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Exercise-Induced Asthma in Figure Skaters*

Edward T. Mannix, PhD; Mark O. Farber, MD; Paolo Palange, MD; Pietro Galassetti, MD; and Felice Manfredi, MD

Many highly trained athletes experience exercise-induced bronchospasm (EIB); studies describing EIB in figure skaters, who may be at increased risk of EIB due to rink temperatures (7 to 10°C), have not been published. We studied professionally coached figure skaters (n=124) for EIB by spirometry at rinkside immediately before a simulated long program and at 0 to 1, 5, 10, and 15 min postexercise. Postexercise spirometry revealed the presence of EIB (a decrease from baseline in FEV₁ of at least 10%) in 43 skaters, while the remainder (n=81, control group) remained relatively stable. Pre-exercise FEV₁, FVC, and FEV₁/FVC ratio were not different between groups. The EIB group had significantly lower FEV₁ vs baseline at each measurement following exercise: baseline, 3.08±0.13; 0 to 1 min postexercise, 2.81±0.13 (p<0.05); 5 min postexercise, 2.77±0.14 (p<0.05); 10 min postexercise, 2.75±0.13 (p<0.05); 15 min postexercise, 2.78±0.13 (p<0.05). The EIB group also had lower FVC: baseline, 3.48±0.16; 0 to 1 min postexercise, 3.16±0.15 (p<0.05); 5 min postexercise, 3.19±0.15 (p<0.05); 10 min postexercise, 3.27±0.16 (p<0.05); 15 min postexercise, 3.26±0.16 (p<0.05). Control subjects, however, experienced no decline in these variables. In conclusion, the incidence of EIB in the figure skaters measured during this investigation (43 of 124=35%) is greater than that of the population at large and other highly trained athletes, signifying that screening for EIB and therapeutic follow-up are reasonable considerations for participants in this sport.

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Key words: athletes; exercise bronchospasm; hyperactive airways

Exercise-induced bronchospasm (EIB) or exercise-induced asthma is a common condition both in the general population1 and in highly trained athletes. The United States Olympic Committee reported that 67 of 597 athletes (11.2%) who competed in the 1984 Summer Games had EIB.2 It is defined as a decrease in lung function, usually greater than a 10% fall in FEV₁, occurring within 15 min after vigorous exercise, at a power output which elicits 85% or more of maximal O₂ consumption for 4 to 10-min periods.2,3 EIB typically starts 1 to 15 min following exercise, with spontaneous resolution to pre-exercise levels in 45 to 60 min.2 The mechanism thought to be largely responsible for EIB is evaporative water loss from the airway mucosa4 leading to local airway hyperosmolarity, which may trigger bronchospasm. Airway cooling also has been thought to play a precipitating role,5 as it is common for cold air inhalation to exacerbate bronchospasm in susceptible individuals.4

Figure skaters may be at increased risk for EIB because they are often subjected to extremely intense exercise (100% of predicted maximum heart rate) and cold air (7 to 10°C) during the 4 to 5-min periods which constitute their long program and for longer periods during training sessions. We therefore studied professionally coached US figure skaters, many of whom were nationally ranked, at the novice, junior, and senior levels with on-ice spirometry before and after a simulated long program to evaluate the pulmonary function response of this athletic subpopulation in their training-competitive environment.

METHODS

One hundred twenty-four figure skaters (ages 11 to 30 years old), including several national champions and medal winners, volunteered and gave informed consent for the study which was approved by the Indiana University Institutional Review Board. All participants had spirometry (Vitalograph, mode R; Vitalograph Medical Instruments; Lenexa, Kan) performed at rinkside (8°C, 60% humidity) immediately prior to and following (0 to 1, 5, 10, and 15 min) a simulated long program (4 to 5 min of strenuous skating routines). Results are expressed at body temperature, ambient pressure, saturated with water vapor.6 Eight athletes were known to have asthma and were taking prescribed medication; they continued their usual medication during the course of the study.

Criteria for EIA was a decrease from baseline in FEV₁ of 10% or greater.2,5 For statistical analysis, two groups were formed: those who experienced EIB, the asthma group, and those who did not experience EIB, the control group. Repeated measures analysis of

*From Indiana University Department of Medicine, Division of Pulmonary and Critical Care Medicine, and Roudebush Veterans Affairs Medical Center, Indianapolis.

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was variance was used to compare the time course of change for the criterion variables in the control and asthma groups. Significant F tests were followed by further analysis using a Student Newman-Keuls test to determine the exact points of difference. Analysis of variance was used for intergroup comparisons. For individual variables, such as maximum change from baseline, a paired t test was used. Significance levels of probability less than 0.05 were considered statistically meaningful. Simple, descriptive analyses were used to examine trends within each group.

**RESULTS**

Postexercise spirometry tests revealed the presence of EIB (a decrease from baseline FEV₁ of at least 10%) in 43 of 124 (35%) skaters. Nineteen of the 43 displayed decreases in FEV₁ of 15% or greater. When individual data for each subject were pooled and analyzed by parametric statistical analysis, no significant intergroup differences in criterion variables were observed during pre-exercise, baseline measurements (Fig 1). Intergroup comparisons of all data points indicated that the asthma group had significantly lower FEV₁ and FVC than control subjects following exercise; no intergroup difference was observed in FEV₁/FVC ratio. The asthma group experienced significant declines in FEV₁ and FVC at each time point during postexercise measurements so that at 15 min postexercise this group was still experiencing a significant decline from baseline in both variables. The asthma group also displayed a negative deflection in the FEV₁/FVC ratio, with a significant decrease in this variable observed 10 and 15 min postexercise. The control group experienced slight, insignificant fluctuations in FEV₁ and FVC during the 15-min postexercise measurement period. A significant (p<0.05) increase in the FEV₁/FVC ratio for control subjects was observed 0 to 1 min following exercise.

Simple, descriptive statistical analyses were performed in an attempt to examine more clearly trends within each group. These analyses revealed that within the asthma group, the range of decline in FEV₁ was -10 to -67%. The average negative maximal deflection from baseline for FEV₁ of the asthma group was -18%. The time points at which the greatest decline in FEV₁ from baseline occurred for each of the asthma group skaters were as follows: 12 of 43 (27.9%) experienced the greatest decline in FEV₁ at 0 to 1 min postexercise; 10 of 43 (23.2%), at 5 min postexercise; 9 of 43 (20.9%), at 10 min postexercise; and 12 of 43 (27.9%), at 15 min postexercise.

In the control group, descriptive statistics revealed that 52 of 81 (64.2%) experienced an increase in FEV₁ following exercise. The other control skaters either experienced a slight decrease in this variable (<10%) or no change. The range of increase in FEV₁ for controls was 1.4 to 20.0%, with an average increase in FEV₁ (for those experiencing an increase) of 7.0%. In addition, 23 of 81 (28.3%) of the healthy control subjects demonstrated the greatest increase in FEV₁ at 0 to 1 min postexercise; 11 of 81 (13.6%), at 5 min postexercise; 8 of 81 (9.9%), at 10 min postexercise; and 10 of 81 (12.3%), at 15 min postexercise.

**DISCUSSION**

The most important finding of this study is that the incidence of EIB among highly trained figure skaters is significantly greater than that of the population at large and apparently greater than that of many other athletes who participate in supervised training programs. In addition, very few of those who experienced EIB following on-ice testing were aware of the magnitude of their breathing problem and its potential for affecting on-ice performance during training and competition.

The incidence of asthma in the general population...
is reported to be 4 to 7%, and 80% of these would be expected to have EIB. Initial reports concerning the incidence of EIB in athletes included the somewhat surprising finding that 11% of the US 1984 Summer Olympic Team experienced EIB. Weiler and coworkers studied the prevalence of bronchial hyperresponsiveness in highly trained college athletes and found that 18 of 151 (12%) football players admitted to a history of asthma, 29 of 151 (19%) indicated the existence of asthma-like symptoms after exercise, and 76 of 151 (50%) had a positive response to a methacholine challenge. These results, plus the findings presented in this report, underscore the need for assessment and therapeutic control of EIB in organized sports.

Differing definitions of EIB may lead to variable estimates of the prevalence of this disorder. Many authors have defined EIB as a fall in FEV₁ of 10% or more, while others define EIB as a reduction of 15% or more. A change in FEV₁ of 10% from baseline has been shown to represent a change greater than two SDs of the normal response.

Symptoms of EIB can be vague and often ascribed to the results of exercise itself. Other than the eight known asthmatic subjects who were tested in the present study, very few of the other skaters who experienced EIB reported any history of breathing difficulties in a health questionnaire which was filled out by all who were tested. Apparently, highly trained athletes are reluctant to complain of symptoms which could be construed as "psychological" or as not having an obvious basis in physical disability. Many of these individuals, upon close personal questioning, revealed significant symptoms which led us to suspect that there indeed was a problem occurring with exercise.

The normal response to exercise tends to be slight bronchodilation, with small increases in FEV₁ and FVC; the FEV₁ should certainly not decrease by more than 10% following exercise. In the present study, neither FEV₁ or FVC increased significantly in the control group. There was, however, a significant increase in the FEV₁/FVC ratio noted in the control subjects immediately following exercise, indicating an exercise-induced improvement in airflow characteristics.

The timing of the exercise-induced changes in airflow for the asthma group indicates two time points when skaters experienced their greatest decline in FEV₁: the 0 to 1 min and 15 min postexercise time points. The 0 to 1-min decline is earlier than one might expect, since other investigators have reported that the greatest decline in airflow occurs 5 to 25 min postexercise. Perhaps the more rapid onset of bronchospasm in some of the skaters is related to an additive effect of vigorous exercise plus the cold ambient conditions, two factors which can independently cause bronchospasm. Air pollution from ice grooming equipment could also be a contributing factor.

It also may be interesting to speculate whether at least some of the observed EIB is acquired as a result of years of exposure to high-intensity exercise in a cold environment. Resolution of this question would require long-term, follow-up testing or prospective testing of young skaters as their skating careers begin.

Although all eight previously known asthmatic subjects were receiving treatment under the supervision of a physician, virtually none of these treatments was satisfactory, either in terms of effect or in approaching what some would consider to be standard care for EIB. Each of these asthmatic subjects experienced significant declines in FEV₁ and FVC during the testing sessions. Those athletes, five in number who had EIB only, were taking only one medication prior to exercise. None used their medication routinely at least 15 min prior to heavy exercise, and most did not use their medication regularly during training sessions. The athletes believed that if they utilized inhaled medication 2 to 5 min prior to exercise that this would achieve adequate airway protection. The concept of maintaining and increasing training intensity by regular use of the medication during the day on a routine basis had not been broached to these young competitors. There was no uniformity of treatment encouraged or mandated by any governing body, and there had been no provisions for follow-up testing for any of the athletes to determine whether their treatment had indeed achieved any normalization of function.

Pulmonary function testing is easily carried out at training and competition sites and under these conditions probably yields the most useful information concerning EIB in competitive athletes. Medical questionnaires filled out by the athletes often leave out crucial information regarding symptoms during and after exercise which can be elicited by a direct medical interview. Evaluating FEV₁ and FVC responses to the athletes' exercise affords the greatest opportunity to establish a diagnosis compatible with EIB.

It is the hope of this investigative team that the results reported here will help establish guidelines for ongoing and future programs for competitive athletes which will mandate that all skaters are tested and retested and that prescribed medication is closely evaluated for its efficacy for treating EIB. Goals of therapy for competitive athletes should be a normalization of lung function after exercise in order to be able to achieve peak performance as well as to be able to train at the necessary intensity to achieve such performance.

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