

Asthma and swimming - benefits and risks

Astmul bronșic și înotul - beneficii și riscuri

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Abstract

Asthma is a global health problem increasing in prevalence, especially among children. For a long time, swimming has been considered the most suitable sporting activity for asthma patients, due to the lower risk of bronchoconstriction, but also to the observed beneficial effects on lung function, especially in children and young people. In recent years, however, more and more authors have warned about the irritating role on the respiratory tree exerted by chlorine products used for the disinfection of swimming pool water. Various studies certify a higher prevalence of asthma or respiratory symptoms among elite swimmers, compared to other categories of athletes, and some authors blame the irritating role of chlorinated products.

This paper proposes a review of current information related to this issue, focusing on the positive effects that swimming has in controlling asthma symptoms and on the potential risks it entails for asthmatic patients.

Keywords: asthma, swimming, chlorinated products.

Rezumat

Astmul bronșic reprezintă o problemă globală de sănătate, cu o prevalență în creștere, mai ales în rândul copiilor. Multă vreme înotul a fost considerat sportul cel mai potrivit pentru astmatici, datorită riscului mai redus de bronhoconstricție, dar și datorită efectelor benefice observate asupra funcției pulmonare, în special la copii și tineri. În ultimii ani însă, tot mai mulți autori au avertizat asupra rolului iritant pe sistemul respirator exercitat de produsele clorinate, utilizate pentru dezinfectia apei din piscine. Diferite studii certifică o prevalență mai mare a astmului bronșic sau a simptomelor respiratorii în rândul înotătorilor de performanță, în comparație cu alte categorii de sportivi, unii autori invocând rolul iritant al produselor clorinate.

Lucrarea de față își propune o trecere în revistă a informațiilor de actualitate privitoare la această problematică, cu accent pe precizarea efectelor benefice pe care le are înotul asupra controlului simptomelor astmului bronșic, dar și asupra potențialelor riscuri pe care acesta le implică pentru pacienții astmatici.

Cuvinte cheie: astm bronșic, înot, produse clorinate.

Introduction

Bronchial asthma is a global health problem that affects 1-18% of the population in various countries, its costs representing a burden for society. Its prevalence is increasing in many countries, especially among children (***, 2015a). Despite the various efficient therapies available, it seems that 75% of European asthma patients are insufficiently controlled (Cazzoletti et al., 2008). Under these circumstances, the identification of additional factors, besides drug therapy with its unquestionable beneficial effects, which may contribute to a better control of the disease, is most welcome (Bacon et al., 2015).

The added value of physical activity in the management of bronchial asthma is highlighted in the GINA guidelines (***, 2015a), which recommend to “encourage people with asthma to engage in regular physical activity because of its general health benefits”; these guidelines also mention that the only sport that brings benefits to the pulmonary

function in young asthmatics is swimming and recommend body weight loss in obese patients (***, 2015a).

For a long time, swimming has been considered the most appropriate physical activity for asthma patients, given the reduced risk of bronchial constriction as compared to other sports, and also, its unquestionable benefits in improving symptoms, especially in children and young adults (Goodman, 2008).

In the recent years, however, controversies have appeared regarding this issue. Several authors have shown the potential risk of swimming for respiratory function because of the chlorine products used in the swimming pools (Villanueva & Font-Ribiera, 2012; Bernard, 2007; Nordberg et al., 2012; Bernard et al., 2009; Bernard et al., 2006; Voisin et al., 2010).

This paper aims to review the current information available in the literature on the practice of swimming by asthma patients and to emphasize its benefits and risks.

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The role of water disinfection products

Water disinfection in the pools is necessary in order to maintain hygiene conditions. This objective can be fulfilled by two methods:

a) chemical methods:

- with residual disinfectants: chlorine, chlorinated products, bromine and bromine based substances;

- without residual disinfectants: ozone

b) physical methods: ultraviolet light

Ozone and ultraviolet radiation destroy or inactivate the existing microbes, without maintaining a residual effect; therefore they are used in combination with chlorine or bromine compounds, which have a residual effect (***, 2014).

At present, chlorinated products are the most commonly used for water disinfection in public swimming pools (***, 2006).

Residual chlorine is chlorine persisting in the water after a 30 minutes contact with the water, and it acts on microorganisms in the water (***, 2014).

According to current regulations, the concentration of free residual chlorine in indoor pools must be between 0.5-1 mg/l, and in outdoor pools between 0.5-1.5 mg/l (***, 2014).

Chlorinated products are known to be direct irritants for the skin and eyes, while inhalation of volatile components irritates the upper airways. The most volatile compound is trichloramine, an extremely irritating gas (Franchek et al., 2009). It is considered that trichloramine reacts with the respiratory epithelium and destroys the integrity of the respiratory mucosa (Song et al., 2010).

WHO acknowledges the secondary “chemical” effect due to chlorine products among the risks of swimming (***, 2006).

This hypothesis is supported by the increased number of patients with respiratory complaints among the personnel of indoor pools and performance swimmers (Bernard et al., 2010; Bougalt et al., 2009; Fisk et al., 2010).

The negative effect of chlorinated products on the airways in asthma patients has been demonstrated by a number of studies (Villanueva et al., 2012; Bernard, 2007; Nordberg et al., 2012; Bernard et al., 2009; Bernard et al., 2006; Voisin et al., 2010). Thus, a more marked bronchial reactivity was evidenced after the administration of metacholine in asthma patients, after 12 minutes spent in chlorinated water (Stav & Stav, 2005).

Responsible for this effect was most probably trichloramine, a gas that causes the typical smell of indoor pools and is considered particularly irritant.

A study performed in Sweden on healthy volunteers, who had not been in the pool for the last two weeks prior to the study, evidenced a significant decrease of the maximum expiratory volume per second after a two-hour exposure to the indoor pool atmosphere. Another component of the study was represented by an epidemiological study on 1741 subjects working in indoor pools. According to their answers to a questionnaire, a statistically significant relation was found between the hours spent daily in the indoor pool environment and the percentage of employees with acute complaints during working hours. The frequently reported

symptoms were: dyspnea (13%), cough (23%), nasal irritation (29%), eye irritation (37%) and throat irritation (24%) (Nordberg et al., 2012).

This study did not evidence alterations in the biological markers of the respiratory mucosa in subjects without atopic background exposed to indoor pool chlorine. However, alterations were evidenced in atopic patients (Nordberg et al., 2012).

Obviously, the irritant effect also depends on the concentration of these products.

Thus, it is considered that they should not be harmful if the prescribed concentrations range is observed and if swimming is practiced moderately (Franchek et al., 2009).

A study performed in a group of 2500 Swedish children, assessed based on a questionnaire at the age of 7-8 years, and then 4 years later, at the age of 11-12 years, found a direct correlation between bronchial asthma onset and the practice of recreational swimming (at least once a week) in indoor pools, in atopic children. The correlation was not found in children without atopy. A dose-effect correlation was also found (Andersson et al., 2015).

Bronchial asthma among performance swimmers

Performance athletes have an increased prevalence of respiratory complaints compared to controls (***, 2015a). They suffer more frequently from asthma, allergic or non-allergic rhinitis, vocal cord dysfunction, chronic cough and recurrent respiratory infections. Bronchial hyperresponsiveness is common among athletes, most of the times without reported symptoms. Bronchial asthma in elite swimmers is characterized by a more reduced correlation between symptoms and lung function; higher pulmonary volumes and expiratory flow, less eosinophilic inflammation; more difficult control of symptoms; some improvement in airway dysfunction after discontinuation of practice (***, 2015a).

Various studies document a higher prevalence of bronchial asthma or respiratory symptoms in performance swimmers compared to other athletes (Bougalt et al., 2009; Fisk et al., 2010; Levesque et al., 2006; Romberg et al., 2012a; Romberg et al., 2012b). Among symptoms, cough is the most common in performance swimmers (Heir et al., 1994).

Exposure to chloramine is considered to be an important pathogenic factor in the development of bronchial asthma, and there is a direct correlation between the degree and duration of exposure on the one hand, and bronchial hyperresponsiveness and lower airway inflammation on the other hand (Bernard et al., 2009).

However, the wide spreading of bronchial asthma among swimmers can also be explained by the fact that swimming is a physical activity generally well tolerated by asthmatics, which makes them choose this sport. It is known that some of them have become Olympic and world champions.

Studies have demonstrated that the intensity, duration and type of exercise influence the severity of symptoms (Heir et al., 1994). For example, at the same level of exercise intensity, the symptoms of bronchial asthma are milder in swimmers than in runners or cyclists (Bar-Yishay et al., 1982). This may be a decisive factor in the

asthma patients' choice of the sport they want to practice (Paivinen et al., 2013).

Bronchial asthma in recreational swimmers

Bronchial asthma is common in leisure swimmers. A study performed in a group of more than 1000 swimmers aged between 8-17 years, whose symptoms were assessed based on questionnaires as well as by spirometry, evidenced the presence of symptoms or asymptomatic bronchial obstruction in a higher percentage than in patients previously diagnosed with bronchial asthma, which indicates again that the disease is under-diagnosed (Fiks et al., 2012).

Population studies in children and adolescents evidence an increase of the risk for bronchial asthma after more than 100 hours spent in swimming pools, a number of hours higher than the duration of training in swimming pools in the case of most studies performed in asthma patients (Bernard et al., 2010).

Hence the utility of prospective studies over longer periods of time in cohorts of recreational swimmers, which would provide additional information on the relationship between indoor swimming as a recreation and the onset of bronchial asthma.

Gender differences

As it is known, the prevalence of bronchial asthma in childhood to adolescence is higher among boys; after puberty the gender ratio is reversed, as later in life the female gender presents a higher risk of developing asthma (Leynaert et al., 2012; Vink et al., 2010).

Regarding the gender difference in performance swimmers, a study carried out on 300 athletes in Finland found significant differences in symptoms. Thus, in women cough was more frequent than in men (Paivinen et al., 2013). Another difference was the age of onset, much lower for boys, while it was around puberty in girls (Paivinen et al., 2013). This latter finding is in accordance with the general statistical data on asthma distribution by gender and age.

Documented benefits of swimming and physical exercise in asthma patients

Several studies provide concrete arguments in favor of swimming and also physical exercise in general in improving symptoms and functional respiratory parameters (Wicher et al., 2010; Bacon et al., 2015; Dogra et al., 2009; ***, 2015b; Mancuso et al., 2013; Dogra et al., 2009; Garcia-Aymerich et al., 2009). On the other hand, the absence of regular physical exercise was associated with more frequent hospital admissions or visits to the doctor (Dogra et al., 2009).

Also, the GINA guidelines (***, 2015a) recommend weight loss in obese patients and regular physical exercise for their beneficial effects on health. At the same time, the guidelines indicate swimming as the only sport that improves lung function in young asthma patients.

A study performed in asthma patients in Canada showed that patients who practice leisure sports for 30 minutes a day on most days in a year have 2.5 times more chances

of having well controlled asthma than patients who do not exercise (Bacon et al., 2015). Seasonal differences were found in relation to sport practices. As expected, participants tended to engage in physical activities during the warm season. On the other hand, asthma symptoms were better controlled in patients who exercised all the year round. Hence, we may conclude that continuous physical exercise and its cumulative effect are the key elements of its positive influence (Bacon et al., 2015). On the other hand, it is also possible that patients with well controlled asthma may engage in physical activities more often and all the year round (Bacon et al., 2015).

A large prospective study performed on 5738 children in Great Britain, followed up between birth and the age of 10, showed that indoor swimming did not increase the risk of asthma, atopy, or respiratory complaints (Font-Ribera et al., 2011). On the contrary, the study found an improvement of respiratory parameters in children who practiced leisure swimming, especially in those who swam frequently. Moreover, no correlation was found between swimming and bronchial hyperreactivity (Font-Ribera et al., 2011). However, the study only included children who practiced swimming as a recreation, not performance sport.

Recently, a study by Bacon et al. (2015), performed on 643 adult Canadian patients with documented bronchial asthma assessed based on the Asthma Control Questionnaire (***, 2015b) after one year of leisure exercise, showed that physical activity significantly improved the control of symptoms. This study reinforces, once more, the benefits of physical exercise and the value added to therapy (Bacon et al., 2015).

Another recent study compared a group of patients who took supervised aerobic exercise for 12 weeks, one hour 3 times a week, with controls, and found that in the exercise group symptoms were significantly better controlled (according to the Asthma Control Questionnaire score) (***, 2015b).

There is also the possibility that an important percentage of asthma patients may choose swimming as a leisure sport because of its apparently lower risk of bronchial constriction.

Discussion

The literature mainly comprises studies performed in three patient categories: employees of swimming pools, performance swimmers, and children. However, the number of studies on asthmatic adults who practice leisure swimming has lately increased. Such studies are welcome as they provide useful information on other patient categories as well. It is important to distinguish between the benefits of swimming as a physical exercise and the effects of chlorinated air.

Certainly, *the benefits of regular physical exercise* for asthma patients are unquestionable and recommended by guidelines (***, 2015a). Among sports, swimming is considered the least "asthmogenic" and the only one proven to improve the respiratory function in young asthmatics (***, 2015a). Body weight loss is also recommended in obese asthma patients (***, 2015a).

Chlorine products used for water disinfection have an irritant effect on the airways (Villanueva et al., 2012;

Bernard et al., 2007; Nordberg et al., 2012; Bernard et al 2009; Bernard et al., 2006; Voisin et al., 2010), a direct correlation being established between the number of hours spent in indoor pools and the onset of asthma. The atopic background also plays an essential role (Nordberg et al., 2012; Andersson et al., 2015).

WHO acknowledges the secondary “chemical” effect due to chlorine products among the risks of swimming (***, 2006).

Most studies were performed in individuals who swam indoors, where the concentration of chlorine gas is higher than in outdoor pools. Of course, the negative effects of disinfectants are minimized in outdoor swimming pools.

There are authors who consider that if the maximum admitted concentrations are maintained, the irritant effects on the respiratory tree will be insignificant; therefore they do not support a direct causality between indoor swimming and the onset of asthma.

The degree of water chlorination is important, and so is the ventilation of the indoor space, the duration spent indoors, and the presence or absence of atopy.

Consequently, it is recommended to all those who practice swimming, especially indoors, to be informed on the concentration of chlorine products in the air of the swimming pool they go to.

In the case of *performance swimmers*, there is a higher incidence of respiratory complaints compared to controls. On the other hand, this may be explained by the fact that swimming is a well tolerated sport by asthma patients, which determines the choice of this sport.

In the case of elite swimmers, there is a weaker correlation between symptomatology and lung function alteration, cough being the most common reported symptom.

Regarding *gender differences*, these are present in the symptomatology of performance swimmers. Thus, women report cough more often than men (Paivinen et al., 2013).

The age of asthma onset is significantly lower in performance male swimmers, while in females it appears during puberty or later in life (Paivinen et al., 2013).

Conclusions

1. The benefits of regular physical exercise for asthma patients are proven and recommended by guidelines.

2. Swimming is the only sport demonstrated to improve respiratory function in young asthmatics.

3. Chlorine products used for water disinfection have an irritant effect on the airways, but the degree of water chlorination is important, and so is the ventilation of the indoor space, the duration spent indoors, and the presence or absence of atopy; certainly, the negative effects are minimized in outdoor swimming pools.

4. In the case of elite swimmers, there is a higher incidence of respiratory complaints compared to controls, but, on the other hand, this may be explained by the fact that swimming is well tolerated by asthma patients, which determines the choice of this sport.

5. It is important to distinguish between the unquestionable benefits of swimming and the irritant effect of chlorine products on the airways.

Conflicts of interest

The authors state that there are no conflicts of interest related to the content of this paper.

References

- Andersson M, Hedman GN, Forsberg B, Eriksson K, Ronmark E. Swimming pool attendance is related to asthma among atopic school children population-based study. *Environ Health*, 2015;14:37. doi:10.1186/s12940-015-0023-x.
- Bacon SL, Lemiere C, Moullec G, Ninot G, Pepin V, Lavoie KL. Association between patterns of leisure time physical activity and asthma control in adult patients. *BMJ Open Respir Res*, 2015;24;2(1):e000083. doi: 10.1136/bmjresp-2015-000083.
- Bar-Yishay E, Gur I, Inbar O. Differences between swimming and running as stimuli for exercise-induced asthma. *Europ J App Physiol Occup Physiol*, 1982;48(3):387-397.
- Bernard A, Carbonnelle S, de Burbure C, Michel O, Nickmilder M. Chlorinated pool attendance, atopy, and the risk of asthma during childhood. *Environ Health Perspect*, 2006;114(10):1567-1573.
- Bernard A, Nickmilder M, Voisin C, Sardella A. Impact of chlorinated swimming pool attendance on the respiratory health of adolescents. *Pediatrics*, 2009;124(4):1110-1118.
- Bernard A. Asthma and swimming: weighing the benefits and risks. *J Pediatr (Rio J)*, 2010;86(5):351-352.
- Bernard A. Chlorination products: emerging links with allergic diseases. *Curr Med Chem*, 2007;14(16):1771-1782.
- Bougalt V, Turmel J, Levesque B, Boulet LP. The respiratory health of swimmers. *Sports Med*, 2009;39(4):295-312.
- Cazzoletti L, Marcon A, Janson C et al. Asthma control in Europe: a real-world evaluation based on an international population-based study. *J Allergy Clin Immunol*, 2008;120(6):1360-1367.
- Dogra S, Baker J, Ardern CI. The role of physical activity and body mass index in the health care use of adults with asthma. *Ann Allergy Asthma Immunol*, 2009;102:462-468.
- Fiks IN, Pereira de Albuquerque AL, Dias L et al. Occurrence of asthma symptoms and airflow obstruction in amateur swimmers between 8 and 17 years of age. *J Bras Pneumol*, 2012;38(1):24-32.
- Fisk MZ, Steigerwald MD, Smoliga JM, Rundell KW. Asthma in swimmers: A review of current literature. *Rhys Sportsmed*, 2010;38(4):28-34.
- Font-Ribera L, Villanueva CM, Nieuwenhuijsen MJ et al. Swimming pool attendance, asthma, allergies and lung function in the Avon Longitudinal Study of Parents and Children Cohort. *Am J Respir Crit Care Med*, 2011;183(5):582-588.
- Franchek D (The Swimming Pools Air Study Group). Swimming pools water treatment and its Health impact. State of the art. *Apunts Med Esport*, 2009;(6):42-47.
- Garcia-Aymerich J, Varraso R, Anto JM et al. Prospective study of physical activity and risk of asthma exacerbations in older women. *Am J Respir Crit Care Med*, 2009(11);179:999-1003. doi:10.1164/rccm.20081.
- Goodman M, Hays S. Asthma and swimming: a meta-analysis. *J Asthma*, 2008;(8)45:639-647.
- Heir T, Oseid S. Self reported asthma and exercise induced asthma symptoms in high-level competitive country skiers. *Scand J Med & Sci Sports*, 1994;4(2):128-133.
- Levesque B, Duchense JF, Gingras S, Lavoie R et al. The determinants of prevalence of health complaints among young competitive swimmers. *Int Arch Occup Environ Health*, 2006;80(1):32-39.
- Leynaert B, Sunyer J, Garcia-Esteban R. et al. Gender differences in prevalence, diagnosis and incidence of allergic and non-allergic asthma: a population-based cohort. *Thorax*, 2012; 67(7):625-631.

- Mancuso CA, Choi TN, Westermann H. et al. Improvement in asthma quality of life in patients enrolled in a prospective study to increase lifestyle physical activity. *J Asthma*, 2013;50 (1):103-107.
- Nordberg G, Lundstrom NG, Forsberg B, Hagenbjork-Gustafsson A et al. Lung function in volunteers before and after exposure to trichloramine in indoor pool environments and asthma in a cohort of pool workers. *BMJ Open*.2012;2(5): e000973.
- Paivinen KM, Keskinen KL, Tikkanen HO. Swimming and Asthma: Differences between Women and Men. *J Allergy (Cairo)*, 2013;2013:520913. doi: 10.1155/2013/520913.
- Romberg K, Tufvesson E, Bjermer L. Asthma is more prevalent in elite swimming adolescents despite better mental and physical health. *Scand J Med Sci Sports*, 2012a;22(3):367-371.
- Romberg K, Tufvesson E, Bjermer L. Extended diagnostic criteria used for indirect challenge testing in elite asthmatic swimmers. *Respir Med*, 2012b;106 (1):15-24.
- Song W, Wei S, Zhou Y, Lazrak A, Liu G et al. Inhibition of lung fluid clearance and epithelial Na⁺ channels by chlorine, hypochlorous acid, and chloramines. *J Biol Chem*, 2010;285(13):9716-9728.
- Stav D, Stav M. Asthma and whirlpool baths. *N Engl J Med*, 2005;353(15):1635-1636.
- Villanueva CM, Font-Ribera L. Health impact of disinfection by products in swimming pools. *Ann Ist Super Sanita*, 2012;48(4):387-396.
- Vink Nm, Postma DS, Schouten JP et al. Gender differences in asthma development and remission during transition through puberty: the Tracking Adolescents individual Lives Survey (TRAILS) study. *J Allergy Clin Immunol*, 2010;126 (3):498-504.
- Voisin C, Sardella A, Marcucci F, Bernard A. Infant swimming in chlorinated pools and the risks of bronchiolitis, asthma and allergy. *Eur Respir J*, 2010;36 (1):41-47.
- Wicher IB, Ribeiro MA, Marmo DB et al. Effects of swimming on spirometric parameters and bronchial hyperresponsiveness in children and adolescents with moderate persistent atopic asthma. *J Pediatr (Rio J)*, 2010;86(5):384-390.
- ***. Global Strategy for Asthma Management and Prevention (update 2015). Available online at: www.ginasthma.org. Accessed in November 26, 2015a.
- ***. Ministerul Sănătății. Institutul Național de Sănătate Publică: Ghid pentru supraveghere și monitorizare a calității apei de piscine și bazine de înot. București, 2014.
- ***. World Health Organisation. Guidelines for safe recreational water environments. Vol. 2. Swimming pools and similar environments. WHO, Geneva, 2006.
- ***. Exercise improves Asthma Control. Study Suggests. *Medscape*. Oct. 29, 2015b.