

Atopy in Elite Endurance Athletes

Renata N. Teixeira, PhD,* Gerson dos Santos Leite, PhD,* Matteo Bonini, MD, PhD,† Renata Gorjão, PhD,‡ Rosana C. Agondi, MD, PhD,§ Cristina M. Kokron, MD, PhD,¶ and Celso R. F. Carvalho, PhD*

Abstract

Objective: To assess the frequency of atopy (specific IgE levels), to evaluate the allergic symptoms using the Allergy Questionnaire for Athletes (AQUA), and to determine whether atopy is associated with allergic symptoms in elite endurance athletes. **Design:** Cross-sectional study. **Setting:** Assessments were performed at Hospital das Clínicas—São Paulo University Medical School. **Participants:** Fifty-nine elite endurance athletes (triathletes and runners). **Main Outcome Measures:** Allergic symptoms were assessed by a validated self-report AQUA questionnaire and atopy by specific IgE level. **Results:** The frequency of atopy (specific IgE to at least one inhalant allergen) and allergic symptoms was 57.6% and 54.2%, respectively. In addition, no association was observed between atopy and allergic symptoms. **Conclusions:** A possible implication from our results is that atopy screening in elite athletes should be performed using AQUA questionnaire and measuring specific IgE simultaneously.

Key Words: allergy, triathletes, runners, specific IgE

(*Clin J Sport Med* 2017;0:1–4)

INTRODUCTION

Allergy is a hypersensitivity reaction initiated by immunological mechanisms that can be antibody or cell mediated, whereas atopy is the genetic predisposition to produce specific immunoglobulin E (IgE) after exposure to allergens. Thus, the term atopy can only be used when an IgE sensitization has been confirmed by the presence of specific IgE antibodies in serum or by a positive skin prick test to common allergens.¹ The prevalence of atopy in Brazil is approximately 9.1%,² whereas the prevalence of allergy in the general (nonathletic) population reaches 20%,^{3,4} and has been rising steadily over the last 20 years. This increase seems to be related to an increase in environmental risk factors such as outdoor and indoor pollution; however, the reasons for this increase remain unclear.⁵

Previous studies have shown a higher prevalence of allergies in top athletes,^{6–9} ranging from 10% to 74%,^{10,11} than in nonathletes, making allergic disorders one of the most common medical conditions in athletes.⁶ The wide variation in the prevalence of allergy in athletes can be attributed to

several factors, including the environmental conditions in which athletes train and compete, the sport modality, the intensity, frequency and volume of training, and the diagnostic methods used.^{7,11,12}

In 2009, Bonini et al developed the AQUA questionnaire, which has been used to screen for allergic diseases in athletes.⁷ This screening tool was validated in soccer players and has already been used to assess runners,^{11,13} revealing, on average, a 60% prevalence of allergy symptoms. Although these studies have shown a high prevalence of allergic symptoms in this population, elite endurance athletes may be even more susceptible in developing atopy because they are exposed to the repeated increased ventilation of unconditioned air containing irritants and/or allergens.^{14,15}

The aim of this study were to assess the frequency of atopy (determined by specific IgE levels) and the most common allergic symptoms using the AQUA questionnaire and to determine whether atopy is associated with allergic symptoms in elite endurance athletes.

METHODS

Study Design and Population

One hundred and three elite male athletes (either runners or triathletes) were invited to take part in this cross-sectional study; 59 were included. The athletes were recruited by contacting coaches and/or athletes themselves, who were informed about the purpose of the study, the assessments used, and the data collection procedures. Participation was voluntary, and those who agreed to participate provided written informed consent before enrollment in the study. This research was conducted in accordance with ethical guidelines and international standards¹⁶ and was approved by the local human research ethics committee (clinical protocol number 207/14).

The inclusion criteria were male individuals aged between 18 and 40 years who were involved in an endurance sport (either running or triathlon) and had been competing at the

Submitted for publication September 16, 2016; accepted March 7, 2017.

From the *Department of Physical Therapy, University of São Paulo School of Medicine, São Paulo, Brazil; †Airways Disease Section, National Heart and Lung Institute (NHLI), Imperial College London & Royal Brompton Hospital, London, UK; ‡Institute of Physical Activity Sciences and Sports, Cruzeiro do Sul University, São Paulo, Brazil; §Department of Clinical Immunology and Allergy, University of São Paulo School of Medicine, São Paulo, Brazil; and ¶Department of Clinical Immunology and Allergy (LIM-60), University of São Paulo School of Medicine, São Paulo, Brazil.

To FAPESP (Fundação de Amparo à Pesquisa de São Paulo); Grants 2014/02915-9 and Conselho Nacional de Pesquisa (CNPq; grants 311443/2014-1 and 487868/2013-7) for financial support.

The authors report no conflicts of interest.

Corresponding Author: Celso R. F. Carvalho, PhD, Department of Physical Therapy, University of São Paulo School of Medicine, São Paulo, Brazil, Department of Medicine School of Medicine, University of São Paulo Av. Dr. Arnaldo 455—room 1210, 01246-903 São Paulo—SP, Brazil (rereiteira@hotmail.com).

Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.

<http://dx.doi.org/10.1097/JSM.0000000000000444>

elite level, which was defined as athletes competing at the national and/or the international level.¹⁷ In addition, the athletes should have been competing for at least 1 year of the competition time established by the Brazilian Athletic Confederation and the Brazilian Triathlon Confederation. The performance criteria that were adopted to ensure that we recruited only elite athletes were as follows: 10 km time under 33 minutes, half marathon time under 1 hour 10 minutes, marathon time under 2 hours 30 minutes (runners), triathlon Olympic distance under 2 hours 5 minutes, half Ironman time under 4 hours 30 minutes, and an Ironman time under 9 hours 30 minutes.

Assessments

Allergic Symptoms and Training Data

The AQUA questionnaire⁶ was used to assess allergic symptoms. It consists of 25 items regarding allergic symptoms, family history of allergy, suspicion of allergy, and the use of allergy medications. The questions received a score, and the sum was used to classify athletes as “with allergic symptoms” (score ≥ 5), and “without allergic symptoms” (score < 5), as previously described.⁷ Participants were also asked to report their training experience, number of training sessions, time (in hours) that they spent in training, and training volume (in km per week) and if the week before data collection was representative of the last year of training. These questions have been previously used¹³ and referred to the week before data collection to ensure that all the athletes had maintained similar training conditions.

Specific IgE Determination and Atopy Definition

All subjects underwent peripheral venous blood sampling for specific IgE determination on a panel of common inhalant allergens, including the most important house dust mites (*Dermatophagoides pteronyssinus* and *Dermatophagoides farina*) and inhalant allergens (*Blomia tropicalis*, cat, and cockroach) (Phadiatop; Phadia100, Thermo-Scientific, Phadia AB, Uppsala, Sweden) according to the manufacturer’s instructions. Sensitization was considered when specific IgE was ≥ 0.35 kUA,⁷ and atopy was defined as a sensitization to at least one of the selected allergens. Athletes with at least one positive specific IgE to any of the in vitro panel allergens were considered to be atopic.¹⁸

Statistical Analysis

Data were analyzed using the SigmaStat 3.5 statistical package (Chicago, IL). The prevalence of atopy and allergic symptoms was calculated as the number of subjects categorized as having atopy and allergic symptoms divided by the total number of subjects in that particular group. Student *t* test or Mann–Whitney *U* test were used to compare the levels of specific IgE, anthropometric characteristics, training data, and the most-reported questions obtained from AQUA questionnaire between atopic and nonatopic athletes. The χ^2 test was used for verifying possible statistically significant associations between atopy (specific IgE > 0.35 kUA) and symptoms of exercise-induced bronchospasm (EIB), asthma, rhinitis, and conjunctivitis. Data are expressed as the median (nonparametric) or mean (parametric) with a 95% confidence interval, and the level of significance was set at $P \leq 0.05$.

RESULTS

Fifty-nine of the 103 invited athletes agreed to participate in the study. The reasons for declining to participate were lack of time (72%), unwillingness to have their blood drawn (11%), did not meet inclusion criteria (8%), and others (9%). The frequency of atopy (specific IgE to at least one inhalant allergen) and allergic symptoms was 57.6% and 54.2%, respectively. Atopic athletes exhibited higher specific IgE than nonatopic athletes [IgE 2.8 kUA/L (1.07–10.7 CI) vs 0.03 kUA/L (0.02–0.06 CI); < 0.001], but there was no significant difference in the mean AQUA score (9.2 ± 7.9 vs 5.9 ± 6.6 ; $P = 0.09$). A physician-diagnosed allergic disease or a suspicion of allergy independent of any medical diagnosis was observed in 32.3% and 47% of the atopic athletes, respectively.

The anthropometric characteristics and training data of the entire group of athletes and of the atopic and nonatopic individuals are shown in Table 1. The performance of the 10 km, half marathon, and marathon runners was 31.0 ± 1.2 minutes, 1 hour:07 minutes ± 1.9 minutes, and 2 hours:24 minutes ± 5.8 minutes, respectively. In addition, the performance of the triathletes competing in the Olympic distance, half Ironman, and Ironman was 1 hour:55 minutes ± 4.9 minutes, 4 hours:03 minutes ± 13.9 minutes, and 9 hours:04 minutes ± 28.9 , respectively. There was no difference in the percentage of atopic and nonatopic athletes with an AQUA score ≥ 5 and any of the most-reported symptoms associated with atopy (Table 2).

TABLE 1. Anthropometric Characteristics and Training Data of All Athletes and by Atopic and Nonatopic Athletes

	All (n = 59)	Atopic (n = 34)	Nonatopic (n = 25)	P
Age, yr	29.9 (28.2–31.6)	29.4 (27.0–31.9)	30.6 (28.2–33.0)	0.50
Weight, kg	64.0 (61.0–68.0)	64.0 (61.0–69.2)	65.0 (61.5–67.5)	0.74
Height, m	1.7 (1.7–1.7)	1.7 (1.7–1.7)	1.7 (1.7–1.7)	0.13
BMI, kg/m ²	20.6 (20.0–21.9)	20.6 (19.7–21.5)	21.5 (20.1–22.9)	0.23
Training experience, yrs	9.8 (8.3–11.3)	10.0 (8.1–11.7)	9.0 (6.8–12.3)	0.52
Number of training sessions, per wk	10.2 (9.2–11.2)	10.5 (9.2–11.8)	9.8 (8.2–11.4)	0.60
Hours of training, per wk	16.7 (14.8–18.7)	17.3 (14.5–20.1)	16.0 (13.1–18.9)	0.57
Volume of training, km per wk	184.5 (149.0–220.0)	204.0 (153.0–255.0)	156.6 (108.2–205.1)	0.23

Values are shown as mean and 5% to 95% confidence interval (in parenthesis).
BMI, body mass index; Km, kilometers; kg, kilograms; m, meters.

TABLE 2. Most-Reported Symptoms Among Atopic and Nonatopic Athletes

	All Athletes (n = 59)	Atopic (n = 34)	Nonatopic (n = 25)	P
AQUA score ≥ 5 (%)	32 (54.2)	20 (58.8)	12 (48.0)	0.28
Most-reported symptoms				
Symptoms of EIB (%)	18 (30.5)	11 (32.4)	7 (28.0)	0.94
Symptoms of asthma (%)	15 (25.4)	10 (29.4)	5 (20.0)	0.49
Symptoms of rhinitis (%)	14 (23.7)	11 (32.4)	3 (12.0)	0.13
Symptoms of conjunctivitis (%)	12 (20.3)	9 (26.5)	3 (12.0)	0.30

Data are presented as number and percentage.
Symptoms of EIB, shortness of breath, cough, and/or itching of the throat after exercise; Symptoms of asthma, tightness of chest, and/or wheeze; Symptoms of rhinitis, sneeze, running, and/or itchy nose (apart from cold); Symptoms of conjunctivitis, red eyes with tearing and itching.

DISCUSSION

Our results show that elite endurance athletes have a high frequency of both atopy and allergic symptoms; however, there is no association between them. These findings suggest that, in elite endurance athletes, appropriate medical evaluations should be conducted to identify atopy using the AQUA questionnaire followed by an objective measurement such as specific IgE.

In this study, we observed that the most frequent symptoms reported by the elite endurance athletes were related to the upper airways. To our knowledge, the few previous studies that have investigated the presence of allergic symptoms in athletes using the same questionnaire (AQUA) evaluated distinct athletic population,⁸ recreational marathon runners, whereas Kurowski et al¹⁹ and Thomas et al¹¹ studied Olympic athletes from several sports modalities. The frequency of shortness of breath, cough, and/or itching of the throat after exercise was similar in our study to that observed in recreational marathon runners⁸ (32.4% vs 32%) and higher than in Olympic athletes from different sports disciplines (32.4% vs 28.4%).¹⁹ This finding is consistent with those of studies, which demonstrates that atopic athletes are at a higher risk of having bronchial hyperresponsiveness^{20,21} and could partially explain the high frequency of these symptoms in our athletes. However, this explanation is speculative, given that the etiology of EIB and AIE is multifactorial and the physiologic processes may vary across athletes depending on several factors, such as the type of training, environment, and exposure to aeroallergens and irritants.²²

When comparing our results with those of Robson-Ansley et al⁸ and Kurowski et al,¹⁹ we found a higher frequency of symptoms such as sneezing, running and itchy nose (32.4% vs 23.7% and 21.3%), and chest tightness and wheezing (29.4% vs 25.4% and 12.5%). A possible explanation for this difference is that all the athletes assessed in our study were competing at the elite level and were engaged in endurance sports, which means that their training is longer and more intensive than that of the athletes assessed in previous studies.^{8,19} This explanation is based on the assumption that the greater the intensity of the exercise, the higher the ventilation rate, which results in a change in the respiratory pattern from nasal to mouth breathing; this shift increases exposure to allergens and irritants and makes these athletes more likely to develop upper respiratory symptoms.⁶

Although the allergy symptoms seem to be influenced by the intensity and type of sport, it is important to confirm that they correspond to real atopy. Therefore, we also found that the

frequency of atopy in our athletes was higher than in the 2 previous studies of recreational runners using the same criteria (58.8% vs 49% and 31%). Although speculative, a possible explanation for the higher frequency of atopy observed in our study may be attributable to the prolonged high-intensity exercise training performed by the elite endurance athletes, which could induce an imbalance in the Th1/Th2 lymphocyte ratio by increasing the Th2 immune response, predisposing these athletes to atopy.²³ This hypothesis is supported by previous studies that have demonstrated an increased incidence of upper respiratory tract infection in elite athletes.²⁴ It is important to reinforce that our study is the first to assess the association between allergic symptoms and atopy in elite endurance athletes. We did not find any such association, probably because of the high proportion (42.3%) of non-atopic athletes reporting allergic symptoms as defined by an AQUA score ≥ 5 . These findings are interesting but unexpected. Considering that the most frequent symptoms reported by the nonatopic athletes were related to the airways after exercise (“shortness of breath, cough or itching of the throat after exercise”), a possible explanation could be that the nonatopic athletes confuse these symptoms with the airway sensations induced by intense exercise (increased ventilation) particularly when cold air or irritants are inhaled. However, it is important to note that this explanation is only a hypothesis and should be investigated in future research.

The fact that we did not find an association between allergic symptoms and atopy suggests that the AQUA questionnaire does not identify allergic symptoms in this population as previously observed in professional soccer players.⁷ In addition, given that sensitization to aeroallergens is a strong predictor of the future development of allergic symptoms, the inclusion of an objective measure to assess atopy on the routine medical examinations of athletes could help in the adoption of proper preventive and therapeutic measures to avoid symptoms.²⁵ However, it is also important to state that clinically positive specific IgE levels without symptoms do not necessarily suggest the need for treatment. Therefore, having an objective measurement such as specific IgE in conjunction with clinical symptoms could lead to a better understanding and proper treatment management of, for instance, allergies that are not IgE-mediated.

Some limitations of our study should be noted. First, specific IgE to allergens was detected by the Phadiatop assay, which screens a fixed set of allergens, suggesting that we might have underestimated the frequency of atopy. Nevertheless, this test is most frequently used to detect allergen-specific IgE antibodies and includes the allergens with the greatest prevalence of

sensitization among atopic individuals. Second, the report of allergic symptoms was obtained retrospectively, introducing the possibility of a memory bias; however, questionnaires are widely used as screening instruments to assess symptoms. Third, our sample size seems to be small with a low achieved power of 0.40; however, the athletes included in our study were competing at either national or international levels and represented approximately 40% of the male runners and triathletes who were competing for at least 1 year at the elite level in Brazil using the database from a previous study.¹³ Therefore, we believe that this sample was the representative of this population.

The total population of elite athletes representing the Norwegian national teams organized by the Norwegian Confederation of Sports in 1997 (1620 athletes: 660 women and 960 men).

In conclusion, we found a high frequency of both allergic symptoms and atopy in elite endurance athletes. In addition, we also observed that the most-reported allergic symptoms were not associated with atopy. A possible implication from our results is that atopy screening in elite athletes should be performed using AQUA questionnaire and measuring specific IgE simultaneously.

References

- Johansson SG, Bieber T, Dahl R, et al. Revised nomenclature for allergy for global use: report of the Nomenclature Review Committee of the World Allergy Organization, October 2003. *J Allergy Clin Immunol*. 2004;113:832–836.
- Macedo SE, Menezes AM, Knorst M, et al. Risk factors for asthma in adults in Pelotas, Rio Grande do Sul State, Brazil. *Cad Saude Publica*. 2007;23:863–874.
- O'Connell EJ. The burden of atopy and asthma in children. *Allergy*. 2004;59:7–11.
- Thomsen SF. Epidemiology and natural history of atopic diseases. *Eur Clin Respir J*. 2015;24:2.
- D'Amato G, Liccardi G, D'Amato M, et al. Environmental risk factors and allergic bronchial asthma. *Clin Exp Allergy*. 2005;35:1113–1124.
- Bonini S, Bonini M, Bousquet J, et al. Rhinitis and asthma in athletes: an ARIA document in collaboration with GA2LEN. *Allergy*. 2006;61:681–692.
- Bonini M, Braidó F, Baiardini I, et al. Allergy questionnaire for athletes. Development and validation. *Med Sci Sports Exerc*. 2009;41:1034–1041.
- Robson-Ansley P, Howatson G, Tallent J, et al. Prevalence of allergy and upper respiratory tract symptoms in runners of the London marathon. *Med Sci Sports Exerc*. 2012;44:999–1004.
- Moreira A, Kekkonen R, Korpela R, et al. Allergy in marathon runners and effect of Lactobacillus GG supplementation on allergic inflammatory markers. *Respir Med*. 2007;101:1123–1131.
- Alaranta A, Alaranta H, Heliövaara M, et al. Allergic rhinitis and pharmacological management in elite athletes. *Med Sci Sports Exerc*. 2005;37:707–711.
- Thomas S, Wolfarth B, Wittmer C, et al. GA2LEN-Olympic study-Team. Self-reported asthma and allergies in top athletes compared to the general population—results of the German part of the GA2LEN-Olympic study 2008. *Allergy Asthma Clin Immunol*. 2010;6:31.
- Nystad W, Harris J, Borgen JS. Asthma and wheezing among Norwegian elite athletes. *Med Sci Sports Exerc*. 2000;32:266–270.
- Teixeira RN, Mendes FA, Martins MA, et al. AQUA as predictor of allergy in elite marathon runners. *World Allergy Organ J*. 2014;7:7.
- Del Gaudio SR, Firinu D, Bjerrmer L, et al. Exercise and asthma: an overview. *Eur Clin Respir J*. 2015;2:27984.
- Maiolo C, Fuso L, Todaro A, et al. Prevalence of asthma and atopy in Italian Olympic athletes. *Int J Sports Med*. 2004;25:139–144.
- Harriss DJ, Atkinson G. Ethical Standards in Sport and Exercise Science Research: 2016 update. *Int J Sports Med*. 2015;36:1121–1124.
- Swann C, Moran A, Piggott D. Defining elite athletes: issues in the study of expert performance in sport psychology. *Psychol Sport Exerc*. 2015;16:3–14.
- Burney P, Malmberg E, Chinn S, et al. The distribution of total and specific serum IgE in the European Community Respiratory Health Survey. *J Allergy Clin Immunol*. 1997;99:314–322.
- Kurowski M, Jurczyk J, Krysztofiak H, et al. Exercise-induced respiratory symptoms and allergy in elite athletes: allergy and Asthma in Polish Olympic Athletes (A(2) POLO) project within GA(2)LEN initiative. *Clin Respir J*. 2016;10:231–238.
- Helenius IJ, Tikkanen HO, Sarna S, et al. Asthma and increased bronchial responsiveness in elite athletes: atopy and sport event as risk factors. *J Allergy Clin Immunol*. 1998;101:646–652.
- Sallaoui R, Chamari K, Mossa A, et al. Exercise-induced bronchoconstriction and atopy in Tunisian athletes. *BMC Pulm Med*. 2009;9:8.
- Kippelen P, Fitch KD, Anderson SD, et al. Respiratory health of elite athletes—preventing airway injury: a critical review. *Br J Sports Med*. 2012;46:471–476.
- Bonini M, Fioretti D, Sargentini V, et al. Increased nerve growth factor serum levels in top athletes. *Clin J Sport Med*. 2013;23:228–231.
- Nieman DC. Risk of upper respiratory tract infection in athletes: an epidemiologic and immunologic perspective. *J Athl Train*. 1997;32:344–349.
- Bodtger U, Poulsen LK, Linneberg A. Rhinitis symptoms and IgE sensitization as risk factors for development of later allergic rhinitis in adults. *Allergy*. 2006;61:712–716.