



US DEPARTMENT OF DEFENSE

## BLAST INJURY RESEARCH PROGRAM COORDINATING OFFICE

### Vehicle Improvement Studies

#### Injury Severity in Mounted Troops Based on Height and Weight

Armored vehicles were used extensively in both Operation Iraqi Freedom and Operation Enduring Freedom by the U.S. military and will continue to be used in future conflicts involving U.S. conventional forces. These vehicles often come under hostile attack during combat operations. Injury outcomes resulting from hostile attacks provide necessary feedback that vehicle developers can use to make equipment changes to enhance safety and prevent and mitigate future injury. With the announcement in December 2015 that all roles in the U.S. military would be open to women, interest has grown in the role height and weight play in injury outcomes. To address this issue, Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC; Fort Detrick, Maryland) and the Navy Bureau of Medicine and Surgery managed by the Wounded, Ill, and Injured program funded research at the Naval Health Research Center (San Diego, California).

The JTAPIC database and the Expeditionary Medical Encounter database were queried for all mounted Service members wounded in action (WIA) between 2007 and 2014. Armed Forces Medical Examiner System records were also examined for all mounted Service members killed in action (KIA) or died of wounds (DOW). The query resulted in 2,776 WIA with 13,171 abbreviated injury scale coded injuries and 435 KIA/DOW with 18,029 coded injuries. Injury severity score (ISS) was determined for each Service member. Height and weight were recorded from the Service members' personnel records and/or autopsy reports (*Clouser, Shaw, et al. 2017*). Univariate analyses and chi-square statistics were used to evaluate differences in height and weight with injury outcomes. Multivariable logistic regression was performed to examine associations between height and weight with casualty status and each body region, while adjusting for significant covariates. Multinomial logistic regression was used to evaluate associations between height and weight and multi-level injury outcomes (e.g., number of injuries and ISS). Height and weight were categorized into 25th, 50th, and 75th percentile for ease of interpretation and meaningfulness based on Marine average body sizes (*U.S. Army Natick Soldier Research 2013*).

In general, KIAs were proportionally shorter and lighter than WIAs (Table 1). Those in the lowest and highest quartiles for weight had significantly higher odds of severe injuries (ISS > 25) than those in the 50th percentile (Table 3). When looking at injuries by body region, heavier occupants (75th percentile) had significantly higher odds of thorax injuries than those in the 50th percentile. Lighter occupants (25th percentile) had significantly higher odds of abdominal injuries than those in the 50th percentile (Table 2).

Applying an engineering perspective to considerations of height and weight of the Service member could be used to facilitate further development of armored vehicle safety upgrades to prevent and mitigate combat injuries.





US DEPARTMENT OF DEFENSE  
**BLAST INJURY RESEARCH PROGRAM**  
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**TABLE 1:** Probability of being KIA (reference = WIA): \*Significance at the  $p < 0.05$  level. Adjusted model: height, weight, number of injuries, and vehicle type. (Table used with permission from the authors)

Characteristic	Adjusted OR	95% CI	Significant?*
<b>Height</b>			
≤ 25th percentile	1.13	0.63, 2.05	No
50th percentile	1.0	Reference	
≥ 75th percentile	.92	0.54, 1.57	No
<b>Weight</b>			
≤ 25th percentile	1.43	0.82, 2.50	No
50th percentile	1.00	Reference	
≥ 75th percentile	.62	.35, 1.11	No

**TABLE 2:** Probability of experiencing more than 3 injuries (reference = 1–3 injuries): \*Significance at the  $p < 0.05$  level. Adjusted model: height, weight, casualty status, and vehicle type. (Table used with permission from the authors)

Characteristic	No. Injuries	Adjusted OR	95% CI	Significant?*
<b>Height (ref = 50th)</b>				
≤ 25th percentile	4-7	1.20	0.94, 1.53	No
≤ 25th percentile	8+	1.02	0.75, 1.37	No
≥ 75th percentile	4-7	1.05	0.86, 1.28	No
≥ 75th percentile	8+	1.01	0.80, 1.29	No
<b>Weight (ref = 50th)</b>				
≤ 25th percentile	4-7	1.13	0.91, 1.40	No
≤ 25th percentile	8+	0.94	0.72, 1.23	No
≥ 75th percentile	4-7	0.90	0.73, 1.13	No
≥ 75th percentile	8+	0.96	0.74, 1.24	No





US DEPARTMENT OF DEFENSE  
**BLAST INJURY RESEARCH PROGRAM**  
**COORDINATING OFFICE**

**TABLE 3:** Probability of experiencing ISS > 3 (reference = ISS 1–3): \*Significance (yes/no) at the  $p < 0.05$  level. Adjusted model included height, weight, severe event (yes/no), vehicle type. (Table used with permission from the authors)

Characteristic	ISS	Adjusted OR	95% CI	Significant?*
<b>Height (ref = 50th)</b>				
≤ 25th percentile	4-8	1.24	0.97, 1.58	No
≤ 25th percentile	9-24	1.15	0.84, 1.57	No
≤ 25th percentile	25+	1.50	0.98, 2.30	No
≥ 75th percentile	4-8	0.92	0.76, 1.13	No
≥ 75th percentile	9-24	1.01	0.78, 1.31	No
≥ 75th percentile	25+	1.15	0.80, 1.64	No
<b>Weight (ref = 50th)</b>				
≤ 25th percentile	4-8	0.90	0.73, 1.12	No
≤ 25th percentile	9-24	0.90	0.68, 1.20	No
≤ 25th percentile	25+	1.49	1.01, 2.20	Yes
≥ 75th percentile	4-8	1.12	0.91, 1.39	No
≥ 75th percentile	9-24	0.90	0.68, 1.19	No
≥ 75th percentile	25+	1.47	1.00, 2.16	Yes

**REFERENCES:**

Clouser, M., Shaw, J., Mazuchowski, E., Galarneau, M. R., and Green, C. 2017. "Injury Severity in Mounted Troops Based on Height and Weight." Military Health System Research Symposium (MHSRS), Kissimmee, FL, August 27-30, 2017.

US Army Natick Soldier Research. 2013. "Development and Engineering Statistics." Natick, Massachusetts.

