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ARTICLE

Asthma as a Barrier to Children's Physical Activity: Implications for Body Mass Index and Mental Health

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ABSTRACT

OBJECTIVES. The purpose of this work was to identify barriers to physical activity in children with asthma and to compare their customary activity levels, BMI and emotional well-being with that of children with other medical conditions. It was hypothesized that children with asthma would have higher BMI and lower levels of customary activity.

PATIENTS AND METHODS. We studied children aged 7 to 14 years attending hospital outpatient clinics for either asthma (asthma group: $n = 56$) or for otorhinolaryngology or dermatological conditions (nonasthma group: $n = 61$). In this cross-sectional survey, children's weight and height were recorded and their BMI classified according to International Obesity Task Force classification of obesity. Child mental health was assessed by the parent-rated Strengths and Difficulties Questionnaire. The child-rated Physical Activity Questionnaire assessed total sedentary and physical activities during the previous 24 hours.

RESULTS. The asthma group had a higher mean BMI (20.78 vs 18.82) and higher rates of obesity (21.4% vs 6.6%). Children with asthma reported fewer physical activities than the nonasthma group (median 4 per day vs 6 per day) but comparable levels of sedentary activities. Asthma was the strongest predictor of lower activity scores, followed by younger age. The asthma group had higher levels of emotional difficulties and, within this group, more active children had better mental health. More parents in the asthma group identified the child's health as a barrier to exercise (60.7% vs 11%). The same was true of children (66.1% vs 11.5%).

CONCLUSIONS. We found that children attending a hospital clinic for asthma were more likely to be obese and were significantly less active than a comparison group with other medical conditions. Asthma was identified as a barrier to exercise by parents and children. Strategies to promote exercise within pediatric asthma care are needed to protect both mental and physical health.

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Key Words
asthma, obesity, exercise, psychological impact, child

Abbreviations
PAQ—Physical Activity Questionnaire
SDQ—Strengths and Difficulties Questionnaire
df—degrees of freedom
OR—odds ratio
CI—confidence interval

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Exercise is a common trigger for asthma in children,[1] but the consequence of this for exercise patterns has been poorly researched. A Norwegian survey of children aged 7 to 16 years found no evidence that children with asthma were less active,[2] but an American study of adolescent girls found that those with asthma were significantly less likely to engage in vigorous physical activity and were less physically fit.[3] Furthermore, a recent survey of Swedish children aged 7 to 9 years found that 74% had restricted their running in the previous week because of their asthma.[4] Firrincieli et al[5] used motion sensor wrist watches to assess activity levels in 54 preschool children attending an inner-city Head Start program. In this relatively deprived group, children with a history of wheeze or a previous admission for asthma in the previous 12 months were significantly less active than children without asthma symptoms. Although the asthma group was small, and there was no control for possible confounding variables, the use of objective measures of activity lends weight to the argument that asthma can impede activity even in very young children. It is not clear, however, whether such findings reflect actual physical limitations. A recent qualitative study of urban children with asthma concluded that many parents worried about their children taking part in physical exercise and often restricted their activities as a result of lack knowledge or misunderstanding of medical advice.[6]

Low levels of activity may be implicated in the observed link between asthma and obesity in children[7] and in young adults.[8] In addition to poorer levels of physical endurance, children with asthma are more likely to have skinfold thickness above the reference range.[9] One study of children from urban ethnic minorities found that 30% of children in the asthma group were above the 95th percentile for weight compared with only 11% in the control group.[10] This risk seems particularly evident for girls.[11] This is a cause for concern, because obese children with asthma have poorer medical outcomes[12] and are less likely to experience remission of asthma symptoms after puberty.[13] Obesity even increases the risk of exercise-induced bronchospasm in nonasthmatic children.[14] The association between obesity and asthma may have an immunologic basis. Tumor necrosis factor is a proinflammatory cytokine that is increased in asthma and is expressed by adipocytes. This raises the possibility that asthma and obesity could have additive or even synergistic proinflammatory effects.[15] Thus, there exists a potential spiral of disadvantage for children with asthma, whereby obesity increases the risks of asthma, and asthma exacerbates obesity by restricting exercise. Prevention of obesity is, therefore, an important goal for asthma management.[16] In obese adults with asthma, there is evidence that even modest weight reductions are associated with improved lung function, including a decrease in peak expiratory flow variability.[17]

In the United Kingdom, asthma is predominantly managed by family practitioners, but children with more severe or unstable asthma will also be under the care of pediatricians and attend hospital-based outpatient clinics. Children attending pediatric clinics have been found to have poorer mental health than that found in the general population,[18] as have children with asthma.[19,20] The benefits of exercise may not, therefore, be only physical. Exercise may impact on mental health by enhancing self-esteem, physical self-worth, and social competence.[21]

There is little evidence concerning the determinants of physical activity in children with asthma, and studies that have examined this question have failed to control for potentially confounding factors, such as social class or mental health. Our recent study evaluating a multimedia health education intervention for children with asthma found low levels of knowledge concerning asthma management,[22] and there were some indications that children were attempting to control asthma by avoiding exercise. This study aims to investigate this further by comparing customary activity, mental health, and BMI between children with asthma and a comparison group of children with other medical conditions.

MAIN RESEARCH QUESTIONS

The following are the main research questions of this research. (1) Do children with asthma have lower levels of physical activity than those with other common chronic conditions? (2) What is the relationship between levels of physical activity and emotional and behavioral problems in children with asthma? (3) What are the barriers to activity in children with and without asthma? (4) Are children attending outpatient clinics for asthma more likely to be overweight than children attending clinics for other conditions? It is hypothesized that children and young people with asthma will have lower levels of physical activity and higher BMI than children with other conditions.

METHODS

Design

We conducted a cross-sectional, observational study comparing BMI, activity levels, and beliefs about exercise between children with asthma (asthma group) and children attending outpatient clinics with other medical conditions (nonasthma group).

Participants

Children attending outpatient appointments at 2 East Midlands (United Kingdom) hospitals were recruited to the study between November 2003 and December 2005. Inclusion criteria were age 7 to 14 years and an outpatient appointment at targeted asthma, otorhinolaryngology, or dermatology clinics. Exclusion criteria were poor

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understanding of English and severe learning disability. Children in the asthma group had been diagnosed with asthma on the basis of wheeze (documented by a health professional) together with recorded bronchodilator responsiveness or peak flow variability as recommended in the current British Thoracic Society/Scottish Intercollegiate Guidelines Network guideline.[23] Children with asthma were excluded from the nonasthma group.

Power

A sample size of 55 in each group gives 90% power to detect a 2-point difference in BMI between groups ($P < .05$, 1-tailed, equal variances assumed) on the basis of an estimated SD of 3.5.

Measures

Physiologic Outcomes

Weight and height were measured in the outpatient clinic and used to calculate BMI. Children were classified as obese, overweight, or not overweight according to International Obesity Task Force cutoffs, which take into account the child's age and gender.[24]

Exercise Beliefs Questionnaire

A parent and a child version of this semistructured interview were developed for this study. Both versions probed perceived barriers to exercise in the child and attempted to identify factors that would encourage the child to exercise more.

Physical Activity Questionnaire

An interview schedule was used[25] to assess the frequency of different types of physical activity in recent past. Children were asked to rate a range of activities, both active and sedentary, on a 3-point scale (none, a little, or a lot) at 3 time points in the previous 24 hours (today before school, yesterday after school, and yesterday during school). Scores were summed to form a total score for sedentary activities and a total score for physical activities with higher scores indicating greater activity. The questionnaire was developed for the Pathways Study, which is funded by the National Heart, Lung, and Blood Institute in the United States and aims to prevent obesity in American Indian children. Permission has been obtained from the University of North Carolina to adapt the measure for this British study. The total number of items was reduced from 80 to 55, mainly by grouping some of the individual activities. For example 5 individual sports formed a combined item (team sports: eg, football and netball). We also changed some terminology (eg, jump rope to skipping) and removed some activities less relevant to our urban population (eg, hiking), because there was an opportunity to specify other activities. The authors claim good agreement between questionnaire responses for the Physical Activity Questionnaire (PAQ) and observed activities.[25] Furthermore, using an interview technique and probing activity in the recent past is most likely to obtain results that correlate with objective measures of activity.[26]

Strengths and Difficulties Questionnaire, Parent Version

We used a brief validated behavioral screening instrument[27] for emotional and behavioral problems designed for use with parents of children and teenagers between 4 and 16 years of age. The 25 items are divided into 5 subscales each of 5 items, generating scores for conduct problems, hyperactivity/inattention, emotional symptoms, peer problems, and prosocial behaviors. Items are rated on a scale of 0 to 2, with higher scores indicating poorer mental health. Internal consistency for each of the 5 subscales has been shown to be good, with a mean Cronbach's α of .73.[28] All of the items on the first 4 subscales are summed (the prosocial items are not included) to generate a total difficulties score. The parent-rated Strengths and Difficulties Questionnaire (SDQ) has been shown to discriminate between child mental health clinic attendees and community controls.[27]

Demographic Questionnaire

A brief questionnaire was completed by the parent to obtain basic demographic information. Occupation was obtained using a free-response question and coded using the National Statistics Socio-economic Classification.[29]

Procedure

Children in the appropriate age range with a forthcoming appointment were identified in outpatient clinic lists. The parents and the child were then sent an information letter describing the study with an invitation to participate. Consenting parents and children were interviewed in the clinic at the time of their planned appointment. Child participants were interviewed using the PAQ and the Exercise Beliefs Questionnaire. Parents completed the demographic questionnaire and the parent versions of the Exercise Beliefs Questionnaire and the SDQ. Children were weighed and measured using clinic scales.

Ethics

The study was granted approval by the Nottingham City Hospital National Health Service Trust Ethics Committee, the Nottingham Research Ethics Committee, and by the Research and Development Directorate, University Hospital, Nottingham, National Health Service Trust.

Analysis

Data were analyzed by using SPSS 14 (SPSS Inc, Chicago, IL). Analysis of variance was used to compare BMI between groups, and Mann-Whitney U tests were used to analyze nonparametric data, such as number of activities. Regression analysis and binary logistic regression

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were used to determine independent associations between independent and dependent variables.

RESULTS

Response Rates

Information letters were sent to parents of 98 children with appointments at 1 of 2 pediatric asthma clinics of whom 56 (60%) were recruited to the study and formed the asthma group. Information letters were sent to parents of 185 children with appointments at pediatric dermatology or otorhinolaryngology clinics of whom 61 (33%) were recruited to the study. However, an estimated 20% of children in the dermatology and otorhinolaryngology clinics had asthma and were excluded. This brings the true response rate to 41%. For both groups, the main reasons for failure to recruit were failure to attend the appointment and time constraints within the clinic.

Demographic Characteristics

The groups were comparable in terms of ethnicity, age, and gender (Table 1). Rather more children in the nonasthma group had parents in professional or managerial occupations, but this difference was not significant.

Asthma Status, Body Weight, and Levels of Activity

Analysis of variance was conducted with BMI as the dependent variable and group (asthma/nonasthma), socioeconomic status (professional or managerial/other), and gender as independent variables. Age was entered as a covariate, because BMI in children varies with age. There was a significant main effect of group, with those in the asthma group having significantly greater BMI than those in the nonasthma group ($F = 7.2$; degrees of freedom [*df*] = 1117; $P = .008$). The covariate age was significant ($F = 16.9$; $df = 1117$; $P < .001$). Neither the socioeconomic status of the family nor gender had any relationship with BMI, and there were no significant interactions.

A binary logistic regression with obesity as the dependent variable and age, socioeconomic status (professional or managerial/other), gender, and asthma group as independent variables found that children in the asthma group were ~4 times more likely to be obese than children in the nonasthma group (odds ratio [OR]: 3.89; $df = 1$; 95% confidence interval [CI]: 1.17–12.88). None of the other variables made any contribution.

Children with asthma reported fewer physical activities in the previous 24 hours ($z = 3.17$; $P = .002$) but comparable levels of sedentary activities (Table 2). Children classified as obese also had lower activity levels compared with nonobese children ($z = -2.6$; $P = .008$). A stepwise multiple regression was conducted with number of physical activities as the dependent variable and age, BMI, gender, and socioeconomic status (managerial/other) as the independent factors. Having asthma was the strongest predictor of lower activity levels ($\beta = -0.29$; $t = -3.36$; $P = .001$) followed by younger age ($\beta = 0.18$; $t = 1.99$; $P = .049$). These variables accounted for just more than 10% of the variance in activity level (adjusted $r^2 = 0.104$). Neither obesity status nor BMI made any significant contribution to physical activity once age and asthma were accounted for.

Mental Health

There were no differences in total, parent-rated SDQ scores between the groups, but children in the asthma group did have higher scores for emotional symptoms ($z = -1.96$; $P = .05$; Table 3). In the asthma group, higher PAQ scores were associated with lower total SDQ scores ($r = -0.35$; $n = 56$; $P = .009$), indicating that higher activity levels were associated with better mental health. In the nonasthma group, this relationship was reversed, with children with more problems reporting greater levels of physical activity ($r = 0.28$; $n = 60$; $P < .03$).

Perceptions of Asthma as a Barrier to Activity

The majority of parents (60.7%) in the asthma group spontaneously reported the child's asthma as a barrier to physical activity, but only 11% of parents in the nonasthma group identified the child's medical condition as a barrier. This difference was highly significant ($\chi^2 = 20.7$; $df = 1$; $P < .001$). Furthermore, 23% of parents in the asthma group identified better control of the child's medical condition as facilitating participation in physical activity compared with 8.2% in the nonasthma group ($\chi^2 = 3.97$; $df = 1$; $P = .05$). These differences were even

TABLE 1 Demographic Characteristics of the Sample

Characteristic	Nonasthma Group ($n = 61$)	Asthma Group ($n = 56$)
Age, mean (SD), y	10.97 (2.3)	10.67 (2.37)
Gender, *n* (%) male	24 (39)	33 (59)
Ethic background, white European, *n* (%)	51 (85)	49 (87.5)
Occupation, *n* (%)		
Professional/managerial	29 (50.9)	18 (33.3)
Intermediate	10 (17.5)	13 (24.1)
Routine	13 (22.8)	20 (37)
Student/unemployed	5 (8.6)	3 (5.6)

TABLE 2 Comparison of BMI and Activity Levels Between Groups

Variable	Nonasthma Group	Asthma Group	*P*
International Obesity Task Force definition			
Not overweight, *n* (%)	42 (68.9)	29 (51.8)	.046
Overweight, *n* (%)	15 (24.6)	15 (26.8)	
Obese, *n* (%)	4 (6.6)	12 (21.4)	
Mean BMI (SD), kg/m^2	18.82 (3.53)	20.78 (4.90)	.008
Median (IQR) total physical activities in 24 h	6 (4–10)	4 (2–5)	.002
Median (IQR) total sedentary activities in 24 h	4 (3–6)	4 (3–5)	

IQR indicates interquartile range.

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TABLE 3 **Comparison of SDQ Scores Between Groups**

Variable	Nonasthma Group	Asthma Group	*P*
Total SDQ score, mean (SD)	9.55 (3.53)	11.20 (6.15)	
Hyperactivity scale score, median (IQR)	3 (1–5.50)	4 (3–6)	
Emotional symptoms scale score, median (IQR)	2 (0–4)	3 (1–5)	.05
Conduct problems scale score, median (IQR)	1 (0.5–3)	1 (0–3)	
Peer problems scale score, median (IQR)	1 (0–3)	1 (1–2)	

IQR indicates interquartile range.

more obvious in the children's responses, with 66.1% of children reporting asthma as a barrier to exercise compared with only 11.5% of children in the nonasthma group identifying their medical condition as a barrier ($\chi^2 = 34.78$; $df = 1$; $P < .001$). Only 3.3% of children in the nonasthma group suggested that better control of their medical condition would help them participate in sport compared with 35.7% of children in the asthma group ($\chi^2 = 18.05$; $df = 1$; $P < .001$).

DISCUSSION

Nearly half of the children in the asthma group were overweight, with >20% falling into the obese category as defined by the International Obesity Task Force classification. Children in the asthma group were significantly heavier than the comparison group, and their risk of being classified obese was ~4 times that of children attending outpatient clinics for other medical conditions. These findings were independent of social class and gender. These results support previous findings from adult studies that asthma is associated with an increased risk of obesity, although results from pediatric studies have been less conclusive.[30]

There are a number of possible explanations for this finding. There is some evidence that obesity can increase the risk of developing asthma in childhood. A longitudinal survey of children who were asthma free during the first 24 months of life found that a BMI above the 85th centile at age 2 to 3 years predicted later development of asthma in boys but not girls.[31] The study controlled for some important confounders, such as parental smoking, but not sociodemographic status. Furthermore the diagnosis of asthma relied on parental report of symptoms and may have included children with obesity-related dyspnea. A recent meta-analysis of 4 cohort studies suggested that obesity in middle childhood increased the relative risk of developing asthma by 50% but, again, failed to control for sociodemographic status.[32] Where pulmonary testing has been conducted in obese children, the relationship with lung disease is not strong, with only a very small minority showing any evidence of an obstructive pattern.[33,34] It is possible that the obese children in our study had obesity-induced dyspnea, but this is unlikely, because asthma was clinically diagnosed in concordance with current British Thoracic Society/Scottish Intercollegiate Guidelines Network guidelines.

As hypothesized, children in the asthma group reported lower levels of physical activity than the control group. Levels of sedentary activities were comparable, however, suggesting that this is not just a result of generalized underreporting of activities. Although obese children were significantly less active, once asthma status was controlled for, weight was no longer related to activity levels. This suggests that asthma directly impedes physical activity in sufferers, and interview data from both parents and children supports this argument, because asthma clearly posed a significantly greater barrier to exercise than the control medical conditions. The differences between the groups were highly significant. Two thirds of children spontaneously reported that asthma stopped them doing sport and more than one third of children in the asthma group identified that better control of their asthma would make them do more activity. Sixty percent of parents also felt that asthma prevented their child from doing more activity.

The consensus in the literature suggests that children who are more active are those who enjoy sport, feel competent, and perceive that there are few barriers and many benefits to physical activity.[35] The results of this study confirm previous qualitative research, which found that parents of children with asthma are concerned about the effects of exercise and perceive asthma as a barrier to sports participation.[6] The majority of children in the asthma group likewise perceived their asthma as a significant barrier to physical activity. This is despite evidence that proper therapeutic management of asthma should allow most children to participate fully in vigorous physical activity,[36] particularly if a thorough warm-up is allowed.[37] If parents discourage exercise in children with asthma, the consequences may be secondary deconditioning as a result of inactivity.[38]

This study provides some support for previous work, suggesting that asthma negatively impacts on mental health.[19,20] Children in the asthma group had higher levels of emotional disturbance than children with other outpatient conditions, but total SDQ scores were not significantly different. Within the asthma group, better mental health was associated with higher levels of physical activity, but in a cross-sectional study, it is not possible to determine whether poor mental health acts as an additional barrier to exercise or whether activity improves mental health in this vulnerable group. The relationship could be mediated by the generalized impact of exercise on health. A study of 11- to 17-year-olds found that children in good health and with asthma were comparable in terms of mental health to children without asthma. Children in poor health with asthma had high levels of psychological problems.[39]

This cross-sectional survey was unable to explore causal relationships between activity and obesity, but the strong associations between asthma and both obesity and low levels of physical activity clearly highlight areas

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for action. The response rate in the control group was lower than ideal, but, for a number of reasons, we are confident that there was no confounding recruitment bias in the clinic. Much of the recruitment was done by nursing staff not involved in the study. The major factors that affected recruitment were failure to attend appointment and time constraints within the clinic. Children who miss outpatient appointments may tend to come from more disadvantaged families, thus introducing the possibility of bias toward higher socioeconomic status. These factors were common to both groups, however, although the otorhinolaryngology clinics were particularly busy. Furthermore, any bias toward higher sociodemographic status arguably reduces the power of the study to detect differences in activity levels and BMI and, thus, render our results more convincing. The difference in the recruitment rates between clinics is almost certainly because of the exclusion in the control groups of children with asthma.

Our measure of physical activity was based on child self-report of activities in the previous day rather than physiologic measures and may not have been representative of typical levels of activity. However, children were attending routine appointments rather than emergency visits, thus minimizing the chance that their reports were influenced by an exacerbation of their condition. Furthermore, 24-hour recall has been shown to correlate better with objective measures of activity than 7-day reports,[26] and it is particularly important with children not to place too great a demand on their memories. The PAQ is arguably a valid, reliable, and practical method of collecting activity data in this particular sample. It uses words and pictures to portray a wide range of activities, and children are only required to choose between 3 levels of response for each activity. The researchers were not blind to study condition, but the use of structured self-report questionnaires reduced the opportunity for bias.

Children in the asthma group were attending outpatient clinics for the treatment of asthma and had a confirmed clinical diagnosis of asthma. Children attending outpatient clinics have been found to have poorer mental health than community samples,[18] and there may also be sociodemographic biases in clinic populations. Therefore, a further strength of this study is that an outpatient control group was used.

CONCLUSIONS

This study highlights the importance of addressing barriers to exercise within pediatric asthma care and identifies the need for effective interventions to promote physical activity. If young people do not get rewarding experiences out of physical exercise early on, they will find it much harder to maintain healthy levels of physical fitness and body weight in adulthood. This is a particular concern for children with asthma for whom obesity and respiratory function have significant health implications. As a psychologically vulnerable group, they are also likely to benefit from the protective effects of exercise on mental health.

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