

Resource Utilization and Expenditures for Overweight and Obese Children

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Objectives: To compare health care utilization and expenditures for healthy-weight patients, overweight patients, and patients with diagnosed and undiagnosed obesity and to examine factors associated with a diagnosis of obesity.

Design: Retrospective study using claims data from a large pediatric integrated delivery system.

Setting: An urban academic children's hospital.

Participants: Children aged 5 to 18 years who presented to a primary care clinic for well-child care visits during the calendar years 2002 and 2003 and who were followed up for 12 months.

Main Outcome Measures: Diagnosis of obesity, primary care visits, emergency department visits, laboratory use, and health care charges.

Results: Of 8404 patients, 57.9% were 10 years or older, 61.2% were African American, and 72.9% were insured by Medicaid. According to the criteria of body mass index (cal-

culated as weight in kilograms divided by the square of height in meters), 17.8% were overweight and 21.9% were obese. Of the obese children, 42.9% had a diagnosis of obesity. Increased laboratory use was found in both children with diagnosed obesity (odds ratio [OR], 5.49; 95% confidence interval [CI], 4.65-6.48) and children with undiagnosed obesity (OR, 2.32; 95% CI, 1.97-2.74), relative to the healthy-weight group. Health care expenditures were significantly higher for children with diagnosed obesity (adjusted mean difference, \$172; 95% CI, \$138-\$206) vs the healthy-weight group. Factors associated with the diagnosis of obesity were age 10 years and older (OR, 2.7; 95% CI, 2.0-3.4), female sex (OR, 1.5; 95% CI, 1.2-1.8), and having Medicaid (OR, 1.6; 95% CI, 1.1-2.3).

Conclusions: Increased health care utilization and charges reported in obese adults are also present in obese children. Most children with obesity had not been diagnosed as having obesity in this administrative data set.

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CHILDHOOD OVERWEIGHT and obesity now affect 3 in 10 or 30% of our nation's youth.¹ Moreover, 6 in 10 obese children have at least 1 risk factor for cardiovascular disease, and an additional 25% have 2 or more risk factors.² The Centers for Disease Control and Prevention reports that 1 in 3 children born in 2000 will develop type 2 diabetes mellitus.³ Even more concerning is the likelihood that an obese child will become an obese adolescent and adult. More than 80% of obese 12-year-olds will maintain their overweight status into adulthood.⁴ The cost of treating adult obesity and its related comorbidities is significant, with estimates approaching \$94 billion per year in 2002.⁵

Data in adults suggest excess utilization and expenditures for obese adults.⁶ Data related to health care resource utilization for overweight children are limited; one estimate suggests that obesity-associated inpatient or hospitalization costs have risen 3-fold from \$35 million from 1979 through 1981 to \$127 million from

1997 through 1999.⁷ However, hospital utilization only reflects a portion of the burden of care for overweight and obese children.

Few data exist on the utilization of health care resources for the detection and treatment of overweight and obese patients in the outpatient setting. Compounding this lack of data are that childhood obesity and its morbidities continue to be underdiagnosed.⁸ Therefore, any evaluation of utilization should take into account the diagnosis of obesity in childhood. This study was undertaken to describe outpatient utilization and expenditures for children and youth with diagnosed and undiagnosed obesity compared with their healthy-weight and overweight peers. Our objectives were to compare health care utilization and expenditures for preadolescents and adolescents with healthy weight, overweight, and diagnosed and undiagnosed obesity who were seen for primary care in a Midwest children's academic center and to examine factors associated with the diagnosis of obesity.

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Table 1. Demographic Characteristics of Study Population

Variable	No. (%) of Patients (N = 8404)
Age, y	
<10	3530 (42.0)
≥10	4874 (57.9)
Sex	
Male	4134 (49.2)
Female	4270 (50.8)
Race/ethnicity	
White	2025 (24.1)
African American	5148 (61.3)
Hispanic	1002 (11.9)
Other	229 (2.7)
Insurance status	
Commercial	1593 (18.9)
Medicaid or other public insurance	6132 (72.9)
Uninsured	679 (8.1)
Weight group	
Healthy weight	5063 (60.2)
Overweight	1493 (17.8)
Diagnosed obesity	793 (9.4)
Undiagnosed obesity	1055 (12.6)

METHODS

PATIENTS

This study was approved by the pediatric institutional review board of the Children's Mercy Hospital. The study was conducted in a primary care center housed within a large integrated pediatric delivery system in the Midwest. This center primarily serves an urban, multiethnic population; 63% of patients are African American, 29% are white, and 6% are Hispanic. The ethnicity categories were assigned by parents of the participants. Ethnicity was included in the data set because obesity is more prevalent in children and youth from ethnic minorities than in their white peers. Medicaid is the predominant type of insurance coverage (67%) for the clinics' patients. Inclusion criteria for the study included patients between the ages of 5 and 18 years who had at least 1 well-child care visit at the primary care center at any point in the years 2002 or 2003. The patients were then followed up for 12 months from the initial date of their well-child care visit.

DATA

Patients were weighed and measured by clinic nursing staff following standard anthropometric techniques. Heights were obtained to the nearest tenth of a centimeter, and weights were obtained to a tenth of a kilogram. Heights and weights were entered into a computerized medical record system at the time of the visit, and body mass index (BMI) was calculated using the method advanced by expert committee recommendations (weight in kilograms divided by the square of height in meters).⁹ Four weight categories were used in the analysis. Patients with a BMI in the 95th percentile or higher for their age and sex and a discharge diagnosis of obesity (according to *International Classification of Diseases, Ninth Revision, Clinical Modification* code 278) at any of their well-child care visits were classified as having a diagnosis of obesity. Patients with a BMI in the 95th percentile or higher for their age and sex and who had no discharge diagnosis of obesity (according to *International Classification of Diseases, Ninth Revision, Clinical Modification* code 278) were classified as having undiagnosed obesity. Chil-

dren and adolescents with BMIs between the 85th and 94th percentiles were classified as overweight. Patients whose BMIs were lower than the 85th percentile were classified as healthy weight.

Demographic data included sex, race/ethnicity, and insurance status. Race/ethnicity was classified as white, African American, or Hispanic. Patients who could not be classified into any of these 3 categories were included in an "other" category. Insurance status was classified as commercial, Medicaid or other public source, or uninsured. Health care resource utilization evaluation included the number of visits that occurred within the year after the initial primary care visit; emergency department (ED), inpatient, outpatient primary care, same day surgery, and observation unit stays; and laboratory use on the basis of blood tests ordered. Health care expenditures were reflected by charge data obtained through the billing system for each of the health care resources used in the year after the initial visit. Because health care charges occurred during multiple years, all data were standardized to 2003 US dollars using an index for inflation calculated by the Bureau of Labor Statistics.

STATISTICAL ANALYSES

A multivariate logistic regression model was applied with weight categories as the primary independent variable and age, sex, race, and insurance as covariates. The dependent variables were laboratory use (any vs none), primary care visits (any vs none), and ED use (any vs none). Analysis of the distribution of the charge variable revealed that it was not normally distributed, but an analysis of variance model was ultimately used because the sample size was large and the mean charge provided a more interpretable estimate than a median charge. If the analysis of variance was statistically significant, we used a Tukey post hoc follow-up to compute the associated 95% confidence intervals (CIs). The Tukey post hoc procedure adjusts for the multiple comparisons produced when all pairwise differences among the 4 obesity categories are examined. All analyses were performed using SPSS statistical software, version 12.0 (SPSS Inc, Chicago, Ill).

RESULTS

A total of 8404 patients were included in the study analysis. **Table 1** gives the baseline characteristics of the study population by age, sex, race/ethnicity, insurance status, and weight categories. Slightly more patients (57.9%) in the study population were 10 years or older. Girls accounted for 50.8% of the study population, and African Americans were the predominant ethnic group represented. Most (72.9%) of the study population was insured by Medicaid or other public insurance, whereas 18.9% had commercial insurance. Fourteen hundred ninety-three children and adolescents (17.8%) were overweight, and 1848 (21.9%) were obese. Of the obese children and adolescents, 793 (42.9%) were actually diagnosed as obese.

Table 2 gives the factors associated with the diagnosis of obesity in a multivariate logistic regression model. Factors associated with an increased probability of diagnosis were age 10 years or older (odds ratio [OR], 2.7; 95% CI, 2.2-3.4), female sex (OR, 1.5; 95% CI, 1.2-1.8), and being insured by Medicaid (OR, 1.6; 95% CI, 1.1-2.3).

Table 3 gives the laboratory use probabilities for each of the 4 weight categories, adjusting for demographic variables (age, race, sex, and insurance status). Children with diagnosed obesity, undiagnosed obesity, and overweight all had a statistically significant increase in the probability of any laboratory use. A strong dose-response pattern was

Table 2. Factors Associated With the Diagnosis of Obesity in 1800 Children With Body Mass Indexes in the 95th Percentile or Higher for Age and Sex

Variable	Diagnosed Obesity, No./Total No. (%)	Adjusted OR (95% CI)
Age, y		
<10	164/607 (27.0)	
≥10	613/1193 (51.4)	2.7 (2.2-3.4)
Sex		
Male	319/856 (37.3)	
Female	458/944 (48.5)	1.5 (1.2-1.8)
Insurance		
Uninsured	48/145 (33.1)	
Medicaid	599/1355 (44.2)	1.6 (1.1-2.3)
Commercial	130/300 (43.3)	1.5 (0.97-2.40)
Race		
White	133/343 (38.8)	
Black	550/1194 (46.1)	1.3 (0.98-1.60)
Hispanic	94/263 (35.7)	1.2 (0.81-1.60)

Abbreviations: CI, confidence interval; OR, odds ratio.

Table 3. Rates of Laboratory Use Among Weight Categories: Multivariate Logistic Regression Model*

Variable	Rate, No./Total No. (%)	Adjusted OR (95% CI)
Healthy weight	625/5063 (12.3)	
Diagnosed obesity	369/793 (46.5)	5.49 (4.65-6.48)
Undiagnosed obesity	257/1055 (24.4)	2.32 (1.97-2.74)
Overweight	230/1493 (15.4)	1.25 (1.06-1.47)

Abbreviations: CI, confidence interval; OR, odds ratio.

*Adjusted for demographic variables (age, race, sex, and insurance status).

seen, with the largest increase in the diagnosed obesity group (OR, 5.49; 95% CI, 4.65-6.48).

A similar analysis for rates of ED and primary care clinic visits showed no statistically significant increases in any of the weight categories (**Table 4** and **Table 5**). The number of inpatient visits was too small to allow any meaningful interpretation and is not included in this analysis.

Table 6 gives the charges (adjusted for inflation) for each of the 4 weight categories by demographic variables. Compared with their healthy-weight peers, children with overweight, diagnosed obesity, and undiagnosed obesity had significantly higher charges, with the highest for the diagnosed obesity category (adjusted mean difference, \$172; 95% CI for difference, \$138-\$206).

COMMENT

Most of the general demographic characteristics of the study population parallel those of other academic children's medical centers. The proportions of African American patients (61.2% vs 15%) and patients insured by Medicaid (72.9% vs 30%) are higher than those found in national samples.^{10,11} The prevalence of overweight (17.8%) and obesity (21.9%) in the overall sample of children and adolescents is slightly higher than national averages, but the trend to higher incidence of overweight and obesity in Hispanic and African American youth is similar to national data trends.¹

Table 4. Rate of Any Emergency Department Use Among Weight Categories: Multivariate Logistic Regression Model

Variable	Rate, No./Total No. (%)	Adjusted OR (95% CI)
Healthy weight	504/5063 (10.0)	
Diagnosed obesity	91/793 (11.5)	1.24 (0.98-1.58)
Undiagnosed obesity	105/1055 (10.0)	0.98 (0.79-1.23)
Overweight	167/1493 (11.2)	1.17 (0.97-1.40)

Abbreviations: CI, confidence interval; OR, odds ratio.

Table 5. Rate of Any Primary Care Visits Among Weight Categories: Multivariate Logistic Regression Model

Variable	Rate, No./Total No. (%)	Adjusted OR (95% CI)
Healthy weight	671/5063 (13.3)	
Diagnosed obesity	110/793 (13.9)	1.18 (0.95-1.48)
Undiagnosed obesity	133/1055 (12.6)	0.94 (0.77-1.16)
Overweight	199/1493 (13.3)	1.05 (0.88-1.25)

Abbreviations: CI, confidence interval; OR, odds ratio.

Table 6. Mean Health Care Charges Among Weight and Demographic Categories: Analysis of Variance Model

Variable	Mean (SD), \$	Adjusted Mean Difference (95% CI), \$
Healthy weight	445 (450)	
Diagnosed obesity	617 (533)	172 (138-206)
Undiagnosed obesity	481 (439)	36 (6-66)
Overweight	473 (461)	28 (2-54)

Abbreviation: CI, confidence interval.

This study found significant undercoding of the diagnosis of obesity in this sample; most children with BMIs in the 95th percentile or higher for sex and age did not have a diagnosis of obesity recorded in their medical records. This observation points to a significant underdiagnosis of obesity in children, which is consistent with previous findings of O'Brien et al.⁸ The findings have implications for studies that examine utilization of services from administrative data sets, since most obese patients would have been excluded from the study if only cases with a diagnosis of obesity had been included. When obesity was present, being female, older, and insured by Medicaid were associated with a higher probability of having diagnosed obesity. We found no increase in primary care or ED visits for the diagnosed obesity category compared with the undiagnosed obesity, overweight, or healthy-weight categories. However, we found a significantly higher rate of utilization of laboratory services in children with overweight, diagnosed obesity, and undiagnosed obesity compared with their healthy-weight peers. This increase was most notable for children with diagnosed obesity. We speculate that this increase reflects primary care provider compliance with expert committee recommendations for laboratory evaluation of obese children and adolescents,⁹ particularly because there was

a 5-fold increase in the diagnosed obesity category. This increase may also reflect signs and symptoms of comorbidities that warrant further evaluation in obese youth.

Our finding of increased charges for all overweight patients compared with their healthy-weight peers is consistent with the increase in health care utilization and charges found by Thorpe et al,⁶ although our increases in children and adolescents are much less significant than those in adults. Thorpe and colleagues determined that this large economic burden could primarily be attributed to increased resource utilization for clinical comorbidities, such as diabetes and cardiovascular risk factors, frequently observed in obese patient populations. We suspect that the reason our effects are less striking is that our population has not yet developed the numbers, types, and severities of these comorbidities. The justification for intervening in this population, therefore, is not so much to reduce current health care utilization and expenditures but to reduce the enormous burden anticipated when these obese children and adolescents become adults.

The greatest strength of this study is the large sample size, which provided excellent precision for all our CIs. This is especially important for the negative findings regarding primary care clinic and ED visits. The CIs for these models are so narrow that they exclude the possibility of a clinically relevant shift. Another strength is that we were able to capture all of the primary care and ED visits for this patient population during the study period. Limitations of our study include the limited geographic region from which our sample was drawn, a higher than average proportion of African American patients, and the large percentage of Medicaid-insured patients. These characteristics may limit the generalizability of the findings to other regions of the country.

In addition, our research method does not capture the number of youths who are overweight or obese but did not seek medical services during the time of the evaluation. The use of charge data as the measure of health care expenditures also overestimates the economic burden of medical care for the patient population because both public and private third-party payers frequently reimburse medical facilities at a discounted rate rather than for the full amount billed as the charge. We performed a limited analysis of the subsequent utilization of patients with overweight, diagnosed obesity, and undiagnosed obesity compared with their healthy-weight peers. We did not evaluate other diagnoses assigned during the well-child care or ED visits or procedures ordered other than blood tests, and we did not examine other outpatient visits during the study period. The addition of these variables might contribute to a fuller view of health care utilization in the study population and the economic burden that occurs in nonprimary, non-ED health care settings. Finally, we recognize that undercoding of obesity is a common phenomenon with multifactorial reasons, including physician concern about subsequent coverage for needed services; we did not attempt to examine these factors in detail. Our speculation that the likelihood of primary care provider diagnosis of obesity is highest when an obese patient has a well-child care visit led us to choose these visits as the baseline encounters from which to examine subsequent resource utilization. Even at these visits, we found significant undercoding of obese patients. Limitations notwithstanding, this study adds to the current body of litera-

ture about utilization of resources in overweight and obese children and compares resource utilization of obese children who were diagnosed as having obesity with those who were not.

Overweight and obese children and adolescents (diagnosed and undiagnosed) have significantly more laboratory evaluation and significantly higher average charges compared with healthy-weight children and adolescents. The diagnosis of obesity was not made in most children despite criteria for it; however, patients who are diagnosed as having obesity appear to have the highest laboratory utilization and health care charges, as seen in this study population of more than 8000 youths. This finding is perhaps reflective of primary care provider intent to detect and treat comorbid conditions. This trend of increased health care utilization, observed even in children younger than 10 years, is similar to the trends seen in adult patients. Efforts to continue to educate primary care providers regarding the diagnosis of obesity and early interventions to address obesity in children are warranted.

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Author Contributions: Dr Hampl had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Hampl and Sharma. *Acquisition of data:* Hampl. *Analysis and interpretation of data:* Hampl, Carroll, and Simon. *Drafting of the manuscript:* Hampl, Carroll, Simon, and Sharma. *Critical revision of the manuscript for important intellectual content:* Hampl, Carroll, and Sharma. *Statistical analysis:* Carroll and Simon. *Administrative, technical, and material support:* Sharma. *Study supervision:* Hampl and Sharma.

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