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Mortality in Female War Veterans of Operations Enduring Freedom and Iraqi Freedom

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Abstract

Background Combat-wounded service members are surviving battle injuries more than ever. Given different combat roles held by men and women, female service members should survive wounds at an unprecedented rate.

Questions/purposes We determined whether the casualty rates for females differ from their male counterparts and characterized wounds sustained by female casualties.

Methods We calculated the percentage of the 5141 deaths among the 40,531 casualties by gender for those serving in Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF) from Defense Manpower Statistics between 2001 and 2009. We searched the Joint Theatre Trauma Registry for female casualties and described their injury characteristics. No matched cohort of male casualties was searched.

Results Female veterans comprised 1.9% of all casualties and 2.4% of all deaths. In OIF, the percent death for women was 14.5% (103 deaths) versus 12.0% (4226 deaths) for men. In OEF, the percent death for women was 35.9% (19 deaths) versus 17.0% (793 deaths) for men. Battle-injured females had a greater proportion of facial and external injuries and more severe extremity injuries compared with those nonbattle-injured.

Conclusions The casualty death rate appears higher for women than men although the mechanisms of fatal injuries are not known and may not be comparable. Although facial, external, and extremity injuries were common among battle-injured females, no conclusion can be made as to whether male casualties sustain similar wounding patterns.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Military service members serving in the current US Overseas Contingency Operations (OCO) are surviving battle injuries seen during wartime at higher rates than all previous conflicts; the overall survival rate for service members injured in OCO is greater than 90% compared with 80% injury survival in World War II and 85% in Vietnam [12]. This increased injury survival rate is largely attributed to our evolving understanding of wounding patterns and how best to treat the acutely wounded combat casualty [9, 10]. For example, improvements in body armor protect against projectile thoracoabdominal injuries. Highly trained combat

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Each author certifies that his or her institution has approved the reporting of these cases, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participating in the study was obtained.
The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.
This study was performed at Brooke Army Medical Center and the Institute of Surgical Research.

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medics are deployed closer to the front lines of battle than ever before [5]. The large number of casualties who sustain extremity injuries now benefit from improved wound management and tourniquet use [14, 17]. Because body-region injury distribution for those injured serving in Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF) is similar to previous armed conflicts, these interventions are credited with improving the survival rates of service members on the front lines of combat [15].

Female service members are typically excluded from direct action combat units; however, women contribute substantially to the war effort in multiple supporting roles off the front lines [1]. Today females comprise nearly 15% of the active-duty military population, and the number of female war veterans has increased dramatically over time as 11.3% of veterans from OCO are female [4, 19]. The improvements in combat casualty care to date should also benefit service members serving away from the front lines such as the growing number of females in the military.

There is increasing evidence that response to war differs in men versus women with regard to posttraumatic stress disorder, depression, and other mental illness [18]. Females' response to the acute trauma of war injury may also differ; the Centers for Disease Control and Prevention reports that the age-adjusted injury mortality rate after trauma for females is 33.74 per 100,000 persons versus 85.46 per 100,000 persons per year for males [3]. Animal models of trauma, hemorrhage, and sepsis demonstrate a higher survival rate and lesser propensity to infection in females versus males [6]. This is largely attributed to the potential protective mechanism of estrogen against inflammation in multiple organ systems [7]. Although the topic is debated, civilian trauma literature supports that female patients do exhibit a survival advantage over males, largely as a result of a decreased incidence of developing inpatient complications [8]. Given the potential survival advantage for females in trauma, one may assume that female warriors who sustain combat wounds survive preferentially compared with their male comrades. To begin addressing this assumption, we must first understand the wounding characteristics and mortality rates for female service members serving in their typical combat roles.

We therefore determined (1) the comparative case fatality rates between males and females injured serving in OEF and OIF; (2) the injury distribution for females injured or killed in either battle or nonbattle injuries; and (3) the injury severity for females injured or killed in either battle or nonbattle injury.

Patients and Methods

This observational study was conducted under and in accordance with a protocol approved by the Brooke Army Medical Center Institutional Review Board. We studied female service members who served and were injured in either OEF or OIF between October 2001 and October 2009. We searched Defense Manpower Data Center—Data, Analysis and Programs Division's Casualties Statistics from October 7, 2001, to October 1, 2009 [4]. The OIF data included all casualties from March 19, 2003, to October 1, 2009. The OEF data included all casualties from October 7, 2001, to September 5, 2009. All casualties, defined as any person who is lost to the organization by reasons of having been declared dead, missing, captured, interned, wounded, injured, or seriously ill, were tabulated and analyzed for all military deaths and all wounded by gender for each theater of operations for their respective time periods (Table 1).

We then searched the Joint Theater Trauma Registry (JTTR, US Army Institute of Surgical Research [ISR], Fort Sam Houston, TX) for female US service members evacuated from OEF or OIF combat theater because of injury during the timeframe specified previously. All female casualties were included. Male service members, foreign nationals, and service members evacuated as a result of disease rather than an injury were excluded. No male comparison group was established.

Age, military rank, number of wounds, number of operative procedures before arrival at a US hospital, status (alive or dead), Injury Severity Scores (ISS), and body-specific ISS were collected from the JTTR on each subject. The body-specific ISS scores rate the severity of injury to six different body regions: (1) the head, neck, and cervical spine; (2) the face; (3) the chest and thoracic spine; (4) the abdomen and lumbar spine; (5) the extremities and bony pelvis; and (6) external injuries to the integument, including tissue loss and burn. Each subject was divided into those who sustained a battle injury and those who sustained a nonbattle injury.

Table 1. Operation Iraqi Freedom and Operation Enduring Freedom have resulted in over 40,000 casualties, 765 of which are female

Operation	Timeframe	Deaths	Wounded	Total
Iraqi Freedom	March 19, 2003, to October 1, 2009	4329	31,494	35,823
Enduring Freedom	October 7, 2001, to September 5, 2009	812	3896	4708
Total	October 7, 2001, to October 1, 2009	5141	35,390	40,531

JTTR entries are consecutively entered into the Registry as information on evacuated casualties is received. Therefore, the result of the JTTR query represents a consecutive sample of female casualties for the previously defined time period and is without selection bias. For each data point searched, all subjects had complete information, limiting information bias. A casualty's entry into the JTTR is limited by the man hours required for an ISR data abstractor to enter the information into the Registry, likely explaining the difference in the Defense Manpower numbers and the JTTR numbers for female casualties; however, there is no selection of JTTR entries that would bias results because casualties are entered into the Registry in consecutive order as they are received by the ISR personnel.

The Defense Manpower Data indicated 40,531 total casualties, 765 of which were female, and 5141 total deaths, 122 of which were female (Table 2). The case fatality rate for each gender was calculated by dividing the number of deaths for each gender by the sum of the number of deaths and the number of nonfatally wounded (Table 3). The case fatality rates are reported as percentages for the entire conflict and for OEF and OIF separately.

The JTTR search resulted in 504 female casualties. Each casualty was categorized as a battle injury or nonbattle injury. We determined differences in mean age and rank between those battle-injured and nonbattle-injured using a Mann-Whitney test because these data are nonparametric and typically skewed toward lower ages and lower ranks for a cohort of combat wounded [15]. Number of wounds and number of operative procedures between those battle- and nonbattle-injured were compared using an unpaired t-test because these data points are more evenly distributed in this large sample. We compared body sites injured (eg, head injury versus no head injury) by body-specific ISS designation between those battle-injured and nonbattle-injured using the chi square method. All data were analyzed using SAS 9.1 (SAS Institute, Inc, Cary, NC) software.

Table 2. The proportion of female deaths is higher than the proportion of female casualties

Operation	Total deaths	Female deaths	Female proportion
OCO	5141	122	2.4%
OIF	4329	103	2.4%
OEF	812	19	2.3%

OCO = Overseas Contingency Operations; OIF = Operation Iraqi Freedom; OEF = Operating Enduring Freedom.

Results

The case fatality rate for females in both OEF and OIF was higher than that for males (Fig 1). Female service members in OEF had a higher ($p = 0.001$) case fatality rate (35.9%) compared with male service members (17.0%). In OIF, the female case fatality rate (14.5%) was higher ($p = 0.048$) than the male case fatality rate (12.0%). (Female service members comprised 1.9% of all casualties and 2.4% of all deaths.) We found no difference ($p = 0.49$) in the percentage of female deaths between operations.

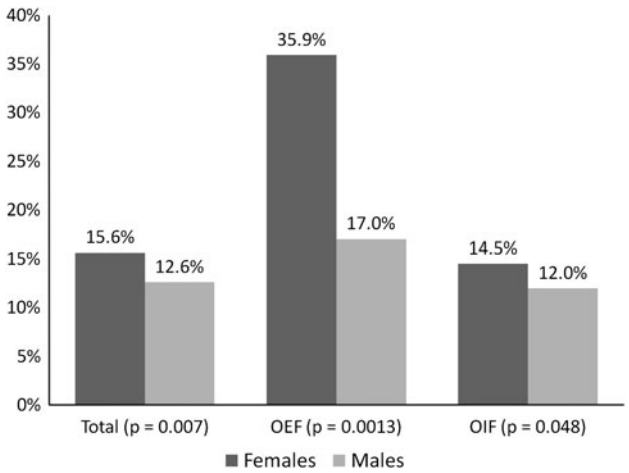

Fig. 1 The case fatality rate for females appears greater than for males both in OIF and OEF. OIF = Operation Iraqi Freedom; OEF = Operation Enduring Freedom.

Table 3. Casualties grouped according to battle or nonbattle injury*

Term	Definition
Casualty	Any person declared dead, missing, captured, interned, wounded, injured, or seriously ill and thus lost to the organization
Battle injury	Any injury sustained as a result of combat during hostile action or as a result of terrorist activity
Nonbattle injury	Any injury sustained resulting from a circumstance not directly attributable to hostile action or terrorist activity
Case fatality rate	$\frac{\text{Total deaths}}{\text{Tota deaths} + \text{total wounded}}$
Female case fatality rate	$\frac{\text{Total female deaths}}{\text{Total female deaths} + \text{total female wounded}}$

* For all wounded, the case fatality rates were calculated and compared among genders.

Table 4. A higher number of individuals were nonbattle-injured for both conflicts

Cohort	Number	Mean age (years)	Median rank	Number of wounds	Number of procedures before evacuation to United States	Number of hospital days before evacuation to United States
Entire cohort	504	27	E4	2.8	2.8	3.7
Battle-injured	199 (39%)	26	E4	4.1	3.7	3.9
Nonbattle-injured	305 (61%)	27	E4	1.9	2.2	3.5
p Value (battle versus nonbattle)		0.1696	0.7493	< 0.001	< 0.001	0.1045

Table 5. A greater percentage of those with battle injury compared with nonbattle injury sustained facial and external (skin) injuries*

Body-specific ISS region	Battle-injured	Nonbattle-injured	Dead
Head/neck/cervical spine	16%	12%	19%
Face	25%	7%	13%
Chest, thoracic spine	12%	9%	25%
Abdomen, lumbar spine	10%	8%	38%
Extremities + pelvis	61%	72%	69%
External	84%	41%	56%

* The abdomen and chest were more likely to be injured in casualties who died; ISS = Injury Severity Score.

One hundred ninety-nine (39.5%) females were battle-injured and 305 (60.5%) were injured in nonbattle circumstances. The average age (27 years; range, 19–53 years) and rank (average, E-4; range, E1 to O-4) was no different between battle-injured and nonbattle-injured (Table 4). The average casualty sustained 2.8 wounds; however, casualties with battle injuries sustained an average of 2.2 more wounds ($p < 0.001$) than those with nonbattle injuries. Females with battle injuries had a greater ($p < 0.001$) proportion of face (25% versus 7%) and external injuries (84% versus 41%) than those with nonbattle injury.

The average ISS among the entire cohort was 7.8, 10.7 with battle injuries and 5.9 for those nonbattle-injured. The extremity body-specific injury severity score was higher ($p < 0.001$) for those battle-injured versus those nonbattle-injured (2.7 versus 2.0). Sixteen female casualties were dead, 12 by battle injury and four by nonbattle injury. The average ISS for these 16 was 24.5. All battle-deceased female casualties were injured in an explosion. A greater proportion ($p = 0.005$) of dead female warriors had an abdomen body-specific injury score (38% versus 10%) compared with the survivors (Table 5).

Discussion

Service members injured serving in OEF and OIF are surviving their wounds more than any other US conflict as a result of advancements available to those serving on the front lines of battle. However, female service members who most often serve in support roles rather than front line combat may not benefit from these advancements like male counterparts who comprise infantry and armored units. The purpose of this study was to determine if the female casualty rate in our current conflicts is comparable to males and to describe the injury locations and injury severities for female service members who survive and die from wounds.

This study has several limitations. First, this study simply identified differences in the death rate of men versus women without characterizing the injuries, cause of death, or mechanisms of injury for all of the dead. This death rate includes all causes, both hostile and nonhostile, for the study periods. Although the data collected from JTTR allow a cohort of females to be critically analyzed, this cohort cannot be assumed to represent all female casualties. Second, we had no information on the injury distribution of all female casualties who survive. If the reason for the increased deaths in female casualties was related to the relatively small size of female soldiers as compared with their male counterparts, then it would be intuitive that female casualties will have sustained more severe injuries as compared with their male counterparts when matched by period and theater of operations. Third, we do not have a matched cohort of male casualties to compare injury mechanism, distributions, and severities. We therefore cannot assume that demographic data or other confounders do not influence the death rates. Fourth, we are unable to report on specific job descriptions held by our cohort of females to study the link between the job and injury characteristics.

Despite a similar prevalence of wounds between genders, we found female service members' death rates while serving in the combat theater appear higher than males. This finding is contrary to what we know from the civilian trauma literature in which death resulting from injury is twice as frequent in males versus females [3, 7, 8]. Although animal studies and some human literature support that estrogen is protective in light of traumatic injury, differences in male and female physiology do not explain this difference in death rate as a result of hostile and

nonhostile combat wounds [6, 8]. Exposure, however, may explain this difference. Although standard protective equipment is offered to each soldier regardless of combat role, such armor most effectively protects against direct fire most likely encountered by all-male combat units. Explosions such as improvised explosive devices (IEDs) can occur anywhere, including away from the front lines, and cause both penetrating injury from fragments and blunt injury from the explosion itself [16]. Explosions cause substantial injury and females in support roles may be more likely to encounter an explosion than direct fire. Furthermore, if explosions are causing a large proportion of the injuries sustained by females, the case fatality rate for these injuries is not directly comparable to single gunshot wound injuries that may occur during direct combat. Although exposure to explosions may influence the death rate in females, the death rate for males injured during explosions is likely to be as high if the rates are controlled for injury mechanism.

A majority of our cohort sustained nonbattle injuries; however, those injured in battle sustained a greater average number of wounds. The proportion of nonbattle-injured female casualties in this cohort was higher than expected versus Defense Manpower statistics, which demonstrate that all nonbattle injures in both conflicts represent 53% of injuries compared with the 61% seen in this cohort [4]. The increased case fatality rate cannot be explained by these proportions of typically less severe nonbattle injury. Battle injuries resulted in more frequent facial and external injuries. Improved body armor protects the chest and abdomen; however, the face and extremities remain vulnerable [10, 15]. The external injuries indicate lacerations, tissue loss, and/or skin burns, all injuries typical after explosions [13]. Therefore, females appear to likely endure explosions as their main battle exposures.

Females battle-injured had more severely rated extremity injuries. Extremity injuries are the most common injuries sustained in these conflicts; and the most severe extremity injuries are attributed to explosions, further suggesting females experience substantial explosion injuries [2, 15]. Furthermore, dead female casualties had a greater proportion with abdominal injuries and tended to have more chest injuries than their counterparts who survived. This is not counterintuitive because chest and abdominal trauma is typically more likely to be lethal compared with extremity injuries [11]. For all females who died, explosion was the cause of injury again confirming that explosions contribute to the severe nature of injuries experienced by females. The support roles occupied by female service members are not immune to explosion tactics because an IED may be found anywhere during combat operations. Males injured in explosions are likely to have similarly severe injuries.

Further research is necessary to address these important questions of what exposures are most likely to cause serious and fatal injuries to female service members. If the female's role in the deployed environment exposes her to more fatal combat injury or greater incidence of nonbattle insult, these exposures should be addressed. These efforts start with the awareness highlighted in this study; for whatever reasons our female service members appear to be dying at a higher rate than their male counterparts.

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