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The effects of body mass index on complications and mortality after emergency abdominal operations: The obesity paradox

Elizabeth R. Benjamin*, Evren Dilektasli, Tobias Haltmeier, Elizabeth Beale, Kenji Inaba, Demetrios Demetriades

Department of Surgery, Division of Acute Care Surgery and Surgical Critical Care, Los Angeles County and University of Southern California Medical Center, Los Angeles, CA, USA

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ABSTRACT

Background: Recent literature suggests that obesity is protective in critically illness. This study addresses the effect of BMI on outcomes after emergency abdominal surgery (EAS).
Methods: Retrospective, ACS-NSQIP analysis. All patients that underwent EAS were included. The study population was divided into five groups based on BMI; regression models were used to evaluate the role of obesity in morbidity and mortality.
Results: 101,078 patients underwent EAS; morbidity and mortality were 19.5% and 4.5%, respectively. Adjusted mortality was higher in underweight patients (AOR 1.92), but significantly lower in all obesity groups (AOR's 0.73, 0.66, 0.70, 0.70 respectively). Underweight and class III obesity was associated with increased complications (AOR 1.47 and 1.30), while mild obesity was protective (AOR 0.92).
Conclusions: Underweight patients undergoing EAS have increased morbidity and mortality. Although class III obesity is associated with increased morbidity, overweight and class I obesity were protective. All grades of obesity may be protective against mortality after EAS relative to normal weight patients.

1. Introduction

Obesity is a common comorbidity in the United States with significant increase in prevalence over the past 20 years. In 1990, the prevalence of obesity in every state was less than 15%, in contrast to 2014, in which all states had an obesity rate higher than 20% and 22 states had obesity rates greater than or equal to 30% (http://www.cdc.gov/obesity/data/prevalence-maps.html).

The association between obesity and increased morbidity and mortality is well described.[1–4] Using self-reported data with age and demographic adjustments, increasing BMI was associated with in increase in overall poor health including increased prevalence of diabetes, hypertension, asthma, and arthritis.[2] In a 14-year prospective study, all cause mortality was found to be lowest in the normal weight patients with increasing mortality risk with incremental rise in BMI regardless of age or gender.[1] The decrease in life expectancy resulting from adult obesity is comparable to that of smoking.[5]

Despite these data that obesity is associated with increased mortality, there are conflicting results in the surgical literature. First described as the Obesity Paradox in the early 2000s, there has been a growing body of literature to support that, while underweight populations may be at higher risk, increasing body mass index (BMI) may either not influence or even be protective against morbidity and mortality after surgery.[6–10] In a 2-year prospective multi-institutional study investigating outcomes after non-bariatric general surgery, overweight and moderately obese patients were found to have lower crude and adjusted mortality rates.[7] Similar results were found after coronary artery bypass and vascular surgery operation.[8,11]

It is increasingly evident that the factors that influence diagnosis, treatment, and outcome in emergency conditions differ from those in elective surgery. Although the association between obesity and surgical complications and post-operative mortality has been investigated in several populations, the relationship of the obesity paradox has yet to be critically evaluated in patients undergoing emergency abdominal surgery (EAS).

* Corresponding author. Division of Acute Care Surgery, Department of Surgery, LAC-USC Medical Center, 2051 Marengo street, IPT C5L-100, Los Angeles, CA 90033, USA.
E-mail address: Elizabeth.Benjamin@med.usc.edu (E.R. Benjamin).

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2. Methods

2.1. Patient selection and data collection

Patients were selected using the American College of Surgeons National Quality Improvement Program (ACS NSQIP) database from 2005 to 2010. ACS NSQIP is a nationally validated, risk-adjusted, outcomes-based program that collects data from institutions across the United States and Canada. All patients that underwent EAS during the time period were collected. Patients that were pregnant, with disseminated cancer, and patients with recent chemo or radiotherapy were excluded (user guide for ACS NSQIP). Preoperative, operative, and postoperative characteristics were abstracted. BMI was used to divide patients into the five World Health Organization (WHO) designated groups: underweight (BMI < 18.50), normal weight (18.50–24.99), overweight (25.00–29.99), class I (30.00–34.99), class II (35.00–39,99), and class III (≥40.00) obesity.

Operative procedures were classified into five groups: appendectomy and appendix-related abscesses (APX), cholecystectomy and gallbladder-related procedures (GB), spleen and hepato-biliopancreatic procedures (S-HBP), upper gastrointestinal tract procedures including operations of the esophagus, stomach, duodenum (UGIT), and lower gastrointestinal tract procedures including jejunum, ileum and colorectal procedures (LGIT).

Baseline characteristics included age, gender, comorbidities, ethanol (EtOH) and tobacco (TOB) use, and presence of systemic inflammatory response syndrome (SIRS), sepsis or septic shock at admission. Operative and postoperative characteristics included American Society of Anesthesiologists (ASA) classification, operation type, wound classification, operative time, and time from admission to surgery (surgical delay). Primary outcome was 30- day mortality and secondary outcome was overall complications.

2.2. Statistical analysis

Continuous variables were compared using the Kruskal Wallis test. Differences in categorical variables were reported using the Chi-square test. A significance of p value < 0.2 on univariate analysis was used for inclusion in the logistic regression analysis to identify independent risk factors for outcome variables.

Binary logistic regression with enter modeling was used to analyze the impact of BMI on 30-day mortality. Results were reported as odds ratio (OR) and adjusted odds ratio (AOR) with 95% confidence intervals (CI) using the normal weight patient group as reference.

Model performance was evaluated using the area under the receiver operating characteristic (ROC) curves and goodness-of-fit test.

All statistical analyses were performed using SPSS for Mac version 20.0 (SPSS. Inc., Chicago, IL).

3. Results

During the study period, 1,525,464 patients were entered into ACS NSQIP. A total of 106,260 patients underwent EAS and after exclusions 101,078 patients were entered into the study. Median age was 47 [IQR25-IQR75: 31–64] and 48.3% were male. The majority of patients were normal or overweight (n = 34,727, 34.4% and n = 32,451, 32.1%, respectively) with only 3518 (3.5%) patients in the underweight group. History of diabetes and hypertension increased with increasing BMI. Conversely, COPD, substance abuse history, and steroid use were more common in the underweight group (Table 1).

In underweight and Class II and III obesity groups, ASA scores were higher when compared to normal weight group. GB operations were more commonly performed in the obese groups while UGIT and LGIT operations were more common in the underweight group. Class II and III obesity were associated with increased total operative time (Table 2).

Higher overall complication rates were noted at the extremes of weight (underweight and class III obesity). Surgical site and deep space infections followed a J-curve with increased rates in the underweight and higher obesity classes. Similar patterns were noted across complications including post-operative sepsis, shock, and need for reoperation (Table 3). On univariate analysis, both underweight patients and those with class III obesity had longer preoperative and total hospital length of stay. Crude mortality was

Table 1
Pre-operative baseline characteristics and comorbidities at hospital admission.

	Body Mass Index (kg/m^2)						All pts (n = 101078)	p value[†]
	Underweight (*n* = 3518)	Normal weight (*n* = 34727)	Overweight (*n* = 32451)	Obesity class I (*n* = 17062)	Obesity class II (*n* = 7462)	Obesity class III (*n* = 5858)		
Sex (Male)	1229 (35.0)	15155 (43.8)	18413 (56.9)	8731 (51.3)	3197 (42.9)	1993 (34.1)	48718 (48.3)	**<0.001**
Age ≥ 65	1303 (37.5)	8981 (26.0)	7967 (24.6)	3917 (23.0)	1538 (20.6)	1013 (17.3)	24719 (24.5)	**<0.001**
DM	202 (5.7)	1903 (5.5)	2701 (8.3)	2205 (12.9)	1260 (16.9)	1452 (24.8)	9723 (9.6)	**<0.001**
COPD	392 (11.1)	1652 (4.8)	1264 (3.9)	730 (4.3)	373 (5.0)	383 (6.5)	4794 (4.7)	**<0.001**
HTN	1142 (32.5)	8735 (25.2)	10147 (31.3)	6421 (37.6)	3240 (43.4)	2904 (49.6)	32589 (32.2)	**<0.001**
Smoker	1081 (30.7)	7831 (22.6)	6743 (20.8)	3607 (21.1)	1610 (21.6)	1230 (21.0)	22102 (21.9)	**<0.001**
Alcohol abuse	150 (4.3)	1096 (3.2)	1091 (3.4)	540 (3.2)	191 (2.6)	126 (2.2)	3194 (3.2)	**<0.001**
Weight loss	442 (12.6)	1057 (3.0)	443 (1.4)	177 (1.0)	81 (1.1)	53 (0.9)	2253 (2.2)	**<0.001**
Steroid use	269 (7.6)	1350 (3.9)	1116 (3.4)	602 (3.5)	268 (3.6)	240 (4.1)	3845 (3.8)	**<0.001**
Cardiac history	137 (3.9)	1070 (3.1)	1190 (3.7)	625 (3.7)	281 (3.8)	147 (2.5)	3450 (3.4)	**<0.001**
Congestive heart failure	92 (2.6)	497 (1.4)	414 (1.3)	274 (1.6)	151 (2.0)	164 (2.8)	1592 (1.6)	**<0.001**
Preoperative sepsis								
SIRS	945 (26.9)	9419 (27.1)	8986 (27.7)	4830 (28.3)	2075 (27.8)	1676 (28.6)	27931 (27.6)	**0.029**
Sepsis	435 (12.4)	2813 (8.1)	2725 (8.4)	1622 (9.5)	803 (10.8)	679 (11.6)	9077 (9.0)	**<0.001**
Septic shock	282 (8.0)	1322 (3.8)	1236 (3.8)	782 (4.6)	448 (6.0)	482 (8.2)	4552 (4.5)	**<0.001**

Values in parentheses are percentages. [†]χ^2 test.
DM: Diabetes Mellitus with oral agents or insulin; COPD: History of severe Chronic Obstructive Pulmonary Disease; HTN: Hypertension requiring medication; Smoker: Current smoker within one year; Alcohol abuse: > 2 drinks/day in 2 weeks before admission; Weight loss: >10% loss body weight in last 6 months; Steroid use: Steroid use for chronic condition; Cardiac history: History of myocardial infarction 6 months prior to surgery; Congestive heart failure: Congestive heart failure in 30 days before surgery; SIRS: Systemic Inflammatory Response Syndrome.

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