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Perception of Bronchoconstriction Following Methacholine and Eucapnic Voluntary Hyperpnea Challenges in Elite Athletes

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Objective: **Self-reported respiratory symptoms are poor predictors of exercise-induced bronchoconstriction (EIB) in athletes. The objective of this study was to determine whether athletes have an inadequate perception of bronchoconstriction.**

Methods: **One hundred thirty athletes and 32 nonathletes completed a standardized questionnaire and underwent eucapnic voluntary hyperpnea (EVH) and methacholine inhalation test. Perception scores were quoted on a modified Borg scale before each spirometry measurement for cough, breathlessness, chest tightness, and wheezing. Perception slope values were also obtained by plotting the variation of perception scores before and after the challenges against the fall in FEV_1 expressed as a percentage of the initial value [(perception scores after − before)/ FEV_1].**

Results: **Up to 76% of athletes and 68% of nonathletes had a perception score of ≤0.5 at 20% fall in FEV_1 following methacholine. Athletes with EIB/airway hyperresponsiveness (AHR) had lower perception slopes to methacholine than nonathletes with asthma for breathlessness only (*P* = .02). Among athletes, those with EIB/AHR had a greater perception slope to EVH for breathlessness and wheezing (*P* = .02). Female athletes had a higher perception slope for breathlessness after EVH and cough after methacholine compared with men (*P* < .05). The age of athletes correlated significantly with the perception slope to EVH for each symptom (*P* < .05).**

Conclusions: **Minimal differences in perception of bronchoconstriction-related symptoms between athletes and nonathletes were observed. Among athletes, the presence of EIB/AHR, older age, and female sex were associated with slightly higher perception scores.**

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Abbreviations: AHR = airway hyperresponsiveness; EIB = exercise-induced bronchoconstriction; EVH = eucapnic voluntary hyperpnea; MIT = methacholine inhalation test; PC_{20} = provocative concentration of methacholine causing a 20% fall in FEV_1; PS_{20} = perception score on the Borg scale at 20% fall in FEV_1

The prevalence of airway hyperresponsiveness (AHR) to various stimuli has been shown to be high in endurance sports athletes.[1] The use of self-reported symptoms to establish a diagnosis of exercise-induced bronchoconstriction (EIB), as assessed through questionnaires or reported to the physician, results in a high frequency of both false-positive and false-negative diagnoses in this population.[2,3] Self-reported respiratory symptoms are not specific enough for the diagnosis of AHR or EIB in athletes.[2] The reasons for this observation are still unclear, and whether athletes have an impaired perception of bronchoconstriction remains to be determined.

Perception of bronchoconstriction following bronchial provocation challenges has been studied in the general population and in subjects with asthma.[4-10] It varies widely among individuals, and depending on the method used, 15% to 60% of adults with asthma can be defined as poor perceivers of bronchoconstriction.[4,7,11] This point is important to consider because failure to perceive bronchoconstriction may lead to decreased therapeutic compliance[12] and an increase in asthma morbidity and mortality.[13,14]

In the general population, the prevalence of asymptomatic AHR is < 15%.[15] In elite athletes, we reported a significantly higher prevalence of asymptomatic

AHR in swimmers (24%) than in winter sports athletes (7%).[3] We suggested that swimmers may have a poor perception of bronchoconstriction, whereas winter sports athletes may have more symptoms triggered by cold air exposure, explaining their frequent complaints of exercise-induced cough.[3] There are several possible explanations for the discrepancies in symptom perception in athletes. First, a protective effect of greater baseline lung function may be present in athletes, especially in swimmers who usually have supranormal FEV_1,[16] ranging from 111% to 170% predicted.[1,3,17] Swimmers may not perceive a fall in FEV_1 of 10% or 20% if they already have such high FEV_1 values. Furthermore, the higher sputum eosinophil counts observed in the airways of swimmers with AHR and higher sputum neutrophil counts in athletes' airways in general[18] may also contribute to decreased respiratory symptom perception, as it has been observed in nonathlete subjects with asthma.[9,19,20] The age of athletes may influence symptom perception because adolescent swimmers have a lower prevalence of AHR/EIB than young adult swimmers.[3,21] Finally, sex may influence perception, thus, explaining the differences reported in asthma diagnosis and symptoms between women and men.[22]

The main aim of the present study was to determine whether competing athletes have a reduced perception of bronchoconstriction following bronchial provocation challenges. Possible discrepancies in respiratory symptom perception were, therefore, studied according to EIB/AHR status, sports performed, resting spirometric values, self-reported symptoms on questionnaire, age, and sex.

Materials and Methods

Subjects

Data on athletes from different sports disciplines and on nonathletes who visited our research center between 2007 and 2011 were analyzed. Subjects had to be aged 14 to 35 years, nonsmokers, and free of any disease that may have interfered with the study. Athletes had to be active competitors, training at least 10 h/wk. Nonathletes taking part in physical activities > 6 h per week or regularly exposed to a chlorinated environment were excluded. Subjects regularly using inhaled corticosteroids were also excluded. Written informed consent was obtained from all subjects or their legal guardian before inclusion in their respective study. Respective study protocols and analyses (1243, 20088, 20141, 20159, 20160, 201366, 20471) were approved by our institutional ethics committee (FWA00003485).

Design

This cross-sectional retrospective analysis was based on data from previous and ongoing prospective studies performed at our research center. The design of the tests has been previously described.[3] Only data from the baseline visit of subjects were considered. Physical examination was conducted, and a questionnaire on current health status and training was administered. Eucapnic voluntary hyperpnea (EVH) and methacholine inhalation test (MIT) were performed consecutively after recovery of expiratory flows within 10% of baseline. Test protocols were the same for all included studies, except nonathlete subjects with asthma had no EVH at the initial visit.

Baseline Spirometry

Spirometry was performed according to American Thoracic Society specifications.[23] Predicted values were defined according to Knudson et al.[24]

EVH Challenge

The EVH challenge was performed according to the method described by Anderson and Brannan.[25] The target ventilation was 30 times the baseline FEV_1. FEV_1 and perception scores were measured before and at 3, 5, 10, 15, 20, 25, and 30 min after EVH. A subject with ≥ 10% fall in FEV_1 at two consecutive time points was considered to have EIB.

Methacholine Inhalation Test

AHR to methacholine was measured using the 2-min tidal breathing method by Crapo et al.[23] After measurements of FEV_1 and FVC, subjects inhaled 0.9% saline followed by doubling concentrations of methacholine, ranging from 0.03 to 128 mg/mL, to obtain a 20% decrease in FEV_1. The response was expressed as the provocative concentration of methacholine causing a 20% fall in FEV_1 (PC_{20}) obtained from the log dose-response curve. AHR was defined as a PC_{20} < 16 mg/mL.

Perception of Bronchoconstriction

Cough, breathlessness, chest tightness, and wheezing were scored on a modified Borg scale (0-10).[5,26] Perception scores were recorded before each FEV_1 maneuver. The perception score on the Borg scale at 20% fall in FEV_1 (PS_{20}) during MIT was determined for each subject by interpolation of the two last perception scores.[11] Linear regressions and subsequent slope values were also obtained by plotting the variation of perception scores before and after the challenge against the fall in FEV_1, expressed as a percentage of the initial value [(perception score after − perception score before)/FEV_1 fall] as previously described by Burdon et al[5] and others.[8,9,20] Slopes were obtained for each symptom following EVH and MIT. For the purpose of this analysis, the higher of the two reproducible measurements at 3 min following EVH was used to calculate the maximal fall in FEV_1 and to evaluate symptom perception [Borg slope = (perception score after EVH at 3 min − perception score before EVH)/percentage of FEV_1 fall at 3 min]. For MIT, perception score before is the score following

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