Exercise-induced Airflow Obstruction in a Healthy Military Population*

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Clinical asthma is estimated to occur in 4 to 7 percent of the US population,1 however, complaints of wheezing and rhinitis are much more common in general surveys. Nineteen percent of an Arizona population2 and 37 percent of a group of medical students3 had such a history in recent studies. The incidence of exercise-induced airflow obstruction is not well known in healthy adults. We studied 100 consecutive US Air Force members to determine the prevalence of respiratory symptoms and the incidence of airflow obstruction after standardized free-run exercise. Subjects who developed airflow obstruction with exercise underwent methacholine challenge. We found that 31 percent of our population had respiratory complaints, but only 6 percent had significant airflow obstruction after exercise. Three of six subjects with abnormal results on exercise spirometry had bronchial hyperresponsiveness in response to methacholine. In summary, objective evidence of exercise-induced airflow obstruction was uncommon in our healthy subjects, although nonspecific respiratory complaints were frequent. In our study, methacholine challenge was positive in only half the subjects with abnormal spirometric data after exercise. We conclude that the diagnosis of exercise-induced asthma in healthy individuals is difficult because of the uncertain relationship between symptoms and objective testing and between modes of objective testing. Additionally, the role of free-run exercise testing needs further investigation in adults being screened for asthma. (Chest 1993; 103:742-44)

Clinical asthma occurs in 4 to 7 percent of the US population; however, complaints of wheezing and rhinitis are much more common in general surveys. Nineteen percent of an Arizona population and 37 percent of a group of medical students had such a history in recent studies. The incidence of exercise-induced asthma is difficult to determine because of the frequency of respiratory symptoms in exercising subjects without objective evidence of airflow obstruction. Another confounding factor is that airflow obstruction is variable and changes from one point in time to the next, and the findings from even standardized tests of bronchial hyperresponsiveness may vary at different times.4

We undertook a prospective study to determine the incidence of respiratory symptoms and exercise-induced airflow obstruction in a healthy population of military health-care workers.

**MATERIALS AND METHODS**

**Subjects**

One hundred consecutive subjects were recruited at the annual military aerobics test for our hospital. All subjects were active-duty US Air Force nonflying hospital personnel, and therefore they had been screened for asthma at the time of entry into military service. Persons with a history of asthma after the age of 12 years are disqualified for entry; however, Air Force members not on flying status generally remain on active duty if asthma develops during their active-duty tenure. At the time of this study, there was no regular aerobics exercise program ongoing at our facility.

Data Collection

Subjects completed a questionnaire that included demographic information, smoking history, past and present respiratory symptoms, and usage of medication.

Exercise Testing

All subjects performed the timed 1.5-mile run in 16 min or less. The run was held in early spring when ambient temperature was approximately 18°C (65°F) and humidity was low. Spirometry was performed on each subject with a portable battery-powered device prior to and at 5 to 15 min after completing the exercise. The best of three efforts was recorded for each test. A 15 percent fall in FEV₁ after exercise was considered abnormal.

Methacholine Challenge

Subjects who had abnormal findings on an exercise test returned for a methacholine challenge in the pulmonary function laboratory on another day. Methacholine challenge was performed as described by Chatham et al.5 and a 15 percent fall in FEV₁ was considered abnormal.

This study was approved by the institutional review board of the hospital, and informed consent was obtained from all subjects undergoing methacholine challenge.

**RESULTS**

There were 68 men and 32 women enrolled in the study. Ages ranged from 19 to 50 years, with a mean of 29 years. All subjects were hospital personnel, including physicians, nurses, administrators, and technicians, and there were no trained athletes. Table 1 summarizes the self-reported smoking and respiratory histories of the enrolled subjects. Thirty-one subjects had at least one respiratory complaint. Respiratory complaints were reported by 8 of the 24 smokers (33 percent) and 23 of the 76 nonsmokers (30 percent).

Six subjects reported a current diagnosis of asthma, but only one subject (a self-reported asthmatic) was taking an inhaled bronchodilator. Two subjects were
Table 1—Results of Questionnaire on Symptoms

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes (n)</th>
<th>No (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current or former smoker?</td>
<td>24</td>
<td>76</td>
</tr>
<tr>
<td>Do you have asthma?</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td>Did you have asthma in childhood?</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>Do you have shortness of breath or wheezing?</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Do you develop wheezing with colds?</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td>Do you have a history of allergies?</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td>Allergy medications (see text)</td>
<td>11</td>
<td>89</td>
</tr>
</tbody>
</table>

receiving desensitization injections for rhinitis, two were receiving nasal steroids, and three were receiving oral antihistamines. Only 1 of the 100 subjects had abnormal spirometric data before exercise (FEV₁ < 75 percent of predicted).

Six of the 100 tested subjects had abnormal spirometric data after exercise (FEV₁ decrease of 15 percent or greater). Subsequent methacholine challenge was positive in three of these six individuals and negative in the other three. Of the three methacholine-positive subjects, one was a smoker, and two reported respiratory symptoms (one with current asthma and one with childhood asthma). Likewise, among the three methacholine-negative individuals, there was one smoker and two with symptoms (both with exertional dyspnea or wheezing). None of these six individuals was using an inhaled bronchodilator.

Discussion

Our finding that 31 percent of the subjects had nonspecific respiratory complaints is consistent with other surveys. In a longitudinal study using questionnaires done in Arizona, 19.2 percent of the population admitted to wheezing, 17.9 percent to cough, and 44.1 percent to allergic rhinitis. Weiler et al. studied a group of young adults and found that 14 percent of a college football team, 12 percent of a college basketball team, and 17 percent of a group of medical and physician assistant students had respiratory symptoms after exercise. These specific data are all similar to our findings summarized in Table 1.

Six of our 100 subjects reported having current asthma, although none of these six had abnormal baseline spirometric data, and only one had abnormal findings on an exercise test and a positive methacholine challenge. Five of our six subjects with abnormal spirometric data after exercise had no self-reported history of adult asthma. In our group, therefore, the self-reported history of asthma was generally not confirmed by objective testing.

Only 6 of our 100 subjects showed an abnormal decline in FEV₁ after exercise, and half of these (3 of 6) had a positive methacholine challenge. This 6 percent rate is similar to that found in other healthy adult populations screened with inhaled agents and in pediatric populations screened with exercise testing. Our 6 percent positivity was markedly less than that of Weiler et al., who found that up to 50 percent of a sample of college athletes and students had bronchial hyperresponsiveness demonstrated by methacholine testing. One may speculate that the very high rate of Weiler et al. may have been due to unique environmental stimuli and resultant atopy in Iowa that were not present in Texas, where our study was conducted.

A notable finding in our group was the difference in the results of exercise testing and methacholine challenge. Other adult populations tested with both methacholine and exercise have shown that methacholine is generally a more sensitive test than exercise in detecting bronchial hyperresponsiveness, however, these studies included only small numbers of subjects and many asthmatic patients. In a study of 527 children, histamine challenge was found to be a more sensitive test than exercise. Exercise testing has not been used as a screening tool in previous studies of large adult populations, so our finding that exercise was a more sensitive screening tool than methacholine in our subjects will require further validation. Specifically, testing all adult subjects with both exercise and inhalation challenge needs to be done to draw firmer conclusions.

The nonstandard nature of the exercise testing in our study is a potential deficiency of the design of our study. There is debate in the pediatric literature on the merits of free-run versus treadmill testing. The free run was a more sensitive test than treadmill exercise in a group of 102 young atopic subjects without clinical asthma. Free-run testing has not been widely done in adult studies, but it more closely approximates the real-life situation in which adults develop respiratory symptoms. Therefore, our results suggest that further studies of free-run testing are needed in adults.

Other considerations in analyzing the design of our study include the timing of spirometry at 5 to 15 minutes after the completion of exercise. We chose this interval because Chatham et al. found that peak bronchospastic responses occurred within the initial 15 minutes after exercise, and this criterion has been widely used in other studies. New data suggest that bronchospasm may occur up to 30 minutes after exercise, so it is possible that we may have missed some abnormal results because of the design of our study.

Finally, this study must be interpreted in light of the subjects and the environmental factors. All subjects were active-duty military medical personnel who did not have active asthma between the age of 12 years and the time of entry into military service. They were not trained athletes and therefore were generally...
typical of the population that staffs any hospital in North America. The study was conducted in the dry environment of Ft. Worth, Tex., during a temperate time of the year. Specific allergy testing was not done on objects who participated, so atopy specific to the population or its environment was unknown.

We conclude that in our sample of healthy military personnel, nonspecific respiratory symptoms were common, but objective evidence of bronchial hyperresponsiveness was not. Exercise testing yielded more abnormalities in airflow than did methacholine challenges, although the numbers tested with methacholine were small. Our study demonstrates that the diagnosis of exercise-induced asthma is difficult, given the poor correlation between symptoms and objective testing and between modes of objective testing. The relationship of nonspecific bronchial hyperreactivity and clinical asthma has recently been called into question by Josephs et al,14 who longitudinally studied 12 adult and 8 pediatric asthmatic patients. These investigations14 found no consistent correlation between symptoms and methacholine responsiveness. Likewise, after studying 2,053 children in New Zealand, Pattemore et al15 concluded that nonspecific bronchial hyperreactivity is related to but not identical to clinical asthma.

Further study is clearly needed to evaluate the role of exercise testing and the merits of free-run versus treadmill testing in adults. Methacholine challenge may not be the best test, particularly when patients complain of exercise-related symptoms. As Cockcroft and Hargrave4 have noted, airway responsiveness varies from one point in time to another. Additionally, exercise may promote bronchial hyperresponsiveness by different mechanisms than methacholine.9 Our study demonstrates the frequency of respiratory complaints in a healthy adult population and the need for better data on objective testing in order to make the diagnosis of asthma.

REFERENCES