
Allergic rhinitis in children with attention-deficit/hyperactivity disorder

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Background: Both allergic rhinitis and attention-deficit/hyperactivity disorder (ADHD) are common pediatric conditions associated with learning difficulties and sleep disturbances. There are conflicting research data regarding the association between ADHD and atopic disorders.

Objective: To determine the prevalence of allergic rhinitis in patients with physician-diagnosed ADHD.

Methods: Patients 5 to 18 years of age who presented with a *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* diagnosis of ADHD to an outpatient pediatric psychiatry clinic were screened for allergic rhinitis with focused history, physical examination, and skin prick testing to common aeroallergens.

Results: Thirty patients were interviewed, with 23 of these undergoing physical examination and skin prick testing. Eighty percent reported allergic rhinitis symptoms, whereas 61% had at least 1 positive prick skin test result. Forty-three percent showed typical physical signs of allergic rhinitis, 100% had a positive atopic family history, and 53% had other associated atopic disorders.

Conclusions: Most children with ADHD displayed symptoms and skin prick test results consistent with allergic rhinitis. Nasal obstruction and other symptoms of allergic rhinitis could explain some of the cognitive patterns observed in ADHD, which might result from sleep disturbance known to occur with allergic rhinitis. Therefore, evaluation and treatment of allergic rhinitis could benefit patients with ADHD.

Ann Allergy Asthma Immunol. 2004;92:663–667.

INTRODUCTION

Allergic rhinitis is a common chronic condition in both adult and pediatric populations. Its prevalence increases from infancy through childhood and adolescence (approximately 40%) and then declines in the older population.¹ Characteristic symptoms include sneezing, pruritus, nasal congestion, and/or rhinorrhea.² Sleep disturbances and cognitive difficulties are also reported to occur in many patients.³

Attention-deficit/hyperactivity disorder (ADHD) is also a chronic condition common in the pediatric population, with an estimated prevalence in school-aged children of 6.8% (9.2% in boys and 3.0% in girls). It is recognized by difficulties with attention, impulsivity, and hyperactivity.⁴ Disturbed sleep patterns have also been described.^{5,6} Because both of these common pediatric disorders are characterized by sleep and cognitive dysfunctions, the purpose of this study is to determine whether allergic rhinitis and atopy (ie, positive skin prick test result) are common in a pediatric population with physician-diagnosed ADHD.

METHODS

Patients

Children, ages 5 to 18 years, with psychiatrist-diagnosed ADHD who met *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria for ADHD were included in this pilot study (Table 1).⁷ Patients were obtained from an outpatient pediatric psychiatry clinic between August 2002 and May 2003.

Study Design

All patients diagnosed as having ADHD present at any given session of the pediatric psychiatry clinic were invited to participate in the study. Patients and parents were told that this study was an attempt to see whether ADHD was associated with nasal allergy and informed of the study procedures. Since patients were all regular visitors to the pediatric psychiatry clinic, which usually refers patients deemed to be in need of allergy care to the allergy clinic, particularly if requested by the parent, we do not believe a significant selection bias favoring patients perceived to be allergic occurred.

After informed consent was obtained from both parent and child, patients were screened for allergic rhinitis with a focused history, focused physical examination, and skin prick testing. Six symptoms of allergic rhinitis were evaluated: (1) nasal congestion or runny nose, (2) itchy or watery eyes, (3) sneezing, (4) snoring or breathing through the mouth, (5) drainage down the throat, and (6) frequent yellow or green nasal discharge. Patients were considered to have a positive

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Received for publication June 27, 2003.

Accepted for publication in revised form December 29, 2003.

Table 1. *DSM-IV* Criteria for Attention-Deficit/Hyperactivity Disorder*

- A. Either 1 or 2:
1. Six or more of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
Inattention
 - a. often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
 - b. often has difficulty sustaining attention in tasks or play activities
 - c. often does not seem to listen when spoken to directly
 - d. often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
 - e. often has difficulty organizing tasks and activities
 - f. often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
 - g. often loses things necessary for tasks or activities (eg, toys, school assignments, pencils, books, or tools)
 - h. is often easily distracted by extraneous stimuli
 - i. is often forgetful in daily activities
 2. Six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
Hyperactivity
 - a. often fidgets with hands or feet or squirms in seat
 - b. often leaves seat in classroom or in other situations in which remaining seated is expected
 - c. often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
 - d. often has difficulty playing or engaging in leisure activities quietly
 - e. is often "on the go" or often acts as if "driven by a motor"
 - f. often talks excessively
 - Impulsivity
 - g. often blurts out answers before questions have been completed
 - h. often has difficulty awaiting turn
 - i. often interrupts or intrudes on others (eg, butts into conversations or games)
- B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before the age of 7 years.
- C. Some impairment from the symptoms is present in 2 or more settings (eg, at school [or work] and at home).
- D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.
- E. The symptoms do not occur exclusively during a pervasive developmental disorder, schizophrenia, or other psychotic disorder and are not better accounted for by another mental disorder (eg, mood disorder, anxiety disorder, dissociative disorder, or a personality disorder)

Abbreviation: *DSM-IV*, *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*.

* Data are from the American Psychiatric Association.⁷

history if they reported at least 2 of the 6 symptoms. Patients were excluded if they had a history of adenoidal hypertrophy, current or recent upper respiratory tract infection, anatomic nasal defects, nasal foreign body, or suspected immunodeficiency.

The physical examination was the same examination performed on all new allergy patients in our clinic and focused on signs consistent with allergic rhinitis, such as pale and/or boggy turbinates, allergic shiners, nasal crease, postnasal drip, and nasal discharge. The same examiner performed the history and physical examination in all but 1 patient. Although we strove to be objective, this was only an observational study and logistical constraints would not permit a second blinded examiner.

Skin prick testing was performed for *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, mold mix, cockroach, dog, cat, feathers, ragweed, tree mix, and grass mix, with a response considered positive if the wheal was at least 3 mm greater than the negative control.

RESULTS

Patients

A total of 30 patients, 24 boys and 6 girls, were recruited into the study (Table 2). A focused history was obtained for all 30 patients, but only 23 underwent physical examination and skin prick testing. Of the remaining, 5 patients failed to return for these procedures secondary to transportation difficulties and 2 decided not to continue in the study once the history was completed for undetermined reasons. We believed that these small numbers would not bias the overall outcome of the study.

Data Analysis

Of the 30 patients with ADHD interviewed in this study, 24 patients (80%) reported at least 2 of the 6 rhinitis symptoms. Sixteen (53%) of these patients had other associated atopic disorders: 13 patients with asthma (42%) and 3 patients with atopic dermatitis (10%). No patients were previously diagnosed as having allergic rhinitis and/or taking medications for allergic rhinitis. A family history was obtained in 28 of the 30 patients interviewed. In the 2 unknown cases, one child was adopted and the other was in foster care. All 28 patients (100%) reported an atopic family history.

Physical examinations and skin prick testing were performed on 23 of the 30 patients interviewed. Ten (43%) of these patients had positive physical signs for allergic rhinitis, including 8 patients with pale and/or boggy turbinates, 2 patients with allergic shiners, 1 patient with a nasal crease, and 3 patients with clear-to-mucoid nasal discharge. Fourteen patients (61%) demonstrated at least 1 positive skin prick test result to a common aeroallergen. Fourteen (60%) of the patients with symptoms of allergic rhinitis had positive skin prick test results. Seven patients (30%) had positive skin prick test results associated with physical signs for allergic disease. The most frequent positive skin test result was to cockroach (8 positive responses), followed by dust mite and cat (5 positive responses each), tree (4 positive responses), and ragweed and grass (3 positive responses each). There

Table 2. Patient Demographics

Patient No./Sex/Age, y	No. of symptoms	Comorbid condition	Family history	No. of positive skin test results	Physical examination results
1/M/7	4	Asthma	Atopy	0	Pale turbinates
2/M/10	2	Asthma	Atopy	0	Normal
3/M/12	3	Asthma	Atopy	3	Boggy turbinates
4/M/9	2		Atopy	0	Mucoid nasal discharge
5/F/11	3	Asthma	Atopy	1	Pale/boggy turbinates
6/F/11	5	Asthma	Atopy	1	Boggy turbinates
7/M/18	4	Tonsillectomy	Atopy	4	Boggy turbinates
8/M/12	2		Atopy	0	Normal
9/M/17	3	Asthma, epilepsy	Atopy	Not done	Not done
10/M/7	3		Atopy	Not done	Not done
11/F/8	1	Eczema	Atopy	Not done	Not done
12/F/16	0		Atopy	0	Pale and/or boggy turbinates
13/M/12	2		Atopy	1	Normal
14/M/6	3		Unknown	3	Boggy turbinates
15/M/11	4		Unknown	Not done	Not done
16/M/6	4		Atopy	Not done	Not done
17/F/12	6	Asthma	Atopy	Not done	Not done
18/F/8	2	Tonsillectomy	Atopy	0	Shiner and crease
19/M/9	2	Eczema	Atopy	4	Normal
20/M/14	3		Atopy	2	Normal
21/M/10	1		Atopy	0	Normal
22/M/13	3	Dyslipidemia	Atopy	1	Normal
23/M/13	1	Tonsillectomy	Atopy	4	Shiners and pale turbinates
24/M/10	3	Asthma	Atopy	3	Normal
25/M/10	2	Seizures	Atopy	1	Boggy turbinates
26/M/15	2		Atopy	2	Normal
27/M/18	0	Asthma	Unknown	0	Normal
28/M/15	2		Atopy	2	Normal
29/M/9	4		Unknown	0	Normal
30/M/6	1	Tonsillectomy	Atopy	Not done	Not done

were no positive responses to dog, molds, or feathers in these patients. Six (43%) of the 14 patients with a positive skin test result also reported a history of asthma. In this particular subgroup of patients, cockroach remained the aeroallergen most frequently evoking a positive skin test response, with 5 positive responses noted. Other positive reactions in this group included tree and cat with 2 positive responses each and grass and dust mite with 1 positive response each.

DISCUSSION

Conflicting data exist in the literature regarding the relationship between ADHD and atopy. Past studies have looked at the controversial role of food and food additives in ADHD. Boris and Mandel⁸ reported improvement in children with ADHD treated with multiple-item elimination diets. Other studies have focused on different aspects of atopy. Roth et al⁹ found an increased frequency of attention-deficit disorder symptoms and poorer performance on laboratory tests sensitive to attentional capacity and inhibitory functions in a group of atopic children (mainly with atopic eczema). One hypothesis for the role of allergies in ADHD involves central nervous system cholinergic/adrenergic activity imbalances, leading to poor regulation of arousal and ADHD behaviors.¹⁰

In contrast to these findings, a study by Gaitens et al¹¹ did not support an association between ADHD and atopic groups based on IgE-mediated atopic responsiveness but could not rule out an association based on other mechanisms. Similarly, McGee et al¹² reported no association between ADHD behaviors and a history of allergic disorders or level of atopic responsiveness by skin test or serum IgE levels. Biederman et al¹³ did not find a significant relationship between ADHD and asthma with regard to etiology or pathophysiology but suggested both are independently transmitted in families.

The purpose of our study was to specifically investigate a possible relationship between allergic rhinitis and ADHD, which have both been associated with cognitive difficulties and sleep disturbances. These known dysfunctions of sleep and cognition that occur in allergic rhinitis could play a role in the behaviors associated with ADHD.

It has been shown that inadequate sleep in children results in problems with daytime fatigue, inattention, irritability, and impulsivity, which resemble symptoms of ADHD.¹⁴ Some children with sleep disorders have been diagnosed as having ADHD before the detection of their sleep disorder,¹⁵ and in children with ADHD, sleep disturbance is a frequent complaint.^{5,6} One study by Corkum et al¹⁶ demonstrated problems

with increased movements during sleep in children with ADHD, whereas Gruber et al¹⁷ reported sleep-wake system instability with regard to true sleep and the onset and duration of sleep. Chervin et al¹⁵ described a higher frequency of habitual snoring in children with ADHD compared with controls from psychiatry and general pediatric clinics, and snoring scores were associated with higher levels of inattention and hyperactivity. These sleep problems could also be related to confounding factors, such as comorbid conditions and concomitant treatment with stimulant medication.¹⁸

Similarly, poorly controlled allergic rhinitis has been associated with loss of sleep and resultant daytime sleepiness in addition to impairment in cognition.³ One mechanism for daytime fatigue can be explained by the increase in sleep-disordered breathing associated with multiple microarousals present in patients with allergic rhinitis. Lavie et al¹⁹ described these characteristic microarousals from sleep to be associated with periodic breathing and episodes of hypopnea and hyperpnea and suggested that both increased nasal discharge and increased upper airway resistance may be responsible. Craig et al²⁰ postulated that "negative pressure generated during inspiration in the nasal airway secondary to nasal congestion may lead to nasal collapse, airway obstruction, and increased number of sleep microarousals." Microarousals can ultimately lead to daytime fatigue due to the associated sleep fragmentation.

Since the nose appears to be the favored means for breathing during sleep, its obstruction often leads to snoring, nocturnal mouth breathing, obstructive sleep apnea, and ultimately the sequelae of disturbed sleep.²¹ McNicholas et al²² reported longer and more frequent obstructive sleep apneas during periods of symptomatic nasal obstruction associated with seasonal (ragweed) allergic rhinitis, whereas Young et al²³ demonstrated increased moderate-to-severe sleep-disordered breathing in patients with nasal congestion attributed to allergic rhinitis.

Craig et al²⁰ conducted a study to determine if reducing nasal congestion with nasal steroids would result in a decrease in sleep complaints and daytime somnolence. In a double-blind, placebo-controlled study of 20 patients, this group was able to show a significant improvement in both nasal congestion and subjective sleep in patients treated with nasal corticosteroids, which did not occur in the placebo group. Sleepiness also improved but was not significant. Nasal obstruction in allergic rhinitis may therefore be an important factor in the sleep disturbance and daytime sleepiness associated with both ADHD and allergic rhinitis.

ADHD is also often associated with significant impairments in academic functioning.⁴ Importantly, allergic rhinitis has been reported to affect cognitive abilities as well. Marshall et al²⁴ conducted a study to evaluate the effect of symptomatic allergic rhinitis on speed of cognitive processing, attention, and both working and recent verbal memory. Many of the study's patients complained of slowed thinking and problems with attention and memory during their allergy seasons. On testing patients with symptomatic ragweed al-

lergy and nonatopic controls both in and out of ragweed season, these authors demonstrated a subtle slowing of cognitive processing during ragweed season and in some patients difficulties in working memory. No deficits were found with regard to attention or recent memory. These results led to the conclusion that symptomatic ragweed allergic rhinitis "often causes significant cognitive difficulties in a subgroup of patients."

Vuurman et al²⁵ went one step farther and evaluated patients with seasonal allergic rhinitis not only for learning impairments but also for the effect of treatments on the impairment. In this study, 67 young adults with symptomatic seasonal allergic rhinitis and 28 matched controls received didactic simulation training for 3 days then returned 14 days later for an examination. Using a double-blind, randomized, parallel group design, the atopic patients received different treatments during the 3-day training, including diphenhydramine hydrochloride, 50 mg, a combination compound of acrivastine, 8 mg, plus pseudoephedrine, 60 mg, or placebo once daily. After training was completed, all atopic patients received the combination compound until time for the examination. The results of this study demonstrated a decreased mean performance at the end of training for all atopic patients compared with healthy controls, and atopic patients treated with diphenhydramine performed significantly worse than both healthy controls and atopic patients who received the combination compound of acrivastine plus pseudoephedrine. Similar results were obtained at the time of examination. This study further supports the finding that allergy symptoms adversely affect learning ability, which is further decreased by treatment with diphenhydramine. Therefore, the cognitive difficulties associated with allergic rhinitis and the medications used to treat it could both play major roles in the ADHD symptoms in some patients.

In our study, most patients with ADHD had symptoms and skin prick test findings consistent with allergic rhinitis. Many patients reported other associated atopic disorders, and all patients reported an atopic family history if the family history was known. Interestingly, in patients with and without asthma, cockroach was the most common positive skin test result, which is not surprising considering the inner-city location of the study. Our study suggests that allergic rhinitis is common in patients with ADHD. Sleep disturbance and associated daytime cognitive dysfunction may be important factors in the relationship between allergic rhinitis and ADHD.

We do not believe that a significant selection bias occurred favoring those participants whose parent felt that their children had allergies, since the patients were all regular visitors to the pediatric psychiatry clinic, which usually refers patients deemed to be in need of allergy care to the allergy clinic, particularly if allergy is an issue raised by parents. If any bias exists it could conceivably be for selecting nonallergic patients, since all patients screened were never referred to the allergy clinic.

Since this was a pilot, observational study and logistical constraints would not permit a second blinded examiner, we cannot omit a possible small selection bias. However, we

used basically the same procedures as in every new pediatric allergy patient, and our physicians always strive for objectivity in patient care. We would hope that this prevailed here.

Even though the study included a small sample size, its findings may be significant in a subset of patients with ADHD. Larger studies with appropriate control groups, sleep monitoring, and ultimately a treatment trial, possibly nasal corticosteroids vs placebo, should be undertaken to further define an association and etiologic relationship between these 2 disorders.

CONCLUSION

This study demonstrates that a large percentage of children with ADHD have allergic rhinitis symptoms with confirmatory skin test results. Nasal obstruction with resultant sleep disturbance and learning impairments associated with allergic rhinitis could explain some of the cognitive and behavioral patterns observed in ADHD. Therefore, evaluation and treatment of allergic rhinitis could potentially benefit a subset of patients with ADHD by improving both sleep and cognitive abilities. Further study is needed that incorporates appropriate control groups and sleep studies to confirm an association between ADHD and allergic rhinitis and define the nature of the relationship.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of Nilsida Badillo and Bernadine Elliott for their help in obtaining patients for this study.

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