Physical fitness and activity among 17-18-year-oldadolescents with asthma

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Abstract

The aim of the study was to assess the level of physical fitness and activity among male adolescents with asthma or otherwise.

The study was conducted among 129 male adolescents (mean age =17.49 years) from two secondary schools in Kielce in April-May 2018. Twenty-two individuals (20.56%) declared having allergic asthma with chronic cough and runny nose. Body height and weight were measured and BMI calculated. Moreover, grip strength (the Jamar dynameter), times of shuttles (Beep Test) and abdominal muscle strength (the sit up/min test) were determined. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) test (long form). An author's questionnaire was applied to collect information about the place of residence and physical status of respondents.

No statistically significant differences were observed in height, weight and BMI. Boys with allergic asthma had lower beep test scores (p=0.001) and sit up/min scores (p=0.038). As compared to individuals without asthma, boys with asthma spent more time bicycling (p=0.05) and less time in car transport (p=0.044).

Clinicians who provide care for adolescents with asthma should encourage them to participate in various forms of physical activity to maintain or improve health-related fitness.

Key words: physical fitness, physical activity, asthma

Introduction

Asthma is a chronic lung disease characterised by airway hyperactivity, which causes chest discomfort, wheezing and cough [1]. The ISAAC study has demonstrated that in recent years approximately 14% of children and adolescents up to 18 years of age had symptoms of asthma and the incidence of this disease has increased in the developed countries within recent 30 years [1-2]. The factors that affect the development of asthma include parental history of asthma, perinatal factors, interactions between genes and the environment and allergies at particular stages of childhood, age, low social status and the quality of external environment [3].

The symptoms of asthma have negative effects on various aspects of health, including health-related quality of life and self-esteem as well as psychological functioning of adolescents during a day [4-5].

Numerous health-related behaviours which affect the course of asthma can be consciously modified. One of them is physical activity and health-related fitness associated with it. Physical fitness and activity are considered positive measures of health. Their high potential reduced the risk of cardiovascular and metabolic diseases as well as some cancers [6].

Correlations between asthma versus physical activity and fitness have not been fully elucidated. Moreover, the available study findings have not explicitly determined whether asthma decreases the potential of physical fitness and limits the physical activity and whether the high level of

physical activity and fitness is a beneficial factor in asthma.

According to some studies, the symptoms of asthma have negative effects on physical activity of children and adolescents, increasing the time of sedentary behaviours. The above mechanism leads to a decrease in health–related fitness and increases the risk of overweight and obesity of individuals with asthma [7]. Such relations seem to be confirmed by independent epidemiological studies as in some countries increased incidences of asthma are accompanied by increases in sedentary behaviours and a substantially lower level of physical activity among young people [8-10]. Furthermore, physical activity has been found to affect the induction of asthma symptoms [11]. For this reason, many affected individuals, especially children and adolescents, do not engage in regular physical activity.

As opposed to the above observations, Schwindt et al. [12] and Welsh et al. [13] have shown positive effects of physical activity on the treatment of asthma and induction of anti-inflammatory effects, suggesting that regular physical activity is beneficial due to its positive impact on the circulatory-respiratory endurance [12-13]. Moreover, Cypcar et al. [14] have revealed that regular fitness exercises can alleviate the symptoms of asthma in children [14]. The findings available do not enable to determine the differences in the level of physical activity and fitness among asthmatic adolescents, as compared to healthy peers. Furthermore, the studies discussed concerned single indices of fitness and activity, such as time and intensity of physical activity or respiratory muscle strength. Only a few studies examined these two aspects of health together. In general, study results about differentiating the level of fitness and activity according to asthma and its symptoms have demonstrated no differences in the level of physical activity and respiratory muscle strength between asthmatic individuals and healthy peers [15-17]. In this regard, the issue of regular treatment and control of asthma seems to be essential [16].

The aim of the present study was to assess the differences in abdominal muscle strength, hand muscle strength and running endurance between healthy male adolescents and those with symptoms of allergic asthma. Moreover, the physical activities in both groups were compared.

Material and methods

The study was conducted in two randomly selected technical secondary schools in Kielce in April and May 2018. The 3- and 4-year students were involved. Finally, 107 boys aged 16-18 years (X=17.49 years; SD=0.59) were qualified for analysis, including 22 with allergic asthma and 95 controls.

Study protocol

Firstly, the author`s questionnaire was carried out to obtain information concerning the type of asthma (type of allergy, allergic asthma (yes-no), specialist care (yes-no), drugs taken related to the symptoms of allergy/asthma during the last year (yes-no), health status (common colds (yes-no), chronic runny nose (yes-no), cough (yes-no), regular physical activity (additional extracurricular physical activities, types and frequency) and places of residence (town-village). The code included the class level and its number and the unique students` code. Based on the data obtained, the group of 28 male students was selected with the symptoms of allergy, allergic asthma during the last year who were treated by a specialist (asthma and allergy symptoms: pollens n=14; fur n=2; mites n=1; pollens x mites x fur n=1; pollens x fur n=2; pollens x mites n=2. Food allergy n=6). The students with food allergy were excluded. Finally, 22 students were included. In the classes in which the students with allergy and asthma studied, all individuals were assessed as for their physical development,

fitness and activity. Their healthy peers constituted the control group. The participation in the study was voluntary. All adult participants gave their written informed consent. In the case of minors, the consent was given by their parents.

Evaluation of physical development

The physical development was assessed by measuring the body height and weight. Based on these measurements, body mass index (BMI) was calculated (kg/m^2). The SECA 217 stadiometer (accuracy - 0.1 cm) and the electronic weighing scales (accuracy- 0.1 kg) were used; the measurements were performed according to the anthropometric methods [18].

Physical fitness

The physical fitness was evaluated by determining the time of a 20 -metre shuttle (the beep test) [19] and the number of sit ups in a minute (abdominal strength and endurance) [20]. The hand muscle strength was assessed using the Electronic Hand Dynamometer Jamar; three measurements were conducted for the right and left hand separately according to the Fess instructions [21].

Physical activity

The physical activity was assessed using the IPAQ (a long version) [22]. The calculations were based on the declared time of physical activity during the day (minutes). The times devoted to home and around-home chores, walking, biking and car transport were presneted.-

Statistical analysis

The data obtained were statistically analysed. For qualitative variables, percentages were calculated separately for healthy, allergic and asthmatic individuals. The correlations were determined using the non-parametric Chi square test.

Quantitative variables were verified using the Shapiro-Wilk test. Means, medians, standard deviations and the interquartile range Q25-Q75 were calculated. Differences in quantitative features between healthy and asthma-affected adolescents were assessed by the Student`s t or Mann-Whitney test according to the distribution. P ≤0.05 was considered statistically significant. All calculations were performed using Statistica 13.1 software.

Results

Over half of boys with asthma and allergy lived in towns, more with asthma than healthy individuals (54.55% vs. 34.13%). However, this relationship was not statistically significant (Table 1).

Amongst the adolescents with symptoms of allergic asthma, 63.63% reported allergy to pollens while 22.72% cross-allergy. The incidence of specific symptoms of allergy between both groups was found to be significant. The individuals with allergy and asthma more frequently had chronic cough (p≤0.001) and runny nose. (p≤0.001). The number of colds within the last year in both groups was similar. All individuals with allergy and asthma visited allergologists.

Regular, additional, extracurricular physical activity was declared by 40 boys - a higher number of those with allergy and asthma compared to healthy ones (p≤0.006).

There were no significant differences in body height and weight as well as BMI between healthy boys and those with allergy and asthma (Table 2).

The right and left hand strength was comparable, irrespective of health status (Table 3).

A significant difference was found in the beep test scores and abdominal muscle strength. The healthy adolescents ran significantly longer (6.63min vs. 6.00min) compared to the affected boys. Moreover, the number of shuttles was higher amongst healthy adolescents.

Both groups were characterised by similar times of walking, moderate and intense efforts during gardening and chores around the house (Table 4).

Table 1. Characteristics of study groups

Variables		Without allergy and asthma	With allergy and asthma	p
		N(%)	N(%)	
Boys (n=107)		85(79.44)	22(20.56)	
Place of living (Cities)		28(34.13)	12(54.55)	0.081
Health status				
Frequent colds (yes)		6(7.32)	4(18.18)	0.125
Chronic cough (yes)		3(3.66)	8(36.36)	0.001
Chronic runny nose (yes)		5(6.10)	16(72.73)	0.001
Regular, additional physical activity (Yes)		26(31.71)	14(63.64)	0.006
Allergens	Pollens	-	14(63.63)	
	Fur	-	2(9.09)	
	Mites	-	1(4.54)	
	Pollens, fur	-	2(9.09)	
	Pollens, mites	-	2(9.09)	
	Pollens, mites, fur	-	1(4.54)	
Regular visits to allergologists and treatment		-	22(100.00)	

Table 2. Somatic characteristics of study individuals

Variables	Without allergy and asthma				With allergy and asthma				P
	$\bar{x}$	SD	Me	Q1-Q3	$\bar{x}$	SD	Me	Q1-Q3	
Body height [cm]	180.13	7.77	180.00	10.00	179.386	9.60	181.00	14.00	0.977
Body weight [kg]	75.11	3.02	75.00	19.00	77.77	14.12	79.00	12.00	0.483
BMI [kg/m^2]	23.06	12.45	22.96	4.69	23.91	3.06	24.50	4.21	0.223

Table 3. Characteristics of physical fitness among study adolescents

Variables	Without allergy and asthma				With allergy and asthma				p
	$\bar{x}$	SD	Me	Q1-Q3	$\bar{x}$	SD	Me	Q1-Q3	
Endurance in beep test [min]	6.63	0.80	6.20	1.02	6.00	0.877	6.20	1.06	**0.001**
Abdominal strength – sit-ups [n/min]	36.22	5.23	37.00	8.00	33.50	5.16	34.00	8.00	**0.038**
Strength of the right hand -hand dynameter [kG]	35.34	4.37	34.50	6.10	35.10	4.56	33.90	6.70	0.664
Strength of the left hand- hand dynamometer [kG]	32.89	4.09	32.40	6.10	31.87	4.67	31.20	7.50	0.232

Table 4. Time devoted to various forms of physical activity during one day, average day in the week preceding the examination

Variables	Without allergy and asthma				With allergy and asthma				P
	$\bar{x}$	SD	Me	Q1-Q3	$\bar{x}$	SD	Me	Q1-Q3	
Bicycling/day [MIN]	40.2	40.31	25.71	38.57	95.10	100,85	64.29	102,86	**0.05**
Walking/day [MIN]	67.9	74.53	40.00	101.00	67.89	40.74	30.00	52.85	0.162
Intensive gardening/ day	52.9	46.29	38.57	46.29	29.28	40.74	8.57	49.28	0.101
Moderate gardening [min]	36.4	53.45	17.14	34.29	60.00	80.10	21.43	60.00	0.815
PA - sum of physical activity/day [min]	140.9	128.96	104.29	138.57	135.17	196.81	62.85	145.00	0.081
Sedentary behaviour time/day[min]	290.5	140.03	300.00	180.00	305.45	154.81	360.00	240.00	0.500
Transport time/day [min]	56.4	41.82	42.86	41.82	35.43	20.69	30,00	22.14	**0.044**

In general, the mean time devoted to physical activity was comparable in both groups. The time devoted to cycling was significantly different. The boys with allergy and asthma more frequently rode a bicycle, as compared to their healthy peers ($p<0.05$).

In both groups, the time devoted to sedentary behaviour was similar. Otherwise, the time spent in car transport was shorter among the adolescents with allergy and asthma.

Discussion

Our study focused on comparing the physical fitness and activity among male adolescents (mean age- 17.49 years) with the symptoms of allergic asthma and healthy individuals. Body height and weight as well as BMI were comparable in both groups. The study findings analysing the correlations between asthma and physical development were inconclusive. Shaheen et al. [23], who analysed the group of 8960 individuals from the 1970 British Cohort Study (BCS1970; mean age=26), have demonstrated that the association between fitness and asthma was stronger only in young women. Continuous observations of Swedish children in the years 1994-2013 within the BAMSE project have confirmed the above results and revealed that the strength of associations between asthma and BMI increases with age yet only among girls. In the group of male individuals, the associations between asthma and BMI were no so clear [24]. The study encompassing the individuals aged 5-17 years has shown that the mean body height and weight in individuals with asthma were lower than in healthy peers. BMI and skinfold thickness were significantly higher in the group with bronchial asthma [25]. Moreover, the study among Russian children aged 5-17 years, have disclosed that the fraction of the children with reduced height is higher in the groups of increasing bronchial asthma severities. Thus, the number of children with lower body height in the groups of intermittent and mild persistent asthma did not differ from the group of healthy peers [26]. Furthermore, the study regarding Swedish children has demonstrated that the differences in body height amongst children with various severities of asthma are likely to result from the use of inhaled corticosteroid (ICS) during examinations. Moreover, the authors have suggested that the differences observed deemed after the completion of growth [27]. It should be emphasised, however, that our study did not

collect information about the treatment options of asthma, the regular use of ICS during one day or during physical activity and the severity of asthma. Therefore, it is difficult to compare our observations with the study findings mentioned above.

The lack of differences in body weight and BMI in both groups is likely to be attributable to higher physical activity declared by the adolescents with asthma [28].

Our findings demonstrated that the level of physical fitness in boys with asthma and healthy individuals is significantly different according to two components: running endurance and abdominal muscle strength. In both cases, the results of adolescents with asthma were worse. The current studies about the physical fitness of asthmatic individuals predominantly regarded the circulatory-respiratory endurance [13]. The running endurance was analysed only in a few studies. Moreover, there are no studies describing strength abilities of asthmatic patients. The studies in children (grades 4-8) with mild asthma have revealed lower scores in the progressive aerobic cardiovascular endurance run (PACER), as compared to their healthy peers [16]. However, long-term endurance efforts (15 months) have been demonstrated to substantially increase the endurance of children, i.e. to double it compared to their peers with asthma [16]. According to Pieri et al. [29], asthma has negative impact on cardiorespiratory endurance [29]. Some other works have shown that children with severe asthma and uncontrolled asthma with low cardiorespiratory fitness can achieve the normal level of physical fitness yet they have to participate in rehabilitation training. In such cases, the treatment of asthma should be controlled by specialists [30].

The sit up test with its modifications is often used to evaluate strength endurance [31], which is significantly and positively correlated ($r=0.37$; $p<0.001$) with cardio-respiratory fitness estimated according to the maximal aerobic capacity ($V(O_2)$ max) and running endurance [32-33]. Therefore, it should be assumed that a low level of running endurance coexists with reduced abdominal muscle strength.

The previous review has stressed the significance of physical activity in improving physical fitness of children and adolescents [34]. Moreover, no higher engagement in sedentary behaviours has been found among asthmatic children, as compared to their healthy peers [35]. However, higher engagement has been observed in adults and regarded television viewing [36]. In our study, there were no differences in the mean number of hours spent for moderate and intense gardening. Furthermore, the total number of hours devoted to physical activity and sedentary behaviours during one day was comparable. The significant differences, however, were observed in the time devoted to bicycling and car transport. The boys with asthma spent more time on cycling and less time on sedentary behaviours connected with car transport, as compared to boys without asthma. Our findings are likely to suggest a higher level of health awareness among adolescents with asthma and/or their parents and their higher concern for health; hence their choice of bicycles as one of the measures to improve the health status [37]. It is also likely that they cover longer distances in towns (from homes to schools and back) using bicycles, as over half of the study population with asthma lives in towns while the percentage of healthy boys living in towns is significantly lower. That is why this kind of transportation is popular in spring and summer when car transport is not so important.

Our findings are consistent with some earlier observations [35-37]. According to Ziętkowski et al. [38], who studied adults with asthma (mean age=35) and healthy adult individuals without asthma (mean age=29), the former showed a

significantly lower level of physical activity in all domains, except for intense gardening and chores around the house. The energy spent on bicycling was by 407MET*day/min lower compared to healthy individuals. The individuals with worse spirometric parameters were characterised by the lowest physical activity. Moreover, higher incidences of hospitalisations were found among individuals with asthma and low physical activity [38]. According to Santos-Silva et al. [39], who studied the group of 11-year-olds, performance in physical education and after school sports activities were different in both groups compared. Healthy children were more active than their peers with allergy and asthma (p=0.011) and did more sports between 6 and 10 pm (p = 0,036). However, there were no differences in the overall level of physical activity, estimated by the PAQ score, between allergic and healthy children (2.40 ± 0.7 *vs.* 2.48 ± 0.62; p = 0.32; p = 0.011) [39]. Some other studies have demonstrated that differences in the level of physical activity depend on the severity of asthma; the highest differences were observed in the moderate-to-severe asthma group, as compared to healthy peers. The children with mild asthma and healthy children were characterised by a comparable level of physical activity [40]. Likewise, Groth et al. [35] have revealed a significantly lower level of physical activity in asthmatic adolescents compared to healthy individuals, yet it regarded only a high – intensity exercise level. Moreover, the time spent on watching TV, computer and game playing was similar in both study groups [35]. Tsai et al. [41] has observed that physical activity 3 times or more a week was associated with fewer occurrences of respiratory symptoms (OR=0.66-0.73) while watching TV more than 3 hours during a day was associated with more occurrences of respiratory symptoms (OR=1.42-1.90) [41].

The results reported by Bernsten et al. [42] are inconsistent with the findings mentioned earlier. The adolescents (mean age = 13.6) with asthma and healthy peers showed similar moderate and vigorous activity (3.7 vs. 3.5 hours/day and 1.5 vs.1.6hours/day; p=0.37, p=0.77, respectively). However, it should be stressed that almost half of the affected individuals used inhaled corticosteroids within recent months (48%) and β2-agonists prior to activity (47%) [42].

Conclusions

Our findings suggest that male adolescents with and without asthma are characterised by a similar level of physical development and hand strength. Significant differences regard running endurance and abdominal muscle strength.

Moreover, in spring and summer, adolescents with asthma are more engaged in bicycling and less in car transport, as compared to healthy boys.

Clinicians who provide care for adolescents with asthma should encouraged them to participate in various forms of physical activity to improve their health-related fitness, including running endurance and strength. Furthermore, asthmatic adolescents should familiarise with the guidelines that promote an active lifestyle. Future research should involve long-term studies regarding the effects of active health-promoting behaviours on the components of physical fitness.

Moreover, it seems that physical fitness tests based on long-term physical efforts, such as the beep test and sit up test during 1 minute can be used to assess the physical fitness in children and adolescents with asthma.

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