Chronic Respiratory Diseases and Sport in Children

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For both healthy children and those with chronic diseases, the ability to engage in play, exercise, and other physical activities is an essential component of daily life. For the pediatrician precise assessment of the cardiorespiratory and metabolic responses to exercise can be a valuable tool in the diagnosis of disease, the assessment of its impact, and for the recommendation of specific programs of physical activity [3]. With the development of non-invasive techniques to analyse gas exchange during exercise, the potential usefulness of exercise testing is increased and has been applied to evaluate children with asthma, cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease and other chronic conditions [7]. It is becoming increasingly clear that physical activity plays a role in subsequent growth and development and there is growing awarenss that patterns of activity established during childhood may profoundly affect health later in life [3].

The mechanisms of exercise intolerance in patients with chronic lung disease are intimately related to the underlying pulmonary pathophysiology and include mechanical factors, ventilatory inefficiency and gas exchange abnormalities. The most obvious physiologic abnormality is airflow obstruction which impairs their ability to develop ventilation adequate for the metabolic needs during exercise. Hypoxemia may also occur during exercise, either as a result of hypoventilation with hypercapnia, ventilation-perfusion mismatching or diffusion abnormalities [10].

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Bronchopulmonary Dysplasia (BPD)

Cardiopulmonary exercise testing is a unique tool used to assess the limits and mechanisms of exercise tolerance. Indeed, several studies have shown that the functional reserve of patients with pulmonary disease is not accurately predicted from resting lung function indices. BPD was first described in 1967 as a typical consequence of neonatal respiratory distress syndrome (RDS) and mechanical ventilation in premature neonates and, at present, is the second most common chronic lung disease in childhood after asthma.

Generally, it is believed that pulmonary function of BPD survivors improves rapidly during the first years of life. However, a consistent reduction of minute ventilation, aerobic fitness and gas transfer during exercise has been found in long-term asymptomatic school-aged survivors of BPD even if pulmonary function at rest was only slightly impaired [1, 5]. We evaluated a group of BPD survivors with a maximal stepwise exercise on a treadmill and showed that $\dot{V}O_2max$ and VE_{max} were about 30% lower than those of control children [9].

The poor exercise performance of these children seems related to an incomplete repair of the injured lungs making the ventilation and the pulmonary gas exchange unable to meet the metabolic requirement of the organism stressed by the exercise. We emphasize the importance of exercise testing as an investigative strategy to evaluate cardiorespiratory function in children with a history of neonatal chronic lung disease.

On the contrary, aerobic power, normal gas exchange and working capacity have been reported in children survivors of prematurity who did not develop BPD, including children with RDS at birth [2, 4]. This suggests that lung repair following RDS is probably complete in most survivors by school age. Their lungs perform in a normal fashion and these children can be expected to perform physically as well as their peers.

Cystic Fibrosis

Many patients with a mild cystic fibrosis have normal exercise tolerance, but as the disease progresses and pulmonary function deteriorates, exercise tolerance likewise diminishes. Although decreasing exercise performance is directly related to decreasing pulmonary function, it is not possible to predict exercise tolerance from the results of standard spirometry. The

prognostic value of exercise testing in patients with cystic fibrosis was demonstrated by Nixon et al. [6, 7]. They evaluated 109 patients with CF who underwent exercise testing and followed them for at least 8 years.

They found that higher levels of aerobic fitness (peak oxygen uptake and peak work capacity) are associated with a significantly lower risk of dying, suggesting a notable association between aerobic fitness and survival. This finding persisted after adjustment for age, sex, colonization of the respiratory tract by *P. cepacia,* pulmonary function and end-tidal PCO_2 at peak exercise. These results suggest that exercise testing may be a valuable tool for determining prognosis in patients with CF.

Asthma

Despite many studies on exercise performance in asthmatic patients, there are still contradictory data concerning the presence of a limited physical fitness in children affected by this chronic lung disease [7].

Recently, emphasis has been placed on a low level of physical conditioning as a possible cause of poor endurance fitness in asthmatic children. We have recently compared ventilation and gas exchange response to exercise in a large group of asthmatic children with that of healthy controls. To exclude the influence of conditioning, healthy controls were matched for habitual level of physical activity. We found that the level of exercise performance of children with controlled, mild-to-moderate asthma was not different from that of healthy controls [8].

Asthmatic and control children showed comparable values of O_2 consumption and minute ventilation both at submaximal and maximal levels of exercise, indicating a similar aerobic work capacity.

Further indices of exercise tolerance, such as maximal ventilation, dyspnea index and maximal oxygen pulse were comparable between the two groups, suggesting that asthmatics appear to have no ventilatory or circulatory limitation to their work capacity. Both in asthmatics and in controls the most important factor affecting exercise tolerance was found to be the level of physical conditioning of the subjects. The only difference regarded the ventilatory pattern during exercise: asthmatics were able to achieve the same minute ventilation as controls by exhibiting lower respiratory frequencies and greater tidal volumes.

The results of this study provide solid evidence for reassuring physicians and parents on the work capacity of asthmatics and for encouraging asthmatic children to take part in sporting activities, recognizing that there is no reason to limit daily physical activity as part of normal lifestyle in well-controlled asthma.

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Reviewer's Comment

The papers by Drs. Baraldi and Nystad present two perceptions of the growing problem of chronic lung disease in children and its impact on exercise performance. Both also point out a very important problem associated with pulmonary disease in these children. This is a tendency toward an excessive sedentary lifestyle to avoid exercise related symptoms.

Baraldi points out that asthmatic children have similar maximal oxygen consumption and endurance to non-asthmatic children when corrected for habitual levels of activity. Nystad suggests that the presence of asthma tends to result in children selecting a more sedentary lifestyle. Both authors stress the point that this tendency for asthmatic children toward a sedentary lifestyle may be a major factor contibuting to the belief of many parents and physicians that these children should be restricted from vigorous physical acitivity.

Both of these papers are encouraging in that they support the concept of increased physical activity in the asthmatic population. As Nystad points out, the prevalence of asthma is steadily increasing in the developed countries around the world. Greater than 10% of many pediatric populations have some bronchospastic symptoms. While the reasons for this increase remain debated, the consequences to those physicians caring for these children are clear. We will be faced with a growing number of children and parents who will need guidance to encourage increased participation in vigorous sports and physical athletics.

To achieve this goal, the use of formal exercise testing in the pediatric population will need to be expanded. Baraldi's article draws attention to the role that formal exercise testing may play in helping treat not only children with asthma but other chronic pulmonary conditions as well. The ability to evaluate cardiopulmonary performance during exercise may have profound therapeutic and prognostic benefits in asthma as well as other diseases. His case for exercise testing in such populations as cystic fibrosis and bronchopulmonary dysplasia are strong. These populations are clearly increasing both despite and as consequence of advancing medical therapies. If we are able to make rational recommendations for exercise therapy and sports participation in these children, increased collection of individual and population base data through formal testing will be essential.

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