
Exercise-induced rhinitis: a common disorder that adversely affects allergic and nonallergic athletes

William S. Silvers, MD, and Jill A. Poole, MD

Background: Exercise is a well-established trigger for allergic disorders such as asthma, urticaria, and anaphylaxis, but the effect of exercise on rhinitis has not been well described.

Objective: To survey individuals with and without nasal allergy who exercise regularly to determine the prevalence and nature of nasal symptoms induced by indoor exercise.

Methods: An original, self-administered questionnaire to evaluate exercise-induced rhinitis (EIR) was distributed to adults who were receiving allergy immunotherapy at a community allergy practice and to members of a community athletic club. Nasal symptoms that occur indoors (runny nose, nasal congestion, postnasal drip) were primarily evaluated. Comparisons with outdoor EIR were determined. The perception of adverse effects of rhinitis on exercise was evaluated.

Results: Sixty-six (40%) of the 164 patients indicated that their indoor EIR adversely affected athletic performance, and this finding occurred more frequently in patients with nasal allergy vs unaffected individuals (53.1% vs 27.7%; $P = .009$). Of the 61.0% who reported increased rhinitis with indoor exercise, rhinorrhea was the most common symptom experienced (48.8%). Indoor EIR occurred more frequently in patients with nasal allergy vs unaffected individuals (69.1% vs 53.0%; $P = .04$). Outdoor EIR occurred in 56.1% of the total population, and patients with nasal allergy reported significantly more rhinitis with outdoor exercise compared with unaffected individuals (71.6% vs 41.0%; $P < .001$).

Conclusions: Exercise-induced rhinitis, predominantly rhinorrhea, commonly occurs in athletes regardless of underlying nasal allergy. A history specific to indoor and outdoor exercise triggers needs to be part of the complete rhinitis history so that specific treatment can be directed.

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INTRODUCTION

Exercise is a well-known trigger in allergic disorders such as asthma,^{1,2} urticaria,³ angioedema,³ and anaphylaxis⁴ in susceptible patients. However, the effect of exercise on allergic and nonallergic rhinitis is not well recognized or characterized. Outdoor exercise was first observed by Blackley⁵ in the late 1800s to worsen sneezing symptoms in patients with hay fever. This was presumably due to increased pollen exposure; thus, he recommended against exercise in these patients. In contrast, it was later observed that nasal congestion actually improved with exercise, and exercise was then recommended as a form of therapy for patients with hay fever.⁶ In 1968, Richerson and Seebom⁷ performed the first scientific studies demonstrating a decrease in nasal airway resistance in individuals with hay fever. Several studies have since confirmed that the nose becomes more patent during exercise in allergic and nonallergic individuals.^{8–11}

The impact of exercise on rhinitis and the effect of rhinitis on exercise received considerable attention before the 1984 Olympics, where evidence indicated that chronic rhinitis occurs and deserves specific management in the athlete.¹² The

rhinitis condition of athletes was attributed primarily to traumatic episodes caused by bruising and reflex stimulation, but other exposures such as cold air, changes in temperature and weather, outdoor pollution, and indoor exposures (formaldehyde, glues, paints, cleaners, and vinyl) were all suggested as possible triggers of exercise-induced chronic rhinitis.¹² In the early 1990s, exercise in cold temperatures, such as in skiing, was demonstrated to trigger a distinct clinical syndrome termed *cold-induced rhinorrhea* or *skier's nose*.¹³ Although the primary nasal symptom was rhinorrhea, nasal congestion and sneezing were also involved.¹³ More recently, it has been demonstrated that endurance athletes in top elite sports reported physician-diagnosed allergic rhinitis more often than other athletes or control subjects.¹⁴ Furthermore, only half of those athletes who reported allergic rhinitis were taking antiallergic medication.¹⁴

In recent years, the immunological and anatomical connections between the upper and lower airways, referred to as the one-airway hypothesis, has gained increasing attention and support.¹⁵ However, in regard to exercise, it appears that the nose and the bronchi respond differently, with the bronchial tree becoming more narrowed as measured by forced expiratory volume in 1 second (FEV₁) and the nose becoming more patent as evaluated by rhinomanometry.¹¹ No studies have addressed the effect of exercise on other nasal symptoms such as rhinorrhea and postnasal drip.

Allergy, Asthma, & Immunology Clinic of Colorado, Englewood, Colorado.
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In the most recent guidelines for the diagnosis and management of rhinitis developed by the Joint Task Force of Practice Parameters in Allergy, Asthma and Immunology,¹⁶ exercise was listed as a potential cause of other rhinitis syndromes without further discussion of diagnosis and treatment of exercise-induced rhinitis (EIR). Despite the lack of attention that EIR has received, the personal experience of the authors was that indoor and outdoor exercise affects the nose, and conversely, rhinitis symptoms can affect exercise. In addition, it was believed that patients commonly complain of this disorder and seek treatment. Therefore, this study aimed to determine the prevalence and nature of nasal symptoms (nasal congestion, rhinorrhea, and postnasal drip) induced by indoor exercise in individuals with and without nasal allergy with comparisons between the 2 groups. Furthermore, because earlier studies suggested that nasal resistance improves during exercise, a distinction between nasal symptoms that occurred during and after exercise was investigated. This study focused primarily on indoor exercise, because it is well appreciated that outdoor exposure, such as pollution, pollen, and cold air, affect rhinitis.^{12,13,17}

METHODS

An original, self-administered questionnaire to evaluate the occurrence of nasal symptoms during exercise was distributed in person to patients who were receiving allergy immunotherapy at a community allergy office (Allergy, Asthma and Immunology Clinic of Colorado, Englewood, CO) and to members of the local health club (Greenwood Athletic Club, Englewood, CO) during a 60-day period (by W.S.S.). The core questions (Fig 1) and additional questions regarding demographic and clinical information were originally developed by one of the authors (W.S.S.). No identifiers were used to link individuals to their responses. The main objective of this study was to evaluate the prevalence of nasal symptoms with indoor exercise; therefore, the questionnaire was designed to measure nominal or categorical data (yes/no responses). Ordinal measurements of severity of the nasal symptoms on a 3-point scale (mild, moderate, severe) were also evaluated. The questionnaire differs from the validated Rhinoconjunctivitis-Specific Quality-of-Life Questionnaire, which measures severity of symptoms in several domains, including activity limitation, sleep impairment, non-nose and eye symptoms, practical problems, nasal symptoms, eye symptoms, and emotional symptoms on a 7-point scale.¹⁸

Individuals eligible for this study were 18 to 50 years old. Exclusion criteria included a current upper respiratory tract infection and exercising less than 2 times per week to ensure that the study population represented those who exercised regularly and could evaluate their nasal symptoms as due to exercise factors not infectious causes. The decision to include only patients receiving immunotherapy from the community allergy clinic was meant to guarantee that most of the population with self-reported nasal allergy actually had allergy, because there is a tendency for the general population to overreport allergic rhinitis.

1. Do you have nasal allergies? Yes _____ No _____
 2. If yes, are you receiving allergy shots? Yes _____ No _____
 3. Do you currently have an upper respiratory infection (Common cold)?
Yes _____ No _____
 4. How many times per week do you participate in routine aerobic exercise?
_____ Less than 2 times per week
_____ 2-4 times per week
_____ Greater than 4 times per week
 5. Do you feel that you breathe better through your nose during exercise?
Yes _____ No _____
 6. Do you feel that nasal symptoms during exercise adversely affect your athletic performance?
Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
-
- Based on your **INDOOR** exercise experience, do you experience the following?
7. **ANY** nasal symptoms during exercise? Yes _____ No _____
→ If no, please go to question 14
 8. Runny nose **during** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
 9. Nasal congestion **during** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
 10. Post nasal drainage **during** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
 11. Runny nose **after** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
 12. Nasal congestion **after** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
 13. Post nasal drip **after** exercise? Yes _____ No _____
If yes, Mild _____ Moderate _____ Severe _____
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14. Do you experience similar symptoms exercising **OUTDOORS**?
Yes _____ No _____
If yes, Same _____ Greater _____ or Less than indoor symptoms _____

Figure 1. Core questions.

Routine aerobic exercise was characterized as less than 2 times per week, 2 to 4 times per week, and greater than 4 times per week. The presence of nasal allergy (yes/no) was determined by self-report. Patients who were receiving allergy immunotherapy were identified. The presence of comorbid conditions, including asthma and nasal polyps, were evaluated. Patients were also asked to list all current medications. However, we did not evaluate patient compliance with medication use with exercise. We did not determine the type of rhinitis (intermittent or persistent allergic rhinitis), baseline characteristics of nasal allergy, or the severity of the underlying nasal allergy diagnosis.

To determine if adverse nasal symptoms occurred during exercise, patients answered yes or no to the question, "Do you feel that nasal symptoms with exercise adversely affect your athletic performance?" The patient ranked an affirmative answer as mild, moderate, or severe. The overall effect of exercising indoors was determined by a yes or no response to the question, "Do you have any nasal symptoms with exercise indoors?" A distinction was then made with nasal symptoms occurring *during* or *after* exercise. Thus, those who answered yes to having nasal symptoms indoors were further asked in

separate questions if they experienced runny nose, nasal congestion, and postnasal drip *during* exercise. In separate questions, patients were then asked if they experienced runny nose, nasal congestion, and postnasal drip *after* exercise. All affirmative answers were ranked as mild, moderate, and severe by the patient. As a comparison, patients were then asked (yes/no) if they experienced similar nasal symptoms with exercise outdoors. Those patients who answered yes were then asked if the symptoms were the same, greater, or less than when exercising indoors.

All statistical analysis was performed using SAS statistical software, version 8.2 (SAS Institute Inc, Cary, NC). Continuous data (age in years) are presented as mean with range. All other data are categorical and are presented as a proportion (frequency) of the total study participants. Participants were grouped as those with nasal allergy and those without nasal allergy as determined by the yes/no response to the presence of nasal allergies. To compare the results between the 2 groups, the χ^2 test statistic was used. $P < .05$ was considered statistically significant.

RESULTS

Of the 200 questionnaires distributed, 191 were completed; 27 individuals failed to meet inclusion criteria and were withdrawn (8 based on age, 10 with self-reported upper respiratory tract illnesses, and 9 who exercised less than 2 times a week). Figure 2 describes the individuals sampled for this study. A total of 164 individuals were eligible for analysis, 59 receiving allergy immunotherapy from the community allergy practice and 105 from a health club. Twenty-two (21%) of the 105 study participants eligible for analysis from the health club self-reported the presence of nasal allergy. Of

the study population, 27 individuals reported asthma: 25 with nasal allergy and 2 without nasal allergy. Only 8 individuals were taking a daily controller medication for their asthma, and we did not evaluate the severity of asthma or dosing of medication taken. Two individuals who were receiving allergy immunotherapy reported the presence of nasal polyps. Only 12 (7%) of the study participants reported comorbid conditions, which included hypertension, hypothyroidism, depression, multiple sclerosis, gout, and Meniere disease.

Table 1 gives the demographic information for the total study population. The study population was predominately female ($n = 118$, 72%), and the mean age was 36.3 years (age range, 18–50 years). All study participants were non-Hispanic white, consistent with the population found in Greenwood Village, CO, a suburban community located south of Denver, CO. Nasal allergy was self-reported by half of the study population ($n = 81$, 49.4%), and 59 of these individuals were receiving allergen immunotherapy. Twenty-seven (33.3%) of the individuals with nasal allergy were taking medication (other than allergy immunotherapy) for their rhinitis. We did not determine compliance with their medications when they exercised. Because patients were excluded if they exercised less than 2 times per week, most of the population exercised 2 to 4 times per week (66.5%) and the remainder greater than 4 times per week.

When study participants were asked if they breathed better through their nose during exercise, approximately two thirds (64.6%) answered no. Furthermore, 40% of the total study population indicated that their nasal symptoms adversely affected athletic performance. Most participants (61.0%) experienced nasal symptoms with indoor exercise, with runny nose most commonly reported followed by nasal congestion and

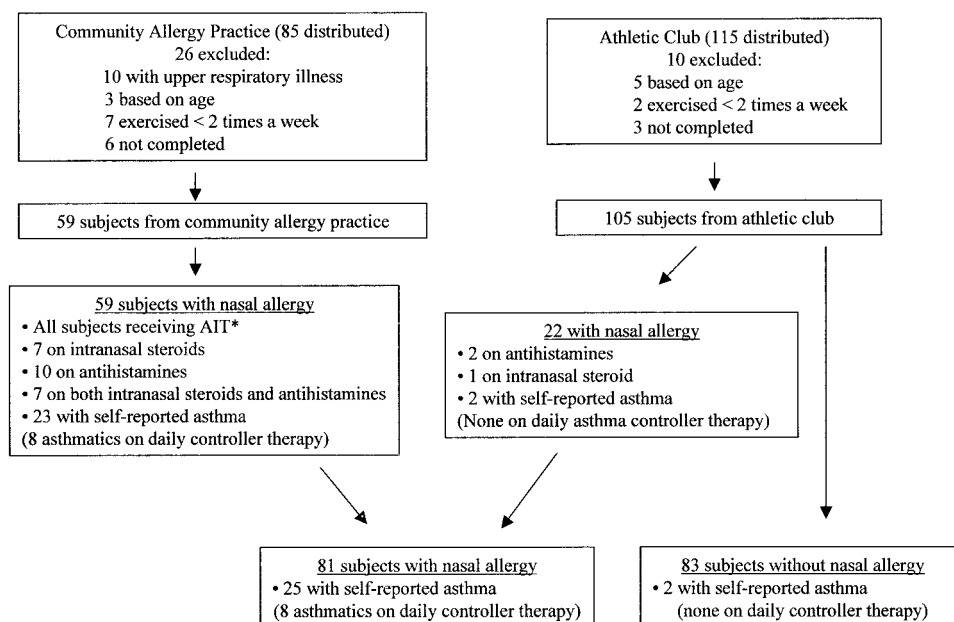


Figure 2. Study sampling and distribution of study participants. AIT indicates asthma immunotherapy.

Table 1. Patient Demographics

Characteristic	No. (%) of patients (N = 164)*
Age, mean (range), y	36.3 (18–50)
Sex†	
Male	46 (28.0)
Female	118 (72.0)
Patient-reported nasal allergy	81 (49.4)
Allergen immunotherapy	59 (36.0)
Exercise	
2–4 times a week	109 (66.5)
>4 times a week	55 (33.5)
Breathe better through nose during exercise	58 (35.4)
Nasal symptoms adversely affect performance	66 (40.2)
Any indoor nasal symptoms with exercise	100 (61.0)
Nasal symptoms <i>during</i> exercise indoors	
Runny nose	80 (48.8)
Nasal congestion	41 (25.0)
Postnasal drip	27 (16.5)
Nasal symptoms <i>after</i> exercise indoors	
Runny nose	55 (33.5)
Nasal congestion	30 (18.3)
Postnasal drip	31 (18.9)
Any outdoor nasal symptoms during exercise	92 (56.1)

* Data are number (percentage) of patients unless otherwise indicated.

† Statistically significantly more females than males were studied ($P < .001$).

postnasal drip. Almost half of the respondents (48.8%) experienced rhinorrhea during exercise compared with one third

(33.5%) who experienced rhinorrhea after exercise. Additionally, more than half of the participants (56.1%) surveyed experienced outdoor nasal symptoms during exercise.

The total population was then grouped as affected with nasal allergy or unaffected as determined by self-report of nasal allergy to evaluate how the presence and absence of nasal allergy affected nasal symptoms during exercise. The results are summarized in Table 2. There were more men who reported nasal allergy than women (34.6% vs 65.4%), but this did not reach statistical significance ($P = .07$). There were significantly more affected participants who reported that nasal symptoms adversely affected their athletic performance compared with unaffected participants (53.1% vs 27.7%; $P = .009$). Individuals affected with nasal allergy experienced more nasal symptoms with exercise indoor than unaffected individuals (69.1% vs 53.0%; $P = .04$). Of the nasal symptoms that occurred during exercise, affected participants were more likely to report nasal congestion and postnasal drip compared with unaffected participants. No difference occurred in reports of runny nose during exercise between groups ($P = .16$). When asked about nasal symptoms after exercise indoors, significantly more affected individuals reported runny nose, postnasal drip, and nasal congestion than unaffected individuals. Outdoor nasal symptoms with exercise were reported significantly more in the individuals with nasal allergy than those without nasal allergy (71.6% vs 41.0%; $P < .001$).

Nasal symptom severity (mild, moderate, severe) was determined for each of the nasal symptoms experienced during and after indoor exercise and is summarized in Table 3. Most symptoms experienced by the respondents were ranked as mild or

Table 2. Exercise-Induced Rhinitis Symptoms in Study Participants With and Without Nasal Allergy

Characteristic	Affected with nasal allergy, No. (%)* (n = 81)	Unaffected, No. (%)* (n = 83)	P value
Age, mean (range), y	36.4 (22–49)	36.5 (18–50)	.94
Sex			
Male	28 (34.6)	18 (21.7)	.07
Female	53 (65.4)	65 (78.3)	
Exercise			
2–4 times a week	54 (66.7)	55 (66.3)	.96
>4 times a week	27 (33.3)	28 (33.7)	
Breathe better through nose during exercise	28 (35.0)	30 (36.1)	.83
Nasal symptoms adversely affect athletic performance	43 (53.1)	23 (27.7)	.009†
Any nasal symptom with exercise indoors	56 (69.1)	44 (53.0)	.04†
Nasal symptoms <i>during</i> exercise indoors			
Runny nose	44 (54.3)	36 (43.4)	.16
Nasal congestion	27 (33.3)	14 (16.9)	.02†
Postnasal drip	19 (23.5)	8 (9.6)	.02†
Nasal symptoms <i>after</i> exercise indoors			
Runny nose	37 (45.7)	18 (21.7)	<.001
Nasal congestion	20 (24.7)	10 (12.1)	.04
Postnasal drip	22 (27.2)	9 (10.8)	.01
Any nasal symptoms outdoors	58 (71.6)	34 (41.0)	<.001†

* Data are number (percentage) of patients unless otherwise indicated.

† Statistically significant ($P < .05$).

Table 3. Nasal Symptom Severity

Nasal symptom	No. (%) of patients		
	Mild	Moderate	Severe
All patients			
Nasal symptoms adversely affect athletic performance (n = 66)	37 (56.1)	26 (39.4)	3 (4.5)
Nasal symptoms <i>during</i> indoor exercise			
Runny nose (n = 80)	51 (63.8)	27 (33.7)	2 (2.5)
Nasal congestion (n = 41)	27 (65.8)	12 (29.3)	2 (4.9)
Postnasal drip (n = 27)	21 (77.8)	5 (18.5)	1 (3.7)
Nasal symptoms <i>after</i> indoor exercise			
Runny nose (n = 55)	32 (58.2)	22 (40.0)	1 (1.8)
Nasal congestion (n = 30)	18 (60.0)	10 (33.3)	2 (6.7)
Postnasal drip (n = 31)	23 (74.2)	8 (25.8)	0
Patients affected with nasal allergy			
Nasal symptoms adversely affect athletic performance (n = 43)	23 (53.5)	19 (44.2)	1 (2.3)
Nasal symptoms <i>during</i> indoor exercise			
Runny nose (n = 44)	25 (56.8)	19 (43.2)	0
Nasal congestion (n = 27)	17 (63.0)	9 (33.3)	1 (3.7)
Postnasal drip (n = 19)	18 (95.0)	1 (5.0)	0
Nasal symptoms <i>after</i> indoor exercise			
Runny nose (n = 37)	19 (51.4)	18 (48.6)	0
Nasal congestion (n = 20)	11 (55.0)	7 (35.0)	2 (10.0)
Postnasal drip (n = 22)	16 (72.7)	6 (27.3)	0
Unaffected patients			
Nasal symptoms adversely affect athletic performance (n = 23)	14 (60.9)	7 (30.4)	2 (8.7)
Nasal symptoms <i>during</i> indoor exercise			
Runny nose (n = 36)	26 (72.2)	8 (22.2)	2 (5.6)
Nasal congestion (n = 14)	10 (71.4)	3 (21.4)	1 (7.2)
Postnasal drip (n = 8)	3 (37.5)	4 (50.0)	1 (12.5)
Nasal symptoms <i>after</i> indoor exercise			
Runny nose (n = 18)	13 (72.2)	4 (22.2)	1 (5.6)
Nasal congestion (n = 10)	7 (70.0)	3 (30)	0
Postnasal drip (n = 9)	7 (77.8)	2 (22.2)	0

moderate. Only a few participants reported severe symptoms with exercise.

DISCUSSION

This study demonstrates that EIR frequently occurs in individuals with and without nasal allergy, and these symptoms are perceived to adversely affect athletic performance. Individuals with nasal allergy more frequently reported that EIR adversely affected their athletic performance compared with unaffected individuals. Individuals affected with nasal allergy were also more likely to have EIR than unaffected individuals, and the most common symptom experienced by both groups was rhinorrhea or runny nose. Furthermore, as anticipated, outdoor exercise triggers rhinitis to a greater degree than indoor exercise. Although the current practice guidelines only list exercise as a potential cause of rhinitis syndromes,¹⁶ these data suggest that EIR commonly occurs and warrants enhanced attention by clinicians who treat rhinitis syndromes.

The observation in this study that nasal symptoms occurred frequently and were bothersome to the individual may appear to be in contrast to previous studies that demonstrated a decrease in nasal resistance with exercise,⁷⁻¹¹ which leads to

the assumption that nasal symptoms improve rather than worsen with exercise. However, those studies have been conducted in research environments with nasal patency as measured by rhinomanometry as the primary outcome, and information regarding subjective measurements of other nasal symptoms, such as rhinorrhea or postnasal drip, was not obtained. In addition, given the nature of these studies, only a small number of individuals could be evaluated. This is now the second study to survey a large number of young, athletic adults and detect a large frequency of EIR.¹⁴ However, our findings are not inconsistent with other previous studies, because nasal congestion was not commonly reported. Instead, rhinorrhea or runny nose was the predominant nasal symptom experienced in those who indicated an increase in nasal symptoms with exercise.

In the past, several reasons to explain the decrease in nasal resistance with exercise have been proposed. The older literature suggests that passive decongestion of the nasal mucosa due to a redistribution of blood flow and/or active decongestion due to an increased tonus of the nasal vessels, a change in the fluid content of the extravascular space, and action of the alar muscles might be playing a role in decreasing nasal resistance.⁸ The most

current explanation for a decrease in nasal resistance is that exercise excites the sympathetic nervous system and decongestion of the nasal mucosa is induced by the shrinkage of the nasal vessels via the cervical sympathetic trunk.¹⁹

Although the immunological and anatomical connections between the upper and lower airways, referred to as the one-airway hypothesis, have gained increasing attention and support,¹⁵ the mechanisms do not appear to be similar in regard to how the nose and bronchi respond to exercise. The response of the nose as measured by rhinomanometry and the response of the bronchi as measured by FEV₁ to exercise in patients with rhinitis and asthma are different.¹¹ The nose becomes more patent and the bronchi become more narrowed.¹¹ Given these differences, the underlying mechanisms responsible for EIR are likely not related to airflow resistance as observed in exercise-induced bronchospasm or asthma.

Instead, the reasons to explain EIR may be more similar to that of vasomotor rhinitis. Vasomotor rhinitis is classically provoked by nonspecific irritant stimuli, such as cold dry air, perfumes, paint fumes, and cigarette smoke.¹⁶ Individuals with vasomotor rhinitis can have predominant symptoms of rhinorrhea or nasal congestion and minimal rhinorrhea. Although not proven, it is believed that vasomotor rhinitis occurs due to increased neural efferent traffic to the blood vessels supplying the nasal mucosa.¹⁶ Enhanced cholinergic glandular secretory activity may be responsible for eliciting rhinorrhea, whereas those with nasal congestion and blockage may have nociceptive neurons with heightened sensitivity to innocuous stimuli.¹⁶ In this current study, patients with EIR were more likely to have runny nose rather than nasal congestion, suggesting that cholinergic stimulation may be playing a role. If this is the case, then EIR might serve as a model for the study of vasomotor rhinitis.

It is possible that EIR may elicit the release of inflammatory mediators in the nasal mucosa. This study was not invasive and did not evaluate individuals for biomarkers of inflammation. Others have shown that cold, dry air but not warm, moist air elicited the release of histamine, prostaglandin D₂, bradykinin, and [3H]-N-a-tosyl-L-arginine methyl ester-esterase activity from the nose, which was associated with symptoms of rhinorrhea and nasal congestion.²⁰ The findings presented here are from studies conducted in the fall months (September-October) near Denver, CO, which is a semiarid environment with relatively low humidity; therefore, it could be argued that respondents were exposed to "dry" air. However, the focus of the study was on indoor not outdoor environments. It is possible that exposure to formaldehyde, glues, paints, cleaners, and vinyls in indoor recreational centers may be in part responsible for the nasal symptoms experienced.¹²

Individuals with nasal allergy not only reported more nasal symptoms with indoor exercise but also were more likely to be adversely affected by EIR during exercise. Nasal allergies were identified and grouped by self-report, and it is possible that respondents overreported the presence of nasal allergies. However, one of the strengths of this study is that patients who were receiving allergy immunotherapy were targeted; therefore, of the total patients reporting nasal allergy, 73% were receiving allergy

immunotherapy. Therefore, the group identified with nasal allergy was likely appropriately labeled. Although our intention of targeting patients who were receiving allergy immunotherapy was to ensure that most patients with nasal allergy did indeed have true allergic rhinitis, it could be argued that these patients were better controlled as opposed to patients not receiving allergy immunotherapy. Further evidence to suggest that this group may have been better controlled is that 60% of the patients with nasal allergy were not taking antiallergy medication. Because of the low numbers of patients taking antiallergy medication, we were unable to draw any firm conclusions about the role of various antiallergy medication and EIR. Thus, in future studies it may be more appropriate to identify and stratify patients based on either severity of allergic rhinitis or type of medications used to control nasal symptoms. Furthermore, patients with a physician-diagnosed allergic rhinitis as opposed to including only those receiving immunotherapy would be adequate for future studies. However, this study demonstrates that even in patients with presumably better-controlled nasal allergy, a high percentage reported symptomatic EIR; therefore, further therapy is warranted to control their symptoms during exercise.

The reasons why patients with underlying allergy were more likely to experience EIR are unclear but may be related to underlying nasal mucosal inflammation. As discussed herein, in patients with baseline rhinitis, it has been demonstrated that challenge with cold, dry air elicits the release of inflammatory mediators associated with mast cells.¹⁸ It is possible that mast cells already recruited to the nasal epithelium by continual allergy exposure are stimulated during exercise, resulting in EIR. This may explain why patients with allergic rhinitis experienced more nasal symptoms with exercise than nonallergic individuals.

Nasal symptoms were more commonly reported to occur during exercise compared with after exercise, although these differences were minor. It is known that in the laboratory, there is a rebound or a return to preexercise nasal resistance 15 to 20 minutes after exercise.⁹ Patients with allergic rhinitis have been shown to have an especially strong rebound increase in nasal airflow resistance after exercise.⁹ This finding has been attributed to excessive dilatation of the nose after exercise. A conclusion from these previous studies was to assume that nasal symptoms would worsen after, rather than during, exercise. Again, one explanation is that these previous studies only evaluated nasal congestion not rhinorrhea, which was most commonly found by these data. However, it is also possible that recall bias may explain why individuals reported symptoms during exercise and not after exercise. Another possible reason to explain these findings is that respondents subjectively answered if EIR occurred after exercise, and a specific interval for nasal symptoms that occurred after exercise was not defined. In addition, nasal congestion needs to be present at baseline for individuals to report improvement with exercise. Respondents were not asked about their baseline symptoms, so any conclusions on this issue are limited. Thus, more studies are warranted to corroborate these findings before any firm conclusions can be drawn about the mechanisms responsible for EIR.

Well-recognized and validated rhinitis quality-of-life questionnaires are available that focus on 3 main activity categories: regular activities at home and at work, social activities, and outdoor activities.¹⁹ However, these questionnaires do not ask about specific nasal symptoms associated with indoor exercise. Thus, an original questionnaire was developed for this study, but it has several limitations, including lack of validation. Although the primary objective in the design of the questionnaire was to ascertain the prevalence by yes/no responses and the nature of EIR, the questionnaire used in this study does not adequately allow the respondent to characterize the symptoms on a meaningful scale, such as a 5- or 7-point scale. Therefore, this questionnaire could not be used for possible interventional studies in which treatment efficacy is evaluated. An additional limitation to this study was that the respondents were primarily non-Hispanic white women; therefore, the findings from this study may not apply to other populations. However, even given these limitations, the findings from this questionnaire study provide insight and useful information in an area that has been otherwise overlooked. The data obtained from this study should prompt others to further investigate the effects and treatment of EIR.

CONCLUSIONS

Although EIR has not received much attention, this study showed that indoor EIR was a common finding in athletic adults regardless of their underlying allergic status. Individuals with nasal allergy were more likely to have EIR, and EIR was more likely to adversely affect exercise than in unaffected individuals. Although previous studies have only focused on nasal congestion and have demonstrated decreased nasal resistance with exercise, this study showed that individuals with indoor EIR most commonly reported increased rhinorrhea. However, a significant percentage of the population subjectively reported the occurrence of nasal congestion and postnasal drip with exercise. Although further studies are necessary to characterize the underlying mechanisms and optimal treatment for EIR, clinicians who treat rhinitis syndromes need to be aware that indoor exercise elicits nasal symptoms that adversely affect that individual's athletic performance. Therefore, in determining precipitating causes of rhinitis, indoor and outdoor exercise as potential triggers need to be added to the complete rhinitis history.

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Requests for reprints should be addressed to:

William S. Silvers, MD

Allergy, Asthma & Immunology Clinic of Colorado

7180 E Orchard Rd

Suite 208

Englewood, CO 80111

E-mail: skiersnoz@silversmd.com