original article

The association between body mass index and frequency of emergency department visits and hospitalization for asthma exacerbation in a pediatric population

Ghadah Abdulrahman Alhekail,[a] Alaa Althubaiti,[a] Sulaiman AlQueflie[a,b]

From the [a]College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia; [b]Department of Pediatrics, King Abdullah Specialized Children's Hospital, Riyadh, Saudi Arabia

Correspondence: Dr. Ghadah Abdulrahman Alhekail · College of Medicine, King Saud bin Abdulaziz University for Health Sciences, PO Box 3660, Riyadh 11426, Saudi Arabia · T: +966502451666 · ghadahalhekail@gmail.com · ORCID: http://orcid.org/0000-0003-0571-6457

Ann Saudi Med 2017; 37(6): 415-419

DOI: 10.5144/0256-4947.2017.415

BACKGROUND: The prevalence of both asthma and obesity are increasing. Although some studies suggest an association between body mass index (BMI) and frequency of emergency department (ED) visits and hospitalization for asthma exacerbation, any association remains unproven.
OBJECTIVE: Estimate the frequency of asthma exacerbation in obese children, and identify any relationship between BMI and frequency of ED visits and hospitalization for asthma exacerbation.
DESIGN: Retrospective review of medical records.
SETTINGS: Tertiary children's hospital, Riyadh.
SUBJECTS AND METHODS: All children aged 2–15 years who attended the ED for asthma exacerbation between January 2015 and January 2016 were included. Children with comorbidities or undocumented asthma were excluded. The Centers for Disease Control and Prevention BMI-for-age growth charts for boys and girls aged 2 to 20 years were used to classify underweight, normal, overweight, and obese.
MAIN OUTCOME MEASURES: The frequency of ED visits and the rate, frequency, and duration of hospitalization.
RESULTS: Of the 1000 cases reviewed, 64.6% were boys and the mean age (standard deviation) of all subjects was 5.6 (3.3) years. The proportions of overweight and obese children was 11.8% and 12.1%, respectively. There was no association between increased BMI and frequency of ED visits for asthma exacerbation (P=.84), duration of hospitalization (P=.41) or frequency of hospitalization (P=.89).
CONCLUSION: There was no evidence of an association between BMI and frequency of ED visits and hospitalization for asthma exacerbation among children.
LIMITATIONS: This study included patients as young as 2 years, while asthma is only well-defined in children >5 years. Asthma triggers that can cause exacerbation despite body weight were not included. We included only frequency of ED visits and hospitalization, which may be inadequate to measure asthma severity.

Childhood obesity is a global health problem. In developed countries, 23.8% of boys and 22.6% of girls were either overweight or obese in 2013, and in developing countries, 12.9% for boys and 13.4% for girls in 2013 were either overweight or obese.[1] Likewise, the prevalence of childhood obesity is increasing in Saudi Arabia. A study showed that the prevalence of overweight, obesity, and severe obesity in children and adolescents from 5 to 18 years of age is 23.1%, 9.3%, and 2%, respectively.[2] Obesity is a major risk factor for several health diseases, such as type 2 diabetes mellitus, hypertension, and abnormal blood lipids. It also increases the risk of certain malignancies, such as endometrial, breast, and colonic carcinoma.[3]

Asthma is a chronic airway disease characterized by inflammation of the airway, bronchospasm, and hypersensitivity to various stimuli. It is estimated that

the lifetime prevalence of patient-reported clinician-diagnosed asthma in United Kingdom is 15.6%.[4] In Saudi Arabia, the prevalence of asthma in the general population is 4.05%.[5] Among schoolchildren between the ages of 8 and 16 years, it reaches 23%.[6]

Different studies suggest an association between asthma and increased BMI. Nahhas et al found that obesity is a risk factor for developing asthma in Saudi Arabia.[7] Some studies suggest that obesity is associated with poor asthma outcome and control.[8,9] However, the association between body mass index (BMI) and the frequency of emergency department (ED) visits for asthma exacerbation and hospitalization has not been studied in our population. Therefore, our study aimed to estimate the frequency of asthma exacerbation in pediatric patients of all BMI categories, and to identify the relationship between BMI and the frequency of ED visits and hospitalization for asthma exacerbation.

SUBJECTS AND METHODS

We retrospectively studied children who came to the ED for asthma exacerbation. The study included all children aged 2-15 for the 12-month period from January 2015 to January 2016 at King Abdullah S pecialist Children's Hospital, Riyadh, Saudi Arabia. Children with an undocumented diagnosis of bronchial asthma at presentation and children with comorbidities or genetic disorders were excluded. The approval of the Institutional Review Board was obtained from King Abdullah International Medical Research Center, Riyadh, Saudi Arabia.

We collected demographic data (gender, age, height, and weight), frequency of ED visits, frequency of hospitalization, and total days of hospitalization after the age of 2 years. Heights and weights were used to calculate BMI by the following formula: BMI=weight divided by height squared (kg/m^2). Subsequently, Centers for Disease Control and Prevention BMI-for-age growth charts for boys and girls aged 2 to 20 years were used to classify underweight, normal, overweight, or obese. Children below the 5th percentile were considered underweight, children from the 5th percentile to less than the 85th percentile were considered normal weight, children from the 85th to less than the 95th percentile were considered overweight, and children in the 95th percentile were considered obese. Collected data were entered into an Excel spreadsheet (Microsoft Office Excel 2011).

IBM SPSS version 24.0 (IBM Corporation, Armonk, NY, USA) was used for data analysis. Frequencies and percentages were used to describe categorical variables while mean (standard deviation) was used for continuous variables. Age was categorized as "Toddlers (2-3 years)", "Pre-school (>4-5)", "School (>6-12)" or "Teens (>13-15)". ED visits were categorized as "Once", "Twice", "3 times", "4-5 times", "6-8 times" or ">8". Hospitalization was categorized as "None", "One day" or "More than one day". Frequency of hospitalization was categorized as either "Once" or "Twice or more".

A chi-square test of association was used to determine the associations between BMI categories and frequency of ED visits, age groups, hospitalization duration and frequency of hospitalization. If differences were found, ANOVA followed by post hoc analysis was used to detect the differences within the groups. The Spearman's rank correlation coefficient or Spearman's rho was used to evaluate the association between BMI and frequency of ED visits and the association between BMI and hospitalization. All tests were considered statistically significant whenever P value ≤.05

RESULTS

Of 1302 patients, 1000 (77%) met the inclusion criteria. The mean (SD) age of the patients was 5.6 (3.3) years. The majority of the patients were male (64.6%, n=646) (**Table 1**). The mean (SD) of BMI was 17.1 (6.4) mg/kg^2. There was no significant difference in the frequency of ED visits for the different BMI groups (P=.84) (**Table 2**). The age groups were significantly (P<.001) different by BMI category (**Table 3**). Using ANOVA and post hoc analysis, no difference was found in age between those with normal or underweight BMI, but significant differences were found between overweight versus normal and underweight, obese versus overweight, and obese versus normal and underweight. However, there was no significant difference between BMI categories in duration (P=.41) and frequency of hospitalization (P= .894). The correlation between ED visits and BMI (correlation coefficient =-0.014, P=.662), and for BMI and hospitalization (correlation coefficient=0.011, P=.740) was not statistically significant.

DISCUSSION

Our study showed that the prevalence of overweight-obese children who presented to ED for asthma exacerbation was 24.1%. In a study conducted in the Philippines, 49% of patients who came to the ED with acute asthma exacerbation were overweight or obese.[10] In Carroll et al study, 22% of ED visits for

Table 1. Baseline characteristics of the patients (N=1000).

Characteristics	Levels	N	%
Gender	Male	646	64.6
	Female	354	35.4
Age groups	Toddlers (2-3)	387	38.7
	Pre-school (>4-5)	208	20.8
	School (>6-12)	353	35.3
	Teens (>13-15)	52	5.2
BMI	Underweight	223	22.4
	Normal	533	53.6
	Overweight	118	11.9
	Obese	121	12.2
ED visits	Once	418	41.8
	Twice	237	23.7
	3 times	115	11.5
	4-5 times	122	12.2
	6-8 times	70	7
	>8	38	3.8
Hospitalization	None	858	85.8
	One day	74	7.4
	More than one day	68	6.8
Frequency of hospitalization	Once	118	83.1
	Twice or more	24	16.9

BMI, body mass index; ED, emergency department.

asthma were overweight patients which is similar to our study.[11] In comparison, 70.8% of asthmatic adults who attended the pulmonary primary care clinic of King Khalid University Hospital were overweight-obese,[12] which was significantly higher than in our study. Overweight-obese children may be more likely to have persistent symptoms of asthma until adulthood, or asthmatic patients may be less likely to engage in physical activities to avoid triggering asthma.

The frequency of ED visits and hospitalization are important factors to determine the severity of asthma. ED visits affect the quality of life and health care utilization and are suggestive of poor asthma control. The impact of BMI on ED visits and hospitalization for asthma exacerbation has been controversial. Some studies suggest an association while others failed to find any association.[11,13-15]

Our findings demonstrated no association between BMI and frequency of ED visits for asthma exacerbation. A recent meta-analysis of 46 070 asthmatic children showed no significant association between overweight/obesity and ED visits, which supports our finding.[15] However, some studies have argued that increased BMI is associated with more unscheduled ED visits.[16,17] Belamarich et al interviewed caregivers for 1322 children aged 4 to 9 years who presented to ED for asthma exacerbation. Belamarich et al interviewed the caregivers of 1322 children aged 4-9 years who presented to the ED for asthma to determine whether obesity is associated with decreased peak expiratory flow rates, increased asthma symptoms, and increased health service use.[16] ED visits was one of the factors to determine the use of the health service. The data showed that obese children had more unscheduled ED visits. There are several ex-

Table 2. The association between body mass index category and emergency department visits.

ED visits	Underweight		Normal		Overweight		Obese	
	n	%	n	%	n	%	n	%
Once	90	21.6	227	54.6	51	12.3	48	11.5
Twice	51	21.7	120	51.1	30	12.8	34	14.5
3 times	32	28.1	60	52.6	10	8.8	12	10.5
4-5 times	29	23.8	62	50.8	13	10.7	18	14.8
6-8 times	15	21.4	40	57.1	8	11.4	7	10
>8	6	15.8	24	63.2	6	15.8	2	5.3

ED: emergency department; *P*=.84 (Pearson chi-square or linear-by-linear association).

Table 3. The association between body mass index category and age and duration and frequency hospitalizations.

Characteristics	Level	Underweight		Normal		Overweight		Obese		*P* value
		n	%	n	%	n	%	n	%	
Age groups	Toddlers	92	23.8	228	59.1	41	10.6	25	6.5	**<.001**
	Pre-school	57	27.5	122	58.9	14	6.8	14	6.8	
	School	66	18.9	170	48.6	48	13.7	66	18.9	
	Teens	8	15.4	13	25	15	28.8	16	30.8	
Duration of hospitalization	None	188	22	461	54	105	12.3	99	11.6	.41
	One day	20	27	35	47.3	5	6.8	14	18.9	
	>One day	15	22.1	37	54.4	8	11.8	8	11.8	
Frequency of hospitalization	Once	32	27.1	57	48.3	10	8.5	19	16.1	.894
	≥Twice	3	12.5	15	62.5	3	12.5	3	12.5	

Statistical analysis by Pearson chi-square or linear-by-linear association.

planations for the differences between Belamarich et al and our study. Belamarich et al included children aged 4 to 9 years. Our study included children aged 2 to 15 and was conducted in Riyadh, Saudi Arabia. On the other hand, Belamarich et al study was conducted in the United States (Bronx, NY; East Harlem, NY; St Louis, MO; Washington, DC; Baltimore, MD; Chicago, IL; Cleveland, OH; and Detroit, MI). The differences in climate and environmental factors can play a role in asthma exacerbation that can yield different results.[18,19] Belamarich et al compared normal weight and obese children only, excluding underweight children. Also, normal weight was considered between the 5th and 95th percentile but in our study normal weight was considered between 5th percentile and less than 85th percentile. In the Belamarich et al study, there may have been caregiver bias to overreport symptoms in obese patients, which may have affected the accuracy of results.

Our study also showed no association between BMI and frequency and duration of hospitalization. A meta-analysis by Ahmadizar showed no significant association between obesity and hospitalization.[15] However, Carroll et al found that overweight children were more likely to be admitted to the hospital than normal weight children.[11] In our study, we used BMI-for-age percentile growth charts. We calculated the BMI based on height and weight whereas Carroll et al used a weight-for-age percentile growth chart. They did not calculate BMI because of retrospective height data loss. Moreover, the ethnicities of the participants of the study by Carroll et al were Hispanic, black and white versus in contrast to the Saudi Arabian population examined in this study.[11] Borrell et al demonstrated that the relationship between BMI and asthma control could vary by race/ethnicity.[20] Different measurements and patient characteristics can yield different results.

Weight loss programs may improve asthma control, but there is inadequate evidence to support this hypothesis. Although a systematic review showed that weight loss could improve asthma control, most randomized control trials in this systematic review had small sample sizes. Further well-designed studies are needed to determine the impact of weight loss on asthma control.[21]

Our study has several limitations. First, there was lack of information about other factors that can indicate the severity of asthma between different BMI groups, such as lung function tests, types and doses of medications used, ICU admissions, and the frequency of daytime and night-time symptoms. Second, asthma is usually diagnosed in children >5 years. In our study, we included children as young as 2 years. Our study mainly depended on physician-diagnosed asthma. However, physicians can misdiagnose asthma. A study in Canada found that approximately one-third of obese and nonobese patients with physician-diagnosed asthma did not have asthma.[22] Misdiagnosis could have impacted our results. Information about triggers, such as environmental triggers and physical activity were not included in our data. Those triggers

can contribute to asthma exacerbation regardless of the BMI.

Our study suggests that BMI is not a predictor for more frequent ED visits for asthma exacerbation and hospitalization. However, further studies should be attempted in multiple cities in Saudi Arabia to confirm this finding.

Acknowledgments

The authors gratefully acknowledge Dr. Abdullah Almojali for his contribution in data analysis. The authors also thank KAIMRC Publication Office for editing the manuscript.

Conflict of interest

None.

REFERENCES

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384(9945):766-81.
2. El Mouzan MI, Foster PJ, Al Herbish AS, Al Salloum AA, Al Omer AA, Qurachi MM, et al. Prevalence of overweight and obesity in Saudi children and adolescents. Ann Saudi Med. 2010;30(3):203-8.
3. Pi-Sunyer X. The Medical Risks of Obesity. Postgrad Med. 2009;121(6):21-33.
4. Mukherjee M, Stoddart A, Gupta RP, Nwaru BI, Farr A, Heaven M, et al. The epidemiology, healthcare and societal burden and costs of asthma in the UK and its member nations: analyses of standalone and linked national databases. BMC Med. 2016;14(1):1-15.
5. Moradi-Lakeh M, El Bcheraoui C, Daoud F, Tuffaha M, Kravitz H, Al Saeedi M, et al. Prevalence of asthma in Saudi adults: Findings from a national household survey, 2013. BMC Pulm Med. 2015;15:77.
6. Al Frayh a R, Shakoor Z, Gad El Rab MO, Hasnain SM. Increased prevalence of asthma in Saudi Arabia. Ann Allergy Asthma Immunol. 2001;86(3):292-6.
7. Nahhas M, Bhopal R, Anandan C, Elton R, Sheikh A. Investigating the association between obesity and asthma in 6- to 8-year-old Saudi children: a matched case–control study. npj Prim Care Respir Med. 2014;24(1):14004.
8. Mosen DM, Schatz M, Magid DJ, Camargo CA. The relationship between obesity and asthma severity and control in adults. J Allergy Clin Immunol. 2008;122(3):507-11.e6.
9. Quinto KB, Zuraw BL, Poon K-YT, Chen W, Schatz M, Christiansen SC. The association of obesity and asthma severity and control in children. J Allergy Clin Immunol. 2011;128(5):964-9.
10. De Vera MJB, Gomez MC, Yao CE. Association of obesity and severity of acute asthma exacerbations in Filipino children. Ann Allergy, Asthma Immunol. 2016;117(1):38-42.
11. Carroll CL, Stoltz P, Raykov N, Smith SR, Zucker AR. Childhood Overweight Increases Hospital Admission Rates for Asthma. Pediatrics. 2007;120(4):734-40.
12. BinSaeed AA. Asthma control among adults in Saudi Arabia study of determinants. Saudi Med J. 2015;36(5):599-604.
13. Hom J, Morley EJ, Sasso P, Sinert R. Body mass index and pediatric asthma outcomes. Pediatr Emerg Care. 2009;25(9):569-71.
14. Luder E, Melnik TA, Dimaio M. Association of being overweight with greater asthma symptoms in inner city black and Hispanic children. J Pediatr. 1998;132(4):699-703.
15. Ahmadizar F, Vijverberg SJH, Arets HGM, De Boer A, Lang JE, Kattan M, et al. Childhood obesity in relation to poor asthma control and exacerbation: A meta-analysis. Eur Respir J. 2016;48(4):1063-73.
16. Belamarich PF, Luder E, Kattan M, Mitchell H, Islam S, Lynn H, et al. Do obese inner-city children with asthma have more symptoms than nonobese children with asthma? Pediatrics. 2000;106(6):1436-41.
17. Sah PK, Teague WG, Demuth KA, Whitlock DR, Brown SD, Fitzpatrick AM. Poor Asthma Control in Obese Children May Be Overestimated Because of Enhanced Perception of Dyspnea. J Allergy Clin Immunol Pract. 2013;1(1):39-45.e2.
18. Wisniewski JA, McLaughlin AP, Stenger PJ, Patrie J, Brown MA, El-Dahr JM, et al. A comparison of seasonal trends in asthma exacerbations among children from geographic regions with different climates. Allergy Asthma Proc. 2016;37(6):475-81.
19. Brozek G, Lawson J, Shpakou A, Fedortsiv O, Hryshchuk L, Rennie D, et al. Childhood asthma prevalence and risk factors in three Eastern European countries--the Belarus, Ukraine, Poland Asthma Study (BUPAS): an international prevalence study. BMC Pulm Med. 2016;16(11):11.
20. Borrell LN, Nguyen EA, Roth LA, Oh SS, Tcheurekdjian H, Sen S, et al. Childhood obesity and asthma control in the GALA II and SAGE II studies. Am J Respir Crit Care Med. 2013;187(7):697-702.
21. Adeniyi FB, Young T. Weight loss interventions for chronic asthma. Cochrane database Syst Rev. 2012;7(7):CD009339.
22. Aaron SD, Vandemheen KL, Boulet LP, McIvor RA, FitzGerald JM, Hernandez P, et al. Overdiagnosis of asthma in obese and nonobese adults. CMAJ. 2008;179(11):1121-31.