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Impact of Obesity on Asthma Morbidity During a Hospitalization

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Abstract

Background—Asthma and obesity are two common pediatric problems. Obesity is a known risk factor for asthma, and obese children with asthma have higher disease burden. However, little is known on how obesity, in urban minority children, composed mainly of Hispanic and Black children, impacts morbidity during pediatric asthma hospitalizations.

Methods—A retrospective chart review was conducted on children age 2 to 18 years hospitalized at the Children's Hospital at Montefiore for an acute asthma exacerbation. We elucidated the association of overweight/obese status with severity of the exacerbation, quantified by length of stay (LOS), and need for intensive care management. Multivariate analysis was conducted to identify independent predictors of length of stay.

Results—Nine hundred and seventy-five children met the inclusion criteria, of whom 55% were normal weight and 45% were overweight/obese. Sixty percent of the cohort was Hispanic and 37% was non-Hispanic African American. The overall average LOS was 2.57 days (range 0.67–12.92). Overweight/obese status was associated with a higher asthma severity at baseline (p=0.021). Overweight/obese children had a longer average LOS compared to normal weight children (2.75 vs. 2.39 days, p<0.01) with more pediatric intensive care unit (PICU) stays (p=0.006), even after adjustment for higher baseline asthma severity. The severity of the exacerbation did not differ by ethnicity.

Conclusion—Obesity in children hospitalized for asthma is associated with more severe asthma exacerbations, longer LOS, and increased utilization of PICU level care, independent of their higher baseline disease severity and ethnicity.

Table of Contents Summary

Obesity and asthma are common pediatric problems. Obese children hospitalized for asthma have more severe exacerbations than normal weight children, independent of their higher baseline asthma severity.

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Introduction

Asthma and obesity are two of the most common chronic pediatric diseases in the United States (U.S.).[1–3] Among children in the U.S. under 18 years of age in 2014, asthma prevalence was 13.4% in African Americans and 8.5% in Hispanics (23.5% in Puerto Ricans).[4] For children 2 to 19 years of age in 2011–2014, 21.9% of Hispanics and 19.5% of African Americans were obese, compared to 14.5% of non-Hispanic whites.[5] Thus, the disease burden of both asthma and obesity is borne disproportionately by minority children, [3,6] likely due to socioeconomic and environmental factors that co-exist with genetic propensity.[1,2,7]

Several studies have identified an association between obesity and asthma among children. [8,9] Children and adults who are obese have an increased risk of developing asthma [10–12] and tend to have more symptoms with worse lung function.[13,14] Obese asthmatic children also have decreased response to controller medications,[15–20] and require more beta agonists and oral steroids with an exacerbation.[21] Additionally, the number of pediatric hospitalizations for obesity-related conditions has almost doubled over the last decade.[22–24]

To better define the role of obesity in asthma morbidity, a few studies have examined its impact on the severity of an asthma exacerbation associated with a hospitalization. Studies that used billing codes to classify obesity and asthma have consistently found longer length of stay (LOS) among obese children that are associated with higher health care costs.[25–27] On the other hand, studies that used body mass index (BMI) percentiles have reported disparate results. While Okubo et al. reported longer LOS among obese children with asthma, Bettenhausen et al. failed to identify such an association.[28,29] In a study confined to children hospitalized in the pediatric intensive care unit (PICU), obese children were slower to recover and had longer LOS.[30] Similar discrepancies were observed for the association of baseline asthma severity with severity of asthma exacerbation and need for an intensive care unit admission in obese children.[30] Additionally measures including need for terbutaline or aminophylline or non-invasive ventilation have not been investigated in these studies.[30] Further, the majority of these studies conducted in urban minority children included African Americans with only small percentages of Hispanic limiting the generalizability of the information to Hispanic children. Taken together, these studies highlight gaps in current literature on the impact of obesity as determined by BMI percentiles on an urban minority population, comprised of both African American and Hispanic children who bear a disproportionately higher asthma burden.

To address these gaps, we proposed to investigate the impact of obesity, defined by BMI percentiles, on several measures of severity of an asthma exacerbation during hospitalization and on the hospital course in an urban minority population, comprised of both Hispanic and African American children, those most affected by both asthma and obesity.[31] We hypothesized that obesity defined by BMI percentiles would be associated with higher severity of asthma exacerbation among urban minority children hospitalized for asthma.

Methods

Study population

A retrospective chart review was performed using a prospectively maintained clinical research database (Clinical Looking Glass) which was queried to identify children ages 2–18 years admitted to Children's Hospital at Montefiore with a diagnosis of status asthmaticus or asthma exacerbation, defined using ICD-9 codes(493.XX), between January 1, 2012 and December 31, 2014. Exclusion criteria included co-existing chronic cardiopulmonary disease, cystic fibrosis, Trisomy 21, immunodeficiency or organ transplant, neuromuscular disease, inflammatory bowel disease, sickle cell disease, chronic lung disease requiring medication or home oxygen use, chronic systemic corticosteroid use, cerebral palsy/ intellectual disability, as previously determined by studies investigating the effect of obesity on asthma hospitalization. [30] The study was approved by the Institutional Review Board at Albert Einstein College of Medicine.

Study variables

Electronic medical records of the children identified using Clinical Looking Glass were reviewed. Patient demographic characteristics including age, weight, height, race/ethnicity, sex, socio-economic status (SES), as well as ED triage time, discharge date and time, were extracted using Clinical Looking Glass. Weight and height were used to calculate age and sex-specific percentiles for BMI for all children. These percentiles were used to classify them as normal-weight (5^{th} to 85^{th} percentile), overweight (BMI ≥ 85^{th} percentile and <95^{th} percentile) and obese (BMI ≥ 95^{th} percentile), based on CDC criteria.[32] Underweight children (BMI<5^{th} percentile) were excluded. SES in Clinical Looking Glass is reported as a z-score calculated from six socioeconomic variables based on the census block and census tract information available on the patient's address.[33] The z-score represents the deviation of the value from the mean of the New York state population.

Clinical data were extracted using a uniform digital data extraction document by 4 of the investigators. Audits for uniformity were performed by the principal investigator. Data collected from chart review included asthma controller medication use, frequency of albuterol doses administered during hospitalization, need for PICU hospitalization, terbutaline, or aminophylline, antibiotics, supplemental oxygen, ventilatory support (intubation, bi-level positive airway pressure, or high frequency nasal cannula), diagnosis of co-existent pneumonia, and insurance. Baseline asthma severity was classified based on the NHLBI guidelines per provider documentation.[34–36] LOS was defined as the number of days from the time of emergency department triage to the time of discharge. Seasonality of hospitalization was classified based on meteorological seasons.

Statistical analysis

The primary outcome variable of interest was LOS. Secondary outcome variables were measures of severity of asthma exacerbation, including time to wean albuterol treatment to every 4 hours and need for PICU hospitalization, continuous albuterol, supplemental oxygen, ventilatory support, aminophylline, or terbutaline. The primary predictor variable was body weight status. BMI percentile and the time variables, including LOS and time to

wean albuterol treatment to every 4 hours, was log transformed to achieve normal distribution. Having identified an association of outcome variables with BMI percentile when analyzed as a continuous variable, we grouped the children into normal-weight, overweight and obese status and used Analysis of Variance (ANOVA) to identify the differences in outcome variables between these three weight categories. Outcome variables that were different by body weight status were driven by differences between normal-weight and overweight and normal-weight and obese but didn't differ between the overweight and obese groups (summarized in Supplemental Tables 1 and 2). We therefore combined the overweight and obese categories and compared them to children in the normal-weight category.

Bivariate analysis between normal-weight and overweight/obese children was done using the Student T-test for the continuous variables (LOS, time to wean to albuterol treatment to every 4 hours, age, and socioeconomic status) and Chi-square test or Fisher Exact test for categorical variables (sex, ethnicity, asthma severity, need for hospitalization in the PICU, supplemental oxygen, ventilatory support, aminophylline, terbutaline, and continuous albuterol). Number of prior admissions was categorized as none, one, two, three, and four or more.[37] Since the LOS was collinear with time to wean albuterol treatment to every 4 hours and was associated with need for a hospitalization in the PICU, we investigated the association of LOS with the above listed predictor variables; correlation coefficients were calculated using the Pearson Test to assess the association of the LOS with above listed continuous variables. Student's T test was applied to analyze the association of LOS with the above listed categorical variables. LOS is reported as geometric mean and range.

Based on these bivariate analyses, we conducted multivariable linear regression analysis to identify the role of overweight/obese status as an independent predictor of LOS, when adjusted for age, baseline asthma severity (intermittent asthma was the reference group), baseline use of montelukast, and inhaled steroids, number of prior admits, need for intensive care, and supplemental oxygen. These variables were included as covariates because they were significantly associated with LOS ($p<0.05$) in bivariate analysis. Since LOS was analyzed as a log-transformed variable, to report its clinically meaningful interpretation, the exponent was calculated of the beta coefficient for the variables that were significant predictors of LOS as derived from the linear regression analysis. Furthermore, the covariates that were associated with LOS and included in multivariable analysis also differed between normal-weight and overweight/obese groups. We therefore repeated the multivariable regression analysis stratified by body weight status to identify the association of these variables with LOS for each weight category. Statistical analysis was conducted on STATA version 14 and statistical significance was set *a priori* at 0.05.

Results

Demographic and baseline asthma characteristics

The demographics and clinical characteristics of the 975 children who met the inclusion criteria are summarized in Table 1. Fifty-five percent were normal-weight and 45% were overweight or obese. Among the overweight/obese children, 60% were Hispanic. The average LOS for the entire cohort was 2.6 days (0.7 to 12.9 days). Normal-weight children

were younger than overweight/obese children. Baseline asthma severity was higher among the overweight/obese group (p=0.021) (Table 1). In keeping with the higher baseline severity, overweight/obese children had a higher number of prior hospitalizations (p=0.005) and a larger proportion were on controller medications compared to normal-weight children (p=0.012) (Table 1). The highest number of hospitalizations was in the winter months (439 (45%)).

Association of overweight/obese status with severity of asthma exacerbation

Overweight/obese children had a longer LOS, which correlated with time to wean of albuterol treatment to every 4 hours (r = 0.89, p= <0.001). Overweight/obese children also had more primary admissions to the PICU from the emergency department (p= 0.010) and higher need for continuous albuterol (p=0.010). (Table 2).

Association of Demographic variables and baseline asthma severity with severity of asthma exacerbation

In addition to its association with overweight/obese status, LOS correlated with age (r= 0.12, p<0.001) and was longer for children with moderate and severe persistent asthma as compared to intermittent asthma (p<0.001) for the entire cohort. It was also longer among children on montelukast as a controller medication (2.7 days (range 0.7 to 10.9 days) vs. 2.4 days (range (0.7 to 12.9 days), (p<0.01) and approached statistical significance for those on ICS (2.6 days (range (0.8 to 12.9 days) vs. 2.5 days (range (0.7 to 12.6 days), p=0.051). LOS did not differ by gender, ethnicity, or SES and was not associated with number of prior admits or the season.

Hospitalization in the PICU was associated with a longer LOS in both normal-weight children (4.0 days vs. 2.3 days, p<0.001) and overweight/obese children (4.4 days vs. 2.6 days, p<0.001). Overweight/obese children took longer to be weaned to albuterol every four hours as compared to normal weight children (1.9 days vs. 1.6 days, p<0.001).

Multivariable analysis

Since factors like age, asthma severity, use of montelukast and hospitalization in the PICU were associated with LOS in bivariate analysis, we conducted a multivariable analysis to identify the independent factors associated with LOS (Table 3A). We found that overweight/obese status, higher age, need for hospitalization in the PICU, supplemental oxygen and ventilatory support remained independent predictors of LOS, after adjusting for baseline asthma severity, including controller medication use. While LOS was longer by 1.1 days for overweight/obese children, it was longer by 1.2 days for those that were hospitalized to the PICU, by 1.5 days for those that needed supplemental oxygen and 1.5 days that needed ventilator support.

Since variables including age, asthma severity, use of montelukast and hospitalization in the PICU that were associated with LOS in bivariate analysis also differed between overweight/obese and normal-weight children (Tables 1 and 2), we further assessed if factors associated with LOS differed by weight status. Among normal-weight children with asthma, the association of LOS with hospitalization in the PICU was rendered non-significant after

adjusting for baseline asthma severity suggesting that baseline asthma severity was the main variable predictor of LOS. In overweight/obese children with asthma, hospitalization in the PICU remained a significant predictor of LOS, even after adjusting for baseline asthma severity (Table 3B).

Discussion

In an urban minority population with high asthma disease burden, we found that overweight/obese children have a higher baseline asthma severity and a more severe exacerbation with a longer LOS when compared to normal-weight children. While the LOS among normal-weight children was associated with their baseline asthma severity, among overweight/obese children it was associated with the severity of the exacerbation, including the need for hospitalization in the PICU, independent of their higher baseline disease severity. These findings suggest that overweight/obese children with asthma have both higher severity of asthma at baseline and more severe exacerbations than normal-weight children with asthma.

Our findings of longer LOS and need for PICU among overweight/obese children support prior evidence that children with asthma who are obese or overweight have a higher disease burden than normal-weight children, likely due to higher baseline disease severity.[38–40] Our study, also validated earlier studies that found longer LOS in obese asthmatic children, [25,26,29] and built on existing literature by investigating several factors that may explain these two aspects of asthma morbidity. We found the need for PICU hospitalization, an objective measure of severity of the exacerbation, as the most pertinent factor associated with longer LOS in overweight/obese asthmatic children, replicating findings reported by Carroll et al. who studied only children hospitalized to the ICU and found overweight/obese children to have a longer LOS.[30] Although we found that overweight/obese children took longer to recover as measured by time to wean albuterol treatments to every 4 hours, we didn't find a difference in the need for aminophylline, terbutaline or antibiotics suggesting that the response to albuterol is delayed in overweight/obese children but their severity of presentation is not associated with higher need for aminophylline or terbutaline. Our findings of slower response to albuterol in the setting of an exacerbation have been reported in the outpatient setting by McGarry et al. who studied a predominantly Hispanic population.[41,42]

Our findings of a longer LOS among overweight/obese children differ from observations reported by other studies,[28,43] which may be explained by several factors. Few studies have included baseline asthma severity.[43,44] Since our study population had higher baseline asthma severity and a larger proportion needed a PICU hospitalization than the population studied by Aragona et al., the higher baseline severity and severity of exacerbation in our population may explain the disparate findings.[43] In keeping with higher disease severity, LOS was more than 2 days in 67.2% of our cohort as compared to 50.7% in the study by Aragona et al. Further, our cohort was comprised of more Hispanics than African Americans as compared to those including in reports by Bettenhausen et al. and Aragona et al.[28,43] We did not find a difference by ethnicity in disease morbidity and its association of body weight, which is different than the findings of Carroll et al., who reported that a higher proportion of Hispanic children were obese. However, they also did not find an independent association of

ethnicity with longer LOS.[44] Lastly, our sample size is larger than any of these studies affording us higher statistical power to detect significant differences between overweight/obese and normal-weight children. Despite using a population with known higher disease burden, our results were similar to those studies using national data sets that used ICD 9 codes to identify patients who were obese.[25–27] Our study adds to this growing body of literature that higher severity of the asthma exacerbation is associated with a hospitalization and this severity was independent of baseline asthma severity.

In keeping with observations of Shanley et al., we found a difference in LOS of nearly a half day for overweight/obese pediatric patients, which were longer than other studies that reported mean differences of 0.09 days, 0.24 days and 6 hours.[25,26,28,29] A half day increase in LOS is associated with approximately $2000 higher mean charges for patients admitted with status asthmaticus[27] further supporting the reports of higher health care expenditure due to obesity-related asthma.[25]

We speculate that the longer LOS may be driven by a distinct pathophysiology of asthma among obese children as compared to their normal-weight counterparts. The pathophysiology of asthma in normal-weight individuals has been well described where in atopic airway inflammation results in hyper-responsiveness, obstruction, increased mucus production, and airway wall remodeling. Asthma phenotype differs in the obese population and can be distinguished by age of onset and markers of Th2 inflammation.[24–26] While obese patients with early-onset asthma have more atopic disease, higher IgE levels, and greater bronchial hypersensitivity, later-onset of asthma among obese individuals is associated with lower IgE levels, decreased bronchial hypersensitivity and lower levels of Th2.[45–47] There is evidence of non-atopic Th1 inflammation in urban minority children with obesity and asthma suggesting inflammation in obese children with asthma is distinct from their normal-weight counterparts.[48] These factors may come together to influence the pharmacokinetics of medications and need further investigation.

Additionally, lifestyle factors including physical activity may play a role in the association in disease burden in overweight/obese as compared to normal-weight children. We and others have found that obese children have lower ability to perform physical activity, a limitation that is linked to their adiposity rather than lower lung function.[49,50] Moreover, obese asthmatic children tend to more sedentary than normal-weight children with asthma.[51–53] The extent to which their baseline asthma severity is associated with these behaviors needs further investigation.

Our findings, in the context of prior literature, suggest that physicians who care for children who are obese and asthmatic during an inpatient hospital stay should be aware that these children may have higher baseline asthma severity, longer LOS and a slower response to albuterol. Given that there are no specific treatments geared toward this population it might be reasonable to suggest that the inpatient physicians provide counseling on weight status and ensure patients have follow-up to assess adequate daily asthma control to prevent further hospitalizations.

Our study has certain limitations. This is a single institution study and may not be generalizable to other institutions. It was done retrospectively and baseline asthma severity classification was dependent on provider documentation leading to about 25% of our cohort lacking a clear classification. In keeping with this limitation, we did not have information on the rates of children who received influenza vaccination. Further, the population served by our hospital is primarily minority and inner-city which may impact the generalizability of our findings to more affluent or Caucasian populations. Additionally, compared to studies that have investigated future risk of ED visits and hospitalizations, we focused on severity of asthma exacerbation.[43,54] The burden of both obesity and asthma are higher in populations such as ours, we believe our findings are pertinent to managing obese children with asthma. Additionally, the detailed investigation of the association of body weight status with inpatient interventions such as supplemental oxygen, ventilatory support, aminophylline, and terbutaline add information on interventions that may have similar or different responses in normal-weight and overweight/obese asthma.

Conclusion

In conclusion, our study is the first to report higher severity of asthma exacerbation in overweight/obese children, independent of their baseline disease severity. It adds to current literature that obese children with asthma differ from their normal-weight counterparts and highlights the importance of these differences in hospitalized children. Further investigation is needed to understand the phenotype of overweight/obese children with asthma, given the existing literature of baseline higher disease severity and our findings of more severe exacerbations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Abbreviations

(BMI)	Body Mass Index
(PICU)	Pediatric Intensive Care Unit
(NHLBI)	National Heart, Lung, and Blood Institute
(CHAM)	Children’s Hospital at Montefiore
(mg)	milligrams
(kg)	kilogram

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What's Known on This Subject

Asthma and obesity are two common pediatric problems. Obesity is a known risk factor for asthma, and obese children with asthma have worse asthma control and lower lung function. However, there is limited understanding of the impact of obesity on hospitalization for an asthma exacerbation.

What This Study Adds

This study reports that asthma exacerbations in obese children are more severe, and are independent of their higher baseline asthma severity. The extent to which lower steroid dose for their body weight plays a role needs further investigation.

Table 1:

Patient demographics and baseline asthma characteristics

	Entire Cohort(n=975)	Normal-Weight (n=533)	Overweight/Obese(n=442)	p value[#]
Patient demographics				
Age (years) [*]	7.64 ± 4.11	6.8 ± 4.0	8.6 ± 4.0	<0.01
Males	537 (55)	294 (55)	243 (55)	1.00
Females	438 (45)	239 (44.8)	199 (45)	
Hispanic	590 (60.5)	324 (61)	266 (60.2)	0.95
African American/ non-Hispanic	362 (37.1)	192 (36)	170 (38.5)	
Ethnicity declined	23 (2.4)	17 (3)	6 (1.3)	
Social economic status (z-score) [*]	−4.3 ± 2.7	−4.3 ± 2.7	−4.3 ± 2.7	0.89
Measures of baseline asthma severity				
Intermittent	146 (15)	86 (16)	60 (14)	0.02
Mild persistent	262 (27)	150 (28)	112 (25)	
Moderate Persistent	256 (26)	124 (23)	132 (30)	
Severe Persistent	85 (9)	38 (7)	47 (11)	
Unknown	226 (23)	135 (25)	91 (20)	
No prior hospitalization	298 (31)	169 (32)	129 (29)	<0.001
One prior hospitalization	201 (21)	131 (25)	70 (16)	
Two or three prior hospitalizations	179 (18)	108 (20)	71 (16)	
Four or more prior hospitalizations	260 (27)	106 (20)	154 (35)	
Unknown prior hospitalizations	37 (3)	19 (3)	18 (4)	
Controller Medication use	571 (59)	293 (55)	278 (63)	0.01
Inhaled Corticosteroids	546 (56)	280 (53)	266 (60)	0.02
Montelukast	315 (32)	143 (27)	172 (39)	<0.01
Season at time of hospitalization				
Spring	192 (19.69)	113 (21.2)	79 (17.9)	<0.01
Summer	154 (15.79)	97 (18.2)	57 (12.9)	
Fall	190 (19.49)	124 (23.3)	66 (14.9)	
Winter	439 (45.03)	199 (37.3)	240 (54.3)	

[*] These variables are reported as mean± standard deviation (SD). All other variables are reported as proportion (n (%)).

[#] p value was derived by T test for continuous variables and by Chi-square or Fisher-exact test for categorical variables.

Table 2:

Inpatient asthma severity measures among normal-weight and overweight/obese children

	Entire Cohort(n=975)	Normal Weight(n=533)	Overweight/Obese (n=442)	p value[#]
Length Of Stay (days)[*]	2.6 (0.67, 12.92)	2.4 (0.67, 10.88)	2.8 (0.75, 12.92)	<0.01
Admission to wean to albuterol treatment every 4 hours (days)[*]	1.70 (0.01, 12.32)	1.54 (0.01, 10.56)	1.86 (0.03, 12.33)	0.01
Transfer from floor to PICU	36 (4)	14 (2.6)	22 (5.0)	0.053
Admission from ED to PICU	103 (10.6)	44 (8.3)	59 (13.3)	0.01
Received supplemental oxygen	336 (34)	171 (32)	165 (37)	0.09
Use of aminophylline	10 (1)	5 (1)	5 (1.1)	0.77
Use of terbutaline	6 (0.6)	3 (0.6)	3 (0.7)	0.82
Received Ventilatory support	47 (5)	22 (4.1)	25 (5.7)	0.27
Need for continuous Albuterol	97 (10)	41 (7.7)	56 (12.7)	0.01
Pneumonia	106 (11)	64 (12)	42 (10)	0.21
Azithromycin	96 (10)	48 (9)	48 (11)	0.33
Other antibiotics	107 (11)	64 (12)	43 (10)	0.26

[*] These variables are reported as geometric mean (range) All other variables are reported as proportion of the cohort (n (%)).

[#] p value was derived by T test for continuous variables and by Chi-square or Fisher-exact test for categorical variables and reflects the comparison between normal-weight and overweight/obese groups.

Table 3A:

Multivariable Analysis of predictors of length of stay for the entire cohort

	β (95% CI)	p value
Overweight/ obese status as compared to normal weight	0.03 (0.01,0 .06)	0.01
Age	0.01 (0.001, 0.01)	<0.01
Admit from ED to PICU as compared those that did not get admitted to PICU	0.06 (0.02, 0.11)	0.01
Received supplemental oxygen as compared to those that did not receive oxygen	0.17 (0.14, 0.19)	<0.001
Received supplemental ventilatory support as compared to those that did not receive supplemental support	0.18 (0.12, 0.24)	<0.001
On inhaled steroid therapy prior to admission as compared to those not on prior inhaled steroid therapy	0.03 (−0.01, 0.05)	0.10
On montelukast therapy prior to admission as compared to those not on prior montelukast.	−0.004 (−0.04, 0.03)	0.81
Mild persistent as compared to intermittent asthma	−0.02 (−0.05, 0.02)	0.32
Mod persistent as compared to intermittent asthma	−0.01(−0.04, 0.04)	0.94
Severe persistent as compared to intermittent asthma	0.03 (−0.02, 0.09)	0.20

Table 3 B:

Multivariable Analysis of predictors of length of stay among normal-weight and overweight/ obese children

	Normal Weight		Overweight/ Obese	
Predictor variables*	**β (95% CI)**	**p value**	**β (95% CI)**	**p value**
Age	0.01 (0.001, 0.01)	0.01	0.004 (−0.0003, 0.009)	0.07
Admit from ED to PICU as compared those that did not get admitted to PICU	0.05 (−0.02, 0.12)	0.17	0.08 (0.02, 0.14)	0.01
Received supplemental oxygen as compared to those that did not receive supplemental oxygen	0.18 (0.12, 0.22)	<0.001	0.16 (0.12, 0.20)	<0.001
Received supplemental ventilatory support as compared to those that did not receive supplemental support	0.18 (0.08, 0.28)	<0.001	0.19 (0.10, 0.27)	<0.001
On inhaled steroid therapy prior to admission as compared to those not on prior inhaled steroid therapy	0.01 (−0.03, 0.05)	0.59	0.05 (−0.003, 0.09)	0.052
On Montelukast therapy prior to admission as compared to those that were not on prior Montelukast	0.01 (−0.04, 0.05)	0.80	−0.02 (−0.07, 0.03	0.45
Mild persistent asthma persistent as compared to intermittent asthma	−0.01 (−0.06, 0.03)	0.55	−0.02 (−0.07, 0.03)	0.43
Mod persistent asthma persistent as compared to intermittent asthma	−0.01(−0.06, 0.04)	0.71	0.01 (−0.05, 0.07)	0.67
Severe persistent asthma persistent as compared to intermittent asthma	0.04 (−0.04, 0.13)	0.29	0.04 (−0.04, 0.13)	0.32