

Burden of Obesity on Pediatric Inpatients with Acute Asthma Exacerbation in the United States



Yusuke Okubo, MD, MPH^{a,b}, Kotaro Nochioka, MD, PhD^{a,c}, Hiroshi Hataya, MD^b, Hiroshi Sakakibara, MD^b, Toshiro Terakawa, MD^b, and Marcia Testa, PhD, MPhil^d *Boston, Mass; and Tokyo, Japan*

What is already known about this topic? Obesity could be a potential risk factor of morbidity and mortality for pediatric patients with asthma; however, the effects of obesity on asthma in children were inconsistent in the previous studies.

What does this article add to our knowledge? Obesity contributed to a higher odds ratio of mechanical ventilation, and a gap of hospital charges between obese and nonobese inpatients with pediatric asthma in 2012.

How does this study impact current management guideline? More attention should be paid to control weight for pediatric patients with asthma, because obesity could be a risk factor of morbidity and an economically complicating factor for pediatric patients with asthma.

BACKGROUND: Obesity and asthma are common health problems in the United States.

OBJECTIVE: The objective of this study was to evaluate the clinical and economic burdens of obesity on hospitalized children with acute asthma exacerbation in 2012.

METHODS: Hospital discharge records of patients aged 2 to 18 years with a diagnosis of asthma were obtained from the 2012 Kids' Inpatient Database, wherein the data were compiled by the Agency for Healthcare Research and Quality. The discharge records were weighted to estimate the number of hospitalizations because of asthma exacerbations in the United States. To classify whether the patient was obese or not, we used the International Classification of Diseases, Ninth Revision, Clinical Modification code 278.0x. We compared the odds of using noninvasive or invasive mechanical ventilation, mean total charges for inpatient service, and length of hospital stay between obese and nonobese patients.

RESULTS: A total of 74,338 patient discharges were extracted. Of these, 3,494 discharges were excluded because of chronic medical conditions. Using discharge weight variables, we estimated a total of 100,157 hospitalizations with asthma

exacerbations among children aged between 2 and 18 years in 2012. Obesity was significantly associated with higher odds of using mechanical ventilation (odds ratio 1.59, 95% CI 1.28-1.99), higher mean total hospital charges (adjusted difference: \$1588, 95% CI \$802-\$2529), and longer mean length of hospital stay (0.24 days, 95% CI 0.17-0.32 days) compared with nonobesity.

CONCLUSIONS: These findings suggest that obesity is a significant risk factor of severe asthma exacerbation that requires mechanical ventilation, and obesity is an economically complicating factor. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;4:1227-31)

Key words: Asthma; Cost; Invasive; Ventilation; Obesity

Asthma and obesity are the most common chronic illness and public health problems of children in the United States. The prevalence of obesity is increasing, and several studies have demonstrated an association between obesity and asthma in children.¹⁻⁸

Obesity could be a potential complicating factor with respect to the treatment and control for asthma. Obese children with asthma exhibited a poor control pertaining to asthma and greater need of albuterol and oral corticosteroids for acute exacerbation, were hospitalized more often, showed a decreased response to inhaled corticosteroids, and had a lower quality of life compared with nonobese children with asthma.⁹⁻¹² Obese children with severe asthma recovered more slowly from severe asthma exacerbation in the pediatric intensive care unit compared with nonobese children with severe asthma.¹³ However, several studies demonstrated the inconsistent results,¹⁴⁻¹⁶ and the association between obesity and severity of acute exacerbation remains unclear.

This study aimed to investigate the association between obesity and the use of mechanical ventilation for inpatients with asthma exacerbation based on the 2012 Kids' Inpatient Database (KID). In addition, we evaluated the incremental hospitalization

^aQuantitative Methods, Harvard T.H. Chan School of Public Health, Boston, Mass

^bDepartment of General Pediatrics, Tokyo Metropolitan Children's Medical Center, Fuchu, Tokyo, Japan

^cClinical Effectiveness, Harvard T.H. Chan School of Public Health, Boston, Mass

^dDepartment of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, Mass

No funding was received for this work.

Conflicts of interest: The authors declare that they have no relevant conflicts of interest.

Received for publication March 25, 2016; revised May 25, 2016; accepted for publication June 7, 2016.

Available online June 30, 2016.

Corresponding author: Yusuke Okubo, MD, Tokyo Metropolitan Children's Medical Center, 2-8-29 Musashidai, Fuchu, Tokyo 183-8561, Japan. E-mail: sunning_dale@yahoo.co.jp.

2213-2198

© 2016 American Academy of Allergy, Asthma & Immunology

<http://dx.doi.org/10.1016/j.jaip.2016.06.004>

Abbreviations used

AD- Atopic dermatitis or eczema
 AR- Allergic rhinitis
 DISCWT- Discharge weight variables
 FA- Food allergy
 ICD-9CM- International Classification of Diseases, Ninth Revision, Clinical Modification
 KID- Kids' Inpatient Database
 LOS- Length of stay
 OR- Odds ratio
 OSA- Obstructive sleep apnea

charges and length of hospital stay between obese and nonobese patients, compared with the charges and length of stay in 2000 and 2003.^{17,18}

METHODS**Study population and participation**

We conducted a retrospective cohort study comprising hospitalized patients with asthma exacerbation aged between 2 and 18 years based on a national representative database (KID) for the year 2012, wherein the data were compiled by the Agency for Healthcare Research and Quality.^{19,20} KID is a large national all-payer hospital pediatric discharge database. It is designed to generate robust national estimates of annual pediatric hospitalizations and present hospital use, outcome, and cost for children aged 20 years or younger. The KID sampling frame was constructed based on all the short-term, nonfederal, general, and specialty hospitals in the United States that had more than 3 million pediatric discharges from 44 states that participated in the Healthcare Cost and Utilization Projects. Discharge weight variables (DISCWT) in KID were developed using American Hospital Association target universe as the standard to produce national or regional estimates of pediatric hospitalizations.¹⁷⁻²⁰ We used DISCWT for all statistical analyses in this study to obtain the national estimates of hospitalizations in the United States.

Hospitalization discharge records were extracted from the KID database in 2012, and hospitalizations with acute asthma exacerbation were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9CM) code (493.xx) in the primary diagnosis field, and weighted to estimate the number of hospitalizations for the United States. Children with chronic medical conditions other than asthma and obesity (congenital heart, kidney, pulmonary, endocrine, hematologic, gastrointestinal, and neurologic diseases; cancer or leukemia; and autoimmune disease) were excluded.

Measurements of variables

Obesity was identified using ICD-9CM codes 278.0x in the secondary diagnosis fields in the discharge records. These codes captured obesity unspecified (278.00), overweight (278.01), and morbid obesity (278.02). Age categories (2-6 years, 7-12 years, or 13-18 years), gender (male or female), race/ethnicity (black, Hispanic, white, or others [Asian and Pacific Islanders, Native Americans, and other race/ethnicity]), primary payer information (private or self-pay, Medicare or Medicaid, no insurance or no information), comorbidities of obstructive sleep apnea (OSA), allergic rhinitis (AR), atopic dermatitis or eczema (AD), and food allergy (FA) were collected as binary or categorical covariates.

Outcomes

The outcomes of interest were total charge for inpatient service in 2012 US dollars, length of hospital stay, and use of mechanical ventilation (noninvasive or invasive). Use of mechanical ventilation was identified by the ICD-9 procedure codes 93.90 and Clinical Classification Software code 216.

Statistical analysis

Descriptive statistics, including mean $\pm$ SD, and frequencies for continuous and categorical data were analyzed for all patients with obesity. A two-sample *t*-test and χ^2 test were used to compare characteristics of obese and nonobese patients. We conducted a multivariable logistic regression to identify the association between obesity and the use of mechanical ventilation. Multiple linear regression was used to assess the relationships between obesity and mean total charge for inpatient services and length of hospital stay. For the adjustment, we added all variables listed above (age, gender, race/ethnicity, primary payer information, comorbidities of OSA, AR, AD, FA, types of admission, and hospital size) into the logistic and linear regression models. For the analysis, the log transformations of total charges and length of hospital stay were necessary to ensure the validity of the error-term normality assumption. Results were adjusted for covariates and reported with 95% confidence intervals. Two-sided *P* < .05 was considered statistically significant for all tests. Data were analyzed using Stata version 14.1 (StataCorp LP, College Station, Tex).

RESULTS

We identified a total of 74,338 patient discharges for acute asthma exacerbations in 2012. Of these, 3,494 discharges were excluded because of chronic medical conditions other than asthma and obesity. Data were analyzed from the remaining 70,844 discharges. Using DISCWT, we estimated a total of 100,157 hospitalizations with asthma exacerbations among children aged between 2 and 18 years in the entire United States, 2012. The patient characteristics for obesity are summarized in Table I. Obesity accounted for 3.58% of all hospitalized children. Obese children had a higher mean age than nonobese children. Compared with white children, the proportion of obesity was significantly greater in black and Hispanic children (*P* < .001), and black children had the highest proportion of obesity. There was a statistically significant difference in the proportion of obese patients with respect to gender, race/ethnicity, and primary payer information. Obese children had higher frequencies of comorbidities such as OSA, FA, AD, and AR.

We used a multivariable logistic regression to analyze the odds of using a mechanical ventilator, comparing obese and nonobese children. The crude odds ratio (OR) of noninvasive or invasive mechanical ventilation comparing obese and nonobese children was 3.22. After adjusting for covariates, the OR remained significant (OR 1.59, 95% CI 1.28-1.99, *P* < .001).

To identify total charges for inpatient service and length of stay (LOS) in hospitals, multiple linear regression analyses were performed with and without adjustment for covariates. Crude analysis showed that mean total charges for inpatient service among obese children were \$3445 higher than those for inpatient service among nonobese children (95% CI \$2471-\$4576, *P* < .001). After adjustment for covariates, the difference was \$1588 (95% CI \$802-\$2529, *P* < .001). Based on crude analysis, the LOS for obese children was 0.41 days longer than

TABLE I. The patient characteristics between obesity and nonobesity by age, gender, race/ethnicity, past medical history, and primary payer information

	Total	Obese	No obese	P value
Total	100,157	3,584	96,573	
Mean age (SD)	6.70 (6.64-6.76)	10.6 (10.4-10.8)	6.6 (6.5-6.6)	<.001
Age 2-6 y	55,524 (54%-56%)	640 (16%-20%)	54,884 (57%)	
Age 7-12 y	33,976 (32%-35%)	1,764 (44%-55%)	32,213 (33%-34%)	
Age 13-18 y	10,657 (10%-11%)	1,180 (30%-36%)	9,476 (10%)	<.001
Female	38,421 (38%)	1,644 (41%-51%)	36,777 (38%)	<.001
Race/ethnicity				
Hispanic	20,902 (19%-23%)	911 (22%-30%)	19,991 (21%)	
Black	34,203 (32%-37%)	1,406 (35%-44%)	32,797 (34%)	
Whites	30,126 (28%-32%)	750 (19%-23%)	29,377 (30%-31%)	
Others	14,295 (12%-18%)	517 (13%-17%)	14,407 (15%)	<.001
Past medical history				
OSA	914 (0.8%-1.0%)	458 (12%-14%)	456 (0.4%-0.5%)	<.001
FA	4,957 (4%-6%)	200 (4%-7%)	4,757 (5%)	<.001
AD	11,104 (10%-12%)	500 (12%-16%)	10,603 (11%)	<.001
AR	2,555 (2%-3%)	182 (4%-6%)	2,372 (2%)	<.001
Primary payer information				
Private/self-pay	37,154 (35%-39%)	1,041 (26%-33%)	36,112 (37%-38%)	
Medicare/Medicaid	59,483 (58%-61%)	2,430 (62%-74%)	57,053 (59%)	
No or others	3,521 (3%-4%)	113 (2%-4%)	3,407 (3%-4%)	<.001

AD, Atopic dermatitis or eczema; AR, allergic rhinitis; FA, food allergy; OSA, obstructive sleep apnea; SD, standard deviation.

that for nonobese children (95% CI 0.33-0.49, $P < .001$). Adjusted analysis revealed that the LOS for obese children was 0.24 days longer than that for nonobese children (95% CI 0.17-0.32, $P < .001$).

We conducted subgroup analysis to assess the effects of obesity on the use of mechanical ventilation by age, gender, and comorbidities of OSA, AR, AD, and FA (Table II). We observed no interaction between obesity and age, gender, comorbidities of OSA, AR, and FA. In terms of the effect of obesity on total charges of inpatient service, there was an only significant interaction between obesity and age ($P = .02$) (Table III).

DISCUSSION

We investigated the burden of obesity on asthma exacerbation in a pediatric inpatient population based on a nationally representative database, KID, in 2012.^{19,20} To the best of our knowledge, this is the first report demonstrating that obese children showed significantly higher odds of requiring mechanical ventilation than nonobese children. Hospitalized obese children showed higher mean total charges and longer LOS in hospitals than nonobese children.

Our study revealed that obesity was significantly associated with the use of mechanical ventilation among hospitalized children with acute asthma exacerbation. Several studies have previously indicated that obesity was associated with increased airway obstruction and inflammation in patients with asthma.²¹⁻²⁵ These previous studies support our findings that obesity leads to an altered pulmonary physiology and greater illness severity, resulting in the use of mechanical ventilation.

The prevalence of obesity and the frequency of obesity-associated hospitalizations continue to grow, and the economic burden of obesity is increasing even among children and

adolescents.^{26,27} However, the economic effects of obesity on pediatric asthma are still controversial.²⁷ Bettenhausen et al²⁷ reported that total charges for inpatient service of status asthmaticus were not significantly different between obese and nonobese children. On the other hand, Woolford et al^{13,17} found that the mean total hospital charges for obese inpatients with asthma were significantly higher than those for nonobese inpatients with asthma (difference: \$1963 in 2000, \$2145 in 2003) using KID. Our results showed that the difference of total charges between obesity and nonobesity in 2012 (\$1588) was significant; however, the difference was smaller than those in 2003 and 2000.^{13,17} The negative results by Bettenhausen et al could be explained by relatively small sample sizes from a few hospitals in a small area compared with our studies from KID, which allowed us to estimate hospitalizations in the entire United States.

A previous study reported that several factors, such as OSA, gender, older age, and obesity, were significantly associated with prolonged length of hospital stay for patients with asthma exacerbation.²⁸ We found that obese children hospitalized with asthma were more likely to stay at the hospital longer than nonobese children (adjusted difference of mean LOS: 0.24 [0.17-0.32] days). The difference of mean LOS between obesity and nonobesity in our study was similar to Woolford's results; however, the difference in 2012 was smaller than that in 2003 (0.44 days) and in 2000 (0.59 days). These incremental differences between total charges and LOS may be explained by evaluation or nutrition consultations related to obesity, the technical difficulty and complexity of procedures such as intravenous catheter placement and airway management, complications such as secondary infections, and greater severity of asthma.

There are some limitations to this study. The number of hospitalization may have been overestimated because of the

TABLE II. Sensitivity analysis for the effects of obesity on ORs of use of mechanical ventilation with respect to age, gender, OSA, AR, AD, and FA

	Obese (%)	Nonobese (%)	Adjusted OR	95% CI	P value
Age					
2-6 y	22/640 (3.5)	622/54,884 (1.1)	2.42	1.43-4.09	
7-12 y	77/1,764 (4.4)	611/32,213 (1.9)	1.62	1.18-2.20	
12-18 y	82/1,180 (7.0)	339/9,476 (3.6)	1.42	1.01-1.99	.56
Gender					
Male	97/1,941 (5.0)	900/59,795 (1.5)	1.55	1.18-2.04	
Female	84/1,644 (5.1)	671/36,777 (1.8)	1.73	1.19-2.49	.45
Obstructive sleep apnea					
OSA	75/458 (16.3)	27/456 (5.9)	3.33	1.45-4.29	
No OSA	107/3,126 (3.4)	1,544/96,117 (1.6)	1.48	1.12-1.98	.45
Allergic rhinitis					
AR	16/182 (9.0)	46/2,372 (1.9)	3.33	1.31-8.46	
No AR	165/3,402 (4.9)	165/94,200 (0.2)	1.53	1.22-1.93	.16
Eczema or atopic dermatitis					
AD	15/500 (3.0)	173/10,603 (1.6)	1.69	1.32-2.16	
No AD	211/3,084 (6.8)	1,751/85,969 (2.0)	1.18	0.66-2.12	.03
Food allergy					
FA	14/200 (7.0)	135/4,757 (2.8)	1.42	0.74-2.73	
No FA	167/3,384 (4.9)	1,436/91,816 (1.6)	1.62	1.29-2.04	.49

AD, Atopic dermatitis or eczema; AR, allergic rhinitis; CI, confidence interval; FA, food allergy; OR, odds ratio; OSA, obstructive sleep apnea; SD, standard deviation.

TABLE III. Sensitivity analysis for the differences of total charges between obesity and nonobesity by age, gender, OSA, AR, AD, and FA

	Obese (mean)	No obese (mean)	Adjusted difference	95% CI	P value
Age					
2-6 y	\$12,942	\$9,394	\$2,187	\$1,208-\$3,356	
7-12 y	\$14,173	\$11,225	\$1,688	\$740-\$2,835	
12-18 y	\$13,229	\$11,751	\$594	\$-98-\$1,429	.02
Gender					
Male	\$13,585	\$10,001	\$1,723	\$838-\$2,775	
Female	\$13,695	\$10,506	\$1,514	\$629-\$2,560	.19
Obstructive sleep apnea					
OSA	\$19,220	\$15,045	\$3,755	\$1,245-\$7,799	
No OSA	\$12,964	\$10,172	\$1,549	\$740-\$2,499	.65
Allergic rhinitis					
AR	\$12,490	\$10,538	\$918	\$-835-\$3,717	
No AR	\$13,698	\$10,182	\$1,612	\$840-\$2,515	.36
Atopic dermatitis					
AD	\$14,149	\$11,127	\$1,389	\$-107-\$3,435	
No AD	\$13,553	\$10,082	\$1,624	\$864-\$2,510	.25
Food allergy					
FA	\$15,849	\$12,043	\$1,101	\$-669-\$3,734	
No FA	\$13,516	\$10,105	\$1,616	\$851-\$2,509	.56

AD, Atopic dermatitis or eczema; AR, allergic rhinitis; CI, confidence interval; FA, food allergy; OSA, obstructive sleep apnea.

inclusion of hospitalizations for children who may not have had asthma, but may have had bronchitis or pneumonia. Detailed clinical information such as baseline severity and use of medication was unknown in the database. Possible miscoding or misclassification of obesity may have underestimated the total number of inpatients with obesity, and the effects of obesity on the outcomes of interest may be biased, although the proportion

of obesity in our study (3.6%) was higher than those in Woolford's results (1.4% in 2000 and 2.1% in 2003). A unique feature of this study was the use of KID, a national pediatric inpatient database, to examine asthma hospitalizations among children in the United States. On the basis of KID, we were able to calculate robust national estimates of asthma hospitalizations and the burden of obesity on hospitalized patients with asthma.

In summary, obesity was significantly associated with severity for pediatric inpatients with asthma exacerbation as demonstrated by increased risk for ventilation, length of hospital stay, and hospital charges. Our analysis indicated a gap of incremental hospital charges between obese and nonobese inpatients with asthma. These findings illustrate the importance of the prevention of obesity for both clinicians and health care payers.

Acknowledgment

We thank Dr Woods, at the division of adolescent/young adult medicine in Boston Children's Hospital for her helpful advice on the interpretation for the statistical analysis and implication for clinical situations.

REFERENCES

1. Flegal KM, Carroll MD, Kit BK, Oden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA* 2012; 397:491-7.
2. Ford E. The epidemiology of obesity and asthma. *J Allergy Clin Immunol* 2005; 115:897-909.
3. Boulet LP. Asthma and obesity. *Clin Exp Allergy* 2013;43:8-21.
4. Litonjua A, Gold D. Asthma and obesity: common early-life influences in the inception of disease. *J Allergy Clin Immunol* 2008;121:1075-84.
5. Dixon A, Holguin F, Sood A, Salome CM, Pratley RE, Beuther DA, et al. An official American Thoracic Society Workshop report: obesity and asthma. *Proc Am Thoracic Soc* 2010;7:325-35.
6. 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;106:1436-41.
7. Rzehak P, Wijga AH, Keil T, Eller E, Bindslev-Jensen C, Smit HA, et al. Body mass index trajectory classes and incident asthma in childhood: results from 8 European Birth Cohorts—a Global Allergy and Asthma European Network initiative. *J Allergy Clin Immunol* 2013;131: 1528-36.
8. Chen YC, Dong GH, Lin KC, Lee YL. Gender difference of childhood overweight and obesity in predicting the risk of incident asthma: a systematic review and meta-analysis. *Obes Rev* 2013;14:222-31.
9. Forno E, Lescher R, Strunk R, Wessis S, Fuhlbrigge A, Celedón JC. Childhood Asthma Management Program Research Group. Decreased response to inhaled steroids in over weight and obese asthmatic children. *J Allergy Clin Immunol* 2011;127:741-9.
10. Quinto K, Zuraw B, Poon KT, Chen W, Schatz M, Christiansen S. The association of obesity and asthma severity and control in children. *J Allergy Clin Immunol* 2011;128:964-9.
11. Borrell L, Nguyen E, Roth A, 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;187:697-702.
12. Carroll CL, Stoltz P, Raykov N, Smith SR, Zucker AR. Childhood overweight increases hospital rates for asthma. *Pediatrics* 2007;120:734-40.
13. Woolford SJ, Gebremariam A, Clark SJ, Davis MM. Incremental hospital charges associated with obesity as a secondary diagnosis in children. *Obesity (Silver Spring)* 2007;15:1895-901.
14. Carroll CL, Schramm CM, Zucker AR. Severe exacerbations in children with mild asthma: characterizing a pediatric phenotype. *J Asthma* 2008;45:513-7.
15. Lang JE, Hossain J, Smith K, Lima JJ. Asthma severity, exacerbation risk, and controller treatment burden in underweight and obese children. *J Asthma* 2012; 49:456-63.
16. Hom J, Morley EJ, Sasso P, Sinert R. Body mass index and pediatric asthma outcomes. *Pediatr Emerg Care* 2009;25:569-71.
17. Woolford SJ, Gebremariam A, Clark SJ, Davis MM. Persistent gap of incremental charges for obesity as a secondary diagnosis in common pediatric hospitalizations. *J Hosp Med* 2009;4:149-56.
18. Carroll CL, Bhandari A, Zucker AR, Schramm CM. Childhood obesity increases duration of therapy during severe asthma exacerbations. *Pediatr Crit Care Med* 2006;7:527-31.
19. Witt WP, Weiss AJ, Elixhauser A. Overview of hospital stays for children in the United States, 2012: Statistical Brief #187. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs [Internet]. Rockville, Md: Agency for Healthcare Policy and Research; 2006 Feb.-2014 Dec.
20. HCUP Kids' Inpatient Database Comparison Report. Healthcare Cost and Utilization Project Agency for Healthcare Research and Quality. Available from <https://www.hcup-us.ahrq.gov/kidoverview.jsp>. Accessed February 20, 2016.
21. Strunk RC, Colvin R, Bacharier LB, Fuhlbrigge A, Fomo E, Arbelaez AM, et al. Airway obstruction worsens in young adults with asthma who become obese. *J Allergy Clin Immunol Pract* 2015;3:765-71.
22. Weinmayr G, Forastiere F, Büchele G, Jaensch A, Strachan DP, Nagel G. ISAAC Phase Two Study Group. Overweight/obesity and respiratory and allergic disease in children: international study of asthma and allergies in childhood (ISAAC) phase two. *PLoS One* 2014;9:e113996.
23. Peters J, McKinney J, Smith B, Wood P, Forkner E, Galbreath A. Impact of obesity in asthma: evidence from a large prospective disease management study. *Ann Allergy Asthma Immunol* 2011;106:30-5.
24. Chen Y, Home S, Dosman J. Body weight and weight gain related to pulmonary function decline in adults: a six year follow up study. *Thorax* 1993;48:375-80.
25. Fantuzzi G. Adipose tissue, adipokines, and inflammation. *Molecular mechanisms in allergy and clinical immunology*. *J Allergy Clin Immunol* 2005;115:911-9.
26. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. *Pediatrics* 2002;109:E81-1.
27. Bettenhausen J, Puls H, Queen MA, Peacock C, Burrus S, Miller C, et al. Childhood obesity and in-hospital asthma resource utilization. *J Hosp Med* 2015;10:160-4.
28. Shanley LA, Lin H, Flores G. Factors associated with length of stay for pediatric asthma hospitalizations. *J Asthma* 2015;52:471-7.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.