Effects of physical training in asthma: a systematic review

Felix S F Ram, Stewart M Robinson, Peter N Black

Abstract

Objectives—To assess the evidence for the effects of physical training on pulmonary function, symptoms, cardiopulmonary fitness, and quality of life in subjects with asthma.

Methods—A search was conducted for randomised controlled trials of subjects with asthma undertaking physical training using the Cochrane Airways Group register of controlled clinical trials, Medline, Embase, Sportdiscus, Science Citation Index, and Current Contents Index. Studies were included in the review if the subjects had asthma, were 8 years of age or older, and had undertaken physical training for at least 20 minutes per session, twice a week, for a minimum of four weeks. The eligibility of trials for inclusion in the review and the quality of the trials were independently assessed by two reviewers.

Results—Eight studies with a total of 226 subjects met the inclusion criteria for this review. Physical training had no effect on resting lung function but led to an improvement in cardiopulmonary fitness as measured by an increase in maximum oxygen uptake of 5.6 ml/kg/min (95% confidence interval 3.9 to 7.2). None of the studies measured quality of life.

Conclusions—Physical training improves cardiopulmonary fitness without changing lung function. It is not clear if the improvement in fitness translates into a reduction in symptoms or an improvement in the quality of life. There is a need for further randomised controlled trials of the effects of physical training in the management of asthma.


Keywords: asthma; physical training; fitness; randomised controlled trials; meta-analysis

Subjects with asthma have a unique response to physical activity. On the one hand, exercise can provoke an increase in airways resistance leading to exercise induced asthma. On the other, regular physical activity and participation in sports are considered to be useful in the management of asthma, especially in children and adolescents, but this has not been investigated in the same detail as the mechanisms of exercise induced asthma.

Exercise induced asthma can be prevented or reduced by pretreatment with a number of medicines including β agonists, chromones, and leukotriene antagonists. Despite this, the fear of inducing an episode of breathlessness inhibits many patients with asthma from taking part in physical activity. A low level of regular physical activity in turn leads to a low level of physical fitness, so it is not surprising that a number of studies have found that patients with asthma have lower cardiorespiratory fitness than their peers, although not every study has reported this.

Physical training programmes have been designed for patients with asthma with the aim of improving physical fitness, neuromuscular coordination, and self confidence. Subjectively, many patients report that they are symptomatically better when fit, but the physiological basis of this perception has not been systematically investigated. A possible mechanism is that an increase in regular physical activity of sufficient intensity to increase aerobic fitness will raise the ventilatory threshold, thereby lowering the minute ventilation during mild and moderate exercise. Consequently breathlessness and the likelihood of provoking exercise induced asthma will both be reduced. Exercise training may also reduce the perception of breathlessness through other mechanisms including strengthening of the respiratory muscles.

We have conducted a systematic review to measure the effects of physical training on subjects with asthma. This review was conducted for the Cochrane Collaboration. With these reviews, every effort is made to locate all published and unpublished studies (without any restriction on language) to answer the question. Explicit criteria are used to select studies for inclusion in the review and to assess their quality. If appropriate, a meta-analysis is used to produce an overall result. Meta-analysis is a statistical procedure to quantitatively summarise the results of randomised controlled trials.

Objectives

This review was undertaken to gain a better understanding of the effects of physical training on the health of subjects with asthma. The objective was to assess the evidence from
randomised controlled clinical trials of the effects of physical training on resting pulmonary function, aerobic fitness, clinical status, and quality of life in asthmatics.

**Methods**

**TYPES OF STUDY AND PARTICIPANTS**

Only trials of subjects with asthma who were randomised to physical training or a control intervention were selected. Subjects had to be aged 8 years or older and their asthma had to be diagnosed by a doctor or by the use of objective criteria—for example, bronchodilator reversibility. Subjects with any degree of asthma severity were included. To qualify for inclusion, the physical training had to include whole-body aerobic exercise for at least 20 minutes, two or more times a week, for a minimum of four weeks.

**SEARCH STRATEGY**

The following terms were used to search for studies: asthma AND (work capacity OR physical activity OR training OR rehabilitation OR physical fitness). The Cochrane Collaboration asthma and wheeze randomised controlled clinical trials register (up to August 1999) was searched for studies. Additional searches were carried out on Medline (1966–1999), Embase (1980–1999), Sportdiscus (1949–1999), Current contents index (1995–1999), and Science Citation index (1995–1999). The reference lists of all the papers obtained were reviewed to identify trials not captured by electronic and manual searches. Abstracts were reviewed without language restriction. When more data were required for the systematic review, the authors of the study were contacted and asked to provide the additional information or clarification.

**DATA COLLECTION AND ANALYSIS**

The following outcome measures were looked for: bronchodilator usage, episodes of wheeze,
Table 3 Summary mean result for each outcome

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome</th>
<th>Weighted mean difference</th>
<th>95% confidence interval</th>
<th>Number of studies contributing to outcome (study reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PEFR (litres/min)</td>
<td>−0.16</td>
<td>−0.40 to 0.07</td>
<td>3, 16, 18, 21</td>
</tr>
<tr>
<td></td>
<td>FVC (litres)</td>
<td>−0.22</td>
<td>−0.68 to 0.23</td>
<td>2, 16, 21</td>
</tr>
<tr>
<td></td>
<td>VeMAX (litres/min)</td>
<td>4.79</td>
<td>−2.78 to 12.38</td>
<td>2, 18, 21</td>
</tr>
<tr>
<td></td>
<td>VO2MAX (ml/kg/min)</td>
<td>5.57</td>
<td>3.94 to 7.19</td>
<td>5, 17, 18, 20, 21, 22</td>
</tr>
<tr>
<td></td>
<td>Work capacity (W)</td>
<td>28.00</td>
<td>22.57 to 33.43</td>
<td>1, 17</td>
</tr>
<tr>
<td></td>
<td>HRMAX (bpm)</td>
<td>3.40</td>
<td>0.99 to 6.28</td>
<td>3, 17, 21, 22</td>
</tr>
<tr>
<td></td>
<td>Episodes of wheeze (days)</td>
<td>−7.50</td>
<td>−22.42 to 7.42</td>
<td>1, 16</td>
</tr>
</tbody>
</table>

The study reference is the reference number.

PEFR, peak expiratory flow rate; FEV1, forced expiratory volume in one second; FVC, forced vital capacity; HRMAX, maximum heart rate; VeMAX, maximum expiratory flow.
which is a method of the meta-analysis used to combine measures on continuous scales. A weighted mean difference (WMD) is allocated for each study, which is a method of the meta-analysis used to combine measures on continuous scales. The statistical software used here (RevMan 4.0.4), this is the inverse of the variance. This method assumes that all of the trials have measured the outcome on the same scale and that for each study the baseline VO2MAX was not significantly different between control and experimental groups. Where the weighted mean difference lies to the right of the line of zero effect, it favours physical training. If the 95% confidence interval does not cross the line of zero effect, the result is statistically significant. For VO2MAX, it is 5.57 ml/kg/min (3.94 to 7.19), represented by the diamond at the bottom of the figure—that is, physical training resulted in an increase in VO2MAX of 5.57 ml/kg/min. The χ² value (7.01) gives an indication of the heterogeneity of the studies. The test of heterogeneity shows whether or not the differences in the results of the five studies are greater than would be expected by chance. In this case the χ² value has to be greater than 9.49 (4 degrees of freedom and α = 0.05) before the studies would be considered heterogeneous. For VO2MAX, χ² is 7.01 and therefore it can be concluded that the randomised controlled trials contributing to this particular outcome were not heterogeneous. This was true for all outcome measures reported in this review.

Table 3 provides a summary of the results. The overall weighted mean difference is shown for each of the outcome measures along with the 95% confidence intervals. For VO2MAX, the increase in VO2MAX was 5.57 ml/kg/min (3.94 to 7.19), represented by the diamond at the bottom of the figure—that is, physical training resulted in an increase in VO2MAX of 5.57 ml/kg/min. The χ² value (7.01) gives an indication of the heterogeneity of the studies. The test of heterogeneity shows whether or not the differences in the results of the five studies are greater than would be expected by chance. In this case the χ² value has to be greater than 9.49 (4 degrees of freedom and α = 0.05) before the studies would be considered heterogeneous. For VO2MAX, χ² is 7.01 and therefore it can be concluded that the randomised controlled trials contributing to this particular outcome were not heterogeneous. This was true for all outcome measures reported in this review.

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fit could not be ascribed solely to physical training. Nonetheless the intervention resulted in significant improvements in exercise endurance time, and the total score for the chronic respiratory disease questionnaire increased by 17 points compared with the control group. In subjects with chronic obstructive pulmonary disease, pulmonary rehabilitation does not lead to an improvement in these parameters unless the subjects undertake exercise training, and the same may be true of asthma. A recent study from Brazil allocated children to physical training or a control group. The study was not included in the review because the allocation of the subjects was not truly random, but it did find that physical training led to significant reductions in the use of both inhaled and oral steroids.

There are a number of pitfalls in conducting systematic reviews. Electronic searches of the literature may identify as few as 50% of the relevant studies. Hand searching of journals may be useful to increase the yield but is labour and time intensive. The Cochrane Collaboration asthma and wheeze randomised controlled trials register incorporates systematic hand searching (retrospective and prospective) of 20 core journals in respiratory disease in an attempt to improve the thoroughness of electronic searching in this area. So that we did not miss any relevant papers, we used several electronic databases in addition to the asthma and wheeze randomised controlled trials register, and we checked the reference lists of all the papers we obtained to identify studies we had not already found. This approach will have reduced our chance of missing relevant studies.

Another source of bias can be with the selection of the relevant studies from the titles and abstracts of papers. This source of bias was reduced by having written inclusion and exclusion criteria and by having two people independently review and select the papers from the abstracts of the 718 studies identified.

The review was restricted to randomised controlled trials. This eliminated a substantial source of data, but this approach is justified because the strength of the evidence obtained from randomised controlled trials is much greater than that obtained from other studies. Adequate randomisation technique and allocation concealment have been found to be important aspects of good quality trials. We attempted to assess the quality of randomisation technique and allocation concealment in the studies that we included in the review. Unfortunately, few of the studies provided information about this, other than stating that the subjects were randomised to physical training or control groups.

A potential weakness of this review is the small number of subjects included. However, the studies that measured VO_{max} were homogeneous and all studies showed a similar effect, which was highly significant (p = 0.001).

In summary, one can conclude that aerobic power improves after physical training in patients with asthma. This appears to be a normal training effect and is not due to an improvement in resting lung function. There is a need, however, for further randomised controlled trials to assess the role of physical training in the management of bronchial asthma. In particular, it will be important to determine whether the improved exercise performance that follows physical training is translated into fewer symptoms and to an improvement in the quality of life.

We would like to thank the following: Mr Stephen Milan, Ms Jane Dennis, Ms Anna Bara, Mr Toby Lasserson, and Ms Karen Blackhall of the Cochrane Airways Group (St George’s Hospital Medical School, London, UK), who gave us advice, translated the German language paper, ran searches using the asthma and wheeze randomised controlled trials register, and provided copies of relevant papers; Dr Bryce Daglish (Rhône-Poulenc Rorer, París, France), who translated the French language paper; Drs A Varray, R Shy, and J Neder, who responded to our request for further information about their research; Dr Philippa Poole, who provided help with the analysis; Dr Peter Gibson and Professor Paul Jones of the Cochrane Airways Group, who edited this systematic review, which first appeared in the Cochrane CD-ROM Library, Issue 1, 1999.

5 Osman AD, Cook DJ, Guyatt GH. How to use an overview. JAMA 1994;270: 1367-71.

Multiple choice questions (one correct answer only)

1 In people with asthma, regular physical training leads to improvements in:
   (a) forced expiratory volume in one second
   (b) vital capacity
   (c) peak expiratory flow rate
   (d) maximal oxygen uptake
   (e) bronchial hyper-responsiveness

2 For systematic reviews of clinical trials to be reliable they should not include:
   (a) unpublished studies
   (b) open uncontrolled studies
   (c) non-English language studies
   (d) small studies
   (e) large studies

3 In subjects with asthma there is clear evidence that:
   (a) β2 agonists should not be used before exercise
   (b) physical training reduces the quality of life
   (c) many types of physical training improve aerobic fitness
   (d) physical training should be restricted to children under the age of 12 years
   (e) only swimming improves aerobic fitness

4 Physical training of asthmatic people has been shown to:
   (a) reduce the need for bronchodilator use
   (b) reduce the incidence of exercise induced asthma
   (c) increase the maximum voluntary ventilation
   (d) increase the maximum exercise ventilation
   (e) increase maximum work capacity

5 The Cochrane Collaboration:
   (a) prepares and maintains systematic reviews of the effects of health care interventions
   (b) is a collection of historical medical biographies
   (c) disseminates information about non-scientific treatments for human diseases and disorders
   (d) maintains a database on the epidemiology of asthma
   (e) is a non-profit organisation which sponsors research into alternative treatments for asthma

Essay questions

Discuss the advantages and disadvantages of systematic reviews of randomised controlled trials in summarising evidence of the effectiveness of health care interventions.

Write an essay on the role and benefits of physical training for patients with asthma.

Take home message

Having asthma need not prevent a patient from obtaining the benefits of increased physical activity. This review shows that people with asthma who take regular exercise can improve their cardiorespiratory fitness and work capacity. Further studies are necessary to determine if regular exercise reduces symptoms and improves the quality of life in asthma.

The Cochrane Collaboration and the Cochrane Airways Group

The Cochrane Collaboration is an international network of individuals and institutions which evolved to prepare systematic periodic reviews of randomised controlled trials. Individual trials may be too small to answer questions on the effects of health care interventions. Systematic reviews that include all relevant studies reduce bias and increase statistical power and make it easier to determine if a treatment is effective or not. With the exponential growth of the medical literature (over two million articles are published annually), systematic reviews help to distill this information down and make it more manageable.

The Cochrane Collaboration is organised into 47 review groups including the Airways Group which was established to prepare reviews on asthma and chronic obstructive pulmonary disease. Before the reviews are published electronically in the Cochrane Library they are peer reviewed. Reviews are then updated at regular intervals. The Airways Group has 211 active reviewers and has completed 39 reviews. Another 86 reviews are in progress. More information about the Cochrane Collaboration including abstracts of the reviews can be found at: www.cochrane.org. The full text of reviews are available on subscription either on the internet or on CD-ROM (www.update-software.com/cochrane.htm).