory infections and later respiratory morbidity has been an issue of interest for recent decades, and there is an association between bronchiolitis or pneumonia in early childhood and later respiratory problems even in adulthood.^{1,2} The results of the Tucson birth cohort study documented that

adulthood asthma, including asthma with early adulthood onset, has its origin in early childhood.³ In addition, a history of lower respiratory infection in infancy seems to associate with chronic pulmonary obstructive disease (COPD) in later life.^{1,2,4}

Three prospective post-bronchiolitis studies, started in the 1980's, have continued beyond puberty, and the knowledge on adulthood outcomes accumulating.^{5–7} In

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these studies, bronchiolitis in infancy has been associated with increased risk of asthma through childhood.^{8–12} Thus far, the results have been published up to the age of 17–20 years, and the prevalence of asthma has varied between 30% and 43%.^{5–7} In addition, these post-bronchiolitis studies have revealed reduced airway function in adulthood.^{5,13,14} Thus, the previous thought that children with early-life wheezing grow out of that tendency, seems to be wrong.

We have prospectively followed a group of children who were hospitalized in 1981–1982 for bronchiolitis or pneumonia at less than 24 months of age. The prevalence of asthma was 15% at 8–10 years of age in the former bronchiolitis and 7% in the former pneumonia patients.⁹ At 18–20 years of age, the prevalence of asthma had increased to 30% (doctor-diagnosed) and 41% (self-reported) in the former bronchiolitis and to 15% and 21%, respectively, in the former pneumonia patients.⁵ In the present study, we continued the prospective follow-up of the cohort at 28–31 years of age.

The aim of the present study was to evaluate the prevalence of asthma and occurrence of respiratory symptoms in the prospectively followed post-bronchiolitis cohort, when the participants were 28–31 years old. In addition, respiratory health-related quality of life was studied by using the Saint George's Respiratory Questionnaire (SGRQ).

MATERIALS AND METHODS

Subjects

During a 12 months surveillance period in 1981–1982, 83 infants less than 24 months of age were hospitalized for bronchiolitis and 44 infants for pneumonia, respectively, in the Department of Pediatrics at Kuopio University Hospital, Finland.¹⁵ Patients included in the bronchiolitis group presented with wheezing or prolonged expiration, and respiratory distress during respiratory infection, and all patients included in the pneumonia group presented with radiologically confirmed alveolar or interstitial infiltration without wheezing.¹⁵ Viral etiology was studied with antigen and antibody assays, as previously described, and RSV was positive in 51/127 (40%) cases.¹⁵ The study subjects have been followed prospectively with repeated study visits until young adulthood.^{5,8,9}

Study Design

In 2010 at the age of 28–31 years, a written questionnaire and an invitation to the clinical study was sent to 122 of the 127 original study subjects with current address available. Sixty (72.2%) of the 83 subjects from the bronchiolitis and 24 (54.5%) of the 44 subjects from the pneumonia group returned the questionnaire, and 48 (57.8%) and 22 (50.0%), respectively, attended the clinical study.

For this study, 488 population-based control subjects who were born in the primary area of Kuopio University Hospital and were matched for sex and birth month were identified at a 4:1 ratio for the 122 cases from the Population Register Centre in Finland. Four control subjects, who had been treated in the hospital for lower airway infection at less than 24 months of age, were excluded. In all, 166 (34.0%) control subjects returned the completed questionnaire, and 138 (28.3%) attended the clinical study.

Questionnaire Data

The structured questionnaire included questions on asthma-presumptive symptoms, like wheezing, repeated night cough, or prolonged day cough apart from infection during the preceding 12 months. In addition, the questionnaire also included inquiries about the presence of previous doctor-diagnosed asthma and the regular use of inhaled corticosteroids (ICS) or on-demand use of bronchodilators during the preceding 12 months. The occurrence of presumptively allergic nasal, eye, and skin symptoms were charted for the preceding 12 months.

Current and previous smoking status was determined. Study subjects were considered to be current daily smokers if they smoked at the time of the study and had smoked at least one cigarette per day for 1 year. Pack-years were calculated for current and earlier smokers if they had smoked daily at least for 1 year, using the following equation: the number of cigarettes smoked daily multiplied by smoking years and divided by 20.

The participants completed the St. George's Respiratory Questionnaire (SGRQ), a widely used self-administered questionnaire designed to measure health impairment and respiratory health-related quality of life in adults with asthma or COPD.^{16–18} Three different component scores can be calculated from the SGRQ: the symptom component (the level of respiratory symptoms based on their frequency and severity), the activity component (the activities that cause breathlessness or the activities in which participation is limited due to breathlessness), and the impact component (social or psychological disturbances resulting from airway disease). The total score summarizes the influence of the disease on the overall respiratory health status of the participant. The scores are expressed as a percentage of complete impairment thus, the score 100 means the worst possible and the score 0 the best possible respiratory health status.^{16,17}

Clinical Study at the Age of 28–31 Years

The clinical study consisted of physical examination, skin prick tests (SPT) for common inhaled allergens, and 2-week home peak expiratory flow (PEF) monitoring.

PEF was measured using a Mini Wright PEF meter (Clement-Clarke International LTD, Harlow, Essex, UK) three times every morning and every evening for 2 weeks. The best of the three values was included in the analyses, if the difference between the two best values was less than 40 L/min.¹⁹ Daily variability over 20% between the PEF morning and evening values for two or more days was considered as abnormal.^{5,20} During the second week, PEF was measured before and 15 min after the administration of inhaled bronchodilator in the morning (Salbutamol 0.4 mg, Buventol easyhaler 0.1 mg/dos, Orion Pharma, Espoo, Finland).¹⁹ After bronchodilator inhalation, PEF improvement of 15% or more at least twice was considered significant. PEF monitoring was considered appropriately completed, if at least seven acceptable morning and evening measurements and 3 days with acceptable pre- and post-treatment measurements were available. Of the 208 study subjects, 180 (86.5%) returned the PEF monitoring results, and 175 (84.1%) were considered as appropriately completed.

Two of the authors (KB and HO) performed SPTs on the forearms of 206 study subjects. ALK Soluprick extracts were used (ALK, Copenhagen, Denmark), including the following allergens: birch, common alder, timothy grass, mugwort, dog, cat, horse, cow, dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*, and *Acarus siro*) and one mold (*Cladosporium herbarum*). A weal with a diameter of at least 3 mm and half of that with the positive control (histamine dihydrochloride) was considered as positive.

Allergic rhinitis and conjunctivitis were defined if there were seasonal symptoms or symptoms triggered by animal contacts during the preceding 12 months. Atopic eczema was defined as itchy eczema at typical locations requiring treatment during the preceding 12 months. Clinical atopy was defined by the presence of allergic rhinitis, allergic conjunctivitis or atopic eczema, combined with atopic sensitization (one or more positive SPT results).

Definition of Asthma

Bronchial asthma was defined by two different ways, reflecting the certainty of the diagnosis. For doctor-diagnosed asthma, an on-going regular maintenance medication with ICSs and a previously settled asthma diagnosis were required. In addition, study subjects who reported asthma-presumptive symptoms and/or repeated use of on-demand bronchodilators during the preceding 12 months, and in addition had a pathological result in the home PEF monitoring, were regarded to have doctor-diagnosed asthma.

Repeated wheezing episodes, chronic night cough, and prolonged cough for more than 4 weeks apart from infection were regarded as asthma-presumptive symptoms.

For self-reported asthma, previously diagnosed asthma combined with asthma-presumptive symptoms or with repeated use of on-demand bronchodilators during the preceding 12 months was required. Cases with doctor-diagnosed asthma were included.

Statistics

The data was analyzed using SPSS 19.0 software (SPSS Inc., Chicago, IL). Chi-square and Fisher's exact tests were used in the analyses of the categorized data. The Mann-Whitney *U*-test was used in the analysis of the continuous SGRQ and pack-years data. Logistic regression was used in the multivariate analyses, and the results are presented as adjusted *P*-values or adjusted odds ratios (OR) and their 95% confidence intervals (95% CI). Multivariate analyses were adjusted for age, sex, current daily smoking (yes or no) and clinical atopy (yes or no) when appropriate.

Ethics

The study was approved by the Ethics Committee of the Pohjois-Savo Health Care District. Written consent was obtained from all study subjects.

RESULTS

Baseline Data

There were 30 (62.5%) males in the bronchiolitis, 8 (36.4%) males in the pneumonia, and 75 (54.3%) males in the control group. The mean age (SD) was 29.5 years (0.72) in the bronchiolitis, 29.4 years (0.58) in the pneumonia, and 29.6 years (0.75) in the control group, respectively.

Fourteen (29.2%) former bronchiolitis patients (*P* = 0.007 vs. controls), 10 (45.5%) former pneumonia patients (*P* = 0.000 vs. controls), and 17 (12.3%) control subjects were current daily smokers. Data on smoked pack-years were available in all 48 bronchiolitis patients, in 20/22 pneumonia patients, and in 135/138 controls. The median of the smoked pack-years was 0.1 (Range 0.0–25.0, *P* = 0.036) in the bronchiolitis group and 0.5 (0.0–22.5, 0.064) in the pneumonia group, compared to controls 0.0 (0.0–25.0).

Adult Respiratory and Allergic Symptoms in Relation to Bronchiolitis or Pneumonia in Infancy

About one-third of the study subjects reported wheezing during the preceding 12 months, and no significant differences were observed between former bronchiolitis patients, former pneumonia patients and controls (Table 1). The use of on-demand bronchodilators and regular ICSs were more common in former bronchiolitis patients than in controls (Table 1). Allergic

TABLE 1—Asthma Symptoms, Asthma Medication and Allergy at the Age of 28–31 Years in the Study Subjects Hospitalized for Bronchiolitis or Pneumonia at Less Than 24 Months of Age, Compared With Population Controls

Asthma symptoms and medication, allergy and atopy	Bronchiolitis in infancy (n = 48)	<i>P</i> -value	Pneumonia in infancy (n = 22)	<i>P</i> -value	Population controls (n = 138)
Asthma symptoms					
Chronic night cough ³	5 (10.4%)	0.311 ¹	5 (22.7%)	0.191 ¹	6 (4.3%)
Prolonged cough ³	5 (10.4%)	0.861 ¹	5 (22.7%)	0.152 ¹	12 (8.7%)
Repeated wheezing ³	16 (33.3%)	0.487 ¹	7 (31.8%)	0.898 ¹	37 (26.8%)
Asthma medication					
Bronchodilating drugs ⁴	17 (35.4%)	0.002 ¹	2 (9.1%)	0.546 ¹	20 (14.5%)
Inhaled corticosteroids ⁴	10 (20.8%)	0.023 ¹	1 (4.5%)	0.539 ¹	12 (8.7%)
Allergies					
Allergic rhinoconjunctivitis ⁵	34/47 (72.3%)	0.059 ²	14 (63.6%)	0.611 ²	82/136 (60.3%)
Atopic eczema ⁵	14 (29.8%)	0.074 ²	4 (18.2%)	0.990 ²	24/137 (17.5%)
Atopic sensitization ⁶	30 (62.5%)	0.558 ²	12 (54.5%)	0.690 ²	79/136 (58.1%)
Clinical atopy ⁶	23 (47.9%)	0.724 ²	10 (45.5%)	0.674 ²	66/136 (48.5%)

Paired comparisons versus population controls; *P* values are presented adjusted¹ for age, sex, clinical atopy and current daily smoking, or adjusted² for age, sex, and current daily smoking only (for definitions, see the text).

For definitions of asthma symptoms³, asthma medication,⁴ allergy symptoms,⁵ or sensitization,⁶ see the text.

diseases and atopic sensitizations were common in all three study groups. There were no significant differences in clinical atopy (allergic disease and atopic sensitization) between the groups (Table 1).

Results of Home PEF Monitoring

Former bronchiolitis patients had diagnostic responses to bronchodilators in the 2-week home PEF monitoring significantly more often than controls (Table 2). There were no significant differences in the daily variability regarded as diagnostic for asthma (Table 2).

Adulthood Asthma in Relation to Bronchiolitis or Pneumonia in Infancy

Doctor-diagnosed asthma was present in 32 study subjects and among them, 23 (71.8%) were on regular maintenance medication for asthma, 29 (90.6%) had asthma-presumptive symptoms, 20 (62.5%) needed on-

demand bronchodilators, and 14 (43.8%) had pathological results in the home PEF monitoring. Self-reported asthma was present in an additional 10 cases all of them reported asthma-presumptive symptoms, and five reported repeated on-demand bronchodilator use.

As seen in Table 3, both doctor-diagnosed asthma (31.3% vs. 10.9%) and self-reported asthma (35.4% vs. 14.5%) were significantly more common in the former bronchiolitis patients than in controls. Asthma figures by both definitions were similar in the former pneumonia patients and in the controls (Table 3).

Saint George's Respiratory Questionnaire

Both former bronchiolitis patients and former pneumonia patients had significantly higher total scores in the SGRQ than the controls (Table 4). The former bronchiolitis group differed from the control group in all parts of the questionnaire, whereas the former pneumonia group differed in terms of symptom scores (Table 4).

TABLE 2—Results of 2-Week Home Peak Expiratory Flow (PEF) Monitoring in the Three Study Groups

Home PEF monitoring results	Bronchiolitis in infancy (n = 37)	<i>P</i> -value ¹	Pneumonia in infancy (n = 18)	<i>P</i> -value ¹	Population controls (n = 120)
Pathological PEF monitoring ²	8 (21.6%)	0.058	2 (11.1%)	0.801	10 (8.3%)
Diagnostic daily variability ³	3 (8.1%)	0.301	1 (5.6%)	0.990	3 (2.5%)
Diagnostic responses to bronchodilators ⁴	7 (18.9%)	0.029	2 (11.1%)	0.479	8 (6.7%)

¹Paired comparisons versus population controls; *P* values are presented as adjusted for age, sex, clinical atopy, and current daily smoking (for definitions, see the text).

²Diagnostic daily variability and/or diagnostic responses to bronchodilators.

³Over 20% variation between morning and evening values for two or more days.

⁴15% or greater improvement after bronchodilator inhalation on two or more mornings.

TABLE 3—Asthma by Two Definitions at the Age of 28–31 Years in the Study Subjects Hospitalized for Bronchiolitis or Pneumonia at Less Than 24 Months of Age, Compared With Population Controls

Current asthma diagnosis	Bronchiolitis in infancy (n = 48)	<i>P</i> -value ¹	Pneumonia in infancy (n = 22)	<i>P</i> -value ¹	Population controls (n = 138)
Doctor-diagnosed asthma ²	15 (31.3%)	0.002	2 (9.1%)	0.532	15 (10.9%)
Self-reported asthma ²	17 (35.4%)	0.003	5 (22.7%)	0.760	20 (14.5%)

¹Paired comparisons versus population controls; *P* values are presented as adjusted for age, sex, clinical atopy, and current daily smoking (for definitions, see the text).

²For definitions of doctor-diagnosed and self-reported asthma, see the text. Subjects with doctor-diagnosed asthma were included in the group of self-reported asthma.

TABLE 4—The Scores Calculated From the St. George's Respiratory Questionnaire in the Three Study Groups

SGRQ components	Bronchiolitis in infancy (n = 48), Median, range, IQ ¹ 25–75	<i>P</i> -value ²	Pneumonia in infancy (n = 22), Median, range, IQ ¹ 25–75	<i>P</i> -value ²	Population Controls (n = 132), Median, Range, IQ ¹ 25–75
Symptom score	9.1 0.0–81.6 0.0–26.3	0.044	18.4 0.0–76.1 5.1–29.9	0.005	5.0 0.0–73.9 0.0–16.3
Activity score	5.7 0.0–79.7 0.0–12.1	0.002	0.0 0.0–30.9 0.0–13.4	0.146	0.0 0.0–48.8 0.0–6.0
Impact score	2.4 0.0–25.5 0.0–9.5	<0.001	0.0 0.0–38.8 0.0–8.4	0.475	0.0 0.0–20.7 0.0–2.4
Total score	5.4 0.0–45.1 0.0–14.7	<0.001	4.9 0.0–42.6 1.3–14.8	0.012	1.5 0.0–37.1 0.0–6.0

¹Interquartile range.

²Paired comparisons versus controls non-adjusted *P* values.

Final Logistic Regression

The study subjects were divided into two groups on the basis of SGRQ scores (lower vs. higher than the median of the controls). Doctor-diagnosed asthma, self-reported asthma, and the categorized SGRQ total score were included as outcomes in the final logistic regression model. The analyses were adjusted for age, sex, current smoking (yes or no), and clinical atopy (yes or no). On average, the former bronchiolitis patients had a 3.8-fold risk for doctor-diagnosed asthma and a 3.4-fold risk for

self-reported asthma compared to controls (Table 5). The risk of having SGRQ total scores above the median of the controls was significantly increased in both bronchiolitis and pneumonia groups (Table 5). When adjusted for smoked pack-years, instead of current smoking, the results did not substantially change (data not shown).

DISCUSSION

There are two main results in the present prospective, controlled, 30-year follow-up study of individuals who

TABLE 5—Final Logistic Regression for Doctor-Diagnosed and Self-Reported Asthma and St. George's Respiratory Questionnaire Points Below the Median of Controls Group, Presented in the Three Study Groups

	Bronchiolitis in infancy (n = 48)	OR (95%CI) ¹	Pneumonia in infancy (n = 22)	OR (95%CI) ¹	Population Controls (n = 138)
Doctor-diagnosed asthma	15 (31.3%)	3.8 (1.6–8.9)	2 (9.1%)	0.8 (0.1–4.0)	15 (10.9%)
Self-reported asthma	17 (35.4%)	3.4 (1.5–7.6)	5 (22.7%)	1.6 (0.5–5.6)	20 (14.5%)
SGRQ total scores above the median of controls	35 (72.9%)	2.6 (1.5–5.6)	17 (77.3%)	3.7 (1.2–11.2)	68/132 (51.5%)

¹IOR, odds ratio; 95%CI, 95% confidence interval; OR is presented as paired comparisons versus population controls as adjusted for age, sex, clinical atopy, and current daily smoking (for definitions, see the text).

were hospitalized for bronchiolitis or pneumonia in infancy. First, after hospitalization for bronchiolitis in infancy, an increased asthma risk could be demonstrated at least until 28–31 years of age. Asthma was present in one-third of the former bronchiolitis patients, but at similar levels (around 10%) in former pneumonia patients and population controls. Second, the differences in terms of self-reported respiratory symptoms were only minor, but the SGRQ scores measuring respiratory health impairment were significantly higher in former bronchiolitis and pneumonia patients than in controls.

The prevalence of asthma in the former bronchiolitis patients (31–35%) was rather similar to the prevalence of asthma 10 years earlier in the same cohort (30–41%).⁵ In addition, the asthma prevalence was in line with the figures from two Swedish post-bronchiolitis studies. More specifically, 43% of the study subjects hospitalized for bronchiolitis at less than 24 months, and 33% of those hospitalized for RSV bronchiolitis at less than 12 months of age had asthma at 17–20 years of age.^{6,7} Although the link between early-life respiratory infections and subsequent long-term respiratory morbidity like asthma and COPD in adulthood is well documented,^{1,4,21–23} the exact mechanisms are unknown. In birth-cohort studies, reduced lung function documented before any respiratory infection has been a risk factor for both lower respiratory infections and wheezing in childhood^{24–29} suggesting, that lower respiratory infections in infancy are merely a sign of an underlying susceptibility. The risk factors for reduced lung function at birth and subsequent wheezing have included maternal smoking during pregnancy,^{26,27,30–32} family history of asthma,^{27,31} and atopy.²⁹ Thus, pre-existing lung function abnormality in infancy, together with altered regulation of airway tone and altered immune responses to viral infections, predisposes infants to lower respiratory infections, which may further damage the airways leading to an increased respiratory morbidity even in adulthood,^{33,34} as seen in the present study at 28–31 years of age.

Wheezing symptoms, prolonged day cough apart from infection, and chronic night cough are widely accepted as asthma-presumptive symptoms.³⁵ In the present study, the former bronchiolitis patients did not report these symptoms substantially more often than controls. That is quite understandable, since 21% of the former bronchiolitis patients were on continuous ICS maintenance medication for asthma. Although the former bronchiolitis and pneumonia patients did not report symptoms substantially more often than the controls, their SGRQ scores revealed limited activities and a harmful impact on their social and emotional lives. In a recent population-based asthma cohort study, all three SGRQ component scores correlated with asthma severity and exacerbation history, and all but symptom scores correlated with lung function.¹⁸ In therapeutic trials,

the difference of 4 points or more in the SGRQ total score has been considered clinically significant.^{16,36} The scores of the former bronchiolitis differed from that of the controls by 3.9 points and pneumonia patients by 3.4 points. This means that the SGRQ findings of the present study at 28–31 years of age after bronchiolitis or pneumonia in infancy probably are clinically significant. The results of the categorized adjusted analyses suggest an independently significant role of lower airway infection in infancy.

Surprisingly, the former bronchiolitis and pneumonia patients smoked more often and more heavily than the population controls. Indeed, the control subjects smoked at a rate that was very similar to the 19% smoking rate in the Finnish population of young adults.³⁷ The harmful effects of smoking on respiratory symptoms and lung function abnormalities are well documented.^{32,38,39} In previous studies, SGRQ scores have been higher in smokers than in non-smokers.^{40,41} However, the number of smoked pack-years was low since our study subjects were young, less than 40-years-old adults. In smokers, a greater than age-related decline in lung function will occur from the fourth decade of life onwards.³² In line, after adjusting all analyses with both current smoking and ever smoked pack-years, we found no significant effect on the prevalence of asthma or on SGRQ scores.

The strengths of the present study are the long follow-up time, a careful collection of clinical data during hospitalization in early childhood, and a well conducted clinical study at the age of 28–31 years. In 1981–1982, the university hospital provided as an only hospital inpatient treatment for a certain child population, which means that the cohort was population-based. The clinical study included a structured questionnaire, the widely used and validated SGRQ, home PEF monitoring, and skin testing. The study was appropriately controlled since age- and sex-matched population controls born in the same area were examined by an identical way as cases. The participants, former bronchiolitis patients, former pneumonia patients, and population controls, now live in different parts of Finland. Therefore, to obtain an acceptable participation rate, the researchers had to travel to 12 different cities around the country to examine the study subjects.

The main shortcoming of the study was the small number of subjects with asthma in the groups of former bronchiolitis and pneumonia patients, despite the fact that participation rate in these groups was fairly good for such a long follow-up. We were able to contact 84 (68.9%) of 122 study subjects with current address available. However, the participation rate in the control group was rather low. It is well-known that symptomatic individuals usually participate in studies more actively than non-symptomatic ones. In line, the asthma prevalence in the controls was 10–15%, which is higher than the 5% asthma

prevalence in non-selected Finnish young adults of the same age.⁴² Thus, the results may be biased to the direction of under-estimation rather than over-estimation of the differences between the bronchiolitis or pneumonia cases and the controls. This indicates that the observed differences evidently are quite strong. Additionally, our results represent the adulthood outcomes of severe early-life bronchiolitis or pneumonia treated in hospital, not the outcomes of mild-to-moderate infections treated at home.

In conclusion, the study was able to confirm the high prevalence of asthma and the substantial need for asthma medication even at 28–31 years of age in subjects who were hospitalized for bronchiolitis at less than 24 months of age. In addition, hospitalization for bronchiolitis or pneumonia in infancy is associated with an impaired respiratory health-related quality of life in 30-year-old adults.

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