

Asthma and swimming: weighing the benefits and the risks

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Swimming is a healthy exercise that is well tolerated by asthmatics because it induces less severe bronchoconstriction than other forms of physical activity. This protective effect of swimming probably results from the high humidity of inspired air at water level, which reduces respiratory water loss and possibly osmolarity of airways mucus. The horizontal position of the body during swimming might also play a role by altering the breathing pathway and thereby producing less airway resistance than do other sports. Swimming is thus frequently recommended to asthmatics as a safe and enjoyable mean to maintain their lung function, to increase their aerobic capacity and to improve their quality of life.

Data reported by Wicher et al.¹ in this issue of *Jornal de Pediatria* add to the evidence that swimming has beneficial effects on the lung function of asthmatics. The authors conducted a follow-up study on 61 children and adolescents with mild atopic asthma who were randomized in swimmers and non-swimmers. The swimming program consisted of a total of 24 sessions of 60 minutes each over a period of 3 months. At the end of the training program, the authors found that the bronchial hyperresponsiveness (BHR) measured by the methacholine test was significantly reduced in swimmers while it did not change in non-swimmers. The swimming pool attended by swimmers had openings in the walls near the roof and thus was presumably well ventilated. Although most studies investigating the effects of swimming on asthmatics, including that of Wicher et al.,¹ were based on follow-up of less than 6 months, it is generally assumed that the benefits of swimming observed in these studies hold for much longer periods of training regardless the type of swimming pool and the method for disinfecting water.

The deeply rooted idea that swimming in indoor pools can only be beneficial for asthmatics is however increasingly questioned by reports of respiratory problems among swimming pool workers,² and competitive³ or recreational^{4,5} swimmers. In the case of competitive swimmers, the

mechanical stress imposed on the airways by the intense training probably plays a role in these problems. Intense exercise, however, cannot be the explanation for the respiratory effects observed in lifeguards or infant swimmers who do not train in the pool. Thus, researchers in the field increasingly relate the poorer respiratory health of swimmers to the irritating effects of chlorine or of its by-products, which depending on type of swimming are

inhaled as gases, microaerosols or even as small volumes of water (e.g. by infant swimmers). The current hypothesis is that these chemicals irritate the airways of swimmers and thereby make them more sensitive to environmental stressors such as allergens or infection agents.⁶

This interpretation is supported by biomarker studies showing that chlorination products can cause acute or chronic disruption of the lung epithelial barriers.^{7,8} Ironically, and adding to the confusion, the physicians who first alerted the medical community about the risks of pool chlorine had their attention drawn by the effects of these chemicals on the airways of their asthmatic patients.^{9,10} The vulnerability of airways of asthmatics to chlorination products was clearly demonstrated in a more recent study showing an increased BHR to methacholine in asthmatics after only a 12-minute immersion in a chlorinated whirlpool bath.¹¹

With the accumulating evidence that chlorine used to disinfect swimming pools is detrimental to the airways of swimmers, it is paradoxical that most physicians and medical associations recommend swimming as a sport particularly suitable to asthmatics. This sounds even more paradoxical as it is generally assumed that the airways of asthmatics are more sensitive to irritating gases than that of non-asthmatics. Actually, this recommendation has transformed the asthma-swimming association in a sort of egg and chicken story, which has contributed to delay the implementation of preventive measures. For instance, it has been known for more than 20 years that competitive

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swimmers suffer more frequently of asthma and allergies than other athletes⁸. These respiratory problems of swimmers received little attention from the scientific and medical communities who attributed them to a selection bias precisely because asthmatics are encouraged to practice swimming. This selection bias, which may also operate for recreational swimmers, is an important confounder in population-based studies exploring associations between asthma and swimming. The possibility of reverse causation, however, cannot be invoked for the respiratory problems of lifeguards who, if any, would be tempted to leave their job rather than to take it when being diagnosed with asthma (the so called "healthy worker" effect). This explanation does not hold for associations with hay fever and allergic rhinitis or for associations with respiratory symptoms or signs of airways inflammation observed in the absence of a diagnosis of asthma.^{4,6}

How can we explain the discrepancy between studies reporting an improvement of lung function in asthmatics and those suggesting that chlorinated pool attendance increases asthma risk? To resolve this paradox, first it is important to distinguish the benefits of swimming as a sport from the effects of chlorine used as biocide or in other terms to disconnect the respiratory effects of the warm and humid air of the swimming pool from those of chemicals polluting the swimming pool air or water. The discrepancy between studies showing beneficial or adverse effects of swimming might result from the fact that these effects develop over different time scale and probably under different exposure conditions. Population-based studies with children or adolescents show that asthma risk increases only from a cumulative pool attendance of more than 100 hours, which largely exceeds the duration of training in most studies on asthmatics. In addition, the risk of asthma appears to systematically culminate with pool attendance during early childhood (before the age of 7 years), thus in subjects who are usually much younger than in follow-up studies among asthmatics. Whether this is a reflection of a greater sensitivity of the airways during childhood or of the fact that young children have to attend the small pool which is heavily polluted by chlorine compounds is unknown. The fact is that exposure conditions in population-based studies linking pool chlorine to asthma risk are not the same as in studies describing the benefits of swimming for asthmatic patients.

What is the next step and what should be the recommendations to regular swimmers? Since the issue is not the benefits of swimming as a sport but the risks posed by chlorine used to disinfect swimming pools, the best step forward is to undertake prospective follow-up studies comparing the respiratory effects of swimming between chlorinated pools and chlorine-free pools. If pool chlorine is detrimental to the lungs of swimmers, benefits of swimming should be greater among regular attendees of chlorine-free

swimming pools than among users of chlorinated pools. If as suggested by recent studies^{3,4,6} swimming in chlorinated pool attendance promotes the development of asthma, then some reversal of airways inflammation or of asthma might be seen among asthmatics who were regular swimmers and who shifted from a chlorinated to a non-chlorinated pool. In the meantime, one can only recommend to regular swimmers, especially those with asthma or with an atopic status, to avoid poorly managed swimming pools with excessive levels of chlorine in air or water. The clues to identify these pools are a strong chlorine smell in pool air and irritating effects on the skin, eyes or upper airways in contact with pool air or water.

References

1. Wicher IB, Ribeiro MA, Marmo DB, Santos CI, Toro AA, Mendes RT, 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):384-90.
2. Fantuzzi G, Righi E, Predieri G, Giacobazzi P, Mastroianni K, Aggazzotti G. Prevalence of ocular, respiratory and cutaneous symptoms in indoor swimming pool workers and exposure to disinfection by-products (DBPs). *Int J Environ Res Public Health*. 2010;7:1379-91.
3. Helenius I, Ryttilä P, Sarna S, Lumme A, Helenius M, Remes V, et al. Effect of continuing or finishing high-level sports on airway inflammation, bronchial hyperresponsiveness, and asthma: a 5-year prospective follow-up study of 42 highly trained swimmers. *J Allergy Clin Immunol*. 2002;109:962-8.
4. Bernard A, Nickmilder M, Voisin C, Sardella A. Impact of chlorinated swimming pool attendance on the respiratory health of adolescents. *Pediatrics*. 2009;124:1110-8.
5. 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;36:41-7.
6. Bernard A. Chlorination products: emerging links with allergic diseases. *Curr Med Chem*. 2007;14:1771-82.
7. Bernard A, Carbonnelle S, Michel O, Higuët S, De Burbure C, Buchet JP, et al. Lung hyperpermeability and asthma prevalence in schoolchildren: unexpected associations with the attendance at indoor chlorinated swimming pools. *Occup Environ Med*. 2003;60:385-94.
8. Bernard A, Carbonnelle S, Dumont X, Nickmilder M. Infant swimming practice, pulmonary epithelium integrity, and the risk of allergic and respiratory diseases later in childhood. *Pediatrics*. 2007;119:1095-103.
9. Mustchin CP, Pickering CA. "Coughing water": bronchial hyperreactivity induced by swimming in a chlorinated pool. *Thorax*. 1979;34:682-3.
10. Rothery SP. Hazards of chlorine to asthmatic patients. *Br J Gen Pract*. 1991;41:39.
11. Stav D, Stav M. Asthma and whirlpool baths. *N Engl J Med*. 2005;353:1635-6.

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