

ORIGINAL ARTICLE

The effects of a swimming intervention for children with asthma

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ABSTRACT

Background and objective: Asthma is a common paediatric airway disease with increasing prevalence. Studies comparing swimming with other sports have found that swimming is unlikely to provoke unstable asthma but possible benefits are not defined. This study investigated the benefits of a 6 week swimming intervention on pulmonary function tests (PFT), PEF and severity of asthma in children.

Methods: Young asthmatics were randomly assigned to the experimental or the control group, with 15 subjects in each group. In addition to regular treatment for asthma, the experimental group received swimming training for 6 weeks. PFT, PEF and severity of asthma were measured.

Results: There was a significant improvement ($P < 0.01$) in PEF in the experimental group compared with the control group (330 L/min, 95% CI: 309–351 vs. 252 L/min, 95% CI: 235–269) after the swimming intervention. There was also a significant improvement ($P < 0.05$) in the severity of asthma in the experimental group compared with the control group.

Conclusions: These data suggest that a swimming programme for asthmatic children can improve some disease parameters (PEF and the severity of asthma). Swimming may be an effective non-pharmacological intervention for the child or adolescent with asthma.

Key words: asthma, peak expiratory flow monitoring, pulmonary function testing, severity of asthma, swimming.

INTRODUCTION

Asthma is a common paediatric airway disease and its prevalence has increased in many countries. In addition to improving the physical capacity of asthmatic children, exercise can help children overcome the effects of weather changes, irritants, colds and the emotional pressure of an asthma attack.^{1,2} Studies

SUMMARY AT A GLANCE

A randomized, controlled study of children with newly diagnosed asthma assessed the effect of a 6-week swimming programme on measures of lung function and asthma severity. Children in the swimming programme showed no improvement in spirometry, but had significant improvements in peak expiratory flow monitoring and asthma symptoms.

comparing swimming to other sports have found that swimming is unlikely to provoke an asthma attack.^{3–5} Swimming aids normal physical and psychological development, and regular swimming can increase lung volume and help develop good breathing techniques. Swimming can improve muscle tone and general fitness, and provide enjoyment for people with asthma. Children participating in swimming have shown significant improvement in all clinical variables including symptoms, hospitalizations, emergency room visits and school absenteeism compared with their previous medical history or with age-matched controls.⁶ These health benefits continued to be observed 12 months after the completion of the swimming intervention.

This randomized controlled trial investigated the effects of a 6-week swimming intervention on pulmonary function testing (PFT), PEF monitoring and the severity of asthma in 30 children with asthma.

METHODS

Patients with asthma diagnosed according to the American Thoracic Society (ATS) criteria⁷ were invited to participate in the study. The Institutional Review Board approved the study and each patient and their parent gave written informed consent. Thirty children, aged from seven to 12 years were enrolled in the study. The subjects were randomly assigned to the experimental or the control group, with 15 subjects in each group. Regular treatment for asthma according to guidelines,⁸ was continued unchanged for the duration of the study. The experimental group received 6-weeks swimming training under supervision (three sessions per week, each session being of 50 min

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duration); the control group received no specific intervention. All objective PFT studies were performed when the children were asymptomatic.

Evaluation comprised pre-intervention evaluation, monitoring of clinical progress and post-intervention evaluation. The pre- and post-evaluations were predominantly PFT including FVC, FEV₁, FEV₁%FVC, FEF₅₀, and (FEF₂₅₋₇₅). Spirometry was measured by a computerized spirometer (Ko Ko Spirometer; Pulmonary Data Service Instrumentation, Inc., Louisville, KY, USA) according to ATS criteria.⁹ The highest values of FEV₁ and FVC were determined by the two best efforts within 5% of each other. Predicted values for gender, age, height and weight were according to Polgar and Promadhat.¹⁰ We assessed subjects' clinical progress by daily PEF (the mean value of morning and evening data) using a peak expiratory flow meter and daily assessment of the severity of asthma monitored at the same time each day. Each parent and each patient was taught to assess the severity of asthma, which was classified as mild intermittent, mild persistent, moderate persistent, or severe persistent, based on the National Heart, Lung and Blood Institute criteria.⁸

During the 6-week training period, the experimental group performed the following swimming routine in a non-chlorinated outdoor pool (26°C, 95% CI: 24–28): 10-min warm-up including breathing exercises in water, 30-min swimming training and 10-min cool-down including breathing exercises in water. The lessons were supervised by certified swimming instructors who were not aware of the child's involvement in the study. For beginners, swimming training was kicking and for experienced swimmers it was freestyle or breaststroke, and the physical work capacity was set at 65% of the peak heart rate.¹¹

Data analysis was done with Microsoft Excel 2000. We determined the means, SD and 95% CI for the different variables in the whole group and in the experimental and control groups. Two-tailed Student's *t*-test was used to compare the differences in continuous variables between groups; Chi-squared test was used to assess the differences in categorical variables between groups. A *P* value < 0.05 was considered to be statistically significant. A sample size of six subjects in each group was calculated to be sufficient to detect a difference of one standard deviation in the PEF *z*-score between the experimental and control groups with 90% power at the 5% significance level.

RESULTS

Overall, the mean age was 10 years (95% CI: 9–11), the mean height 138 cm (95% CI: 134–142) and the mean body weight 39 kg (95% CI: 35–43). There was no significant difference in clinical data (Table 1), PFT (Table 2), PEF (Fig. 1), or the severity of asthma between the groups at baseline.

There was a significant improvement ($P < 0.05$) in post-intervention FEV₁ (107%, 95% CI: 97–117 vs. 92%, 95% CI: 84–100), FEF₅₀ (85%, 95% CI: 77–93 vs. 69%, 95% CI: 63–75) and FEF 25–75 (87%, 95% CI: 77–97 vs.

Table 1 The characteristics of the study group at baseline, by study group

	Experimental group (<i>n</i> = 15)	Control group (<i>n</i> = 15)
Age (years)	10 (9–11)	10 (9–11)
Height (cm)	141 (136–146)	136 (130–142)
Weight (kg)	41 (34–48)	36 (30–42)
BMI (kg/m ²)	20.6 (18.4–22.5)	19.5 (17.8–21.6)
Gender (M/F)	10/5	10/5
Use of steroid inhaler (N)	4	5
Family history of asthma (N)	3	4
Atopy* (N)	7	8
Hay fever† (N)	5	4

* Atopy was defined by the skin prick test.

† Hay fever was defined by the skin test and symptoms.

69%, 95% CI: 62–76) in the experimental group compared with their pre-intervention test results (Table 2), but the post-intervention PFT results for the experimental group did not differ to those in the control group at the end of the study (Table 2).

There was no significant difference between the groups in PEF at baseline (244 L/min, 95% CI: 228–260 vs. 224 L/min, 95% CI: 209–239), but in the experimental group there was a significant improvement after 3 weeks (300 L/min, 95% CI: 281–319 vs. 237 L/min, 95% CI: 224–250, $P < 0.05$) and after 6 weeks (330 L/min, 95% CI: 309–351 vs. 252 L/min, 95% CI: 235–269, $P < 0.01$) compared with the control group (Fig. 1). In the experimental group, there was a significant improvement in post-intervention PEF ($P < 0.05$) compared with baseline, which was not seen in the control group (Fig. 1).

Post-intervention there was a significant improvement ($P < 0.05$) in severity of asthma in the experimental group compared with the control group (data not shown). There was also a significant improvement ($P < 0.001$) in severity of asthma post-intervention in the experimental group compared with baseline which was not seen in the control group.

DISCUSSION

The main findings of this study are that, compared with controls, significant improvements in PEF and severity of asthma were found in the experimental group after the 6-week swimming intervention. In addition, significant improvements in FEV₁, FEF₅₀, FEF₂₅₋₇₅ and PEF were seen in the experimental group post-intervention compared with baseline, and there was also a significant improvement in the severity of asthma post-intervention in the experimental group compared with baseline. These data suggest that a swimming programme for asthmatic children can improve disease parameters (PEF and the severity of asthma), but not PFT parameters.

Table 2 Pulmonary function test results of the experimental group ($n = 15$) and the control group ($n = 15$), at baseline and post-intervention

	Experimental group		Control group	
	% (95% CI)		% (95% CI)	
	Before	After	Before	After
FVC (%)	91 (81–101)	101 (92–110)	98 (84–112)	101 (88–114)
FEV ₁ (%)	92 (84–100)	107 (97–117)*	102 (92–112)	105 (94–116)
FEV ₁ /FVC (%)	86 (82–90)	89 (85–93)	90 (86–94)	90 (86–94)
FEF50 (%)	69 (63–75)	85 (77–93)*	75 (66–84)	76 (67–85)
FEF25–75 (%)	69 (62–76)	87 (77–97)*	78 (68–88)	79 (69–89)

* $P < 0.05$ when comparing two experimental values.

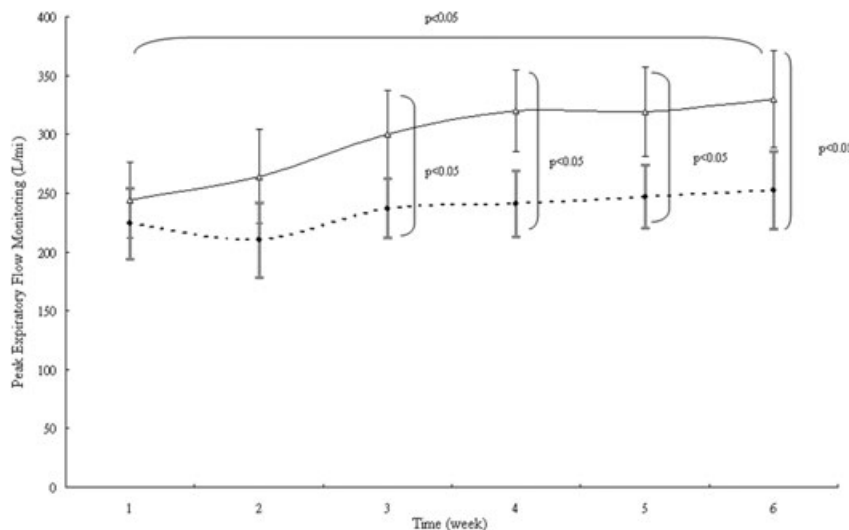


Figure 1 Peak expiratory flow results for the experimental group ($n = 15$) and the control group ($n = 15$) during a 6-week swimming intervention. There was a significant improvement ($P < 0.05$) after 3 weeks, and a further significant improvement ($P < 0.01$) after 6 weeks for the experimental group compared with the control group. The experimental group improved significantly post-intervention compared with baseline ($P < 0.05$). —△—, experimental group; --●--, control group.

Potential confounders in this study included differences in medication use (the swimming group may have increased use of pre-exercise albuterol, leading to improvement) or greater compliance with controller medications. Reports of symptom frequency may have affected parents' or participants' expectations of improvement if they were assigned to swimming group. In addition, frequent contact with health providers improves asthma self-awareness and asthma control, and just being in frequent contact with the other children with asthma may have modified compliance with treatment for asthma. For the experimental group, the significant improvement in objective PFT parameters compared with controls may have been because the experimental group started with poorer lung function test results and so had a more room to improve. Finally, our study was limited by the short period of observation and a relatively small number of participants.

Wardell and Isbister reported that patients who underwent a swimming intervention understood asthma better, and changed their medication from relieving medications to preventive ones.¹² Swimming is one of the best forms of exercise for children with asthma, as it is less likely to trigger asthma than other forms of exercise. Swimming may be an effective non-

pharmacological intervention for the child or adolescent with asthma.¹³ Studies have looked at the benefits of swimming in four areas: swimming improving markers of cardio-respiratory fitness and physical conditioning, swimming as a form of exercise to cause fewer asthma attacks, swimming improving asthma symptoms, and swimming improving respiratory function.^{14–16} Several mechanisms have been proposed. Dry inspired air is a major contributor to exercise-induced broncho-constriction (EIB), either by enhancing evaporative cooling or by increasing the osmolarity of airway mucus. The high humidity of inspired air in swimming induces less EIB than running.¹⁷ Recumbent exercise can produce a greater central blood flow than upright exercise, and may improve gas diffusion and ventilation—perfusion matching. Moreover, minute ventilation in the recumbent position is lower than in the upright position, and may induce lower respiratory heat loss (RHL).¹⁸ A greater ventilatory efficiency and improved gas exchange have been shown when recumbent exercise was performed in water compared with on land.¹⁹ Besides, the peripheral vasoconstriction during immersion increases central blood volume, which may decrease RHL and EIB.²⁰ Other mechanisms suggested to explain the low risk of an asthma attack

associated with swimming include lower pollen content over the water,²¹ higher hydrostatic pressure on the chest to reduce the expiratory effort and work,²² hypoventilation due to a controlled breathing pattern to induce hypercapnia,^{23,24} and peripheral vasoconstriction to increase central blood flow¹⁸ and reduce RHL. Physical activity may prevent or modify airway inflammation,^{25,26} but further studies are needed to determine the mechanisms underlying this association.

Two harmful effects of swimming, in addition to EIB, for patients with asthma have been suggested; increased parasympathetic drive during water immersion and sensitivity to chlorine. Our study was performed in a non-chlorinated outdoor pool. Engagement of patients with mild persistent asthma in recreational swimming in non-chlorinated pools, combined with regular medical treatment and education, leads to improvement in their parameters of lung function and also to a more significant decrease of their airway hyper-responsiveness compared with patients treated with medicine alone.²⁷ The swimming of infants in chlorinated indoor swimming pools is associated with airways changes that, along with other factors, seem to predispose children to the development of asthma and recurrent bronchitis.²⁸ The prevalence of childhood asthma and availability of indoor swimming pools in Europe are linked through associations that are consistent with the hypothesis implicating pool chlorine in the rise of childhood asthma in industrialised countries.²⁹ Swimming pool attendance and exposure to chlorination by-products showed adverse health effects on children.³⁰ Outdoor chlorinated swimming pool attendance is associated with higher risks of asthma, airways inflammation and some respiratory allergies.³¹ Elite swimmers may have increased airway inflammation and bronchial hyper-reactivity, probably as a result of repeated exposure to chlorine derivatives.³²

A swimming training programme showed significant improvement in clinical variables including the frequency of attacks, change in PEF, number of wheezing days, number of days requiring medication, emergency room visits, rate of hospitalization and days absent from school.⁶ In addition, there were improvements in asthma severity, mouth breathing, snoring, chest deformity, enjoyment of the programme, swimming proficiency, continuing swimming, self confidence, doctor visits, hospitalization, school absence, asthma management, understanding of asthma and feelings of disadvantage.³³ Our studies confirm that swimming appears to be a useful form of exercise for asthmatics.

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