

Original article

Fitness, daily activity and body composition in children with newly diagnosed, untreated asthma

Background: Information about how the asthma disease affects the life style and health in children is sparse.

Aim: To measure fitness, daily physical activity and body composition in children with newly diagnosed, untreated asthma and healthy controls, and to assess the association between the level of asthma control and these parameters.

Methods: Daily physical activity measured using accelerometry, cardiovascular fitness and body composition (per cent fat, per cent lean tissue and bone mineral density) were measured in 57 children with newly diagnosed, untreated asthma and in 157 healthy age- and sex-matched controls. The level of asthma control was assessed by measurements of a variety of asthma outcomes.

Results: Children with asthma were less fit (35.1 vs 39.3 ml O₂/min/kg) ($P < 0.001$), had a higher body per cent fat (22.8 vs 19.5%) ($P < 0.01$) and a higher frequency of overweight (24.6 vs 14.2%) ($P < 0.05$) than healthy controls. Per cent body fat correlated negatively to overall daily activity ($P < 0.001$) and to time spent in high or vigorous activity ($P < 0.001$). Fitness correlated positively to time spent in high and vigorous activity ($P < 0.001$). Within the asthma group, the level of asthma control, fitness and the time spent in vigorous activity correlated positively ($P < 0.02$).

Conclusion: Children with untreated asthma are less fit and have a higher body per cent fat and frequency of obesity than their healthy peers. Uncontrolled asthma is associated with a reduced fitness and daytime spent in intensive activity. Overweight children are physically less active than normal weight children.

S. Vahlkvist, S. Pedersen

Pediatric Research Center, Kolding Hospital,
University of Southern Denmark, Kolding, Denmark

Key words: asthma control; body composition; children; fitness; physical activity.

Signe Vahlkvist
Pediatric Research Center
Kolding Hospital
University of Southern Denmark
Skovvangen 2
DK – 6000 Kolding
Denmark

Accepted for publication 9 March 2009

The ability to participate in daily physical activities is considered important for a child's social, psychological and physical health and development (including long-term prevention of life style associated diseases). Therefore, the ability to participate in normal physical activity is one of the goals in paediatric asthma management (1). However, at present, the information about how the asthma disease and its level of control affect the life style (including the daily physical activity) and general physical health in children is sparse. The various studies addressing this have varied in design, outcome measures and conclusions, and the clinical characterization of the patients has generally been sparse (2–5).

The present study was initiated to assess the effects of untreated asthma and the effects of asthma treatment on the daily physical activity level in children and a variety of outcomes related to physical activity.

Aims

- To compare physical fitness, daily physical activity, running distance during a standardized exercise test,

body composition (fat, lean tissue and bone mass), resting blood pressure and heart rate in children with newly diagnosed untreated asthma, with the same parameters in healthy age- and sex-matched children.

- To assess the association between the level of asthma control and the parameters mentioned above.
- To assess the association between various measures of physical activity and parameters of body composition, resting blood pressure and heart rate, in healthy children and children with asthma.

Participants

Children aged 6–14 years suspected of asthma in general practice were referred for evaluation. All children with symptoms (cough, wheeze, dyspnoea) and variability in forced expiratory volume in 1 s (FEV₁) > 12% of the predicted value after a β_2 -reversibility test or an exercise challenge were invited to participate in the study. For each asthma case, three healthy, sex- and age (± 6 months)-matched controls were included. Healthy controls were defined as children without any known chronic disease and with no abnormal physical findings at

the first visit. The control children were recruited from local schools in the uptake area.

Exclusion criteria

Children with other chronic diseases (heart disease, metabolic diseases and diseases, which might interfere with normal daily activity) were excluded. Furthermore, children suspected of having problems with complying with the laborious study programme were not included.

Children with allergic rhinitis or atopic dermatitis could be included in both groups (asthma and healthy controls) provided that the condition was stable.

Study design

The study was an open, 1 year, case-controlled trial (Fig. 1). Healthy children were seen at the clinic five times and children with asthma eight times during the study period (Fig. 1). During the first 4 weeks after inclusion (baseline period), the patients were seen three times at the clinic where the following measurements were made: ergometer bicycle fitness test (6), a treadmill exercise test, a dual energy X-ray absorptiometry (DEXA) scan, a methacholine challenge test, measurement of exhaled nitric oxide (eNO), measurement of blood pressure, height and weight and assessment of parameters of asthma control, including lung function, Childhood Asthma Control Test (C-ACT) (7) and Pediatric Asthma Quality of Life Questionnaires (PAQLQ) (8).

Throughout the whole 4-week baseline period, daily physical activity was measured 24 h a day using the RT3 accelerometer (Stayhealthy, Monrovia, CA, USA). Daily recordings of symptoms (0–3) were scored separately for day and night (0 representing no symptoms and 3 severe symptoms), rescue β_2 use, morning and evening peak expiratory flow rates and fractional eNO

using Nioxmino[®] (Aerocrine AB, Solna, Sweden) were made in diaries.

Except for methacholine challenges and asthma questionnaires, the healthy controls performed the same measurements at the clinic visits as the children with asthma. Their home monitoring was restricted to accelerometer measurements. Their monitoring periods and clinic visits took place during the same periods as their matched children with asthma to minimize the influence of seasonal variation in activity.

After the baseline period, treatment with inhaled corticosteroids was initiated in all asthma patients. The present study reports the results of the analysis of the baseline data.

Methods

Lung function was measured according to the ERS guidelines (9). β_2 -reversibility was determined by the measurement of FEV₁ before and 15 min after inhalation of 1 mg salbutamol. The exercise challenge was performed on a 10% sloped treadmill. The children ran for 8 min, the speed was adjusted to achieve a heart rate higher than 180 beats per minute (bpm) for at least the last 3 min of the test. Running distance was recorded. The FEV₁ was measured before and repeatedly after exercise. The maximal per cent fall in FEV₁ was calculated.

Responsiveness to methacholine was assessed by inhalation of increasing doses of aerosolized methacholine from a Spira Elektro 2 inhalation dosimeter (Spira Respiratory Care Center, Hammenlinna, Finland). The FEV₁ was measured before the test and 3 min after each inhalation. The dose producing a 20% fall in FEV₁ (PD₂₀) was assessed by extrapolation.

Cardiovascular fitness was measured by a maximal ergometer test (6) using Tunturi E 85 electronic cycle ergometer (Accell Fitness, Turku, Finland). The workload was increased every 3 min until exhaustion. The start workload and increases in workload depended on the age, gender and bodyweight. Criteria for exhaustion were at least two of the following three: (i) heart rate

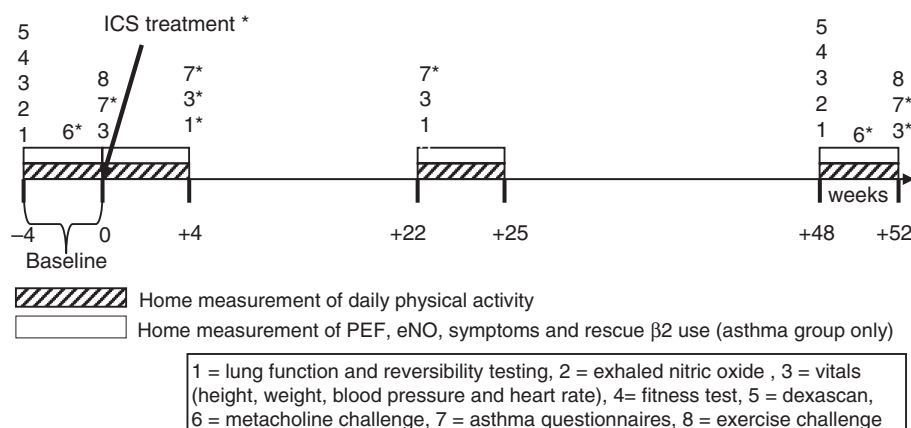


Figure 1. Study design. For children with asthma, a 4-week baseline assessment period without any regular asthma treatment was followed by 52 weeks with anti-asthma treatment. After 1 year, all measurements from the baseline period were repeated. Tests marked with '*' were performed in asthma children only. ICS, inhaled corticosteroids.

above 185 bpm; (ii) the child was unable to continue despite encouragement by the observer; (iii) subjectively assessed by the observer. All children inhaled 1 mg salbutamol 15 min before the test. The maximal oxygen uptake (VO_{2max}) was calculated from the maximal workload (W_{max}) as $12 \times W_{max} + 5 \times \text{weight}$ and fitness as VO_{2max}/weight .

Body composition was measured using DEXA using a Lunar Prodigy Advance densiometer (Scanex Medical Systems, Hoersholm, Denmark). Total body mass, total fat, total lean tissue, bone mineral density (BMD) and age-matched *z*-score were measured.

Exhaled nitric oxide was measured using a chemiluminescence analyser according to ERS/ATS guidelines (10). Heart rate and blood pressure were measured using a Dinamap pro 300 electronic monitor (Criticon company, Tampa, FL, USA). Standing height was measured without shoes as an average of three measurements on a Harpenden stadiometer (Holtain, Crymch, UK). Weight was measured with light clothing and without shoes. Body mass index (BMI) was calculated as $\text{weight}^2/\text{height}$. Percentiles of height, weight and BMI were calculated (11).

'Pediatric Asthma Quality of Life Questionnaire' (8) and 'C-ACT' (7) were used to assess asthma control level. Pediatric Asthma Quality of Life Questionnaire consists of 23 questions with response options on a 7-point scale where 1 indicates maximum impairment and 7 no impairment. Pediatric Asthma Quality of Life Questionnaire was answered by the child at the clinic without parents in the room. C-ACT consists of four questions for the child and three for a parent. Twenty-seven points is maximal score, and 20 points or more indicates satisfactory asthma control. Both PAQLQ and C-ACT have been validated against objective parameters of asthma control (7, 8).

A visual analogue scale ranging from 0 to 10 (0 representing worst imaginable asthma and 10 representing no asthma troubles) was used to assess the child's perception of the impact of the disease on the daily life. The study was approved by the local Ethics committee and informed consent was obtained from all participants and their parents before any study-related procedures were undertaken.

Data management

Activity was quantified as overall daily activity in counts per minute, and minutes per day spent at activity levels corresponding to rest, moderate, high and vigorous activity. These cut points for activity levels has been validated to correspond to energy expenditure of 3 metabolic equivalents (METs) for the high level and 6 METs for the vigorous level (12). Days where the monitor had not been carried for at least half of the daytime were excluded from analysis.

Overweight was defined in two ways: (i) as a per cent body fat > 30% and (ii) as a BMI exceeding the age-adjusted cut point as defined by Cole et al. (13). Mean arterial pressure (MAP) was calculated as $\text{MAP} = 2/3 \times \text{diastolic pressure} + 1/3 \times \text{systolic pressure}$. Blood pressure was measured at two occasions during run-in and an average of these measurements was used for analysis. To characterize the patients more thoroughly, a 0–8 graded scoring system of asthma control was developed based on objective clinic measurements only: reversibility test, exercise challenge, methacholine challenge and eNO (Table 1).

Statistics

A mixed effect linear regression model was used to assess differences in outcomes between the two groups. Asthma status was used as

Table 1. The scoring system for asthma control

	0 point	1 point	2 points
Reversibility to bronchodilator	<12%	≥12%	≥20%
Exercise-induced fall in FEV ₁	<15%	≥15%	≥30%
Methacholine challenge	>4	≤ 4 μmol	≤ 1 μmol
eNO	<16 ppb	≥16 ppb	≥40 ppb

Score ranged from 0 points indicating good asthma control to 8 points indicating poor asthma control.

FEV₁, forced expiratory volume in 1 s; eNO, exhaled nitric oxide.

fixed effect and every group of four matched children as random effect. Conditional logistic regression was used to assess the risk of being overweight. Pearson's correlations were calculated (i) between the asthma scoring system and C-ACT and the outcomes of activity and body composition respectively and (ii) between the outcomes of activity and the outcomes of body composition. In all analyses, significance was assumed at $P < 0.05$. All statistics were calculated using STATA statistical software (StataCorp, College Station, TX, USA).

Results

Ninety-two children aged 6–14 years were referred for evaluation of asthma. Thirty-four did not meet the inclusion criteria. One girl fulfilled the criteria, but declined participation, leaving 57 children for inclusion. Because of problems with recruitment, only 157 healthy children were included. Two boys with asthma and two healthy boys dropped out shortly after inclusion because they found the study too demanding. The two groups were comparable with respect to age, height, weight and puberty stage (Table 2). The height percentile was lower and the weight percentile higher in the asthma group than in the controls, but the difference was only statistically significant for the weight percentile (Table 2).

The vast majority of children with asthma suffered from mild disease with few symptoms and little need for rescue β_2 . Still their lung function was significantly lower, and their eNO, β_2 -reversibility and fall in lung function after exercise were significantly higher than in the healthy children (Table 2). The majority had moderately increased bronchial responsiveness to methacholine and their C-ACT and visual analogue score (VAS) suggested that the asthma was not optimally controlled (Table 2). The result of the PAQLQ indicated a small impact of the disease on the quality of life.

Even if FEV₁ was only moderately reduced in the asthma group, the mean fall in FEV₁ after exercise was 28.6% and in 30% of the children, the fall was greater than 50%. The score from the 0 to 8 graded scoring system of asthma control showed marked inter-individual variation: score less than 2 ($n = 11$), score 2 ($n = 6$), score 3 ($n = 4$), score 4 ($n = 12$), score 5 ($n = 10$), score 6 ($n = 7$), score 7 ($n = 5$) and score 8 ($n = 0$). Similar

Table 2. Comparisons of the main outcomes measured in healthy children and in children with untreated, newly diagnosed mild asthma

Variable	n	Asthma group	Healthy group	P-value
		Mean (95% CI)	Mean (95% CI)	
Age	57/155	9.60 (9.1–10.1)	9.7 (9.4–10.0)	NS
Boys n (%)	57/155	32 (56%)	84 (54 %)	NS
Tanner stage (1–5)	56/155	1.3 (1.1–1.5)	1.4 (1.2–1.5)	NS
Height (cm)	57/155	139.2 (135.8–142.6)	140.5 (138.4–142.6)	NS
Height percentile	57/155	65.8 (58.4–73.2)	70.1 (66.2–73.9)	NS
Weight (kg)	57/155	36.3 (32.9–39.6)	34.8 (33.2–36.4)	NS
Weight percentile	57/155	68.6 (60.7–76.5)	59.5 (55.3–63.8)	<0.05
FEV ₁ (% predicted)	56/155	90.0 (85.2–94.8)	103.4 (101.6–105.1)	<0.005
EIB (% fall)	57/148	28.6 (23.0–34.3)	4.57 (3.7–5.5)	<0.0005
eNO (ppb)	56/148	36.7 (27.2–46.2)	10.21 (8.5–11.9)	<0.0005
β ₂ -reversibility (%)	56/148	8.6 (6.7–10.6)	2.92 (2.0–3.8)	<0.0005
PD ₂₀ (μmol)	55/0	2.16 (1.39–2.92)	NA	NA
C-ACT score (0–27)	49/0	19.7 (18.5–21.0)	NA	NA
C-ACT score <20/≥20	19/30			
PAQLQ score (1–7)	55/0	5.7 (5.4–6.0)	NA	NA
VAS score (0–10)	52/0	5.8 (5.2–6.5)	NA	NA
β ₂ use (puffs/day)	55/0	0.6 (0.5–0.7)	NA	NA
Day symp. (0–3)	55/0	0.5 (0.4–0.7)	NA	NA
Night symp. (0–3)	55/0	0.3 (0.2–0.5)	NA	NA
Symp. duration (months)	49/0	32.7 (23.0–42.4)	NA	NA

FEV₁, forced expiratory volume in 1 s; eNO, exhaled nitric oxide; PD₂₀, provocative dose causing a decrease of 20% in FEV₁; C-ACT, Childhood Asthma Control Test; PAQLQ, Pediatric Asthma Quality of Life Questionnaires (PAQLQ); VAS, visual analogue score; CI, confidence interval; NS, not significant; NA, not applicable.

inter-individual variations were seen in the C-ACT and VAS scores. The asthma control score correlated significantly negatively with the C-ACT score ($r = -0.33$ $P < 0.02$ and $r = -0.38$ for patients with a score > 1).

Compliance with wearing the RT3 was high: only 0.6 (healthy) and 1.5 (asthma) days were removed because they did not meet the quality criteria, corresponding to 2% and 6% of the recordings. An average of 21.6 days (7–28) and 20.1 days (2–27) was available for analysis for the healthy and the asthma group respectively.

Seventeen children did not meet the quality criterion for approval of the fitness test, mainly because they were too short for the bicycle. For the remaining outcomes, the number of missing data was negligible. The results from the activity measurements, fitness tests, exercise tests, DEXA scans, blood pressure and heart rate measurements are given in Table 3.

Children with asthma were significantly less fit, ran significantly shorter distances during the exercise tests and achieved a significantly lower heart rate during the fitness test than their healthy controls. Moreover, children with asthma had a significantly higher BMI, body per cent fat and a higher frequency of obesity than their healthy controls. No statistically significant differences were found between the two groups in overall daily activity, time spent in high or vigorous activity, blood

pressure, resting heart rate, BMD, z-score or lean tissue mass.

Per cent body fat correlated negatively to both overall daily activity ($P < 0.001$) and to time spent in high or vigorous activity ($P < 0.001$). Fitness correlated positively to time spent in high and vigorous activity ($P < 0.001$). No statistically significant correlation was found between fitness and overall daily activity ($P = 0.09$). Finally, BMD z-score correlated positively to per cent body fat ($P < 0.001$). Total daily activity or time spent in high intensity activity did not show any significant associations with any of the other measurements.

Within the asthma group, a significant negative correlation was observed between fitness ($P < 0.02$) and vigorous activity ($P < 0.02$), respectively, and the 0–8 asthma score in patients with a score higher than 1 (Fig. 2). A weak correlation was also seen between the asthma score and time spent in at least high activity. Similarly, there was a significant negative correlation between per cent fall in FEV₁ after exercise and fitness ($r = -0.46$, $P < 0.01$) and time in vigorous activity ($r = -0.3$, $P < 0.05$), and C-ACT correlated with time in vigorous activity ($r = 0.35$, $P < 0.05$) but not with fitness. No statistically significant correlations were seen between asthma score and BMI or per cent body fat.

Discussion

We found that compared with controls children with asthma were less fit and ran shorter distances during the exercise tests. Moreover, asthma children had a higher BMI, body per cent fat and a higher frequency of obesity than their healthy controls, but these differences were not associated with differences in overall daily activity, time spent in high or vigorous activity, blood pressure, resting heart rate, BMD, z-score or lean tissue mass between the two groups. The shorter distances run during the treadmill exercise challenge might have been caused by the development of bronchoconstriction during the test. In contrast, bronchoconstriction was prevented before the fitness test. Therefore, the lower fitness in the asthma children was not caused by bronchoconstriction during this test and so other asthma-associated factors are likely to have been responsible. The higher body weight in children with asthma could not explain this finding because analyses adjusting for this difference resulted in similar conclusions.

The development of the asthma score was an attempt to make an assessment of asthma control based on objective measurements only as the existing tools of asthma control assessment are mainly based on subjective measures. Several studies have found that children and their parents (as well as their physicians) often overestimate control and underestimate severity (14, 15). The score has not been formerly validated but it correlated

Table 3. Comparisons of the main outcomes measured in healthy children and in children with untreated, newly diagnosed mild asthma

	<i>n</i>	Asthma group	Healthy group	OR (95% CI)	<i>P</i> -value
		Mean (95% CI)	Mean (95% CI)		
Activity (counts/min)	55/153	348.3 (325.1–371.5)	362.6 (350.5–374.8)		NS
High activity (min/day)	55/153	31.1 (26.5–35.7)	34.0 (31.5–36.5)		NS
Vigorous activity (min/day)	55/153	7.1 (5.6–8.6)	8.3 (7.4–9.2)		NS
Fitness (ml O ₂ /min/kg)	46/145	35.1 (32.9–37.3)	39.3 (38.2–40.5)		<0.001
Max heart rate (fitness test)	46/144	189.2 (186.0–192.4)	194.3 (192.8–195.7)		<0.001
Distance run* (m)	54/149	813.4 (766.9–865.2)	916.8 (892.5–941.1)		<0.01
Average heart rate† (bpm)	56/148	189.7 (187.7–191.7)	190.6 (189.4–91.8)		NS
Resting blood pressure (MAP)	52/151	87.3 (85.4–89.1)	87.5 (85.8–89.2)		NS
Resting heart rate (bpm)	52/151	78.5 (75.9–81.2)	80.7 (78.6–82.7)		NS
Body per cent fat (%)	56/155	22.8 (19.9–25.6)	19.5 (18.2–20.8)		<0.01
BMD (g/cm ²)	56/155	0.9 (0.8–1.0)	0.9 (0.9–0.9)		NS
BMD z-score	56/154	0.3 (0.1–0.5)	0.4 (0.3–0.5)		NS
BMI (kg ² /cm)	56/155	18.2 (17.2–19.4)	17.3 (16.9–17.6)		0.02
Overweight‡ (% of group)	56/155	28.6% (16.4–40.8)	12.3% (7.1–17.5)	3.4 (1.4–0.9)	<0.01
Overweight§ (% of group)	57/155	24.6% (13.1–36.1)	14.2% (8.6–19.7)	2.3 (1.0–0.0)	<0.05

bpm, beats per minute; MAP, mean arterial pressure; BMD, bone mineral density; BMI, body mass index; CI, confidence intervals; OR, odds ratio; NS, not significant.

*During exercise test.

†Average of heart rate during the 3 last minutes of exercise test.

‡Based on BMI.

§Based on per cent body fat.

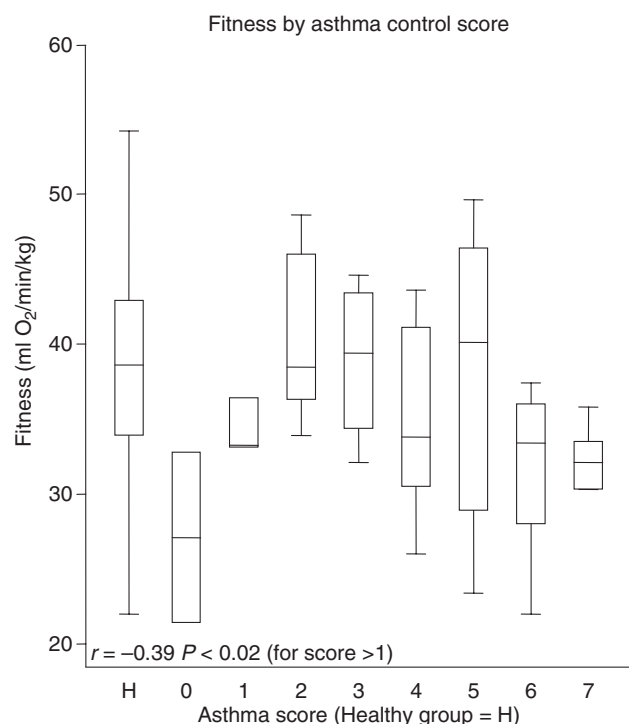


Figure 2. Association between fitness and an asthma control score based on objective measurements at the clinic visits during baseline. For scores > 1, fitness correlated negatively with control of asthma.

with the validated C-ACT test. When the reason for the very low scores in some patients was scrutinized, it was realized that some of these patients ($n = 4$) had been

wrongly included because they did not fulfil the inclusion criteria. When exploring the potential association between asthma control level and fitness, it did not make sense to include these patients in the analysis. The reason for the low fitness in this group remains unknown. The reason that these patients had been included was mainly their high number of asthma-like symptoms of which breathlessness in association with activity was dominant. We therefore believe that although their symptoms mimicked asthma, they were mainly caused by other factors such as poor fitness and overweight.

In the light of the lower fitness in children with asthma and the correlation between fitness and high intensive activity level, it was expected that the asthma children should have been less physically active or spent less time in vigorous activity than their healthy controls. However, this was not the case. The results from earlier studies addressing this issue have varied. Some studies using self reporting (16–18) found that children with asthma or wheeze were less active than healthy children, one found no difference between the groups (4) and one (19) even found increased activity in children with asthma based on diary records. In studies using an accelerometer, one (3) found young children with a history of wheezing to be less active than healthy controls whereas two found no difference (2, 5). The patients in these studies were less well characterized with respect to the level of asthma control and disease severity than the patients in our study. A recent study in 13- to 14-year-old adolescents found no difference in physical activity and fitness between adolescents treated for asthma and healthy controls (20).

The reason for the discrepancy between the results of the various studies remains unknown, but our data may provide some possible explanations. It was obvious from our data that children with mild asthma constitute a very heterogeneous group; around 30% experienced a fall in FEV₁ after exercise of more than 50% while around 20% had falls <10%. Similar variations were observed in the various asthma control tests and our control score based on objective criteria alone. We found that, in children scoring higher than 1 point, both fitness and time per day spent in vigorous activity depended significantly on the level of asthma control as well as on the degree of bronchoconstriction. This, together with a lower time in vigorous activity in children with a lower C-ACT score suggest that the discrepancy in earlier studies could have been because of differences in asthma severity or control levels in the various studies. As these studies differed with respect to characterization of patients this cannot be definitely answered.

Although the correlations mentioned above were weak-moderate, it must be remembered that fitness depends on genetic factors as well as several life-style factors. Therefore, it is unlikely that any single parameter alone would correlate strongly with fitness. We therefore believe that the associations between fitness, intensive activity, the fall in lung function after exercise and the asthma score (including C-ACT for activity level) suggest that poor asthma control may be one important contributor to the reduced fitness found in the children with asthma. However, our 1-year longitudinal data measured after treatment will elucidate this further. The importance of asthma control/severity for the daily activity levels has been corroborated in a large study in adults, in which increased levels of bronchial hyperresponsiveness were associated with decreased self-reported daily activity (21).

Although the RT3 accelerometer has been validated in children (12), it has some drawbacks in assessing the physical activity in children. Our data suggest that total daily physical activity may not be the most sensitive parameter to differentiate between healthy children and children with a disease. It seemed that at least for children with asthma, future trials should focus more on the time spent in vigorous activity as this parameter correlated well with the child's fitness and asthma control level. The drawback is that the time per day the children spent in intensive physical activity was low and hence it might be less sensitive to change. The low level of intensive activity could be a true finding, but we believe that it is more likely to have been caused by the way we decided to record the activity levels. One-minute intervals were used because this mode was the only way to store data for a sufficient period of time (in the 1-s interval mode, the RT3 can only store data from a total of 3 h of activity).

However, the problem with the 1-min interval is an underestimation of the time spent in high intensity activity because many short bursts of high activity may be missed as they are diluted when the activity level is stored as a mean of 1 min. Therefore, activity devices with a sufficient capacity to store short interval collected data (1–15 s) over longer periods of time would be preferable. Finally, another possible reason for the finding of no difference between the two groups could be an overrepresentation of physically active children amongst the children in the asthma group as suggested by Ownby et al. (19), i.e. children with a high daily activity may be more likely to be diagnosed with asthma than children with a low daily activity.

The finding that children with mild asthma had a higher occurrence of overweight and obesity is in agreement with earlier studies (22–25). However, the causality remains unclear. Prospective cohort studies (22, 25) have found that overweight and obese children have a higher risk of asthma at follow up than children with a normal body weight. This speaks against a reverse causality (asthma leading to more sedentary lifestyle leading to overweight). Our findings of a negative correlation between per cent body fat and total daily activity as well as time spent in vigorous activity demonstrate that overweight is a risk factor for a more sedentary life style in children. However, no conclusion can be made about the asthma disease itself as a possible contributor to the overweight.

It was reassuring that the BMD was not adversely affected by the asthma disease in this group of patients with mainly mild asthma. However, before any negative effects can be ruled out, studies on larger numbers of children with more severe asthma and children who have had untreated disease for longer periods are needed.

Conclusion

Children with untreated, newly diagnosed asthma are less fit and have a higher body per cent fat and frequency of overweight than their healthy age- and sex-matched peers. Uncontrolled asthma is statistically significantly associated with a reduced fitness and time spent in intensive activity during the day. Overweight children are physically less active than normal weight children and spend less time in intense physical activity.

Acknowledgments

The study is supported by a grant from Danish Pediatric Asthma Center.

References

1. Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M et al. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J* 2008;**31**:143–178.
2. Eijkemans M, Mommers M, de Vries SI, van BS, Stafleu A, Bakker I et al. Asthmatic symptoms, physical activity, and overweight in young children: a cohort study. *Pediatrics* 2008;**121**: e666–e672.
3. Firrincieli V, Keller A, Ehrensberger R, Platts-Mills J, Shuffelbarger C, Geldmaker B et al. Decreased physical activity among Head Start children with a history of wheezing: use of an accelerometer to measure activity. *Pediatr Pulmonol* 2005;**40**:57–63.
4. Nystad W. The physical activity level in children with asthma based on a survey among 7–16 year old school children. *Scand J Med Sci Sports* 1997;**7**:331–335.
5. van Gent R, van der Ent CK, Essen-Zandvliet LE, Rovers MM, Kimpfen JL, de Meer G et al. No differences in physical activity in (un)diagnosed asthma and healthy controls. *Pediatr Pulmonol* 2007;**42**:1018–1023.
6. Hansen HS, Froberg K, Nielsen JR, Hyldebrandt N. A new approach to assessing maximal aerobic power in children: the Odense School Child Study. *Eur J Appl Physiol Occup Physiol* 1989;**58**:618–624.
7. Liu AH, Zeiger R, Sorkness C, Mahr T, Ostrom N, Burgess S et al. Development and cross-sectional validation of the Childhood Asthma Control Test. *J Allergy Clin Immunol* 2007;**119**:817–825.
8. Juniper EF, Guyatt GH, Feeny DH, Ferrie PJ, Griffith LE, Townsend M. Measuring quality of life in children with asthma. *Qual Life Res* 1996;**5**:35–46.
9. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A et al. Standardisation of spirometry. *Eur Respir J* 2005;**26**:319–338.
10. ATS/ERS Recommendations for Standardized Procedures for the Online and Offline Measurement of Exhaled Lower Respiratory Nitric Oxide and Nasal Nitric Oxide, 2005. *Am J Respir Crit Care Med* 2005;**171**:912–930.
11. Andersen E, Hutchings B, Jansen J, Nyholm M. Heights and weights of Danish children. *Ugeskr Laeger* 1982;**144**:1760–1765.
12. Rowlands AV, Thomas PW, Eston RG, Topping R. Validation of the RT3 tri-axial accelerometer for the assessment of physical activity. *Med Sci Sports Exerc* 2004;**36**:518–524.
13. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ* 2000;**320**:1240.
14. Rabe KF, Vermeire PA, Soriano JB, Maier WC. Clinical management of asthma in 1999: the Asthma Insights and Reality in Europe (AIRE) study. *Eur Respir J* 2000;**16**:802–807.
15. Desfougeres J-L, Sohler B, Freedman D, Annunziata K, Lemoine A, Poterre M. Perception of asthma control by patients: results of a survey in 5 European countries. *Eur Respir J* 2007;**30**: (Suppl. 51): Abstract 253261.
16. Glazebrook C, McPherson AC, Macdonald IA, Swift JA, Ramsay C, Newbould R et al. Asthma as a barrier to children's physical activity: implications for body mass index and mental health. *Pediatrics* 2006;**118**:2443–2449.
17. Lang DM, Butz AM, Duggan AK, Serwint JR. Physical activity in urban school-aged children with asthma. *Pediatrics* 2004;**113**:e341–e346.
18. Chiang LC, Huang JL, Fu LS. Physical activity and physical self-concept: comparison between children with and without asthma. *J Adv Nurs* 2006;**54**:653–662.
19. Ownby DR, Peterson EL, Nelson D, Joseph CC, Williams LK, Johnson CC. The relationship of physical activity and percentage of body fat to the risk of asthma in 8- to 10-year-old children. *J Asthma* 2007;**44**:885–889.
20. Berntsen S, Carlsen KC, Anderssen SA, Mowinckel P, Hageberg R, Bueso AK et al. Norwegian adolescents with asthma are physical active and fit. *Allergy* 2009;**64**:421–426.
21. Shaaban R, Leynaert B, Soussan D, Anto JM, Chinn S, de MR et al. Physical activity and bronchial hyperresponsiveness: European Community Respiratory Health Survey II. *Thorax* 2007;**62**:403–410.
22. Castro-Rodriguez JA, Holberg CJ, Morgan WJ, Wright AL, Martinez FD. Increased incidence of asthmatic symptoms in girls who become overweight or obese during the school years. *Am J Respir Crit Care Med* 2001;**163**:1344–1349.
23. Figueroa-Munoz JI, Chinn S, Rona RJ. Association between obesity and asthma in 4–11 year old children in the UK. *Thorax* 2001;**56**:133–137.
24. Flaherman V, Rutherford GW. A meta-analysis of the effect of high weight on asthma. *Arch Dis Child* 2006;**91**: 334–339.
25. Gilliland FD, Berhane K, Islam T, McConnell R, Gauderman WJ, Gilliland SS et al. Obesity and the risk of newly diagnosed asthma in school-age children. *Am J Epidemiol* 2003;**158**:406–415.