Global Journal of Medical Research: K
Interdisciplinary
Volume 15 Issue 1 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Impacts of Asthma-Obesity Association's on Children's Moderate and Vigorous Physical Activities

By Abdulraouf Y. Lamoshi & Lesley E. Cottrell
West Virginia University/ Tripoli Medical Center, United States

Abstract- *Background:* This study was developed to explore the relationship between asthma and obesity and the impact of that association on children's physical activities. Potential age and gender differences in the association between asthma, obesity, and activity were also examined.

Methods: Children were recruited from outpatient physician clinics to participate in a cross-sectional study. Child body mass index percentile and asthma severity were clinically assessed. Children's physical activity was assessed through parent report and assigned appropriate metabolic equivalent task (MET) scores.

Results: 75 children participated in the study. Regardless of their asthmatic and weight statuses, boys and girls significantly differed based on their average MET scores ($p = .007$), respectively. Younger, mildly asthmatic children had significantly higher MET scores than older, mildly asthmatics ($p<.05$); younger, severe asthmatics had moderately higher average MET scores than older, severe asthmatics ($p<.05$).

Conclusion: Young asthmatic children and boys overall are more physically active than the older, asthmatic children and girls overall, respectively.

Keywords: *asthma-obesity association, moderate and vigorous physical activities, children.*

GJMR-K Classification: *NLMC Code: WD 300*

Strictly as per the compliance and regulations of:

Impacts of Asthma-Obesity Association's on Children's Moderate and Vigorous Physical Activities

Abdulraouf Y. Lamoshi [α] & Lesley E. Cottrell [σ]

Abstract - ***Background:*** This study was developed to explore the relationship between asthma and obesity and the impact of that association on children's physical activities. Potential age and gender differences in the association between asthma, obesity, and activity were also examined.

Methods: Children were recruited from outpatient physician clinics to participate in a cross-sectional study. Child body mass index percentile and asthma severity were clinically assessed. Children's physical activity was assessed through parent report and assigned appropriate metabolic equivalent task (MET) scores.

Results: 75 children participated in the study. Regardless of their asthmatic and weight statuses, boys and girls significantly differed based on their average MET scores ($p = .007$), respectively. Younger, mildly asthmatic children had significantly higher MET scores than older, mildly asthmatics ($p<.05$); younger, severe asthmatics had moderately higher average MET scores than older, severe asthmatics ($p<.05$).

Conclusion: Young asthmatic children and boys overall are more physically active than the older, asthmatic children and girls overall, respectively. Established age and gender differences in physical activity may be found more readily among specific samples of children, particularly those with asthma.

Keywords: asthma-obesity association, moderate and vigorous physical activities, children.

I. Introduction

Many studies show that asthma and obesity are important public health problems because of their high prevalence among children; these medical problems affect the quality of life of the patients and consume significant amounts of money to provide the necessary medical care [22]. Researchers have postulated and established a positive association between obesity and asthma; however, a definitive causal relationship and an understanding of which condition comes first remain unobvious [4,16]. Moreover, patients who are obese and have asthma symptoms do not respond in the same manner to asthma medications as non obese patients [7].

Author α: Pediatric Surgery Department, Tripoli Medical Center, Tripoli, Libya. e-mail: raofdr@yahoo.com

Author σ: Department of Pediatrics, School of Medicine, West Virginia University.

The main asthma-obesity potential mechanism is the significant pressure from the overall weight gain. Overweight children carry extra pounds making it harder for some to be physically active, particularly asthmatic children [24]. Tidal volume and functional residual capacity also decrease due to mechanical impact of the fat tissue [4]. This, in turn, affects the lung function especially when the body demands for oxygen increase [4]. Obesity also leads to loss of the tightening of gastroesophageal sphincter which causes gastroesophageal reflux, in turn leading to aspiration of the stomach contents [14]. As a result the lung airways get constricted which makes the respiratory process a hard task [4]. The other potential mechanism is that increase in body weight causes the immune system to secret some inflammatory substances which could result in over reaction of the airways that in turn leads to constriction of those air passages and difficulty in breathing [3]. Other targeted mechanisms for the association between asthma and obesity are related to immunological changes, dietary modifications, genetic factors, and activated sex hormones [4,14].

Early teen-age girls' asthma symptoms and obesity risk measured by body mass index (BMI) are significantly associated [6]. A similar conclusion has been drawn by another study which stated that girls who develop early menarche are at a higher risk of developing asthma and obesity [8]. Only obese or overweight girls between 6 and 11 years are seven times at a higher risk of developing asthma [19]. Asthma prevalence was higher among girls who are younger than 11 years and developed early puberty [4]. There is some controversy about which gender is at a higher risk in some studies' conclusions. However, they are more inclined toward the girls' side, and the difference in these studies could be due to the children's ages at which the association was reported [4,21,22]. The prevalence of obesity and overweight among children was 6.87% in boys and 9.5% in girls [12]. The most acceptable hypothesis for the higher prevalence of asthma among females is that adipose tissue's aromatase converts androgens into estrogens, which in turn change lung development and airway tone responsiveness at the age of puberty [4].

Asthma-obesity association has negative impact on children's physical activity where children with asthma have 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) [9]. Also, they found that asthma is the strongest predictor of lower activity scores, and the asthma group has higher levels of emotional problems and, within this group, more active children have better mental status [9]. Parents in the asthma group identified the child's health as an obstacle to exercise (60.7% vs. 11%) and the same is true of children (66.1% vs. 11.5%) [9]. Asthma was identified as a barrier to exercise by parents and children [25]. Strategies to promote exercise within pediatric asthma care are needed to protect both mental and physical health [5]. Furthermore, physical activity is influenced negatively by asthma and obesity, and it can become worse because of their additive effect [20]. However, there are some other studies which show no association between asthma and physical activity [20] or asthmatic children do more physical activities than non asthmatic children [17,18].

Types of physical activity, and their MET scores, are subjected to change when children are divided into two groups, 6 -9 years and 10- 14 years. The first group is more inclined to participate in anaerobic activities, and the older children tend to participate in more organized activities [23]. Children between ages of 6 to 11 year spent more time doing moderate to vigorous physical activities than older children who are between ages of 12 to 15 years, and girls spent less time doing moderate to vigorous physical activities than boys of the same age [1]. Guerra et al.'s study finding could be one potential indicator of decreasing physical activities between these groups where it showed that BMI increases progressively with age after the age of 6 years until the age of 11 years [10].

In general, the concomitant increase in prevalence of both disorders in children has led to interest in the relationship between these two epidemics [22]. The debate about the nature of the asthma-obesity relationship is ongoing and some possible explanations should be considered to comprehend the reality of that association [14]. However, working to decrease the BMI would improve the status of asthma patients in terms of frequencies of the attacks, need to treatment, and side effects of those medications [6]. Based on what stated above, meticulous exploration of asthma-obesity association effect on children physical activities could be the first step to manage this issue. We don't know how the combination of being asthmatic and obese might influence physical activity? What are the gaps based on the current research for these three variables and why should we look at them now?

The research aspect of this study aimed to provide several benefits to the research community and society as a whole. The main goal was to will identify ways in which childhood obesity and/or asthma, age, and gender impacts a child´s physical.

II. Methods

An observational cross-sectional study of 145 children (7-12 years) was conducted to examine the impact of asthma obesity association on children's physical activities. This study was a secondary analysis of a larger cross sectional clinical study that examined children's the psychological, physiological, and cognitive impact of obesity and asthma. The ultimate goal of this work is to decrease asthma and obesity prevalence and maintain or increase physical activity among all children, regardless of asthma or obesity condition. The short-term goal of this study was to examine obesity-asthma association impact on children physical activities. Based on the existing literature, we hypothesis that:

1. asthma and obesity are associated together;
2. the amount of physical activities will be less among asthmatic children;
3. the amount of physical activity will be less among children who are obese; and
4. asthma and obesity have will have an additive effect on children's physical activity

This study was designed to explore the impact of asthma-obesity association on children's physical activities. This topic has not been examined in this sense closely and thoroughly before.

Measures: In this study, we focused on certain items in some questionnaires such as how often the children do exercise per week, from parents' perspective, and severity of asthma based on number asthmatic attacks during the daytimes and at nighttimes per week and month. From pulmonary function test's items, forced expiratory volume of the first second (FEV1) was used to categorize the severity of asthma from laboratory view. Reviewing the history form and case report form show the BMI% and whether the children have been diagnosed as asthmatic before or not.

Study variables were gathered by survey and clinical assessment during a scheduled clinic visit. The following measures were incorporated into the present study:

Childhood Obesity: Children´s height (inches) and weight (pounds) measured using the SECA Road Rod stadiometer (78"/200 cm) and the SECA 840 Personal Digital Scale. Children asked to remove their shoes and jackets prior to assessing their height and weight. Body mass index for each child calculated using the recommended equation by the Centers for Disease Control. All weight percentile categories (e.g., normal, overweight, obese) were based on the age and gender, specific growth charts recommended by the Centers for

Disease Control and Prevention (CDC) [11]. We used MBI% to classify the participants into: < 5th percentile under weight, 5-85th percentile normal weight, 85-95th percentile are overweight, and > 95th percentile are obese.

Childhood Asthma : The standard lung function test was carried out according to the recommended standards. The main value which was used in this study is the forced expiratory volume in one second (FEV1). FEV1 < 60 is severe asthma, 60-80 moderate asthma, and > 80 mild asthma and normal.

Asthma Severity : Asthma Assessment Form was used to assess the severity of asthma symptoms in terms of number of attacks per week during the day time and night time. Mild: 1-6 days /week and 3-4 nights/month, moderate: daily during days and 5-9 nights/ month, and severe: continuous during daytime and 10 nights/ month.

Children physical activities were collected from parents who were asked to recall what their children´s activities were over the past week. MET is "the ratio of the metabolic rate of the average person while seated and resting, to the metabolic rate of a particular person while performing some task" [2]. MET stands for Metabolic Equivalents of Task. One MET is "equivalent to a metabolic rate consuming: 3.5 milliliters of oxygen or 1 kilocalorie, per kilogram of body weight per minute" [2]. For that purpose we used the CDC and American College of Sports Medicine (ACSM) guidelines for the definition of the activities, 3-6 METs are moderate and greater than 6 METs are vigorous (Martin, Morrow, Jackson, and Dunn, 2000), Table 2. MET scores for children's physical activities is measured based on this form. Physical activities score is calculated by multiplying the times of each activity by hours of each activity by the assigned MET value for that activity. The sum of the scores gave the overall value for each activity over the last week before filling the form [15].

Children's age was collected as a continuous variable and later grouped into two categories younger (7-10 years) and older (11-13 years).

Statistical Analysis: SPSS for Windows Version 20.0 was used for data analysis. Descriptive statistics were summarized as mean (with SD) and frequency (%). Chi-square test and Student's t test were used to compare differences between groups. MANOVA analysis was conducted with total MET's scores as the dependent variable and group (asthma vs. nonasthma) and BMI% (healthy weight vs. overweight and obese) as independent variables. An interaction between asthmatic status and BMI% of the children was created and placed in the model as an independent variable. Basic model-fitting techniques for regression analysis, including goodness-of-fit assessment and regression diagnostics (e.g., residual analysis, detection of influential cases, and check for multicollinearity) were applied. Because physical activity data were not distributed normally, two outliers were removed before t tests and regression analyses were carried out. For all tests, p-values of 0.05 were considered statistically significant. Approval was obtained from the Institutional Review Board.

III. Results

Sample: A total of 145 children were recruited into the study; 75 children completed the physical activity data. Fifty-eight percent (43) of the sample was males, and the majority of the sample was Caucasian (85.5%). Seventy-nine (54.5%) children were of healthy weights; 66 (45.5%) were either obese or overweight. Seventy-seven (53.1%) were non-asthmatics and 68 (46.9%) were asthmatics (28 mild, 33 moderate, and 7 severe).

Obesity and Asthma Prevalence: Out of the 75 children who completed the physical activity form 41 (54.7%) were non-asthmatic, 15 (20%) were mild asthmatics, 14 (18.7%) were moderate asthmatics, and 5 (6.7%) were severe asthmatics. In terms of body composition, 43 (58 %) were under- or healthy weight and 31 (42%) were overweight or obese. Based on gender, more girls (48.39%) were asthmatic than boys (44.19%); on the other hand, boys (44.19%) were more likely to be overweight or obese than girls (31.71%). When grouped by their asthma and body composition status, 29 (38.7%) were non-asthmatic and non-obese/overweight, 18 (24%) were non-asthmatic and obese/overweight, 15 (20%) were asthmatic and non-obese/overweight, and 13 (17.3%) were asthmatic and obese/overweight, Table 1. The mean MET score of all children was 49.82 (SE = 4.62).

Table 1 : Participants' Demographic

Characteristic	Participants' # (%)
Gender	
Boys	43 (58%)
Girls	31 (42%)
Age	9.59 year
Group 1 (7-10 years)	44 (59.5%)
Group 2 (11-13 years)	30 (40.5%)
Race	
White	65 (87.8 %)

Black	3 (4.1%)
Hispanic	2 (2.7%)
Asian	2 (2.7%)
Family history of Asthma	
Yes	29 (38.6%)
No	42 (56%)
Missing	4 (5.4%)
Asthma	
Yes	34 (45.3%)
No	41 (54.7%)
Height	49.34 (9.07)
Weight	89.78 (39.86)
BMI %	60.51(31.74)

Obesity and Asthmatics and Physical Activity: Regardless of their asthmatic and weight statuses, boys and girls significantly differed based on their average MET scores (63.32 vs. 43.77) respectively ($F = 7.87$, $P = .007$) (Figure 1). Concerning the age, there was no significant difference in MET scores where the younger group had insignificantly higher MET scores (60.97 vs. 43.09) ($F = 1.05$, $P = .311$). Asthmatic participants, regardless of the severity, did not differ in terms of their MET scores from non-asthmatics: non-asthmatics' mean MET score was 37.27 (SE = 6.47), mild asthmatics' mean MET score was 61.03 (SE = 11.03), moderate asthmatics' mean MET score was 64.26 (SE = 11.25), and severe asthmatics' mean MET score was 63.81 (SE = 18.59) ($P = .284$). Overweight and obese children, regardless of their asthma status, had slightly higher mean MET scores than the healthy weight children (X = 56.93 and X= 51.70 respectively) but this was not a significant difference ($p = .331$).

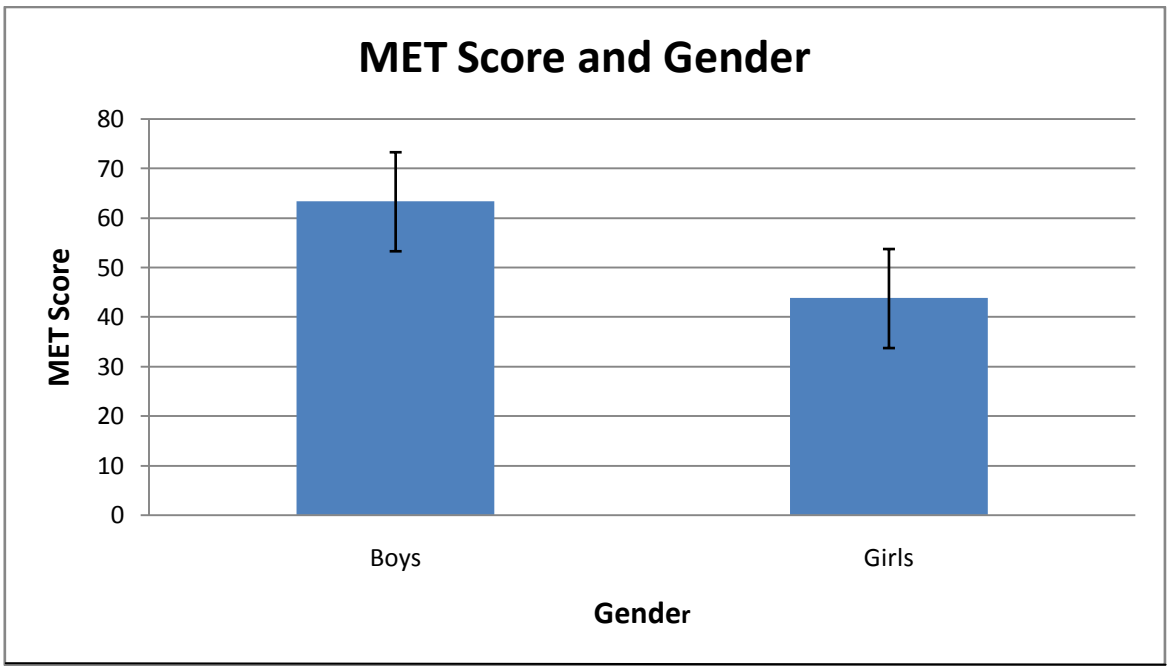

Figure 1 : Metabolic Equivalent Task Score of the Participants According to Gender

Analysis of the Composite Group: An interaction effect between participant age and asthma diagnosis was found with regard to average MET scores ($F = 3.08$, $P = .036$). Specifically, younger mildly asthmatic children had significantly higher MET scores than older mildly asthmatics (81.25 vs. 20.60, $p<.05$). Younger severe asthmatics also had moderately higher average MET scores than older severe asthmatics (65.71 vs. 60.00, $p<.05$), Figure 2.

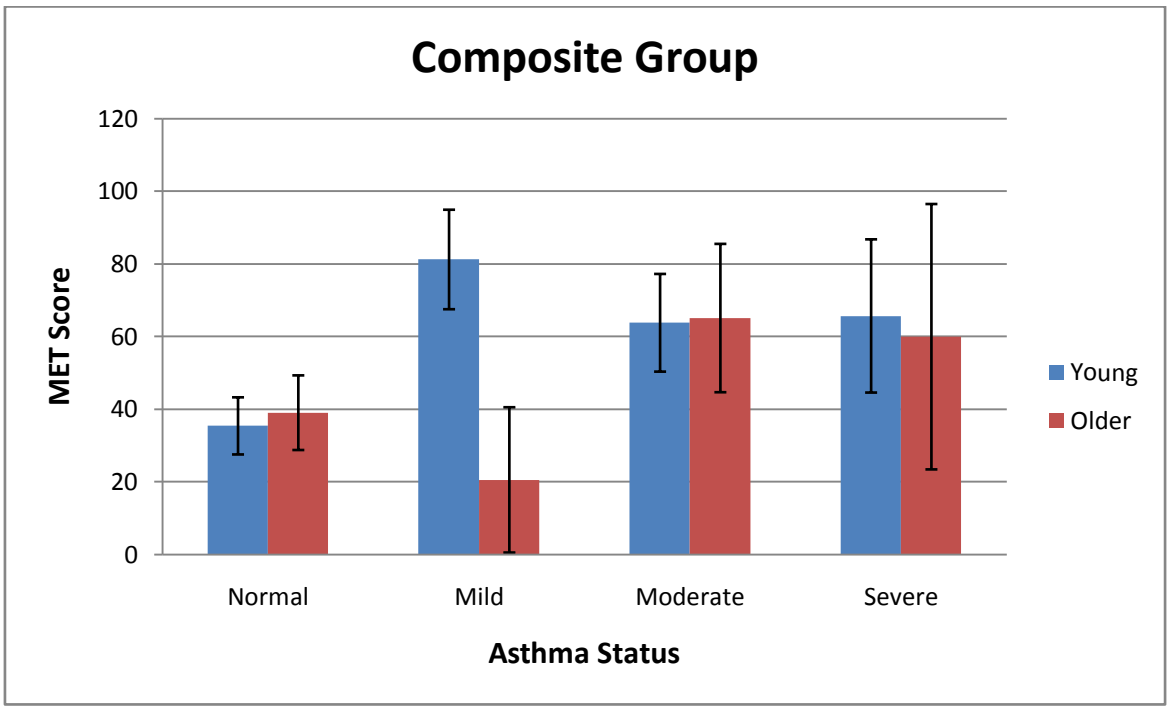

Figure 2 : Metabolic Equivalent Task Score of the Participants According to the Age and Asthma Statuses

IV. Discussion

The main findings of this study were that mild and severe asthmatic young children and boys, in general, were significantly involved in moderate to vigorous physical activity than mild and severe asthmatic older children and girls, respectively. BMI alone had no significant influence on children's moderate to vigorous physical activities.

Table 2 : The Survey was used to Assess Children Moderate and Vigorous Physical Activities

	Activities' List	MET
1.	Ride bike, Skate (roller, inline, ice, skateboard)	4
2.	T-ball/Baseball/Softball, Basketball, Golf, Dodge ball	4.5
3.	Play on playground, chase/tag, climb trees	3.5
4.	Jump rope, hopscotch, Trampoline, Bounce house	8
5.	Football, Soccer, Hockey, Tennis, Kickball	7
6.	Martial arts (karate, judo, etc.)	4
7.	ATV, dirt bike	5
8.	Dance, cheerleading, gymnastics	4
9.	Swimming	4

Our results, about gender and age differences in asthma and obesity, are supported by two studies, at least, which showed that asthmatic children do more physical activities than non asthmatic children [13,18]. Also, girls are less moderately to vigorously active than boys ($p < .001$) [1]. These findings are also underpinned by older girls' higher risk of developing asthma, which could hinder them from being physically active [4]. Moreover, children after age of 6 years tend to have higher BMI [10]. Additionally, there are some studies that found asthma and obesity in general to have no significant impact on children's physical activity [9,25]. In addition, Belcher et al.'s study revealed that children between 6 and 11 years are significantly more moderately to vigorously active than those children between 12 and 14 years ($p < .001$) [1].

Significance of this study finding is that asthmatic young children who see their doctors in POC could be more adherent to their physicians' advice about increasing their physical activities, in comparison to older asthmatic children. Well controlled asthma patients may have normal lives and they are recommended to increase their exercise to decrease their weights or to keep their weights within the normal range to avoid asthma exacerbations [27]. As a matter of fact, if a student's asthma is under well controlled, s/he can participate fully in any physical activity most of the time. Furthermore, there are many famous athletes who have had asthma and have succeeded because they followed their asthma action plans [26]. Moreover, Lang et al. concluded that children whose parents

believed exercise may alleviate their asthma symptoms tended to be highly active [13].

Our exclusion of sedentary activities aimed to focus on those activities that can be easily noticed and not be over-estimated or under-estimated and affect children's weights or inducing asthma. This hypothesis is supported by other studies which excluded low-MET activities, such as watching TV because they found that those activities contribute disproportionately to the total METs, which cause them to limit their consideration to activities which would obviously increase deep inspirations [18].

This study has a number of strengths. First, this was the first study up to our knowledge explored the shared impact of asthma and obesity on children's physical activities. There are many studies have studied either of those effect on children activities. However, we think, it is difficult to separate between asthma and obesity in the clinical setting and getting recommendation for asthmatics or obese children after controlling the other factor may not practical enough when it comes to talk with the parents about the best regimens for their children. Second, we studied the effect of asthma alone, obesity alone, and their shared effect on our participants and impact of age and gender on children moderate to vigorous physical activities. Third, most of the reviewed studies results showed that asthmatic or obese children tend to have lower levels of physical activities. However, the tools that are used to measure the physical activities are not detailed as ours. For instance, the Glazebrook's study asked the children 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)" [9]. Scores were added together to give a total score for both kinds of activities and higher scores indicating higher activity [5,9,25]. In comparison, the questionnaire used in this study examined the entire week of activities and the duration of time on average. The MET scores of the moderate and vigorous activities were then calculated only to exclude the sedentary ones such watching TV or doing home work which could be exaggerated by some parents and underestimated by others. For that purpose we used the CDC and ACSM guidelines for the definition of the activities, 3-6 METs are moderate and greater than 6 METs are vigorous. Fourth strength was that most of the reviewed studied depended only self-report questionnaire to assess the severity of asthma which could be subjected to recall bias. On the other hand, our study used both self-report questionnaire [5,25] and lung function test to evaluate the severity of asthma which gives more strength to this study.

Limitations: First, this study was a cross sectional retrospective study. Second, selection bias because all participants have been recruited from the outpatients clinic. We expect that those patients have medical insurance, better socioeconomic status, and high educational parents' statuses, so they are more committed to the doctors' recommendations regarding encouraging their children to increase their physical activities in order to lose weight and improve their respiratory symptoms especially in advanced stage, moderate to severe asthma and high BMI%. Third constrain was the low number of participants who filled the physical activity form 75 children (55%). Further research should be prospective and try to recruit participants from the whole community to reflect the real situation of physical activities of asthmatic and non-asthmatic children.

All in all, mild and severe asthmatic young children are more physically active than the mild and severe asthmatic older children. The established declines in the physical activity are more prevalent among the asthmatic children in this sample. Regardless of their asthma diagnosis, girls were less physically active than boys, in general.

The main implication of this study is to bring clinicians' attention to focus on the children who are less physically active. These findings provide additional evidence for working with older asthmatic children and girls as they age to improve their physical activity. Clinicians may wish to encourage these particular groups to be more active and inform them about the benefits of physical activities on the asthma symptoms and the health in general. Through clear understanding of the relationship between physical activity and asthma, weight status, age, and gender, this study may provide some guidelines for future intervention to target the most vulnerable groups in a way that can improve their current health statuses through designing a multidimensional view of different points available for intervention (e.g., behavior programs, medical intervention). Also, these results provide an opportunity to offer the building blocks parents could use to ensure their children maintain a healthy weight, gain the proper nutrients, and engage in activity that will reduce their risks of health problems as adults.

References Références Referencias

1. Belcher B, Berrigan D, Dodd K, et al. Physical activity in US youth: Impact of race/ethnicity, age, gender, & weight status. Medicine and science in sports and exercise 2010;42:2211
2. Byrne N, Hills A, Hunter G, et al. Metabolic equivalent: one size does not fit all. Journal of Applied physiology 2005; 99:1112-1119
3. Canöz M, Erdenen F, Uzun H, et al. The relationship of inflammatory cytokines with asthma and obesity. Clin Invest Med 2008; 31:E373-379
4. Castro-Rodríguez J. Relationship between Obesity and Asthma. Arch Bronconeumol 2007; 43:171-175

5. Chiang L, Huang J, Fu L.Physical activity and physical self-concept: comparison between children with and without asthma. J Adv Nurs 2006;54:653-662
6. Chinn S, Downs S, Anto J, et al. Incidence of asthma and net change in symptoms in relation to changes in obesity. Eur Respir J 2006;28:763-771
7. Delgado J, Barranco P, Quirce S. Obesity and asthma. J Investig Allergol Clin Immunol 2008; 18:420-425
8. Farah S, Salome C. Asthma and obesity: a known association but unknown mechanism. Respirology 2012;17:412-21
9. Glazebrook C, Mcpherson A, Macdonald I, et al. Asthma as a barrier to children's physical activity: implications for body mass index and mental health. Pediatrics 2006; 18:2443-9
10. Guerra S, Wright A, Morgan W, et al. Persistence of asthma symptoms during adolescence: role of obesity and age at the onset of puberty. Am J Respir Crit Care Med 2004;170:78-85
11. Hammer L, Kraemer H, Wilson D, et al. Standardized percentile curves of body-mass index for children and adolescents. Am J Dis Child 1991;145:259-263
12. Kajbaf T, Asar S, Alipoor M. Relationship between obesity and asthma symptoms among children in Ahvaz, Iran: a cross sectional study. Ital J Pediatr 2011;37:1
13. Lang D, Butz A, Duggan A, et al. Physical activity in urban school-aged children with asthma. Pediatrics 2004;113:e341-346
14. Luder, E. Obesity and Asthma. Adipose Tissue and Adipokines in Health and Disease: 2007;341-349
15. Mindell J, Holmes B. Physical activity. In: Nelson M, Erens B, Bates B, Church S, Boshier T, eds. Food Standards Agency. Low income diet and nutrition survey, Nutritional status Physical activity Economic, social and other factors. Vol 3. 1st ed. Edinburgh, UK: The Stationery Office 2007;101-129
16. Navarro B, Eslava A, Monge J. Relationship among obesity, asthma and pulmonary function. Bol Med Hosp Infant Mex 2011;68:157-168
17. 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
18. Ownby D, Peterson E, Nelson D, et al. 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
19. Peroni D, Pietrobelli A, Boner A. Asthma and obesity in childhood: on the road ahead. Int J Obes (Lond) 2010;34:599-605
20. Rundle A, Goldstein I, Mellins R, et al. Physical activity and asthma symptoms among New York City Head Start Children. J Asthma 2009;46:803-809
21. Schaub, B., von Mutius, E. Obesity and asthma, what are the links? Current opinion in allergy and clinical immunology 2005;5:185-193
22. Story R. Asthma and obesity in children. Current Opinion in Pediatrics 2007;19: 680–684
23. Strong W, Malina R, Blimkie C, et al. Evidence based physical activity for school-age youth. J Pediatr12005;46:732-737
24. Sutherland T, Cowan J, Young S, et al. The Association between Obesity and Asthma. Am J Respir Crit Care Med 2008;178:469–475
25. Tsai S, Ward T, Lentz M, et al. Daytime physical activity levels in school-age children with and without asthma. Nurs Res 2012;61:252-259
26. U.S. Department of Health and Human Service (2012) U.S. Department of Health and Human Service, National Institute of Health. Asthma and physical activity in the school: Making a difference http://www.nhlbi.nih.gov/health/public/lung/asthma/phy_asth.pdf Accessed June 13, 2013
27. Worsnop C. Asthma and physical activity. Chest Journal 2003;124:421-422