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Research Article

Post-Procedure Outcomes of Obese Patients after Trauma Using a Large National Dataset

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Abstract

Background: Obesity is a chronic disease that is linked to unfavorable outcomes following hospital interventions. This study aimed to evaluate the relationship between increased BMI and adverse outcomes in the trauma population undergoing in hospital procedures.

Methods: This retrospective cohort study utilized data from the Trauma Quality Program (TQP) Participant Use File (PUF) for 2020 and 2022. Adult trauma patients were stratified into six weight classes: underweight (BMI less than 18.5 kg/m^2), healthy (BMI 18.5–25 kg/m^2), overweight (BMI 25-30 kg/m^2), class 1 obesity (BMI 30-34.9 kg/m^2), class 2 obesity (BMI 35-39.9) and class 3 obesity (BMI greater than 40 kg/m^2). Post-procedure complications and discharge disposition were compared between the groups.

Results: The study included 598,894 trauma patients. Patients in the underweight group had the oldest average age (61.1 +/- 22.6 years, p<0.001) and less male patients (n=8350, 42.0%, p<0.001). Total length of stay was longest in the class 3 obesity group (145.5 +/- 202.1 inpatient hours, p<0.001). Underweight patients had the highest in-hospital mortality and were less likely to be discharged home from the hospital (p<0.001). On multivariate analysis, age was the only variable found to be associated with increased inpatient mortality (OR 1.020, 95% CI 1.019-1.02, p<0.001).

Conclusion: Hospital length of stay was longest in post-procedure trauma patients with class 3 obesity. Underweight patients had the worst outcomes in terms of mortality and discharge disposition. Post-procedure intervention strategies targeting the extremes of weight are needed to improve recovery following procedures for these high-risk trauma patients.

Keywords: Obesity; Trauma; Outcomes

Introduction

Obesity is a chronic disease defined as an excess of fat accumulation that contributes to an increase in adverse health outcomes. Body Mass Index (BMI), which is a calculation of a person's weight divided by their height, defines any value above 30 kg/m^2 as obese. In the United States, the burden of obesity on the healthcare infrastructure is rising at a staggering level [1]. The impacts of obesity on different areas of the medical system need evaluation to improve patient outcomes.

For surgical patients, obese patients have unfavorable outcomes including higher mortality, increased operative time, more intra-operative blood loss, longer hospital stays and more post-operative complications [2-4]. However, there have been conflicting results on outcomes for patients with elevated BMIs. An "obesity paradox" may exist which can portend protective effects during injury or surgical interventions in this patient population [5-8]. Patients at the extremes of BMI measurements who are underweight or morbidly obese have worse outcomes [9,10]. Patients undergoing emergency surgical procedures with mild to moderate obesity were found to have improved outcomes compared to patients with normal BMIs [6]. The mechanism for these observed differences is unclear but may involve increased lean fat distribution, better pre-operative nutritional status, less inflammation or a genetic survival advantage [7,11].

The relationship of obesity and traumatic injuries has been well-studied [12-15]. Several previous large database studies focused on the impact of the obesity paradox on blunt chest trauma and abdominal trauma [16-19]. However, there is a dearth of literature on the impacts of the obesity paradox in the general trauma population undergoing procedures while admitted to the hospital following traumatic injury. This study aimed to evaluate the relationship between increased BMI and adverse outcomes in the trauma population. We hypothesized that there would be worse post-procedure outcomes for obese trauma patients.

Methodology

Institutional Review Board approval was obtained from Louisiana State University Health and Sciences Center. A HIPAA waiver of consent was also granted. The Trauma Quality Programs (TQP) Participant Use File (PUF) was obtained from the American College of Surgeons (ACS). The TQP PUF is the representative dataset for trauma research from the ACS. This large national database contains information from participating Level I, II, III, IV, V or undesignated trauma centers. Admission years utilized were 2020 and 2022. Patients undergoing operative and selected non-operative procedures that were essential to the diagnosis, stabilization or treatment of the patient's specific injuries or complications were included. Patients with missing or incorrect data on admission weight and/or height were removed. Data collected included: age, gender, race, smoking history and co-morbid conditions including diabetes mellitus, Chronic Obstructive Pulmonary Disease (COPD) and hypertension. Average total inpatient hours were documented. Discharge disposition including: home, skilled nursing facility, hospice, inpatient rehab and long-term hospital care was noted. Unplanned ICU, operating room visits and re-admission within 30 days was recorded. Patients were stratified into six weight classes using the World Health Organization classifications based on body mass index (BMI) [20]. The six classifications are: underweight (BMI less than 18.5 kg/m^2), healthy (BMI 18.5-25 kg/m^2), overweight (BMI 25-30 kg/m^2), class 1 obesity (BMI 30-34.9 kg/m^2), class 2 obesity (BMI 35-39.9 kg/m^2) and class 3 obesity (BMI greater than 40 kg/m^2). Data were analyzed using Chi Squared for categorical data and one way analysis of variance for continuous variables. A stepwise binary logistic regression analysis controlling for age, male gender, Caucasian race, COPD and BMI was performed. Significance of $p<0.05$ was used (SPSS version 30, Armonk, NY).

Result

Patient Population

During the study period, a total of 598,894 surgical trauma patients were identified from the TQIP database. The average BMI for the entire cohort was 27.7 +/- 6.7 kg/m2. Normal BMI was the most common group (n=210,981, 35.2%), followed by overweight (n=193,296, 32.3%), Class 1 obesity (n=101,828, 17.0%), Class 2 obesity (n=42,754, 7.1%), Class 3 obesity (n=30,535, 5.1%) and underweight (n=19,500, 3.3%) Fig. 1.

Patient Demographics

The average age for the entire cohort was 55.3 +/- 21.1 years old with 60.0% (n=362,778/598,894) male gender and 66.1% (n=395,638/598,894) Caucasian race. Patients in the underweight group had the oldest average age (61.1 +/- 22.6 years, $p<0.001$) while the class 3 obesity cohort had the youngest patient group (52.0 +/- 18.1). The underweight group had fewer male patients (n=8350/19,500, 42.0%, $p<0.001$) compared to the highest amount in the overweight group (n=127,710/193,296, 66.1%) Table 1.

Pre-existing Conditions

There was no difference between the cohort in terms of the incidence of pre-existing diabetes and hypertension ($p>0.05$). Smoking history was not different between the cohorts ($p>0.05$). The incidence of COPD was highest in the class 3 obesity group (0.4%, n=112/30,535, p=0.04) Table 1.

Clinical Outcomes

Overall average hospital length of stay was 125.6 +/- 186.2 hours. Total length of stay was highest in the class 3 obesity group (145.5 +/- 202.1 hours, $p<0.001$). The overall inpatient mortality rate was 2.6% (n=15762/598,894). Post-procedure complications of unplanned intubation, unplanned surgery, unplanned ICU admission and re-admission were not different between the groups ($p>0.05$). Table 2.

Discharge Disposition

The majority of patients were discharged home (n=399,607/598,894, 66.7%). Patients in the underweight group were less likely to be discharged home (n=10765/19500, 55.2%) and more likely to be discharged to a skilled nursing facility (n=4087/19500, 21.0%) or hospice (n=518/19500, 2.7%) compared to the other cohorts (p<0.001). Underweight patients also had the highest mortality rate (n=753/19500, 3.9%, p<0.001) compared to the other weight classes Table 2.

Logistic Regression

On multivariate analysis, age was found to be associated with inpatient mortality in this patient cohort (OR 1.020, 95% CI 1.019-1.02, p<0.001) Table 3.

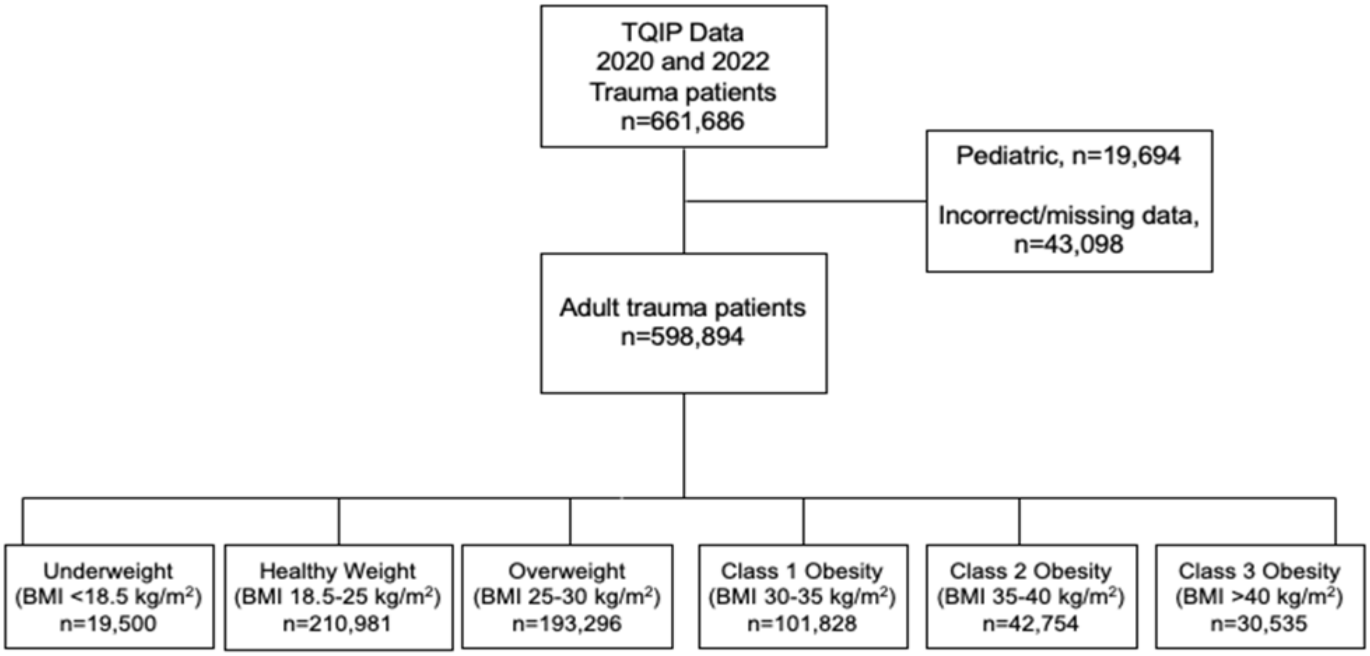

Figure 1: Stratification of adult trauma patients undergoing in-hospital procedures by World Health Organization weight class.

	Underweight n=19500	Normal n=210981	Overweight n=193296	Class 1 Obesity n=101828	Class 2 Obesity n=42754	Class 3 Obesity n=30535	p-value
Demographics							
Age, mean years (SD)	61.1 (22.6)	55.2 (22.8)	55.8 (20.6)	55.2 (19.4)	54.1 (18.7)	52.0 (18.1)	<0.001
Male, n (%)	8350 (42.0)	125000 (59.2)	127710 (66.1)	63495 (62.4)	23944 (56.0)	14279 (46.8)	<0.001
Race							
White, n (%)	13862 (71.1)	138825 (65.8)	127189 (65.8)	67306 (66.1)	28367 (66.3)	20089 (65.8)	<0.001
Black, n (%)	2601 (13.3)	31782 (15.1)	24297 (12.6)	12971 (12.7)	6187 (14.5)	5068 (16.6)	<0.001
Other, n (%)	3037 (15.6)	40374 (19.1)	41810 (21.6)	21551 (21.2)	8200 (19.2)	5378 (17.6)	<0.001
Co-morbidities							
Diabetes, n (%)	612 (3.1)	6803 (3.2)	6206 (3.2)	3310 (3.3)	1397 (3.3)	967 (3.2)	0.93
COPD, n (%)	48 (0.2)	609 (0.3)	534 (0.3)	323 (0.3)	116 (0.3)	112 (0.4)	0.04
Hypertension n (%)	290 (1.5)	3116 (1.5)	2901 (1.5)	1447 (1.4)	622 (1.5)	440 (1.4)	0.66
Risk Factors							
Smoker, n (%)	1512 (7.8)	16088 (7.6)	14624 (7.6)	7797 (7.7)	3243 (7.6)	2297 (7.5)	0.87

Table 1: Patient demographics, co-morbidities and risk factors for adult trauma patients undergoing procedures as stratified by weight class. Bold values are statistically significant.

	Underweight n=19500	Normal n=210981	Overweight n=193296	Class 1 Obesity	Class 2 Obesity	Class 3 Obesity	p-value

				n=101828	n=42754	n=30535	
Inpatient Hours	133.3 (204.7)	122.9 (182.4)	122.7 (183.2)	126.1 (188.3)	133.5 (191.2)	145.5 (202.1)	<0.001
Complication, n (%)							
Unplanned OR, ICU or re-admission	15 (0.08)	133 (0.06)	141 (0.07)	55 (0.05)	24 (0.06)	14 (0.05)	0.26
Unplanned intubation	9 (0.05)	82 (0.04)	69 (0.04)	22 (0.02)	12 (0.03)	12 (0.04)	0.18
Discharge Destination, n (%)							
Home	10765 (55.2)	138499 (65.6)	132488 (68.5)	70212 (69.0)	28576 (66.8)	19067 (62.4)	<0.001
Skilled nursing Facility	4087 (21.0)	29244 (13.9)	22507 (11.6)	11847 (11.6)	5625 (13.2)	4823 (15.8)	<0.001
Hospice	518 (2.7)	2797 (1.3)	1656 (0.9)	627 (0.6)	253 (0.6)	163 (0.5)	<0.001
Inpatient Rehab	2366 (12.1)	22381 (10.6)	21185 (11.0)	11602 (11.4)	5226 (12.2)	4215 (13.8)	<0.001
Long Term Care hospital	120 (0.6)	1410 (0.7)	1357 (0.7)	804 (0.8)	402 (0.9)	354 (1.2)	<0.001
In-patient mortality	753 (3.9)	5627 (2.7)	4933 (2.6)	2623 (2.6)	1038 (2.4)	788 (2.6)	<0.001
Other	891 (4.6)	11023 (5.2)	9170 (4.7)	4113 (4.0)	1634 (3.8)	1125 (3.7)	<0.001

Table 2: Clinical outcomes and discharge disposition for adult trauma patients undergoing procedures as stratified by weight class. Bold values are statistically significant.

Variable	Odds ratio	95% Confidence Interval	p-value
Age	1.02	1.019-1.02	<0.001
Male gender	0.52	0.502-0.53	<0.001
Caucasian race	0.826	0.798-0.85	<0.001
BMI	0.997	0.994-0.99	0.012
COPD	0.997	0.992-1.00	0.319

Table 3: Binary multi-logistic regression of factors that could impact inpatient mortality for adult trauma patients.

Discussion

The global rise of the disease of obesity has extended to impacting outcomes for the trauma population, which is also a growing segment of patients worldwide. In this study, we found that underweight trauma patients had worse outcomes after undergoing a procedure during their hospital stay. While inpatient length of stay was longest in the class 3 obesity group, a multi-variate logistic regression analysis did not find obesity to be a significant risk factor for inpatient mortality for trauma patients undergoing an inpatient procedure. Thus, the results from this study did not find a clear association with elevated BMI and worse outcomes in trauma patients undergoing procedures.

Atkins and colleagues used the National Trauma Data Bank, which was the predecessor to the TQIP PUF, over a 9 year period (2013-2021) for blunt abdominal trauma [19]. The authors found that BMI may be protective against abdominal injury in isolated, blunt abdominal trauma. The authors also concluded that mortality did not decrease with increasing BMI which may be secondary to the higher incidence of co-morbidities in this patient population. In our study, we did not find any difference in mortality for patients with elevated BMI and certain co-morbidities. A significant age difference was found between the class 3 obesity group, which was younger than the other obesity groups and the underweight cohort which was the oldest. On multi-variate analysis, age was found to be a significant risk factor for inpatient mortality. This area merits further research to determine the impacts of age in the context of the "obesity paradox" for trauma patients undergoing in-hospital procedures following trauma.

Several prior studies demonstrated worse outcomes for obese patients with blunt chest trauma [10,16,17]. Choi and colleagues found that patients with morbid obesity were associated with longer hospital and ICU lengths of stay [10]. Similarly, Cone, et al., concluded that the obesity paradox did not extend to blunt chest trauma [16]. This study found that hospital length of stay was longer in trauma patients with class 3 obesity following procedures. However, inpatient mortality and discharge disposition were found to be worse in the underweight patient cohort, suggesting that this population is more vulnerable to a complicated hospital stay following interventions. In non-trauma patients undergoing emergency surgery, a previous study by Benjamin and colleagues using the ACS-NSQIP database found higher mortality in underweight patients, but significantly lower mortality in all obesity groups [6]. Interestingly, underweight and class 3 obesity were associated with increased complications and class 1 obesity was protective. The authors also concluded that underweight patients had worse morbidity and mortality following surgery, which was also consistent with our study findings. The observation of this "obesity paradox" in patients undergoing emergency general surgery procedures was similar to what we found for trauma patients undergoing procedures while hospitalized.

The differences in outcomes for underweight trauma patients undergoing procedures during their hospital admission is likely linked with poor nutrition at baseline prior to the trauma [5]. Several studies have demonstrated that patients with hypoalbuminemia prior to surgery have worse outcomes [21-23]. Due to the emergent nature of these procedures in the trauma population, there is often not a way to optimize the nutritional status of these patients prior to interventions [24]. This dilemma limits potential interventions to mitigate post-procedure complications in this high-risk population. Additional studies focused on this group could help to develop guidelines that specifically target underweight trauma patients who require inpatient procedures.

This study has several limitations which merit further discussion. While the data set used for this study represents a large national representation of trauma centers across the United States, not all trauma centers participate in TQP. This observation could limit the general applicability of these results to other trauma centers. In addition, the de-identified data set does not contain specific details on each study patient which could introduce some inherent bias as not all confounding variables could be evaluated. This data set is also retrospective which can also introduce an additional element of bias. The years evaluated for this study (2020 and 2022) spans the COVID-19 pandemic which could have impacted some of the trends observed. Despite these limitations, this is the first study to use the TQIP data to study this growing issue of obesity and quality outcomes in the trauma population following in-hospital procedures.

Conclusion

In conclusion, this study did not find a strong association in adult trauma patients between BMI class and in-hospital mortality after an in-hospital procedure. Underweight trauma patients had the worst outcomes. This finding could indicate that less than ideal body mass is a risk factor for fatal trauma outcomes. However, despite not having increased surgical complications, class 3 obesity patients remain hospitalized significantly longer than patients with normal BMI and are less likely to be discharged to their home compared to other patients with obesity, indicating that their recovery times are longer after undergoing similar trauma and similar procedures. Age was found to be a significant risk factor for inpatient mortality. It may be necessary to implement targeted post-procedure interventions to improve recovery for underweight trauma and class 3 obese patients.

Conflict of Interest

Dr. Smith is a paid consultant for Aroa Biologics and on the advisory board for Prytime Medical. The other authors declare no conflicts of interest.

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Author Contributions

II: Data analysis, drafting of the manuscript; JPH: Critical revisions of the manuscript; PG: Critical revisions of the manuscript; AM: Critical revisions of the manuscript; LS: Critical revisions of the manuscript; AAS: Study design, data analysis, supervision, critical revisions of the manuscript.

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