

# Obesity Identified by Discharge ICD-9 Codes Underestimates the True Prevalence of Obesity in Hospitalized Children

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**Objectives** To define inpatient care of obese children with or without an obesity diagnosis.

**Study design** A total of 29 352 inpatient discharges (18 459 unique inpatients) from a tertiary children's hospital were analyzed. Body mass index (BMI) was calculated from measured height and weight. "Obesity" was defined as BMI  $\geq$ 95th percentile by using Centers for Disease Control and Prevention 2000 growth charts. "Diagnosed obesity" was defined by primary, secondary or tertiary *International Classification of Diseases, Ninth Revision* codes for "obesity" or "overweight." Analyses controlled for multiple inpatient records per individual.

**Results** A total of 5989 discharges from the hospital (20.4%) were associated with obesity, but only 512 discharges (1.7%) indicated obesity as a diagnosis. An obesity diagnosis identified only 5.5% of inpatient days for obese inpatients. Obese patients with an obesity diagnosis (Ob/Dx) had fewer hospital discharges per person and shorter lengths of stay than obese patients without an obesity diagnosis (Ob/No Dx). Patients with Ob/Dx had higher odds of mental health, endocrine, and musculo-skeletal disorders than non-obese inpatients, but Ob/No Dx patients generally did not.

**Conclusions** Inpatient obesity diagnoses underestimate inpatient utilization and misidentify patterns of care for obese children. Extreme caution is warranted when using obesity diagnoses to study healthcare utilization by obese children. (*J Pediatr* 2009;154:327-31)

Childhood obesity is increasingly prevalent, with nearly 20% of 12- to 19-year-old children classified as obese.<sup>1</sup> These children and adolescents are at risk for developing metabolic and other complications, some of which may require inpatient treatment. Overweight and obese adults experience greater inpatient utilization and health care expenditures than adults of normal weight,<sup>2,3</sup> but limited information exists for obese children and adolescents about the utilization of inpatient care.

Existing studies of inpatient utilization associated with obesity in children frequently rely on administrative databases and a discharge diagnosis of obesity to identify obese individuals.<sup>4</sup> However, it is unclear whether this provides an accurate reflection of actual inpatient utilization of resources by obese children. At Cincinnati Children's Hospital Medical Center, the patient's height and weight are recorded in the electronic medical record for each inpatient stay, enabling the calculation of body mass index (BMI) for all individuals, regardless of inpatient diagnosis. The goal of this study was to determine total and diagnosis-specific inpatient utilization patterns for patients who have a measured BMI that identifies them as obese compared with patients with a clinician-assigned diagnosis of obesity.

## METHODS

Cincinnati Children's Hospital Medical Center (CCHMC) is a 468-bed facility including 251 general medical/surgical, 109 intensive care unit, 62 psychiatry, and 46 rehabilitation/long-term care beds. It is the only provider of tertiary pediatric medical and psychiatric care within a 50-mile radius of Cincinnati, Ohio.

AOR	Adjusted odds ratio	ICD-9-CM	<i>International Classification of Diseases Ninth Revision, Clinical Modification</i>
BMI	Body mass index	Non-Ob	Neither measured nor diagnosed obesity
CCHMC	Cincinnati Children's Hospital Medical Center	Ob/Dx	Obesity with an obesity diagnosis
CCS	Clinical Classification System	Ob/No Dx	Obesity without an obesity diagnosis
Dx/Non-Ob	Diagnosed obesity without obesity		

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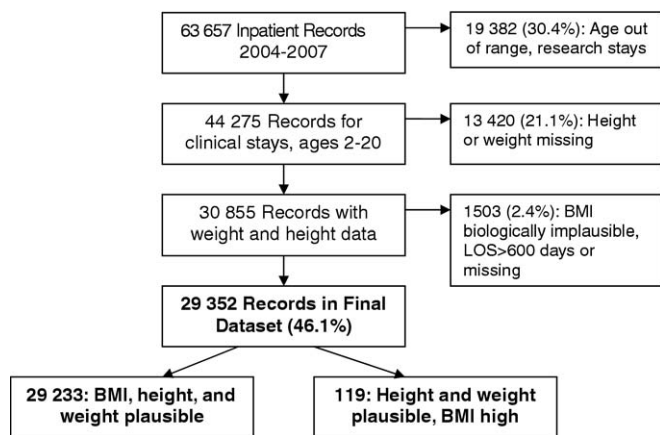


Figure 1. Compilation of final dataset.

CCHMC inpatient data from July 1, 2003, until April 30, 2007 (fiscal years 2004–partial 2007;  $n = 63\,657$  inpatient records), were obtained from the hospital data center, after obtaining approval for the study from the CCHMC Institutional Review Board. Data included unique medical record number, sex, race, date of birth, date of admission, height, weight, length of stay, and primary, secondary, and tertiary discharge diagnosis *International Classification of Diseases Ninth Revision, Clinical Modification* (ICD-9-CM) codes. Beginning in October 2003, the hospital implemented an automated system to prompt the entry of patient height at each inpatient stay, enabling the calculation of BMI. Patient age was calculated from date of birth and date of admission.

Inpatient stays for individuals  $<2$  years or  $>20$  years old were excluded, as were admissions designated as research (rather than clinical) discharges or discharges without a recorded length of stay. In addition, 1 visit for a child with an obesity diagnosis was excluded, with an outlier length of stay of 607 days. A flowchart depicting data cleaning for the final analysis set ( $n = 29\,352$  inpatient records; 18 459 unique individuals) is found in Figure 1.

BMI was calculated from patient height and weight, and the Centers for Disease Control and Prevention 2000 Growth Charts were used to determine age- and sex-specific BMI percentiles.<sup>5</sup> To identify and eliminate obvious data entry errors, biologic plausibility of height, weight, and BMI data were determined by using World Health Organization standards for identifying outliers in anthropometric data.<sup>6</sup>

Four mutually exclusive classifications of inpatient obesity were considered, on the basis of the presence or absence of diagnosed obesity or measured obesity. Diagnosed obesity was identified as inpatient records with a primary, secondary, or tertiary discharge ICD-9 code of 278.00, 278.01, or 278.02, corresponding to “obesity not otherwise specified,” “morbid obesity,” or “overweight,” regardless of BMI. Obesity<sup>7</sup> was identified as inpatient records with a valid, measured BMI  $\geq 95$ th percentile, regardless of discharge diagnosis. Four groups could then be identified: neither measured nor diagnosed obesity (Non-Ob reference group), diagnosed obesity without obesity (Dx/Non-Ob), obesity without an obesity

diagnosis (Ob/No Dx), and obesity with an obesity diagnosis (Ob/Dx).

The Clinical Classification System (CCS) was used to classify diagnosis-specific care, using discharge ICD-9-CM codes.<sup>8</sup> This multi-level classification system developed by the Healthcare Cost and Utilization Project<sup>8</sup> identifies 18 broad (level-1) categories of care, on the basis of systems of the body and defined with sets of ICD-9-CM codes. Each level-1 category of care can then be subdivided into more refined level-2 classifications, which include more limited sets of diagnoses. Data are reported for all CCS level-1 categories with at least 500 primary diagnoses (approximately 2% of all discharge records) in the analysis set. In addition, 5 mental health level-2 categories with at least 350 primary diagnoses are reported (eg, affective disorders, schizophrenia, anxiety disorders, preadult disorders, and other mental conditions).

### Statistical Analysis

All data analysis was conducted with SAS software version 9.1 (SAS Institute, Cary, North Carolina). Unadjusted pair-wise differences in clinical characteristics by obesity category were determined by using  $\chi^2$  analysis, unpaired  $t$  tests or analysis of variance, as appropriate. Discharges per person were calculated for each unique medical record number, and then analyzed by obesity category using general linear modeling, with adjusted least squares means plus or minus 95% CI reported. Because the same unique individual may contribute multiple inpatient discharges to the dataset (range, 1–57 discharges), the remaining data were analyzed using repeated measures analyses to allow for correlations in the inpatient discharges for the same individual. Differences in average length of stay by obesity category, accounting for multiple inpatient discharges per individual, were determined using adjusted least squares means from repeated measures analysis of variance using PROC MIXED. The adjusted odds ratios (AOR) and 95% CI of having a primary diagnosis within a specific CCS category of care (versus all other categories) were calculated using generalized estimating equations with PROC GENMOD. All adjusted models included patient age, sex, and fiscal year of hospital discharge. Data are presented as means plus or minus SD, AOR (95% CI), or adjusted mean (95% CI).  $P$  values  $\leq .05$  were considered to be significant.

### RESULTS

Children aged 2 to 20 years with a BMI  $\geq 95$ th percentile accounted for 5989 inpatient hospital discharges (20.4%) from 2004 to 2007 (Table I). However, only 512 inpatient stays (1.7%) were associated with any diagnosis of obesity. Of these, 42 (8.2%), 175 (34.2%), and 295 (57.6%) stays had a primary, secondary, or tertiary diagnosis of obesity, respectively. Four hundred seventy-five (92.8%) of these stays were for individuals classified as obese at the time of the stay.

A diagnosis of obesity had only an 8% sensitivity rate to detect patients who were obese according to their BMI; however, the specificity rate was very high, at 99.8%. In

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