

Original article

Predictive value of allergy and pulmonary function tests for the diagnosis of asthma in elite athletes

Background: Asthma is frequently found in athletes, often associated with rhinitis and allergy.

Aim: To study the predictive value of allergy and pulmonary function tests for the diagnosis of asthma in athletes.

Subjects and methods: Ninety-eight national preOlympic athletes underwent an accurate medical examination including a validated questionnaire for asthma and rhinitis, spirometric recordings and skin prick testing with a panel of the most frequent inhalant allergens. Bronchodilator and/or exercise challenge were also performed in asthmatic subjects.

Results: Clinical asthma was present in 20.4% of athletes, rhinitis in 35.3% (in 21.4% of cases alone and in 13.9% associated with asthma). Positive prick tests were recorded in 44.4% of athletes (in 60.5% of asthmatics, in 95.2% of rhinitics and in 21.0% of nonasthmatic – nonrhinitic subjects). Mean spirometric values and distribution of abnormal values were not different among asthmatics, rhinitics and nonasthmatics – nonrhinitic patients. Skin-tests positivity was not related to the abnormal spirometric data found in individual cases. Provocation tests with bronchodilators or exercise did not appear sensitive enough to diagnose mild forms of asthma in subjects with normal basal spirometric values.

Conclusions: Allergy testing and spirometry should be performed routinely in athletes because of the high prevalence of allergy, rhinitis and asthma in this population. However, the predictive value of these tests and of the bronchial provocation tests performed in this study seems too low to document mild or subclinical asthma in athletes.

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The prevalence of asthma in elite athletes has been reported to be particularly high, up to 22.8% in summer sports (1) and up to 54.8% in winter sports (2), also depending on methods used for diagnosis. Moreover, in studies performed in comparable population samples and with comparable methods of diagnosis, the disease seems to be on the increase, the prevalence of asthma having been recorded as 9.7% of US Olympic athletes in 1976 and as 21.9% in 1996 (3). Fatal asthma exacerbations may also occur in both competitive and non-competitive athletes during sports (4). Seventeen (1, 5) to 36.0% (2) of asthmatic athletes are current users of asthma medications, mainly inhaled β -2 agonists which are included by the World Anti-Doping Agency among prohibited drugs, only permitted with a documented diagnosis of asthma (6, 7). Accordingly, the diagnosis of asthma represents a very hot issue in sports medicine for an adequate and safe management of elite athletes (8, 9).

Rhinitis and atopy are also particularly frequent in athletes. In fact, at Sydney Olympics 29% and 41% of

Australian athletes had, respectively, seasonal allergic rhinoconjunctivitis and positive skin tests to at least one inhalant allergen (10). In another national delegation, the prevalence rates were 25% and 33% respectively (11). It is widely appreciated that rhinitis and asthma often co-exist and that up to 40% of allergic rhinitis subjects may have asthma (12). As longitudinal studies indicate that rhinitis frequently precedes the development of asthma (13) and many patients with rhinitis alone show nonspecific bronchial hyper-responsiveness (14), allergic rhinitis is considered a risk factor for asthma (15). Accordingly, the WHO guidelines on Allergic Rhinitis and its Impact on Asthma (ARIA) recommend that all subjects with rhinitis should be studied for asthma (16).

Standard spirometry is currently performed in elite athletes and may certainly document moderate to severe asthma. However, the predictive value of commonly used pulmonary function tests vs criteria suggested by the International Olympic Committee (IOC) for diagnosis of asthma in athletes (7) has not yet been investigated in

mild asthmatics or in rhinitis subjects with sub-clinical asthma. Similarly, the potential value of allergy tests in predicting rhinitis and/or asthma – as suggested by their preferential allergic origin in athletes – has not been extensively investigated.

We report here the results of allergy skin tests and spirometric tests in 98 preOlympic athletes and their predictive value for diagnosis of asthma in elite athletes.

Subjects and methods

Ninety-eight Italian preOlympic athletes (71 males and 27 females. Mean age 28 years; range 19–40) underwent an accurate clinical examination including anamnestic data collected through a standard validated questionnaire, spirometric tests and allergy skin tests. Data were related to the different sports disciplines of athletes, which were also grouped according to the intensity and length of effort as well as to the environment in which these were practised. Based on this subdivision, disciplines were classified to endurance ($n = 23$) and nonaerobic/mixed ($n = 75$) as well as indoor ($n = 42$), outdoor ($n = 54$) or mixed ($n = 4$).

Diagnosis of asthma and rhinitis

The diagnosis of asthma and/or rhinitis was made according to the GINA (<http://www.ginasthma.com>) and ARIA guidelines (16) and was based on a comprehensive evaluation of all clinical criteria (positive answer to key questions of a modified ECRHS (17) questionnaire, history, clinical documentation and objective examination at the time of the study).

Patients with both asthma and rhinitis were considered asthmatics.

Allergy tests

Allergy tests were executed by skin prick testing on the forearm of the athletes using the following panel of allergens (Lofarma, Italy): Grass, *Parietaria officinalis*, *Dermatophagoides pteronyssinus*, Olea, Ragweed, Alternaria, Artemisia, Cat dander.

Negative (diluent) and positive (histamine 1 mg%) controls were evaluated too. The presence of a wheal reaction > 3 mm in diameter was considered as a positive response.

Spirometric tests

Spirometric tests were performed with a Quark PFT2 spirometer (Cosmed). Values of $FEV_1 \leq 80\%$ of predicted and of $MMEF_{25-75\%} \leq 70\%$ of predicted were considered as abnormal. Exercise challenge was performed according to ATS guidelines for indications, contra-indications and assessment of response (18). The field challenge was performed according to the protocol of Rundell et al. (19). A fall of $FEV_1 \geq 10\%$ after a free running up to 85–95% of maximal heart rate at a temperature of 20–25°C with a relative air humidity below 50% was considered a positive response. Bronchodilator test was performed by measuring FEV_1 15 min after 200 µg inhaled salbutamol; an increase of 12% of predicted values was considered as a positive response. Asthmatic athletes with baseline $FEV_1 \leq 110\%$ of predicted value underwent a bronchodilator test, while those with baseline $FEV_1 \geq 110\%$ were challenged with a field exercise test.

Statistical analysis

The Statistical analysis was performed using the spss 13 Software. Student's *t*-test was used to compare mean spirometric values in the different groups, the chi-squared test for comparison of positive/negative results between groups. A *P*-value < 0.05 was considered statistically significant. The relative risk (RR) was also determined.

Results

A diagnosis of asthma was made in 20/98 athletes (20.4%). The prevalence rate of asthma was significantly ($P < 0.05$) higher in endurance athletes (7/23, 30.4%) than in other athletes (13/75, 17.3%), while it was not significantly different among indoor, outdoor and mixed disciplines. The overall prevalence of rhinitis was 34.7% (34/98), in 21 cases (21.4%) alone and in 13 cases (13.9%) associated with asthma. The prevalence of rhinitis was independent of the discipline practiced.

Positive skin tests to at least one allergen were recorded in 44 athletes (44.4%), *D. pteronyssinus*, Grass and *Parietaria* being the most frequent causes of sensitization. There was no difference in the type of sensitization between athletes exercising outdoor and indoor. In fact, 14 of the 27 athletes sensitive to *D. pteronyssinus* practiced outdoor sports and 12 of the 27 athletes sensitive to grass and/or *Parietaria* practiced indoor sports.

The presence of a positive skin test was significantly predictive of a clinical diagnosis of rhinitis (RR 4.9) but not of asthma. In fact, the prevalence of positive skin tests was 60.5% in asthmatic subjects, 95.2% in rhinitic ones (82.6% in the population of patients with rhinitis and asthma) and 21.0% in nonasthmatic – nonrhinitic athletes (Table 1).

In asthmatic subjects, mean spirometric values were normal ($FEV_1 99.9 \pm 13.0\%$; $MMEF_{25-75\%} 82.0 \pm 22.0\%$ of theoric value). Twelve out of 20 asthmatic athletes had FEV_1 values $> 100\%$ and only one showed an abnormal value of FEV_1 . $MMEF_{25-75\%}$ was below normal threshold in six subjects.

Mean spirometric values were also normal in rhinitic athletes ($FEV_1 102.8 \pm 14.1\%$; $MMEF_{25-75\%} 93.6 \pm 19.5\%$). However, three rhinitic athletes had FEV_1 or $MMEF_{25-75\%}$ below normal values.

Table 1. Allergy and pulmonary function tests in pre-Olympic athletes

	Asthmatic, ($n = 20$)	Rhinitics, ($n = 21$)	No clinical diseases, ($n = 57$)
Positive skin tests	60.5%	95.2%	21.0%
FEV_1 (% of theoric values)	$99.9 \pm 13.0\%$	$102.8 \pm 14.1\%$	$103.0 \pm 13.6\%$
$MMEF_{25-75\%}$ (% of theoric values)	$82.0 \pm 22.0\%$	$93.6 \pm 19.5\%$	$91.2 \pm 22.7\%$

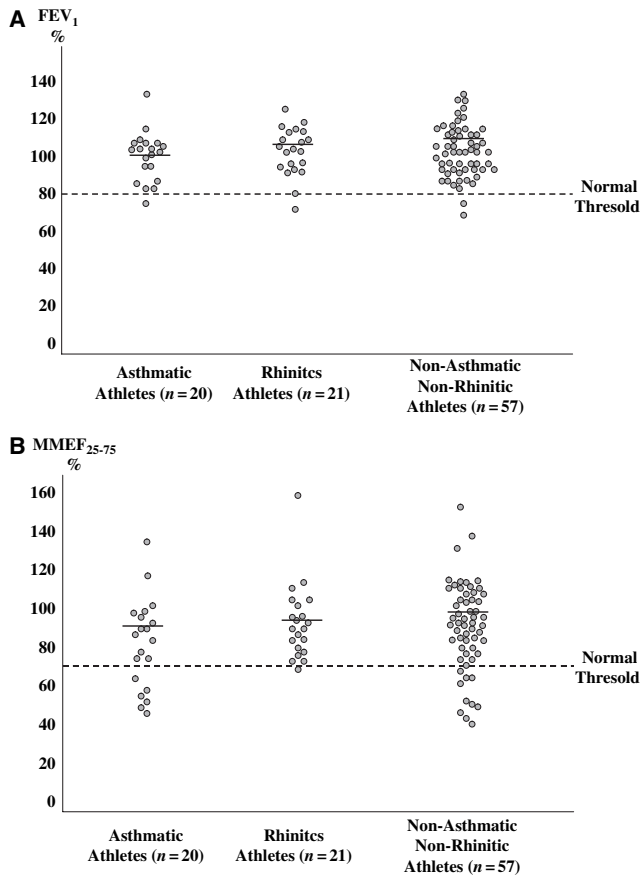


Figure 1. Pulmonary function tests [(A) FEV₁ as % of theoric values; (B) MMEF₂₅₋₇₅ as % of theoric values] in asthmatic, rhinitic and non-asthmatic/non-rhinitic athletes.

Table 2. Challenge tests in asthmatic athletes

Case no.	Baseline FEV ₁ (% predicted)	Postbronchodilator FEV ₁ (% predicted)	Postexercise FEV ₁ (% predicted)
1	105	110	
2	85	108	
3	102	110	
4	83	113	
5	89	105	
6	102	111	
7	84	n.p.	
8	95	110	
9	95	105	
10	106	108	
11	102	112	
12	105	109	
13	115		110
14	101	108	
15	78	139	
16	101	111	
17	107	109	
18	136		128
19	111		105
20	96	n.p.	

n.p. Not performed.

Abnormal values of FEV₁ (2/20) and of MMEF₂₅₋₇₅ (11/20) were also recorded in nonasthmatic – nonrhinitic athletes. Mean values of FEV₁ and MMEF₂₅₋₇₅ and distribution of abnormal values were not different among asthmatic, rhinitic or nonasthmatic – nonrhinitic athletes (Fig. 1A, B).

The presence of atopy was not related to abnormal spirometric values, as mean values of FEV₁, MMEF₂₅₋₇₅ and the distribution of abnormal values were not significantly different in allergic and nonallergic subjects, independently whether they had asthma, rhinitis or no clinical disease.

In the only one asthmatic athlete with an abnormal FEV₁ the bronchodilator test was positive, with an increase of 39.0% of the predicted value. However, in asthmatic subjects with normal basal FEV₁, the bronchodilator test was usually negative (Table 2).

Exercise provocation test was always negative in athletes with normal basal spirometric values, even in the presence of a positive history for asthma.

Discussion

The high prevalence of asthma found in this study (20.4%) is in agreement with data reported by other recent studies on elite athletes (1–3,5). Our results however suggest that the high prevalence in athletes is not confined only to swimmers and to those who perform endurance events particularly in cold climatic condition as long-distance runners, country-skiers and hockey players.

Asthma, even mild, is associated with a mixed type of eosinophilic and neutrophilic airways inflammation in athletes (20, 21). Interestingly, this inflammation disappears with finishing high level sports, while persists whether the activity is continued (22).

Our study also confirms the high prevalence of rhinitis and allergy in athletes, as previously reported (10, 11). A relevant finding is represented by the frequent association between rhinitis and asthma in athletes, as reported in the general population. In fact, 60.5% of our asthmatic subjects also had rhinitis and 38.2% of rhinitics were affected by clinical asthma too. Therefore, the WHO-ARIA recommendation to study all rhinitic patients for asthma and all asthmatic subjects for rhinitis should be extended to elite athletes too.

Out of 21 rhinitic athletes, 20 had positive skin tests while these were positive in 60.5% of asthmatics and in 21.0% of nonasthmatic – nonrhinitic athletes. Accordingly, skin prick test should be performed routinely in all athletes for the detection of the (frequent) sensitization. Positive skin tests may also be predictive of rhinitis with or without asthma but not of asthma alone.

Spirometry appears to be poorly sensitive to detect mild or intermittent asthma in athletes, possibly because

exercise training is associated with basal spirometric values above 100% of theoretic threshold in many athletes. On the other hand, spirometric tests may reveal subclinical abnormalities in a significant proportion of rhinitic and nonrhinitic – nonasthmatic athletes calling for further pulmonary function testing in these subjects.

The IOC includes positive response to bronchodilators among tests to prove asthma and to permit the use of β -2 adrenergic drugs in athletes (7). However, in our study, this test was often negative in the presence of normal spirometric values, thus suggesting that challenges inducing bronchoconstriction are more useful than those with bronchodilators to reveal asthma in subjects with normal basal spirometric values.

Among challenge tests, field exercise testing – although performed only in a few athletes with baseline FEV₁ values higher than normal – was poorly effective to document bronchoconstriction in athletes with normal spirometry and mild asthma. Accordingly, we would expect that field exercise test is not sensitive enough to reveal an abnormal subclinical bronchial reactivity in rhinitic patients too. Therefore, a subclinical bronchial hyperreactivity might be better documented through a set of direct and indirect bronchial challenges, including

methacholine test (which, in our opinion, represents the best test to prove bronchial hyper-reactivity in mild or subclinical asthma) or surrogates of exercise testing such as the eucapnic voluntary hyperventilation and the mannitol test (19, 23, 24).

In conclusion, asthma, rhinitis, and allergy are particularly frequent in elite athletes. While allergy and spirometry tests should be performed routinely in all athletes, they seem to have a low predictive value for the diagnosis of asthma. Accordingly, diagnosis of asthma in athletes still needs a more accurate protocol of pulmonary function testing which should find consensus of experts. This, while avoiding abuse of banned drugs, should guarantee adequate treatment to all asthmatic athletes.

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