

Incremental Hospital Charges Associated With Obesity as a Secondary Diagnosis in Children

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Abstract

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Objective: The objective was to evaluate the association of obesity as a comorbidity with hospital charges, by comparing charges for pediatric hospitalizations with vs. without obesity as a secondary diagnosis.

Methods: Using the 2000 Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID), a nationally representative sample of pediatric hospital discharges, we identified the most common non-pregnancy-related principal diagnoses for children 2 to 18 years of age: asthma, pneumonia, affective disorders, and appendicitis. For each we compared mean charges and mean length of stay for hospitalizations with vs. without obesity as a secondary diagnosis, adjusting for relevant socio-demographics and hospital type.

Results: Among children's discharges in 2000, 1.1% listed obesity as a secondary diagnosis. These had a disproportionate likelihood of being older, black, Medicaid beneficiaries, and hospitalized at a general hospital. Adjusted mean hospital charges were significantly higher for discharges with obesity as a secondary diagnosis vs. those without: appendicitis (\$14,134 vs. \$11,049; $p < 0.01$), asthma (\$7766 vs. \$6043; $p < 0.05$), pneumonia (\$12,228 vs. \$9688; $p < 0.05$), and affective disorders (\$8292 vs. \$7769; $p < 0.01$). Whereas obesity as a secondary diagnosis

was associated with a pattern of increased adjusted mean length of stay, only asthma and affective disorders had statistically significant differences (0.6 days) ($p < 0.01$).

Conclusion: This national analysis suggests obesity as a secondary diagnosis is associated with significantly higher charges for the most common reasons for pediatric hospitalizations. This presents a financial imperative for further research to evaluate factors that contribute to higher inpatient charges related to obesity as a comorbidity and underscores the need for obesity prevention initiatives.

Key words: pediatrics, hospitalization, secondary diagnosis, comorbidity, economics

Introduction

Although recent increases in the prevalence of childhood overweight (BMI at the 95th percentile or greater for sex and age) have been well documented (1–3),¹ the economic burden of obesity has been studied almost exclusively in adults (4–6). To our knowledge, only one study has estimated the economic costs of obesity-related conditions incurred during childhood. In their investigation of hospital costs, Wang and Dietz (7,8) focused chiefly on classic outcomes of obesity, such as diabetes, sleep apnea, and gallbladder disease. However, healthcare costs attributable to obesity in children who have not yet developed these classic outcomes of obesity were not examined and remain unknown.

The objective of this study was to broaden the perspective of the economic consequences of childhood obesity, by examining specific charge and length-of-stay (LOS)² data for pediatric discharges with obesity listed as a secondary diagnosis among children hospitalized for common pediatric illness not traditionally linked to obesity. We assumed that such discharges would reflect instances in which obe-

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¹ The "overweight" designation is equivalent to obesity among adults, and since childhood overweight must be coded as *obesity* on ICD-9-CM provider encounter forms, we will use the term obesity for the remainder of this manuscript.

² Nonstandard abbreviations: LOS, length of stay; KID, Kid's Inpatient Database 2000; ICD-9-CM, *International Classification of Diseases*, 9th Revision, *Clinical Modification*; CCS, Clinical Classification Software.

sity contributed to the clinical course but was not as directly linked to the reason for admission as in the previous study by Wang and Dietz (7,8). Importantly, studies in adults have shown that patients with obesity may experience a higher severity of respiratory symptoms because of altered pulmonary physiology, and obesity may also generally lead to an increased complexity of procedures (9,10).

Thus, we hypothesized that, among pediatric patients hospitalized for common childhood illnesses, the presence of obesity as a comorbid but not necessarily causative condition would be associated with higher hospital charges and longer LOS. In other words, obesity may serve as a clinically meaningful comorbidity for conditions to which it has not traditionally been physiologically linked, and as such may influence hospital LOS and charges.

Research Methods and Procedures

Data Source and Sample

We analyzed data from the Healthcare Cost and Utilization Project Kids' Inpatient Database (KID) for the year 2000, a nationally representative sample of annual pediatric hospital discharges. Analysis using the KID allows for improved estimates due to the discharge from community, non-rehabilitation hospitals in the 27 Healthcare Cost and Utilization Project participating states. Excluded are long-term hospitals, psychiatric hospitals, and alcohol/chemical dependency treatment facilities (11). The KID includes a sample of pediatric discharges from all hospitals in the sampling frame. Stratified systematic sampling was utilized to select 10% of uncomplicated in-hospital births and 80% of other pediatric cases (12). Data found in standard hospital discharge abstracts are provided for >2 million pediatric discharges. For each discharge, it includes *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes, LOS, total hospital charges, and patient demographic information (11).

Using ICD-9-CM codes, the KID provides the principal diagnosis for each discharge, along with up to 14 secondary diagnoses. It also provides Clinical Classification Software (CCS) codes, a diagnostic categorization scheme that permits grouping of related conditions. ICD-9-CM codes are collapsed into a smaller number of categories that are sometimes more useful for presenting descriptive statistics than are individual ICD-9-CM codes or the much broader categories of Diagnosis Related Groups. For example, all ICD-9-CM codes for specific types of pneumonia would be grouped together under one CCS code but would exclude other respiratory conditions such as pneumothorax, which would generally be included in the respiratory condition Diagnosis Related Group (11).

The 2000 KID contained 2,516,833 unweighted discharges, representing 7,291,038 discharges in the population. Our sample included all discharges for non-pregnancy-

related conditions, in children 2 years of age (due to the Centers for Disease Control definition for overweight based on BMI that starts at age 2) (13,14) to 18 years of age (unweighted $N = 1,741,765$).

Key Variables

Outcome Variables. Our outcome variables were LOS and total charges for each common non-pregnancy-related principal discharge diagnosis. For the 2000 KID, total charges included all hospital fees with the exception of professional fees (15).

Main Independent Variable of Interest. The presence of obesity as a secondary diagnosis was considered our main independent variable of interest. Discharges were classified as either with or without obesity based on the presence of the ICD-9-CM code 278.0x as a secondary diagnosis (1 if yes, 0 if no).

Other Independent Variables. Sex, age (2 to 5, 6 to 10, 11 to 14, and 15 to 18 years), race (white, black, Hispanic, other), region (Northeast, Midwest, South, West), hospital type, based on classification by the National Association of Children's Hospitals and Related Institutions (general hospital, children's unit in a general hospital, and children's hospital), and payer, based on the payer listed as the expected primary payer (Medicaid, private, other), were considered other independent variables. We chose independent variables due to their established association with our outcomes and for their pattern of association with childhood obesity.

Analyses

Using CCS codes, we identified the 5 most common principal non-pregnancy-related discharge diagnoses for children 2 to 18 years old. These were asthma (CCS 128), pneumonia (CCS 122), affective disorders (e.g., depression and bipolar disorder) (CCS 69), appendicitis (CCS 142), and fluid/electrolyte disorders (CCS 55). Importantly, this group of diagnoses included conditions associated with obesity and conditions not associated with obesity. Given this distinction, we analyzed diagnostic subgroups separately.

For all discharges associated with these common principal diagnoses, we calculated mean LOS and mean total charges. Bivariate and multivariable analyses were designed to test the study hypothesis that obesity as a secondary diagnosis is associated with incremental economic charges and LOS. We composed our model of characteristics that we hypothesized as potentially related to hospital charges and LOS, based on published literature (4,16,17). The covariates that we decided to include in the model were retained in the final models regardless of the bivariate associations of the covariates with the outcomes. For each independent variable with missing data, we included in the analyses a category for unreported values. The KID is

known to have a large number of missing data for race; therefore, in keeping with other studies using the KID (18), we also ran our multivariate analyses excluding those discharges with unreported race, and we present our findings including the unreported race category.

Multiple linear regression was performed adjusting for the covariates listed above. We conducted our regressions after log-transformation of LOS and total charge data, due to the skewed nature of their distributions. Predicted values on the log scale, for those with obesity and without obesity as a secondary diagnosis adjusted for the listed covariates, were obtained. We then back transformed these to their original scale using methods developed by Duan (19). For each principal diagnosis, we analyzed the differences in predicted mean LOS and predicted mean total charges between discharges with and without obesity as a secondary diagnosis, adjusted for the listed covariates, using the *p* values obtained from the regression analyses.

We also considered the potential influence on our dependent variables of comorbidities besides obesity. We, therefore, examined whether other comorbidities were listed more frequently in hospitalizations with obesity than in hospitalizations without obesity. The only comorbidity that appeared more often in the obesity-related hospitalizations was diabetes. However, the proportion of discharges with obesity and diabetes present together was low for all of the principal diagnostic categories studied (asthma 4.9%, pneumonia 6.6%, affective disorders 3.0%, and appendicitis 1.0%). Therefore, we judged the co-occurrence of diabetes and obesity as secondary diagnoses too infrequent to be an explanatory factor for the overall incremental differences in LOS and charges.

All analyses were weighted to account for the complex probability sampling of the dataset and permit inferences regarding national hospital discharge patterns. The same sample of discharges was used to analyze LOS and charges, with the weighting variable DISCWT used for all variables except charges and the weighting variable DISCWT-CHARGE used for estimates of charges. All results are presented as weighted data unless otherwise noted. All analyses were conducted using STATA 8.0 (StataCorp LP., College Station, TX).

This study was approved by the Institutional Review Board of the University of Michigan Medical School.

Results

After applying our exclusion criteria, 771,274 unweighted discharges remained for analysis. Characteristics of the discharges in the study subpopulation are presented in Table 1. Among those non-pregnancy-related discharges for children 2 to 18 years old, 1.1% had obesity listed as a secondary diagnosis. Those with obesity as a secondary diagnosis were generally older, more likely of black race, and more likely hospitalized at general hospitals. In addition,

the proportion of discharges with obesity as a secondary diagnosis charged to Medicaid was consistently 5% to 10% higher than among discharges without obesity.

Sample Characteristics

Among the non-pregnancy-related discharges for children 2 to 18 years old, the five most common CCS category diagnoses, in decreasing order of frequency, were asthma, pneumonia, affective disorders, appendicitis, and fluid and electrolyte disorders. The proportion of discharges within each of the CCS categories studied, which had obesity as a secondary diagnosis, were as follows: asthma, 1.4%; pneumonia, 0.6%; affective disorders, 4.3%; and appendicitis, 0.8% (Figure 1). Among the fluid/electrolyte disorders, there were too few observations with obesity as a secondary diagnosis (57 discharges) to permit further analysis of this group (20).

Discharges with obesity as a secondary diagnosis were disproportionately more likely to occur among females and older children across all 4 remaining CCS categories. For race/ethnicity and hospital type, there were also significant differences comparing diagnoses with vs. without obesity, but these differences did not follow consistent patterns across the 4 CCS categories. Of note, analyses of these data excluding children of unreported race were not substantively different from those where the unreported group was excluded (data not shown). We provide demographic details by diagnostic category in a separate appendix available online (see *Obesity* website, www.obesityresearch.org).

Differences in Mean Charges

In Table 2, we present results for analyses of mean charges. For all 4 of these common discharge conditions, the adjusted mean hospital charges were statistically significantly higher for discharges in which obesity was listed as a secondary diagnosis, compared with those where it was not. The greatest relative differences occurred among discharges for asthma (29%), appendicitis (28%), and pneumonia (26%).

Differences in Mean LOS

While obesity as a secondary diagnosis was associated with a pattern of increased mean LOS for all 4 diagnostic categories studied, only asthma and affective disorders had longer LOS that were statistically significant. In both cases, children with obesity listed as a secondary diagnosis stayed 0.6 days longer, on average, than children without obesity listed as a secondary diagnosis (Table 3).

Discussion

Recently published analyses of the national economic burden of obesity (4,5) have not included children. However, the potential financial repercussions associated with

Table 1. Characteristics of the study subpopulation from the 2000 KID

Variable	Discharges*	
	With obesity as secondary diagnosis	Without obesity
Unweighted <i>n</i>	8696	762,407
Weighted population size	17,672	1,509,637
Age (%)		
2 to 5 yrs	4.8	27.4
6 to 10 yrs	14.7	22.4
11 to 14 yrs	34.4	20.9
15 to 18 yrs	46.1	29.3
Sex (%)		
Male	45.5	53.8
Race/ethnicity (%)		
White	46.8	50.9
Black	20.7	14.3
Hispanic	14.9	14.3
Other	4.8	5.6
Unreported	12.8	14.9
Payer (%)		
Medicaid	42.6	32.1
Private	47.1	58.0
Other	9.4	9.4
Unreported	0.9	0.5
Hospital region (%)		
Northeast	17.3	21.7
Midwest	24.6	20.0
South	37.6	36.3
West	20.5	22.0
Hospital type (%)		
General hospital	68.2	61.0
Children's unit in general hospital	15.2	18.6
Children's hospital	14.3	17.9
Unreported	2.3	2.5

KID, Kid's Inpatient Database 2000.

* Non-maternal discharges 2 to 18 years old, excluding discharges with obesity as a primary diagnosis (unweighted, *n* = 171).

increasing rates of pediatric obesity over the last two decades warrant attention. We chose to examine hospitalizations because they account for nearly one fourth of health-care costs nationally (21). Additionally, because many pediatric patients may not yet have developed common outcomes of obesity, we chose to focus on the impact of obesity on charges for common childhood discharge diagnoses. Examining the 4 most common hospital discharge diagnoses for children, we found that obesity as a secondary diagnosis was associated with significantly higher charges.

These differences persisted even when controlling for sex, age, race/ethnicity, region, payer, and hospital type. While obesity as a secondary diagnosis was associated with a pattern of increased adjusted mean LOS, only asthma and affective disorders had statistically significant differences.

The only previous study to examine the costs of childhood obesity used fiscal data from discharges regardless of diagnosis to calculate their estimates (7). To our knowledge, ours is the first study to use patient-specific charge data to assess the charges associated with obesity in the pediatric

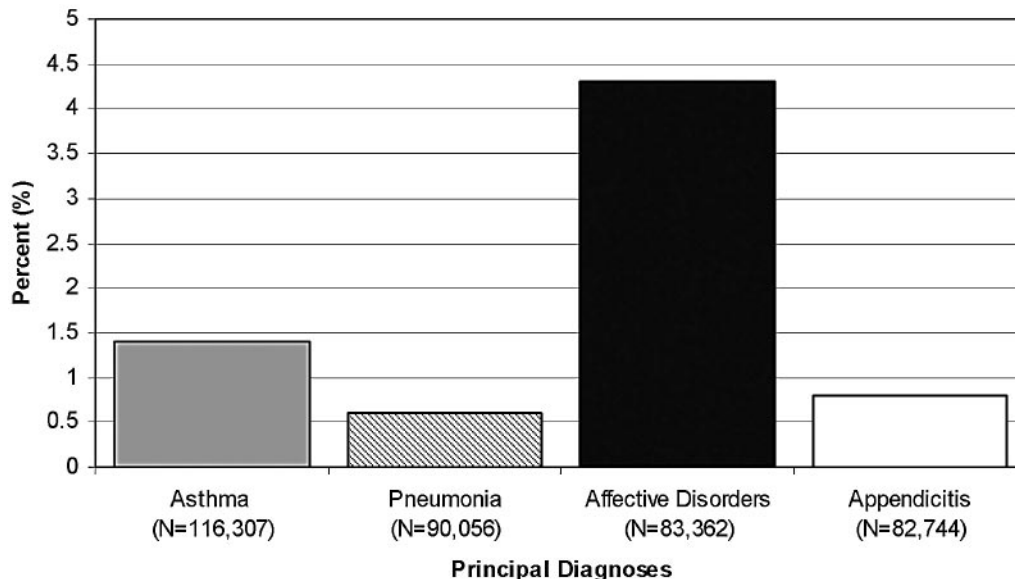


Figure 1: Proportions of discharges for four common principal diagnoses with obesity as a secondary diagnosis.

population and the first to focus primarily on the incremental charges incurred with obesity as a secondary diagnosis.

Our findings reveal longer LOS and significantly higher charges incurred by children for whom obesity was coded as a secondary diagnosis, but the clinical underpinnings of these findings are yet to be determined. Whereas the results regarding higher charges were consistent across the four diagnostic categories, the underlying mechanisms for these increases may not be the same. Concordant with our original hypotheses based on the adult literature (9,10), the respiratory illnesses may have higher charges and longer LOS due to increased severity of symptoms. In contrast, a surgical diagnosis such as appendicitis may be affected by increased complexity of procedures related to a patient’s weight status, thereby prolonging stays and increasing charges. Increased need for care due to appropriate referrals such as

nutrition consults, challenges associated with airway management, and difficulty with vascular access leading to, for example, a delay in initiation of treatment, may have impacted resource use for all categories studied. However, we were unable to investigate whether these issues indeed explained our findings using the KID database.

For three of the four diagnostic categories examined, Medicaid beneficiaries accounted for a significantly higher proportion of discharges associated with obesity than they did for discharges without. This suggests that Medicaid might shoulder a disproportionate burden of the economic consequences associated with childhood obesity. In turn, this pattern presents an economic rationale for increased national funding to develop effective obesity prevention and treatment programs, and to help implement such programs particularly in communities that Medicaid serves. With Medicaid funding at both state and federal levels facing

Table 2. Mean charges for discharges coded with obesity as a comorbidity vs. those without

Principal diagnosis	Adjusted* mean charges (\$)		Difference (\$)	Adjusted <i>p</i>
	With obesity	Without obesity		
Asthma (<i>N</i> = 116,307)	7766	6043	1723	0.012
Pneumonia (<i>N</i> = 90,056)	12,228	9688	2540	0.016
Affective disorders (<i>N</i> = 83,362)	8292	7769	523	0.001
Appendicitis (<i>N</i> = 82,744)	14,134	11,049	3085	0.005

Discharge-level weight (DISCWTCARGE) used to estimate charges, which accounts for missing Texas data.

* Adjusted for sex, age, race, region, payer, and hospital type.

Table 3. Mean length of stay (days) for discharges coded with obesity as a comorbidity vs. those without

Principal diagnosis	Adjusted* mean LOS		Difference	Adjusted <i>p</i>
	With obesity	Without obesity		
Asthma (<i>N</i> = 116,307)	3.04	2.45	0.6	<0.001
Pneumonia (<i>N</i> = 90,056)	4.26	3.89	0.4	0.064
Affective disorders (<i>N</i> = 83,362)	7.72	7.11	0.6	0.001
Appendicitis (<i>N</i> = 82,744)	3.33	3.16	0.2	0.187

LOS, length of stay.

* Adjusted for sex, age, race, region, payer, and hospital type.

major fiscal constraints, any clinical factor associated with consistently higher charges warrants programmatic attention.

An additional noteworthy result from this study was the prevalence of discharges for affective disorders that included obesity as a secondary diagnosis. At 4.3%, this rate was more than three times higher than those seen with any of the other common diagnostic categories that we examined. While not necessarily implying causality, this speaks to the strong clinical association of psychological problems with childhood obesity, which may manifest as anything from decreased quality of life to social isolation to depression (22–24). Although the difference in mean charges for those discharges with and without obesity in this CCS category was modest (\$523), the net effect nationally is incremental charges in excess of \$1 million.

Our findings support our hypothesis that obesity, at least in this group of common discharges coded with obesity, has an economic implication beyond that caused by the “classic” clinical consequences of obesity. These findings suggest the need for further research to explore the clinical basis for the higher charges associated with obesity in children before the onset of the classic comorbidities of obesity. In particular, it is essential to determine the specific ways in which obesity complicates care for common childhood illnesses. Of note, while we focused exclusively on hospital charges, care in the outpatient setting may also be influenced by the presence of childhood obesity. This remains an area yet to be evaluated.

Limitations

Analyses using discharge data are potentially limited by the accuracy and consistency of coding. The ability to identify obesity, especially as a comorbidity, is particularly affected by this constraint. This may stem from the absence of any clear financial incentive to include obesity among the discharge diagnoses, as it is not typically reimbursable (25). The prevalence of discharges in our study subpopulation coded with obesity as a secondary diagnosis in this sample

was 1.1%. Although there are no prior studies that indicate how frequently obese children are hospitalized, national prevalence data regarding child and adolescent obesity suggest that this prevalence is likely to under-represent the actual prevalence of obesity among hospitalized pediatric patients.

If these discharges are representative of the population of discharges where obesity was present but not coded, then our study would likely underestimate the incremental economic implications of obesity. Alternatively, the discharges coded with obesity as a secondary diagnosis may represent more severe cases of obesity. If this is the case, we cannot generalize our finding to all discharges with obesity but only to those discharges in which obesity was deemed clinically significant enough to warrant inclusion among the discharge diagnoses, as a formal secondary diagnosis (as stipulated by ICD-9-CM guidelines for official recording) (26).

Although the KID provides national estimates of discharge level data, the dataset offers limited ability to examine patterns of diagnostic or ancillary procedures or to distinguish between comorbid conditions present on admission and in-hospital complications of pediatric asthma, pneumonia, affective disorders, and appendicitis (27). Analyses related to race/ethnicity were also limited by missing data. However, our results remained consistent whether including or excluding the “race unreported” group. Across the CCS categories, there were variable race patterns that likely relate to rates of obesity for each diagnosis and/or other healthcare patterns.

In the KID, once we went beyond the fourth most common non-pregnancy-related principal diagnosis, the number of unweighted cases with obesity listed as a secondary diagnosis was too small to offer reliable estimates. Thus, our ability to explore the relationship between obesity as a secondary diagnosis and incremental charges and LOS for other clinical categories was hampered. Findings may differ for other conditions not evaluated here.

Finally, hospital charges are related to but not a precise reflection of the cost of hospital care. Importantly, we do not expect that the ratio of hospital costs to charges varies by whether obesity was coded as a comorbidity or not.

In summary, obesity appears to influence patterns of hospital care for children, not just for outcomes commonly associated with obesity, but for common hospital conditions generally considered unrelated to obesity as well. Among the most prevalent non-pregnancy-related causes for pediatric hospitalization, obesity as a secondary diagnosis was consistently associated with significantly higher hospital charges and frequently associated with longer LOS.

The precise etiology of these differences remains unknown. However, these findings may have implications for both clinicians and healthcare payers. For clinicians, higher charges and longer lengths of stay may reflect additional challenges in caring for children with obesity in the inpatient setting. For healthcare payers, higher hospital charges associated with obesity for common childhood conditions may prove to be a financial incentive for obesity prevention efforts and for the reimbursement of obesity treatment in the ambulatory setting.

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