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Disparities in Mortality and Morbidity in Pediatric Asthma Hospitalizations, 2007 to 2011

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Abstract

OBJECTIVE: Asthma is a leading cause of pediatric admissions. Although several factors including race have been linked to increased overall asthma morbidity and mortality, few studies have explored factors associated with inpatient asthma outcomes. We examined factors associated with mortality and morbidity in children admitted for asthma.

METHODS: Data were obtained from the US Nationwide Inpatient Sample for 2007 to 2011. Patients 2 to 18 years old with a primary diagnosis of asthma were included. Predictor variables were sociodemographic and hospital factors and acute/chronic secondary diagnoses. Outcomes were mortality, intubation, length of stay (LOS), and costs. Weighted national estimates were calculated. Multivariable analyses were performed.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.acap.2015.12.014.

RESULTS: There were 97,379 (478,546 weighted) asthma admissions. Most patients were male (60.6%); 30% were white, 28% black, and 18% Hispanic. Mortality rate was 0.03%, and 0.3% were intubated. Median LOS was 2 (interquartile range, 1–3) days. Median costs were $2,950 (interquartile range, $1990–$4610). Native American race, older age (13–18 years), and West region were significant independent predictors of mortality. Intubation rate was lower in Hispanic compared with white children (P=.028). LOS was shorter in Asian compared with white children (P=.022) but longer in children with public insurance and from low income areas (P<.001). Average costs were higher in black, Hispanic, and Asian compared with white children (P<.05).

CONCLUSIONS: With the exception of Native Americans, race/ethnicity is not associated with inpatient asthma mortality and has varied effects on morbidity. Recognition of factors associated with increased asthma mortality and morbidity might allow for earlier, more effective treatment and avoidance of complications.

Keywords

asthma; disparities; hospitalizations; morbidity; mortality

ASTHMA IS ONE of the most common conditions seen in pediatric patients. In 2009, 9.6% of children (7.1 million children) in the United States were estimated to have asthma.[1] Asthma symptoms lead to 10.5 million missed school days per year.[1] More than 5% of all pediatric hospital admissions are for asthma,[2] making it a leading cause of pediatric hospitalizations.

It has been well established that racial and ethnic disparities exist in pediatric patients with asthma. Black and Hispanic children have a higher asthma prevalence and overall rates of mortality compared with white children.[1–3] Readmission rates are twice as high in black compared with white children.[4] Black and Hispanic children have higher rates of emergency department (ED) use and hospitalizations for asthma.[5–8] Black and Hispanic children often use the ED for their usual source of care[9] and miss more school days because of their asthma compared with white children.[10] These disparities can in part be explained by financial and social hardship,[4] worse access to care including to primary care physicians,[7,11] and improper controller and rescue medication use.[6,10,12]

Although black and Hispanic race and ethnicity have been shown to be predictors of mortality and morbidity from asthma in the outpatient setting, little is known on the national level about whether disparities persist for children after they have been admitted. One national study that examined inpatient asthma disparities in pediatric and adult patients ages 5 and older reported no significant differences in hospital deaths from asthma according to race or ethnicity in their multivariable analysis.[13] The study reported that mortality was more likely in older adults, male patients, patients with more chronic conditions, and during winter months.[13] Although this study provides some evidence against racial and ethnic disparities associated with inpatient asthma mortality, it did not specifically examine predictors of other more common adverse outcomes such as increased costs, longer length of stay (LOS), or other measures of more severe disease/morbidity, which might have different predictors or in which disparities would be more easily identified because mortality is rare. In addition, the study did not provide detail regarding the specific comorbidities that might

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lead to worse outcomes as has been done in studies in other settings.[14–16] Another study of asthmatics at academic children's hospitals (from July 2002 to June 2003) found that black children had statistically shorter unadjusted LOS and lower charges (after adjusting for LOS) than white children although these differences might not be clinically significant[17]; additional multivariable analyses were not presented. Furthermore, in the past decade there have been no published nationally representative studies on racial and ethnic disparities in inpatient asthma admissions and little work on asthma outcomes in Native American or Asian children.

The purpose of this study was to determine the factors associated with mortality, intubation, LOS, and costs in children admitted for asthma exacerbations between 2007 and 2011 in a nationally representative sample in the United States, including whether racial and ethnic disparities or the presence of specific diagnoses are independent predictors of these outcomes.

METHODS

DATA SOURCE

We analyzed data from the 2007 to 2011 Nationwide Inpatient Sample (NIS), the largest all-payer publicly available inpatient data set, which is part of the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality. The NIS consists of a representative stratified sample of approximately 20% of US hospital admissions; the complex sampling design allows for the calculation of national estimates.[18] Because of the deidentified nature of the data present in the NIS, this study did not meet the definition for human subjects research and was exempt from full review by the New York University School of Medicine institutional review board.

SUBJECTS

Patient records were included in the analysis if they had a primary discharge diagnosis of asthma according to the *International Classification of Diseases, Ninth Revision* code 493, and were 2 to 18 years old. Patients with asthma as a secondary diagnosis were not included. There were no additional exclusion criteria.

MEASURES

The primary predictor variable of interest was race/ethnicity (a single category in the NIS, with "Hispanic" defining anyone identified as being of Hispanic ethnicity in the data set). Data were also collected on additional possible indicators of income disparities (insurance type and median household income quartile [income ranges vary by year[18]; 2007 ranges were used for simplicity] according to patient zip code [patient location according to zip code is not available]), demographic factors (sex, age [grouped as ages 2–5, 6–12, and 13–18 years]), hospital-level characteristics (region, rural/urban location, teaching status, and bed size [small, medium, or large; definition differs depending on location and teaching status as defined by the Healthcare Cost and Utilization Project[18]]), and hospitalization timing (weekend admission, year [as a continuous variable], and discharge quarter [January–March, April–June, July–September, October–December]). Data on presence of several acute (pneumonia, influenza, and respiratory syncytial virus [RSV]) as well as chronic (obesity, obstructive sleep apnea [OSA], allergic rhinitis, eczema, mood disorders, gastroesophageal reflux disease, and tobacco addiction [coded in the patient record]) secondary diagnoses chosen on the basis of previous studies showing associations with presence of asthma or worse asthma severity[14–16] were also collected (see the Appendix for secondary diagnosis coding criteria).

The outcome variables of interest were mortality, intubation (defined by presence of *International Classification of Diseases, Ninth Revision* procedural codes for intubation/mechanical intubation: 96.04, 96.70, 96.71, 96.72), LOS, and total costs. To determine estimated total costs of hospitalization, charges were converted to costs using NIS Cost-to-Charge data files.[19] Group-weighted average cost-to-charge ratios were used in the analysis.

ANALYSIS

Bivariate and multivariable regression analyses were performed to determine whether any of the previously mentioned predictor variables were associated with the outcomes of mortality, intubation, LOS, and costs. LOS was also included as a predictor in the multivariable regressions in which cost was the outcome. In addition, missing data for all predictor variables were reassigned to a separate missing variable category and analyzed to determine if missing data predicted any of the outcomes. Logistic and linear regressions were used for dichotomous (mortality and intubation) and continuous (LOS and costs) outcomes, respectively. Because LOS and cost distributions were skewed, the data were natural log-transformed for all bivariate and multivariable linear regression analyses. We then applied Duan's method to retransform all linear regression results from the log to the original scale.[20] A P value < .05 was considered significant in all cases. All statistical methods conducted respected the complex survey design using sample weighting in Stata SE version 12.1 (StataCorp, College Station, Tex).

RESULTS

DESCRIPTIVE RESULTS

Data from 97,379 admissions met inclusion criteria and were analyzed; this represents a weighted statistical sample of 478,546 hospitalizations. Information related to patient demographic characteristics, hospital-level factors, hospitalization timing, and patient outcomes are presented in Table 1. Most patients were male and had public insurance. White and black children each represented approximately 30% of the sample, and 18.1% of our sample was Hispanic. More than one-third were in the lowest income quartile. Most of the admissions were to large, urban, teaching hospitals. A secondary diagnosis of pneumonia was present in 13.7% of hospitalizations. The frequency of other diagnoses of interest in asthmatic patients ranged from just less than 1% to 3% of patients. Mortality rate was 0.03%, and 0.3% of patients required intubation. Median LOS was 2 (interquartile range, 1–3) days. Median costs were $2,760 (interquartile range, $1,860–$4,320).

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MULTIVARIABLE ANALYSES

Independent predictors of mortality from the multivariable regression analysis are presented in Table 2. After adjusting for all relevant predictor variables (see Table 2), Native American children had a greater odds of mortality than white children (odds ratio, 11.15; 95% confidence interval [CI], 1.09–114.49; $P = .042$). Race/ethnicity was otherwise not an independent predictor of mortality. Older age group (13–18 years old) and West region were also independently associated with mortality (Table 2).

Independent predictors of intubation are presented in Table 3. Hispanic children were less likely than white children to be intubated (odds ratio, 0.59; 95% CI, 0.36–0.94; $P = .028$). Race/ethnicity was otherwise not an independent predictor of intubation. Older age, several secondary diagnoses (pneumonia, influenza, RSV, OSA, tobacco addiction), West region, urban/teaching hospital status, and large bed size were all independently associated with intubation (Table 3).

Multivariable analyses for LOS are presented in Table 4. On average, Asian/Pacific Islanders had 0.12 fewer hospital days than white children (95% CI, −0.24 to −0.02 days; P=.022). Race/ethnicity was otherwise not independently associated with LOS. Children with private insurance had 0.17 fewer hospital days compared with those with public insurance (95% CI, −0.20 to −0.14 days; P<.001). Children living in zip codes with the highest average income ($ $63,000) had 0.30 fewer hospital days compared with the lowest income ($1–$38,999) group (95% CI, −0.36 to −0.22 days; P<.001; Table 4). Other independent predictors of longer LOS included older age group, female sex, presence of several secondary diagnoses (including pneumonia, influenza, RSV, and several chronic diagnoses), urban/nonteaching hospitals (compared with rural hospitals), and large bed size.

Multivariable analyses for costs (adjusted for LOS) are presented in Table 4. Significantly higher costs were seen in black (increment $310; 95% CI, $145–$531; P<.001), Hispanic (increment $359; 95% CI, $198–$573; P< .001), and Asian (increment $248; 95% CI, $39–$535; P= .016) children compared with white children. Average cost of admission was $291 more in children living in the highest compared with the lowest income areas (95% CI, $102–$549; P=.001). There were no significant differences in costs between children with private and public insurance; however, total costs were lower in the “other” insurance group compared with those with public insurance (Table 4). Other independent predictors of higher costs included older age groups, female sex, several secondary diagnoses, and LOS. Independent predictors of lower costs included urban/nonteaching hospitals (compared with rural) and medium and large bed size (compared with small bed size). Finally, missing median income according to zip code data was associated with lower costs, and missing sex data was associated with higher costs (Table 4).

Results of bivariate analyses for all outcomes are provided in the Appendix.

DISCUSSION

In this large national study of disparities among pediatric inpatients with a primary diagnosis of asthma we found that Native American children had higher odds of inpatient death

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compared with white children and that otherwise, race and ethnicity were not independent predictors of inpatient asthma mortality. In terms of measures of inpatient morbidity, Hispanic children were less likely to be intubated than white children. LOS was longer in children with public insurance and living in low-income areas and shorter in Asian children than in white children. Total costs were higher in black, Hispanic, and Asian children and in children living in high-income areas. The results of this study support previous research from a decade ago showing that mortality rates in black and Hispanic children who are sick enough to be admitted for asthma exacerbations are not significantly different than rates in white children.[13,17]

Although we did not find a difference in mortality rates for black and Hispanic compared with white children admitted for asthma exacerbations, there are a few important caveats. The low inpatient asthma mortality rates seen in this and other studies[15,19] make it difficult to detect statistically significant black and Hispanic disparities in mortality when important differences might actually exist. In addition, white and black children each represented approximately 30% of the sample, despite the white population in the United States being close to 6 times the size of the black population according to recent census data.[21] Although there were no differences in mortality rates among black compared with white children already admitted to the hospital for asthma, our results would support previous studies showing that combined inpatient and outpatient asthma mortality rates in US children are higher in black compared with white children.[2,3] It is also possible that these overall racial disparities in mortality might be because of an excess of deaths occurring in the outpatient and prehospital/ED settings.

Statistical disparities in inpatient mortality were identified among Native American children, a group that is less well studied. Native Americans do experience substantial morbidity from asthma with higher prevalence and similar hospitalization rates in some subgroups compared with white children.[22–24] Previous studies have indicated that many barriers exist to management of asthma in Native Americans, including poor access to care, poor understanding of asthma, improper use of controller medications, cultural factors, and difficulty communicating with providers,[24–26] suggesting that these children have more severe disease, and supporting the higher inpatient mortality rate found in this study. Finally, although higher levels of mortality in Native Americans would be consistent with outpatient barriers and disparities experienced in this group, the large CI (because of the small number of subjects and the rare outcome of mortality) and P value just < .05 limit the strength of this conclusion, so further study of Native American inpatient asthma outcomes is warranted.

Costs (adjusted for LOS) were close to $300 higher in black and Hispanic children compared with white children in our multivariable analysis even though other adverse outcomes such as longer LOS and mortality were not greater in these minority groups. It has been well established that there are substantial disparities between these groups and white children in the outpatient setting with higher rates of death,[2,3] more missed school days,[10] worse access to care,[7,11] and improper controller and rescue medication use.[6,10,12] It is possible that these children require additional treatment and workup upon arrival to the ED to compensate for some of these outpatient disparities, which might lead to higher costs. Because of the large numbers of black and Hispanic children who are admitted for asthma

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each year,[2] these higher costs are likely to have substantial economic effect. Conversely, Hispanic children had significantly lower odds of intubation compared with white children. One could speculate that because of the increased mortality seen in Hispanic children in the outpatient setting[2,3] that these sicker children are not surviving to make it to the hospital for intubation. It is also possible that Hispanic children are presenting to hospitals that are less likely to intubate or that there are other factors not accounted for in the NIS.

Average adjusted costs were approximately $200 higher in Asian/Pacific Islanders compared with white children. Other studies have established that there are cultural barriers that affect Asian families and that Asian families have less asthma knowledge compared with white families.[27,28] Asthma might also be underdiagnosed in some Asian individuals.[28] It is possible that Asian children might be sicker in the outpatient setting and the higher costs might be associated with more treatment early on in the hospital course to compensate for these disparities. One study on pediatric asthma admissions in California found that Asian children were more likely to have experienced an adverse outcome (in this case defined by cardiopulmonary resuscitation, intubation, or death) compared with white children,[29] so the presence of disparities in our study was not surprising. Conversely, Asian children had a shorter LOS compared with LOS for white children in our study. It is possible that there are factors that are not being measured that account for the discrepancy between LOS and costs in Asian children. Because of the limited number of studies on asthma in Asian children, additional research is needed.

In addition to the racial and ethnic disparities observed, our study also found associations between the presence of several acute and chronic comorbidities and worse outcomes in children admitted with asthma exacerbations, adding to a previous national study that showed that a higher number of chronic conditions was associated with increased mortality.[13] In our study, a secondary diagnosis of pneumonia or presence of RSV was associated with a two- to threefold increased odds of intubation, more than an additional day added on to LOS, and added additional costs. These data support previous studies showing that children with asthma admitted to California hospitals were more likely to experience adverse outcomes if they also had a diagnosis of pneumonia.[29] Diagnoses of influenza, OSA, tobacco addiction, allergic rhinitis, and gastroesophageal reflux disease all were associated increased rates of intubation, longer LOS, and/or higher costs, which supports previous studies showing worse asthma outcomes in people with these diagnoses.[14–16] The effect of secondary diagnoses on mortality could not be assessed, because there were very few deaths, and coding of secondary diagnoses was also less likely among patients who died. However, secondary diagnosis data should be interpreted with caution. The absence of a diagnosis of pneumonia or a viral illness in an administrative data set signifies only that its presence was not coded. As such, these diagnoses could be undercoded in children who are not as ill.

This study has limitations. Race/ethnicity data were missing for 16% of the subjects in this study; this is common in studies of large administrative data sets.[13] Conclusions on the basis of the race/ethnicity data are only applicable for states that report race/ethnicity. Several states do not report race/ethnicity data to the NIS.[18] It is possible that the race/ethnicity of children in these states could have affected our analysis; however, missing

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race/ethnicity data was not an independent predictor of any of the outcomes studied when it was analyzed as a separate category. In addition, the variability in how data are collected and coded in administrative data sets leads to some limitations in reliability of the data. Additional studies are therefore needed in which race/ethnicity as well as outcome data on mortality/morbidity are collected prospectively in a standardized manner to minimize any bias presented by missing or retrospectively collected data. Of note, when sex and income quartile according to zip code data were missing, costs were respectively $677 higher and $502 lower on average. It is unclear why missing income and sex data would be associated with costs, indicating that sex and income data should be interpreted with caution. Costs were unexpectedly higher in patients who lived in zip codes with higher average income. Future studies could consider prospectively collecting socioeconomic status data. We also acknowledge that disease coded as asthma in the 2- to 5-year-old age group might not represent the same clear diagnosis of asthma as seen in older children. Also other studies have established that asthma severity often differs within different subgroups of Asian, Native American, and Hispanic children; for example, outcomes are different for Mexican, Puerto Rican, and other Hispanic subgroups.[24,30] This level of analysis is not available in administrative data sets. In addition, further research should examine additional factors associated with worse asthma outcomes in other settings that are not included in the NIS, such as the negative effects of air pollution[31,32] or secondhand smoke and the association between poor outcomes and local viral activity patterns. It is possible that some of these factors might explain some of the differences in outcomes seen in different regions of the country (such as the higher odds of mortality and intubation seen in the West region compared with the Northeast). We also acknowledge that the selection of $P < .05$ as a cutoff for significance might have increased the chance of a type I error.

In conclusion, our study shows that black and Hispanic race/ethnicity are not independent predictors of inpatient asthma mortality, a finding consistent with studies of inpatient asthma mortality conducted 1 decade ago. The higher rate of combined outpatient and inpatient asthma mortality which previously has been reported in black and Hispanic children is therefore likely to be because of factors that occur before hospitalization. A new finding in our study is the greater odds of inpatient death among Native American individuals. Race and ethnicity had other varying effects on asthma morbidity, including intubation, LOS, and costs. Several other factors, including the presence of several acute and chronic secondary diagnoses, also were associated with in-hospital morbidity. Recognition of risk factors predictive of mortality and morbidity from asthma exacerbations might allow for earlier and more effective treatment and should be the impetus for targeted interventions in groups with these risk factors; several studies have identified interventions that improve outcomes in Hispanic/black, low-income, and urban children.[33,34] Future research should explore other factors, such as local air pollution data, not available for study in large data sets that might be associated with mortality and morbidity. In addition, the finding of apparent disparities in inpatient asthma outcomes suggests the need to expand the study of groups such as Native American and Asian individuals.

Supplementary Material

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WHAT'S NEW

Native American children have higher inpatient asthma mortality rates compared with white children. Race and ethnicity are otherwise not independent predictors of inpatient mortality and have varied effects on intubation, length of stay, and costs.

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Table 1.

Patient and Hospital Characteristics (n = 97,379)

Variable	Value
Race/ethnicity	
White	29,496 (30.3)
Black	27,306 (28.0)
Hispanic	17,628 (18.1)
Asian/Pacific Islander	1787 (1.8)
Native American	726 (0.8)
Other	4542 (4.7)
Missing	15,894 (16.3)
Insurance	
Public	51,934 (53.3)
Private	37,524 (38.5)
Other	7748 (8.0)
Missing	173 (0.2)
Median income according to zip code	
$1 to $38,999	36,377 (37.4)
$39,000 to $47,999	22,265 (22.9)
$48,000 to $62,999	18,924 (19.4)
≥$63,000	16,689 (17.1)
Missing	3124 (3.2)
Median age (IQR), years	6 (3 to 9)
Sex	
Female	37,081 (38.1)
Male	58,973 (60.6)
Missing	1325 (1.4)
Secondary diagnoses	
Pneumonia	13,314 (13.7)
Influenza	1267 (1.3)
RSV	1352 (1.4)
Obesity/overweight	2890 (3.0)
Obstructive sleep apnea	830 (0.9)
Mood disorders	750 (0.8)
Tobacco addiction	752 (0.8)
Allergic rhinitis	1787 (1.8)
Eczema	1050 (1.1)
Gastroesophageal reflux	2632 (2.7)
Region	
Northeast	23,378 (24.0)
Midwest	17,665 (18.1)
South	39,646 (40.7)

Variable	Value
West	16,690 (17.1)
Location/teaching status	
Rural	10,705 (11.0)
Urban/nonteaching	27,307 (28.0)
Urban/teaching	59,367 (61.0)
Bed size *	
Small	13,302 (13.7)
Medium	22,561 (23.2)
Large	61,516 (63.2)
Weekend admission	25,357 (26.0)
Year	
2007	20,048 (20.6)
2008	18,323 (18.8)
2009	22,143 (22.7)
2010	19,711 (20.2)
2011	17,154 (17.6)
Quarter	
January to March	22,322 (22.9)
April to June	18,756 (19.3)
July to September	20,246 (20.8)
October to December	28,132 (28.9)
Missing	7923 (8.1)
Outcomes	
Mortality	26 (0.03)
Intubated	290 (0.30)
Median LOS (IQR), days	2 (1 to 3)
Median total costs (IQR)	$2950 ($1990–$4610)

IQR indicates interquartile range; RSV, respiratory syncytial virus; and LOS, length of stay.

Data are presented as n (%) except where otherwise stated.

*Definition differs depending on hospital location and teaching status.[18]

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Table 2.

Independent Predictors of Inpatient Mortality‡

Variable	Adjusted OR (95% CI)
Native American (reference: white)	11.15 (1.09–114.49) *
13- to 18-year-old age group (reference: 2–5)	7.10 (1.93–26.05)†
West region (reference: Northeast)	14.05 (1.62–121.51) *

OR indicates odds ratio; CI, confidence interval.

*$P < .05$.

†$P < .01$.

‡The model also adjusted for the following variables that did not reach statistical significance: race/ethnicity (black, Hispanic, and "other"), median income according to zip code, age group, sex, diagnosis of pneumonia, region, hospital bed size, and timing of admission (by quarter of year, weekend vs weekday, and year).

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Table 3.

Independent Predictors of Inpatient Intubation[§]

Variable	Adjusted OR (95% CI)
Hispanic (reference: white)	0.59 (0.36 to 0.94) [*]
Age, years (reference: 2–5)	
6 to 12	1.64 (1.15 to 2.34)[†]
13 to 18	4.31 (3.03 to 6.12)[‡]
Secondary diagnoses	
Pneumonia	2.09 (1.62 to 2.69)[‡]
Influenza	2.96 (1.64 to 5.33)[‡]
RSV	3.26 (1.72 to 6.17)[‡]
Obstructive sleep apnea	3.68 (2.00 to 6.77)[‡]
Tobacco addiction	2.46 (1.28 to 4.72)[†]
West region (reference: Northeast)	1.77 (1.01 to 3.09) [*]
Urban/teaching hospital (reference: rural)	3.69 (1.96 to 6.95)[‡]
Large bed size (reference: small)[//]	1.68 (1.13 to 2.48)[†]

OR indicates odds ratio; CI, confidence interval; and RSV, respiratory syncytial virus.

[*] $P < .05$.

[†] $P < .01$.

[‡] $P < .001$.

[§] The model also adjusted for the following variables that did not reach statistical significance: race/ethnicity (black, Asian, Native American), and “other” insurance type, median income according to zip code, sex, region, hospital bed size and location/teaching status, additional secondary diagnoses (obesity/overweight, mood disorders, allergic rhinitis, eczema, and gastroesophageal reflux), and timing of admission (by quarter of year, weekend vs weekday, and year).

[//] Definition differs depending on hospital location and teaching status.[18]

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Table 4.

Independent Predictors of Inpatient LOS and Total Costs[§]

Variable	LOS Increment, days (95% CI)	Costs Increment (95% CI)
Race/ethnicity (reference: white)		
Black	NS	+$310 (+$145 to +$531)*
Hispanic	NS	+$359 (+$198 to +$573)*
Asian/Pacific Islander	−0.12 (−0.24 to −0.02)†	+$248 (+$39 to +$535)†
Native American	NS	NS
Other	NS	NS
Missing	NS	NS
Insurance (reference: public)		
Private	−0.17 (−0.20 to −0.14)*	NS
Other	−0.20 (−0.25 to −0.14)*	−$122 (−$198 to −$18)†
Missing	NS	NS
Median income according to zip code (reference: $1–$38,999)		
$39,000 to $47,999	−0.09 (−0.13 to −0.04)‡	NS
$48,000 to $62,999	−0.17 (−0.23 to −0.11)*	+$197 (+$53 to +$388)‡
≥$63,000	−0.30 (−0.36 to −0.22)*	+$331 (+$116 to $+$624)‡
Missing	NS	−$569 (−$701 to −$364)*
Age, years (reference: 2–5)		
6 to 12	+0.48 (+0.42 to+ 0.56)*	+$275 (+$189 to +$384)*
13 to 18	+0.70 (+0.60 to +0.82)*	+$500 (+$357 to +$676)*
Sex (reference: male)		
Female	+0.14 (+0.10 to +0.18)*	+$45 (+$14 to +$85)‡
Missing	NS	+$767 (+$280 to +$1461)*
Secondary diagnoses		
Pneumonia	+1.21 (+1.06 to +1.37)*	+$402 (+$264 to +$582)*
Influenza	+0.68 (+0.45 to +0.82)*	NS

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Variable	LOS Increment, days (95% CI)	Costs Increment (95% CI)
RSV	+1.42 (+1.17 to +1.71)[*]	+$289 (+$113 to +$523)[*]
Obesity/overweight	+0.40 (+0.27 to +0.54)[*]	+$170 (+$50 to +$331)[‡]
Obstructive sleep apnea	+1.22 (+0.90 to +1.59)[*]	NS
Mood disorders	NS	NS
Tobacco addiction	NS	+$183 (+$36 to +$380)[†]
Allergic rhinitis	+0.21 (+0.09 to +0.37)[‡]	+$153 (+$14 to +$335)[†]
Eczema	NS	NS
Gastroesophageal reflux	+0.88 (+0.67 to +1.11)[*]	+$237 (+$96 to +$424)[*]
Region (reference: Northeast)		
Midwest	−0.15 (−0.26 to −0.01)[†]	NS
South	NS	−$598 (−$740 to −$367)[*]
West	NS	NS
Location/teaching status (reference: rural)		
Urban/nonteaching	+0.11 (+0.001 to +0.23)[†]	−$200 (−$327 to −$15)[†]
Urban/teaching	NS	NS
Bed size (reference: small)[‖]		
Medium	+0.20 (+0.003 to +0.44)[†]	−$432 (−$644 to −$104)[†]
Large	+0.34 (+0.15 to +0.56)[*]	−$443 (−$638 to −$136)[‡]
Weekend (reference: weekday)	+0.05 (+0.02 to +0.09)[‡]	+$130 (+$87 to +$187)[*]
Year (continuous)	NS	NS
Quarter (reference: January–March)		
April to June	−0.20 (−0.23 to −0.17)[*]	NS
July to September	−0.20 (−0.24 to −0.16)[*]	+$123 (+$65 to +$202)[*]
October to December	−0.19 (−0.22 to −0.15)[*]	+$136 (+$73 to +$218)[*]
Missing	NS	NS
LOS		+$863 (+$631 to +$1149)[*]

LOS indicates length of stay; CI, confidence interval; RSV, respiratory syncytial virus; and OR, odds ratio.

[*] $P < .001$.

† $P < .05$.

‡ $P < .01$.

§ All variables in the table were included in the multivariable analysis.

// Definition differs depending on hospital location and teaching status.[18]

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