

Factors Influencing Physical Activity Levels in Children with Asthma

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Purpose. The purposes of this study were to assess the amount of physical activity children with asthma participate in and to explore the factors which influence their levels of physical activity.

Methods. A total of 152 children with asthma, ranging in age from 8 to 11 years, were enrolled in this study. The amount of physical activity for each child was gathered from self-reported 3-day physical activity logs (3d-PAL). Personal, diseased-related, psychological and environmental factors influencing physical activity were gathered from questionnaires completed by children and from parent interviews.

Results. Only 32.9% of children with asthma took part in 20 minutes or more of vigorous physical activity (VPA) more than three times per week, much less than the 85% participation rate advised by the Healthy People 2010 objectives. Access to exercise facilities, exercise-induced attack (EIA), and gender were predictors of moderate-to-vigorous physical activity (MVPA) ($p < 0.001$). Children with more access to exercise facilities ($p < 0.01$) and fewer episodes of EIA ($p < 0.01$) were more likely to engage in MVPA; furthermore, boys with asthma participated more in MVPA than girls ($p < 0.01$). Access to team sports was the determinant of VPA ($p < 0.05$).

Conclusions. Inactive children with asthma need appropriate exercise prescriptions to increase physical activity. Pediatric practitioners can enhance physical activity by advising parents to improve access for their children to exercise facilities, prescribing appropriate treatment for EIA, and encouraging girls with asthma to be more active. (*Mid Taiwan J Med* 2006;11:205-13)

Key words

asthma, children, EIA, MVPA, physical activity

INTRODUCTION

Asthma is the most common chronic childhood disease; in fact, its prevalence and incidence in children have increased over the past few decades in western countries and in Taiwan [1,2]. Exercise-induced attacks (EIA) cause children with asthma to avoid moderate-vigorous physical activity, which can lead to inactive lives in adulthood [3,4]. One study reported that 55% of children with asthma perceived physical

activity as the main cause of asthma attacks and, therefore limit their physical activity [5]. The standard medical wisdom for the past few decades has been that asthmatic children should limit their physical activity; however, according to the current National Asthma Diagnosis and Treatment Guidelines, "most people with asthma can lead normal lives and participate competitively in sports" [3]. Children with asthma should participate in physical activity, thus ensuring normal psychosocial development and good quality of life. Although "normal physical activity" has been cited as a treatment objective in the guidelines for diagnosing and treating asthma

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in the United States [6], the United States Health Interviews Survey reported that 30% of children with asthma had limited physical activity [7]. Children with asthma in the U.S. [8] and Taiwan [9] were reported to be less active than their peers. Understanding the determinants of physical activity among children with asthma will be very important to developing appropriate strategies for increasing their physical activity.

Besed on the United States Surgeon General's report that emphasized the relationships between physical activity and health [10], several international recommendations of physical activity for children and adolescents have been developed and evaluated [11,12]. First, Sallis and Patrick established the Physical Activity Guidelines for Adolescents (PAGA) [13], which recommended that children and adolescents participate in more than 90 minutes per week of moderate-to-vigorous physical activity (MVPA). Second, the Healthy People 2010 objective No. 22.6 recommended that children participate in more than 150 minutes per week of MVPA. Third, the Healthy People 2010 objective No. 22.7 suggested that children take part in a minimum of 60 minutes per week of vigorous physical activity (VPA) [14]. Fourth, the guidelines for children and adolescents in the United Kingdom Expert Consensus recommended that children participate in more than 420 minutes per week of MVPA [15]. Most of the recommendations were established by computing the minutes per week of MVPA and VPA. The international recommendations of physical activity for children and adolescents were also appropriate for normal development of children with asthma.

Few studies have focused on the behavioral factors that influence the amount of physical activity that healthy children and children with asthma participate in. Personal, interpersonal and environmental factors must be considered in physical activity studies [10]. Some factors that have been found to influence the physical activity of children are gender (boys are more active than girls) [16,17], and disease severity (moderately to severely ill children are less active than healthy

children) [13,18]. A recent study found that perceived competence in engaging in physical activity among children with asthma was significantly correlated with aerobic fitness [17]. Physical self-perception, one aspect of self-concept (a psychological dimension), has been shown to affect the level of physical activity and physical fitness of healthy children [19]. Perceived health status is another factor that affects health behaviors [20] and was a strong predictor of physical inactivity in the Ontario Health Survey [21]. According to Prochaska and DiClemente's Transtheoretical Theory [22], an individual's intention to change the behavior of physical activity is considered an important factor in motivating people to exercise [23]. There is a relationship between environmental factors, such as access to exercise and physical activity [15]. Access to exercise programs has been shown to significantly increase participation in physical activity among adolescents [24].

Therefore, this study was designed to describe the level of physical activity of children with asthma in Taiwan and to explore predictive factors influencing physical activity levels in this population. The ten factors explored included personal factors (gender, age), disease-related factors (asthma severity, EIA), psychological factors (stage of change, perceived health status, physical self-concept), and environmental factors (access to exercise information, access to exercise facilities, and access to team sports).

MATERIALS AND METHODS

Participants

This cross-sectional survey of children with asthma was conducted at three medical centers in Taiwan. Data were collected from questionnaires and activity logs completed by children and from interviews with their parents from October 2001 to December 2001. To be eligible for participation in the study, children needed to be from 8 to 11 years of age, have physician-diagnosed asthma [25], be clinically stable and show no signs of any other chronic disease or major physical disabilities. Of the 173 children recruited, 152

completed the questionnaire with their parent's informed consent. Nineteen children did not finish the questionnaire completely.

The final sample of 152 asthmatic children with valid data resulted in a response rate of 87.9%. No significant differences in demographic data were found between participants who completed the questionnaire and those who did not. Sample size ($N = 152$) was determined by power analysis of sampling; the significance levels were set as follows: $\alpha = 0.05$, correlation = 0.4, and power level = 0.78 [26].

Questionnaire and activity log

Data on the predictive factors influencing physical activity levels were collected from a structured, self-administered questionnaire with 10 factors in four categories. Data on physical activity levels were collected from a three-day physical activity log (3-dPAL). The four categories were personal, disease-related, psychological and environmental predictive factors. Personal factors included gender and age. Disease-related factors included asthma severity and the frequency of EIA during the previous year. Asthma severity was divided into four grades (intermittent mild, mild continuous, moderate, and severe), according to the Global Initiative for Asthma [27]. Psychological factors included the contemplation stage of changing exercise behavior, perceived health status and physical self-concept. Stage of change was classified using the five stages of Transtheoretical Theory [27,28]. Perceived health status was assessed by a four-item, five-point Likert's scale modified from the Perceived Health Status scale [28,29]. Cronbach's α for the internal consistency of this scale used in the present study was 0.71. Physical self-concept was evaluated using a six-point, 29-item Likert's scale originally developed by Fox and Marsh [30,31] and modified for use in Taiwan by Chung [32]. This scale, which measures perceptions about one's flexibility, tolerance, agility, obesity, appearance and strength, had good reliability ($\alpha = 0.80$) and construct validity. Higher scores indicated a more positive physical self-concept. Cronbach's α for

this scale in our study was 0.89.

The 3d-PAL was used to measure physical activity level at 15-minute intervals during the previous week. This instrument, designed by Bouchard et al [33] has been used as a convenient measure of physical activity among school-aged children in Taiwan. This instrument has good test-retest reliability ($r = 0.88$), good criterion validity ($r = 0.74$) and gives results consistent with 7-day measures of physical activity level [34]. Each child was asked to record one of nine levels of physical activity on one weekday, one Saturday and one Sunday during the previous seven days. The nine physical activity levels were: level 1, sleep; levels 2 to 5, mild activity; levels 6 to 7, moderate activity and levels 8 to 9, vigorous activity. A pilot study was conducted to test the comprehension and responsiveness of 15 school-aged children to the questionnaire. Test-retest reliability in this study was 0.78. Based on the pilot study results, the instrument was refined to be as clear as possible; for example, we provided the Chinese pronunciation of difficult words and designed a sample answer demo sheet. After these corrections, most school-aged children were able to understand the 3d-PAL.

Data analysis

SPSS for Windows (version 10.0) was used to analyze descriptive and inferential statistics. The level of significance was set at $\alpha = 0.05$. MVPA was classified as the time children spent at levels 6 to 9 during the previous seven days (min/wk). VPA was classified as the time that children took part in levels 8 to 9 activities (min/wk).

Multiple Regression analysis was used to determine predictors of physical activity. Collinearity diagnosis was used to examine the interrelationship between factors when tested by Multiple Linear Regression. This diagnosis indicated that the interrelationship among the ten variables was low; the variance inflation factor (VIF) of predictors was around 1; the tolerance ranged from 0.7 to 0.9, and the conditional indexes were less than 30 [35].

RESULTS

Participants

Of the 152 participants, 65.8% were boys and 34.2% were girls. The mean age was 9.88 years (SD = 1.17) (Table 1). Asthma severity was mild in most of the children (n = 134, 88.1%), moderate in 12 children (8.1%), and severe in one child (0.7%). Nearly half of the children had experienced EIA at least once in the previous year (n = 63, 42%). Only 39 children (25.7%) reported taking part in regular physical activity. More than half of the children (n = 97, 63.9%) did not regularly participate in physical activity. These children felt that their health status was moderate to good and that they had a moderately positive

physical self-concept. Their access to information about exercise for children was quite low, with a mean of 2.3 (SD = 1.5). Participants reported, on average, access to 8 exercise facilities, with a range of 1 to 16. Only 40 children (29.5%) had the opportunity to engage in team sports.

Levels of physical activity

Thirty participants (19.7%) were defined as being inactive because they performed no moderate or vigorous activity during the seven days preceding the survey [10]. More than half of the children (n = 92, 60.5%) participated in more than the PAGA-recommended 90 min/wk of MVPA, and 62 children (40.8%) took part

Table 1. Descriptive data on factors influencing physical activity of children with asthma

Factor	n	Range	No. (%)	Mean (SD)
Personal factors				
Gender	152			
Male			100 (65.8)	
Female			52 (34.2)	
Age (yr)	152			
8			29 (19.1)	
9			26 (17.1)	
10			31 (20.4)	
11			66 (43.4)	
Disease-related factors				
Asthma severity	147			
Mild Intermittent			113 (76.9)	
Mild Continuous			21 (14.3)	
Moderate			12 (8.1)	
Severe			1 (0.7)	
EIA	150			
None			87 (58.0)	
1-2			37 (24.7)	
3-5			17 (11.3)	
> 7			9 (6.0)	
Psychological factors				
Stage of change	152			
Pre-contemplation			1 (0.6)	
Contemplation			7 (4.6)	
Preparation			89 (58.6)	
Action			16 (10.5)	
Maintain			39 (25.7)	
Perceived health status	151	7-20		13.7 (3.1)
Physical self-concept	151	55-168		112.9 (21.8)
Environmental factors				
Access to exercise information	152	0-9		2.3 (1.5)
Access to exercise facilities	152	1-16		8.2 (3.1)
Access to sports team	151			
Yes			40 (26.5)	
No			111 (73.5)	

EIA = exercise-induced attack.

in more than 150 min/wk of MVPA as recommended in the Healthy People 2010 objective No.22.6. Fifty children (32.9%) participated in more than 60 min/wk of VPA as recommended in the Healthy People 2010 objective No.22.7. Only eleven children (7.2%) participated in more than the UK experts consensus-recommended 420 min/wk of MVPA. The levels of physical activity recorded in the 3d-PAL varied greatly among participants (Table 2). The variations in MVPA ranged widely, from zero to 911.25 min/wk, with a mean 157.06 min/wk. Levels of VPA were also quite dispersed, ranging from zero to 315 min/wk, with a mean 58.05 min/wk. Boys with asthma engaged in more MVPA than girls with asthma ($t = 2.195$, $p = 0.014$). The amount of MVPA differed between boys with and those without EIA.

Predictors of physical activity

Of the 10 factors examined as predictors of physical activity, only four were entered into the stepwise multiple regression analysis: access to

exercise facilities, EIA, gender, and access to sport teams (Table 3). None of the psychological factors influenced the time spent participating in physical activity. Access to exercise facilities, gender and EIA significantly and positively influenced the children's MVPA, explaining 13% of the variance in MVPA. Access to sport teams predicted only vigorous physical activity, with an R^2 value of 0.037.

Gender, EIA, and MVPA

The above results indicate that MVPA was significantly influenced by gender, EIA and access to exercise facilities. Further comparison of the influences of gender and EIA interaction on physical activity levels revealed that these factors significantly influenced MVPA in asthmatic boys with EIA (Table 2), but not in asthmatic girls with EIA. General Linear Model/Univariate testing of the interaction between gender and EIA indicated that gender affected only MVPA. EIA significantly affected boys with asthma. Neither gender nor EIA, or their interaction had a significant effect on VPA.

Table 2. Comparison of the influence of exercise-induced attack (EIA) and gender on physical activity (min/wk) in children with asthma

Physical activity	Moderate-vigorous physical activity	Vigorous physical activity
Total	157.06 (159.57)*	58.05 (81.41)
Boys		
EIA (n = 48)	135.70 (137.65)	59.06 (85.97)
Non-EIA (n = 51)	214.63 (204.12)	66.69 (81.69)
<i>p</i>	0.027	0.652
Girls		
EIA (n = 15)	108.75 (104.35)	48.25 (64.67)
Non-EIA (n = 36)	126.35 (110.65)	46.35 (80.89)
<i>p</i>	0.601	0.936

*Mean \pm SD. $^{\dagger}p < 0.05$.

Table 3. Stepwise multiple regression of physical activity (min/wk) in children with asthma

Predictor	Moderate-vigorous physical activity (β)	Vigorous physical activity (β)
Access to exercise facilities	0.235 †	
EIA	-0.237 †	
Gender	-0.204*	
Access to sport teams		0.193*
R^2	0.130	0.037
<i>p</i>	< 0.0001	0.017

* $p < 0.01$, $^{\dagger}p < 0.001$.

DISCUSSION

In this study, children with asthma engaged in physical activity at levels far below those recommended by the Healthy People 2010 objectives [10]. Of this sample, 19.7% were inactive, which is much higher than the target level, even for children with mildly to moderately severe asthma. According to the PAGA [13], children should engage in MVPA for ≥ 30 minutes at least 3 times per week. Only 60.5% of children in the present study ($n = 92$) participated in more than 90 min/wk of MVPA. The Healthy People 2010 objective No.22.7 states that children should engage in vigorous physical activity ≥ 20 minutes at least three times per week. Less than a third of the children with asthma ($n = 50$, 32.9%) in this study participated in more than 60 min/wk of VPA.

This study explored and evaluated 10 factors which influence the physical activity levels in 152 children with asthma. Of these 10 factors, access to exercise facilities was the most significant predictor of MVPA in children with asthma. This predictor is a modifiable factor influencing physical activity behavior. This finding is consistent with other studies in healthy children [20,36] and supports the general premise that providing a supportive exercise environment will motivate children to participate in MVPA. Our findings go beyond those of previous studies on physical activity in children with asthma, which did not include environmental factors. We analyzed the 10 factors as competitive variables using regression analysis to predict the dependent variables. Environmental factors were shown to be more important than psychological factors. Pediatric clinicians should suggest that parents create more exercise facilities and motivate their asthmatic children to exercise.

We also found that gender and EIA predicted which asthmatic children were at risk for physical inactivity. Girls engaged in MVPA significantly less than boys with asthma, indicating that girls need more encouragement to engage in exercise. Participation in teams sports was a predictor of VPA (Table 3). Whether gender

differences in MVPA are due to participation in sporting activities was not validated in the present study. EIA was the factor that most impacted the physical activity of children with asthma, especially in boys (Tables 2, 3).

A gender difference in physical activity has been reported in many studies on healthy children [16,17]. Among healthy children, girls are always less active than boys. Trost et al [37] found that participation in sports was the primary cause for gender differences in activity of healthy school-aged children. Pianosi reported no gender differences in BMI, asthma severity and physical fitness in children with asthma [18]. EIA, not gender, may be the main factor affecting the physical activity of children with asthma.

The prevalence of EIA in the present study was 42%, a figure far less than the 90% prevalence of asthma reported by Milgrom et al [38]. This result could be because EIA frequently goes undiagnosed. They also found that 50% of asthmatic children with a negative history for EIA had a positive response to exercise challenge [38]. The limitation in this study was that EIA was measured by self-report questionnaires, which was not as precise as the exercise challenge test. Children's reporting is often doubted because of their memory and the perception about EIA. Therefore, there is a need for further study to differentiate between perceived and actual EIA. Regardless of whether EIA is perceived or actual, pediatric clinicians have to understand the patient's condition and provide necessary suggestions or treatment. Appropriate prevention strategies, such as adequate warm-up and cool-down periods, and medical therapy for EIA during exercise periods have been recommended to achieve a normal level of physical activity for children with asthma [39,40].

Although the 3d-PAL is a precise and valid tool for measuring physical activity, the findings of this study are still limited because we did not use an objective measure of physical activity and did not perform long-term monitoring. A more accurate measurement of physical activity could provide more sensitive measurements of different levels of physical activity and yield more accurate

findings. The ten predictive factors of physical activity used in the regression analysis were not totally accounted for in the model; 87% of the variance in MVPA could not be explained. The failure to predict physical activity from psychological factors is disappointing, since such factors are modifiable and could be enhanced by patient education. Accurate diagnosis of EIA by biological measurement is suggested for further research.

The results of this study indicate that pediatric practitioners should encourage children with asthma to be more physically active. They should also advise parents to provide an environment that supports exercise. Pediatric physicians also should give appropriate medication to prevent and treat EIA. Parents and schoolteachers also have to encourage girls with asthma to be more active. Assessing physical activity levels, providing medications to prevent EIA before exercise, and teaching children with asthma to follow exercise guidelines should be standard clinical practices in asthma clinics.

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氣喘兒童身體活動之影響因子

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目的 本研究目的在評估氣喘兒童身體活動程度以及探討影響身體活動的因素。

方法 針對152位8至11歲的氣喘兒童，利用3日身體活動量表自我陳述過去七天的身體活動狀況，並以問卷訪談氣喘兒童及其父母，收集有關個人、疾病、心理以及環境等影響身體活動的因素。

結果 只有32.9%的氣喘兒童每週至少參加三次超過20分鐘的費力活動，遠少於2010全民健康目標的85%。接近運動設施、運動引發氣喘發作以及性別是影響氣喘兒童參加中度與費力活動的主要決定因子($p < 0.001$)，越接近運動設施以及較少因運動引發氣喘發作的氣喘兒童較會參與中度與費力活動，男生比女生較會參與中度與費力活動。參與運動團隊是費力活動的決定因子。

結論 不運動的氣喘兒童需要適當的運動處方以增加其身體活動，兒科執業人員應可以透過建議父母增加運動器材的可近性，適當治療運動引發氣喘發作，以及多鼓勵氣喘女孩參加活動等來增進身體活動。(中台灣醫誌 2006;11:205-13)

關鍵詞

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