DETECTION OF RESPIRATORY ILLNESS IN ATHLETES OF THE UNIVERSITY OF THE FREE STATE THROUGH A PERIODIC HEALTH EVALUATION WITH AND WITHOUT SPIROMETRY

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Abstract:-
Background - Exercise-induced bronchospasm (EIB) is a common medical condition which can have devastating complications, particularly in otherwise healthy active athletes. Since EIB is unpredictable but preventable, medical personnel and coaches are often the primary support givers in such events and need not be informed about the risk factors and proper management of the athlete with this, sometimes undiagnosed, respiratory problem. The periodic health evaluation (PHE) is mandatory in some, but not all, sports and covers a few basic questions regarding the athlete's respiratory health.
Objectives - To determine the prevalence of underlying respiratory disease in a population of varsity level athletes. In addition, the study aimed to test whether the addition of a specific tool would increase the sensitivity of the PHE as it is implemented by the International Olympic Committee (IOC), therefore investigating if spirometry before and after an exercise challenge would diagnose any new athletes with exercise-induced bronchospasm (EIB).
Methods - Thirty-two participants met the inclusion criteria. Periodic health evaluations were done to enquire about a detailed history from the athletes and physical examination with special attention to the respiratory system. Baseline spirometry followed by an exercise challenge test and serial post-exercise spirometries were done on all the participants according to the guidelines provided by the American Thoracic Society.
Results - The results of this study confirmed that a thorough history and clinical examination alone do not lead to the diagnosis of EIB. Furthermore, we conclude that a resting baseline spirometry does not indicate that an athlete is at risk for, or, has EIB. In the absence of eucapnic voluntary hyperpnea (EVH) as the preferred challenge test according to the International Olympic Committee-Medical Commission (IOC-MC), an exercise challenge test will be as valuable. Almost 10% of the athletes in our study, which were healthy according to the PHE and baseline spirometry, had a positive spirometry for EIB after an exercise challenge test as indicated by a fall of $\geq$ 10% from the baseline forced expiratory volume in one second (FEV_1).
Conclusion - As the aim of a PHE is to assure safe sports participation, proper identification and treatment of athletes with EIB should be implemented. Our study confirms that clinical assessment alone is not of significant predictive value and another tool such as serial post-exercise spirometry is necessary to identify the athletes with unrecognized EIB. The addition of a standardized exercise challenge followed by serial spirometries to all participants will in fact have a very positive impact on the current medical care of the athletes.

Keywords - Exercise-induced bronchospasm (EIB); Spirometry; Exercise challenge test; Periodic Health Evaluation (PHE); International Olympic Committee-Medical Commission (IOC-MC)

I. INTRODUCTION

EIB poses a discrete yet silent danger to any athlete and could be life-threatening if not managed properly. Failure to diagnose or exclude EIB leads to decreased performance on physical and emotional level, as well as unnecessary exposure to drugs. EIB could decrease the athlete's ability to train and compete, furthermore it could increase hospital admissions in case of the undiagnosed and subsequently untreated athlete. It is reported that 32 of 108 (29.6%) children died suddenly during sports activities. The majority of them were not using any preventative therapy [1].

Definitions: EIB is a transient narrowing of the airways in an athlete who is usually without any asthma symptoms, but shows symptoms and signs during and/or after vigorous exercise [2]. The bronchospasm is reversible with inhaled beta-2-agonsits [3]. The condition is divided into two sub-groups: the athlete with chronic asthma in which exercise is a trigger for bronchoconstriction (known as exercise induced asthma, EIA); and the athlete without chronic asthma which only experiences bronchoconstriction associated with exercise (known as exercise induced bronchospasm, EIB) [4]. Subsequently EIB is a physiological response rather than a medical disease.

II. PREVALENCE

Many cases of EIB are undiagnosed. EIB occurs in about 10% of the general population who do not have a known history of asthma [5],[6]. EIB occurs in 5-10% of patients who have no respiratory or allergic disease [7]. Eleven percent of the 1984 US Summer Olympic Team athletes had either asthma of EIB [8]. In the 1996 US Summer Olympic Team it is reported that 17% of the US athletes were identified as having asthma [9].A study was done on athletes of the 1998 US Winter Olympic Games and found that 22.4% athletes were positive for EIB and the overall

incidence of EIB was 23% across seven of the sports and genders [10], [11]. The variability in prevalence of EIB depends on the season (summer or winter sports), the type of sports (cross-country skiers, endurance type of sports) as well as environmental factors (ice rink or on the grass fields). One study indicated that the intensity of exercise as well as the specific temperature and humidity of the inhaled air are modifying factors in the severity of the EIB response [12]. Previous studies have indicated that EIA in patients with seasonal asthma has a significant relation to humidity and temperature. The prevalence was 50% in summer, 86.4% in spring/fall and 84% in winter [13].

The maximum reduction in FEV1 post-exercise increases significantly in a cold environment as compared with the same exercise under regular conditions. It was also found that the exercise capacity was decreased as measured by VO2 peak and peak running speed. The participants reported that their breathing during exercise in such a cold environment was much more difficult and slower as well as that they experienced a shortened time to exhaustion [14]. On the contrary the exercise capacity (as measured by VO2 peak and peak running speed) improves in humid conditions [15]. This difference in prevalence at high/low temperatures was demonstrated with a prevalence of 60% in cold (10degrees Celsius) and 40% in hot (45degreesCelsius) air in a study on trained adolescent males who did high intensity interval exercise tests with maximal heart rate of 95% under conditions with almost 50% relative humidity [16]. When interpreting the prevalence of EIB it is important to take into account the environmental factors which could either aid in the development of the condition of in exacerbation thereof. Sport which require significant aerobic exercise such as endurance sports, basketball, soccer and ice hockey have been referred to as sport with a high asthmogenic potential. On the contrary golf, baseball, bowling, volleyball, weight lifting and martial arts have a low asthmogenic potential. Water sports in a humid environment but high chlorine content of the water, have been referred to as intermediate asthmogenic[7].

The large variability in the prevalence of EIB is due to a lack of standardized methodology for the diagnosis thereof, the type of exercise, environmental factors and possible underlying respiratory related illnesses such as atopy or allergic conditions and previous history of asthma, as well as the diagnostic criteria [17]. Bronchial provocation tests (BPT's) are indicated if a bronchodilator test is inconclusive and EIB is still expected. These tests are either direct or indirect tests aimed at provoking bronchospasm by inhalation of cold dry air, certain aerosols or by doing an exercise challenge to provoke the symptoms [18]. Peak expiratory flow rate (PEFR) is measured during a maximally rapid exhalation with immediate maximal inhalation. PEFR is not particularly sensitive in detecting the presence of limitation of the airflow, therefore the variability among athletes is very large (more than 30%) as it is effort dependent [19], [20]. Spirometry is indicated to evaluate and monitor asthma in athletes. The test allows measurement of lung volumes according to forced vital capacity (FVC), the volume exhaled in the first second of expiration (FEV1) and the ratio of FEV1/FVC. These measurements are reproducible and much less variability is seen (equal to or less than 5%) [21].

III. DIAGNOSIS

In case of suspected EIB it is necessary to obtain a history, a physical examination and formal lung function testing. History alone should not be the main indicator for further EIB-testing such as spirometry. A prevalence of 36% was found in athletes without symptoms suggestive of EIB and prevalence of 35% in athletes with symptoms [22]. Furthermore, in the group with positive EIB testing there were 25% without any self-reported symptoms. It seems that elite athletes are poor perceivers of their symptoms and are prone to interpret EIB symptoms as exertional fatigue, poor conditioning or a lack of motivation.

The formal diagnosis of EIB is based on the measured lung function changes due to exercise as a trigger, and not on the presence or absence of clinical symptoms [23]. There is currently no gold standard test for EIB [3], however the International Olympic Committee-Medical Commission (IOC-MC) is accepting the results of airway challenges including exercise, eucapnic voluntary hyperventilation (EVH), metacholine as well as saline challenges. The IOC-MC regards the exercise or EVH challenge as positive for the diagnosis of IEB when the FEV1 fall $\geq$ 10% from the baseline value. EVH is reported to have a high specificity (90% and 100%) for the diagnosis of active asthma when the FEV1 fall is measured as $\geq$ 10% and $\geq$ 15% respectively [24]. On the contrary lung challenge testing such as the exercise test (a physiological test) is the most commonly available test.

IV. METHODOLOGY

This study is a prospective descriptive study to determine the prevalence of respiratory illnesses in a specific athletic population. Furthermore the study has an analytical cross sectional part to determine the sensitivity of the clinical history, examination and the value of spirometry, as a possible additional screening tool to the current standard periodic health examination (PHE).

The participants were athletes of the University of the Free State (UFS) in Bloemfontein, South Africa. The sample size was determined by the number of athletes who required PHE's at the UFS Sport and Exercise Medicine Clinic for 2012. Thirty-seven athletes were selected by non-randomized, sequential sampling. The inclusion criteria were any male or female athlete, participating competitively in a recognized sport at the University, at the age of 19 and 25 years during the year 2012. Any athlete older than 25 or younger than 19 years, was excluded.

The data collection (after obtaining informed consent) started with the completion of a standard IOC PHE questionnaire [25] by the athlete. The researcher added some specific respiratory related questions to the standard paper as well as three spirometry tests after an exercise challenge and bronchodilator. The examiner went through the questionnaire with the participant to fill gaps or explain some of the questions. The physical examination included weight, height, body mass index, vital signs ant a thorough systemic examination – also according to the IOC PHE. The spirometry was done on all participants, irrespective of the presence or absence of any risk factors associated with EIB. Baseline spirometry was done followed by an exercise challenge. The exercise challenge test was followed by another two spirometries done at three and six minutes after completion of the exercise. Two puffs of a bronchodilator (salbutamol 100mcg) were administered after the six minutes spirometry. This was followed by one final spirometry 15 minutes post-bronchodilator. The technique of performing spirometry was standardized according to the American Thoracic Society (ATS) guidelines [26].

Correlations between risk factors in history, physical examination and spirometry:

Outcome of spirometries and risk factors for EIB

Risk factor	Spirometry POSITIVE	Spirometry NEGATIVE
Known asthmatic (n = 1)	1 (100%)	0
Athletes with hay fever (n = 8)	2 (25%)	6 (75%)
Athletes using respiratory medication (anti-asthmatics and/or ant-histamines) (n = 5)	2 (40%)	3 (60%)
Athletes not on respiratory medication (n = 27)	2 (7%)	25 (93%)

From the above results, the following correlations are of note:

Past history of asthma: three patients (9.3%) had a past history of asthma, of which 2 (66% of athletes with past history, 6% of sample population) were reconfirmed as present EIB with spirometry.

Present history of asthma: one athlete (3%) had a history of current asthma. After abstinence from asthma medication for the 24 hours before the lung function testing, two cases of EIA were confirmed (66% of known asthma, 6% of sample population), while 50% of athletes with known asthma were either misdiagnosed before, spirometry was false negative, or the asthma was well controlled despite a wash-out period of anti-asthmatic medication.

History of other respiratory conditions: eight athletes (25%) had a history of hay fever/allergic rhinitis. Of these, three (37.5%) had a positive spirometry for EIB, and six (62.5%) did not show signs of EIB on examination of spirometry.

Taking medication for respiratory conditions: six athletes (18.7%) took medication for asthma for allergic rhinitis, of which two cases of EIB were confirmed with spirometry.

Smoking: six athletes (18.7%) gave a history of smoking. None of them had any other indication of asthma in history, physical examination or spirometry.

CONCLUSION

The main findings are: almost ten per cent (9.4%) of the sample population of university athletes was diagnosed with EIB with spirometry. Of these athletes, 66% (n = 3), or 6.3% (n = 32) of the population were not aware that they currently suffered from the condition. Of the three athletes with known present or past asthma, only one athlete was reconfirmed with spirometry, indicating a poor correlation between history of asthma and spirometry. Of the three athletes with EIB showed any clinical signs of respiratory disease, rendering physical examination at rest a poor predictor of EIB. None of the smokers in the population showed any history, physical sign or positive spirometry for EIB, rendering smoking a poor predictor of EIB.

Our study found that past/present asthma and allergic diseases of the upper respiratory tract are significant risk factors for the development of EIB in the athlete. Furthermore the results confirm the need of an adequate exercise challenge with serial post-exercise spirometry in elite athletes irrespective of the presence/absence of risk factors as the correlation between risk factors from the history and EIB is very poor. If resting spirometry alone was the only screening tool to identify the athlete at risk for EIB then none (0%) would have been diagnosed. By adding the exercise challenge and the serial spirometries 9.4% new EIB's were diagnosed and consequently saved from significant mortality as seen in acute cases of bronchospasm.

REFERENCES

[1] Rossini, G.J., Crocetti, J., Rogers, J., et al. Asthma deaths associated with sporting activities [abstract]. Am J Respir Crit Care Med. 2000;161:623.

[2] Storms, W.W. (1999). Exercise - asthma: diagnosis and treatment for the recreational induced or elite athlete. Med Sci Sports Exerc. 31 p. S33-S38.

[3] Dickinson, J.W., Whyte, G.P., McConnell, A.K., Harries, M.G. (2006). Screening elite winter athletes for exercise induced asthma: a comparison of three challenge methods. Br J Sports Med. 40 (2) p. 179-182.

[4] Weiler, J.M., Anderson, S.E., Randolph, C., Bonini, S., Craig, T.J., Pearlman, D.S., Rundell, K.W., Silvers, W.S., Storms, W.W., Bernstein, D.I., Blessing-Moore, J., Cox, L., Khan, D.A., Lang, D.M., Nicklas, R.A., Oppenheimer, J., Portnoy, J.M., Schuller, D.E., Spector, S.L., Tilles, S.A., Wallace, D., Henderson, W., Schwartz, L., Kaufman, D., Nsouli, T., Shieken, L., Rosario, N. (2010). Pathogenesis, prevalence, diagnosis, and management of exercise-induced bronchoconstriction: a practice parameter. Ann of Allergy AsthmaImmunol. 105 (6 Suppl) p. S1 - S47.

[5] Parsons, J.P., Cosmar, D., Phillips, G., Kaeding, C., Best, T.M., Mastronarde, J.G. (2012). Screening for Exercise-Induced Bronchoconstriction in College Athletes. J Asthma. 49 (2) p. 153-7.

[6] Parsons, J.P., Mastronade, J.G. (2005). Exercise-induced bronchoconstriction in athletes. Chest. 128 (6) p. 3966-74.

[7] Hermansen, C.L., Kirschner, J.T. (2005). Identifying Exercise-induced Bronchospasm: treatment hinges on distinguishing it from chronic asthma. Phys Sportsmed. 33 (12) p. 25-30.

[8] Voy, R.O. (1984). The US Olympic Committee experience with exercise-induced bronchospasm. Med Sci Sports Exerc. 18 (3) p. 328 - 30.

[9] Weiler, J.M., Layton, T., Hunt, M. (1998). Asthma in United States Olympic athletes who participated in the 1996 summer games. J Allergy Clin Immunol. 102 (5), p. 722-6.

[10] Weiler, J.M., Ryan, E.J. 3rd. (2000). Asthma in United Sates Olympic athletes who participated in the 1998 Olympic Winter Games. J Allergy Clin Immunol. 106 (2), p. 267-71.

[11] Wilber, R.L., Rundell, K.W., Szmedra, L., Jenkinson, D.M., Im, J., Drake, S.D. (2000). Incidence of exercise-induced bronchospasm in Olympic winter sport athletes. Med SciSports Exerc. 32 (4) p. 732-737.

[12] Noviski, N., Bar-Yishay, E., Gur, I., Godfrey, S. (1987). Exercise intensity determines and climatic conditions modify the severity of exercise-induced asthma. Am Rev Respir Dis. 136 (3) p. 592-4.

[13] Koh, Y.I., Choi, I.S. (2002). Seasonal difference in the occurrence of exercise-induced bronchospasm in asthmatics: dependence on humidity. Respiration. 69 (1) p. 38-45.

[14] Stensrud, T., Berntsen, S., Carlsen, K.-H. (2007). Exercise capacity and exercise-induced bronchoconstriction (EIB) in a cold environment. Respir Med. 101 (7) p. 1529-1536.

[15] Stensrud, T., Berntsen, S., Carlsen, K.-H. (2006). Humidity influences exercise capacity in subjects with exercise-induced bronchoconstriction (EIB). Respir Med. 100 (9) p. 1633-1641.

[16] Mohammadizadeh, M.A., Ghanbarzadeh, M., Habibi, A. (2012). Effect of high intensity interval exercise in high/low temperatures on exercise-induced bronchoconstriction (EIB) in trained adolescent males. World J Sport Sci. 6 (4) p. 417-424.

[17] Aissa, I., Frikha, A., Ghedira H. (2009). Prevalence of exercise-induced bronchoconstriction in teenage football players in Tunisia. Ann Saudi Med. 29 (4) p. 299-303.

[18] Constantinou, D. (2010). Exercise-induced bronchoconstriction - current update and implications for treating athletes. Current Allergy & Clinical Immunology. 23 (2) p. 64-70.

[19] Enright, P.L., Lebowitz, M.D., Cockroft, D.W. (1994). Physiologic measures: pulmonary function tests. Asthma outcome. Am J Respir Crit Care Med. 149 (2 Pt 2) p. S9-18.

[20] Crapo, R.O. (1994). Pulmonary function testing. N Engl J Med. 331 p. 25.

[21] National Asthma Education and Prevention Program: expert panel report III: Guidelines for the diagnosis and treatment of asthma. Bethesda, MD. National Heart, lung, and blood Institute 2007. NIH publication no. 08-4051. Available from :www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm.

[22] Parsons, J.P., Kaeding, C., Phillips, G., Jarjoura, D., Wadley, G., Mastronarde, J.G. (2007). Prevalence of exercise-induced bronchospasm in a cohort of varsity college athletes. Med Sci Sports Exerc. 39 (9) p.1487-92.

[23] Parsons, J.P., Hallstrand, T.S., Mastronarde, J.G., Kaminsky, D.A., Rundell, K.W., Hull, J.H., Storms, W.W., Weiler, J.M., Cheek, F.M., Wilson, K.C., Anderson, S.D. (2013). An Official American Thoracic Society Clinical Practice Guideline: Exercise-induced Bronchoconstriction. Am JRespir Crit Care Med. 187 (9) p. 1016-1027.

[24] Hurwitz, K.M., Argyros, G.J., Roach, J.M., Eliasson, A.H., Phillips, Y.Y. (2005). Interpretation of eucapnic voluntary hyperventilation in the diagnosis of asthma. Chest. 108 (5) p. 1240-5.

[25] Ljungqvist, A., Jenoure, P., Engebretsen, L., et al. (2009). The International Olympic Committee (IOC) Consensus Statement on Periodic Health Evaluation of Elite Athletes. Br JSports Med. 43 (9) p. 631-643.

[26] Miller, M.G., Weiler, J.M., Baker, R., Collins, J., D'Alonzo, G. (2005). National Athletic Trainers' Association Position Statement: Management of Asthma in Athletes. J Athl Train. 40 (3) p. 224-245.

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