

ORIGINAL ARTICLE

Relationship between rhinitis and nocturnal cough in school children

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Abstract

Background: There is a complex relationship between rhinitis, asthma, and nocturnal cough.

Methods: To evaluate whether rhinitis is an important risk factor for nocturnal cough and whether this effect is independent of asthma, we analyzed data collected using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire in a population-based nationwide survey. A child who had experienced a dry cough at night in the past 12 months in the absence of a cold was defined as having nocturnal cough.

Results: After excluding 11,475 records with incomplete data, data from 136,506 children were analyzed. Nocturnal cough was significantly more prevalent in children with current rhinitis compared with children without rhinitis. The association between rhinitis and nocturnal cough was significant in children who had current asthma (adjusted OR [95% CI]: 2.26 [2.00–2.56] in children aged 6–7 yr, 1.90 [1.58–2.30] in those aged 13–14 yr, and 1.86 [1.60–2.19] in those aged 16–17 yr), and this association was even higher among children who had no asthma (adjusted OR [95% CI]: 3.65 [3.36–3.97] in children aged 6–7 yr, 3.05 [2.79–3.32] in those aged 13–14 yr, and 2.69 [2.51–2.88] in those aged 16–17 yr).

Conclusions: There was a close association between rhinitis and nocturnal cough in young children through adolescents, and this effect was independent of asthma. Upper airways should be examined in children with nocturnal cough.

Cough is a common health complaint among children, and most cases are caused by airway tract infections. Among the various types of cough, nocturnal cough is a troublesome condition for children and their caregivers because it causes sleep disturbance. The prevalence rates of nocturnal cough not associated with colds vary geographically. The reported rates included 27.3% in inner city school children aged 5–18 yr in the United States (1); 27.5–42.5% in children aged 6–14 yr in Mozambique (2); and 11.4–13.2% in children aged 6–17 yr in Japan (3). A 5-yr follow-up study performed in Korea showed that the prevalence rates of nocturnal cough not associated with colds in children aged 12–15 yr increased from 3.9% to 7.1% over the 5 yr, in parallel with an increase in the frequency of asthma (4).

In addition to asthma, nocturnal cough can potentially be caused by several factors, such as rhinitis, sinusitis, and gastroesophageal reflux (5). There are complex relationships among these factors. For instance, nocturnal cough can be accompanied by rhinitis and sinusitis and might only be a symptom of asthma. However, both nasal conditions show a strong association with asthma (6, 7). Owing to the complexity of these relationships, few studies of the association between rhinitis and nocturnal cough in children have been published. One birth cohort study that followed 1024 children showed that rhinitis was an independent risk factor for recurrent cough (8). However, there have been no large population-based surveys to evaluate the association between rhinitis and nocturnal cough in children.

The aims of this study were to evaluate whether rhinitis is an important risk factor for nocturnal cough and whether this effect is independent of asthma. To address these questions, we analyzed data collected from a population-based nationwide survey that was performed using the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire.

Methods

Study population

This study was a cross-sectional and questionnaire-based survey performed in 6- to 7-yr-old, 13- to 14-yr-old, and 16- to 17-yr-old school children in Japan and carried out from April through July 2008. To ensure nationwide representation, schools were randomly selected from all prefectures. The total number of children recruited was 179,218, corresponding to approximately 2% of the pediatric population, according to data from the National Institute of Population and Social Security Research. The study protocol was approved by the independent review board (IRB) of the National Center for Child Health and Development.

Questionnaire

The survey used a Japanese version of the ISAAC questionnaire (9), which was distributed through teachers of the participating schools. The questionnaires for children aged 6–7 yr were completed by their parents, and those for older children were answered by the children. In addition to questions related to symptoms, the questionnaire included questions regarding living area, gender, height, and weight.

Nocturnal cough was defined as a positive response to the question ‘In the past 12 months, have you (or your child) had a dry cough at night, apart from a cough associated with a cold or chest infection?’ Current asthma was defined as answering positively to the question ‘Have you (or your child) had wheezing or whistling in the chest in the past 12 months?’ Among children who did not have asthma in the preceding 12 months, a child who had a positive response to the question ‘Have you (or your child) ever had wheezing or whistling in the chest at any time in the past?’ was defined as having a past history of wheezing. Current rhinitis was defined as a positive answer to the question ‘In the past 12 months, have you (or your child) had a problem with sneezing, or a runny, or a blocked nose when you (or he/she) did not have a cold or the flu?’ Severity of rhinitis was graded according to the answer to the question ‘In the past 12 months, how much did this nose problem interfere with your (or your child’s) daily activity?’ where possible answers were ‘not at all’, ‘a little’, ‘a moderate amount’, or ‘a lot’.

Statistical analyses

The chi-square test was used to compare the differences in the prevalence of current symptoms between groups. Because nocturnal cough is one of the clinical manifestations of

asthma, the data were stratified into groups of children with or without current asthma. A logistic regression analysis was performed to estimate the effects of rhinitis and other confounding factors, such as living area, gender, obesity, and past history of wheezing, on nocturnal cough prevalence. Multivariate analysis was used to evaluate the association of degree of impairment of daily activities because of nasal symptoms with prevalence of nocturnal cough. A *p* value < 0.05 was considered to be statistically significant. All analyses were performed using the statistical package of SPSS for Windows version 17.0J (SPSS Inc., Chicago, IL, USA).

Results

Of the 179,218 children, 149,464 replied to the questionnaire (response rate, 92.1% in children aged 6–7 yr; 78.8% in children aged 13–14 yr; and 81.6% in children aged 16–17 yr). After excluding incomplete data, 139,506 questionnaires were analyzed (Fig. 1). Nocturnal cough was present in 11.8% to 13.3% of the children, and a few differences in its prevalence among the three age groups were observed (Table 1). Among children with nocturnal cough, approximately one-third had nocturnal cough and asthma in the previous 12 months, and the remaining children had nocturnal cough alone. There were no age-specific differences in the ratios of nocturnal cough alone to nocturnal cough with current asthma. In contrast, the prevalence rate of current rhinitis was lower in children aged 6–7 yr than in the older children. Furthermore, only in children aged 6–7 yr, there was a clear gender difference in the prevalence of current rhinitis, current asthma, and nocturnal cough accompanied by current asthma; boys had more symptoms than girls.

Because nocturnal cough is one of the clinical manifestations of asthma, the data were stratified into groups of children with or without current asthma. Among the children without current asthma, there was a significantly higher incidence of nocturnal cough in children with current rhinitis compared with children without current rhinitis (14.9% vs. 4.2% in children aged 6–7 yr, 12.8% vs. 4.3% in children aged 13–14 yr, and 13.6% vs. 5.3% in children aged 16–17 yr, *p* < 0.001 in all cases). Even among children with asthma, nocturnal cough was significantly more prevalent in the children with rhinitis than those with no rhinitis (50.1% vs. 30.8% in children aged 6–7 yr, 40.1% vs. 25.4% in children aged 13–14 yr, and 39.9% vs. 26.5% in children aged 16–17 yr, *p* < 0.001 in all cases). Factors such as living area, gender, obesity, and past history of wheezing could affect the prevalence of nocturnal cough (3). After adjusting for these factors, current rhinitis was still significantly associated with nocturnal cough in children with current asthma (adjusted OR [95% CI]: 2.26 [2.00–2.56] in children aged 6–7 yr, 1.90 [1.58–2.30] in those aged 13–14 yr, and 1.86 [1.60–2.19] in those aged 16–17 yr) (Table 2). Even among children who did not have current asthma, after adjusting for confounding factors including past history of wheezing, there was a clear association between current rhinitis and nocturnal cough. Specifically, the ORs associated with current rhinitis were

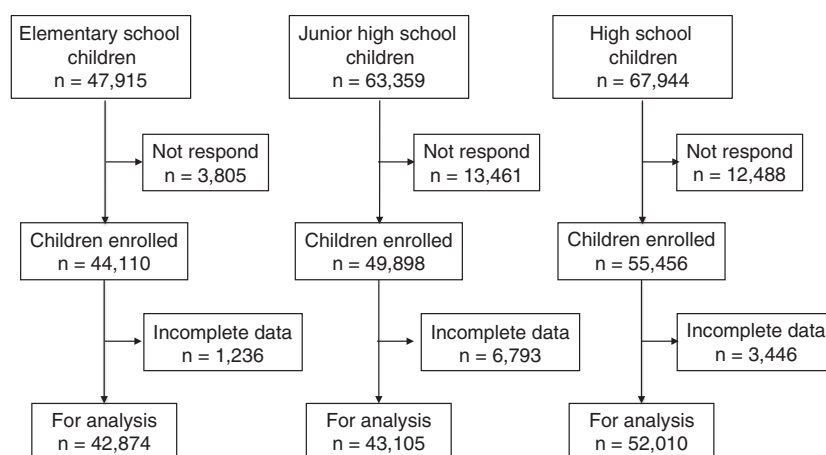


Figure 1 Participants in the cross-sectional and questionnaire-based survey.

Table 1 Baseline characteristics of the study participants

	Total	Boys	Girls	p-Value*
Children aged 6–7 yr	42,874	21,861	21,013	
Nocturnal cough	5712 (13.3)	3169 (14.5)	2543 (12.1)	<0.001
Nocturnal cough alone	3165 (7.4)	1628 (7.4)	1537 (7.3)	0.600
Nocturnal cough and current asthma	2547 (5.9)	1541 (7.0)	1006 (4.8)	<0.001
Current rhinitis	18,930 (44.2)	10,592 (48.5)	8338 (39.7)	<0.001
Current asthma	5798 (13.5)	3435 (15.7)	2363 (11.2)	<0.001
Children aged 13–14 yr	43,105	21,080	22,025	
Nocturnal cough	5152 (12.0)	2400 (11.4)	2752 (12.5)	<0.001
Nocturnal cough alone	3573 (8.3)	1653 (7.8)	1920 (8.7)	<0.001
Nocturnal cough and current asthma	1579 (3.7)	747 (3.5)	832 (3.8)	0.196
Current rhinitis	25,891 (60.1)	12,668 (60.1)	13,223 (60.0)	0.906
Current asthma	4195 (9.7)	2098 (10.0)	2097 (9.5)	0.135
Children aged 16–17 yr	52,010	26,815	25,195	
Nocturnal cough	6112 (11.8)	3119 (11.6)	2993 (11.9)	0.383
Nocturnal cough alone	4518 (8.7)	2298 (8.6)	2220 (8.8)	0.329
Nocturnal cough and current asthma	1594 (3.1)	821 (3.1)	773 (3.1)	0.967
Current rhinitis	27,148 (52.2)	14,222 (53.0)	12,926 (51.3)	<0.001
Current asthma	4311 (8.3)	2264 (8.4)	2047 (8.1)	0.192

Data represent number (percentage).

*Chi-square analysis for evaluating gender differences.

higher compared with children with current asthma (adjusted OR [95% CI]: 3.65 [3.36–3.97] in children aged 6–7 yr, 3.05 [2.79–3.32] in those aged 13–14 yr, and 2.69 [2.51–2.88] in those aged 16–17 yr).

Among children with current rhinitis, more than 80% of the children answered that their daily activity was impaired by rhinitis symptoms (data not shown). The children who reported the most impairment of their daily activities by rhinitis symptoms had a higher prevalence of nocturnal cough in the past 12 months. After adjusting for the confounding factors (living area, gender, obesity, and past history of wheezing), the ORs for nocturnal cough in children

who reported that their daily activities were impaired ‘a lot’ were significantly higher compared with children whose daily activities were not impaired at all (Table 3).

Discussion

In this study, using a large population-based nationwide survey, we found that rhinitis was independently associated with nocturnal cough unrelated to colds in school children. The effects of rhinitis on nocturnal cough were independent of gender, obesity, and asthma. Consistent with our findings, a birth cohort study revealed that rhinitis was a risk factor

Table 2 Association of current rhinitis with nocturnal cough in children with and without current asthma

	Children with current asthma		Children without current asthma	
	Adjusted OR*	95% CI	Adjusted OR†	95% CI
Children aged 6–7 yr	2.26	2.00–2.56	3.65	3.36–3.97
Children aged 13–14 yr	1.90	1.58–2.30	3.05	2.79–3.32
Children aged 16–17 yr	1.86	1.60–2.19	2.69	2.51–2.88

OR, odds ratio; CI, confidence interval.

*Adjusted for living area, sex, and obesity.

†Adjusted for living area, sex, obesity, and past history of wheezing.

for recurrent cough with or without wheezing at the age of 6–18 yr, and this effect was independent of age within this range (8). In addition, a cross-sectional study revealed a significant association between snoring and nocturnal cough in preschool children, and this association was significant in both non-asthmatic and asthmatic children when examined separately (10).

The mechanisms underlying the association between rhinitis and nocturnal cough in children with no current asthma are not well understood. Nocturnal cough without wheezing might solely be a manifestation of asthma, specifically, cough-variant asthma. Allergic rhinitis and asthma commonly occur together because they share a common underlying allergic

inflammatory pathogenesis. Although no population-based studies have evaluated the prevalence of cough-variant asthma in children, this clinical entity does not seem to be the main cause of the nocturnal cough without wheezing. Furthermore, our results showed that even among children without current asthma, children with current rhinitis had a higher prevalence of nocturnal cough compared with children without rhinitis and that the OR associated with rhinitis was higher in children without current asthma compared with children who had current asthma. These results suggest that rhinitis is a risk factor for nocturnal cough, independent of asthma.

Cough-triggering nerves are located in the hypopharynx and larynx, and cough reflex hypersensitivity is predicted to amplify cough by increasing the efficiency of endogenous and environmental stimuli to trigger cough (11). In rhinosinusitis, cough reflex sensitivity might be augmented by secretions dripping down from the nose into the larynx (12). Activation of sensory nerve in the nose also sensitizes the cough reflex. In particular, histamine applied into the nose caused sensitization of the cough reflex in healthy subjects (13). The cough sensitivity of patients with allergic rhinitis was higher than that of healthy subjects and was further increased among patients with pollen allergy during the pollen season compared with out-of-pollen season (14). Our findings show that children whose nasal symptoms more severely impaired their daily activities had a significantly higher prevalence of nocturnal cough. Combined with the previous data, these results suggest that the extent of nasal inflammation could affect the development of nocturnal cough. It has been shown that the treatment of allergic rhinitis helps to improve asthma control. A nested, case-control study of patients aged 6 yr and older

Table 3 Association of impairment of daily activities because of nasal symptoms with nocturnal cough in children with rhinitis

Degree of Impairment	Children with current asthma			Children without current asthma		
	Prevalence of nocturnal cough (%)	Adjusted OR*	95% CI	Prevalence of nocturnal cough (%)	Adjusted OR†	95% CI
Children aged 6–7 yr						
Not at all‡	37.7	1		11.4	1	
A little	47.3	1.51	1.23–1.87	14.0	1.22	1.06–1.42
Moderate	58.1	2.40	1.90–3.02	17.7	1.57	1.34–1.85
A lot	60.4	2.62	1.99–3.46	19.4	1.79	1.47–2.19
Children aged 13–14 yr						
Not at all‡	25.6	1		10.5	1	
A little	36.2	1.55	1.16–2.07	11.8	1.13	0.99–1.29
Moderate	43.2	2.14	1.60–2.87	14.3	1.27	1.15–1.39
A lot	48.2	2.52	1.87–3.41	15.4	1.38	1.24–1.54
Children aged 16–17 yr						
Not at all‡	33.4	1		11.4	1	
A little	35.0	1.15	0.87–1.52	12.6	1.13	0.99–1.28
Moderate	42.2	1.58	1.19–2.10	14.8	1.23	1.12–1.34
A lot	47.7	1.97	1.47–2.64	16.1	1.34	1.21–1.49

OR, odds ratio; CI, confidence interval.

*Adjusted for living area, sex, and obesity.

†Adjusted for living area, sex, obesity, and past history of wheezing.

‡Reference group in regression.

with both allergic rhinitis and asthma revealed that treatment with either nasal corticosteroids or antihistamines was associated with a significant reduction in the risk of asthma-related emergency room treatment and hospitalization (15). Further studies will be needed to determine the effects of treatment of rhinitis on nocturnal cough, especially in children without asthma.

One of the limitations of our study is that the cross-sectional design does not define whether rhinitis precedes the development of nocturnal cough or vice versa. A prospective cohort study in which 1670 healthy adults were followed for approximately 5 yr showed that rhinitis was a risk factor for developing recurrent cough not associated with colds among adults and that the effect of rhinitis on recurrent cough was independent of other known risk factors including asthma and smoking (16). It remains to be determined whether an early treatment of nasal symptoms might reduce the risk of lower airway abnormalities, such as asthma and nocturnal cough. Another limitation of this study was that we failed to account for several important confounding factors, such as parental tobacco smoking, socioeconomic status, medications for rhinitis and asthma, and atopic status. Controlling for these factors might affect the association between rhinitis and nocturnal cough.

In conclusion, there was a close association between rhinitis and nocturnal cough in young children through adolescents. As the Allergic Rhinitis and its Impact on Asthma (ARIA) recommends (17), upper airways should be examined in children with respiratory symptoms including nocturnal cough. Further studies will be needed to understand the mechanisms underlying the association between upper and lower airways.

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Conflict of interest

All the authors declare that they have no conflict of interest.

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