HHS Public Access

Author manuscript

Med Care. Author manuscript; available in PMC 2021 August 01.

Published in final edited form as:

Med Care. 2020 August ; 58(8): 722–726. doi:10.1097/MLR.0000000000001346.

Hospital Length of Stay, Charges, and Costs Associated With a Diagnosis of Obesity in US Children and Youth, 2006–2016

Lyudmyla Kompaniyets, PhD[*], **Elizabeth A. Lundeen, PhD**[*], **Brook Belay, MD, MPH**[*], **Alyson B. Goodman, MD, MPH**[*], **Florence Tangka, PhD**[†], **Heidi M. Blanck, PhD**[*]

[*]Division of Nutrition, Physical Activity, and Obesity (DNPAO);

[†]Division of Cancer Prevention and Control (DCPC), National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), Centers for Disease Control and Prevention (CDC), Atlanta, GA.

Abstract

Background: Childhood obesity is linked with adverse health outcomes and associated costs. Current information on the relationship between childhood obesity and inpatient costs is limited.

Objective: The objective of this study was to describe trends and quantify the link between childhood obesity diagnosis and hospitalization length of stay (LOS), costs, and charges.

Research Design: We use the National Inpatient Sample data from 2006 to 2016.

Subjects: The sample includes hospitalizations among children aged 2–19 years. The treatment group of interest includes child hospitalizations with an obesity diagnosis.

Measures: Hospital LOS, charges, and costs associated with a diagnosis of obesity.

Results: We find increases in obesity-coded hospitalizations and associated charges and costs during 2006–2016. Obesity as a primary diagnosis is associated with a shorter hospital LOS (by 1.8 d), but higher charges and costs (by $20,879 and $6049, respectively); obesity as a secondary diagnosis is associated with a longer LOS (by 0.8), and higher charges and costs of hospitalizations (by $3453 and $1359, respectively). The most common primary conditions occurring with a secondary diagnosis of obesity are pregnancy conditions, mood disorders, asthma, and diabetes; the effect of a secondary diagnosis of obesity on LOS, charges, and costs holds across these conditions.

Conclusions: Childhood obesity diagnosis-related hospitalizations, charges, and costs increased substantially during 2006–2016, and obesity diagnosis is associated with higher hospitalization charges and costs. Our findings provide clinicians and policymakers with additional evidence of

Correspondence to: Lyudmyla Kompaniyets, PhD, Division of Nutrition, Physical Activity and Obesity, Centers for Disease Control and Prevention, 4770 Buford Highway, NE, Mailstop S107-5, Atlanta, GA 30341-3717. opt4@cdc.gov.

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

The authors declare no conflict of interest.

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website, www.lww-medicalcare.com.

the economic burden of childhood obesity and further justify efforts to prevent and manage the disease.

Keywords

child obesity; hospital; inpatient; length of stay; charges; costs

Childhood obesity is a serious public health concern in the United States.[1] Prevalence of childhood obesity remains high, with 18.5% of children living with obesity.[2] Childhood obesity can result in higher health care costs, as it is associated with an increased risk of insulin resistance,[3,4] hypertension,[5] asthma,[6] and depression.[7]

Prior studies find associations between childhood obesity and hospital care utilization and costs. Trasande et al[8] find that obesity as a secondary diagnosis in children aged 2–19 years is associated with a 0.85-day higher length of stay (LOS), $1634 higher charges, and $727 higher costs (in 2005 dollars). Another study in 2000 shows that a secondary obesity diagnosis is associated with higher charges in hospitalizations with appendicitis, asthma, pneumonia, and affective disorders.[9] Wang and Dietz[10] report an increase in obesity-associated annual hospital costs for children from $35 million during 1979–1981 to $127 million during 1997–1999. Trasande et al[8] update these findings by demonstrating a near-doubling in obesity-coded child hospitalizations and a rise in costs from $125.9 to $237.6 million during 2001–2005.

These studies provide information on the inpatient costs of childhood obesity and their trends from the late 1970s to the mid-2000s. However, published studies on obesity-associated hospital care utilization and costs for children over the last decade are lacking. Our study analyzes the hospital LOS, charges, and costs associated with an obesity diagnosis among children aged 2–19 years over 2006–2016. We also present the overall patterns in obesity-coded hospitalizations, as well as the most frequent co-occurring conditions, where a primary diagnosis in a hospital setting exists in tandem with a secondary diagnosis of obesity.

METHODS

Our sample includes ~4.1 million discharges of children aged 2–19 years during 2006–2016, from the National Inpatient Sample (NIS) database. NIS is the largest publicly available and nationally representative all-payer inpatient health care database in the United States.

We differentiate between primary diagnosis and secondary (other) diagnoses. Primary diagnosis is the first-listed diagnosis, or “the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care.”[11] Secondary diagnoses are listed in positions 2–30 on the medical record.

To identify discharges with obesity diagnosis, we use the International Classification of Diseases, Ninth Revision (ICD-9) codes of 278.00 and 278.01 and the International Classification of Diseases, 10th Revision (ICD-10) codes of E66.8, E66.9, E66.0, E66.01, and E66.09. To identify primary conditions that co-occur with the secondary diagnosis of

obesity, we use the Clinical Classifications Software (CCS) tool that clusters the ICD diagnoses into distinct categories.

We convert charges and costs into 2016 dollars, using the Personal Consumption Expenditures: Health Care Index.[12] All data transformations are described in Appendix A1 (Supplemental Digital Content 1, http://links.lww.com/MLR/C20).

First, we plot the trends in hospitalizations, total and average charges, and costs (all unadjusted measures). Statistical significance of trends is assessed using nonparametric tests for trend across ordered groups. Then we identify 14 most frequent primary CCS diagnosis categories co-occurring with secondary obesity diagnosis over 2006–2016. Next, we use logistic regression, where the dependent variable is the presence of secondary obesity diagnosis, and the independent variables of interest are year, primary CCS diagnosis category (categorical variable with 14 categories), and their interaction. The average marginal effect of year represents the absolute annual change in the proportion of hospitalizations with a secondary diagnosis of obesity.

All statistical models include the following controls: race/ethnicity, sex, age group, hospital region, the median income for the patient's ZIP code (in quartiles), payer type, hospital location, and teaching status, year indicator, and ICD change indicator. We create a separate category for unreported race/ethnicity, sex, and income. All statistical analyses use the 5% significance level and are performed using SAS 9.4 and Stata/MP 15.1.

Next, we estimate the association between the diagnosis of obesity and 3 dependent variables: hospitalization LOS (model 1), charges (model 2), and costs (model 3). Model 1 is a negative binomial model with the log link function[13]; models 2 and 3 are generalized linear models with the log link and gamma distribution.[14] The independent variables of interest are the primary and secondary diagnoses of obesity (reference: no obesity diagnosis). Incremental differences are calculated as average marginal effects.

In addition, we analyze whether the link between obesity diagnosis (primary or secondary) and LOS, charges, and costs differs by sex or by primary CCS diagnosis. To accomplish this, we reestimate the 3 models above, introducing interactions between sex and obesity diagnosis (primary or secondary). We also reestimate the 3 original models, introducing primary CCS diagnostic category (categorical variable with 14 categories) and its interaction with the secondary diagnosis of obesity.

RESULTS

In our sample of child hospitalizations over 2006–2016, mean hospital LOS is 3.8 days, mean charges and costs are $29,333, and $9192 per hospitalization (Appendix Table A2, Supplemental Digital Content 1, http://links.lww.com/MLR/C20).

During 2006–2016, hospitalizations with a primary, secondary, and no obesity diagnosis increased by 56%, 83%, and 27%, respectively (Fig. 1). In hospitalizations with a primary, secondary, and no obesity diagnosis, the unadjusted total charges increased by 86%, 263%, and 48%, while the total costs increased by 47%, 182%, and 12%, respectively.

Among hospitalizations with a secondary diagnosis of obesity, pregnancy-related conditions represent the most frequent primary CCS diagnostic category, followed by mood disorders, asthma, and diabetes (Table 1). The proportion of hospitalizations with a secondary diagnosis of obesity ranges from 1.53% (within pneumonia CCS) to 14.56% (within biliary tract disease CCS). This proportion has increased from 0.12 percentage points (in pregnancy-related hospitalizations) to 0.72 percentage points annually (in biliary tract disease hospitalizations).

Obesity as a primary diagnosis (vs. no diagnosis of obesity) is associated with 1.8-day lower LOS, but $20,879 higher charge and $6049 higher cost (all $P < 0.001$) (Table 2). Obesity as a secondary diagnosis (vs. no diagnosis of obesity) is associated with 0.8-day higher LOS, $3453 higher charge, and $1359 higher cost (all $P < 0.001$). This positive association between secondary obesity and LOS holds in 10 of 14 primary CCS categories—ranging from 0.3 days for asthma to 0.9 days for lower limb fracture (Table 2). This association is not significant among hospitalizations for biliary tract disease, schizophrenia, or "other nervous system disorders," and negative among hospitalizations for "other bone disease and musculoskeletal deformities." The positive association between secondary obesity diagnosis and charges (costs) holds in 9 of 14 primary CCS categories. This association is not significant among hospitalizations for biliary tract disease, schizophrenia, or epilepsy, and negative among hospitalizations for "other bone disease and musculoskeletal deformities" or "other nervous system disorders."

The incremental difference in charges (costs) associated with a primary obesity diagnosis is higher in females, while the incremental difference in charges (costs) resulting from a secondary obesity diagnosis is higher in males. The association between LOS and obesity diagnosis is not statistically different by sex. The same incremental differences are shown as percentages in Appendix Table A3 (Supplemental Digital Content 1, http://links.lww.com/MLR/C20).

A robustness check using "any diagnosis of obesity" as the independent variable of interest yields marginal effects similar to those of secondary obesity diagnosis (results not shown).

DISCUSSION

Our study spanning the 2006–2016 period finds increases in the obesity-coded hospitalizations from 36,176 to 65,895, the associated total charges from $850.9 million to $3.03 billion, and costs from $313 to $868.4 million (in 2016 dollars). To the best of our knowledge, these data have not been updated since a 2009 analysis that finds a near-doubling in the number and total cost of hospitalizations with any obesity diagnosis over the 1999–2005 period.[8] The increase in hospitalizations, charges, and costs could be explained by a similar secular trend among all health conditions; however, our analysis shows a decrease in the overall number of child hospitalizations and an increase in obesity-associated hospitalizations, which partly explains the relative increase in obesity-associated total costs and charges. Increased hospitalizations with an obesity diagnosis could be explained by an increase in obesity-associated conditions and/or improved coding of obesity over time.

Pregnancy conditions constitute the most common primary CCS category in hospitalizations with a secondary diagnosis of obesity. Our findings of the most frequent primary diagnoses co-occurring with the secondary diagnosis of obesity are consistent with those of Trasande et al.[8] We find significant annual increases in the proportion of hospitalizations with a secondary diagnosis of obesity within all most frequent primary CCS categories.

Hospitalizations with a primary obesity diagnosis exhibit a significantly shorter LOS, but higher charges and costs, compared with hospitalizations with no obesity diagnosis. Principal procedures associated with these hospitalizations include gastroenterostomy, gastrectomy, gastroplasty, and gastric bypass. These costly procedures, often associated with bariatric surgery, may be associated with a shorter LOS, compared with other hospitalizations.[15] This may be due to the efficiency of these procedures and/or heterogeneity of hospitalizations in the reference category. Some examples include laparoscopic gastroenterostomy (2.13 mean LOS; $47,438 mean charge) and sleeve gastrectomy (1.84 mean LOS; $46,576 mean charge) versus the reference category most frequent primary diagnoses: pregnancy-related conditions (2.65 mean LOS; $14,266 mean charge) and mood disorders (6.76 mean LOS; $18,130 mean charge).

Hospitalizations with a secondary diagnosis of obesity exhibit a significantly longer LOS, and higher charges and costs than hospitalizations without an obesity diagnosis. This is consistent with previous studies of 1999–2005 data.[8,9] This positive association holds in pediatric conditions that commonly co-occur with obesity, such as asthma, mood disorders, and diabetes,[6,8,16–19] as well as pregnancy-associated hospitalizations. Given that pregnancy-associated hospitalizations account for around 18% of all hospitalizations with a secondary diagnosis of obesity, these hospitalizations contribute significantly to total charges and costs.

Among “other nervous system disorders,” which include benign intracranial hypertension, obesity diagnosis shows no link with LOS and negative associations with charges and costs. These findings may be due to multiple factors including: (1) the heterogenous nature of the condition; and (2) the possibility that obesity as a disease associated with intracranial hypertension may be recognized more readily, thus leading to earlier discharges and reduced costs.[20–23]

The association between obesity diagnosis and charges (costs) significantly differs by sex, which may be explained by the differences in the nature of hospitalizations by sex.

Our study has limitations. First, the adoption of obesity-related performance measures and increased recognition of childhood obesity as a public health problem during the study period may have affected provider coding behavior. Therefore, caution should be used in any final interpretation of the trend data. The second limitation is the shift in coding from ICD-9 to ICD-10, which we account for my including an indicator variable in all models. Third, the incremental differences in LOS, charges, and costs do not represent the causal effect of obesity on these measures, but their correlation with a diagnosis of obesity. Fourth, due to under-coding of obesity in claims, the total number, charges, and costs of obesity-associated hospitalizations are underestimated, while the incremental differences in LOS, charges, and

costs may be underestimated or overestimated. This approach was used because the measured body mass index is not available in this dataset. Fifth, cost-to-charge ratios are missing in ~3% of the observations, but we follow the Agency for Healthcare Research and Quality (AHRQ) guidelines to impute and reweight the cost estimates. Sixth, we do not control for Medicaid expansion by state, since the NIS dataset lacks state identifiers. Finally, findings may be affected by the increased number of allowable listed diagnoses per hospitalization across the years. Since only 0.88% of secondary obesity cases are recorded due to the increase, we argue that the effect of this increase on our results is likely negligible.

This paper presents evidence that hospitalizations for other conditions are more costly when obesity is present as a diagnosis and provides a rationale for why obesity prevention is important. It provides clinicians and policymakers with additional evidence of the economic burden of childhood obesity and further justifies efforts to prevent and manage the disease. Future research could link measured body mass index to medical claims–based expenditures, to more accurately capture the costs associated with obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENT

The authors thank Dr Mona Sharifi, MD, MPH, Assistant Professor of Pediatrics, Yale New Haven Hospital, for her review of this manuscript and constructive support.

REFERENCES

1. Centers for Disease Control and Prevention. Childhood obesity facts. 2019. Available at: www.cdc.gov/obesity/data/childhood.html. Accessed July 28, 2019.
2. Hales CM, Fryar CD, Carroll MD, et al. Trends in obesity and severe obesity prevalence in US youth and adults by sex and age, 2007–2008 to 2015–2016. JAMA. 2018;319:1723–1725. [PubMed: 29570750]
3. Friedemann C, Heneghan C, Mahtani K, et al. Cardiovascular disease risk in healthy children and its association with body mass index: systematic review and meta-analysis. BMJ. 2012;345:e4759. [PubMed: 23015032]
4. Kjellberg E, Roswall J, Bergman S, et al. Longitudinal birth cohort study found that a significant proportion of children had abnormal metabolic profiles and insulin resistance at 6 years of age. Acta Paediatr. 2019;108:486–492. [PubMed: 30328152]
5. Jackson SL, Zhang Z, Wiltz JL, et al. Hypertension among youths—United States, 2001–2016. MMWR Morb Mortal Wkly Rep. 2018;67:758–762. [PubMed: 30001558]
6. Okubo Y, Nochioka K, Hataya H, et al. Burden of obesity on pediatric inpatients with acute asthma exacerbation in the United States. J Allergy Clin Immunol Pract. 2016;4:1227–1231. [PubMed: 27372599]
7. Sutaria S, Devakumar D, Yasuda SS, et al. Is obesity associated with depression in children? Systematic review and meta-analysis. Arch Dis Child. 2019;104:64–74. [PubMed: 29959128]
8. Trasande L, Liu Y, Fryer G, et al. Effects of childhood obesity on hospital care and costs, 1999–2005. Health Aff (Millwood). 2009;28:w751–w760. [PubMed: 19589800]
9. Woolford SJ, Gebremariam A, Clark SJ, et al. Incremental hospital charges associated with obesity as a secondary diagnosis in children. Obesity. 2007;15:1895–1901. [PubMed: 17636109]

10. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979–1999. Pediatrics. 2002;109:e81. [PubMed: 11986487]
11. Healthcare Cost and Utilization Project (HCUP). NIS description of data elements. Agency for Healthcare Research and Quality: Rockville, MD; 2018. Available at: www.hcup-us.ahrq.gov/db/nation/nis/nisdde.jsp. Accessed May 25, 2019.
12. Dunn A, Grosse SD, Zuvekas SH. Adjusting health expenditures for inflation: a review of measures for health services research in the United States. Health Serv Res. 2018;53:175–196. [PubMed: 27873305]
13. Cameron AC, Trivedi PK. Regression Analysis of Count Data. Cambridge, UK: Cambridge University Press; 2013.
14. Manning WG, Mullahy J. Estimating log models: to transform or not to transform? J Health Econ. 2001;20:461–494. [PubMed: 11469231]
15. Jakob T, Cal P, Deluca L, et al. Shorter than 24-h hospital stay for sleeve gastrectomy is safe and feasible. Surg Endosc. 2016;30:5596–5600. [PubMed: 27142438]
16. Carsley S, Tu K, Parkin PC, et al. Overweight and obesity in preschool aged children and risk of mental health service utilization. Int J Obes (Lond). 2019;43:1325–1333. [PubMed: 30546134]
17. Twig G, Reichman B, Afek A, et al. Severe obesity and cardio-metabolic comorbidities: a nationwide study of 2.8 million adolescents. Int J Obes (Lond). 2019;43:1391–1399. [PubMed: 30258119]
18. Kloppenborg JT, Fonvig CE, Nielsen TR, et al. Impaired fasting glucose and the metabolic profile in Danish children and adolescents with normal weight, overweight, or obesity. Pediatr Diabetes. 2018;19:356–365. [PubMed: 29193487]
19. Bettenhausen J, Puls H, Queen MA, et al. Childhood obesity and in-hospital asthma resource utilization. J Hosp Med. 2015;10:160–164. [PubMed: 25449960]
20. Paley GL, Sheldon CA, Burrows EK, et al. Overweight and obesity in pediatric secondary pseudotumor cerebri syndrome. Am J Ophthalmol. 2015;159:344–352. [PubMed: 25447107]
21. Matthews Y-Y, Dean F, Lim MJ, et al. Pseudotumor cerebri syndrome in childhood: incidence, clinical profile and risk factors in a national prospective population-based cohort study. Arch Dis Child. 2017;102:715–721. [PubMed: 28356250]
22. Smith SV, Friedman DI. The idiopathic intracranial hypertension treatment trial: a review of the outcomes. Headache. 2017;57:1303–1310. [PubMed: 28758206]
23. Markey KA, Mollan SP, Jensen RH, et al. Understanding idiopathic intracranial hypertension: mechanisms, management, and future directions. Lancet Neurol. 2016;15:78–91. [PubMed: 26700907]

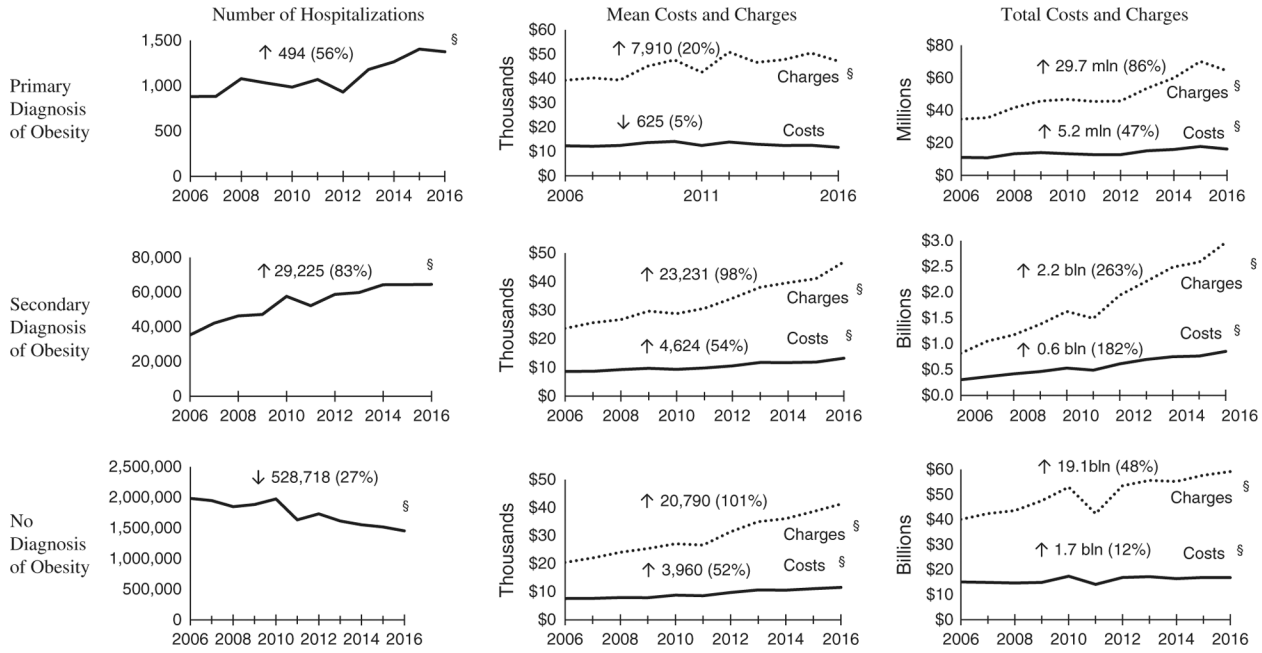

FIGURE 1.

Trends in hospitalizations, costs, and charges among children and youth aged 2–19 years, 2006–2016. Estimates of hospitalizations, charges, and costs are unadjusted measures. The percentages represent the relative percent change of each measure from 2006 to 2016, not annual change. §$P < 0.05$ in the nonparametric tests for the trends in the number of hospitalizations, mean, and total charges and costs. *Source*: Authors' analysis of data from the National Inpatient Sample (NIS), 2006–2016.

TABLE 1.

Primary CCS Diagnoses That Most Frequently Co-occur With the Secondary Diagnosis of Obesity, 2006–2016

Primary CCS Diagnosis (n)	No. Hospitalizations With a Secondary Diagnosis of Obesity 2006–2016	Percent of Hospitalizations With a Secondary Diagnosis of Obesity Within Each Primary CCS Category 2006–2016	Annual Change (Absolute Percentage Points) in the Proportion of Hospitalizations With a Secondary Diagnosis of Obesity—Within Each Primary CCS Category (95% CI)
Pregnancy-related conditions (181–196)	106,132	2.64	+0.12 (0.11, 0.13)***
MHSA: mood disorders (657)	89,464	6.25	+0.36 (0.33, 0.40)***
Asthma (128)	33,423	3.35	+0.41 (0.37, 0.45)***
Diabetes (49–50)	24,282	5.70	+0.36 (0.33, 0.40)***
Appendicitis (142)	20,890	2.50	+0.21 (0.19, 0.23)***
Biliary tract disease (149)	19,247	14.56	+0.72 (0.65, 0.79)***
Skin and subcutaneous tissue infections (197)	16,962	3.54	+0.34 (0.31, 0.38)***
Pneumonia (122)	12,998	1.53	+0.23 (0.21, 0.26)***
MHSA: schizophrenia and other psychotic disorders (659)	9590	6.19	+0.34 (0.30, 0.37)***
Epilepsy, convulsions (83)	9387	1.72	+0.17 (0.16, 0.19)***
Pancreatic disorders (152)	9296	10.62	+0.62 (0.56, 0.68)***
Other bone disease and musculoskeletal deformities (212)	8188	6.02	+0.37 (0.33, 0.41)***
Other nervous system disorders (95)	7158	5.34	+0.39 (0.35, 0.44)***
Fracture of lower limb (230)	6673	2.65	+0.22 (0.20, 0.24)***

The model estimated in column 4 includes race/ethnicity, sex, age group, hospital region, median income for patient's ZIP code, payer type, location, and teaching status, International Classification of Diseases change as controls.

CCS indicates clinical classifications software; CI, confidence interval; MHSA, mental health and/or substance abuse.

*** $P < 0.001$.

Source: Authors' analysis of data from the National Inpatient Sample (NIS), 2006–2016.

TABLE 2.

Length of Stay, Charges, and Costs For Hospitalizations Among Children and Youth Aged 2–19 Years With a Diagnosis of Obesity, 2006–2016

Independent Variable	Increment (95% CI) in Length of Stay Associated With Diagnosis of Obesity	Increment (95% CI) in Total Charges Associated With Diagnosis of Obesity	Increment (95% CI) in Total Costs Associated With Diagnosis of Obesity
Obesity as a primary diagnosis	−1.8 (−1.9, −1.6)***	+20,879 (17,611, 24,146)***	+6,049 (4687, 7410)***
By sex			
Males	−1.9 (−2.2, −1.5)***	+14,894 (10,822, 18,965)***^^^	+4247 (2674, 5820)***^^^
Females	−1.6 (−1.7, −1.6)***	+21,044 (17,886, 24,202)***^^^	+6127 (4836, 7418)***^^^
Obesity as a secondary diagnosis	+0.8 (0.7, 0.9)***	+3453 (2802, 4104)***	+1359 (1161.9, 1556)***
By sex			
Males	+0.9 (0.8, 1.1)***	+5080 (3862, 6297)***^^	+2021 (1617, 2426)***^^^
Females	+0.7 (0.6, 0.8)***	+2613 (2048, 3178)***^^	+1020 (849, 1191)***^^^
By primary condition			
Pregnancy-related conditions	+0.5 (0.4, 0.5)***	+2903.6 (2518, 3289)***	+1099 (994, 1204)***
MHSA: mood disorders	+0.5 (0.3, 0.7)***	+1760 (1121, 2400)***	+662.7 (482, 843)***
Asthma	+0.3 (0.3, 0.4)***	+3116 (2281, 3951)***	+1116 (866, 1365)***
Diabetes	+0.5 (0.4, 0.6)***	+1566 (703, 2429)***	+686 (406, 965)***
Appendicitis	+0.3 (0.2, 0.4)***	+3404 (2261, 4547)***	+1086 (777, 1396)***
Biliary tract disease	−0.1 (−0.2, 0.01)	−598 (−1763, 567)	−206 (−549, 137)
Skin and subcutaneous tissue infections	+0.5 (0.4, 0.6)***	+3697 (2880, 4513)***	+1332 (1077, 1587)***
Pneumonia	+0.6 (0.4, 0.8)***	+8105 (5318, 10,892)***	+2829 (2004, 3654)***
MHSA: schizophrenia	+0.9 (−0.05, 1.8)	+1034 (−995, 3062)	+397 (−332, 1126)
Epilepsy, convulsions	+0.2 (0.01, 0.4)*	+1419 (−881, 3717)	+590 (−98, 1278)
Pancreatic disorders	+0.4 (0.1, 0.7)*	+5124 (2300, 7948)***	+1593 (778, 2408)***
Other bone disease	−0.7 (−0.9, −0.5)***	−34,494 (−39,005, −29,983)***	−10,775 (−12,278, −9271)***
Other nervous system disorders	−0.1 (−0.5, 0.3)	−6629 (−9960, −3298)***	−1686.3 (−2720, −652)**
Fracture of lower limb	+0.9 (0.6, 1.2)***	+6431 (3131.0, 9730)***	+2356 (1404, 3307)***
Observations	4,041,963	3,975,469	3,903,598

Each model includes race/ethnicity, sex, age group, hospital region, median income for patient's ZIP code, payer type, location, and teaching status, year, International Classification of Diseases change as controls.

CI indicates confidence interval; MHSA, mental health and/or substance abuse.

*$P < 0.05$,

**$P < 0.01$,

***$P < 0.001$ (statistical difference from 0).

^^$P < 0.01$,

^^^$P < 0.001$ (statistical difference of interaction on sex).

Source: Authors' analysis of data from the National Inpatient Sample (NIS), 2006–2016.