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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.



## 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 >30 kg/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 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 to 2010 assessed the relationship between blunt trauma and outcomes for patients with morbid obesity and concluded that patients with BMI >40 kg/m$^2$ were at an increased risk for in-hospital complications and mortality following blunt injury.[7] In contrast, a study by Ferranda et al. concluded that obesity (BMI >25 kg/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.[2–6,8,9] It is critical to examine the potential risk for

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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 Fig. 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 $>30$ kg/m$^2$ 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 (http://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 $\geq$30 kg/m$^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 $\geq$5 comorbidities. Diabetes and obesity were not included in the comorbidity count variable because they were analyzed independently.

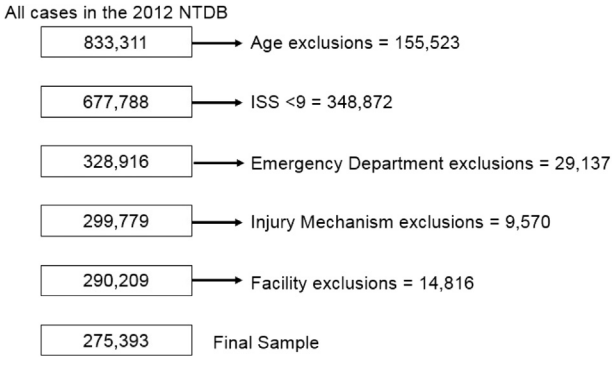


**Fig. 1.** Study sample exclusions.

### *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 (Fig. 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.