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Predictors of Inpatient Hospital Cost and Length of Stay Associated with Childhood Obesity: Analysis of Data from the 2012 KID's Inpatient Database

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Abstract

Introduction: Childhood obesity affects 1 in 6 US children, disproportionately impacting minorities and those from low socioeconomic backgrounds. While prevalence, trends, and risks of childhood obesity are well documented, hospital costs have not been studied at the national level.

Methods: A retrospective analysis of the 2012 Kids' Inpatient Database (HCUP) was analyzed to identify length of stay (LOS) and cost per hospital inpatient discharge for children age 2 to 18 years with a secondary diagnosis of obesity. Descriptive statistics for hospital and patient characteristics identified, binary variables were analyzed using the Student's t-test, and variables with multiple categories were analyzed using simple linear regression. Significant variables ($P<.05$) were included in a multi-variable regression analysis. **Results**: A total of 52,566 children with obesity were included in the study, with a mean age of 13 years. Most (60%) were male, 42% were White, 25% were African-American, and 25% were Hispanics. Approximately 75% of children were admitted to a teaching hospital, 58% were funded by Medicaid, and 68% were admitted to a large hospital. The average LOS was 4.1 days and the average cost per discharge was $8,396. Patients aged 11 to 18 had the highest LOS, and patients aged 5 to 10 had the highest cost per discharge. White and Hispanic patients had a higher cost per discharge than African-American patients, and Whites had higher LOS. Higher costs were associated with teaching hospitals, hospitals with small bed size, weekday admission, diabetes diagnosis, higher household income, stays with operating room procedures, and hospitals located in the western region. Predictors explained 60.3% of variation in cost per discharge. **Discussion**: Inpatient hospital costs for children with a secondary diagnosis of obesity are significant. Policies and programs to reducing childhood obesity target decreased morbidity and mortality; however, they also present an opportunity for costs savings.

Introduction

Childhood obesity, defined as the 85th to 95th percentiles of the weight for length growth references[1], has increased at an alarming rate in the United States over the past three decades[2-4]. Between 2011 and 2014, the prevalence of obesity was 17% and affected about 12.7 million children and adolescents aged 2-19 years[5]. While obesity now affects 1 in 6 children in the United States, minority and low-socioeconomic-status groups are disproportionately affected at all ages[4]. Although the prevalence, trends, and associated risk factors of childhood obesity is well documented[5], the economic burden and overall hospital cost of the condition has not been adequately studied at the national level in the United States.

With the current increase in the overall healthcare cost in the United States, there is a strong interest to enhance efficacy through reform and system improvement[6,7]. A better understanding of factors associated with increased hospital cost and length of stay (LOS) for childhood obesity may help hospitals improve the efficiency of the care they provide and allow payers and providers to decrease costs while maintaining high standards of care.

Prior studies on the economic burden of childhood obesity are limited to hospital costs associated with the known outcomes of obesity or by using hospital charge as a proxy for cost[8-10]. Using national hospitalization data from the publicly available Kids' Inpatient Database (KID), we sought to determine predictors of inpatient hospital cost and LOS in children with obesity as a secondary diagnosis.

Methods

This is a retrospective study based on the 2012 Kids' Inpatient Database (KID) developed by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ)[11]. The KID is the largest publicly available all-payer pediatric (≤20 years of age) inpatient care database in the United States. The database is a sample of pediatric discharges from all community, non-rehabilitation hospitals in 44 participating States. Systematic random sampling is used to select 10% of uncomplicated in-hospital births and 80% of other pediatric cases from each participating state. The 2012 KID database includes 4179 hospitals with 3,195,782 pediatric discharges. HCUP categorize hospital regions as northeast, midwest, south, and west. Hospital ownership, teaching status, location, bed size, and other important hospital characteristics are also included in the database. In total, 70 children's hospitals (400,835 pediatric discharges) and 4,109 hospitals that admit all patients (2,794,947 pediatric discharges) were included in 2012 database. For the purpose of our analysis the inpatient core file, the hospital file, and cost-to-charge ratios file of the KID 2012 database were used.

We studied 52,566 pediatric hospitalizations for children between 2 and 18 years of age with a secondary diagnosis of obesity as identified through the 9th version of the international classifications of diseases (ICD-9-CM) codes (278.0, 278.00, 278.01, 278.02, 278.03). All children under the age of 2 were excluded as the center for disease control definition for overweight based on BMI that start at age 2[12,13]. In addition, we excluded discharges from the analysis if total cost or hospital LOS exceeded mean values by >3 standard deviations.

Variables

Total cost per hospital discharge was the main dependent variable and was determined by converting the total per case hospital charge to a hospital cost estimate (estimate = total charges * hospital cost-to-charge ratio). The independent variables included age group, sex, race, LOS, region of hospitals (northeast, midwest, south, west), hospitals teaching status, median income by zip-code, bed-size category (small, medium, large), patient's diabetes status. To identify patients with diabetes, we used the Clinical Classifications Software (CCS) codes (49, 50) and the Diagnosis Related Groups version 24 (DRG24) code 295. The CCS diagnosis codes originate from a uniform and standardized coding system developed by HCUP that collapses a multitude of ICD-9-CM codes into a smaller number of clinically meaningful categories[14]. DRG24 is assigned by the Centers for Medicare & Medicaid Services (CMS) DRG Grouper algorithm during HCUP processing, and has been available since 2006[15]. These important codes were applied to maximize the accuracy of the data abstraction process, reduce potential missing cases, and maintain the validity of the overall outcome.

Analysis

Descriptive statistics for hospital and patient characteristics were used to present percentages, proportions, means, and standard deviations for variables included in the study. For total cost, Student's t-test was used to test for significant differences between binary predictor variables. Simple linear regression with total cost as the independent variable was used to test for significant differences between categories. All variables that were significantly associated with total cost ($p < 0.05$) were included in the multivariable regression analysis. We used this stringent criterion for inclusion in the model due to the large sample size.

We performed multivariate general linear regression to assess the predictors of total hospital cost per discharge associated with obesity as a secondary diagnosis. The regression models included age (5 to 10 and 11 to18; 2 to 4 as reference), race (white as a reference), sex (female as reference), emergency service (admission through the hospital emergency department), hospital region ("East" as reference), median income by zip code (<38,999 as reference), hospital bed size ("Small" as reference), indicator of major operating procedure, number of procedures > 5, number of diagnoses > 6, number of chronic conditions > 2, payer (Medicare as reference), indicator of patient transferred-in status ('not a transfer' as a reference) patient diabetic status, indicator of patient transferred-out status ('not a transfer' as reference), elective admission status, and LOS. The weighting scheme design by HCUP were used to account for the complex probability sampling of the dataset and permit inferences regarding national hospital discharge patterns. All analyses were performed using SAS® version 9.3 (Institute Inc., Cary, NC, USA).

Results

A total of 52,566 children with obesity were included in the study (Table 1). Mean age was 13 years, 60% were males, and 42%, 25%, and 25% were White, African-American, and Hispanic, respectively. About 80% of the patients were admitted through elective admission and 74% were admitted to a teaching hospital. Medicaid was primary payer for 58% of admissions, and the majority (68%) of the patients were admitted to a large hospital.

Table 1. Characteristic of hospitals and patient discharges with a secondary diagnosis of obesity

Characteristics	No. of Patients	Percent
Unweighted sample *n*	37,526	100
Weighted population *n*	52,566	100
Age Group		
2-4 y	1,576	3
5-10 y	7,793	15
11-18 y	43,196	82
Sex		
Male	20,847	40
Female	31,712	60
Race/ethnicity		
White	20,586	42
Black	12,020	25
Hispanic	12,137	25
Other	38,29	8
Major OR* procedure		
OR procedure	12,109	77
No OR procedure	40,456	23
ED& service indicator		
Emergency	25,656	51
Non-Emergency	26,911	49
Median Income (by zip code)		
<38,999	19,072	37
39,000 - 47,999	13,198	26
48,000 - 62,999	11,373	22
>63,000	7,477	15
Admission day indicator		
Weekday	42,790	81
Weekend	9,776	19
Elective admission indicator		
Elective	10,591	80
Non-elective	41,843	20
Patients diabetes status		
Diabetic	5,913	11
Non-Diabetic	46,654	89
Region of Hospital		
Northeast	9,042	17
Midwest	12,829	24
South	18,276	35
West	12,419	24
Hospitals teaching status		
Teaching	39,043	74
Non-Teaching	13,523	25
Primary expected payer		
Medicaid	30,438	58
Private insurance	18,092	34
Medicare	242	0.5
Other Payer#	3,655	7
Discharge quarter		
January- March	13,494	26
April-June	13,053	25
July-September	12,589	24
October-December	13,424	25
Bed-size category		
Small (1-99)	5,157	10
Medium (100-399)	11,720	22
Large (≥ 400)	35,690	68

*OR: operating room; #other payer: self-pay, no charge, and other; &ED: emergency department

Table 2. Hospital length of stay, total hospital charges, and total hospital costs by patient and hospital characteristics for patient discharges with a secondary diagnosis of obesity

Characteristics	Length of stay	Total charges	Total costs
All patients	4.1 (4.2)	$26,527 ($36722)	$8,396 ($12204)
Age Group			
2-4 y	3.1 (3.6)	$25,587 ($37,345)	$7,886 ($11,868)
5-10 y	3.7 (4.0)	$26,654 ($36,008)	$8,573 ($12,420)
11-18 y	4.2 (4.2)	$26,538 ($36,825)	$8,383 ($12,177)
Sex			
Male	4.2 (4.4)	$29,055 ($40,319)	$9,298 ($13,719)
Female	4.0 (3.9)	$24,877 ($34,033)	$7,806 ($11,051)
Race/ethnicity			
White	4.2 (4.1)	$24,752 ($35,648)	$8,077 ($12,205)
African-American	4.0 (4.2)	$24,587 ($33,451)	$7,771 ($11,344)
Hispanic	3.7 (3.9)	$32,306 ($41,597)	$9,246 ($12,726)
Other	4.1 (4.3)	$26,555 ($37,032)	$8,512 ($11,812)
Region of Hospital			
Northeast	4.3 (4.6)	$25,695 ($34,787)	$7,653 ($10,619)
Midwest	4.3 (4.0)	$22,139 ($29,149)	$7,997 ($11,476)
South	4.0 (4.1)	$24,886 ($37,109)	$7,860 ($12,418)
West	3.6 (3.9)	$34,609 ($42,875)	$10,290 ($13,507)
Hospitals teaching status			
Teaching	4.2 (4.3)	$28,428 ($39080)	$9,146 ($13,000)
Non-Teaching	3.7 (3.6)	$21,096 ($27945)	$6,251 ($9,097)
Median Income (by zip code)			
<38,999	4.4 (4.1)	$25,248 ($35164)	$7,863 ($11,616)
39,000 - 47,999	4.1 (4.0)	$26,225 ($36940)	$8,458 ($12,533)
48,000 - 62,999	4.1 (4.1)	$27,770 ($37959)	$8,830 ($12,711)
>63,000	4.2 (4.3)	$29,747 ($38341)	$9,322 ($12,221)
Admission day indicator			
Weekday	4.4 (4.2)	$26,695 ($37013)	$8,478 ($1,2279)
Weekend	3.8 (3.9)	$25,790 ($35409)	$8,037 ($11,860)
Bed-size category			
Small (1-99)	3.6 (3.9)	$27,365 ($39031)	$10,219 ($16,173)
Medium (100-399)	3.8 (3.7)	$26,750 ($37597)	$8,899 ($13,227)
Large (≥ 400)	4.3 (4.3)	$26,341 ($36125)	$7,988 ($11,189)
Major OR* procedure			
OR procedure	3.7 (3.8)	$45,437 ($50547)	$14,471 ($17,479)
No OR procedure	4.2 (4.2)	$21,017 ($28431)	$6,626 ($9,157)
Patients diabetes status			
Diabetic	3.8 (3.9)	$26,904 ($38474)	$8,549 ($12,240)
Non-Diabetic	4.1 (4.2)	$26,479 ($36494)	$8,376 ($12,199)

Total cost was identified by converting the total hospital charge to hospital cost estimates (Hospital Costs = Cost-to-Charge Ratios*Total Charges); Data are presented in mean (SD); OR, operating room

The average LOS for all patients was 4.1 days and the average cost per discharge was $8,396 (Table 2). Patients aged 11 to 18 had the highest average LOS (4.2), while patients aged 5 to10 had the highest average cost per discharge ($8,573). Compared to African-American patients ($7,771), Hispanic ($9,246) and White ($8,077) patients had a higher cost per discharge (Table 2). Higher average LOS was observed for White patients (4.2 days). In addition, teaching hospitals, weekday admission, hospital with small bed size, diabetic patients, higher household income, operating room procedures during hospitalization, and hospitals located in the western region were associated with higher costs. There was a statistically significant (based on two independent t-tests) average inpatient hospital cost difference of $607.35 between obese and non-obese children.

Table 3 Parameter estimates, SEs, and P values from multivariate regression analysis predicting total charge for patient discharges with a secondary diagnosis of obesity

Explanatory Variables	Parameter estimate	Standard error	P value
Intercept	-579.26	707.61	0.41
Age 5-10 y	484.70	264.26	0.06
Age 11-18 y	847.09	250.11	0.0007
African-American	43.44	111.82	0.69
Hispanic	183.32	119.94	0.12
Other	-458.49	166.21	0.0058
Male	782.29	87.57	<.0001
Emergency Service	1222.21	101.32	<.0001
Midwest	3548.33	159.41	<.0001
South	1497.03	168.95	<.0001
West	-217.69	227.99	0.33
Income 39,000-47,999	429.20	108.30	<.0001
Income 48,000-62,999	495.57	115.45	<.0001
Income > 63,000	846.29	136.84	<.0001
Died during hospitalization	24153.31	1196.14	<.0001
Elective Admission	1405.69	124.45	<.0001
Medium bed-size (100-399)	-583.21	165.04	0.0004
Large bed-size (≥ 400)	-1967.82	150.35	<.0001
Diabetic patients	954.89	134.77	<.0001
Non-teaching hospitals	-1725.73	97.78	<.0001
No. of procedure > 5	14440.05	296.98	<.0001
No. diagnosis > 6	1071.47	91.07	<.0001
No. of chronic conditions > 2	666.63	136.66	<.0001
Length of stay	1420.54	12.96	<.0001

Number of observations = 52,566; adjusted R^2 = 60.3%.

In the multivariate cost regression (Table 3), hospital cost per discharge was significant ($p<.05$) for male patients, 11-18 age group, LOS, in-hospital mortality, diabetic patients, teaching hospitals, procedure > 5, elective admission, chronic condition > 2, midwest and southern regions, admission through the emergency department, and medium and large hospitals. Predictors explained 60.3% of the variation in cost per discharge.

An additional day in the hospital was associated with an average $1,421 increase in hospital cost per discharge. Costs were $782 higher among male (vs female) patients. Compared to teaching hospitals, non-teaching hospital were associated $1,725 lower cost. Relative to eastern hospitals, midwest and southern hospital were associated with $3,548 and $1,497 higher costs, respectively, while western hospitals had $218 lower cost per discharge. Medium and large bed size hospitals were also associated with $583 and $1,768 lower cost, respectively, than small bed-size hospitals.

Admission through the emergency department was associated with $1,222 higher cost. Compared to non-diabetic patients, diabetic patients had $955 higher cost. In-hospital mortality was associated with $24,153 higher costs, chronic condition diagnosed during hospitalization was associated with $667 higher cost, and higher household income levels were increasingly associated with higher hospital costs (Table 3).

Discussion

Childhood obesity is a serious medical condition with longstanding consequences for the health of children. It has been established in the literature that there are significant inpatient hospital costs and average LOS for children with a primary diagnosis of obesity; however, this study shows that there are also significant inpatient hospital costs and average LOS for children with a *secondary* diagnosis of obesity. While many variables are expected to be associated with higher costs (e.g., inpatient days, admission through the ED, admission to a teaching hospital, higher numbers of beds, admission with comorbid diabetes, diagnosis of chronic disease while an inpatient, and admissions with mortality), variables such as hospital location in the mid-west and south, increased household income, Hispanic and white patients, male patients, and patients aged 5-10 years would not be intrinsically associated with increased costs. Similarly, the finding that patients aged 11-18 years are associated with longer average LOS is not intuitive.

As childhood obesity rates continue to increase, mitigating drivers for increased hospital inpatient costs and average LOS related to location, race, gender, and age is an important strategy to address cost and utilization concerns.

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