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Prevalence of respiratory symptoms in an athlete population

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KEYWORDS

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Nociceptive symptoms;
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Elite athletes

Summary This study aimed to look at the prevalence and type of respiratory symptoms experienced by athletes and to assess the possible influence on the perception of symptoms of training duration and environment. A group of 698 athletes (107 with diagnosed or self-reported asthma) filled out a questionnaire on their respiratory condition. They exercised either in cold air ($n = 176$), dry air ($n = 384$), humid air ($n = 95$) or mixed dry and humid air ($n = 43$). Past exercise-related symptoms reported by athletes were breathlessness (48.7%), phlegm production (22.8%), wheezing (15.6%), cough (15.2%), and chest tightness (7.4%). Only 25% of asthmatic athletes reported having current exercise-induced symptoms of breathlessness, 21.7%, wheezing and 17.4%, chest tightness; current exercise-induced symptoms of breathlessness, wheezing or chest tightness were also reported, respectively, in 38.9%, 3.6% and 2.7% of athletes without a diagnosis of asthma. The perception of exercise-induced symptoms was not influenced by the duration of training or environment. In conclusion, (1) a minority of asthmatic athletes report troublesome respiratory symptoms with exercise, (2) breathlessness is not more frequently reported in asthmatic athletes than in those without such diagnosis while cough and wheezing are more common in asthmatic subjects and (3) the prevalence of respiratory symptoms is independent of training environment and duration of training.

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Introduction

The prevalence of asthma in athletes is higher than in the general population.^{1–10} Airway hyperresponsiveness is found in athletes more frequently than symptomatic asthma, with its prevalence ranging from 13% to 60%.^{11–16} The discrepancy between asthma and airway hyperresponsiveness may be due, in part, to a non-recognition or underreporting of exercise-induced respiratory symptoms, which may be considered as normal consequences of high-

intensity training by athletes. Training itself may increase the threshold beyond which respiratory nociceptive sensations are considered as abnormal symptoms as a result of temporal adaptation, as shown following allergen-induced bronchoconstriction.¹⁷

Asthma symptoms include mainly breathlessness, chest tightness, dyspnea, wheezing, phlegm production and cough. Among respiratory symptoms, “dyspnea”, or breathlessness, have been the most frequently studied; they, however, describe a variety of uncomfortable respiratory sensations and different descriptive terms have generally been used to define the sensations associated with bronchoconstriction.¹⁸ These last may however be

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influenced by the frequency and intensity of respiratory symptoms, following intense stimuli such as in competitive sport. Furthermore, other factors, such as the type of training environment, may influence the perception of respiratory symptoms.

This study therefore looked at the prevalence and perception of respiratory symptoms in high-level athletes practicing sports demanding intense respiratory work. To our knowledge, no data have been reported on the prevalence and characteristics of various asthma-related respiratory symptoms in athletes during exercise and on the influence of training environment (dry air, cold air, humid air, mixed dry and humid air) or duration of training on the perception of symptoms.

Methods

Subjects

This study has been done as a part of a survey of 1469 athletes from the province of Quebec, selected from a list of sports disciplines provided by the Sports Activity branch of the Government of Quebec, who were mailed a questionnaire on respiratory condition. A total of 33 sports disciplines were selected for this project. Subjects were contacted by this means without initial knowledge of the investigators of their asthmatic or atopic status. Seven hundred athletes, mean age 19.2 ± 0.2 , returned their completed questionnaires. Out of these, 698 were adequately completed. The athletes were analyzed as a single group for their respiratory symptoms related to exercise, but also by sub-group, according to the type of air inhaled during training: cold air, dry air, humid air and mixed (dry and humid) air (Table 1).

Study design

The questionnaire completed by the athletes included questions on gender, age, past and present history of asthma, medication, respiratory infections, respiratory symptoms associated with exercise and nociceptive sensations related to their respiratory condition. This study was part of a research program on respiratory health of the athlete populations in the Province of Quebec.

Questionnaire

The respiratory questionnaire, administered in French, was translated from a questionnaire used

Table 1 Subjects' characteristics.

Gender	384 F, 314 M
Age (Mean \pm sem)	19.2 ± 0.2
Range	10–61
Pulmonary health status	
Physician diagnosed asthma	92 (13.2%)
Self-reported asthma	15 (2.1%)
No asthma	591 (84.7%)
Current or past use of asthma medication	
Physician diagnosed asthma	
Short-acting β_2 -agonists (S-a β_2)	38
Long-acting β_2 -agonists	1
Inhaled corticosteroids (IC)	5
S-a β_2 + IC	23
IC + leukotriene receptor antagonist	1
Self-reported asthma	0
No asthma	0
Type of air inspired during training (number of subjects)	
Cold air	176 (25.2%)
Dry air	384 (55.0%)
Humid air	95 (13.6%)
Mixed air (dry and humid)	43 (6.2%)

for the European Community Health Survey.^{19,20} It surveys the last 12-month prevalence of symptoms of asthma and is adapted to be easy to fill out, relying on short written or multiple-choice answers. It included, however, additional questions such as: "When you exercise, do you feel respiratory symptoms such as breathlessness, chest tightness, wheezing? If so, do they occur during exercise, within an hour after exercise or between 2 and 8 h after exercise? Another question was about exercise-induced coughing: "When you exercise, do you cough? If so, does it occur during or within an hour after a period of exercise?"

As post-nasal drip can be a marker of nasal symptoms and a possible cause of exercise-induced cough, the following questions were also added: "When you exercise or after exercise, do you ever have secretions in the throat or post-nasal drip? Questions on symptoms of (a) breathlessness, (b) wheezing, (c) cough, (d) phlegm production and (e) chest tightness were presented in the form of two tables: one for past symptoms (experienced in the last years since they train, but not necessarily current) and one for current (still present) symptoms, experienced in connection with exercise.

A series of questions was also included on nociceptive respiratory sensations: "When you

Table 2 Frequency of exercise-related nociceptive sensations in athletes.

Nociceptive sensation	Order of frequency	Number of subjects (%)	Frequency (asthmatic subjects)* <i>n</i> = 92	Frequency (non asthmatic subjects) <i>n</i> = 591	<i>P</i>
I feel that my breathing is rapid	1	465 (66.6)	54 (59)	404 (68)	>0.05
I feel that I am breathing more	2	287 (41.1)	39 (42)	244 (41)	>0.05
My breath does not go out all the way	3	235 (33.7)	50 (54)	180 (30)	1.4×10^{-5}
I cannot take a deep breath	4	157 (22.5)	40 (43)	114 (19)	1.5×10^{-6}
My breathing requires effort	5	139 (19.1)	36 (39)	99 (17)	3.7×10^{-6}
My breathing is heavy	6	133 (19.0)	37 (40)	93 (16)	2.7×10^{-7}
I feel a hunger for more air	7	125 (17.9)	24 (26)	98 (17)	0.03
I am gasping for breath	8	111 (15.7)	17 (18)	90 (15)	>0.05
I cannot get enough air	9	100 (14.3)	26 (28)	69 (12)	7.8×10^{-5}
I feel out of breath	10	99 (14.2)	21 (23)	76 (13)	0.02
My breathing requires more concentration	10	99 (14.2)	28 (30)	68 (12)	1.4×10^{-5}
My chest is constricted	12	67 (9.6)	20 (22)	45 (8)	1.5×10^{-4}
I feel that I am smothering	13	63 (9.0)	19 (21)	40 (7)	7.7×10^{-5}
My chest feels tight	14	62 (8.9)	20 (22)	40 (7)	2.6×10^{-5}
My breathing requires more work	15	48 (6.9)	12 (13)	35 (6)	0.02
I feel that my breath stops	16	45 (6.4)	16 (17)	27 (5)	4.2×10^{-5}
My breathing is shallow	17	37 (5.3)	12 (13)	23 (4)	0.001
I feel that I am suffocating	18	33 (4.7)	11 (12)	20 (3)	0.001

*Physician-diagnosed asthma. Frequency of nociceptive sensations in athletes with self-reported asthma (*n* = 15) was not significantly different from that of athletes with physician-diagnosed asthma.

exercise, do you feel or have you felt the sensations described by the following sentences?" A list of short sentences (Table 2) describing symptoms was provided, and athletes were to indicate whether they experienced those feelings when exercising. A questionnaire on respiratory nociceptive (unpleasant) sensations was added in order to identify athletes who do not usually report symptoms but still felt nociceptive sensations possibly related to asthma symptoms. The questions on respiratory nociceptive sensations, previously tested by Simon et al., were translated into French.¹⁸

Statistical analysis

Results concerning respiratory symptoms and nociceptive sensations are expressed in number and percent of athletes. Number of years of training

and hours of training per week are expressed as mean \pm sem. Symptoms of exercise-induced breathlessness, wheezing, cough, phlegm production, chest tightness and nociceptive respiratory sensations were tested for correlation with age, type of air inhaled during training (cold, dry, humid, mixed), diagnosis of asthma, number of years in competitive sport, number of hours per week training in their own competitive sport and in general training. Fisher's exact test was used for statistics.

Results

Subjects' characteristics are shown in Table 1. The athletes had been training for 8.8 ± 0.2 years and were currently training in their own sports

discipline for a mean of 14.7 ± 0.4 h/week and in sports in general for a mean of 22.9 ± 0.6 h/week.

Questionnaire

One hundred and twelve of the 698 athletes (16.0%) mentioned that they experienced periods of wheezing, marked breathlessness and/or chest tightness when they exercised. Most athletes experiencing these symptoms reported that they occurred during exercise ($n = 95$), while for some, it was an hour ($n = 30$) or two to eight hours after completion of exercise ($n = 12$). Exercise-induced cough was reported by 120 athletes (17.2%), 48 having episodes of cough during exercise and 80 within the hour following their effort. While exercising or immediately afterward, several athletes had pharyngeal secretions ($n = 80$, 11.5%) or post-nasal discharge (187, 26.8%); 127 individuals (18.2%) had these symptoms on other occasions as well.

More athletes reported past symptoms than current symptoms (past/current) related to exercise and breathlessness was experienced more frequently (340, 48.7%/257, 36.8%) than wheezing (109, 15.6%/43, 6.2%), cough (106, 15.2%/51, 7.3%), phlegm production (159, 22.8%/104, 14.9%) or chest tightness (52, 7.4%/34, 4.9%, Fig. 1).

Self-described nociceptive symptoms

Nociceptive sensations perceived by athletes with exercise are summarized in Table 2. The most frequent were: "My breathing is rapid" ($n = 465$ athletes, 66.6%), "I feel that I am breathing more" ($n = 287$, 41.1%) and "My breath does not go out all the way" ($n = 235$, 33.7%).

History of asthma and allergies

When athletes were questioned about symptoms compatible with asthma in the last 12 months, 101 (14.5%) mentioned having episodes of wheezing, which was accompanied by breathlessness in 62 (8.9%); 50 (7.2%) subjects had these wheezing episodes without current respiratory infections. In the last 12 months, occasional early awakening with a sensation of respiratory discomfort occurred in 66 athletes (9.4%), while 15 (2.1%) occasionally woke up because of breathlessness and 202 (28.9%) because of a coughing spell. Twenty subjects (2.9%) reported an asthma exacerbation in the last 12 months, 166 (23.8%) had nasal allergies (including pollens) and 38 (5.4%) took asthma medications (Table 3).

Symptoms related to exercise

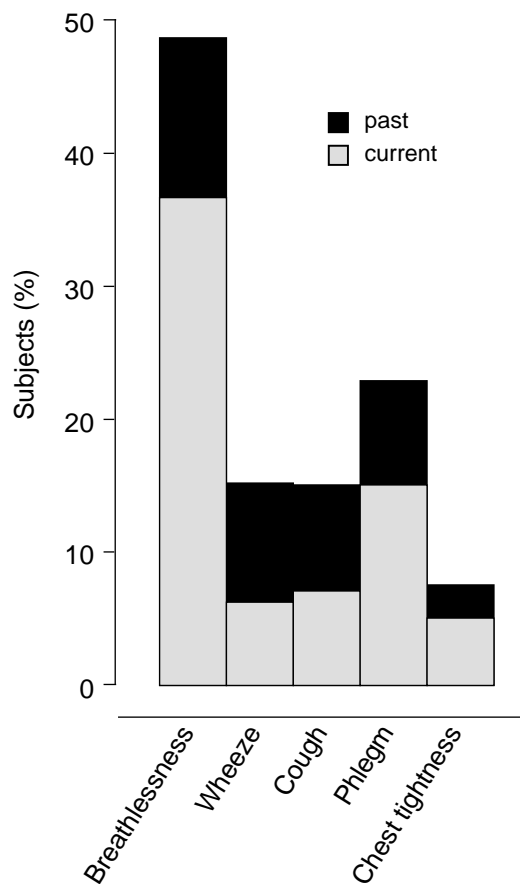


Figure 1 Past symptoms (experienced in the last years, may or may not be still present) and current (actual) respiratory symptoms related to exercise.

Current respiratory symptoms and nociceptive respiratory sensations: relationship with subjects' characteristics

Gender

Symptoms of exercise-induced breathlessness were more frequently reported by female (42.7%) than male athletes (29.6%, $P = 0.0004$). Although exercise-induced wheezing was more frequently experienced by females than by males (7.8% and 4.1%, respectively), this difference did not reach statistical significance ($P = 0.057$). Exercise-related cough, phlegm production and chest tightness were perceived similarly in both groups.

Age

There were no differences in the reporting of current exercise-induced symptoms of wheezing, cough, phlegm production and chest tightness according to the age of subjects.

Table 3 Asthma symptoms in the last 12 months.

Symptom/medication use	Prevalence (%)		
	Athletes (Province of Quebec) <i>n</i> = 698	General population (Montreal, Canada)* <i>n</i> = 2959	General population ECRHS (1996 report) [†] <i>n</i> > 125 000
Wheezing	14.5 ^{‡,¶}	23.7	20.3
Breathless with wheezing	8.9 [‡]	14.8	10.4
Waking with breathlessness	2.1 ^{‡,¶}	7.5	7.0
Waking with cough	28.9	31.4	26.9
Exacerbation of asthma	2.9 [‡]	6.8	3.8
Nasal allergies	23.8	—	23.0
Asthma medication	5.4	6.1	4.1

*Means calculated from Manfreda et al.²¹ (20–44-year old men and women). Reproduced with permission.

[†]Means calculated from the European Community Respiratory Health Survey 1996²⁰ (including 48 centres, 22 countries) (20–44-year old men and women). Reproduced with permission.

[‡]*P* < 0.05 significantly different from the general population of Montreal, Canada.

[¶]*P* < 0.05 significantly different from the general population of the European Community Respiratory Health Survey.²⁰

Table 4 Current exercise-induced symptoms and type of air inhaled during training.

	Physician- diagnosed asthma* <i>n</i> (%)	Breathlessness (<i>n</i> , %) (257, 36.8%)	Wheezing (<i>n</i> , %) (43, 6.2%)	Cough (<i>n</i> , %) (51, 7.3%)	Phlegm production (<i>n</i> , %) (104, 14.9%)	Chest tightness (<i>n</i> , %) (34, 4.9%)
Cold air (<i>n</i> = 176)	25 (14.2%)	57 (32.4%)	8 (4.6%)	17 (9.7%)	28 (15.9%)	9 (5.1%)
Dry air (<i>n</i> = 384)	50 (13.0%)	153 (39.8%)	26 (6.8%)	21 (5.5%)	52 (13.5%)	16 (4.2%)
Humid air (<i>n</i> = 95)	11 (11.6%)	31 (32.6%)	9 (9.5%)	9 (9.5%)	14 (14.7%)	8 (8.4%)
Mixed air (<i>n</i> = 43)	6 (14.0%)	16 (37.2%)	0	4 (9.3%)	10 (23.2%)	1 (2.3%)
<i>P</i>		>0.05	>0.05	>0.05	>0.05	>0.05

*Athletes with self-reported asthma (*n* = 15) were distributed as follows: cold air (*n* = 3), dry air (*n* = 9), humid air (*n* = 1), mixed air (*n* = 2).

Type of air inhaled during training

The proportion of athletes reporting current respiratory symptoms according to the type of air they breathed during their training was not significantly different between the four sub-groups (Table 4). The distribution of asthmatic patients (diagnosed or self-reported asthma) was similar in all four sub-groups (*P* > 0.05).

The three most frequent nociceptive sensations perceived in relation to exercise were the same for the four groups (*P* > 0.05 for all three most frequent), regardless of the type of air inspired during exercise (Table 5). The other nociceptive sensations were also perceived similarly among the four groups of athletes.

Current exercise-induced symptoms and history of asthma

Breathlessness with exercise was perceived in a similar proportion in athletes with diagnosed and self-reported asthma (25.0% and 26.7%, respectively) compared with athletes without asthma (38.9%, *P* = 0.025; Fig. 2). However, asthmatic athletes had significantly more exercise-related wheezing (physician-diagnosed asthma: 21.7%, self-reported: 13.3%), cough (13.0% and 20.0%, respectively) and chest tightness (17.4% and 13.3%) than those without asthma (wheezing: 3.6%, *P* < 0.0001; cough: 6.1%, *P* = 0.008 and chest tightness: 2.7%, *P* < 0.0001). Phlegm production was similar in all three groups (*P* > 0.05).

Table 5 Type of air inspired during exercise and frequency of self-described nociceptive sensations in athletes.

Self-described nociceptive sensation related to exercise	Cold air (n = 176)		Dry air (n = 384)		Humid air (n = 95)		Mixed air (n = 43)	
	Order of frequency	n of subjects (%)	Order of frequency	n of subjects (%)	Order of frequency	n of subjects (%)	Order of frequency	n of subjects (%)
I feel that my breathing is rapid*	1	120 (68.2)	1	253 (65.9)	1	61 (64.2)	1	31 (72.1)
I feel that I am breathing more*	2	80 (45.5)	2	152 (40.0)	3	33 (34.7)	2	22 (51.2)
My breath does not go out all the way*	3	55 (31.3)	3	129 (33.6)	2	36 (37.9)	3	15 (34.9)

* $P > 0.05$ between the four groups.

The most frequent respiratory nociceptive sensations related to exercise were the same for athletes with and without diagnosed or self-reported asthma (Table 5). Proportions of asthmatic subjects presenting those self-described nociceptive sensations were significantly higher than that of non-asthmatic subjects ($P < 0.05$ for 15/18 statements).

Training

There were no differences in the proportion of athletes presenting current respiratory symptoms according to the number of years (mean: 8.8 years) or the number of h/week (mean: 14.7h) they trained either in their own sports discipline or in general.

Discussion

Breathlessness, exercise-induced phlegm production, wheezing and cough, in order of frequency, were the most prevalent respiratory symptoms in athletes; these last two symptoms (in addition to chest tightness) were more frequent in asthma although phlegm production and breathlessness frequencies were similar among asthmatic or non-asthmatic subjects. These findings were independent of training environment and duration of training, and were not always associated with asthmatic status. A large proportion of athletes with an asthma diagnosis report no nociceptive sensation with exercise.

The response rate to the questionnaire was 47.7%, which we consider a successful response in such a study since solicitation is very extensive in athletes and can easily become time consuming. The possibility of a bias due to those who failed to respond cannot be excluded. However, as this was an anonymous voluntary participation-type questionnaire, we have no information regarding the characteristics of the athletes who did not return the questionnaire.

Although 15.3% of athletes had a previous diagnosis of asthma or self-reported asthma, few of them reported respiratory or nociceptive sensations. As expected, reports of past and current asthma-related symptoms and of nociceptive sensations were more frequent in asthmatic than in non-asthmatic athletes. However, only 25% of the asthmatic athletes mentioned having current exercise-induced symptoms of breathlessness and this percentage was down to 21.7% and 17.4%, respectively, for symptoms of wheezing and chest tightness, suggesting that they either had no or very little current asthma or that they considered

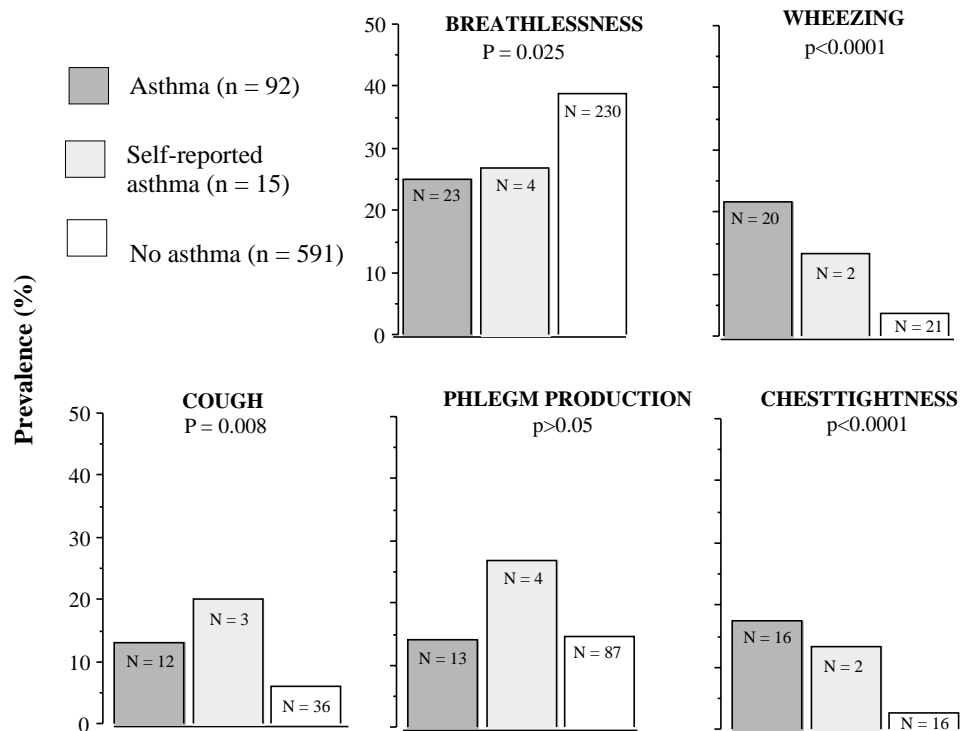


Figure 2 Current exercise-induced symptoms and asthma.

respiratory symptoms to be a normal consequence of high-intensity exercise and therefore not worth reporting.

Surprisingly, the percentage of non-asthmatic athletes experiencing exercise-induced breathlessness was higher than for those with asthma. This could be because asthmatic athletes are used to being breathless and thus do not pay as much attention to this symptom as do non-asthmatic athletes. A certain number of athletes from the non-asthmatic group experienced symptoms of wheezing and chest tightness; this may suggest an underreporting of asthma in some of them, or it may be that this type of symptom is a normal consequence of intense exercise. The same comment may be applied to phlegm production, found in a similar proportion of asthmatic and non-asthmatic athletes.

The fact that a larger number of athletes reported respiratory symptoms in the past compared with current symptoms, both in relation to exercise and on other occasions, could be attributed to a reduction in asthma severity, to an increased tolerance to symptoms over time or to a better control of symptoms through medication and/or training techniques, such as warming up before exercise.

Significantly more asthmatics described respiratory nociceptive sensations than did subjects without asthma, although the questionnaire on

respiratory nociceptive sensations did not allow a clear-cut distinction between asthmatic and non-asthmatic athletes. Besides, a large proportion of asthmatic athletes reported no respiratory nociceptive sensations related to exercise. This could possibly be explained by the fact that they do not perceive, do not recognize or do not want to recognize these respiratory sensations, or that their asthma is so well controlled that nociceptive sensations disappeared. Respiratory nociceptive sensations were reported by a greater percentage of athletes than were respiratory symptoms. This suggests that athletes perceive and recognize nociceptive sensations but do not necessarily consider them as troublesome symptoms. For example, the nociceptive sensation related to exercise, defined by the phrase "My chest feels tight," was described by 20 asthmatic (22% of those with physician-diagnosed asthma) and 40 non-asthmatic athletes (7%), while exercise-induced chest tightness was reported by 16 asthmatic (17.4%) and 16 non-asthmatic athletes (2.7%). In those without asthma, these symptoms may result from airway sensations induced by the intense exercise-induced increase in ventilation, particularly when cold air or irritants are inhaled.

Concerning possible asthma symptoms in the last 12 months, fewer athletes described symptoms of wheezing, breathlessness with wheezing, waking with breathlessness or attacks of asthma compared

to reported surveys of the general population or in the ECRHS report (Table 3).^{19,20} Given that the prevalence of asthma is higher in athletes than in the general population, according to previous reports, this observation may appear surprising. However, the possibility that athletes, who are used to repeated extensive exercise sessions, may be more tolerant to respiratory symptoms, may explain the lower reporting and consequently, the apparently lower occurrence of asthma symptoms.¹⁻¹⁰ This is in agreement with one of our previous studies and with the report from Salome et al. showing that subjects with asymptomatic airway hyperresponsiveness are not poor perceivers of airway narrowing, but may underreport their symptoms.^{15,22}

Questionnaires are useful tools when evaluating the prevalence of respiratory symptoms in a population. However, they do not take into consideration the varying levels of perception and/or tolerance to symptoms between individuals. In our study, athletes may have had symptoms without perceiving or identifying them as such; furthermore, their symptoms may have been well controlled with asthma medication and/or avoidance of triggers (e.g. allergens); they may also have had symptoms and denied them; finally, they may truly have been asymptomatic. For these reasons, the use of self-reported respiratory symptoms to evaluate asthma may lead to a number of false negative and false positive diagnoses.²³ Future studies on these athletes should ideally include objective measures of airflow obstruction and/or airway hyperresponsiveness. Although respiratory symptoms have not previously proven to be good predictors of airway responsiveness in adults, it would be of interest to look for a correlation between symptoms and airway hyperresponsiveness, especially in symptomatic subjects without diagnosis of asthma.²⁴ As symptomatic airway hyperresponsiveness has been associated with the presence of more marked airway inflammation when compared with asymptomatic airway hyperresponsiveness, it could be useful to assess airway inflammation non-invasively in those subjects to determine whether it plays a possible role in the expression of symptoms.²⁵⁻²⁷ Such inflammatory process may, however, also be present in non-asthmatic subjects and contribute to respiratory symptoms.

Neither the type of air inhaled during training nor the duration of training seemed to influence the perception of respiratory symptoms or that of nociceptive sensations. We felt that sports such as swimming could be associated with a lower prevalence of respiratory symptoms, those last

being somewhat more difficult to recognize in such environment, or that it would be worse when sports are performed in cold air. The lack of difference in symptom prevalence between sports suggests that the type of air inhaled during exercise does not significantly influence perception.

In conclusion, exercise-induced breathlessness, phlegm production, wheezing, cough and chest tightness, in order of frequency, were the most prevalent respiratory symptoms in athletes. Only a small percentage (about 25%) of athletes with physician-diagnosed asthma reported exercise-induced symptoms of asthma, suggesting either an adequate control of symptoms with medication or poor perception, under-recognition, acquired tolerance, denial or, in some cases, truly asymptomatic changes in pulmonary function. Most athletes experiencing symptoms of wheezing and chest tightness had asthma, but some "non-asthmatic subjects" also described the same symptoms; this might be an indication of unrecognized asthma or a normal response to intense exercise. Phlegm production was perceived by a similar proportion of athletes in both groups; here again, it may reflect a normal physiological response to exercise-induced hydrocaloric exchange. The environment in which athletes regularly train, their age and the duration of their training did not affect perception of their respiratory symptoms.

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