A Comparison of Length of Hospitalization and Costs in Obese and Non-Obese Pediatric Patients at a Single Hospital in Honolulu

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Abstract

The association of obesity with increased hospital costs and length of stay among hospitalized pediatric patients identified by ICD-9 coding may be underestimated due to underreporting of appropriate ICD-9 coding for obesity status. The objective of this study was to compare these lengths of stay and hospital costs. A retrospective chart review was conducted of pediatric patients admitted from May 2009 to January 2012 at Kapi'olani Medical Center, Honolulu, Hawai'i, with the 20 most common primary admission diagnosis ICD-9 codes. Length of hospital stay and total hospital costs were compared for obese, overweight, and normal-weight patients based on body mass index (BMI), controlling for age, sex, ethnicity, insurance type, diagnosis, and calendar year using logistic regression. Analysis of 730 patients showed 1% of overweight patients and 35% of obese patients were correctly coded with the corresponding ICD-9 code for weight status. Obese patients had 15% longer hospital stays and 19% higher hospital costs than normal weight patients, when controlled for age, sex, ethnicity, insurance type, calendar year, and primary diagnosis. Subgroup analyses of the top 3 most common primary admission diagnoses showed obese patients with asthma had significantly higher hospital costs than normal weight patients. Obesity is an independent risk factor for increasing hospital resource utilization in hospitalized pediatric patients. Documentation of ICD-9 codes for overweight and obesity in this cohort drastically underrepresented the true prevalence of obesity and overweight status in this sample of hospitalized children. Further research is needed to better understand the complex role of obesity in pediatric inpatients, particularly among those with asthma.

Keywords

asthma, BMI, hospital cost, length of stay, pediatric obesity

Abbreviations

BMI = body mass index
CDC = Centers for Disease Control and Prevention
CI = confidence interval
ICD-9 = International Classification of Diseases-9th Edition
KMCWC = Kapi'olani Medical Center for Women and Children

Introduction

The overall prevalence of obesity in United States (US) children aged 2 through 19 has increased since the 1980s from 10% to 17% in 2011-2014.[1] The burden of disease from obesity and its associated co-morbidities resulting in increasing health care costs has become a growing national concern. Two large studies of children 2-17 years of age found a positive correlation between childhood obesity and the number of hospitalizations which included obesity as a discharge diagnosis, as well as higher total costs for these hospitalizations.[2,3] Another study examining the 2002-2005 Medical Expenditure Panel Survey found that obese and overweight children aged 6-19 years old generated more outpatient visits, more prescription drugs, and greater emergency room expenditures, especially among adolescents. Nationally, these additional expenditures represent an increase of $14.1 billion spent annually in the US health care system.[4] Several other studies utilizing large national databases of hospitalized pediatric patients have also found an association between obesity and longer hospital stays and higher hospital costs.[5-7]

However, despite the statistical strength of these large studies, each relied solely on International Classification of Diseases, Ninth Edition (ICD-9) coding to identify overweight and obese subjects rather than body mass index (BMI) calculations. These studies may have underestimated the extent of the association between overweight and obesity and medical resources cost and utilization. One study showed that of 20.4% of hospitalized children meeting BMI-based obesity criteria, only 1.7% had the obesity ICD-9 code listed among their discharge diagnoses.[8] There are a few smaller pediatric studies that have examined hospital outcomes using BMI, rather than ICD-9 coding, to categorize patient body composition but these studies looked at only specific admission diagnoses such as burn injuries, asthma, or H1N1 influenza. Overall, they found that obese children tended to have longer hospital stays and require more intensive care or treatment.[9-12] In addition, studies on the relationship between obesity and hospital resource utilization are sparse in disadvantaged ethnic minority groups where the prevalence of overweight and obesity may be higher than in the general population, such as among Pacific Islander youth. The racial composition of Hawai'i's population is unique as compared to other US states, with 21% identifying as at least part Native Hawaiian, 48% as Asian, and 4% as Other Pacific Islander, according to 2010 state census data.[13]

The objective of this study was to retrospectively examine the impact of obesity on hospital costs and length of stay in pediatric patients in a predominantly Asian and Pacific Islander population, utilizing BMI to identify obesity status.

Methods

This was a retrospective cross-sectional chart review study of pediatric admissions between May 1, 2009 and January 31, 2012 conducted at Kapi'olani Medical Center for Women and Children (KMCWC), Honolulu, Hawai'i. KMCWC is the only

children's hospital in the state of Hawai'i and admits children and adolescents who require specialized pediatric care from all islands of Hawai'i as well as Pacific nations. Hospitalization data for patients ages 2-18 years admitted to the general pediatric ward, from the island of O'ahu, the most populated island of Hawai'i, were reviewed. Each patient was assigned a single primary admission diagnostic ICD-9 code by the treating clinician to indicate the primary reason for the patient's admission. Additional secondary ICD-9 codes were selected by the clinician to indicate the patient's other medical problems, such as obesity, if applicable. Research subjects were identified and selected based on having 1 of the 20 most common ICD-9 primary admission diagnostic codes during the study period. To simplify and strengthen the analysis of data in this study, similar diagnoses were consolidated and some of the primary admission diagnostics categories were combined into more generalized ones when appropriate. For example, *cellulitis of the leg* was combined with *cellulitis of the arm* to create 1 *cellulitis* category. This process resulted in the consolidation of the original 20 diagnostic groups into 9. These included asthma, cellulitis, pneumonia, dehydration, seizures, Kawasaki disease, meningitis, diabetic ketoacidosis, and appendicitis. Pediatric admissions were excluded if BMI data were missing. Patients with secondary ICD-9 codes indicating complex medical conditions, such as cerebral palsy, G-tube dependency, and congenital heart disease, were also excluded because these conditions were more likely to lead independently to higher hospital costs and longer lengths of stay. Patients with non-O'ahu residential zip codes were excluded, as patients transferred from other islands may represent patients with higher acuity of illness which local referring hospitals were unable to manage.

BMIs were calculated in children 2 years and older as weight (in kilograms) divided by height (in meters) squared based on the weight and height measurement taken on admission by nursing personnel. BMI was converted automatically into percentiles for age and sex, based on standard Centers for Disease Control and Prevention (CDC) growth charts, by the hospital electronic medical record system. Children 2 years and older were defined as underweight if their BMI was < 5th percentile, overweight if their BMI was ≥ 85th percentile but < 95th percentile, and obese if BMI was ≥ 95th percentile; children were considered normal weight if they did not fall into any of these categories, according to definitions of childhood obesity established by the CDC.

For analyses, age in months, length of stay, and total hospital costs were treated as continuous variables. Costs were controlled for calendar year. Other variables were analyzed after classification into categories. Insurance type was categorized as private insurance, Medicaid, or no insurance. Residence, based on zip codes from hospital registration, was categorized into those living in Honolulu and those living outside the city of Honolulu. Ethnicity was based on the ethnicity reported by the patient's parents at hospital registration.

Statistical Analysis

This study compared the length of hospital stay and total hospital costs across the 4 BMI groups while controlling for age, sex, residency, primary diagnosis, Honolulu residency, and insurance type, using quantile regression analysis with results calculated as median differences. SAS Version 9.4 (SAS Institute Inc., Cary, NC) was the statistical program used for analysis.

This research study was reviewed by the Hawai'i Pacific Health Research Institute and found to be exempt from Institutional Review Board Review (Hawai'i Pacific Health Research Institute Study Number 2010-145).

Results

A total of 1601 pediatric patients ages 2-18 were admitted during the study period with the 9 reformulated diagnostic categories listed above. The 3 most common diagnoses were asthma, cellulitis, and pneumonia. After applying exclusion criteria (there were 350 charts with missing BMI data, 341 charts with complex medical conditions, and 180 charts with non-O'ahu residential zip codes), 730 subjects remained eligible for analysis.

Of the subjects, 57% were male and 43% were female; 52% had Medicaid insurance, 48% had private insurance, and none were uninsured. The majority of children were young: 57% were 2-5 years of age, 20% were 6-9, 11% were 10-12, and 13% were 13-17 years of age. Based on parent-reported ethnicity, 15% of included patients were Asian (including Chinese, Korean, Japanese, Laotian), 13% were Filipino, 22% were Hawaiian or part Hawaiian, 9% were Other Pacific Islander (including Tongan, Marshallese, and Micronesian), 11% were Samoan, and 12% were Caucasian, with 20% reporting no ethnicity. The authors chose to analyze Filipinos, Hawaiians, and Samoans as separate categories from other Asians and Other Pacific Islanders because these ethnic groups made up large proportions of the study cohort (Table 1).

Based on calculated BMI on admission, 11% of the subjects were underweight, 59% were normal weight, 12% were overweight, and 18% were obese. Only 34.6% of obese patients and 1% of overweight patients were coded with the corresponding ICD-9 code for weight status. Obesity prevalence was higher among Samoans (45%), Hawaiians (21%), and Filipinos (14%) compared to Other Pacific Islanders (11%), Caucasians (8%), and Asians (5%). Prevalence of Medicaid insurance was higher among Pacific Islanders (92%), Samoans (78%), and Hawaiians (52%) as compared to Filipinos (44%), Caucasians (36%), and Asians (26%). Neither length of stay nor total hospital costs differed significantly by ethnicity.

Most hospital stays were short: the 25th percentile was 1 day, the median (50th percentile) was 2 days, and the 75th percentile

Table 1. Patient Demographics	
	N=730
Weight Category	
Underweight (BMI < 5th percentile)	78 (11%)
Normal weight (BMI 5th to 84th percentile)	432 (59%)
Overweight (BMI 85th to 95th percentile)	90 (12%)
Obese (BMI ≥ 95th percentile)	130 (18%)
Sex	
Male	414 (57%)
Female	316 (43%)
Age	
2-5 years	413 (57%)
6-9 years	144 (20%)
10-12 years	81 (11%)
13-17 years	92 (13%)
Insurance Type	
Medicaid	376 (52%)
Private Insurance	354 (48%)
Ethnicity	
Asian	107 (15%)
Filipino	95 (13%)
Hawaiian or Part Hawaiian	159 (22%)
Samoan	77 (11%)
Other Pacific Islander	64 (9%)
Caucasian	85 (12%)
Other	88 (12%)
Not reported	55 (8%)
Primary Diagnosis	
Asthma	200 (27%)
Pneumonia	136 (19%)
Cellulitis	121 (17%)
Dehydration	90 (12%)
Appendicitis	59 (8%)
Kawasaki disease	49 (7%)
Seizures	30 (4%)
Diabetic ketoacidosis	23 (3%)
Meningitis	22 (3%)

A total of 730 patients were identified who met the study inclusion criteria and who were admitted under the top 9 primary diagnoses. Each patient was identified with a single primary diagnosis. Demographic information on the BMI weight category, sex, age, insurance type, ethnicity, and primary diagnosis are shown here.

was 2 days, since a majority of the patients only had a hospital stay of 2 days. The median (50th percentile) total hospital cost was $9392. The 25th percentile of total hospital cost was $6275 and the 75th percentile was $14 767.

Compared to normal-weight patients, obese patients had a 15% longer length of stay (95% CI, 1%-30%), controlling for age, sex, Honolulu residency, primary diagnosis, and insurance type (Table 2). Hospital costs for obese patients were 19% higher than those for normal-weight patients (95% CI, 7%-31%). This represented higher hospital costs of $1015 for obese patients compared to normal-weight patients (95% CI, $144-$1895). No significant differences in lengths of stay or total hospital costs were found between overweight or underweight patients compared to normal-weight patients.

In a separate analysis of the top 3 admission diagnoses (asthma, cellulitis, and pneumonia), utilizing individual quantile regression analysis while controlling for demographic variables and calendar year, obese patients had 36% higher total hospital costs compared to normal-weight patients with asthma. There was a non-significant trend towards higher hospital costs for obese patients compared to normal weight patients with cellulitis. There was a non-significant trend towards longer length of stay for obese patients compared to normal-weight patients with asthma or cellulitis (Table 3).

Table 2. Length of Stay and Total Hospital Costs in Underweight, Overweight, and Obese Patients Compared to Normal-Weight Patients

	Difference in length of stay compared to normal-weight patients			**Difference in total hospital costs compared to normal weight patients***		
BMI Weight category	**% Difference**	**95% CI**	**P-value**	**% Difference**	**95% CI**	**P-value**
Under-weight	-3	-21-16	.77	-3	-17-11	.63
Over-weight	-1	-17-16	.94	-0.4	-14-13	.95
Obese	15	1-30	.04	19	7-31	< .01

Age, sex, primary diagnosis, Honolulu residency, and insurance type were controlled. Obese patients had a statistically significant 15% longer length of stay and statistically significant 19% higher total hospital costs compared to normal-weight patients. No significant difference in length of hospital stay or total hospital costs were found for overweight and underweight patients compared to normal-weight patients. Costs indicators were adjusted for calendar year.

Table 3. Length of Stay and Total Hospital Costs in Underweight, Overweight, and Obese Patients Compared to Normal-Weight Patients Admitted Under the Top 3 Admission Diagnoses

	Difference in hospital length of stay compared to normal-weight patients			Difference in total hospital costs compared to normal-weight patients		
Primary Diagnosis	**% Difference**	**95% CI**	***P*-value**	**% Difference**	**95% CI**	***P*-value**
Asthma						
Underweight	-4	-37% - 30%	.82	-3	-27% - 21%	.79
Overweight	-8	-42% - 27%	.67	-5	-31% - 20%	.68
Obese	18	-10% - 46%	.21	36	13% - 59%	<.01
Cellulitis						
Underweight	37	-13% - 86%	.15	38	-8% - 83%	.11
Overweight	4	-30% - 37%	.82	1	-27% - 29%	.96
Obese	26	-1% - 54%	.06	15	-9% - 40%	.23
Pneumonia						
Underweight	-27	-76% - 22%	.29	-17	-58% - 24%	.43
Overweight	-37	-81% - 8%	.11	-14	-51% - 23%	.45
Obese	-25	-67% - 17%	.24	-31	-68% - 5%	.09

Age, sex, primary diagnosis, Honolulu residency, and insurance type were controlled. Obese patients had 36% higher total hospital costs compared to normal-weight patients with asthma. There was a non-significant trend towards higher hospital costs for obese patients compared to normal weight patients with cellulitis. There was a non-significant trend towards longer length of stay for obese patients compared to normal-weight patients with asthma or cellulitis.

Discussion

As shown in previous studies, ICD-9 codes for obesity and overweight were underreported for patients with above normal BMI; the charts for only 1% of overweight patients and 35% of obese patients were coded with the corresponding ICD-9 code for weight status. Furthermore, 22% of charts in the initial study sample were excluded due to missing BMI data, mainly because patients' heights were not recorded in the medical chart. Height may be omitted due to a patient's clinical instability, uncooperative behavior, or oversight by medical staff. Additional investigation is needed to explore ways to improve documentation of pediatric admission height. Nevertheless, even when BMI data were available in the chart, a majority of patients who met the definition of obesity or overweight based on BMI did not have the corresponding ICD-9 code entered in the chart. Omission of the appropriate ICD-9 codes may represent a failure of the treating clinician to recognize that the patient's BMI meets the definition of obesity or overweight, or the clinician may feel that obesity or overweight status does not constitute a medical problem to be addressed during the hospital stay. Further research is needed to identify strategies to improve compliance with accurately recording ICD-9 code for pediatric obesity or overweight status. Improved utilization of ICD-9 codes will lead to more accurate reporting of the true prevalence of pediatric obesity in hospitalized patients and improved interpretation of studies based on large databases built from medical chart records and ICD-9 coding.

In this study, obese patients had statistically significant longer lengths of stay. However, given the overall short duration of lengths of stay (with median and 75th percentile both equal to 2 days), the clinical impact of this finding is likely negligible. However, the data also showed that obese patients had significantly higher hospital costs compared to non-obese patients for their overall hospital stay. Further analysis examining differences between obese and non-obese patients with the top 3 admission diagnoses (asthma, cellulitis, and pneumonia) found significantly higher hospital costs only for obese patients with asthma, suggesting that obesity may play a greater role in the hospitalization costs for certain primary diagnoses.

Obesity may predispose patients to metabolic, physiological, and anatomical alterations that may make obese patients more susceptible to asthma complications and lead to higher hospital costs. Obesity may adversely affect pulmonary mechanics and impede recovery from an asthma exacerbation. Studies have shown that patients with metabolic syndrome or increased abdominal obesity were more likely to have impaired forced expiratory volume and lower functional residual capacity.[14,15] Obesity produces metabolic alterations leading to an inflammatory state that may promote asthma related physiological changes. Elevated leptin levels in obese children with asthma compared to non-obese children with asthma promotes a higher T-helper cells-1/T-helper cells-2 ratio, an inflammatory pattern associated with lower airway obstruction and bronchoconstriction.[16] Obese children are at greater risk for developing asthma compared to non-obese children.[17] Moreover, reports suggest that asthma is more severe among obese children. [18,19]

Similar to other studies in Hawai‘i, this study documented a higher prevalence of obesity among Samoans and Native

Hawaiians as compared to other ethnic groups. Despite higher percentages of Asians and Pacific Islanders in the sample compared to the continental US, the overall prevalence of obesity (18%) and overweight (12%) as determined by BMI in our hospital study population in Hawai‘i was similar to pediatric data reported nationally.[1] In the national data, Asian and Pacific Islander groups are often categorized together as a single group, thus the higher rates of obesity among Pacific islanders ethnic groups (20-45% in our sample) may be offset by the lower rates of obesity among Asians (5% in our sample).

There are several limitations to our study. The sample is limited to patients at 1 hospital, hospitalized over a 32-month period. Because patients from non-O‘ahu zip codes and those with complex medical conditions were excluded, a majority of the study patients (54% of our initial sample) was excluded from analysis, which may limit the clinical utility of the data. The data were limited to computer extraction of the medical records based on our inclusion criteria for BMI, zip codes, and admission diagnoses. Individual chart review to explore other potential reasons for prolonged hospital stays or costs was not performed, ICD-9 diagnoses codes may not capture issues such as poor medical follow up care, limited family resources, or more severe initial hospital presentation. Length of stay was calculated based on only admission and discharge dates. Individual chart review was not performed to look at hours of hospital stay for a more detailed analysis. Age was not controlled in the regression analysis, and a large portion of the patients (57%) were very young, aged 2-5 years, which may make these findings less applicable to older patients.

While the results of this study are consistent with others demonstrating an association between obesity and increased hospital length of stay and greater hospital costs, causality remains unclear. Severity of disease, demographics, and hospital factors need to be considered and analyzed in a more comprehensive analysis. Until utilization of ICD-9 codes for pediatric obesity and overweight status can be improved, future prospective studies of hospitalized children obese children as identified by measured by BMI rather than ICD-9 codes are needed to explore the complex interplay involved in the association between obesity and increased hospital resource utilization. In particular, studies exploring the association between obesity and asthma may identify more prospective targets for obesity and asthma-related patient interventions.

Conflict of Interest

None of the authors identify any conflicts of interest.

Acknowledgements

This project received funding support from NIH awards U54MD007584 and U54RR026136 from the NCRR and P20 MD000173 from the NIMHD.

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