

# Childhood body mass index and perioperative complications

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## Summary

**Background:** Our aim was to describe the incidence of quality assurance events between overweight/obese and normal weight children.

**Methods:** This is a retrospective review of the quality assurance database of the Mott Children's Hospital, University of Michigan for the period January 2000 to December 2004. Using directly measured height and weight, we computed the body mass index (BMI) in 6094 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. Frequency of quality assurance events were compared between normal weight, overweight, and obese children.

**Results:** There were 3359 males (55.1%) and 2735 females (44.9%). The mean age for the entire population was  $11.9 \pm 5.2$  while the mean BMI was  $21.6 \pm 6.7 \text{ kg}\cdot\text{m}^{-2}$ . The overall prevalence of overweight and obesity was 31.6%. Obesity was more prevalent in boys than girls ( $P = 0.016$ ). Preoperative diagnoses of hypertension, type II diabetes, and bronchial asthma were more common in overweight and obese than normal weight children ( $P = 0.0001$  for hypertension,  $P = 0.001$  for diabetes and  $P = 0.014$  for bronchial asthma). Difficult airway, upper airway obstruction in the postanesthesia care unit (PACU) and PACU stay longer than 3 h and need for two or more antiemetics were more common in overweight and obese than normal weight children ( $P = 0.001$ ). There was no significant difference in the incidence of unplanned hospital admission following an outpatient surgical procedure between normal weight and overweight/obese children.

**Discussion:** Studies on perioperative aspects of childhood overweight and obesity are rare. Our report shows a high prevalence of overweight and obesity in this cohort of pediatric surgical patients. Certain perioperative morbidities are more common in overweight

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and obese than in normal weight children. There is a need for prospective studies of the impact of childhood overweight and obesity on anesthesia and surgical outcome.

**Keywords:** Body mass index, obese, overweight, pediatric surgery, complications, perioperative

## Introduction

Childhood overweight and obesity have reached epidemic proportions in the USA and according to recent surveys the prevalence of obesity in American children has tripled in the last three decades (1). The 2003–2004 National Health and Nutrition Examination Survey (NHANES), estimates that 17% of US children and adolescents ages 2–19 years are obese (2). Childhood obesity has several well recognized health and social consequences that can persist into adulthood (3). For example, 50% of obese children will grow up to be obese adults while 75% of obese adolescents will be obese adults (3).

The consequences of obesity during the perioperative period in adult patients are well recognized by anesthesiologists and surgeons (4–6). In addition to a high prevalence of medical comorbidities such as type II diabetes, hypertension, obstructive sleep apnea and bronchial asthma (4), obesity in adult patients is associated with increased incidence of difficult airway, perioperative myocardial infarction and postoperative wound infection (5,6). There are very few data on the outcome of overweight and obese children after surgery. A recent abstract with a small cohort of obese children did not find any difference between obese and normal weight children following anesthesia for dental surgery (7). Another review article based on unpublished ongoing audit from a single hospital in the UK found a higher frequency of critical incidents in obese children compared with obese adults (8). What is evident from reviewing the medical literature is that there is a paucity of data on perioperative outcomes of the overweight and obese child.

The purpose of this study was to determine whether an association exists between high body mass index (BMI) and the risk of perioperative complications in a pediatric surgical population. Our hypothesis was that perioperative complications would be more common in overweight and obese

children compared with their normal weight counterparts.

## Methods

Following institution review board approval, we performed a retrospective review of the Quality Assurance (QA) database of the Mott Children's Hospital, a component of the University of Michigan Health System. Resident physicians and certified registered nurse anesthetists are responsible for entering data into a computerized database on all children anesthetized in our hospital. The QA database is integrated with our anesthesia information system (Centricity, GE Medical Systems Information Technology, Milwaukee, WI, USA). There is a 'QA committee' that carries out weekly independent review of all the cases entered in the database to check for errors or missing data. We reviewed data for the period between January 1, 2000 and December 1, 2004 and extracted the following clinical, demographic, and anthropometric data from the database: surgical specialty, surgical procedure, American Society of Anesthesiology (ASA) classification, age, gender, height, and weight. We routinely measure the height and weight of all children prior to anesthesia and elective surgery at our institution. BMI was calculated as weight in kilograms divided by the square of the height in meters ( $BMI = \text{kg} \cdot \text{m}^{-2}$ ). Children were classified as normal weight (BMI < 85th percentile), overweight (BMI > 85th and <95th percentile), or obese (BMI  $\geq$  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) (9). Children with secondary causes of obesity such as Prader-Willi syndrome, Cushing's syndrome, nephrotic syndrome as well as those on obesogenic medications such as corticosteroids, Risperidol® (Jansen Pharmaceuticals Products, Titusville, USA) and

Depo Provera® (Major Pharmaceutica, Livernia, USA) were excluded from the study.

Quality Assurance events were classified into: preoperative (medical comorbidities), intraoperative (airway, cardiovascular, neurologic, others) and postoperative (occurring in the PACU). Events such as persistent nausea and/or vomiting, shivering, airway obstruction, prolonged PACU stay, inadequate pain control, unplanned admission, significant dysrhythmias are among some of the adverse complications that are routinely documented by the PACU nurses.

We defined difficult laryngoscopy as more than one documented attempt at laryngoscopy (with or without a different laryngoscope blade) and difficult mask airway: as the use of two handed mask ventilation or use of oropharyngeal airway.

Upper airway obstruction was documented as severe stridor requiring airway support such as chin lift, oral or nasal airway adjunct.

### Statistical analysis

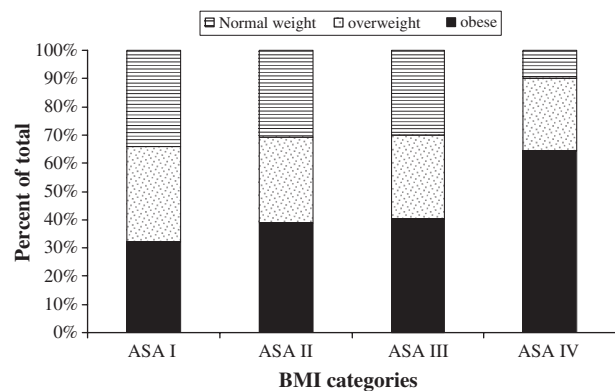
Data analysis was carried out with SPSS v.14.0 (SPSS Inc., Chicago, IL, USA). Basic descriptive statistics, including means, standard deviations and percentages were calculated for the demographic and anthropometric data. Pearson's chi-square for categorical variables and one-way ANOVA were used to examine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

### Results

We reviewed 6171 cases entered into the database over the study period. We excluded 77 cases from the analysis because of incomplete BMI data (40 patients had missing weight, 37 patients had missing height). The biophysical and demographic data of the study population are shown in Table 1. There were 3359 males (55.1%) and 2735 females (44.9%). The mean age of the population was  $11.9 \pm 5.2$  while the mean BMI was  $21.6 \pm 6.7 \text{ kg}\cdot\text{m}^{-2}$ . The prevalence of overweight and obesity were 14.4% and 17.2% respectively. Although boys were younger than girls in this study population, they were more likely to be obese ( $P = 0.018$ ).

**Table 1**  
Biophysical characteristics of a pediatric surgical population

	Male, n = 3359	Female, n = 2735	Total, n = 6094	<i>P</i> -value
Age (mean year $\pm$ SD)	11.6 $\pm$ 5.2	12.2 $\pm$ 5.2	11.9 $\pm$ 5.2	0.001
Height (mean meter $\pm$ SD)	1.5 $\pm$ 0.3	1.4 $\pm$ 0.3	1.5 $\pm$ 0.4	0.001
Weight (mean kg $\pm$ SD)	52.8 $\pm$ 29.2	49.0 $\pm$ 24.1	51.1 $\pm$ 27.6	0.001
BMI (mean $\text{kg}\cdot\text{m}^2 \pm$ SD)	21.6 $\pm$ 6.8	21.6 $\pm$ 6.5	21.6 $\pm$ 6.7	1.000
BMI category (%)				
Normal weight (kg)	67.0	70.3	68.4	0.006
Overweight	14.9	13.7	14.4	0.197
Obese	18.2	16.0	17.2	0.018



**Figure 1**  
Obese patients were more frequent in ASA class III and IV than overweight or normal weight children,  $P = 0.0006$ ; whereas there was no significant difference in the distribution of the three weight groups in ASA class I and II,  $P > 0.05$ .

Body mass index showed a positive correlation with age ( $r = 0.459$ ,  $P < 0.01$ ) in both males ( $r = 0.468$ ,  $P < 0.01$ ) and females ( $r = 0.449$ ,  $P < 0.001$ ). Patient distribution by ASA classification and BMI category is shown in Figure 1. Obese patients had significantly higher ASA scores than their normal weight counterparts ( $P = 0.001$ ). There was a significantly higher prevalence of medical comorbidities in overweight and obese patients compared with their normal weight peers. Hypertension ( $P = 0.001$ ), type II diabetes ( $P = 0.001$ ) and bronchial asthma ( $P = 0.006$ ) were more common in children with BMI over the normal range (Table 2). Difficult airway was significantly more common in obese patients. The frequencies of other intraoperative QA events were not significantly different

**Table 2**

Frequency of QA events between normal weight, overweight and obese children

<sup>b</sup> QA Events	Normal weight (n = 4171), (%)	Overweight (n = 875), (%)	Obese (n = 1048), (%)	P values <sup>a</sup>
Preoperative				
Asthma	12.7	14.4	16.1	0.006
Diabetes	0.53	0.4	2.6	0.001
Hypertension	1.4	2.6	4.1	0.001
Intraoperative				
Difficult mask airway	2.2	3.6	7.4	0.001
Difficult laryngoscopy	0.4	0.2	1.3	0.005
Bronchospasm	0.4	0.0	0.5	0.156
Dental injury	0.0	0.1	0.1	0.111
Cardiac arrest	0.0	0.0	0.0	ns
PACU				
Upper airway Obstruction	0.07	0.3	1.6	0.001
Stay >3 h	0.86	1.3	1.9	0.026
≥2 antiemetics	0.6	1.1	1.3	0.039
Vomiting	0.4	0.8	0.6	0.263
Unplanned admit	0.5	0.5	1.0	0.063

<sup>a</sup>P values generated with Pearson chi-square with two degrees of freedom comparing the three groups. <sup>b</sup>Obese vs normal weight:  $P < 0.001$ ; overweight vs normal weight:  $P = 0.01$  for hypertension, otherwise  $P > 0.05$  for other parameters; overweight vs obese:  $P < 0.01$  for diabetes, difficult mask airway, difficult laryngoscopy and upper airway obstruction, otherwise  $P > 0.05$  for all other parameters.

PACU, Postanesthesia care unit; QA events, quality assurance events.

between the different BMI categories (Table 2). Overweight and Obese children were more likely to have prolonged stay (>3 h) in the PACU probably a reflection of the increased incidence of upper airway obstruction ( $P = 0.001$ ) and need for more than two antiemetics (Table 2).

## Discussion

Studies on the risk of childhood overweight and obesity in the perioperative period are rare. We have shown from this large retrospective study that there is an association between high BMI and certain perioperative complications. This study is unique because it is to our knowledge, the first to spotlight the obese child as a high risk patient for certain complications. While it is considered axiomatic among anesthesiologists and surgeons that being overweight or obese carries increased perioperative risks, many of these

conclusions come from studies and experience with adult obese patients (4,10,11). Very few data exist on this topic in the pediatric surgical population (8,12). However these are review articles drawing largely on adult-derived data.

Data from adults (13) suggests that difficult airway is more common in obese than in nonobese patients. Difficult airway may be described as difficult laryngoscopy and/or difficult mask airway. The incidence of difficult laryngoscopy in the obese population was about 15% in one study (14). Our data show that whereas difficult laryngoscopy is significantly commoner in the obese child, the incidence was only 1.3%. This may be because other physical characteristics that are known to contribute to difficult laryngoscopy in adults (beard, thick neck, pregnancy, large breasts etc) are not present in children. Mask ventilation plays several major roles in pediatric anesthesia including, performance of inhalational induction assistance or control of ventilation and maintenance of ventilation in a difficult laryngoscopy and intubation situation. The obese population in our patients had a significantly higher incidence of difficult mask airway than the overweight or normal weight children. There are no studies to date in children specifically looking at the role of BMI and mask ventilation. Clearly there is a need for prospective data on the role of high BMI and difficult laryngoscopy and mask ventilation in the pediatric surgical patient.

Childhood obesity is known to be associated with many diseases that are of importance to the anesthesiologist. There is a high prevalence of hypertension, type II diabetes and bronchial asthma in obese children (15,16). Our study further confirms these observations. How these preexisting conditions interact with anesthesia in the pediatric population is unknown. What is known is that patients with bronchial asthma have an increased likelihood of developing perioperative bronchospasm particularly following general anesthesia with tracheal intubation (17). Although we observed a higher prevalence of bronchial asthma in our overweight and obese patient population, we did not observe any difference in the incidence of perioperative bronchospasm between the three groups.

We found a nonlinear relationship between BMI and assigned ASA status. Also of interest, 35% of obese and 20% of morbidly obese children

(BMI  $\geq$  35, an adult criterion) were classified as ASA I (i.e., healthy patient) suggesting that either these children were incorrectly classified or the anesthesiologist did not consider obesity or morbid obesity a risk factor for perioperative complications in these children. Clinical experience and adult-derived data indicate that obese and morbidly obese patients are rarely given a normal ASA score (ASA I). As the ASA score is often used, for perioperative risk stratification, policy making, performance evaluation, resource allocation, reimbursement of anesthesia service and it is frequently cited in clinical research (18), there is a need to define the potential contribution of assigned ASA classification for obese children and how it can affect perioperative outcome.

This is a single-center retrospective review; therefore it has some of the well-known limitations of retrospective data such as susceptibility to incomplete data and under-reporting. However, every effort was made to check the validity of the data used in this study.

In conclusion, we have shown in this large retrospective review, that certain perioperative complications are more frequent in overweight and obese children than their lean counterparts. With the rising prevalence of childhood overweight and obesity in the USA and most developed countries, it is logical to expect that anesthesiologists will increasingly have to care for obese children. Therefore there is a need for clear characterization of the perioperative risks faced by these children.

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