# Pediatric allergic rhinitis: Physical and mental complications

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## ABSTRACT

*Allergic rhinitis (AR) affects up to 40% of children in the United States and its prevalence continues to increase. Most AR develops during the pediatric years and it is the most common chronic allergic disorder seen in children. It is important to note that AR is more than just sneezing and a nuisance for the children. There are numerous complications that can lead to significant problems both physically and mentally in the child who suffers with AR. Under physical complications, otitis media with effusion, recurrent and/or chronic sinusitis, asthma, and snoring impact children with AR. Sleep disturbances, poor school performance, and hyperactivity are all mental complications seen in many children related to their nasal allergies. It is important for the clinician to take AR in the child seriously to prevent or control complications that can have a detrimental effect on the child.*


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**Key words:** Allergic rhinitis, asthma, children, chronic, mental complications, otitis media, physical complications, sinusitis, sneezing, snoring

Allergic rhinitis (AR) affects a large percentage of the pediatric population, with some studies suggesting it is as high as 40%.[1] It is increasing in prevalence, like all atopic conditions in children, and is the most common chronic allergic disorder seen in the pediatric population. Most AR begins in the pediatric/adolescent population and is classically associated with repetitive sneezing, nasal itching, rhinorrhea, and nasal congestion. Although AR usually is divided into two types, seasonal and perennial, according to the type of allergen triggering symptoms, the World Health Organization has developed guidelines that classify AR into intermittent and persistent, depending on the length of time each year that the patient has symptomatology.[2] If AR only affected the nose, then aggressively managing it in the child might not be a major choice of the clinician. Unfortunately, AR in children can have numerous complications that have a major impairment on the child and the family.[3,4] Physical complications commonly seen include otitis media with effusion (OME), recurrent and/or chronic sinusitis, and asthma. Sleep, poor school performance, hyperactivity, and decreased quality of life lead the list of mental complications that have been found in this group.

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## PHYSICAL COMPLICATIONS

### Otitis Media with Effusion

OME is a significant medical problem in the pediatric population. It is estimated that >80% of all children have at least one episode of otitis media by the age of 3 years and that 40% will have three or more episodes.[5] In children <15 years old, the number of visits was ~16 million (11.8% of the total visits for any reason in children).[6]

Tomonaga *et al.* showed that in children with a primary diagnosis of AR, 21% had OME; in the control group representing the general population, only 6% had OME ($p < 0.01$).[7] In children with a primary diagnosis of OME, 50% had AR; in the general population, only 17% had AR ($p < 0.01$). These results suggest that AR affects tubal function (even temporarily) and that AR may be a risk factor in children prone to OME.

Caffarelli *et al.* evaluated 172 children with OME and a control group of 200 children using a questionnaire for atopy, allergy skin tests, and a clinical evaluation of allergic symptoms and hypersensitivity to aeroallergens.[8] They found no significant difference between patients and control group as far as family history of atopy or positive skin-prick test reaction. They did find that symptoms associated with atopy occurred signif-

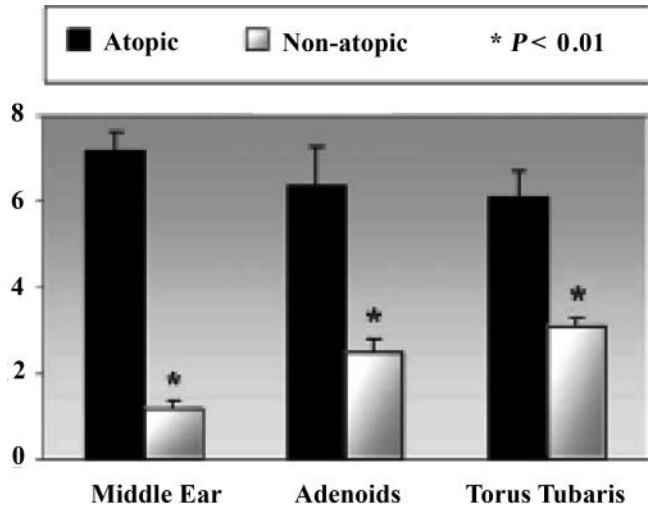


*Figure 1. A comparison of eosinophil expression between atopic and nonatopic patients with OME. Middle ear fluid levels measured in percentage of total cells. Torus tubaris and adenoid tissue levels measured in number of cells per square millimeter. Atopic patients with OME had significantly higher eosinophil expression compared to nonatopic patients. Adapted with permission from Ref. 10.*

icantly more frequently in the group with OME ($p < 0.001$) and concluded that the association of OME with symptoms associated with atopy may play a part in the pathogenesis of the disorder.

Chantzi *et al.* evaluated 88 1–7-year-old children with OME, diagnosed by clinical and tympanometric evaluation and 80 matched controls.[9] A standardized questionnaire to assess factors related to OME and allergy-related symptoms was used along with skin-prick tests and/or CAP-FEIA. They found that factors increasing risk for OME in the univariate analysis included IgE sensitization, dyspnea, wheezing, asthma, paroxysmal sneezing, rhinitis, eczema, "any allergic disease," family history of otitis media, and family history of allergy. After multivariate analysis, IgE sensitization, wheezing, nasal obstruction, family history of otitis, and child care attendance remained as independent risk factors for development of OME. The authors concluded that IgE sensitization and respiratory allergy symptoms may be independent risk factors for the development of OME.

Is there data to confirm that allergic inflammation can be seen in OME? Nguyen *et al.* examined middle ear effusions, torus tubaris (eustachian tube mucosa at the nasopharyngeal orifice), and adenoidal tissue biopsy specimens in 45 patients undergoing simultaneous tympanostomy tube placement for OME and adenoidectomy for adenoid hypertrophy.[10] Eleven of the 45 patients with OME (24%) were atopic. They found that the middle ear effusions of atopic patients had significantly higher levels of eosinophils (Fig 1), T lymphocytes, and IL-4 mRNA$^+$ cells ($p < 0.01$) and significantly lower levels of neutrophils and IFN-γ mRNA$^+$ cells ($p < 0.01$) compared with nonatopic patients. Thus, in atopic patients with OME, the allergic inflammation occurs on both sides of the eustachian tube, both in the middle ear and in the nasopharynx. This research supports the notion that the middle ear is a component of the "one airway" in atopic individuals.

Although there are data suggesting a linkage between OME and AR, there is controversy on whether routine evaluation for allergies should be done in children with OME. A recent guideline on management of OME by The American Academy of Pediatrics, American Academy of Family Physicians, and American Academy of Otolaryngology–Head and Neck Surgery made no recommendations for allergy management as a treatment for OME.[11] They based their recommendation on insufficient evidence of therapeutic efficacy or a causal relationship between allergy and OME. They state that their guideline is not intended as a sole source of guidance in evaluating children with OME. Rather, it is designed to assist primary care and other clinicians by providing an evidence-based framework for decision-making strategies. It appears prudent that if the child with OME has significant symptoms of AR, then evaluation of allergy as a factor in the child's OME should be entertained.

**Sinusitis**

Sinusitis is a potential complication of AR. The relationship between rhinitis and sinusitis may involve inflammation in one compartment leading to secondary inflammation in the other compartment, such as in the case of rhinitis leading to obstruction of the osteomeatal complex. The relationship also may involve individual manifestations of a shared process, such as allergic disease.[12] Based on a 1996 survey, the United States had an estimated 33 million cases of sinusitis (12.5% of the general population) with 14% in patients <18 years old.[13] In a Los Angeles population of 70 children who were 3–16 years of age with AR, 53% had abnormal sinus radiography. In this subgroup, 4 children (6%) had marked thickening (>6 mm) of the maxillary sinus walls, and 15 children (21%) had complete opacification of one or more sinus cavity.[14] Savolainen evaluated the rate of allergy in 224 patients with verified acute maxillary sinusitis by means of an allergy questionnaire, skin testing, and nasal smears.[15] Allergy was found in 56 patients (25%). In addition, allergy was considered probable in 14 patients (6.5%). The corresponding percentages in the control group were 16.5 and 3, respectively. The difference is statistically significant ($p < 0.05$).

Huang *et al.* studied 413 children for 5 years, of whom 215 had perennial AR and 198 had seasonal AR,

to examine the prevalence of sinusitis in these patients. They found that the prevalence of sinusitis was significantly higher among patients with PAR than among those with SAR regardless of age or season and that mold allergy is an important risk factor for sinusitis in these children.[16]

Serious complications related to sinus disease can occur in the child with AR. Holzmann showed that AR was a potential risk factor for the development of orbital complications of acute rhinosinusitis in children.[17] One hundred two children presenting with orbital swelling were investigated by computed tomography (CT) of the paranasal sinuses and the orbit as well as for underlying AR. Sixty (58.8%) patients had orbital complications of clinical and radiological acute rhinosinusitis. AR was found in 9 (64.3%) of 14 children with preseptal cellulitis, in 1 (25%) of 4 children with periostitis, and in 13 (76.5%) of 17 children with subperiosteal abscess. The authors concluded that AR may be a cofactor in the pathogenesis of orbital complications of acute rhinosinusitis.

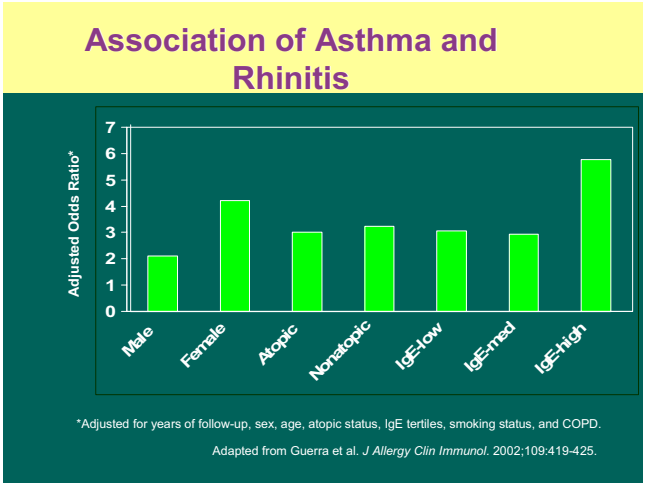


***Figure 2.*** *Association of asthma and rhinitis. The adjusted odds ratio for all groups showed a statistical association for both allergic and nonallergic rhinitis with asthma. Adapted with permission from Ref. 19.*

**Asthma**

There is a strong epidemiological link between AR and asthma with AR occurring in the vast majority of asthma patients. Wright *et al.* showed that the presence of physician-diagnosed AR in infancy was independently associated with doubling the risk of developing asthma by the age of 11 years.[1] They found that 32% of the children with rhinitis developed asthma and only 5% were without rhinitic symptoms. In the classic work by Settipane *et al.*,[18] 1836 college freshman at Brown University were followed for 23 years. They were evaluated prospectively by questionnaires, interviews, and physical examinations, and allergy skin tests were performed for the presence of asthma and AR. In a 23-year follow-up study, 1021 (64%) subjects returned their completed questionnaires. Of these, 738 (72%) had been skin tested as freshmen. The authors found that AR and positive allergy skin tests are significant risk factors for developing new asthma. The freshman were three times more likely to develop asthma that had AR than the freshman who did not have allergies.[18] Guerra *et al.* performed a large, longitudinal community population study to determine the extent to which rhinitis is an independent risk factor for adult-onset asthma.[19] They found that rhinitis, both allergic and nonallergic, was a significant risk factor for asthma (crude odds ratio, 4.13; 95% confidence interval, 2.88–5.92; Fig 2). They also observed that patients with rhinitis with persistent and severe nasal symptoms and a personal history of physician-confirmed sinusitis had an additional increased risk of asthma development.

Numerous studies have documented that treatment of AR will improve asthma outcomes. Intranasal corticosteroids have been shown to decrease asthma symptoms and airway hyperreactivity. Corren *et al.* wanted to determine whether treatment with intranasal corticosteroids and/or second-generation antihistamines is associated with changes in rates of asthma exacerbations resulting in emergency room visits and/or hospitalizations in patients with asthma and AR.[20] They evaluated 361 patients treated in the emergency department and/or hospitalized for asthma and were compared with 1444 controls in a large managed care organization. Patients treated with intranasal corticosteroids and the combination of inhaled corticosteroids and second-generation antihistamines had significantly lower odds ratios for both emergency department visits and asthma. Leukotriene modifier agents, such as montelukast, and omalizumab, an immunomodulator agent, also have been established to show efficacy in both AR and asthma.[21,22]

AR often precedes the development of asthma in children, which is commonly called the "atopic march." Recent research has indicated that the use of allergen immunotherapy in children with AR can decrease the risk of development of asthma. Novembre *et al.* evaluated 113 children aged 5–14 years with AR to grass pollen and no other clinically important allergies were randomized in an open study to receive specific sublingual immunotherapy for 3 years or standard symptomatic therapy.[23] The children on sublingual immunotherapy were 3.8 times less likely to develop asthma after 3 years than the control subjects. Niggemann *et al.* recently published a 5-year follow-up of children treated for 3 years with specific subcutaneous immunotherapy for AR to grass and/or birch pollen.[24] These children were compared with a control group of AR children for allergy symptoms and the develop-

ment of asthma. The immunotherapy-treated children had significantly less asthma after 5 years as evaluated by clinical symptoms (odds ratio 2.68, [1.3–5.7]) in favor of specific subcutaneous immunotherapy for prevention of development of asthma.

### Snoring

Another complication to consider in children with AR is snoring. Chng *et al.* administered a questionnaire on snoring to parents of 11,114 children aged 4–7 years in randomly selected preschools and primary schools in Singapore.[25] They found that snoring and habitual snoring were reported in 28.1 and 6.0% of the children, respectively. On multivariate logistic regression analysis, it was found that one of the significant associations with snoring was atopy (asthma, AR, or atopic dermatitis). In fact, atopy was the strongest risk factor for habitual snoring.

In children with snoring secondary to AR, obstructive sleep apnea syndrome may be present and lead to additional medical problems.[26] McColley *et al.* did a prospective study of 39 children with habitual snoring who were referred for polysomnography.[27] A radioallergosorbent test (RAST) was performed to check for allergen sensitization. They found that 14 subjects (36%) showed sensitivity to allergens; this is higher than expected for the general pediatric population. The frequency of obstructive sleep apnea syndrome was increased in subjects with positive RAST results compared with those with negative RAST results (57% versus 40%; $\chi^2 = 9.11$; $p < 0.01$), suggesting that allergy may be a risk for habitual snoring in children. Of course not all snoring in children is caused by AR, but it is important to include it in the differential diagnosis in evaluating the child that snores.

## MENTAL COMPLICATIONS

### Sleep

Children with AR will present not only with physical complications but also can have a history of various recurrent and persistent mental health problems. In a survey of general practitioners, it was found that home life was affected in 34% of their patients because of AR.[28] Impaired sleep is one of the major complications of pediatric AR. The sleep disorders seen in AR are caused by nasal congestion and obstruction and often lead to physical fatigue.[29] At night, nasal congestion is at its worst, especially when one is lying down to sleep. Nasal congestion is particularly severe in the early morning hours, and nasal obstruction worsens when lying down.[30,31] Children with AR might experience microarousals during sleep, as well as irregular breathing such as snoring and obstructive apnea.[29] Leger *et al.* recently showed that patients with AR have more trouble falling asleep, take more sedatives for sleep, experience nocturnal awakenings, feel that they do not get enough sleep, or still feel tired after waking.[32] In developing the Rhinoconjunctivitis Quality of Life Questionnaire for adolescents, Juniper *et al.* surveyed a group of 12- to 17-year old patients with AR; they found that 78% lacked a good night sleep, 75% were unable to get to sleep, and 64% wake up in the middle of the night (Fig 3).[33]

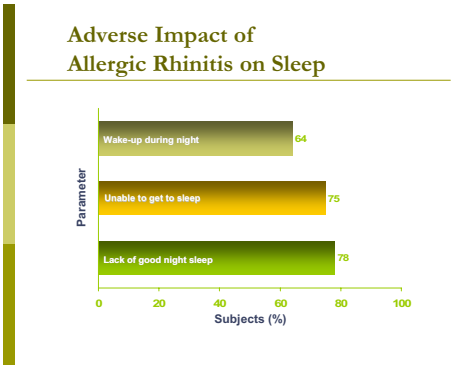


***Figure 3.*** *High incidence of sleep-related problems in adolescents with allergic rhinitis. Adapted with permission from Ref. 33.*

### Poor School Performance

Symptoms of AR, such as sneezing, nasal rubbing, and rhinorrhea also can be distracting for the child at school.[34] These problems, coupled with a good night's sleep, make it hard for children to function well in the classroom. Unable to participate optimally, children become frustrated and may have negative interactions with teachers.[34] Children with AR have a higher absence rate at school than children without the condition and may fall behind in classes.[34] Vuurman *et al.* used of a didactic computer simulation teaching children with and without seasonal AR about desert agriculture during the pollen season.[35] Desert agriculture was taught during the pollen season because none of the children would have had previous knowledge of the subject. Groups of allergic children received different treatments before instruction, *i.e.*, sedating (diphenylhydramine HCl) or nonsedating (loratadine) antihistamines or placebo. All returned after 2 weeks for an examination measuring their retained knowledge on the subject. Examination results showed large and consistent impairing effects of nasal allergies on prior learning. Both the placebo and the sedating antihistamine groups learned significantly less than normal controls. Marshall *et al.* showed during ragweed seasons that allergic patients experienced subtle slowed speed of cognitive processing with some patients also having difficulties in working memory.[36]

### Hyperactivity

Another complication in pediatric AR patients is irritability, behavior problems, and mood disorders.[37]

Children with AR need to carry tissues, blow their nose frequently, sniff, snort, and rub their eyes and nose. These behaviors make children self-conscious and peers may be annoyed by them, leading to teasing.[38] Borres *et al.* surveyed 17 year old patients with allergic rhinoconjunctivitis and found a vast majority were embarrassed by their appearance because of symptoms of AR.[39] Of the many diseases with symptoms that overlap those of AR, one is attention deficit/ hyperactivity disorder (ADHD). In both diseases, children display symptoms of reduced concentration, impaired learning, loss of sleep, and fatigue.[40] Brawley *et al.* evaluated children from 5 to 18 years of age with a diagnosis of ADHD for allergy. The screening for allergy included history, physical examination, and allergy skin testing. The researchers found that 75% of children with ADHD reported had two or more symptoms associated with AR, 100% had a family history of AR, and 69% tested positive on one or more allergy skin tests. This research suggests that nasal obstruction, sleep disturbance, and other symptoms of AR could cause the symptoms seen in ADHD. Evaluation and treatment of AR may be beneficial in children diagnosed with ADHD.[40]

It is clear that AR in children is more than sneezing and nasal itching. Complications associated with this condition are numerous and can have a major effect on the child both physically and mentally. Therefore, it is important not only to recognize and aggressively manage AR in the child, but also to evaluate for the possible complications that may accompany this condition.

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