



## Effects of Body Mass Index on Outcome Measures of the Patients with Penetrating Injuries; A Single Center Experience

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### ABSTRACT

**Objective:** To determine if there was any decrease in measures of injury severity or outcome with obese patients (body mass index greater than or equal to 30 kg/m<sup>2</sup>) as compared to non-obese patients (body mass index less than 30 kg/m<sup>2</sup>).

**Methods:** We conducted a retrospective review of the trauma database maintained by Natividad Medical Center's Level 2-Trauma program. From July 1st, 2014 to July 1st, 2017 there were 371 cases of penetrating trauma in adults between the ages of 18-80 years old. Overall 311 patients had BMI data recorded. We divided these 311 patients into two groups: penetrating injury due to firearm (n=198) and penetrating injury due to stabbing or piercing (n=113). We compared non-obese patients against obese patients for age, gender, Injury Severity Score (ISS), length of stay (LOS), Intensive Care Unit LOS, units of blood given, direct transfer from ED to operating room, and mortality.

**Results:** A total of 311 patients were included in the study, 198 (63.6%) patients suffered from gunshot wounds and 113 (36.4) from stab or piercing wounds. The mean age was 33.6±12.8 and there were 283 (91%) men among the victims. Overall 87 (28%) required emergent surgery and a 19 (6.1%) mortality rate was recorded. In the gunshot wound group there was no significant difference between non-obese and obese patients for age ( $p=0.400$ ), gender ( $p=0.900$ ), ISS ( $p=0.544$ ), LOS ( $p=0.273$ ), Intensive Care Unit LOS ( $p=0.729$ ), units of blood given ( $p=0.300$ ), or mortality ( $p=0.855$ ). We found that in the stab or piercing group there was no significant difference between non-obese and obese patients for age ( $p=0.900$ ), gender ( $p=0.900$ ), ISS ( $p=0.580$ ), LOS ( $p=0.839$ ), Intensive Care Unit LOS ( $p=0.305$ ), units of blood given ( $p=0.431$ ), or mortality ( $p=0.321$ ).

**Conclusion:** Our findings indicate that in our patient population, there was no significant difference in markers of injury severity, morbidity, or mortality in adult non-obese patients as compared with obese patients. Furthermore, there was no significant difference between the two groups in operative rates, suggesting that obesity may not confer a protective effect in penetrating trauma.

**Keywords:** Trauma; Obesity; Penetrating injury; Gunshot injury; Stab wound; Risk factors.

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## Introduction

Obesity has remained central to the discussion of healthcare in America, with nearly 35% of the adult population classified as obese with body mass index of more than 30 kg/m<sup>2</sup> [1]. Obesity has been associated with increased morbidity and mortality in hospitalized patients as well as in patients who suffer from blunt abdominal trauma [2, 3]. Studies comparing hospital outcome data such as length of stay, Intensive Care Unit (ICU) length of stay, and ventilator days have demonstrated that morbidly obese and obese patients have worse outcomes with a variety of injuries [4-6]. However, there have been few studies examining the effects of obesity on penetrating trauma. We hypothesized that a larger amount of subcutaneous tissue seen in patients with higher BMIs has a protective effect in the setting of penetrating trauma. Here we study the outcomes in victims of penetrating trauma by comparing non-obese to obese patients.

## Materials and Methods

### Study Population

We conducted a retrospective review of the trauma database maintained by Natividad Medical Center (NMC), a 172 bed rural Level-2 Trauma Center located in Salinas, California. The study methods were approved by the Touro University Institutional Review Board. All patients older than 18 years of age who suffered from penetrating trauma between July 1<sup>st</sup>, 2014 and July 1<sup>st</sup>, 2017 were extracted from our trauma registry. 371 cases fit these initial inclusion criteria; we then excluded patients without BMI data, Injury Severity Score (ISS), gender, age, or ICD 10 diagnosis. This included 311 cases. These patients were then grouped by ICD 10 codes consistent with penetrating stab wounds or by center for disease control and prevention (CDC) mechanism of injury classification (firearm). There were 113 in the stab wound group and 198 in the gunshot wound category.

### Study Protocol

For each group, we conducted a series of univariate analyses comparing non-obese to obese patients for age, gender, Injury Severity Score (ISS), hospital length of stay (LOS), intensive care unit LOS, units of blood given, direct transfer from emergency department (ED) to operating room, and mortality. We chose to use only 2 study groups as opposed to multiple BMI subgroups given our smaller sample size. Units of blood given were analyzed only for patients who received blood. Transfer directly to the Operating Room (OR) from the ED was analyzed by evaluating ED disposition data. All patients who were taken from emergency triage, either via CT scanner or directly, to the operating room and were not first admitted to ICU, medical/surgical floor, or discharged home were considered a transfer to

the OR. Mortality was calculated by analysis of discharge disposition indicating that the patient expired in hospital.

### Statistical Analysis

All the statistical analyses were conducted using the statistical package for social sciences (SPSS Inc., Chicago, Illinois, USA) version 16.0. All the data are presented as mean±SD as appropriate. The proportions were compared using the chi-square test. The parametric variables with normal distribution were compared using independent t-test. The parametric variables without normal distribution were compared using the Mann-Whitney U-test. A two-sided p-value of less than 0.05 was considered statistically significant.

## Results

A total of 311 patients were included in the study, 198 patients suffered from gunshot wounds and 113 from stab or piercing wounds. The average age was 33±12 with 91% male. The mean ISS was 11±10, mean LOS 4.5±6, mean ICU LOC 3±2.5, mean PRBCs in 24 hours 12±12.5. 28% required emergent surgery and a 6% mortality was found (Table 1).

**Table 1.** Baseline characteristics of study population.

Variables	Values
Number	311
Gunshot Wounds	198 (63.3%)
Stab Wounds	113 (36.7%)
Age in years (mean±SD)	33±12
Gender (% male)	283 (91%)
ISS (mean±SD)	11±10
LOS Days (mean±SD)	4.5±6
ICU LOS Days (mean±SD)	3±2.5
PRBC w/in 24 hours units (mean±SD)	12±12.5
Emergent Surgery	87 (28%)
Mortality (%)	8 (6%)

Data was extracted from our Trauma Database which is maintained by trauma registrars. The database was queried including patients between 18 and 80 years of age between July 1<sup>st</sup>, 2014 and July 1<sup>st</sup>, 2017. A de-identified dataset was provided for review. Results of the statistical analyses were grouped by stab wound or gunshot wound. Of the 113 patients suffering from stab wounds, 69 (61%) were non-obese and 44 (39%) were obese. In the gunshot wound group of 198 patients, 117 (59%) were non-obese and 81 (41%) were obese.

Of the stab wounds, there was no significant difference in age between non-obese and obese groups ( $p=0.900$ ). Of the non-obese patients, the mean age was 36±14 years old and in the obese group, the mean age was 35±10 years of age. Gender was also not significantly different, with 87% non-obese being men and 86% obese patients were men ( $p=0.900$ ). Mean ISS ( $p=0.580$ ), hospital length of

**Table 2.** Comparison of outcomes between non-obese and obese groups suffering from stab wounds and gunshot wounds.

<b>Stab Wounds</b>			
N Stabbed	113		
BMI <sup>a</sup> <30	69 (61%)		
BMI <sup>a</sup> ≥30	44 (39%)		
	<b>Non-Obese</b>	<b>Obese</b>	<b>p-value</b>
Age in years (mean±SD)	36±14	35 ±10	0.900
Gender (% male)	87%	86%	0.900
ISS (mean±SD)	7±7.5	8±7.7	0.580
LOS <sup>c</sup> Days (mean±SD)	3±4	3±3	0.839
ICU <sup>b</sup> LOS Days (mean±SD)	3±2	2±1	0.305
PRBC <sup>d</sup> w/in 24 hours units (mean±SD)	9±11	7±1	0.431
Emergent Surgery (%)	20%	20%	0.970
Mortality (%)	1.4%	0%	0.321
<b>Gunshot Wounds</b>			
N Shot	198		
BMI <sup>a</sup> <30	117 (59%)		
BMI <sup>a</sup> ≥30	81 (41%)		
	<b>Non-Obese</b>	<b>Obese</b>	<b>p-value</b>
Age in years (mean±SD)	30±12	29±9	0.400
Gender (% male)	94%	95%	0.900
ISS (mean±SD)	14±12	13±11	0.544
LOS <sup>c</sup> Days (mean±SD)	5±8	6±6	0.273
ICU <sup>b</sup> LOS Days (mean±SD)	3±3	4±3	0.729
PRBC <sup>d</sup> w/in 24 hours units (mean±SD)	16±24	8±9.5	0.300
Emergent Surgery (%)	29%	36%	0.324
Mortality (%)	9.4%	8.6%	0.855

<sup>a</sup>BMI: Body mass index; <sup>b</sup>ICU: Intensive care unit; <sup>c</sup>LOS: Length of stay; <sup>d</sup>PRBC: Packed red blood cells

stay ( $p=0.839$ ), ICU length of stay (0.305), and units of blood given ( $p=0.431$ ), did not differ significantly and values for each group can be found in Table 2. 20% of either group went directly to the operating room ( $p=0.970$ ), and mortality was 1.4% in the non-obese group and 0% in the obese group ( $p=0.321$ ).

Of the gunshot wounds, there was also no significant difference in age ( $p=0.400$ ) or gender ( $p=0.900$ ). For obese patients, the mean age was 30±12 years old and 94% were men. For non-obese patients, 29±9 years old was the mean age and 95% of patients were male. The mean ISS ( $p=0.544$ ), hospital length of stay ( $p=0.273$ ), ICU length of stay ( $p=0.729$ ), and units of blood given ( $p=0.300$ ), did not differ significantly (Table 2). While obese patients showed a trend toward direct admission to the operating room at 36% compared to 29% in the non-obese group, there was no statistically significant difference ( $p=0.324$ ). Mortality was also similar at 9.4% in non-obese and 8.6% in the obese patients ( $p=0.855$ ).

## Discussion

Common wisdom suggests that a layer of subcutaneous adiposity might provide a protective barrier against penetrating wounds, but the literature is not in agreement that this is the case. A study by Osborne et al in 2014 reported on 2196 patients admitted for traumatic injuries, 132 cases of penetrating trauma were treated, and among whom there was no statistical difference in outcome

between obese and non-obese groups for injury patterns, complications, length of stay, discharge disposition, and mortality rates [2]. Another study by Bloom *et al* in 2015, reported on 281 patients with abdominal stab wounds stratifying patients across 4 BMI groups and found that there was not a significant decrease in ISS, length of ICU stay, rates of peritoneal violation, visceral injury, and injuries requiring therapeutic operation with higher BMI [3].

Contrary to the findings by Bloom *et al.*, [3] in our 311 patients, there was no significant difference between obese patients when compared non-obese patients. Although Bloom *et al.*, stratified their patients according to the CDC's definitions (BMI<18.5 kg/m<sup>2</sup>, 18.5-29.9 kg/m<sup>2</sup>, 30-34.9 kg/m<sup>2</sup>, >35 kg/m<sup>2</sup>), they were able to find a statistically significant correlation between increasing BMI and a decrease in markers of injury severity [3]. This does not however demonstrate that a higher BMI is protective against penetrating trauma.

To determine if outcomes varied with BMI, we compared LOS, ICU LOS, blood transfusion requirements, need for emergent surgery, and mortality; as markers of outcome. Since the two groups were not significantly different in age, gender, or ISS score, we could postulate that injuries and patient demographics were not significantly different and say with some level of confidence that outcomes were not different based solely on BMI. It is also worth noting that both groups with similar injuries underwent transfer directly to the operating room

at rates that did not differ significantly in both stab and gunshot wound groups. This suggests that the layer of adiposity present in obese patients was not sufficient to provide adequate shielding of the body cavities from penetrating wounds.

To our knowledge, there have been no other studies of magnitude on the potential effects of increasing BMI on injury outcome in patients suffering penetrating trauma. The purpose of our study was to specifically compare outcome parameters in obese and non-obese patients with gunshot wounds or stab wounds to determine if there was any significant difference in our patient population.

Obesity is a significant burden on healthcare in America and many victims of traumatic injury are obese. To date, there have been few studies on the effect of obesity on penetrating trauma and if a level of abdominal adiposity confers a protective layer. In our review of 311 patients with penetrating trauma, we found that there was no decreased rate of operation or of other measures of injury outcome, such as mortality, LOS, ICU LOS, or units of blood transfused in obese patients. This study suggests that there may not be a protective effect of obesity in penetrating injury and calls for more investigation into outcomes of penetrating trauma in obese patients.

Several limitations of this study should be recognized. First, the number of patients (311) limits the power of our results. Second, injury severity score

is a gross measure of injury severity and may not take into account individual severity and complications of relatively limited injuries. Finally, we were unable to obtain individual data on operation type or number, which would be a valuable measure of the utility of abdominal adiposity as a means of visceral protection. These limitations, however, should not detract from the lack of a correlation between BMI and outcome. Future research should include larger samples sizes and a more in depth review of injuries and indications for emergent surgeries.

In conclusion, our findings indicate that in our patient population, there was no significant difference in markers of injury severity, morbidity, or mortality in adult non-obese patients with obese patients. Furthermore, there was no significant difference between the two groups in operative rates, suggesting that obesity may not confer a protective effect in penetrating trauma.

### Disclosures

None of the authors of this manuscript have any financial relationship to disclose. This project was reviewed and approved by the Touro University Institutional Review Board and meets all ethical standards.

**Conflicts of Interest:** None declared.

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