




# The long-term effect of an exercise and diet intervention in asthma patients: a 1-year follow-up on a randomised controlled trial

Adrian Koch Bentzon<sup>1</sup>, Linda Wolfgang Loehde<sup>1</sup>, Vibeke Backer and Louise Toennesen 

**Affiliations:** Respiratory Research Unit, Dept of Respiratory Medicine, Bispebjerg University Hospital, Copenhagen, Denmark. <sup>1</sup>These authors contributed equally.

**Correspondence:** Adrian Koch Bentzon, Respiratory Research Unit, Dept of Respiratory Medicine, Bispebjerg University Hospital, Tagensvej 15, 251 Copenhagen, Denmark. E-mail: [adrianbentzon@gmail.com](mailto:adrianbentzon@gmail.com)

## ABSTRACT

**Background:** In the EFFORT (Effects of Exercise and Diet in Nonobese Asthma Patients – A Randomized Controlled Trial) study, maximum exercise capacity ( $V'O_{2max}$ ) increased significantly within a 2-month high-intensity spinning period. Furthermore, the study concluded that only the combined exercise and diet intervention improved asthma control, significantly. This study examined whether original improvements in  $V'O_{2max}$  and asthma control were present 1 year after intervention completion.

**Method:** In the original trial, 149 patients were randomised into four study groups. Participants were assessed with an incremental cycle ergometer test and the Asthma Control Questionnaire (ACQ). Of the 149 patients, 66 accepted the follow-up invitation. Participants were distributed in their original groups: exercise group (n=18), diet group (n=117), combined diet and exercise group (n=115) and the control group (n=110). Patients were assessed with original procedures. Though, upon measuring  $V'O_{2max}$ , the original four study groups were merged into one spinning group (n=127) and one nonspinning group (n=133).

**Results:** Comparing the spinning and nonspinning group, there was no significant between-group difference in  $V'O_{2max}$ , at 1-year follow-up (p=0.3). In addition, there was no significant between-group difference in ACQ score (p=0.6). Hence, in the combined group, the initial improvement in the ACQ score had regressed to pre-intervention values within 1 year from study completion.

**Conclusion:** There were no measurable long-lasting effects on  $V'O_{2max}$  1 year after the intervention was completed. Furthermore, there was no long-lasting effect of the combined intervention on asthma control.



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**This study provides evidence that improvements in maximal oxygen uptake prompted by a 2-month spinning programme regress to pre-intervention values. However, results suggest the presence of long-lasting improvements in self-reported asthma control.** <http://bit.ly/2wpMQDf>

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## Introduction

Previous studies have shown an association between exercise and dietary interventions and improvements in asthma control, measured on bronchial hyperresponsiveness, airway inflammation and the number of exacerbations [1–3]. In addition, diets with low glycaemic index are associated with decreases in low-grade systemic inflammation [4], a condition associated with asthma. However, the above-mentioned studies revolve around low to moderate exercise interventions, and none of the studies have examined the effect of a combined exercise and diet intervention, in an asthma population. In contrast, the EFFORT (Effects of Exercise and Diet in Nonobese Asthma Patients – A Randomized Controlled Trial) study involved a 2-month supervised high-intensity exercise intervention and/or diet intervention. The study population included 149 nonobese (<30 body mass index (BMI)) patients with asthma randomised into three intervention groups and one nonintervention group (control group). Patients were distributed into an exercise group, diet group, diet and exercise group (combined group), and one control group. Each participant was assessed thoroughly at baseline and following the 2-month intervention period, using various procedures and questionnaires, including the Asthma Control Questionnaire (ACQ). The EFFORT asthma study concluded that patients that underwent an exercise intervention increased  $V'O_{2max}$  significantly compared with the control group. Diet alone, had no significant impact on  $V'O_{2max}$ . However, only the combined group showed a significant improvement in asthma control, compared with the control group [5]. While the outcomes support findings in similar trials, the long-term effects of high-intensity exercise and dietary interventions in asthma populations remains to be investigated. This 1-year follow-up study intends to examine these potential effects, using  $V'O_{2max}$  and asthma control as an indirect measure of behavioural changes. Since the diet intervention alone had no significant effect on this study's primary and secondary outcome, the focus was on the long-term effects of the exercise and combined intervention.

## Methods

Patients reconsented upon study entry and prior to any follow-up examinations. The study was approved by the Ethics Committee of Copenhagen, Denmark (H-4-2013-116) and registered at ClinicalTrials.gov (ID: NCT023559464).

### Study design

The study was conducted as a follow-up study on the EFFORT asthma trial, 1 year after the trial was completed. In the 1-year follow-up study, participants were kept in their original randomisation groups: 1) exercise group, 2) diet group, 3) combined group and 4) control group.

All patients from the EFFORT asthma trial were invited to participate in the 1-year follow-up study. Participants were initially contacted by e-mail. Upon no response, participants were then contacted by phone. 1 year after completing the 2-month intervention programme, the original  $V'O_{2max}$  and ACQ score measurements were repeated. In total, 66 patients were recruited, and 60 were included in the analyses. Following the EFFORT asthma trial, patients from the diet and control group were offered an exercise programme equivalent to the original exercise intervention. Patients that completed the subsequent exercise programme were excluded from the analyses (n=6).

In the final analysis of  $V'O_{2max}$ , the four groups were merged into one spinning group (n=27), including patients from the exercise group and the combined group, and one nonspinning group (n=33), including patients from the diet group and the control group (figure 1).

### Outcome assessment

At baseline, forced expiratory volume in the first second (FEV<sub>1</sub>) and forced vital capacity were measured in each patient. Lung capacity was assessed using spirometry according to European Respiratory Society (ERS) standards [6]. In addition, a skin-prick test was performed at baseline, according to the European standard [7]. Patients were defined as “atopic” if the skin-prick test was positive.

The level of  $V'O_{2max}$ , was measured with an incremental cardiopulmonary, cycle ergometer test following the American Thoracic Society guidelines [8].

To determine any changes in fat mass, patients were assessed with a DEXA scan, according to the Osteoporosis Screening Guidelines [9].

Furthermore, asthma control in each participant was evaluated with the validated five-item ACQ (according to the procedure in the original EFFORT asthma trial). The questionnaire addresses asthma symptoms within the past week and general limitations in daily activities [10]. Patients were also asked about their daily use of corticosteroids (ICSs), dosage and number of inhalations, during the last 2 months. Lastly, patients were asked to report on the amount of light, moderate and heavy exercise activity, in minutes a week, during the past 3 months.

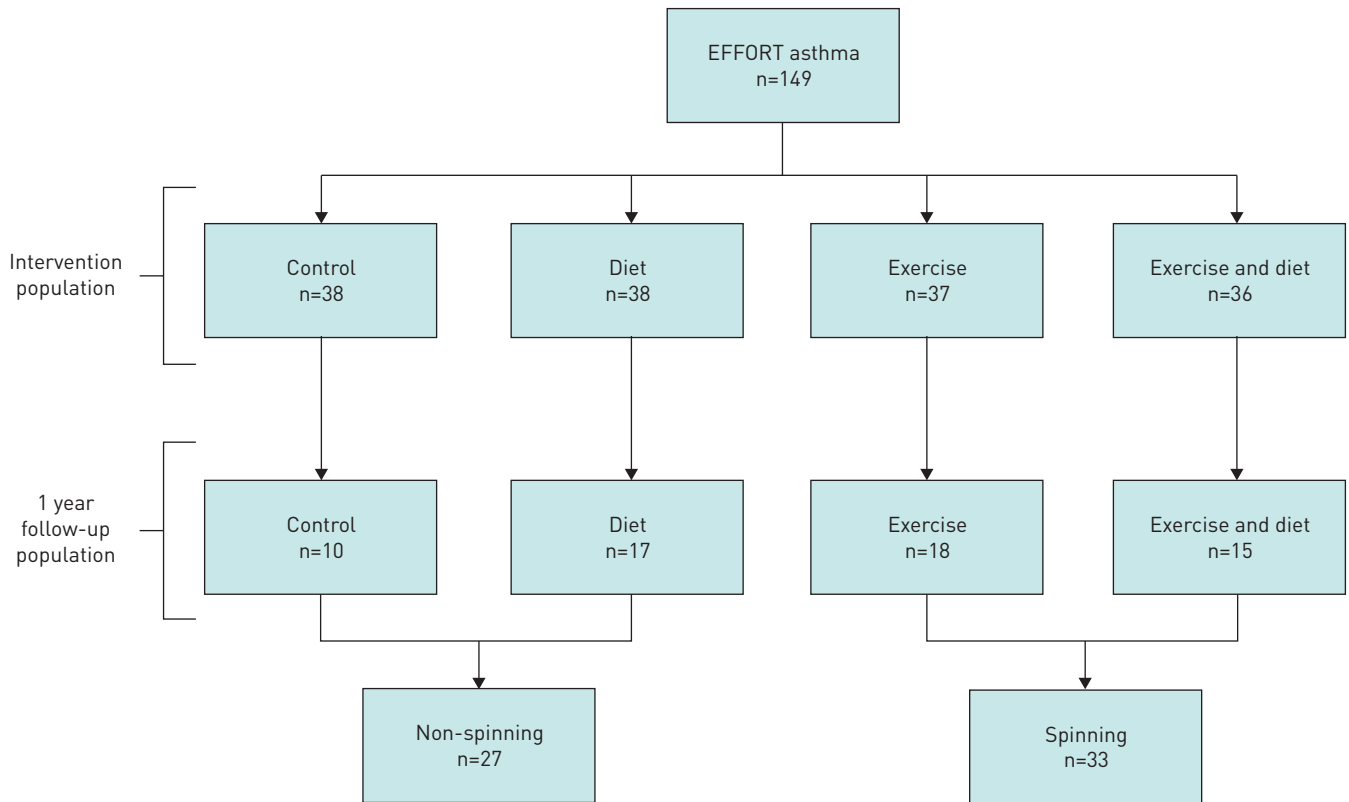


FIGURE 1 Flowchart. EFFORT: Effects of Exercise and Diet in Nonobese Asthma Patients – A Randomized Controlled Trial.

**Statistical analyses**

All statistical analyses were conducted with SPSS version 24.0. Cross-sectional analysis of  $V'O_2max$  was performed using unpaired t-tests (normally distributed variable). Between-group analyses of patient distributions, ACQ scores and ICS usage were conducted with an ANOVA linear regression model. Categorical variables (e.g. sex, smoking and atopy) were compared using Chi-squared tests.

**Results**

**Patient characteristics**

Between-group analyses of baseline characteristics were conducted with participants distributed in their original randomisation groups (exercise group, diet group, combined group, and the control group). There was no significant between-group difference compared on sex, age, smoking habits, BMI, FEV1, and asthma-related atopy (table 1).

TABLE 1 Pre-intervention characteristics by randomisation group				
	Exercise group	Diet group	Combined group	Control group
<b>Patients</b>	18	17	15	10
<b>Females</b>	7 [38.9%]	11 [64.7%]	11 [73.3%]	3 [30%]
<b>Age years</b>	41.1±12.7	44.1±14.8	47.9±10.5	41.0±12.8
<b>BMI kg·m<sup>-2</sup></b>	24.6±2.1	24.1±2.6	25.7±2.6	25.0±1.9
<b>FEV1 % predicted</b>	88.6±11.8	88.1±16.8	84.1±13.4	89.4±16.0
<b>Smoking</b>				
Former	5 [27.7%]	4 [23.5%]	6 [40%]	3 [30%]
Never	12 [66.6%]	13 [76.4%]	9 [60%]	7 [70%]
<b>Atopy</b>	14 [77.7%]	10 [66.6%]	10 [76.9%]	7 [77.7%]

Data are presented as mean±SD unless otherwise stated. BMI: body mass index; FEV1: forced expiratory volume in 1 s.

TABLE 2 Maximal oxygen uptake ( $V_{O_2max}$ ) by spinning/nonspinning group at 1-year follow-up

	Spinning group	Nonspinning group	p-value
<b>Patients</b>	29	24	
<b><math>V_{O_2max}</math> mL·min<sup>-1</sup> mean±sd</b>	2848.6±779.0	2482.8±692.1	0.3
p-value denotes the overall significance of differences between the two study groups.			

**Maximal oxygen uptake**

There was no significant difference in  $V_{O_2max}$ , between the spinning and the nonspinning group, at 1-year follow-up (p=0.3) (table 2). Hence, the original increase in  $V_{O_2max}$ , was not detectable 1 year after study completion.

**Asthma control questionnaire**

Analysis of the ACQ score was also conducted with participants distributed in their original randomisation groups (exercise group, diet group, combined group, and the control group).

Between-group analysis on ACQ scores was nonsignificant (p=0.6). The initial improvement in ACQ score, detected in the combined group, could not be reproduced at the 1-year follow-up (figure 2).

**Inhaled corticosteroids**

The analysis on the daily amount of ICS consumption (ICS prescription adjusted for compliance), was equally conducted with participants distributed in their original randomisation groups: exercise group (452.1 µg·day<sup>-1</sup>), diet group (436.9 µg·day<sup>-1</sup>), combined group (578.0 µg·day<sup>-1</sup>) and the control group (494.0 µg·day<sup>-1</sup>). Between-group analysis on ICS usage, showed no significant difference in ICS consumption between the four study groups, at the 1-year follow up (p=0.75).

**Discussion**

In this 1-year follow-up study on supervised dietary and exercise interventions in asthma patients, results showed that  $V_{O_2max}$  regressed to pre-intervention levels, 1 year after the intervention was completed. In addition, there were no significant between-group differences in ACQ score. Hence, the 2-month high-intensity exercise programme and dietary intervention did not induce long-lasting behavioural changes.

There are few follow-up studies on diet and exercise interventions and, to our knowledge, no previous follow-up studies in asthma patients. In fact, most recent reviews on lifestyle interventions and behavioural changes call for additional follow-up studies [11–14]. However, our findings support previous outcomes on counselling and behavioural changes in cardiovascular and diabetic patient populations [15–17]. These

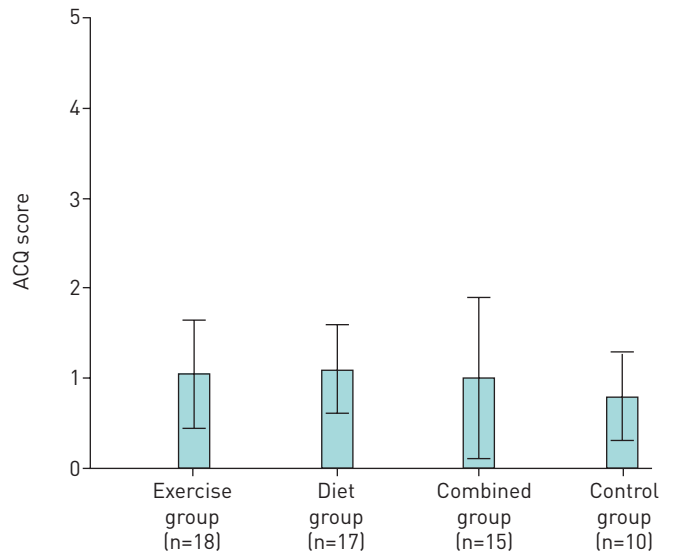


FIGURE 2 Asthma Control Questionnaire (ACQ) scores by randomisation group, at the 1-year follow up. Results are presented as mean±sd.

studies, also, concluded that changes in exercise capacity and dietary habits regressed to pre-intervention levels after counselling was discontinued. The studies, however, primarily revolved around counselling and educational interventions, and the duration of the follow-up periods were longer. Other follow-up studies on patients with chronic obstructive pulmonary disease undergoing pulmonary rehabilitation showed long-term improvements, measured according to the BODE (BMI, airflow obstruction, dyspnoea, exercise capacity) index, 9 to 12 months after the intervention was completed [18, 19].

In contrast, other follow-up studies on supervised exercise interventions in gastric bypass and cancer patients have concluded that the exercise interventions induced long-lasting effects on physical activity and dietary intake habits. These studies involved patients with more immediate life-threatening conditions [20, 21] and therefore possibly less comparable to patients with mild-to-moderate asthma. Although a recent study involving 3×8 weeks of highly supervised exercise interventions during 1 year, in patients with heart transplants, found no significant difference in exercise capacity 5 years after the intervention was completed [22].

Considering this study's outcome, the potential impact of ICS adjustments on ACQ score was taken into consideration. However, between-group analysis on ICS usage, at the 1-year follow-up, was nonsignificant.

There are some limitations to this study; in similar randomised trials, the duration of the intervention period has ranged from 3–6 months. Although the 2-month intervention period in the EFFORT asthma trial was slightly shorter, thorough searches on follow-up studies showed no distinct correlation between the duration of the intervention period and study outcome [23–25]. Furthermore, the study was challenged by a small study population and limited statistical power. Considering the nonsignificant results, the presence of type II errors cannot be excluded. Additionally, the study was susceptible to loss to follow up despite the comprehensive process to re-recruit patients. In contrast with the original EFFORT trial, patients did not directly benefit from participating and only 44% of the patients were re-recruited. Upon recruitment, seasonal aggravation in asthma symptoms was taken into account by examining patients 1 year after entering the original EFFORT trial, with a maximal variation of 2 months.

In conclusion, this real-life follow-up study on patients with mild-to-moderate asthma symptoms provides the first evidence that improvements induced by exercise and dietary interventions, subsides within 1 year from intervention completion.

If physical and dietary interventions were implemented, as a nonpharmacological add-on, in regular asthma treatments, findings suggest that frequent booster interventions, and perhaps longer intervention periods, may be needed to maintain and prolong initial improvements.

Conflict of interest: None declared.

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