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Laps or lengths? The effects of different exercise programmes on **asthma control** in children

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Abstract

Introduction: Exercise training has been shown in numerous studies to improve lung function and asthma control in children with asthma. Swimming has been shown to be of benefit in children with asthma, but which form of exercise is better for asthmatics has not been determined to date. The aim of this study was to examine if swimming improved lung function and asthma symptoms in asthmatic children when compared with different forms of exercise and a control group.

Methods: Subjects with asthma were randomly assigned to either one of three different exercise training groups (swimming, football and basketball) or a control group. Spirometry was performed before and after and the subjects were asked to keep asthma diaries and perform daily peak flow measurements.

Results: 41 children and adolescents between the ages of nine and 16 participated in the study. After completing the training, children across all three exercise programmes had significantly higher forced vital capacity (FVC) percentage values when compared to the control group. The swimming group demonstrated a significant increase in the percentage peak expiratory flow

(PEF) following the exercise programme when compared with the control group (78.3 ± 9.3 versus 89.0 ± 14.9 , $p = 0.04$). All children on exercise training programmes reported an improvement in their asthma symptoms via asthma diaries.

Conclusion: This study suggests that a swimming training programme is more beneficial in terms of peak flow measurements when compared with other exercise training programmes.

Keywords

Asthma, exercise training, swimming.

Introduction

The role of exercise in improving asthma control in patients has been demonstrated in previous studies. However, there is very little evidence to demonstrate that one form of exercise rather than another improves asthma control. The studies that have been done on asthmatic children have suggested that perhaps swimming is a superior form of exercise compared with other forms of exercise (1-4). A Cochrane review performed in 2013 concluded that swimming in asthmatic children was well tolerated, improved their lung function and improved their cardiorespiratory fitness (5). A major drawback of the studies included in this review was that none of them compared one form of exercise with another. The aim of our study was to assess the clinical benefits of different forms of exercise including swimming, football and basketball in stable asthmatic children and adolescents. Our hypothesis was that swimming would result in improved asthma symptoms and improved lung function measures when compared with other sporting activity.

Methods

We invited children and adolescents with asthma from the community to partake in this prospective study. Asthma sufferers were identified through the local general practitioners network or through advertisements at local schools. To meet the inclusion criteria for the study, participants had to have doctor diagnosed asthma confirmed by their primary care physician. Only asthma patients with either mild or moderate asthma were included in the study. Exclusion criteria were children with severe asthma and/or those with another chronic paediatric condition. Informed consent from the participants and their parents was obtained. Participants were then

randomly assigned to either a swimming, football, basketball or control group using a simple randomisation sequence. Subjects underwent spirometry testing (using a Carefusion™ microloop spirometer) both pre- and post-study according to ATS criteria (6). We asked all participants to fill out asthma diaries and perform twice-daily peak flow readings throughout the duration of the study. An exit survey was conducted to collect qualitative data regarding general wellbeing and symptoms, and to assess participants' feelings towards exercise and asthma control after taking part in the study. The study was approved by the Irish College of General Practitioners (ICGP) research ethics committee.

Six-Week Exercise Programmes

Each participant began a six-week exercise programme in their allocated sport for forty minutes once a week. The exercise programmes were designed by the Dublin City University (DCU) Human Health and Performance Department and consisted of predominantly four sections: dynamic warm-up, speed work, conditioning games/drills and cool down, ensuring similar workload in all sports. The swimming training programme took place in an indoor pool. The estimated energy expenditure of the three different sports activities was calculated using the Metabolic Equivalent of Task (MET) method (7). There was no statistical difference in the energy expenditure between the three groups. Additional information on each individual exercise programme along with details on the chlorine level of the swimming pool used in this study are included in the supplemental material. The control group did not take part in any regular exercise programme during the six weeks of the study.

Statistical Analysis

Chi-squared and independent t-tests were used to compare the demographics of the study groups. Mixed ANOVA tests were used to analyse spirometry results, peak flow data and symptoms (SPSS 20, IBM).

Results

Participant demographics:

In total, 41 children and adolescents between the ages of nine and 16 (mean of 12.9 ± 2.2 SD) participated in the study (Table 1). Of the participants taking part in the study, 24 (58.5%) were male and the majority had mild to moderate doctor diagnosed asthma with only 3 (7.3%) participants being admitted to hospital with an asthma exacerbation ever. When we examined demographics of the four groups, there were no differences between them except for a statistically significant lower number of male participants in the control group when compared with each of the exercise groups (Table 2).

Spirometry readings:

We compared spirometric data both before and after the exercise programmes (Table 3). Spirometric values increased numerically in all exercise groups, but there was only a statistically significant increase in the percentage forced vital capacity (FVC) values across all three (swimming, $p = 0.007$; football, $p = 0.007$; basketball, $p = 0.008$) when compared to the control group. In addition, only the swimming group demonstrated a significant increase in the

percentage peak expiratory flow (PEF) before and after the exercise programme when compared with the control group (78.3 ± 9.3 versus 89.0 ± 14.9 , $p = 0.035$).

Peak Flow Meter Readings:

All exercising groups showed an upward trend in participant-recorded PEF (Figure 1). The swimming group had the largest increase (11%) in overall mean PEF from the beginning of the exercise programme to the end, compared with smaller increases in the football group (6%) and in the basketball group (8%). The control group showed a slight downward trend (-3%). The swimming group was the only group that had a statistically significant increase in PEF meter readings when compared with the control group ($p = 0.04$).

Asthma diaries and exit survey:

All participants in all three groups tolerated the exercise programmes well and no adverse effects were reported. No subjects reported either an increase or decrease in the use of their asthma medications over the duration of the study. From the swimming group, 77% (7/9) reported improved asthma symptoms, compared with 37.5% (3/8) from the basketball group and 25% (2/8) from the football group. No participants from the control group reported improved symptoms. All participants surveyed from the swimming group (8/8, 100%) said that they felt an increase in their general wellbeing over the course of the exercise programme. This compares with 50% (4/8) from the basketball group, 62.5% (5/8) from the football group, and 9% (1/11) from the control group.

Discussion

Our study confirms, as shown in previous studies, that sporting activities improves lung function and asthma symptoms in young children and adolescents with asthmatics. The study also demonstrates that swimming is well tolerated and a more beneficial form of exercise for children with asthma when compared with either football or basketball in respect to improved peak expiratory flow readings.

Swimming has long been recommended as a form of exercise for asthmatic patients on the basis that it causes less exercise induced bronchoconstriction compared with other forms of exercise (8). There are a number of different theories reported in the literature as to why swimming causes less exercise induced bronchoconstriction (4). The air above the pool is particularly humid which may result in a lowering of respiratory heat loss (9). Controlled breathing during swimming leads to increased alveolar carbon dioxide levels resulting in less exercise induced bronchoconstriction (10). Other studies have shown that the combination of the horizontal position adopted during swimming and immersion in water itself may also contribute to improved ventilatory and diffusion parameters (11, 12). However, the evidence for this overall hypothesis has been conflicting in published literature (5).

To our knowledge, this is the first prospective study to compare different forms of exercise compared to a control group to examine lung function and asthma symptoms in an paediatric asthmatic population. A number of studies have shown that exercise training in different forms is safe and is recommended for children (13) and adults (14) with asthma. In addition, there have been a number of studies demonstrating the positive effects of swimming training programmes

on children with asthma when compared with a control group (1, 2, 4, 15--18). Recent systematic reviews have concluded that swimming is well tolerated and both increases lung function and cardiopulmonary fitness but could not determine whether swimming is better than any other form of exercise (3, 5, 19). Our study findings would be consistent with these reviews in respect to improved asthma symptoms and PEF in our exercise groups, in particular the swimming group.

Against these positive findings, there has been emerging concerns regarding the effect of chlorination of swimming pools on asthmatic children (20). Some reports suggest that chlorine increase airway inflammation and respiratory symptoms in young children with asthma (21-23). In our study, none of participants in the swimming arm of our study reported an increase in respiratory symptoms or in the use of reliever medications.

Our study showed significant improvements with PEF measurements in the swimming arm compared with the football or basketball arms. However, all three forms of exercise programmes were associated with improved asthma symptoms means that we cannot definitively report that the increases in the PEF data observed in the swimming group were associated with a clinically significant change. Some studies have questioned whether not peak flow monitoring is an accurate method of measuring asthma control in a paediatric setting (24). The fact that our spirometry PEF% data correlated with the home PEF monitoring results adds to the strength of our study. Other studies have reported increases in other spirometric values including FEV1 which was not demonstrated in our study (2, 4). Possibly this finding was not replicated in our study because of the smaller numbers recruited. Another limitation of our findings is the brevity

of the weekly exercise programmes and the shortened timeframe over which the study was conducted. We postulate that perhaps a more individualised and intense training programme over a period of months rather than weeks may yield more robust findings on the impact of different exercise programmes on asthmatic children.

In conclusion, all forms of exercise training modules in our study were well tolerated and were associated with improved FVC% values, home PEF measurements and asthma symptoms. Only swimming training showed statistically significant increases in both home and spirometric PEF measurements, suggesting that swimming is a more beneficial form of exercise when compared to other forms of training.

Declaration of interests:

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1: Study participants demographics

Patient demographics	n = 41
Age (years)	12.9±2.2
Gender (Male, %)	24 (58.5)
Height (cm)	161.5±13.2
Weight (kg)	57.0±14.6
BMI (kg/m ²)	21.8±3.9
Family history of asthma	21 (51.2)
Atopy	17 (41.5)
Eczema	11 (26.8)
Hayfever	22 (53.7)
Current smoker	8 (19.5)
Hospitalisation with asthma exacerbation ever	3 (7.3)

Data shown is presented as n (%) and mean ± SD (range)

Table 2: Study participant demographics by grouping

Demographics	Swimming n = 9	Football n = 9	Basketball n = 11	Control n = 12
	9	9	11	12
Age	13.3±1.9	13.2±1.6	13.5±1.8	12.0±3.1
Male (%)	5 (55.6)	7 (77.8)	9 (81.8)	4 (33.3)*
Height	160.2±10.7	163.4±10.5	166.9±13.0	155.9±15.9
Weight	57.9±14.3	58.2±12.3	62.3±13.9	50.0±16.4
BMI	23.1±5.2	21.4±3.0	22.1±3.1	20.9±4.2
Family history of asthma	6 (66.7)	5 (55.6)	4 (36.4)	6 (50.0)
Atopy	4 (44.4)	5 (55.6)	4 (36.4)	4 (33.3)
Eczema	3 (33.3)	2 (22.2)	2 (18.2)	4 (33.3)
Hayfever	4 (44.4)	6 (66.7)	7 (63.6)	5 (41.7)
Current smoker	0 (0)	2 (22.2)	3 (27.3)	3 (25.0)
Hospitalisation with asthma exacerbation ever	0 (0)	1 (11.1)	1 (9.1)	1 (11.1)

Data shown is presented as n (%) and mean ± SD (range)

*p-value<0.05

Table 3: Spirometry data

	Swimming n = 8		Football n = 8		Basketball n = 11		Control n = 10	
FVC (%)	101.0±10.5	104.4±10.3*	94.1±14.4	97.5±12.6*	95.5±16.1	99.6±16.2*	96.5±12.4	96.5±9.9
FEV1 (%)	96.0±13.2	99.8±12.5	91.5±14.9	93.2±12.1	95.7±20.1	100.6±15.2	93.4±10.8	93.3±8.6
FEV1/FVC (%)	75.6±2.9	76.6±1.1	76.6±1.1	76.6±1.1	79.6±10.1	82.6±9.7	78.9±7.1	78.6±6.2
PEF (%)	78.3±9.3	89.0±14.9*	79.6±13.8	79.7±12.1	82.4±18.6	87.2±14.8	84.7±13.8	84.3±14.8

Data shown is presented as n (%) and mean ± SD (range)

*p-value<0.05