

## REVIEW ARTICLE

# Complex Interaction between Obesity and Trauma

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## ABSTRACT

Trauma and obesity are large-scale epidemics that can be associated with significant morbidity and mortality. In few studies, it has noted that there is the 'obesity paradox' (obesity has been found to be protective against mortality) due to certain causes, i.e. heart failure or cardiovascular disease. Subcutaneous fat can show great variability between individuals and increased subcutaneous fat may be protective against injuries by cushioning the internal abdominal organs against injurious forces in road traffic accidents. Many factors including the body fat distribution, body shape, and center of gravity may play an important role in the different injury patterns and severity of injury between men and women. A better understanding of how obesity influences trauma related injuries not only will help to improve the outcome but also foster the development of interventions to address the most salient and modifiable risk factors to reduce obesity related morbidity and mortality. In present article, we review the relevant literature with special considerations to understand the interactions of obesity and trauma with their impact on patient management and outcomes.

**Keywords:** Obesity, Trauma, Risk factor, Outcome.

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## RESUMEN

El trauma y la obesidad son epidemias a grande escala que pueden estar asociadas a una morbilidad y mortalidad significativa. En algunos estudios, se ha observado que existe una 'paradoja de la obesidad' (la obesidad se ha encontrado ser protectora contra la mortalidad) debido a ciertas causas, por ejemplo la insuficiencia cardíaca o la enfermedad cardiovascular. La grasa subcutánea puede mostrar una gran variabilidad entre los individuos y el aumento de la grasa subcutánea puede ser protectora contra lesiones amortiguando los órganos abdominales internos contra fuerzas perjudiciales en los accidentes de tráfico. Muchos factores, incluyendo la distribución de grasa corporal, la forma del cuerpo, y el centro de gravedad pueden jugar un papel importante en los

diferentes patrones de lesiones y la gravedad de la lesión entre hombres y mujeres. Una mejor comprensión de cómo la obesidad influencia a las lesiones relacionadas a trauma no sólo contribuirá mejorar los resultados, sino también fomentar el desarrollo de intervenciones para abordar los factores de riesgos más sobresaliente y modificables para reducir la morbilidad y la mortalidad relacionada a la obesidad. En este artículo, revisamos la bibliografía pertinente con especial consideraciones para entender las interacciones de la obesidad y el trauma en su impacto en el manejo y los resultados del paciente.

**Palabras claves:** Obesidad, Trauma, Factores de riesgo, Resultado.

## INTRODUCTION

The prevalence of obesity in many countries is continued to increase at an alarming rate and it is predicted that this trend will continue into the near future.<sup>1-6</sup> Obesity is not only the independent risk factor for many medical problems including cardiovascular disease, type-2 diabetes, cancer, osteoarthritis of the knee and hip, and obstructive sleep apnea<sup>7-12</sup> but also a well-established and important risk factor after major surgery and severe trauma.<sup>13-17</sup> It has been shown that following trauma; obese patients sustain different injuries than lean patients and can have worse outcomes.<sup>18</sup> Also the results of some studies indicate that obesity can be associated, albeit often marginally, with traumatic injuries, especially during participation in sports or motor vehicle accidents.<sup>19-24</sup> In present article, we review the relevant literature with special considerations to understand the interactions of obesity and trauma with their impact on patient management and outcomes.

## DEFINITION

Trauma and obesity are large-scale epidemics that can be associated with significant morbidity and mortality.<sup>25-27</sup> Obesity is defined by a person's body mass index (BMI) and calculated by dividing a person's body mass (in kilograms) by the square of their stature (in meters). Obesity is defined as a BMI greater than 30 kg/m<sup>2</sup>. Under weight (BMI < 18.5 kg/m<sup>2</sup>), normal weight (BMI = 18.5-24.9 kg/m<sup>2</sup>), overweight (BMI = 25-29.9 kg/m<sup>2</sup>), obese (BMI = 30-39.9 kg/m<sup>2</sup>) and morbidly obese (BMI >40 kg/m<sup>2</sup>).<sup>1,2,5,28,29</sup> It was estimated that from 1980 to 2000, the prevalence of obesity in United States increased from 14.4 to 30.5% and in 2005 to 2006; approximately 72 million Americans were

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obese.<sup>27</sup> It has been estimated that about 35% of Americans are overweight (BMI of 25 to 29 kg/m<sup>2</sup>); about 25% are obese (BMI of 30-39.9 kg/m<sup>2</sup>); and 5% are morbidly obese (BMI >40 kg/m<sup>2</sup>).<sup>5</sup> It was observed that in 2007 to 2008, the prevalence of obesity was 32.2% among adult men and 35.5% among adult women (where 'overweight' was defined as a BMI of 25.0 to 29.9 and 'obese' was defined as a BMI of 30.0 or higher).<sup>10</sup> Although most of the studies rely on BMI as a measure of obesity, BMI is not the best measure of obesity as BMI misclassify adults with BMI below 30 kg/m<sup>2</sup>.<sup>7,30</sup>

### Fat is Good

In few studies, it has noted that there is the 'obesity paradox,' whereby obesity has been found to be protective against mortality due to certain causes (i.e. heart failure or cardiovascular disease).<sup>31,32</sup> Excess weight in elderly people (65 years and older) have been shown to offer protective benefits with respect to bone loss, osteoporosis, and hip fracture.<sup>33,34</sup> Subcutaneous fat can show great variability between individuals and increased subcutaneous fat may be protective against injuries by cushioning the internal abdominal organs against injurious forces in road traffic accidents.<sup>22,35</sup> However, it is not true for all the regions of the body, there is worsened injury severity in the extremities, particularly the lower extremities, with increased fat thickness.<sup>22</sup>

### Pathology

Many factors including the body fat distribution, body shape, and center of gravity may play an important role in the different injury patterns and severity of injury between men and women.<sup>36</sup> A large body mass with excess adiposity may contribute to motor vehicle crash,<sup>36</sup> however the exact associations between obesity and body injuries are not well understood.<sup>37,38</sup> Higher risk of injury in obese individuals may be attributed to differences in body shape, fat distribution, and center of gravity between obese and normal-weight subjects, and between men and women.<sup>38</sup> Also the fat distribution and the amount and proportion of subcutaneous and visceral fat along with related waist and hip girths differs between men and women.<sup>39-42</sup> Obese male drivers had a higher risk of injury in upper body regions, including the head, face, thorax, abdomen, and spine, than did obese female drivers.<sup>38</sup> The higher risk of injury associated with a high BMI could be caused by combination of momentum effects, comorbidities of obesity, and the body's response to injury.<sup>21,43-47</sup> Cabin designs in vehicles may not be optimal for obese drivers whose body size and shape differ considerably from the standard specifications

and may contribute to an increased risk of injury.<sup>48,49</sup> Apart from above mentioned factors obstructive sleep apnea is more prevalent in obese people and sleep apnea, sleepiness, and fatigue can potentially contributing injury factors for injuries.<sup>50-54</sup>

### MANAGEMENT

Obese patients represent a significant challenge to the acute care physicians as there are unique anatomic and physiologic considerations making them distinct from lean patients.<sup>2</sup> As there is lack of studies and guidelines about the clinical approach to the obese trauma patient, presently we rely on either small series and case reports or general articles for the management of obese critical patients.<sup>55-59</sup> As for any other trauma patient, the management of these patients begins with airway assessment and management.<sup>60-64</sup> Despite inherent difficulties most obese patients should be able to be orotracheally intubated.<sup>65</sup> If difficult airway is encountered, salvage techniques such as a laryngeal mask airway and awake fiberoptic intubation may be needed.<sup>62-65</sup> Metabolic and nutritional support is an essential part of treating trauma patients and hemodynamic monitoring can be challenging in obese trauma patients.<sup>66</sup> The metabolic syndromes associated with obesity needs to be recognized as these will lead to a prothrombotic state and it need to plan to take appropriate steps in an attempt to prevent deep venous thrombosis.<sup>67-69</sup> Regarding nutritional needs of the critically injured obese patient, the surgeon must be aware of the paradoxical response of obese individuals as these patients rather than using abundant fat stores, obese patients will preferentially metabolize protein during the stressed state.<sup>70</sup>

### Complications

It has been found that the patients with a BMI of greater than or equal to 30 suffered a twofold increase in mortality compared with lean patients (32% vs 16%) and a fourfold increase in the rate of multiple organ failure (13% versus 3%).<sup>49</sup> Many studies have shown that increased body weight is associated with increased death in motor vehicle collisions.<sup>21,71,72</sup> Morbid obesity has been identified as an independent risk factor for mortality following severe trauma, and the risk may be a two- to fourfold increase.<sup>59</sup> However in few studies there was no statistically difference between the obese and non-obese patients in terms of mortality.<sup>18</sup> Obese patients are at overall increased risk of complications including multiple system organ failure, adult respiratory distress syndrome and renal failure requiring dialysis.<sup>59,73</sup> It has been speculated that increased mortality could be attributed at least par-

tially to a higher rate of co-morbidities among the obese patients.<sup>21</sup> Obesity has been linked to many conditions such as diabetes, hypertension, dyslipidemia, vascular disease, malignancy and liver disease<sup>74</sup> but also obese patients are more prone for venous thromboembolism, chronic obstructive pulmonary disease, sleep-disordered breathing<sup>75,76</sup> and surgical procedures related complications.<sup>77-79</sup>

## Prevention

Injury prevention and obesity share a common goal of improving individual health, and public health programs to improve health should be coordinated.<sup>80</sup> Presently, it is unknown that if weight reduction would lower injury rates.<sup>81</sup> It has been suggested that weight reduction can prevent injuries or that prevention efforts should be targeted to overweight or obese individuals.<sup>82-84</sup> To emphasize further, a better understanding of how differences in body composition affect regional body tolerance to high-energy trauma will help engineers to design vehicle safety systems capable enough to optimally protect each specific individual occupant.<sup>35</sup>

## CONCLUSION

In summary, although obesity will remain a prevention and public health issue but it is expected that it will be an increasing part of daily surgical practice including trauma care. It is anticipated that the personals involved in acute trauma will need a core understanding of the pathophysiology of obesity and how obesity impacts the care of these critically ill and injured patients. A better understanding of how obesity influences trauma related injuries not only will help to improve the outcome but also foster the development of interventions to address the most salient and modifiable risk factors to reduce obesity related morbidity and mortality.

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