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Prevalence of Cardiovascular and Respiratory Complications Following Trauma in Patients with Obesity

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Abstract

BACKGROUND—It is generally accepted that obesity puts patients at an increased risk for cardiovascular and respiratory complications after surgical procedures. However, in the setting of trauma, there have been mixed findings in regards to whether obesity increases the risk for additional complications.

OBJECTIVE—The aim of this study was to identify whether obese patients suffer an increased risk of cardiac and respiratory complications following traumatic injury.

METHODS—A retrospective analysis of 275,393 patients was conducted using the 2012 National Trauma Data Bank. Hierarchical regression modeling was performed to determine the probability of experiencing a cardiac or respiratory complication.

RESULTS—Patients with obesity were at a significantly higher risk of cardiac and respiratory complications compared to patients without obesity [OR:1.81; CI:1.72–1.91]. Prevalence of cardiovascular and respiratory complications for patients with obesity was 12.6% compared to 5.2% for non-obese patients.

CONCLUSIONS—Obesity is predictive of an increased risk for cardiovascular and respiratory complications following trauma.

Keywords

Obesity; complication; trauma; post-operative care

INTRODUCTION

Obesity rates have persistently increased in the United States over the last 20 years.[1] Its prevalence has caused increased awareness regarding obesity's pathophysiology and how it impacts other aspects of patients' health. Today, nearly a third of the U.S. adult population meet the definition of obesity (body mass index > 30kg/m^2) and, with that, has acquired an increased risk of developing additional comorbid conditions.[1–2] Trauma is the third most prevalent cause of death in the United States and being in poor physical health can greatly

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increase mortality risk.[3] Thus, obese trauma patients are a medically complex subset of patients with a potential for unforeseen complications, including periods of hypoxia, unplanned intubation, increased incidence of pulmonary hypertension, heart failure, and mortality.[2–3]

The surgical treatment of obese patients with traumatic injuries must assess both intra- and post-operative risks factors. As a patient's BMI increases, their risk of developing a surgical complication increases as well.[1–6] Obesity is associated with several respiratory abnormalities including hypercapnia and sleep apnea, as patients with obesity typically have an increased demand for ventilation.[1–6] Other known obesity-related cardiovascular and respiratory comorbidities include atherosclerotic cardiovascular disease, heart failure, systemic and pulmonary hypertension, cardiac arrhythmias, deep vein thrombosis, and history of pulmonary embolism.[1–6]

Currently, literature examining how obesity affects health outcomes in trauma patients is generally limited to specific mechanisms of injury. Despite the growing concern for how to clinically manage patients with obesity, there are conflicting findings on how obesity impacts trauma outcomes.[2–5] For example, a study utilizing the National Trauma Databank from 2007–2010 assessed the relationship between blunt trauma and outcomes for patients with morbid obesity and concluded that patients with BMI > 40k g/m^2 were at an increased risk for in-hospital complications and mortality following blunt injury.[9] In contrast, a study by Ferranda et. al concluded that obesity (BMI > 25k g/m^2) was not a risk factor for mortality after traumatic injury of any mechanism, but patients with a higher BMI were at an increased risk for complications only following surgery.[6]

While it is generally accepted that obesity is associated with adverse outcomes for injured patients, this prompts further exploration.[2–8] It is critical to examine the potential risk for complications in patients with an increased BMI in order to bring awareness and resources to the patient population at risk following traumatic injury. The aim of this study was to identify whether obesity is predictive of cardiovascular and respiratory complications following traumatic injury using a large national data source.

METHODS

Data Source

A retrospective study of all trauma patients ages 18–89 with an Injury Severity Score (ISS) of 9 or greater was performed using data from the 2012 National Trauma Databank (NTDB). Patients whose mechanism of injury was due to burn, drowning, poisoning, suffocation, overexertion, or natural/environmental causes were excluded. Patients who were transferred, discharged from the emergency department, died in the emergency department, or left against medical advice were also excluded. Patients treated at facilities that failed to report comorbidity status and complication status on 20% or more of cases were also excluded from the analysis. A study flow chart is provided in Figure 1.

Measures

The primary outcomes of interest were cardiovascular and respiratory complications. The complications examined included acute respiratory distress syndrome (ARDS), cardiac arrest, deep vein thrombosis (DVT), pulmonary embolism (PE), myocardial infarction (MI), and unplanned intubation. The independent variable of interest was obesity, which was defined by the NTDB as a BMI >30kg/m2 and included in the database's comorbidity file. All complications and comorbidities were previously classified and coded by the NTDB. A detailed description of how complications and comorbidities are defined in the dataset is available in the 2012 National Trauma Data Bank User Manual, available publicly online (https://www.facs.org/~/media/files/quality%20programs/trauma/ntdb/ntdbmanual2012.ashx).

We also examined patient demographic and clinical data including age group (18–40, 41–60, 61–89), gender, ISS group (9–14, 15–24, 25 and higher), injury type (blunt, penetrating), Glasgow Coma Scale motor score (GCS) group (1–2, 3–4, 5–6), and whether or not the patient underwent a surgical procedure (procedure or no procedure). Comorbidity variables included alcoholism, ascites within 3 days of trauma, bleeding disorder, chemotherapy for cancer, congenital anomalies, congestive heart failure, smoking, cerebrovascular accident history, diabetes, disseminated cancer, advanced directive limiting care, esophageal varices, functionally dependent health status, history of angina within past month, history of myocardial infarction, history of peripheral vascular disease, hypertension requiring medication, impaired sensorium, prematurity, obesity (BMI ≥30kg/m^2), respiratory disease, steroid use, cirrhosis, dementia, major psychiatric illness, drug abuse, prehospital cardiac arrest with CPR, and other. Comorbid conditions were grouped as: no comorbidities present, 1–2 comorbidities, 3–4 comorbidities, and ≥5 comorbidities. Diabetes and obesity were not included in the comorbidity count variable because they were analyzed independently.

Statistical Analysis

Descriptive analysis comparing characteristics between patients with obesity and patients without obesity were carried out using chi square, student's T tests, and fisher's exact tests. The prevalence of cardiovascular and respiratory complications in patients with obesity and patients without obesity was also calculated. Alpha was set at 0.05 and all statistical tests were two-sided.

A hierarchical regression model was used to model the probability of experiencing a cardiovascular or respiratory complication. The outcome variable in this model was a binary variable indicating whether or not the patient experienced ARDS, cardiac arrest, DVT, PE, MI, or unplanned intubation. The model controlled for age group, gender, ISS group, injury type, obesity, diabetes, comorbidity count, and GCS motor score. The hospital facility key was included as a random effect to account for clustering of patients within the same hospitals.

A second series of regression models were also ran to examine the effect of obesity on the likelihood of developing each individual cardiovascular or respiratory complications. In each of these models a single complication was used as the outcome variable. All models

controlled for the same covariates as the previously described model. The SAS procedure GLIMMIX was used to carry out the hierarchical regression analyses. All statistical analysis was performed utilizing SAS 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Univariate Analyses

A total of 275,393 patients (obese: 14,210; not obese: 261,183) met the inclusion criteria for this study. There was a significant association between age, gender, mechanism of injury, GCS motor score, number of comorbidities, diabetes, and surgical procedure with obesity. Patients with obesity were more often female, older, and had a greater number of comorbidities including diabetes. Although statistically significant, there was a small absolute difference in the percentage of patients with penetrating injuries (7.42% non-obese, 5.36% obese; $p<0.001$) and low GCS motor score (GCS 1–2 non-obese 7.64%, obese 7.97%; $p=0.024$). (Table 1)

All of the cardiovascular and respiratory complications examined in this analysis were found to be significantly associated with obesity (all $p<0.001$). Prevalence of cardiovascular and respiratory complications for trauma patients with obesity was 12.6% as compared to 5.2% for patients without obesity. The percentage of patients with ARDS, cardiac arrest, DVT, PE, MI, and unplanned intubation were higher in the obesity group (Figure 2).

Multivariable Analyses

Hierarchical regression model results demonstrated that patients with obesity were at a significantly higher risk of cardiac and respiratory complications as compared to patients without obesity. We found an approximately 80% greater risk of developing respiratory or cardiovascular complications in patients with obesity. Older adults also had a significantly increased risk of developing cardiac and respiratory compilations compared to adults aged 19–40. In particular, patients over 60 were 71% more likely to develop a cardiovascular or respiratory complication. Patients undergoing a surgical procedure were nearly five times as likely to experience cardiac and respiratory complications. Patients with comorbid conditions were also at a significantly increased risk for cardiac and respiratory complications compared to patients without comorbid conditions. Females were almost 30% less likely to develop cardiac and respiratory complications as compared with males. Blunt injuries were also associated with a 10% lower risk of respiratory and cardiac complications. (Table 2).

Analyses of individual cardiac and respiratory complications showed that patients with obesity were at an 82% increased risk for ARDS, 69% increased risk for cardiac arrest, 83% increased risk for DVT, 63% increased risk for unplanned intubation, and over twice as likely to develop a pulmonary embolism (Table 3).

DISCUSSION

The growing prevalence of obesity has initiated more research in determining how best to care for patients with obesity following injury. Our results suggest that patients with obesity

are at a significantly increased risk of experiencing cardiovascular and respiratory complications including ARDS, cardiac arrest, DVT, PE, and unplanned intubation after trauma. Several other studies have found that BMI influences post-operative cardiac and respiratory complications as excess body mass is known to cause changes in the cardiovascular system.[13–19,21] Obesity is also a factor known to affect pulmonary physiology and consequently patients often experience reduced lung volume, which can result in pickwickian syndrome.[8,13] Varon and Marik reported that obesity is known to cause changes in pulmonary function, including a total reduction in the respiratory system and increased airway resistance.[13] Ditillo et al. reported that ARDS was one of the most common complications experienced by morbidly obese patients.[9] Several studies have also reported that patients with obesity are at an increased risk for the occurrence of pulmonary complications following surgery.[13–17] Rose et al. found that patients with obesity were twice as likely to experience acute postoperative respiratory events.[18] Many of the adverse effects of obesity on post-surgical respiratory complications are likely exacerbated in the trauma setting due to their inability to physiologically compensate in response to their injury.[8,13] Furthermore, obese blunt trauma patients may experience poorer survival outcomes due to their frequency of respiratory failure.[13,19]

With the increasing prevalence of obesity, the clinical implications of our findings stress the need for specialized treatment strategies for managing the obese trauma population. Studies examining factors that may affect outcomes for this patient population and minimize the risk of complications after surgical interventions are particularly needed. Our results indicate that obese patients are predisposed to complications associated with high mortality rates and that a need for additional surveillance and postoperative care may exist. Adequate care may include essential equipment, longer hospital stays and rehabilitation time, and need for increased staff.[12] Often, patients with obesity must remain in the hospital rather than be transferred to a care facility due to the restraints of their BMI and the lack of appropriate facilities outside of a hospital. Thus, our study seeks to provide further insight into the complication risks of obese trauma patients and provide a foundation for further studies into their postoperative needs and care management.

Limitations

Limitations of this study arise from the use of national secondary data. Our study examined national trauma data that coded obesity as a comorbidity rather than listing a BMI, height, or weight. Furthermore, obesity, as indicated by the NTDB, was noted as a BMI greater than 30 kg/m^2, which is inclusive of patients with morbid obesity. Therefore, our study was not able to assess the linearity of the relationship between BMI and risk of cardiopulmonary complications. Also, this analysis did not account for specific surgical site which could have implications on the type of complications experienced. Further analysis examining surgical site with respect to postoperative complications is warranted. We were also unable to determine how emergent the procedures performed on patients were, which would have provided some insight into patients' risk of complication.

CONCLUSIONS

Our findings indicate that obesity is independently predictive of increased risk for cardiovascular and respiratory complications following trauma. Obesity was found to be a risk factor for cardiac arrest, acute respiratory distress syndrome, pulmonary embolism, deep vein thrombosis, and unplanned intubation following trauma. Obese trauma patients have an increased risk of complications that predispose them to need additional postoperative care, potentially including essential equipment, longer hospital stays and rehabilitation time, and increased staffing. This study hopes to provide further insight into the specific risks obese patients experience after trauma and provide a foundation for further studies into improving their inpatient care. Recently, hospitals have focused on preoperative conditioning as a means to reduce complications in the elective surgical population. However, future studies regarding specific interventions to prevent respiratory and cardiovascular complications in patients with obesity who require emergent care are needed.

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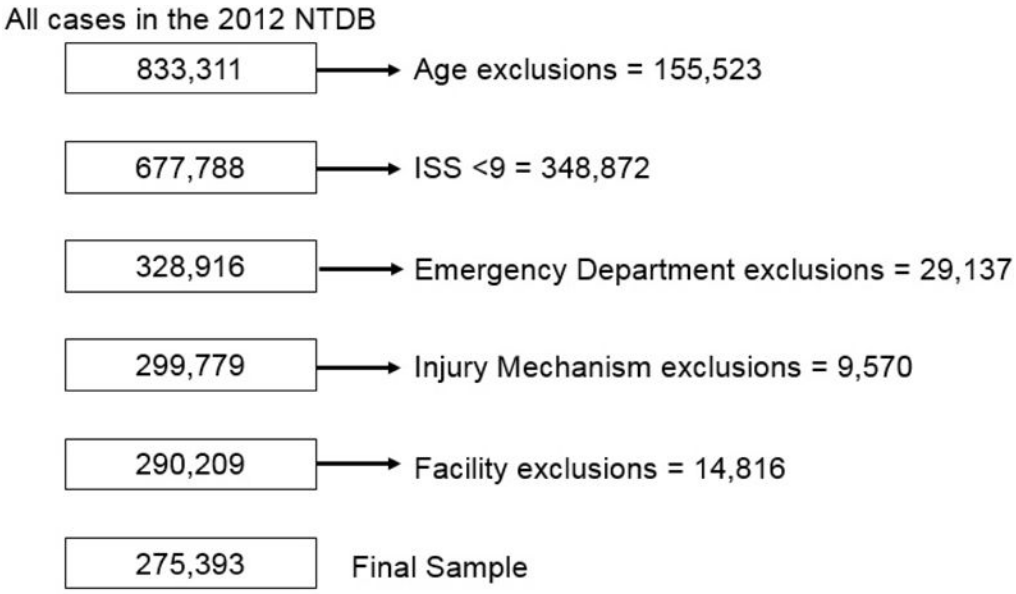

Figure 1.
Study Sample Exclusions

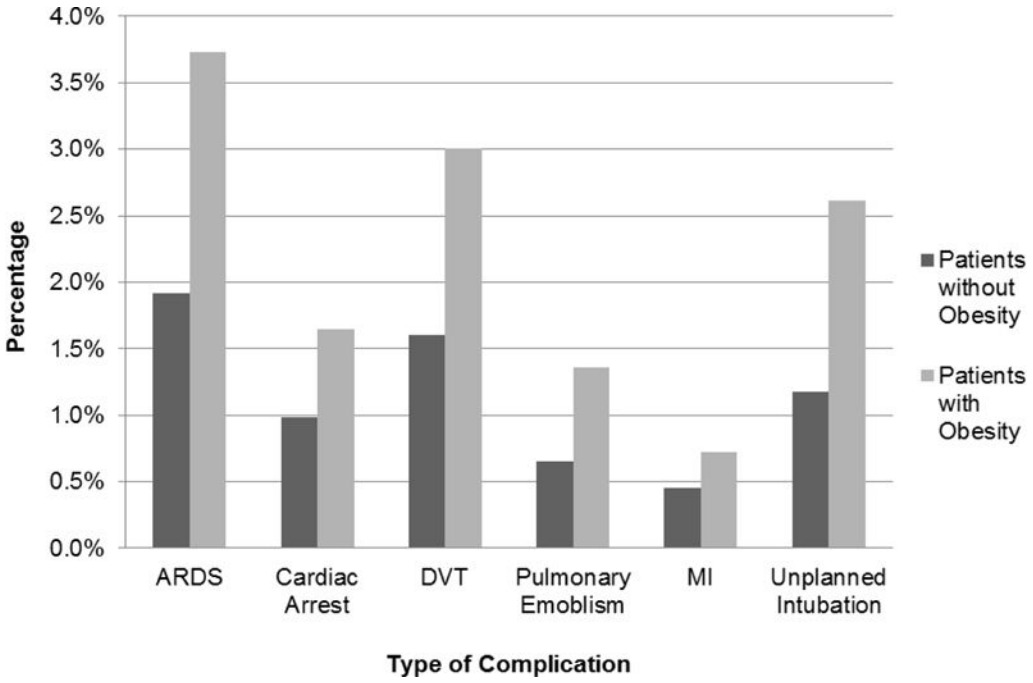

Figure 2.

Percentage of cardiac and respiratory complications for persons with obesity versus without. ARDS = Acute Respiratory Distress Syndrome, DVT = Deep Vein Thrombosis, MI = Myocardial Infarction

Table 1

Descriptive Characteristics of Study Cohort

	Non-Obese (n=26,1183)	Obese (n=14,210)	p value
Gender			<.0001
Male	63.05%	55.95%	
Female	36.95%	44.05%	
Age			<.0001
18–40	31.99%	23.97%	
41–60	27.47%	35.65%	
61–89	40.55%	40.38%	
Injury Type			<.0001
Blunt	92.58%	94.64%	
Penetrating	7.42%	5.36%	
Injury Severity Score			0.378
9–14	63.9%	63.7%	
15–24	22.8%	22.6%	
25 or Greater	13.3%	13.7%	
GCS Motor Score			0.024
1–2	7.64%	7.97%	
3–4	1.99%	1.69%	
5–6	90.37%	90.33%	
Surgical Procedure	78.62%	82.90%	<.0001
Number of Comorbidities *			<.0001
0	43.67%	28.16%	
1–2	48.81%	59.68%	
3–4	6.95%	11.15%	
5+	0.56%	1.01%	
Diabetes	12.27%	30.25%	<.0001
Died	4.9%	5.1%	0.178

* Obesity and diabetes not included in the number of comorbidities. GCS Motor Score = Glasgow Coma Scale Motor Score

Table 2

Predictors for Cardiovascular and Respiratory Complications

	Odds Ratio	Lower CL	Upper CL
Obesity			
No Obesity		Reference	
Obesity	1.81	1.72	1.91
Gender			
Female		Reference	
Male	0.71	0.69	0.73
Age Group			
18–40		Reference	
41–60	1.43	1.38	1.48
61–89	1.71	1.64	1.77
Injury Severity Score			
9 to 14		Reference	
15 to 24	2.48	2.40	2.57
25 and greater	4.60	4.43	4.76
Injury Type			
Penetrating		Reference	
Blunt	0.90	0.85	0.94
Diabetes Status			
No Diabetes		Reference	
Diabetes Status	1.15	1.11	1.20
Number of Other Comorbidities			
None		Reference	
1 to 2	1.21	1.17	1.25
3 to 4	1.87	1.74	2.02
5 or greater	2.01	1.28	3.17
GCS Motor Score			
1 to 2		Reference	
3 to 4	0.86	0.80	0.92
5 to 6	0.35	0.34	0.37
Surgical Procedure			
No Procedure		Reference	
Surgical Procedure	4.84	4.56	5.13

Obesity and diabetes not included in the number of comorbid conditions. GCS Motor Score = Glasgow Coma Scale Motor Score

Table 3

Adjusted Odds Ratios with 95% Confidence Intervals for Cardiovascular and Respiratory Complications Associated with Obesity

	Odds Ratio	Lower CL	Upper CL
ARDS	1.82	1.68	1.98
Cardiac Arrest	1.69	1.50	1.89
DVT	1.83	1.67	2.00
Pulmonary Embolism	2.09	1.84	2.37
Unplanned Intubation	1.63	1.48	1.81

Each model controlled for patient age, gender, ISS, mechanism of injury, GCS motor score, surgical procedure, number of comorbidities, and diabetes. ARDS = Acute Respiratory Distress Syndrome, DVT = Deep Vein Thrombosis