Prevalence of Overweight and Obesity in a U.S. Pediatric Surgical Population

Olubukola O. Nafiu, MD, FRCA; Khady S. Ndao-Brumlay, PharmD; Olumuyiwa A. Bamgbade, MD, FRCA; Michelle Morris, MS; and Josephine Z. Kasa-Vubu, MD, MS

Ann Arbor, Michigan

Objective: To describe the prevalence of overweight and obesity in a pediatric surgical population from a large teaching hospital in the United States.

Methods and Procedures: We carried out a retrospective review of the perioperative database for the period January 2000 to December 2004 at the University of Michigan. Using directly measured height and weight, we computed body mass index (BMI) on 6,017 children. Overweight and obesity were defined using age- and gender-specific cut-off according to the National Center for Health Statistics (NCHS)/Centers for Disease Control and Prevention (CDC) (2000) growth charts. We also examined the type of surgical procedures most commonly performed on overweight and obese children, and the distribution of overweight and obese patients by preoperative American Society of Anesthesiologist (ASA) classification.

Results: We found a somewhat "heavy" pediatric population with a mean BMI of 21.6kg/m^2. The mean BMI in males was 21.7 kg/m^2 and 21.6 kg/m^2 in females. BMI showed a positive correlation with age overall ($r=0.48$, $p < 0.01$), and in both males and females. The overall prevalence of overweight and obesity using age-specific criteria was 14.4% and 17.2%, respectively. Approximately 10% of the children met adult criterion for obesity (BMI ≥30 kg/m^2). Orthopedic and otolaryngological procedures were the most common surgeries in this cohort of overweight and obese children. We further found that 35.3% of obese and 20.6% of morbidly obese children were classified as ASA I.

Conclusion: The prevalence of overweight and obesity is high in this pediatric surgical population. Follow-up studies examining the impact of overweight and obesity on perioperative outcome are needed.

Key words: prevalence ■ pediatrics ■ surgery ■ overweight ■ obesity

© 2007. From the Department of Anesthesiology (Nafiu, Bamgbade, Morris) and Pediatrics (Ndao-Brumlay, Kasa-Vubu), University of Michigan Medical School, Ann Arbor, MI. Send correspondence and reprint requests for *J Natl Med Assoc.* 2007;99:46–51 to: Dr. Olubukola Nafiu, University of Michigan Medical Center, Department of Anesthesiology, 1500 E. Medical Center Drive, 1H247 UH—Box 0048, Ann Arbor, MI 48109; phone: (734) 936 4280; fax: (734) 936 9091; e-mail: onafiu@med.umich.edu

INTRODUCTION

The prevalence of overweight and obesity among children and adolescents in the United States has increased three-fold in the last three decades.[1] Recent estimates indicate that one in four children and adolescents in the United States are classifiable as either overweight or obese.[2] This epidemic of overweight and obesity means that physicians will be caring for an increasing number of children with high body mass index (BMI). Additionally, the publication of guidelines for adolescent bariatric surgery[3] spotlights the morbidly obese adolescent as a surgical patient.

It is considered axiomatic among anesthesiologists and surgeons that the obese patient presents enormous perioperative challenges.[4] In addition to a high prevalence of medical comorbidities such as type-2 diabetes, hypertension and bronchial asthma,[5,6] obesity in adults is associated with increased incidence of difficult airway, obstructive sleep apnea, and postoperative wound infection. Unfortunately, many of these comorbidities are becoming prevalent in obese children,[7] but data on the perioperative aspects of childhood overweight and obesity are very scarce. A thorough review of the literature revealed only two review articles specifically addressing the problem of childhood obesity and anesthesia.[8,9] This study's aim was to examine the prevalence of overweight and obesity in a pediatric surgical population at a large tertiary teaching hospital. We also examined the type of surgical procedures and American Society of Anesthesiologist (ASA) classification in overweight and obese children. It is, to our knowledge, the first attempt to study the subject in the pediatric surgical population.

METHODS

Following institutional review board approval, we performed a retrospective review of the quality assurance database of the Mott Children's Hospital, a component of the University of Michigan Health System. We reviewed data for the period beginning January 1, 2000 and ending December 1, 2004. Resident physician and registered nurse anesthetists are responsible for entering

data on all patients anesthetized in the system. We extracted the following clinical, demographic and anthropometric data from the database: surgical specialty, surgical procedure, ASA classification, age, sex, race, height and weight. It is customary to measure the height and weight of all children prior to anesthesia and surgery at our institution. Body mass index (BMI) was calculated as weight (kg)/squared height (m^2). Children were classified as normal weight (BMI <85th percentile), overweight (BMI >85th and <95th percentile), or obese (BMI ≥95th percentile) using age and gender-specific reference growth charts from the National Center for Health Statistics (NCHS)/Centers for Disease Control and Prevention (CDC).[10]

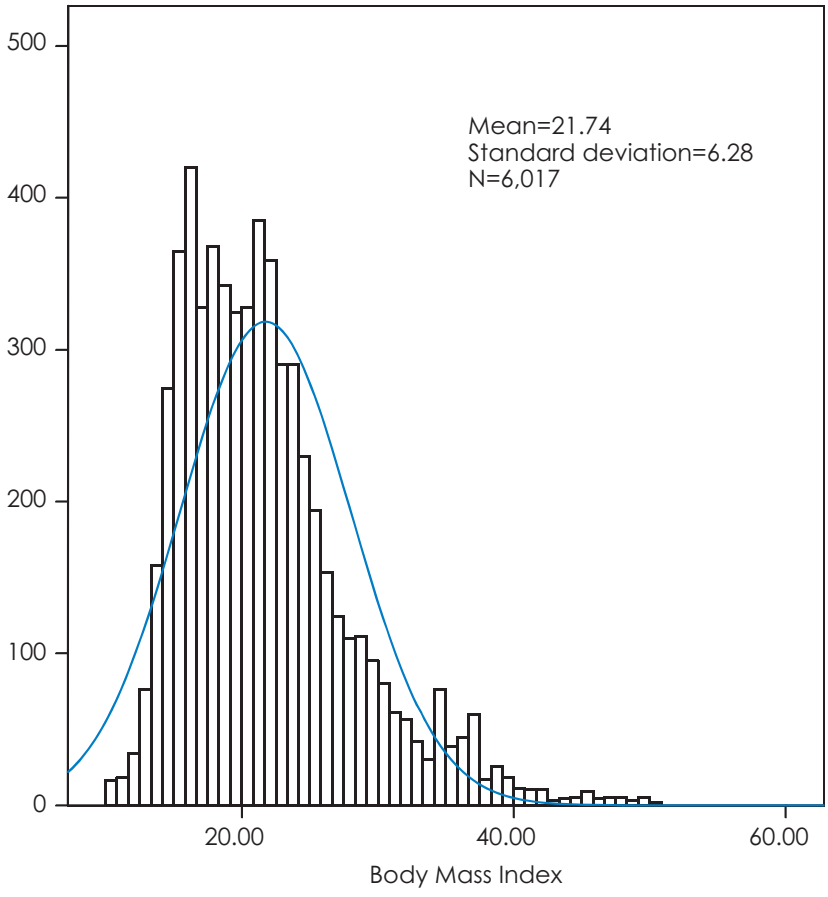
Children with secondary causes of obesity such as Prader-Willi syndrome, Cushing's syndrome, nephrotic

Table 1. Summary of demographic statistics of a pediatric surgical population

	Males (n=3,359)	Females (n=2,658)	Total (n=6,017)	P
Age (mean years ± SD)	11.6 ± 5.2	12.1 ± 5.2	11.8 ± 5.2	0.06
Height (mean meters ± SD)*	1.5 ± 0.4	1.46 ± 0.3	1.48 ± 0.4	0.00
Weight (mean kg ± SD)*	52.7 ± 29.5	48.1 ± 23.8	51.1 ± 27.6	0.00
BMI (kg/m^2)	21.7 ± 6.3	21.7 ± 6.2	21.7 ± 6.3	0.16
BMI (% yes)*†				0.01
Normal weight	67.0	70.3	68.4	
Overweight	14.9	13.7	14.4	
Obese	18.2	16.0	17.2	

* Male-female mean and proportion differences at p<0.05; † Two-by-two Chi-squared tests: normal weight versus overweight: p=0.085; normal weight versus obese: p=0.012; overweight versus obese: p=0.613

Figure 1. BMI distribution in a pediatric surgical population



MRI: magnetic resonance imaging; PM&R: physical medicine and rehabilitation medicine; Others: thoracic surgery, burns, interventional radiology

syndrome as well as those on obesogenic medications such as corticosteroids, Risperidol® and Depo Provera® were excluded from the study.

Statistical Analysis

Data analysis was carried out with SPSS v.14.0 (SPSS Inc., Chicago, IL). Basic descriptive statistics, including means, standard deviations and percentages were calculated for the demographic, clinical and anthropometric data. Pearson's Chi-square for categorical variables and 1-way ANOVA for continuous variables were used to examine age-group and gender differences in the distribution of clinical and anthropometric measures. A p value of <0.05 was considered statistically significant.

RESULTS

Sample Description

A total of 6,017 children formed the study population. Their descriptive characteristics are shown in Table 1. Ages ranged from 2–18 years with a mean of 11.8 years. There were 3,409 (56.6%) males and 2,608 (43.3%) females.

Anthropometric Statistics

The population had a mean BMI reminiscent of an adult sample (21.6 ± 6.7kg/m^2; range 10.09–50.83 kg/m^2). The overall prevalence of overweight and obesity was 31.5%. The BMI distribution showed modest positive skewness (Figure 1) with about 10% meeting adult criterion for obesity (BMI ≥30 kg/m^2) and 4.5% meeting the criterion for morbid obesity (BMI ≥35 kg/m^2). Using age- and gender-specific definition of overweight and obesity, 14.4% and 17.2% children were overweight and obese, respectively. Boys were significantly taller and weighed more than girls. Boys and girls did not differ based on age or BMI; however, boys were more likely to be overweight than to be normal compared to girls (Table 1). Pearson correlation coefficients were calculated for BMI and age by gender. BMI showed a positive correlation with age (r=0.459, p<0.01) in both males (r=0.468, p<0.01) and females

Figure 2. ASA classification by weight group

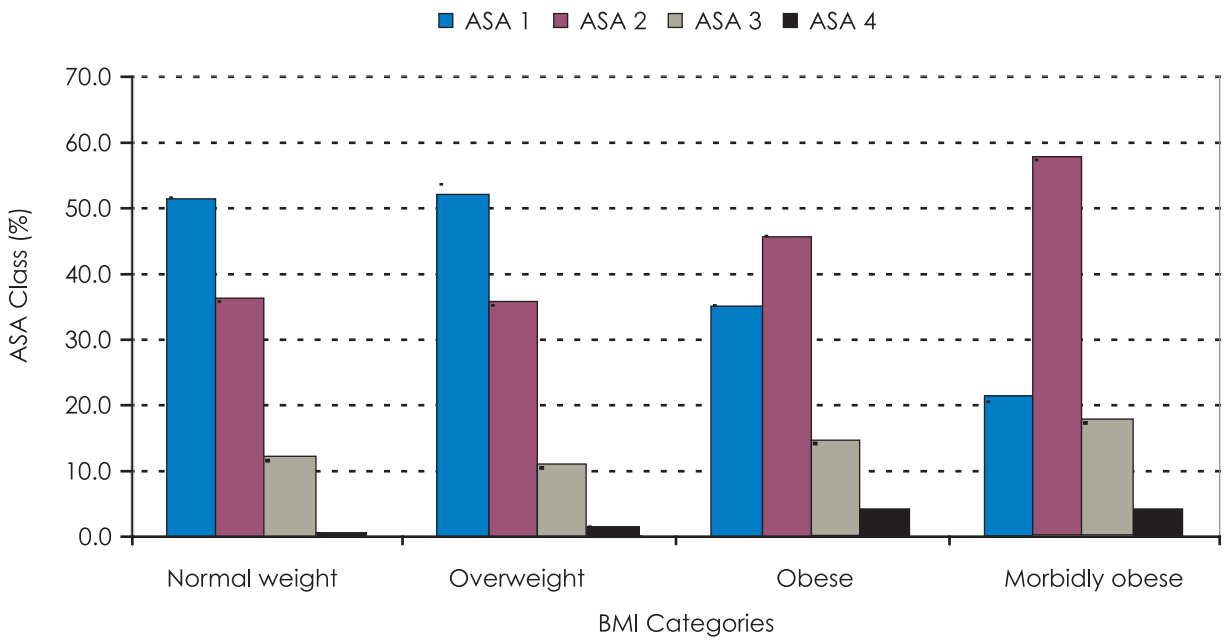


Table 2. Age group and gender-specific prevalence (%) of overweight and obesity

	Males*				Females**			
Age (Years)	N	Normal	Overweight	Obese	N	Normal	Overweight	Obese
2–7	920	67.4	16.2	16.4	672	70.7	14.1	15.2
8–12	686	64.0	14.4	21.6	454	65.2	15.6	19.2
13–18	1,797	67.9	14.4	17.8	1565	71.6	13.0	15.4
Total	3,403	67.0	14.9	18.2	2,691	70.3	13.7	16.0

* Pearson Chi square, p=0.063; ** Pearson Chi square, p=0.111

(p=0.449, p<0.001). Age- and gender-specific prevalences of overweight and obesity were calculated and are shown in Table 2. The highest prevalence of overweight and obesity in children was in the peripubertal age group 8–12 years in both males and females.

ASA Classification

The distribution of cases by ASA classification and weight group is shown in Figure 2. Most patients were classified as ASA I or II (48.5% ASA I; 37.7% ASA II; 12.2% ASA III; 1.6% ASA IV). The mean BMI scores for patients by ASA classification was as follow: 21.6 ± 5.4 for ASA I; 21.8 ± 7.5 for ASA II; 20.8 ± 8.0 for ASA III; and 21.6 ± 6.7 for ASA IV. Post-hoc Bonferroni procedures support a significant difference among ASA I, ASA III and ASA IV. ASA I and ASA II were not significantly different (p=0.998). Interestingly, 35.3% of obese and 20.6% of morbidly obese patients were classified as ASA I.

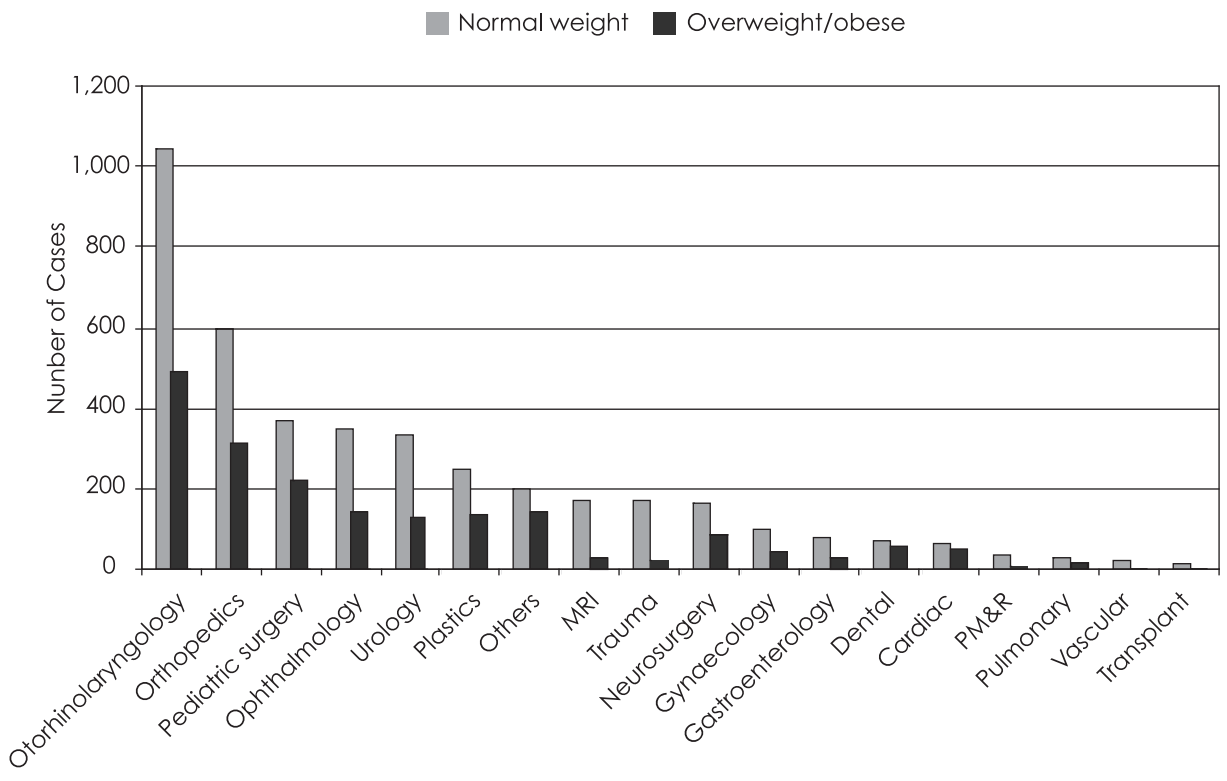
Surgical Specialties

Patient distribution by surgical specialties and weight category is shown in Figure 3. Orthopedic procedures were the most frequent surgery in overweight and obese children. Otolaryngologic and general surgical procedures were the next most commonly performed in overweight and obese children.

DISCUSSION

This is the first attempt to describe the prevalence of overweight and obesity in a pediatric surgical population. With the current relentless increase in the prevalence of overweight and obesity in children,[2] it is almost axiomatic that pediatric anesthesiologists and surgeons would increasingly have to care for children with higher BMI. Our results indicate that about 31.5% of children presenting for surgery and anesthesia at the University of Michigan are either overweight or obese. Equally concerning is the finding of a prevalence of morbid obesity (by adult standards of BMI ≥35) of 4.6% in this cohort of pediatric patients. Although none of these children were having bariatric surgery, 1.6% had BMI falling within the bariatric surgery range (BMI ≥40). The magnitude of the problem observed may reflect the fact that Michigan has some of the highest prevalence of overweight and obesity in the United States.[11] However, with the absence of comparable data in pediatric surgical units from other parts of the country, it is difficult to say whether the prevalence observed in our study will be seen in other hospitals with comparable pediatric surgical populations. Nonetheless, the prevalence of overweight and obesity in children has nearly tripled in the last two decades across the United States.[1,2] It is therefore conceivable to speculate that similar rates of obesity in young perioperative patients would be displayed across the country. While there is fairly extensive litera-

Figure 3. Distribution of cases by surgical specialties and weight category



ture on the anesthetic and perioperative complications of obesity in adults,[8] very few data exist on the subject in children.[8,9]

The ASA classification is the most widely used preoperative physical status assessment scheme in anesthesia.[12] It has been used, albeit erroneously, for per-operative risk stratification, which affects policy-making, performance evaluation, resource allocation and reimbursement of anesthesia service; and it is frequently cited in clinical research.[13]

We were quite surprised to find a nonlinear relationship between BMI and ASA status, with lowest mean BMI score obtained in patients falling in ASA-III classification, since adult data suggest that overweight and obese patients are usually given higher ASA scores.[14] Equally surprising is the observation that 35.3% of obese and 20.6% of morbidly obese children were classified as ASA I (i.e., healthy patient), suggesting that either these children were incorrectly classified or the anesthesiologist did not consider morbid obesity a risk factor for perioperative complication. Clinical experience and adult-derived data indicate that obese and morbidly obese patients are rarely given a normal ASA score (ASA I). However, because there are no pediatric data on the contribution of overweight and obesity to adverse perioperative outcomes, it is difficult to draw firm conclusions from these observations. There is a need to define the potential contribution of assigned ASA classification for obese children and how it can affect perioperative outcome.

Sixty-to-70% of obese adolescents are likely to remain obese as adults and, thus, present a higher risk of long-term comorbidity. In our study, there was a surge in the prevalence of surgery in the peripubertal period for both boys and girls. This apparent age-related higher vulnerability needs to be further studied. Orthopedic and otolaryngologic procedures were the most commonly performed surgeries in our cohort of overweight and obese children. Previous studies have shown that obese children have a high prevalence of orthopedic abnormalities such as slipped capital femoral epiphysis, Blount's disease (tibia vara) and other forms of degenerative arthropathies.[15,16] Our data support these earlier studies. Otolaryngologic procedures such as adenotonsillectomy appear to be very commonly performed in obese children presumably because both obesity and adenotonsillar hypertrophy can contribute to obstructive sleep apnea.[17,18]

In conclusion, we have presented data on the prevalence of overweight and obesity in a cohort of elective pediatric surgical patients as well as the type of surgical procedures commonly performed in overweight and obese children. Our study provides a foundation upon which future studies of childhood obesity in the perioperative period may be built. We can infer from adult surgical patients that obese children are more likely to present greater perioperative challenges than their leaner counterparts, yet these data are lacking in children. We call for more studies to define the surgical risk of the overweight and obese child. Our report is a first step in that direction.

STUDY LIMITATIONS

This is a single-center retrospective study and therefore has some of the well-known limitations of retrospective data, the most important being representativeness. Additionally, we do not have data on ethnic distribution of these children or the socioeconomic status of their families. Race is a well-known confounder of obesity in studies.

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