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Physical Injury and Psychological Outcomes among U.S. Combat Veterans

A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Public Health (Epidemiology)

by

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Chair

University of California, San Diego

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2007
DEDICATION

To my wife, Sabrina.
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ABSTRACT OF THE DISSERTATION

Physical Injury and Psychological Outcomes among U.S. Combat Veterans

by

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Doctor of Philosophy in Public Health (Epidemiology)

University of California, San Diego, 2007

San Diego State University, 2007

Professor Richard A. Shaffer, Chair

OBJECTIVES: There were three objectives of this dissertation: (1) compare rates of psychological outcomes between battle and non-battle injury; (2) assess injury-specific predictors of post-traumatic stress disorder (PTSD) and other psychological outcomes; and (3) examine the role of traumatic brain injury in the development of psychological outcomes. METHODS: Three population-based retrospective studies were conducted utilizing data from the Navy and Marine Corps Combat Trauma Registry (CTR), the Career History Archival Medical and Personnel System (CHAMPS), and, for objective one only, Post Deployment Health Assessments (PDHA). The Navy-Marine Corps CTR contains information on clinical encounters during Operation Iraqi Freedom for battle and non-battle injury. Male U.S.
combatants injured between September 2004 and February 2005 were included in the study. Outcome data through November 2006 were abstracted from CHAMPS in the form of ICD-9 codes indicating mental health diagnosis (ICD-9 290-319) and specifically PTSD (ICD-9 309.81). For objective one, self-reported mental health symptoms from the PDHA were also utilized as outcome data. RESULTS: Battle injuries had higher rates of PTSD, other mental health diagnoses, and self-reported mental health symptoms when compared to non-battle injuries, with the greatest effect observed with increasing battle injury severity. Overall the rate of PTSD was 17.0% among battle injuries and 5.1% among non-battle injuries, and rates of any mental health outcome were 31.3% and 14.2% among battle and non-battle injuries, respectively. Among battle injuries, injury severity predicted both PTSD and any mental health outcome. Any mental health outcome was also predicted by gunshot wounds and diastolic blood pressure; the effect of diastolic blood pressure was modified by injury severity. Post-injury heart rate did not predict PTSD or any mental health outcome. The rate of traumatic brain injury (TBI) among battle injuries was 21.0%, and TBI prevalence was associated with blast injury. When examining injuries of moderate or higher severity, TBI was associated with lower rates of mental health diagnosis compared to non-head injuries. CONCLUSIONS: Battle injuries were associated with high rates of PTSD and other psychological outcomes, and important predictors included injury severity and gunshot wounds. Lower rates of mental health diagnoses among those with TBI may be due to symptom overlap between TBI and many psychological disorders. Unmeasured confounding effects of combat exposure and medical utilization may have influenced the results.
I. INTRODUCTION

Participation in direct wartime activities is a unique stressor usually involving, among other things, a perceived threat to one’s life. Psychological issues, which may manifest themselves in both acute and persistent forms, have been documented in every major military conflict since the U.S. Civil War. In recent military conflicts, increased survival from both wounds and disease has brought focus onto psychological casualties. Post traumatic stress disorder (PTSD), or the psychological consequences of exposure to a stressful event that someone may perceive as traumatic, has been associated with military combat since it was first recognized in veterans of the Vietnam War. Physical injury has been shown to be associated with the development of PTSD and other psychological illness (either directly or comorbid with PTSD). Few studies have examined the relationship between injuries acquired during military conflict and subsequent development of PTSD and other psychological outcomes.

Across the major military conflicts since the 19th century, symptoms of psychological casualties, or war neuroses, have been similar and have commonly included fatigue, headache, disturbed sleep, and dizziness. It has been suggested that any major differences in symptom reporting across conflicts were due to cultural differences over time in both patient reporting and doctor interpretation. Nonetheless, most psychological casualties during military conflict can be classified as either acute or persistent.

Combat stress reactions (CSR) are the typical form of acute psychological casualty seen in military conflicts, although different nomenclature has been used for
different conflicts (e.g. shellshock, battle fatigue). These stress reactions were defined by Solomon as occurring when “…a soldier is stripped of his psychological defenses and feels so overwhelmed by the threat that he or she becomes powerless to counteract or distance himself or herself from it and is inundated by feelings of utter helplessness and anxiety”. The U.S. Army Center for Health Promotion and Preventive Medicine identifies some individual warning signs for CSR as extreme restlessness, increased startle response, poor hygiene, apathy, inability to sleep, and reckless actions.

The primary persistent condition of interest for the current proposal is PTSD, which according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, is characterized by re-experiencing, hyperarousal, and avoidance of stimuli occurring at least one month following a traumatic event. Additionally, these symptoms must persist for at least one month. Acute stress disorder, a more recently formalized diagnosis, is meant to act as a predictor for PTSD and is characterized by the presence of traumatic stress symptoms within the first 30 days of the traumatic event. Other psychological outcomes that have been found to be independently associated with trauma include generalized anxiety disorder, substance abuse, phobia, and major depressive disorder. Comorbid psychological diagnoses are very common in those suffering from PTSD, with depressive disorders, substance abuse, and other anxiety disorders being the most commonly reported.

The role of physical injury as a predictor of PTSD has only been recently elucidated, and unfortunately as a result of methodological issues there has been great variability in estimation of rates. Before PTSD became a formal diagnosis, early
studies identified the presence of PTSD-like symptomology. Symptoms of PTSD following injury were first described in 1866 by Erichsen; in this case PTSD symptoms were described following railway accidents. Other studies of injuries and their relationship to PTSD re-emerged in the late 1980s following the formalization of the PTSD diagnosis; these studies were primarily within populations of motor vehicle accident survivors. The role of specific physical injuries (e.g. traumatic brain injuries) in the development of psychological illness, especially PTSD, is still cause for debate in scientific literature.

**HISTORY OF WAR NEUROSES**

*Early References*

Although some speculate that PTSD related symptoms have been mentioned as far back as the 7th century B.C. in Homer’s Iliad, the first documented account of psychological symptoms during military operations was in the 17th century. Johanness Hofer, among others, wrote of “nostalgia”, characterized by feelings of homesickness, experienced by deployed soldiers. This diagnosis would later be described in the context of the U.S. Civil War. The Napoleonic Wars of the 18th century saw the advent of the term “wind contusion”, which described cases of tingling, twitching, and sometimes partial paralysis experienced by soldiers near an explosion but with no physical wound. These symptoms may have originated from a somatization of stress, leading to anxiety induced physical symptomology. This is also theorized to be the origin of disordered action of the heart (DAH), first described by Hartshorne as “exhaustion of the heart” and made famous by Jacob DaCosta during the U.S. Civil War. Disordered action of the heart was characterized by symptoms such as
shortness of breath, palpitations, and chest pain, which were exacerbated upon physical exertion.¹ Later conflicts would see both DAH and CSR, although the conditions would often be called by different names.¹ It was difficult in early conflicts to distinguish between DAH and CSR, as some DAH patients may have suffered from CSR concurrently.¹ This ambiguity was also seen during the Boer war, where Bowlby described “the appearance of functional nervous symptoms” in soldiers under prolonged mental strain.²

World War I

During World War I, a study by Salmon showed an incidence of psychological illness twice as high in deployed troops compared to the general population.², ¹⁷ Subsequent research also found that rank was associated; officers exposed to combat had double the incidence of psychological illness but this same association was not present among enlisted personnel.², ¹⁸ Many military psychologists at this time highly encouraged the acceptance of psychological casualties as an inevitable occurrence, and recommended rapid treatment near the front. Studies among British troops indeed showed a higher return to duty rate when treatment was done near the front without the patient being evacuated from his unit. This rate, however, did not distinguish between returning to combat or non-combat duty.² As a result of this war, a condition characterized by an anxiety like reaction caused by low exposure to phosgene and chlorine chemical warfare agents was coined as “gas hysteria”.⁴ During this war, CSR was known as “shellshock”, and was defined by Southborough as a “…nervous and mental exhaustion” which was the result of prolonged strain and hardship.⁴, ¹⁹ Although shellshock was initially attributed to concussive effects of new weaponry, a
psychological pathway was eventually accepted for this condition. The “effort syndrome” was the World War I version of DAH, termed as such due to the exacerbation of symptoms upon physical exertion.\textsuperscript{1} Originally attributed to the wearing of military packs that was thought to compress blood vessels in the chest, the effort syndrome was later attributed to multiple other causes. It was additionally discovered that the effort syndrome was pre-existing in some patients (occurring prior to the war), and that exercise rehabilitation was an effective treatment.\textsuperscript{1} The effort syndrome was the third most common reason for disability among British troops. Their pension records allowed for the first follow-up study of psychological casualties post-combat; however, the lack of a quality comparison group did not allow for conclusive findings.\textsuperscript{1,20}

\textit{World War II}

Upon the entrance of the British to World War II, studies by Wood further shed light on the mechanism of DAH. Among Wood’s major findings were that DAH occurred just as frequently in civilians as in uniformed personnel, and that a psychological diagnosis could nearly always be made in DAH cases. Additionally, Wood found that DAH was associated with a family history of nervousness.\textsuperscript{21-23} In the years following these studies, it became readily accepted that DAH was a condition of psychological origin; Wood even suggested that it be renamed “anxiety neurosis”.\textsuperscript{1,21} Overall during World War II, 5-30\% of all medical casualties from battle areas were casualties of psychological origin. The actual figure depended primarily on the type of warfare fought, number of killed/wounded in action, intensity of battle, and cumulative combat experience.\textsuperscript{2} The association with battle intensity and total
physical casualties was later confirmed by Israeli studies of the Yom-Kippur and Lebanon wars. As found in previous conflicts, psychological casualties of World War II treated near the front without evacuation had a higher return to duty rate; however, when examining rates of returning to combat duty, it was found that a majority of those returning to duty never did return to combat.

**Korea and Vietnam Conflicts**

Battle fatigue, also known as CSR, was officially formalized as a diagnosis in the 1952 Gray Manual, and remained an important clinical problem during the Korean conflict of the 1950s. Interestingly, DAH diagnoses were not as common during this conflict, possibly due to its acceptance as a psychological disorder which may have led to fear of stigmatization and thus underreporting of symptoms. The Vietnam War saw a surprisingly low rate of psychological casualties during the conflict, but later produced ‘Post-Vietnam Syndrome’, which was subsequently formalized as PTSD in 1980. Following the formalization of PTSD diagnosis, retrospective epidemiological studies identified cases of PTSD in both World War II and Korea veterans. The Vietnam Experience Study, conducted in the mid 1980s, estimated that 16.5% of Vietnam veterans had experienced PTSD at some time during or following their military service. This study also showed a positive association of PTSD with combat, using military occupational specialty as a proxy for combat exposure. Other psychological disorders such as major depression, substance abuse, and anxiety were of higher prevalence among Vietnam veterans compared to the general population.
The Persian Gulf War, Afghanistan, and Iraq

Problems with PTSD persisted after the Persian Gulf War of 1991. Although there were relatively few casualties among the United Nations troop coalition, potential traumatic stressors included risk of chemical/biological warfare, direct combat, and exposure to dead or wounded Iraqi soldiers and civilians.²⁹ A review by Stimpson, et al. examined 20 studies of Gulf War veterans and found higher prevalence of both PTSD and common mental disorders among deployed individuals when compared to a non-deployed comparison group.²⁹ Following the conflict, investigations soon began on a potential new syndrome, termed Gulf War Illness (GWI), among Gulf War veterans. This syndrome was characterized by a plethora of symptoms, including fatigue, headache, muscle/joint pain, diarrhea, and rash.¹ The current prevailing theory of GWI etiology is multiple illnesses with multiple causes, including psychological causes.³⁰

The military conflicts following the September 11, 2001 terrorist attacks included Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) in Iraq. Prevalence of major depression, general anxiety, and PTSD symptomatology was significantly higher among OIF veterans (compared to OEF veterans), which was likely due to a greater reported exposure to combat during OIF.³¹ Hoge, et al. found that 19.1% of returning U.S. military from OIF reported a mental health problem, compared to 11.3% from OEF and 8.5% from other locations.³² In this same study among 222,620 military personnel deployed to OIF, 9.8% reported PTSD-like symptomology, 4.5% reported anhedonia or depressed mood, and 1.6%
reported anhedonia with depressed mood. Evidence does not currently suggest a re-emergence of GWI among OIF or OEF veterans.

**PHYSICAL INJURY AND PSYCHOLOGICAL ILLNESS**

*Physical Injury in Military Populations*

Few studies have examined the relationship between physical injury and psychological outcomes during military conflicts. Physicians during World War I reported that soldiers injured in combat were less likely to suffer from shellshock. Wood, in his famous World War II studies of DAH, theorized that due to the respect and sympathy injured soldiers garner they rarely develop psychological symptoms. In an Israeli study, Merbaum and Hefez reported that injured soldiers showed minimal psychological disturbances. Studies of PTSD among Vietnam veterans, however, have identified a two to three fold greater lifetime prevalence of PTSD symptoms in injured combat veterans compared to noninjured. A more recent study by Koren, et al. examined PTSD risk among combat-injured Israeli soldiers after controlling for combat exposure; the results showed a more than eight-fold increased risk among those with combat injury compared to those uninjured. Hoge, et al. found significant associations between physical injury and PTSD among OIF and OEF veterans, reporting odds ratios of 3.27 and 2.49, respectively. A more recent study by Grieger, et al. found that among severely combat-injured OIF veterans, early severity of physical problems due to the injury was predictive of PTSD and depression development.
Physical Injury in Civilian Populations

Most studies examining the relationship between physical injury and psychological illness have been conducted within civilian populations, most notably victims of motor vehicle accidents. Rates of PTSD measured at 1-6 months post-vehicular accident ranged from 18% to 42%. When examining rates at 12 months post-vehicular accident, prevalence of PTSD ranged from 14% to 32%. One study by Schnyder, et al. identified an extremely low 12-month rate of PTSD post-accident of 1.9%. Variation of reported prevalence among these studies is likely due to methodological problems such as varying timing of symptom assessment, inadequate sample sizes, and unrepresentative samples. Studies have also shown an increased risk among accident survivors of anxiety disorder, depression, acute stress disorder, and substance abuse.

Numerous studies have identified a positive association between physical injury and PTSD development among survivors of disasters. A follow-up study of Pentagon employees who survived the September 11, 2001 terrorist attack found that those injured were 8 times as likely to have probable PTSD and 5 times as likely to have probable depression. A similar association was found among child survivors of both an earthquake in Taiwan and an industrial disaster in France. A study following a terrorist bombing in France examined the effect of injury on PTSD development after defining the injury severity as low, moderate, or high; those with high severity were nearly 3 times as likely to develop PTSD when compared to those with low severity.
Comparing Combat Injury to other Injury Types

Few studies show a direct comparison between combat-related injury and other sustained injury in regards to PTSD development. One study conducted following the Persian Gulf War compared a traumatic injury group with a non-traumatic group. The traumatic injury group was not exclusively combat-related injury, however, and included injuries due to motor vehicle and heavy machinery accidents. The non-traumatic group contained conditions such as orthopedic injuries and acute infectious conditions. The study conducted a medical record review and found those in the traumatic injury group were more likely to report symptoms of psychiatric concern. Due to its cross-sectional design, however, temporality could not be established.

Another study by Schwartz, et al. examined PTSD following terrorist attacks; though not combat-related trauma, terrorism-related trauma is a similar phenomenon specific to the civilian community. The study compared injured survivors of terrorist attacks admitted to local emergency rooms with injured survivors of non-terror related trauma. The study found a PTSD rate of 40.9% among those injured by terrorist attacks compared to 24.2% for non-terror related trauma victims. Victims of terror attacks also had a higher prevalence of anxiety and depression symptoms.

Injury Related Predictors of PTSD

Studies have also examined predictors of PTSD following physical injury. Objective injury measures, such as injury severity score, appear to be a poor predictor of later psychological illness, although further research is needed. Subjective measures of severity, such as perceived threat to life, have been found associated with later development of PTSD.
Heart rate following physical injury has been implicated as a predictor of PTSD following injury, but in at least one study, it was found to have a protective effect. Studies of other cardiovascular measures, such as blood pressure, have yielded less conclusive results.

**Traumatic Brain Injuries**

The prevalence of traumatic brain injury (TBI), or a traumatically induced physiological disruption of brain function, appears to be elevated in OIF compared to Vietnam veterans. According to recent reports, 22\% percent of total wounded uniformed personnel involved in OIF had injuries to the head, face, or neck (a proxy indicator for TBI) compared to approximately 12-14\% during Vietnam. This higher percentage of TBI is likely due in part to advances in field medical care which has resulted in better injury survival rates, as well as the style of warfare fought by the enemy in OIF. Improvised explosive devices are responsible for many of the attacks currently undertaken in OIF, and it’s estimated that 59\% of those injured by these blasts meet the criteria for TBI. A review by Van Reekum, et al. cites strong evidence associating TBI with major depression, anxiety disorders, and bipolar effective disorder. Among studies that have specifically examined the potential association between PTSD and TBI, results have been mixed. The traditional view was that the impaired consciousness seen in TBI patients precludes encoding of the traumatic event, thereby acting as a protective factor against development of PTSD. Recent studies, however, have provided evidence that these two conditions are not mutually exclusive, although TBI patients with impaired memory for the event
or an extended period of unconsciousness do seem to have lower rates of PTSD.\textsuperscript{66-71} Other studies have shown no difference between the rates of PTSD in TBI as compared with non-TBI patients.\textsuperscript{66-69, 72, 73}

**PURPOSE OF CURRENT STUDY**

The purpose of this study was to examine the association between physical injury during OIF deployment and subsequent diagnosis of psychological outcomes, with particular interest in PTSD diagnosis. Based on the evidence present in civilian populations, as well as the somewhat limited evidence within military populations, it was hypothesized that physically injured OIF combatants would have a higher rate of PTSD than previous estimates from the general OIF deployed population, and that more severe injuries would be associated with higher rates of PTSD and other psychological outcomes.

Injured OIF combatants were identified from the Navy-Marine Corps Combat Trauma Registry (CTR), a database of injuries incurred during OIF maintained by Naval Health Research Center, San Diego (NHRC).\textsuperscript{74, 75} An example of data collected for the CTR can be found in Appendix I. Outcome data was ascertained from two sources: the Career History Archival Medical and Personnel System (CHAMPS)\textsuperscript{76, 77} and the Post Deployment Health Assessment (PDHA).\textsuperscript{78} An example of the PDHA form can be found in Appendix II.

To begin, the overall cohort of injured OIF combatants was described separately for battle and non-battle injury by standard demographic statistics, military related factors, and later development of psychological outcomes. Potential physiological predictors of PTSD and other mental health outcomes, to include heart
rate and blood pressure, were then examined, as were predictors related to injury characteristics, such as mechanism, severity, and location. Finally, an analysis was conducted specifically examining those personnel with traumatic brain injury. All analyses were done using SAS 9.1 for Windows.
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II: MENTAL HEALTH SEQUELAE OF BATTLE AND NON-BATTLE INJURY AMONG OPERATION IRAQI FREEDOM VETERANS

ABSTRACT

BACKGROUND: Limited research exists on the relationship between physical injury and post traumatic stress disorder (PTSD) within military populations.

OBJECTIVE: To describe the post-injury prevalence of PTSD and other psychological outcomes among injured, male combatants from Operation Iraqi Freedom (OIF), and to examine differences between battle and non-battle injuries.

METHODS: A total of 1968 men (831 battle-injuries and 1137 non-battle injuries) injured between September 2004 and February 2005 during OIF comprised the study population. Patients were classified as either battle or non-battle injury, and were followed through November 2006 for diagnosis of mental health outcome (ICD-9 290-319). Additionally, 918 patients (46.6%) were included in a subgroup analysis to examine the presence of self-reported mental health symptoms. RESULTS: Of the battle-injuries, 64.7% were classified as minor, 18.7% moderate, 11.2% serious, and 5.4% severe. Compared to non-battle injuries, battle injuries had a greater risk of PTSD and other mental health diagnosis, with the greatest effect seen as severity of battle injury increased. Self reported mental health symptoms were significantly higher for both minor and moderate-severe battle injury when compared to non-battle injury and previous population estimates from an earlier OIF period.

CONCLUSION: Compared to non-battle injuries, OIF veterans with a battle injury were at greater risk of PTSD and other psychological morbidity, with the greatest
effect seen as severity increased. More research is needed to further define this relationship by examining potential mechanisms and addressing the possible confounding effect of combat exposure.
INTRODUCTION

Traumatic events can lead to a variety of psychological outcomes, including generalized anxiety disorder, substance abuse, phobia, post traumatic stress disorder (PTSD), and major depressive disorder.\(^1\) Post traumatic stress disorder, first formalized as a diagnosis in 1980, is an anxiety disorder initiated by exposure to a traumatic event and characterized by symptoms of avoidance, re-experiencing, and hyper-arousal.\(^2,3\)

Post traumatic stress disorder is a significant source of morbidity among military personnel;\(^4,5\) research within military populations after Vietnam, the Persian Gulf War, and Operation Iraqi Freedom (OIF) has found higher rates of PTSD and other psychological morbidity among deployed compared to non-deployed personnel.\(^5-7\) Among military deployed personnel, physical injury appears to be an important predictor of PTSD. Studies of PTSD among Vietnam veterans have identified a two to three fold greater lifetime prevalence of PTSD symptoms in injured combat veterans compared to uninjured.\(^8,9\) A recent study by Koren, et al. found a more than eight-fold increased risk of PTSD among those with combat injury compared to those uninjured.\(^10\) Hoge, et al. found a similar association between physical injury and PTSD among OIF veterans.\(^11\) These findings closely resemble those among civilian populations surviving terrorist attacks and natural disasters, and among police officers involved in critical shooting incidents.\(^12-18\) Some studies among military populations, however, have failed to replicate this result.\(^19-22\) Previous research within military populations has generally not compared battle and non-battle injury with respect to the relationship between injury and mental health.
The purpose of the current study was to describe the prevalence of PTSD, other mental health outcomes, and self-reported mental health symptoms among injured OIF combatants. Rates of mental health outcome for battle and non-battle injury were compared; self-reported mental health symptoms were additionally compared to previous population estimates by Hoge, et al.7

METHODS

Study Population

The study population was identified from the U.S. Navy-Marine Corps Combat Trauma Registry (CTR), which is a deployment health database maintained by Naval Health Research Center (NHRC) consisting of documented clinical encounters of deployed military personnel; records are obtained for battle injury, non-battle injury, disease, psychiatric and routine sick call encounters.23, 24 Eligible personnel for this analysis were Operation Iraqi Freedom (OIF) combatants presenting to forward medical treatment facilities for battle or non-battle injury during the 6-month period from September 2004 to February 2005. Precise date of injury was not indicated for all personnel, therefore date of arrival for medical care was used as a proxy for injury date. After excluding females due to low representation among battle injuries (less than 1%) and 41 individuals who died as a result of their wounds, 2088 participants (881 battle injuries, 1207 non-battle injuries) were matched against the Career History Archival Military Personnel System (CHAMPS). A database maintained by NHRC, CHAMPS contains demographic, career, and medical information on all military members on active duty in the U.S. Armed Services since 1973 (see Gunderson, et al., 2004, for a detailed description of CHAMPS).25 A total of 1983 eligible injured
personnel (95.0%) had a matching record in CHAMPS. Fifteen individuals were
excluded due to evidence of military discharge less than 90 days into the follow-up
period; a total of 1968 male, injured personnel (831 battle injuries, 1137 non-battle
injuries) comprised the study population.

Measures

Injuries were classified as either battle or non-battle based on thorough review
of the Navy-Marine Corps CTR clinical record by clinical research staff. A battle
injury was defined as any injury that resulted from hostile action. Injury severity was
calculated for battle injuries using the Injury Severity Score (ISS).26 Although not
measured for non-battle injuries, most of the non-battle injuries were minor orthopedic
injuries corresponding to an ISS of 1-3. In order to take injury severity into account,
injury status was categorized into non-battle and minor (ISS 1-3), moderate (ISS 4-8),
serious (ISS 9-15), and severe (ISS ≥ 16) battle injury.

This study utilized a retrospective design. Four primary outcomes were
considered: 1) diagnosis of any mental health outcome; 2) diagnosis of PTSD; 3)
diagnosis of mood/anxiety disorder; and 4) self-reported mental health symptoms.

Diagnoses in the form of ICD-9 codes were abstracted from the CHAMPS
system. The CHAMPS database was updated through November 2006, therefore there
were approximately 22-27 months of follow-up time, although some participants were
discharged from the military over the course of the follow-up period; upon military
discharge CHAMPS no longer monitors personnel. Those discharged without a
mental health diagnosis were assumed to have not developed the outcome.
A diagnosis of PTSD was indicated by an ICD-9 code 309.81, and any mental health outcome was indicated by an ICD-9 code in the range 290-319, excluding 305.10 (tobacco addiction). The date of PTSD diagnosis must have been at least one month post-injury as the definition of PTSD requires symptoms to persist for at least one-month; any diagnosis of PTSD less than one month post-injury was treated as a previous mental health diagnosis. Other mental health outcomes of interest included mood disorders (ICD-9 296, 300.4, 301.13, 311) and anxiety disorders (ICD-9 300.00-300.02, 300.21-300.29, 300.3, 308.3, 308.9, 309.81). Due to a typically high rate of comorbidity, mood and anxiety disorders were combined for analysis. Though not primary outcomes of interest, rates of adjustment disorders (ICD-9 309.0-309.9, excluding 309.81), substance abuse disorders (ICD-9 291, 292.0-292.1, 292.3-292.9, 303, 304, 305.0, 305.2-305.7, 305.9) and other mental health disorders (other ICD-9 code between 290 and 319 not previously listed) were also examined.

Self reported mental health symptoms were abstracted from post-deployment health assessments (PDHA). The Department of Defense (DoD) requires that all military personnel complete a PDHA within one to two weeks of return from an overseas deployment using revised DoD Form 2796. A list of all pertinent mental health questions is shown on Table 1. Post traumatic stress symptoms were ascertained using a previously validated 4-item screening tool. Answering “yes” to 3 of the 4 questions was considered a screen positive and a risk factor for PTSD. For purposes of comparing to previous population estimates by Hoge, et al., an alternate screen positive definition of answering “yes” to 2 of 4 questions was used. Symptoms of depression were ascertained using a modified version of a previously
validated 2-item screening instrument; the patient must have answered “a lot” to at least one of the depression questions to be considered a screen positive for depression. Patients who screened positive for PTSD or depression, or endorsed any of the other mental health questions, were considered to have “any mental health concern”. In this analysis, participants were restricted to those who completed a PDHA 1-6 months post injury to increase the likelihood that injury was the predating factor for the PDHA screening results. A total of 918 individuals (46.6%) met this criterion and comprised the study population for this subgroup analysis.

Other variables were utilized for adjustment purposes only. Age, military rank, and military service were abstracted from the clinical record for all persons in the study population. Intelligence, reportedly related to development of PTSD, was measured with the Armed Forces Qualification Test (AFQT) score abstracted from CHAMPS. Marital status was abstracted from CHAMPS as well. Previous mental health diagnoses have also been identified as a risk factor for PTSD development, and were ascertained from CHAMPS. Patients with an ICD-9 code between 290 and 319 (excluding 305.10) at any time while in the military since January 1, 2000 and prior to the date of injury were considered to have a previous mental health diagnosis. Reported history of combat experiences was ascertained from the PDHA for the subgroup analysis. Reporting “yes” to either seeing dead bodies, discharging a weapon, or perceiving a threat to one’s life indicated exposure to any combat experience.
Data Analysis

All statistical analyses were performed in SAS version 9.1. Demographic information was presented by injury status (non-battle, minor battle, moderate battle, serious battle, severe battle). Differences across groups by injury status were tested using chi-square and Fisher’s exact tests for categorical variables and analysis of variance for continuous variables. Prevalence rates for mental health diagnoses were reported by injury status, and differences in rates were tested using chi-square and Fisher’s exact tests. Logistic regression modeling was used to build a predictive model relating injury status with subsequent mental health diagnosis; potential confounders were assessed by using a criterion of a 20% change in odds ratio. Multiple sensitivity analyses were conducted to assess the impact of loss to follow up via military discharge; in one case it was assumed all discharges developed the outcome and in another it was assumed a 50% random sample of the discharges developed the outcome. Sensitivity analyses were conducted separately for first-year discharges and total discharges. Self reported mental health symptoms were reported by injury status, and differences were compared using chi-square tests; a separate analysis was restricted to those reporting any combat experience. Additionally, self-reported mental health symptoms were compared to previous estimates in the OIF population by Hoge, et al from May 1, 2003 through April 30, 2004.\(^7\)

RESULTS

Table 2 shows both the overall and battle injury-specific characteristics of the study population. The mean age of the population was 25.0 +/- 6.3 years, and those with battle injuries were significantly younger than those with non-battle injuries. A
majority of all injuries were among junior enlisted (E1-E5); this was consistent across injury status. Military rank did not differ by injury status. A majority of all injuries (76.6%) occurred among Marine Corps personnel; military service differed by injury status with those in the Army accounting for more serious and severe battle injuries. Non-battle injuries were significantly more likely to be married than severe battle-injured personnel. Moderate-severe battle injuries were significantly less likely to answer a PDHA 1-6 months post-injury.

Rates of mental health outcome are presented in Table 3 by injury status. Due to military discharge, follow-up time ranged from 90 to 820 days (median 707 days). Among those with any battle injury, rates of any mental health outcome, mood/anxiety disorders, and PTSD were 31.3%, 22.7%, and 17.0%, respectively compared to 14.2%, 8.1% and 5.1% for non-battle injuries. A majority of mental health diagnoses occurred within the first year post-injury. The median time to diagnosis of any mental health outcome was 125.5 days (range 1 to 729 days) and 267.0 days (range 6 to 764 days) for battle and non-battle injury, respectively. Compared to non-battle injury, rates of all mental health outcomes were significantly higher among battle injury, particularly those with moderate-severe injuries.

The final multivariate model relating battle injury status to subsequent mental health diagnosis is shown in Table 4. Compared to non-battle injury, those with minor (OR 2.63, 95% CI 1.82, 3.81), moderate (OR 4.01, 95% CI 2.46, 6.54), serious (OR 8.69, 95% CI 5.22, 14.47), and severe (OR 8.88, 95% CI 4.51, 17.48) battle injury were more likely to receive a diagnosis of PTSD. Similar associations were observed for mood/anxiety disorders and any mental health outcome. None of the demographic
variables, either on their own or all together, changed the magnitude of the odds ratio by greater than 20% and were thus not included in the final model.

The effect of loss to follow-up via military discharge was assessed with sensitivity analyses. A total of 11.6% (n=96) and 10.7% (n=122) were discharged without a mental health diagnosis within one-year post-injury among battle and non-battle injuries, respectively. After the first year, an additional 10.6% (n=88) of battle injured and 10.6% (n=120) of non-battle injured were discharged. Rate of discharge did not differ in battle injury compared to non-battle injury. Those lost to follow-up were younger, of more junior rank, less likely to be married, and more likely to serve in the Marines. Results of the sensitivity analyses showed that associations between battle-injury status and mental health diagnosis remained consistent.

Frequencies of self-reported mental health symptoms from the PDHA are shown in Table 5. As a result of a low PDHA response rate among moderate, serious, and severe battle injuries, these groups were combined into moderate-severe battle injuries for this analysis. A greater percentage of non-battle injuries compared to battle injuries completed a PDHA less than one-month post-injury, and were not included in the analysis. Additionally among BI, a greater percentage of Marines failed to complete a PDHA 1-6 months post-injury and moderate-severe injury was associated with not completing a PDHA or completing a PDHA less than one-month post-injury. Rates of self-reported mental health symptoms were significantly higher among both the minor and moderate-severe battle injured groups when compared to the non-battle injured group, with the exception of screening positive for depression. After restricting to those with any combat experience, all associations remained
significant, with the exception of any mental health concern using the stricter
definition of PTSD screen positive. A diagnosis of PTSD was significantly associated
with screening positive for PTSD (using both definitions), although predictive
capability was poor; 18.4% of those answering 2 or more PTSD questions and 27.5%
of those answering 3 or more PTSD questions also had a diagnosis of PTSD present in
CHAMPS.

The rates of self-reported mental health symptoms were then compared to
previous population estimates among those deployed during OIF from May 1, 2003 to
April 30, 2004; results are shown in Figure 1. Rates of all self-reported mental health
symptoms were significantly higher when compared to the previous population
estimates, including those for non-battle injuries. Battle injured patients had higher
rates of any combat experience compared to previous estimates, whereas NBI did not
differ significantly from the previous estimates.

DISCUSSION

Physical injury is an important predictor of PTSD and other mental health
outcome among deployed military personnel. The present study found a greater risk
of mental health diagnosis when comparing battle injury to non-battle injury, with the
largest effect seen with increasing battle injury severity. Rates of all categories of
mental health outcome were significantly higher among battle injury compared to non-
battle injury. Self-reported symptoms of any mental health concern and PTSD were
significantly higher among minor and moderate-severe battle injuries compared to
non-battle injuries, and were significantly higher than previous population estimates.
The present study identified, among those with battle injury, a 31.3% rate of any mental health outcome and a 17.0% rate of PTSD. These results are similar to a recent finding among OIF veterans seeking treatment at the Veterans Administration (VA) where rates of 25.0% and 13.0% were identified for any mental health outcome and PTSD, respectively. The one-year rate for any mental health outcome found among non-battle injuries (9.3%) is consistent with a previous estimate by Hoge, et al. found among the general OIF deployed population. A previous study among OIF combat veterans also found results similar to the present study. In assessing combat experiences, Hoge, et al. found that OIF veterans who indicated “being wounded or injured” had a three-fold higher risk of PTSD; a similar association was found in the same study among combat veterans deployed to Afghanistan. The present study utilized a group of non-battle injured personnel for comparison purposes. One other study from the Persian Gulf War examined psychiatric morbidity among those medically evacuated, and compared traumatically injured to a group consisting of other medical conditions (e.g. chest pain, gastrointestinal bleeding, orthopedic injuries). The study found that those with a traumatic injury were more likely than those with other medical conditions to receive a psychiatric diagnosis.

The primary finding of this study was the increased risk of mental health diagnosis among those with battle injury; the largest effect was observed as severity of battle injury increased. Similar results were found with self reported mental health symptoms. This finding may be explained by the recovery-impeding (RI) model, one of three models proposed by Koren, et al. to explain the relationship between physical injury and PTSD. The first two models involve psycho-neurobiological
mechanisms, one where the injury augments the effect of the trauma itself and the other where the injury creates excess risk of PTSD through an independent psycho-neurobiological mechanism; the influence of these models is difficult to establish in the present study due to lack of information. The RI model proposes that the physical injury itself blocks the recovery process by serving as a constant reminder of the trauma. This may explain the relationship found with battle injuries, with the greater association among battle injuries with a higher injury severity explained by a greater rate of disability. If it is assumed that disability is associated with increasing injury severity, this may augment the blocking of the recovery process through additional pain and greater impact on daily life as a result of the disability. A recent study by Grieger, et al. identified early physical problems as a risk factor for PTSD and depression among injured OIF combat veterans.\textsuperscript{36} Alternatively, the associations may be a result of a higher rate of combat exposure among those injured in battle. The finding may also be a result of medical utilization bias, as those injured in battle, especially those with higher injury severity, are likely to have more frequent contact with healthcare providers who may refer them for mental health issues. Overall, these results indicate the need for increased mental health screening among all battle-injured individuals.

Two important secondary findings from the PDHA analysis were the elevated mental health symptoms among non-battle injured when compared to previous population estimates and the strong inverse association between injury severity and completion of a PDHA. The previous population estimates of mental health symptoms were identified from an earlier period of OIF. It is likely that there are
different baseline rates of mental health symptoms for these different periods, especially when assuming some individuals may have been on their second deployment during the period of the present study. There may have also been more traumatic exposures during the period of the present study, although frequency of any combat experience did not differ when comparing NBI to the previous period; this may be due, however, to an inability to quantify the amount of combat exposure. The inverse association between injury severity and completing a PDHA may identify a potential area for intervention. Although more severe injuries likely utilize health services more frequently in the time following the injury, it is still important to document deployment-specific exposures and health concerns. The inverse association with injury severity remained after including those individuals who completed a PDHA less than one-month post-injury.

Several limitations were present in this study. The inability to accurately quantify combat exposure is problematic. Even when the “any combat experience” measure from the PDHA is utilized, individuals who had few exposures are equated with those who had many; questions do not ask how much combat experience, just if the individual had any at all. Regarding the study population, the data are collected from Navy-Marine Corps medical treatment facilities only, as such there is a preponderance of injuries from the Marine Corps; Level 1 and 2 injuries treated by Army facilities are not represented. The primary outcome measures utilized were ascertained from an electronic database that tracks, among other things, medical encounters. Previous studies in the area of physical injury and mental health have for the most part utilized survey instruments with participants to ascertain a diagnosis.
Utilization of medical encounter data likely led to an underestimate of psychological morbidity due to either an aversion to seek treatment or only the most severe cases presenting, and also may have caused the aforementioned medical utilization bias. Toward the end of the follow-up for this study, data from CHAMPS may not have been fully updated due to a lag in entering ICD-9 codes. In order to account for the lag, the analysis was repeated including only outcomes diagnosed through August 2006 and similar results were found. A larger problem is the high rate of loss to follow-up via military discharge due to the nature of the CHAMPS database, and the inability of CHAMPS to track personnel post-discharge. There is also possible selection bias with the PDHA analysis among battle injuries; moderate-severe injuries often completed a PDHA less than one month post-injury, and were thus not included in the PDHA analysis due to the nature of the PDHA questions (the PTSD questions inquired about symptoms specifically in the previous 30 days).

The primary strength of the current study is that, to our knowledge, it is the first population-based study to assess the relationship between physical injury and mental health within a military population that compares battle and non-battle injury. Additionally, the injury-specific information available from the Navy-Marine Corps CTR allowed for the identification of minor, moderate, serious, and severe battle injuries utilizing the Injury Severity Score. The use and high matching rate of the CHAMPS database allowed for assessment of demographic variables, as well as previous mental health diagnoses. Utilizing PDHA data as an outcome measure helped correct for the expected underestimation of mental health diagnosis, although it likely overestimated presence of PTSD and other mental health symptoms. The
PDHA data also allowed for the comparison of our results to previous population estimates.

In conclusion, those with battle injuries appear to be at greater risk of PTSD and other mental health outcomes when compared to non-battle injuries; the greatest effect is seen with increasing battle injury severity. These results remain consistent when examining self-reported mental health symptoms. Future studies should incorporate a more complete follow-up period by utilizing VA databases, and should attempt to quantify combat exposure for adjustment purposes. As advances in field medicine lead to greater survival from battle injury, the impact of post-injury psychological morbidity needs to be further defined.

The text of Chapter II, in part, will be submitted for publication as:


The dissertation author was the primary researcher and author.
<table>
<thead>
<tr>
<th>Post Traumatic Stress</th>
<th>Depression</th>
<th>Other Mental Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you ever had any experience that was so frightening, horrible, or upsetting that, in the past month, you…</td>
<td>Over the last 2 weeks, how often have you been bothered by any of the following problems?</td>
<td>Are you currently interested in receiving help for a stress, emotional, alcohol, or family problem? (yes/no)</td>
</tr>
<tr>
<td>Have had any nightmares about it or thought about it when you did not want to? (yes/no)</td>
<td>Little interest or pleasure in doing things (none/some/a lot)</td>
<td>Are you having thoughts or concerns that…</td>
</tr>
<tr>
<td>Tried hard not to think about it or went out of your way to avoid situations that remind you of it? (yes/no)</td>
<td>Feeling down, depressed, or hopeless (none/some/a lot)</td>
<td>You might have serious conflicts with your spouse, family members, or close friends? (yes/no/unsure)</td>
</tr>
<tr>
<td>Were constantly on guard, watchful, or easily startled? (yes/no)</td>
<td></td>
<td>You might hurt or lose control with someone? (yes/no/unsure)</td>
</tr>
<tr>
<td>Felt numb or detached from others, activities, or your surroundings? (yes/no)</td>
<td></td>
<td>Over the last 2 weeks, how often have you been bothered by any of the following problems?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thoughts that you would be better off dead or hurting yourself in some way (none/some/a lot)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>During this deployment have you sought, or do you now intend to seek, counseling or care for your mental health? (yes/no)</td>
</tr>
</tbody>
</table>
Table 2 - Descriptive Statistics by Battle Injury Status, Male Injured Combatants (n=1968), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Battle Injuries</th>
<th></th>
<th></th>
<th></th>
<th>Non-Battle Injuries</th>
<th>p-value †</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (n=1968)</td>
<td>Minor (n=538)</td>
<td>Moderate (n=155)</td>
<td>Serious (n=93)</td>
<td>Severe (n=45)</td>
<td>(n=1137)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>25.0 (6.3)</td>
<td>24.2 (5.5)*</td>
<td>24.1 (5.2)*</td>
<td>24.2 (4.9)</td>
<td>22.6 (3.7)*</td>
<td>25.6 (6.9)</td>
</tr>
<tr>
<td>Rank (%)</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>E1-E3</td>
<td>813 (41.3)</td>
<td>222 (40.6)</td>
<td>69 (44.5)</td>
<td>42 (45.2)</td>
<td>18 (40.0)</td>
<td>466 (41.0)</td>
</tr>
<tr>
<td>E4-E5</td>
<td>839 (42.6)</td>
<td>242 (44.2)</td>
<td>61 (39.4)</td>
<td>31 (33.3)</td>
<td>31 (69.0)</td>
<td>487 (42.8)</td>
</tr>
<tr>
<td>E6-E9</td>
<td>207 (10.5)</td>
<td>53 (9.7)</td>
<td>19 (12.3)</td>
<td>13 (14.0)</td>
<td>3 (6.7)</td>
<td>119 (10.5)</td>
</tr>
<tr>
<td>WO/Officer</td>
<td>107 (5.4)</td>
<td>30 (5.5)</td>
<td>6 (3.9)</td>
<td>7 (7.5)</td>
<td>2 (4.4)</td>
<td>63 (5.5)</td>
</tr>
<tr>
<td>Missing</td>
<td>2 (0.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Service (%)</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Army</td>
<td>353 (17.9)</td>
<td>97 (18.0)</td>
<td>24 (15.5)</td>
<td>20 (21.5)</td>
<td>17 (37.8)</td>
<td>195 (17.2)</td>
</tr>
<tr>
<td>Marines</td>
<td>1508 (76.6)</td>
<td>417 (77.5)</td>
<td>123 (79.4)</td>
<td>70 (75.3)</td>
<td>27 (60.0)</td>
<td>871 (76.6)</td>
</tr>
<tr>
<td>Other/Unknown</td>
<td>107 (5.4)</td>
<td>24 (4.5)</td>
<td>8 (5.2)</td>
<td>3 (3.2)</td>
<td>1 (2.2)</td>
<td>71 (6.2)</td>
</tr>
<tr>
<td>Married (%)</td>
<td>931 (47.3)</td>
<td>247 (45.9)</td>
<td>63 (40.7)</td>
<td>42 (45.2)</td>
<td>13 (28.9)*</td>
<td>566 (49.8)</td>
</tr>
<tr>
<td>AFQT (score)‡</td>
<td>58.9 (18.5)</td>
<td>58.3 (19.0)</td>
<td>59.2 (18.6)</td>
<td>58.1 (18.6)</td>
<td>65.8 (18.8)</td>
<td>58.9 (18.1)</td>
</tr>
<tr>
<td>Previous MH diagnosis (%)</td>
<td>136 (6.9)</td>
<td>25 (4.7)</td>
<td>14 (9.0)</td>
<td>8 (8.6)</td>
<td>2 (4.4)</td>
<td>87 (7.7)</td>
</tr>
<tr>
<td>Answered PDHA</td>
<td>918 (46.7)</td>
<td>277 (51.5)</td>
<td>32 (20.7)*</td>
<td>17 (18.3)*</td>
<td>9 (20.0)*</td>
<td>583 (51.3)</td>
</tr>
</tbody>
</table>

†  examining differences across categories
‡  due to missing data, N size is 509, 150, 89, 43, and 1077 for minor BI, moderate BI, serious BI, severe BI, and non-battle injury, respectively
*  significantly different from non-battle injuries after adjusting for multiple comparisons
Table 3 - Rates of Mental Health Diagnosis by Battle Injury Status, Male Injured Combatants (n=1968), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Total Bi (n=831)</th>
<th>Non-Battle Injury (n=1137)</th>
<th>p-value†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total (n=1968)</td>
<td>Battle Injury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=538)</td>
<td>(n=155)</td>
<td>(n=45)</td>
</tr>
<tr>
<td>Post-traumatic Stress Disorder</td>
<td>141 (17.0)*</td>
<td>58 (5.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Any Mental Health Diagnosis‡</td>
<td>260 (31.3)*</td>
<td>161 (14.2)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within first year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mood/Anxiety Disorders</td>
<td>189 (22.7)*</td>
<td>92 (8.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Mood only</td>
<td>189 (22.7)*</td>
<td>92 (8.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Anxiety only</td>
<td>114 (13.7)*</td>
<td>47 (4.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Comorbid</td>
<td>59 (7.1)*</td>
<td>31 (2.7)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Adjustment Disorders</td>
<td>80 (9.6)*</td>
<td>49 (4.3)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Substance Abuse Disorders</td>
<td>56 (6.7)*</td>
<td>46 (4.1)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Other</td>
<td>106 (12.8)*</td>
<td>60 (5.3)</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

† examining differences across all categories
‡ patients can have more than one diagnosis
* significantly different from non-battle injuries after adjusting for multiple comparisons
Table 4 - Final Multivariate Model, Battle Injury Status and Mental Health, Male Injured Combatants (n=1968), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Any Mental Health Outcome*</th>
<th>Mood and Anxiety Disorders**</th>
<th>Post Traumatic Stress Disorder***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diagnosis +/-</td>
<td>Diagnosis +/-</td>
<td>Diagnosis +/-</td>
</tr>
<tr>
<td></td>
<td>OR (95% C.I.)</td>
<td>OR (95% C.I.)</td>
<td>OR (95% C.I.)</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>p-value</td>
<td>p-value</td>
</tr>
<tr>
<td>0.97 (0.95, 0.99)</td>
<td>0.96 (0.94, 0.99)</td>
<td>0.98 (0.96, 1.01)</td>
<td>0.23</td>
</tr>
<tr>
<td>Injury Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Battle</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Battle, Minor</td>
<td>1.63 (1.25, 2.12)</td>
<td>2.07 (1.51, 2.84)</td>
<td>2.63 (1.82, 3.81)</td>
</tr>
<tr>
<td>Battle, Moderate</td>
<td>4.02 (2.80, 5.78)</td>
<td>5.06 (3.38, 7.56)</td>
<td>4.01 (2.46, 6.54)</td>
</tr>
<tr>
<td>Battle, Serious</td>
<td>7.49 (4.81, 11.67)</td>
<td>6.05 (3.76, 9.75)</td>
<td>8.69 (5.22, 14.47)</td>
</tr>
<tr>
<td>Battle, Severe</td>
<td>9.28 (4.96, 17.38)</td>
<td>9.10 (4.87, 17.03)</td>
<td>8.88 (4.51, 17.48)</td>
</tr>
</tbody>
</table>

* includes anxiety, mood, adjustment, substance abuse, and other disorders
** excludes adjustment, substance abuse, and other disorders
*** includes only post traumatic stress disorder diagnosis
Table 5 - Responses to Mental Health Questions from PDHA by Battle Injury Status, Male Injured Combatants (n=918), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th>N (%)</th>
<th>Battle Injuries</th>
<th>p-value †</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (n=918)</td>
<td>Minor (n=277)</td>
</tr>
<tr>
<td>PTSD screen (+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or more PTSD questions</td>
<td>217 (23.6)</td>
<td>102 (36.8)‡</td>
</tr>
<tr>
<td>3 or more PTSD questions</td>
<td>109 (11.9)</td>
<td>53 (19.1)‡</td>
</tr>
<tr>
<td>Depression screen (+)</td>
<td>81 (8.8)</td>
<td>28 (10.1)</td>
</tr>
<tr>
<td>Any Mental Health Concern*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or more PTSD questions</td>
<td>285 (31.1)</td>
<td>116 (41.9)‡</td>
</tr>
<tr>
<td>3 or more PTSD questions</td>
<td>215 (23.4)</td>
<td>85 (30.7)‡</td>
</tr>
</tbody>
</table>

† Examining differences across categories
‡ Significantly different from non-battle injuries after adjusting for multiple comparisons
* Positive response to any of the 8 criteria: depression screen (+); PTSD screen (+); interest in receiving help for stress, emotional distress, family problem (yes); thoughts of hurting self (some or a lot); thoughts of serious conflicts with others (yes); thoughts of hurting someone or sense of a loss of control with others (yes); and have sought or intend to seek care for mental health (yes).
§ Does not retain significance after adjusting for any combat experience
Significantly different from Hoge, et al. after adjusting for multiple comparisons

Figure 1 – Post Deployment Health Assessments, Comparison to Hoge, et al.

* Significantly different from Hoge, et al. after adjusting for multiple comparisons

† Hoge CW, et al. (2006) Mental health problems, use of mental health services, and attrition from military service after returning from deployment to Iraq or Afghanistan. JAMA 295(9): 1023-31.
REFERENCES


III. INJURY-SPECIFIC PREDICTORS OF POST-TRAUMATIC STRESS DISORDER AMONG BATTLE INJURED OPERATION IRAQI FREEDOM VETERANS

ABSTRACT

BACKGROUND: Determinants of psychiatric morbidity following physical injury, particularly post-traumatic stress disorder (PTSD), are not well defined within military populations. OBJECTIVE: To identify physiological and injury-specific predictors of PTSD and other mental health outcomes among injured male combatants. METHODS: A total of 831 men injured during military combat between September 2004 and February 2005 comprised the study population. Patients were followed through November 2006 for diagnosis of PTSD (ICD-9 309.81) or any mental health outcome (ICD-9 290-319). RESULTS: During the follow-up period, 31.3% of patients received any mental health diagnosis and 17.0% received a PTSD diagnosis. Compared to minor injuries those with moderate (OR 2.37, 95% CI 1.61, 3.48), serious (OR 4.07, 95% CI 2.55, 6.50), and severe (OR 5.22, 95% CI 2.74, 9.96) injuries were at greater risk of being diagnosed with any mental health outcome. Similar results were found for serious (OR 3.03, 95% CI 1.81, 5.08) and severe (OR 3.21, 95% CI 1.62, 6.33) injuries with PTSD diagnosis. Those with gunshot wounds were at greater risk of any mental health diagnosis, but not PTSD, when compared to other mechanisms of injury (OR 2.07, 95% CI 1.35, 3.19). Diastolic blood pressure measured post-injury was associated with any mental health outcome, and the effect was modified by injury severity. CONCLUSION: Injury severity was a significant
predictor of any mental health diagnosis and PTSD diagnosis. Gunshot wounds and
diastolic blood pressure were significant predictors of any mental health diagnosis, but
not PTSD. Further studies are needed to replicate these results and elucidate potential
mechanisms for these associations.
INTRODUCTION

Post traumatic stress disorder (PTSD), an anxiety disorder characterized by symptoms of avoidance, re-experiencing, and hyperarousal, has an estimated lifetime U.S. prevalence of 10% among women and 5% among men.\textsuperscript{1,2} Physical injury has been identified as a risk factor for PTSD in both military combat populations\textsuperscript{3-6} and civilians surviving disasters.\textsuperscript{7-12} Post-injury physiological measures, including heart rate and blood pressure, as well as injury-related variables such as severity, location, and mechanism may also be related to subsequent development of PTSD.

A meta-analysis by Buckley, et al. identified consistent findings of elevated baseline heart rate and blood pressure among individuals with PTSD compared to those without PTSD.\textsuperscript{13} Multiple studies have also shown that elevated heart rate following trauma is a predisposing factor for development of PTSD.\textsuperscript{14-22} Heart rate was identified as a significant predictor of PTSD when measured immediately following trauma and one-week after, though not at one-month post injury.\textsuperscript{14, 15} Other studies, however, have failed to confirm this relationship.\textsuperscript{23, 24} In one study, a significant inverse association between post-trauma heart rate and PTSD was identified.\textsuperscript{24} To our knowledge, the relationship between post-trauma heart rate and PTSD has not been examined within a military population.

Injury severity score (ISS) is an objective measure of injury severity that has been examined as a predictor of PTSD.\textsuperscript{25} Some studies have shown a positive association between ISS and PTSD,\textsuperscript{26-29} but multiple other studies have failed to replicate this result,\textsuperscript{30-36} with one showing a negative association with ISS.\textsuperscript{37} Other objective measures of injury severity have been examined with mixed results.\textsuperscript{8, 38-41} A
recent study by Greiger, et al. of severely injured veterans of Operation Iraqi Freedom (OIF) identified an association between subjective injury severity and PTSD.\textsuperscript{42}

Other aspects of injury (e.g. mechanism and location) have not been thoroughly examined in the literature. Some civilian studies have identified associations between PTSD and injury mechanism,\textsuperscript{30, 43, 44} and PTSD and facial location among burn patients.\textsuperscript{45, 46}

The purpose of this study was to assess potential predictors of PTSD and other mental health outcomes following injuries sustained during combat. Post-trauma heart rate and blood pressure, as well as injury mechanism, location and severity, were examined.

METHODS

Study Population

The study population was identified from the U.S. Navy-Marine Corps Combat Trauma Registry (CTR), which is a deployment health database maintained by Naval Health Research Center (NHRC) consisting of documented clinical encounters of deployed military personnel; records are obtained for battle injury, non-battle injury, disease, psychiatric and routine sick call encounters.\textsuperscript{47, 48} Eligible personnel in this study were Operation Iraqi Freedom (OIF) combatants presenting to forward medical treatment facilities for battle injury during the 6-month period from September 2004 to February 2005. Precise date of injury was not indicated for all personnel, therefore date of arrival for medical care was used as a proxy for injury date. After excluding females due to low representation (less than 1%) and 38 individuals who died as a result of their wounds, 881 participants were matched against the Career History
Archival Military Personnel System (CHAMPS). A database maintained by Naval Health Research Center (NHRC), San Diego, CA, CHAMPS contains demographic, career, and medical information on all military members on active duty in the U.S. Armed Services since 1973 (see Gunderson, et al., 2004, for a detailed description of CHAMPS). A total of 841 eligible injured personnel (95.5%) had a matching record in CHAMPS. Ten individuals were excluded due to evidence of military discharge less than 90 days into the follow-up period; a total of 831 male injured personnel comprised the study population.

Measures

Data for the independent physiological variables were abstracted from the Navy-Marine Corps CTR clinical record. Heart rate, measured in beats per minute, and blood pressure, both diastolic and systolic measured in millimeters of mercury (mmHg), were ascertained following injury. No information existed regarding the method of measurement, whether it was manual or equipment-based. In the case that multiple heart rate and blood pressure measurements were taken, only the first recorded were used. Thirty-four patients had evidence of these physiological measures being taken more than 24 hours post-injury, and were excluded from analysis of these measures. In addition, approximately 10% of data was missing for physiological measures.

The severity of injuries was first described using the Abbreviated Injury Scale (AIS); a composite Injury Severity Score (ISS) was then calculated by onsite NHRC researchers. Injury mechanism (e.g. improvised explosive device, gunshot wound) was indicated on the Navy-Marine Corps CTR clinical record. Injury location
on the face was indicated by either an AIS beginning with 2 (indicating facial injury),
or an AIS beginning with 9 (indicating external injury) together with an ICD-9 code
indicating facial injury.

This study utilized a retrospective design. Two different methods were used to
define cases: 1) diagnosis of any mental health outcome; and 2) diagnosis of PTSD
specifically. Diagnoses in the form of ICD-9 codes were abstracted from the
CHAMPS system. The CHAMPS database was updated up through November 2006,
therefore there were approximately 22-27 months of follow-up time, although some
participants were discharged from the military over the course of the follow-up period;
upon military discharge CHAMPS no longer monitors personnel. Those discharged
without a mental health diagnosis were assumed to have not developed the outcome.

A diagnosis of PTSD was indicated by an ICD-9 code 309.81, and a diagnosis
of any mental health outcome was indicated by an ICD-9 code in the range 290-319,
excluding 305.10 (tobacco addiction). For diagnosis of PTSD, the date of diagnosis
must have been at least one month post injury as per the definition of PTSD that
requires symptoms to persist for at least one-month; any diagnosis of PTSD less than
one month post-injury was treated as a previous mental health diagnosis.

Other variables were utilized for adjustment purposes only. Age, gender,
military rank and service were abstracted from the Navy-Marine Corps CTR clinical
record for all persons in the study population, and marital status was abstracted from
CHAMPS. Intelligence, which is related to development of PTSD,$^{51}$ was measured
with the Armed Forces Qualification Test (AFQT) score abstracted from CHAMPS.$^{52}$
Previous mental health diagnoses have also been identified as a risk factor for PTSD
development, and were ascertained from CHAMPS. Presence of an ICD-9 code between 290 and 319 (excluding 305.10) at any time (while in the military) since January 1, 2000 and prior to the date of injury was considered a previous mental health diagnosis.

Data Analysis

Heart rate was assessed as a continuous variable in descriptive analysis and then categorized for statistical modeling purposes. Based on previous literature, a cutoff of at least 95 beats per minute was used to create a dichotomous variable of elevated vs. non-elevated heart rate. Injury location was dichotomized into either facial or non-facial injury. Mechanism of injury was categorized into a 7-level variable for descriptive analysis, then collapsed into a 3-level variable for modeling purposes to ensure an adequate number of responses in each level; the two mechanism categories of interest, improvised explosive devices (IED) and gunshot wounds (GSW), were used as two of the levels and the reference level was all other mechanisms. Injury severity score (ISS) was categorized as per previous literature; the range of ISS is 1 to 75, and groupings for this study were minor injury (ISS 1-3), moderate injury (ISS 4-8), serious injury (ISS 9-15), and severe injury (ISS 16 or higher).

Differences across groups by outcome status – any mental health outcome and PTSD diagnosis – were tested using chi-square and Fisher’s exact tests for categorical variables and two-sample t-tests for continuous variables. Regression analysis was conducted separately for each of the outcome classifications. Additionally, physiological and injury specific measures were analyzed separately so as not to lose
statistical power in the injury-specific model due to missing physiological data. Logistic regression analysis was conducted for all potential predictor variables individually, with only age in the model. Any predictor variable meeting a significance level of .10 was advanced to further multivariate analysis; any physiological variable meeting this criterion, however, was reanalyzed adjusting for injury severity. Interaction was tested between physiological variables and injury severity. After placing predictors together in a logistic regression model, the significance level for the final model was $\leq 0.05$. Potential confounders were assessed by inserting each individually into the model and observing for a 20% change or greater in any odds ratio. Adjusted odds ratios, confidence intervals, and p-values were reported for all associations. Multiple sensitivity analyses were conducted to assess the impact of loss to follow up via military discharge; in one case it was assumed all discharges developed the outcome and in another it was assumed a 50% random sample of the discharges developed the outcome. Sensitivity analyses were conducted separately for first-year discharges and total discharges.

**RESULTS**

There were a total of 831 patients in this study. Age ranged from 18 to 54 years with a mean of 24.1 +/- 5.3 years. More than three-quarters (76.7%) of the participants were members of the Marines, compared to 19.0% in the Army and 4.3% in other services or unknown. A large majority (84.1%) of the participants were of ranks E1-E5 (junior enlisted).

Seventeen percent (n=141) of all patients received a diagnosis of PTSD at sometime during the follow-up period. When examining any mental health outcome,
31.3% (n=260) received an ICD-9 diagnosis between 290 and 319 during the follow-up period. Median time until any mental health diagnosis was 125.5 days, with a range of 1 day to 729 days.

Of the 831 injuries, 64.7% were classified as minor, 18.7% as moderate, 11.2% as serious, and 5.4% as severe. The largest proportion of injuries (41.3%) were caused by IED, followed by other blast injuries (19.0%), and gunshot wounds (17.6%). Approximately 42% of all injuries involved a facial injury. Among the total study population, the post-injury physiological measures of heart rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were 86.5 +/- 18.6 beats per minute, 128.2 +/- 16.3 mmHg, and 72.2 +/- 13.2 mmHg, respectively.

Table 6 presents the prevalence of demographic, injury-specific, and physiological variables by case status. Because multiple outcome definitions are being used, descriptive statistics are shown for the two individual study populations: 1) any mental health diagnosis vs. no mental health diagnosis; and 2) PTSD diagnosis vs. no PTSD diagnosis.

Compared to those without a mental health diagnosis, those with any mental health diagnosis were younger, of more junior rank, more likely to serve in the Army, had lower overall AFQT scores, and were more likely to have a previous mental health diagnosis. When comparing PTSD diagnosis to no diagnosis, the aforementioned associations with military service and AFQT score remained whereas the associations with age and previous mental health diagnosis did not retain statistical significance. Those who were married were more likely to receive a diagnosis of PTSD.
Patients with any mental health diagnosis had a higher post-injury heart rate and a lower post-injury diastolic blood pressure; there were no differences in these variables when comparing PTSD diagnosis to no diagnosis. Those excluded from the analysis of physiological measures, due to either missing measurements or evidence of measurements taken greater than 24 hours post-injury, were more likely to be minor injuries and more likely to be Marines. Injury mechanism and injury severity differed when comparing any mental health diagnosis to no mental health diagnosis and PTSD diagnosis to no PTSD diagnosis; the highest rates of any mental health diagnosis were seen among those with moderate-severe injuries and those injured via gunshot wound. Patients with a PTSD diagnosis were less likely to have suffered a facial injury compared to those without a PTSD diagnosis. Injury severity was additionally associated with branch of service, with those in the Army suffering more severe injuries, heart rate, which was significantly higher among severe injuries compared to minor, moderate, and serious injuries, systolic blood pressure, which was significantly lower among severe injuries compared to minor and moderate injuries, diastolic blood pressure, which was significantly lower among severe injuries compared to minor, moderate, and serious injuries, and injury mechanism, with gunshot wounds associated with more severe injuries.

Age-adjusted logistic regression modeling for all physiological predictors (elevated heart rate, SBP, DBP) and injury-specific predictors (injury severity, injury mechanism, facial location) is shown in Table 7. Injury severity was significantly associated with diagnosis of any mental health outcome, with an approximately two to six-fold greater risk in moderate, serious, and severe injuries compared to minor
injuries. Serious and severe injuries had a three-fold greater risk of PTSD diagnosis compared to minor injuries. Gunshot wounds conferred a 2.70 times greater risk (95% CI 1.79, 4.06) of diagnosis of any mental health outcome and a 2.02 times greater risk (95% CI 1.25, 3.24) of PTSD diagnosis compared to other mechanisms. Facial injury indicated a protective effect for PTSD diagnosis (p-value 0.04). Although elevated heart rate (p-value = 0.03) was associated with any mental health outcome, after adjusting for injury severity the p-value rose to above the criterion level of .10 and the variable was thus restricted from further analysis.

A test for interaction between injury severity and diastolic blood pressure was significant for any mental health outcome (<0.01), but not PTSD. Table 7 presents the details of the interaction. Among minor and moderate injuries, post-injury diastolic blood pressure was inversely associated with any mental health outcome. Conversely, among severe injuries increasing diastolic blood pressure was positively associated (p-value = 0.05) with any mental health outcome.

Table 8 shows the final injury-specific predictive model for any mental health outcome and PTSD. Potential confounders were assessed, and none, either individually or all together, changed any of the odds ratios by 20% or greater. The final model included age, injury severity, injury mechanism, and, for PTSD diagnosis only, facial injury.

Compared to minor injury, those with moderate, serious, and severe injury were 2.37 (95% CI 1.61, 3.48), 4.07 (95% CI 2.55, 6.50), and 5.22 (95% CI 2.74, 9.96) times more likely to be diagnosed with any mental health outcome, respectively. Similar results were found for PTSD diagnosis; those with serious and severe injury
were 3.03 (95% CI 1.81, 5.08) and 3.21 (95% CI 1.62, 6.33) times more likely to receive a PTSD diagnosis. Compared to other mechanisms of injury, those injured by gunshot wound were 2.07 (95% CI 1.35, 3.19) times more likely to be diagnosed with any mental health outcome; a similar association was not found with PTSD. Facial injury was not associated with PTSD diagnosis.

The impact of loss to follow up via military discharge was assessed with a sensitivity analysis. In the first year of follow-up, 96 (11.6%) patients were discharged without a mental health diagnosis. An additional 88 (10.6%) were discharged after the first year of follow-up. Those lost to follow up were younger, of more junior rank, were less likely to be married, and were more likely to serve in the Marines. All associations were consistent throughout the sensitivity analysis.

**DISCUSSION**

Physical injury among military combat veterans is associated with later psychological morbidity such as PTSD. The present study found positive associations between injury severity and mental health diagnosis, both any mental health outcome and PTSD, among a population of battle injured male combatants. Gunshot wounds and diastolic blood pressure were predictive of any mental health outcome, but not PTSD. No association was found between post-injury heart rate and subsequent mental health outcome after adjusting for injury severity. Degree of combat exposure, not measured in the present study, and differences in medical utilization may have influenced the results.

Although the literature generally supports that physical injury is a risk factor for mental health outcome, less evidence exists for objective injury severity. One
study found that an ISS score of 11 and above was predictive of development of PTSD among motor vehicle accident (MVA) survivors. An earlier study demonstrated significantly higher ISS scores among MVA survivors who developed PTSD compared to those who did not develop PTSD. Both of these studies, however, had study populations with higher overall ISS scores than the current study. In contrast to the aforementioned studies, one study found that the subjective measure of perceived threat to life was a much better predictor of PTSD following traumatic injury than was ISS.

To our knowledge, the relationship between injury mechanism and mental health outcome has not been previously examined within a military combat population. Among a population of orthopedic injuries, Starr, et al. found a greater percentage of PTSD among those injured in motor vehicle accidents compared to falls. Holbrook, et al. found that later PTSD development was predicted by penetrating injuries and assaults, relative to other mechanisms of injury. The only study found to directly address gunshot wounds was among a pediatric population; gunshot wounds were significantly associated with development of PTSD.

The null finding between heart rate and PTSD development is not consistent with much of the existing literature. Specifically, Zatzick, et al. found a significant predictive association between heart rate assessed in the emergency room and subsequent PTSD development; this study also used the same cutoff for elevated heart rate as the current study (95 beats per minute). The study population, however, was very different from the current study; more than one-third female, inclusion of intentional injuries, higher injury severity, and high frequency of drug and alcohol
abuse. An earlier study by Shalev, et al. found similar results in a much different study population – mildly injured and excluding those with head injury and past/present substance abuse or psychosis; those who developed PTSD had significantly higher heart rates both in the emergency room and one-week later.\textsuperscript{15} The lack of a finding in the present study may be due to the nature of the study population. It is possible that the stress response of combat forces in general is very different from the civilian population. Alternatively, heart rate measurements may have been inaccurate due to differing methods of ascertainment in the field.

Multiple theories can explain the primary findings of the present study that injury severity and mechanism, as well as post-injury diastolic blood pressure, were associated with mental health diagnoses. Mayou and Bryant found that severity of injury substantially predicted self-report of physical recovery 3-months post-injury.\textsuperscript{56} Thus, increasing injury severity may be associated with greater risk of disability, which has been shown in multiple studies to be associated with development of PTSD and other psychological symptoms.\textsuperscript{57-59} Greiger, et al. found that early severity of physical problems, measured subjectively, was associated with later development of both PTSD and depression.\textsuperscript{42} Injury severity may also be related to increasing degree of combat exposure, thus explaining the positive association. Another theory regarding injury severity is that of increased medical utilization. The primary outcomes of interest are ascertained via a database of medical encounters. Those with more severe injuries may have increased visits to medical facilities, which may increase the chances of that individual being referred for mental health evaluation. This theory is supported by the fact that, in the current study, increasing injury
severity is strongly associated with evacuation to higher level of care, which may lead to greater detection of mental health problems; this may indicate the need for targeted mental health screening for minor battle injuries and those injuries not evacuated to higher levels of care. The association with gunshot wounds may be a result of higher battle intensity, assuming those presenting with gunshot wounds may be more likely to be consistently involved with close-combat. This greater exposure to close-combat can lead to other psychological stressors such as witnessing the death of friends, civilians, and enemy soldiers. Another theory is that there may be greater detail remembered with the trauma; those with gunshot wounds may be more likely to visualize their attacker which could lead to a more severe traumatic memory. To our knowledge, the association found with diastolic blood pressure, and its significant interaction with injury severity, is a unique finding. It is possible this association may be a result of blood pressure altering medications given at the point of injury. Further research is needed to replicate this finding.

There are limitations that warrant mention. Multiple variables that may have affected the results were absent from the analysis, including combat exposure, blood loss, and medications provided. Regarding the study population, the data are collected from Navy-Marine Corps medical treatment facilities only, thus there is a preponderance of injuries from the Marine Corps; Level 1 and 2 injuries treated by Army facilities are not represented. The primary outcome measures utilized were ascertained from an electronic database that tracks, among other things, medical encounters; therefore to be classified with the outcome one would have to seek treatment first. Previous studies in the area of physical injury and mental health have
for the most part utilized survey instruments with all participants to ascertain diagnosis. The limitation of using medical encounter data is that many individuals exhibiting symptoms may be missed due to an aversion to seeking treatment. Additionally, those seeking treatment may be the most severe cases. Toward the end of the follow-up for this study, data from CHAMPS may not have been fully updated due to a lag in entering ICD-9 codes. In order to account for the lag, the analysis was repeated including only outcomes diagnosed through August 2006 and similar results were found. A larger problem is the high rate of loss to follow-up via military discharge and the inability of CHAMPS to track personnel post-discharge.

The primary strength of the current study is that it is one of few military-specific population based studies to examine the relationship between physical injury and psychological morbidity. A wide range of injury severity is included in the current study, compared to a recent study that examined PTSD and depression only among severely injured combatants. Additionally, the injury-specific information, including mechanism and post-injury physiological measures, to our knowledge has not been thoroughly documented within a military combat population. Because this information is collected at baseline, issues such as recall bias are avoided. The use and high matching rate of the CHAMPS database allowed for assessment of demographic variables, as well as previous mental health diagnoses.

In conclusion, diagnosis of PTSD and any mental health outcome was predicted by injury severity among a population of male, injured military combatants. Additionally, gunshot wounds and diastolic blood pressure predicted diagnosis of any mental health outcome. The results of this study may indicate a need for greater
mental health screening of specific injured subgroups of combat personnel. Future studies should attempt to quantify combat exposure, and should incorporate data from the Veterans Administration in order to track those discharged due to their injury. Physical injuries are a reality of war, and further understanding of their relationship with psychological morbidity is essential.

The text of Chapter III, in part, will be submitted for publication as:


The dissertation author was the primary researcher and author.
### Table 6 - Descriptive Characteristics by Diagnosis, Male Battle Injured Combatants (n=831), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Any Mental Health Outcome</th>
<th>Post Traumatic Stress Disorder</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Total (n=831)</td>
<td>Diagnosis + (n=260)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diagnosis + (n=141)</td>
</tr>
<tr>
<td></td>
<td>No. (%) or Mean (SD)</td>
<td>p-value†</td>
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<tr>
<td>Age (years)</td>
<td>24.1 (5.3)</td>
<td>23.5 (4.5)</td>
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<td>Rank (%)</td>
<td>347 (41.8)</td>
<td>126 (48.5)</td>
</tr>
<tr>
<td>E1-E3</td>
<td>352 (42.4)</td>
<td>104 (40.0)</td>
</tr>
<tr>
<td>E4-E5</td>
<td>88 (10.6)</td>
<td>24 (9.2)</td>
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<td>WO/Officer</td>
<td>44 (5.3)</td>
<td>6 (2.3)</td>
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<td>Service (%)</td>
<td>158 (19.0)</td>
<td>87 (33.5)</td>
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<tr>
<td>Army</td>
<td>637 (76.7)</td>
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<tr>
<td>Marines</td>
<td>36 (4.3)</td>
<td>12 (4.6)</td>
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<td>Married (%)</td>
<td>365 (43.9)</td>
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<td>AFQT (score)‡</td>
<td>58.9 (18.9)</td>
<td>56.6 (18.4)</td>
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<tr>
<td>Previous MH diagnosis (%)</td>
<td>49 (5.9)</td>
<td>28 (10.8)</td>
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### Injury-Specific

<table>
<thead>
<tr>
<th>Injury Mechanism (%)</th>
<th>Any Mental Health Outcome</th>
<th>Post Traumatic Stress Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvised Explosive Device</td>
<td>343 (41.3)</td>
<td>105 (40.4)</td>
</tr>
<tr>
<td>Grenade</td>
<td>56 (6.7)</td>
<td>18 (6.9)</td>
</tr>
<tr>
<td>Mortar</td>
<td>68 (8.2)</td>
<td>17 (6.5)</td>
</tr>
<tr>
<td>Blast, Other</td>
<td>158 (19.0)</td>
<td>34 (13.1)</td>
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<tr>
<td>Gunshot Wound</td>
<td>146 (17.6)</td>
<td>69 (26.5)</td>
</tr>
<tr>
<td>Fragment/Shrapnel</td>
<td>43 (5.2)</td>
<td>12 (4.6)</td>
</tr>
<tr>
<td>Other</td>
<td>17 (2.1)</td>
<td>5 (1.9)</td>
</tr>
<tr>
<td>Facial Injury (%)</td>
<td>346 (41.6)</td>
<td>101 (38.9)</td>
</tr>
</tbody>
</table>

### Physiological

<table>
<thead>
<tr>
<th>Physiological</th>
<th>Any Mental Health Outcome</th>
<th>Post Traumatic Stress Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate (bpm)*</td>
<td>86.5 (18.6)</td>
<td>89.0 (21.0)</td>
</tr>
<tr>
<td>Systolic BP (mmHg)**</td>
<td>128.2 (16.3)</td>
<td>128.3 (18.7)</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)***</td>
<td>72.2 (13.2)</td>
<td>70.3 (13.5)</td>
</tr>
</tbody>
</table>

† comparing diagnosis+ to diagnosis-<br>‡ due to missing data, N size is 791<br>* due to missing data, N size is 726<br>** due to missing data, N size is 731<br>*** due to missing data, N size is 725
Table 7 - Age-adjusted Associations, Physiological and Injury-specific Predictors, Male Battle Injured Combatants (n = 831), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th></th>
<th>Any Mental Health Outcome</th>
<th>Post Traumatic Stress Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diagnosis +/- (n=831) OR (95% C.I.)</td>
<td>p-value</td>
</tr>
<tr>
<td>Injury-specific</td>
<td></td>
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<tr>
<td>Injury Severity</td>
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<tr>
<td>Minor</td>
<td>1.00</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.47 (1.69, 3.62)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Serious</td>
<td>4.62 (2.92, 7.31)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Severe</td>
<td>5.68 (3.00, 10.76)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Facial Injury (yes/no)</td>
<td>0.84 (0.62, 1.13)</td>
<td>0.24</td>
</tr>
<tr>
<td>Injury Mechanism</td>
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</tr>
<tr>
<td>Other</td>
<td>1.00</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>IED</td>
<td>1.32 (0.95, 1.85)</td>
<td>0.10</td>
</tr>
<tr>
<td>Gunshot Wound</td>
<td>2.70 (1.79, 4.06)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Physiological*</td>
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<tr>
<td>Heart Rate ≥ 95 (yes/no)*</td>
<td>1.45 (1.03, 2.03)</td>
<td>0.03§</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)**</td>
<td>1.00 (0.99, 1.01)</td>
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<tr>
<td>Diastolic Blood Pressure (mmHg)†</td>
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<tr>
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<td>0.02</td>
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<tr>
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<td>0.01</td>
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<tr>
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<tr>
<td>Severe injury</td>
<td>1.04 (1.00, 1.08)</td>
<td>0.05</td>
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</table>

* due to missing data, N size is 726, 731, and 725 for heart rate, systolic, and diastolic blood pressure, respectively
§ p-value > 0.10 after adjusting for injury severity
† significant interaction between diastolic blood pressure and injury severity (<.01), results presented by injury severity
<table>
<thead>
<tr>
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<th>Any Mental Health Outcome</th>
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<tbody>
<tr>
<td></td>
<td>Diagnosis +/- (n=831)</td>
<td>OR (95% C.I.)</td>
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<tr>
<td>Age (years)</td>
<td>0.97 (0.94, 1.00)</td>
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<tr>
<td>Injury Severity</td>
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<td>&lt;.01</td>
</tr>
<tr>
<td>Moderate</td>
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<td>Serious</td>
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<tr>
<td>Gunshot Wound</td>
<td>2.07 (1.35, 3.19)</td>
<td>&lt;.01</td>
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</tbody>
</table>
REFERENCES


IV: TRAUMATIC BRAIN INJURY AMONG BATTLE INJURED 
OPERATION IRAQI FREEDOM VETERANS: PREVALENCE AND 
PSYCHOLOGICAL OUTCOMES

ABSTRACT

BACKGROUND: The prevalence and mental health sequelae of traumatic brain injury (TBI) during the current U.S. military conflict in Iraq has not been thoroughly examined. OBJECTIVE: To describe the prevalence of TBI among injured male combatants, and examine the role of TBI in the development of mental health outcomes, particularly post-traumatic stress disorder (PTSD). METHODS: A total of 831 men who were injured during military combat between September 2004 and February 2005 comprised the study population. Patients were classified as mild TBI, moderate-severe TBI, other head injury, or non-head injury, and were followed through November 2006 for mental health diagnoses (ICD-9 290-319). RESULTS: Among the total sample, 18.7% were classified as mild TBI, 2.3% as moderate-severe TBI, 32.8% as other head injury, and 46.2% as non-head injury. Those with TBI had more severe injuries, and had a higher frequency of being injured by a blast than those without TBI. Among those suffering moderate-severe injuries overall (Injury Severity Score ≥ 4), those with mild and moderate-severe TBI were less likely to receive a mental health diagnosis, particularly PTSD and mood/anxiety disorders. CONCLUSION: The prevalence rate of head injury among this cohort of injured male combatants is 53.8%; 21.0% of the cohort met the criteria for a TBI. Among those with moderate-severe injuries overall, those with TBI were less likely to receive
a mental health diagnosis over the follow-up period when compared to non-head injuries. This finding may represent a problem with differential diagnosis, as symptoms of TBI can mimic those of psychological disorders. Further research is needed to replicate these results and to address the impact of TBI among veterans of the current military conflict in Iraq.
INTRODUCTION

Traumatic brain injury (TBI) is defined as brain damage secondary to an externally inflicted trauma, and has a higher prevalence among military personnel compared to the general population; military males have a higher rate than civilian males, and military females have a rate roughly equivalent to civilian males.\(^1,2\) Post traumatic stress disorder (PTSD) is an anxiety disorder initiated by a traumatic event and characterized by symptoms of avoidance, re-experiencing, and hyper-arousal.\(^3,4\) Research on the relationship between TBI and PTSD has yielded mixed findings.\(^5\)

The incidence of TBI during the current U.S. military conflict in Iraq is elevated compared to previous conflicts. This finding may be due to an increase in the incidence of blast injuries or a greater number of battle casualties who survive their wounds.\(^1,6\) It has been reported that 59\% of those injured from improvised explosive devices during OIF meet the criteria for TBI.\(^6\)

Some researchers have argued that impaired consciousness, a hallmark symptom of TBI, precludes re-experiencing of the event required for PTSD diagnosis, possibly due to impaired recollection of the event.\(^7\)\(^{10}\) Further, studies examining TBI patients with self-reported amnesia for the traumatic event found low rates of PTSD.\(^11\)\(^{13}\) Other studies identified an inverse relationship between TBI severity and PTSD incidence; those with mild TBI were more likely to develop PTSD compared to more severe TBI.\(^7\)\(^{14}\)\(^{15}\) At least two studies, however, found PTSD to be prevalent following severe TBI.\(^16\)\(^{17}\)

In general, research supports the occurrence of PTSD following mild TBI.\(^11\)\(^{18}\) In addition to PTSD, a review by Van Reekum, et al. cites strong evidence
associating TBI with major depression, anxiety disorders, and bipolar affective disorder. A limitation of studies that have investigated the relationship between TBI and PTSD is the potential misdiagnosis of PTSD, as organic symptoms of TBI can resemble PTSD symptoms. Furthermore, the definition and measurement of TBI and PTSD has not been consistent across studies.

The purpose of this study was to describe the prevalence of TBI among a population of battle-injured male combatants and to examine the role of TBI in the development of PTSD and other mental health outcomes. It was hypothesized that TBI would be associated with higher rates of mental health outcomes compared to non-TBI.

**METHODS**

*Study Population*

The study population was identified from the U.S. Navy-Marine Corps Combat Trauma Registry (CTR), which is a deployment health database maintained by Naval Health Research Center (NHRC) consisting of documented clinical encounters of deployed military personnel; records are obtained for battle injury, non-battle injury, disease, psychiatric and routine sick call encounters. Eligible personnel for this analysis were Operation Iraqi Freedom (OIF) combatants presenting to forward medical treatment facilities for battle injury during the 6-month period from September 2004 to February 2005. Precise date of injury was not indicated for all personnel, therefore date of arrival for medical care was used as a proxy for injury date. After excluding females due to low representation (less than 1%) and 38 individuals who died as a result of their wounds, 881 participants were matched
against the Career History Archival Military Personnel System (CHAMPS). A database maintained by NHRC, CHAMPS contains demographic, career, and medical information on all military members on active duty in the U.S. Armed Services since 1973 (see Gunderson, et al., 2004, for a detailed description of CHAMPS). A total of 841 eligible injured personnel (95.5%) had a matching record in CHAMPS. Ten individuals were excluded due to evidence of military discharge less than 90 days into the follow-up period; a total of 831 male, injured personnel comprised the study population.

**Measures**

Traumatic brain injury was defined by two methods. Initially medical records were reviewed by clinical research staff on the Navy-Marine Corps CTR. A narrative field describing the injury was evaluated and a diagnostic code based on the *International Classification of Diseases* (ICD-9-CM, version 2005) was assigned to each. An ICD-9 code in the following ranges was defined as a TBI (n = 124): 800.0-801.9 (fractures of the vault or base of the skull); 803.0-804.9 (other and unqualified and multiple fractures of the skull); and 850.0-854.1 (intracranial injury, including concussion, contusion, laceration, and hemorrhage). The CHAMPS database was then used to identify any additional patients coded with a TBI ICD-9 code. Any patient with a TBI ICD-9 code listed in CHAMPS within one month of the injury was included in the analysis as a TBI (n = 50). A total of 174 patients were identified as having TBI.

For TBI patients identified via coding by Navy-Marine Corps CTR researchers, severity of TBI was indicated with the Abbreviated Injury Scale (AIS).
The AIS ranges from 1 (relatively minor) to 6 (currently untreatable), and is determined separately for each different body region. Severity of TBI was determined by maximum AIS score for the head region – head AIS 1-2 indicated mild TBI, head AIS 3-5 indicated moderate-severe TBI. A majority of TBI identified via CHAMPS did not have a head AIS score present; in this case the TBI was assumed to be of mild severity due to a closed head injury.

Patients with non-head injuries, the reference group, were defined by the presence of an AIS code indicating a region other than the head, neck, or face. A separate category, other head injury, was used to prevent potential misclassification of TBI within the reference group. Other head injury was defined as an injury to the head, neck, or face which did not meet the criteria for TBI.

This study utilized a retrospective design. Three outcomes were considered: 1) diagnosis of any mental health outcome; 2) diagnosis of PTSD; and 3) diagnosis of mood/anxiety disorder.

Diagnoses in the form of ICD-9 codes were abstracted from the CHAMPS system. The CHAMPS database was updated up through November 2006, therefore there were approximately 22-27 months of follow-up time, although some participants were discharged from the military over the course of the follow-up period; upon military discharge CHAMPS no longer monitors personnel. Those discharged without a mental health diagnosis were assumed to have not developed the outcome.

A diagnosis of PTSD was indicated by an ICD-9 code 309.81, and any mental health outcome was indicated by an ICD-9 code in the range 290-319, excluding 305.10 (tobacco addiction). The date of PTSD diagnosis must have been at least one
month post injury as the definition of PTSD requires symptoms to persist for at least one-month; any diagnosis of PTSD less than one month post-injury was treated as a previous mental health diagnosis. Other mental health outcomes of interest included mood disorders (ICD-9 296, 300.4, 301.13, 311) and anxiety disorders (ICD-9 300.00-300.02, 300.21-300.29, 300.3, 308.3, 308.9, 309.81). Due to a typically high rate of comorbidity, mood and anxiety disorders were combined for analysis. Though not primary outcomes of interest, rates of adjustment disorders (ICD-9 309.0-309.9, excluding 309.81), substance abuse disorders (ICD-9 291, 292.0, 292.1, 292.3-292.9, 303, 304, 305.0, 305.2-305.7, 305.9), and other mental health disorders (any other ICD-9 code between 290 and 319 not previously listed) were also examined. Other variables were utilized for adjustment purposes only. Injury severity was first described using the AIS; a composite Injury Severity Score (ISS, range 1 to 75), was then calculated by Navy-Marine Corps CTR researchers at NHRC.\textsuperscript{32,33} Injury mechanism was indicated on the Navy-Marine Corps CTR clinical record. Age, military rank, and military service were also abstracted from the clinical record for all persons in the study population. Intelligence, reportedly related to development of PTSD,\textsuperscript{34} was measured with the Armed Forces Qualification Test (AFQT) score abstracted from CHAMPS.\textsuperscript{35} Marital status was also abstracted from CHAMPS. Previous mental health diagnoses have been identified as a risk factor for PTSD development, and were ascertained from CHAMPS.\textsuperscript{36} Patients with an ICD-9 code between 290 and 319 (excluding 305.10) at any time (while in the military) since January 1, 2000 and prior to the date of injury were considered to have a previous mental health diagnosis.
**Data Analysis**

Head injury status was categorized as moderate-severe TBI, mild TBI, other head injury, and non-head injury. Mechanism of injury was categorized into a 7-level variable for descriptive analysis, then collapsed into a 3-level variable (improvised explosive device, gunshot wounds, and other) for modeling purposes to ensure an adequate number of responses in each level. Injury severity score (ISS) was categorized as minor injury (ISS 1-3), moderate injury (ISS 4-8), serious injury (ISS 9-15), and severe injury (ISS 16 or higher).\textsuperscript{37-39}

All statistical analyses were performed in SAS version 9.1. Prevalence of TBI was calculated for the entire cohort and stratified by injury mechanism. Differences across groups by head injury status were tested using chi-square and Fisher’s exact tests for categorical variables and analysis of variance for continuous variables. Prevalence rates for mental health diagnoses were reported by head injury status. Logistic regression modeling was used to build a predictive model relating TBI with subsequent mental health diagnosis; covariates significantly associated with head injury status (p < .05) were adjusted for in this regression analysis. Multiple sensitivity analyses were conducted to assess the impact of loss to follow up via military discharge; in one case it was assumed all discharges developed the outcome and in another it was assumed a 50\% random sample of the discharges developed the outcome. Sensitivity analyses were conducted separately for first-year discharges and total discharges.
RESULTS

There were a total of 831 patients in this study. Age ranged from 18 to 54 years with a mean of 24.1 +/- 5.3 years. The majority (76.7%) of patients were Marines, 19.0% were in the Army, and 4.3% were in other services or unknown. Most of the patients (84.1%) were of ranks E1-E5 (junior enlisted). Of the 831 injuries, 64.7% were minor, 18.7% were moderate, 11.2% were serious, and 5.4% were severe. The largest proportion of injuries (41.3%) were caused by IED, followed by other blast injuries (19.1%), and gunshot wounds (17.7%).

Figure 2 shows the prevalence of mild and moderate-severe TBI, compared to other head injuries and non-head injuries. Among all injuries, 53.8% involved a head injury. The prevalence of TBI among the total cohort was 21.0% (18.7% mild, 2.3% moderate-severe). When including only those evacuated out of theater (n=278), the TBI rate was 27.7% (data not shown). Figure 3 shows TBI prevalence by mechanism of injury. Overall, the highest TBI prevalence was seen among blast injuries from improvised explosive devices (IED) and blast due to other causes (e.g. landmine, rocket). Both of these prevalence estimates were significantly higher than the non-blast comparison group (gunshot wounds) after adjusting for multiple comparisons. Prevalence of TBI was not significantly different when comparing blasts due to grenade or mortar to gunshot wounds.

Demographic and injury-specific variables stratified by head injury status (i.e. mild TBI, moderate-severe TBI, other head injury, and non-head injury) are presented in Table 9. Military rank, service, age, marital status, AFQT score, and rate of previous mental health diagnosis did not differ significantly by head injury status.
Improvised explosive devices were responsible for a larger percentage of TBI and other head injury than non-head injury. Injury severity was higher among TBI compared to the other groups.

Rates of mental health outcome by head injury status are shown in Table 10. In the overall cohort, the rates of any mental health outcome, PTSD, and mood/anxiety disorder were 31.3%, 17.0%, and 22.7%, respectively. Median time until any mental health diagnosis was 125.5 days, with a range of 1 day to 729 days. Rates of any mental health diagnosis among mild and moderate-severe TBI were 33.6% and 47.4%, respectively; when examining only diagnoses in the first year post injury similar rates of 28.4% and 42.1% were identified (data not shown). Rates for other mental health disorders differed significantly across head injury groups; those with moderate-severe TBI had significantly higher rates of other mental health disorders compared to non-head and other head injuries. Rates of PTSD, mood/anxiety disorders, and adjustment disorders did not differ significantly across head injury groups.

Based on a strong association between injury severity and any mental health outcome, with minor injuries showing significantly lower rates compared to all other levels (data not shown), multivariate logistic regression was conducted separately for minor injuries (ISS 1-3) and moderate-severe injuries (ISS ≥ 4). Thus, the minor injury group only contained mild TBI, and the moderate-severe injury group contained both mild and moderate-severe TBI and was more likely to contain individuals with multiple trauma. The minor and moderate-severe injury groups were similar on demographic variables, and the minor injury group was less likely to contain those injured via gunshot wound. Based on significant associations with head injury status,
injury mechanism and injury severity were adjusted for in addition to age. Table 11 shows the results of the logistic regression analysis. When examining those with moderate-severe injuries (ISS ≥ 4), mild TBI showed lower rates of any mental health outcome (OR 0.53, 95% CI 0.28, 1.01), mood/anxiety disorders (OR 0.34, 95% CI 0.17, 0.70), and PTSD (OR 0.37, 95% CI 0.17, 0.81) compared to non-head injuries. A similar association was found between moderate-severe TBI and any mental health outcome (OR 0.31, 95% CI 0.10, 0.96), mood/anxiety disorders (OR 0.13, 95% CI 0.04, 0.50), and PTSD (OR 0.29, 95% CI 0.08, 1.06). No significant associations were identified when examining minor injuries (ISS 1-3).

The impact of loss to follow up via military discharge was assessed with a sensitivity analysis. In the first year of follow-up, 96 (11.6%) patients were discharged without a mental health diagnosis. An additional 88 (10.6%) were discharged without a mental health diagnosis after the first year of follow-up. Those lost to follow-up tended to be younger and of more junior rank, were less likely to be married, and were more likely to serve in the Marines. The associations found with TBI and mental health diagnoses were consistent when including all discharges, but inconsistent when including first year discharges only.

DISCUSSION

Higher rates of TBI have been found in the current military conflict in Iraq compared to the Vietnam War. The role of TBI in the development of PTSD and other mental health disorders has yet to be elucidated. The present study found a total TBI prevalence of 21.0% (18.7% mild TBI, 2.3% moderate-severe TBI) among a cohort of male, battle-injured veterans. Among moderate-severe injuries (ISS ≥ 4),
those with TBI were significantly less likely to receive a mental health diagnosis compared to non-head injuries; similar associations were not found among those suffering minor injuries (ISS 1-3).

The overall rate of head injury found in this study (53.8%) is consistent with at least two other studies among Operation Iraqi Freedom (OIF) casualties. Wade, et al. identified 52% of all battle injured between March and September, 2004 had an injury to the head, neck, or face. Another study examining injuries incurred by one battalion between March and August 2004 found that 53% of all injuries were to the head, neck, or face. Among only casualties who were medically evacuated during OIF, two other studies found lower prevalence rates of 22% and 25%, respectively. The prevalence also differs from the first combat period of OIF, March 23 through April 30, 2003, where a rate of 18.6% was identified. Compared to previous military conflicts, the rate of head injury during OIF was significantly higher. In a meta-analysis of military conflicts between 1914 and 1976, the overall prevalence of head and neck injury was estimated at 16%. The prevalence of head injuries during the 1st Gulf War and Vietnam has been reported at around 20%.

The increased prevalence of head injury in this combat population compared to previous military conflicts may be explained by a greater proportion of blast injuries and a greater survival rate for injured personnel. Approximately 75% of all injuries in the present study were caused by a blast mechanism compared to 50% during the Vietnam War. According to casualty estimates updated as of March 24, 2007, the ratio of combat wounded to died of wounds was approximately 9 to 1, compared to 3 to 1 during Vietnam, which indicates greater survival from injuries.
The present study found one-year mental health diagnosis rates of 28.4% and 42.1% among mild and moderate-severe TBI, respectively. This is comparable to a previous study among a non-military population where TBI and mental health diagnosis was ascertained in a methodology similar to the present study; one-year rates of 25.5% and 38.0% were identified for mild and moderate-severe TBI, respectively.\(^47\) Despite these comparable rates, the present study found, when comparing mild and moderate-severe TBI to non-TBI, significantly lower rates of mental health diagnoses among overall moderate-severe injured (ISS \(\geq 4\)) patients. Other studies using injured, non-TBI reference groups have yielded contradictory results. One study found rates of depression higher among severe TBI compared to an injured control group,\(^48\) and another study found similar six-month rates of PTSD among those with mild TBI compared to an injured control group.\(^18\) The results are also inconsistent with other studies among military combat populations that found head injury to be associated with psychological outcome.\(^49, 50\)

There are many possible explanations as to why, among moderate-severe injuries (ISS \(\geq 4\)), the TBI group appears to have lower rates of mental health diagnoses than the non-head injury group. The most likely explanation is that this may represent the problems with differential diagnosis, as psychological symptoms may be attributed to the TBI. Previous studies have elucidated the symptom overlap between TBI and PTSD,\(^24-27\) and other research supports post-concussion symptoms being similar to mood and anxiety disorders.\(^51\) Extremity injuries may also play a role in the results of the present study. Over 90% of patients in the non-head injury group sustained injuries to the extremities. Although this group generally had less severe
injuries than the TBI groups, injuries to the extremities may result in more immediate and visible disability, whereas disability due to TBI may take longer to become fully recognized. A recent study by Grieger, et al. identified early physical problems as a risk factor for PTSD and depression among injured OIF combat veterans. Alternatively, the findings may represent the inverse associations previously found for severity of TBI and incidence of PTSD and mood/anxiety disorders. Those with an impaired recollection of the event due to a head injury may not process the memory as completely as those without a head injury, which could lead to decreased psychological effects of the traumatic memory. The findings may also be explained by bias due to loss to follow up via military discharge. During the first year, those with TBI had a higher rate of loss to follow up (14.1%) than non-head injuries (7.3%), although this difference was not statistically significant.

Several limitations were present in this study. Regarding the study population, the data are collected from Navy-Marine Corps medical treatment facilities only, as such there is a preponderance of injuries from the Marine Corps; Level 1 and 2 injuries treated by Army facilities are not represented. In studies estimating the prevalence of head injury during previous military conflicts, most utilized primary injuries only. The present study defined an individual as having a head injury if any of their injuries were to the head, neck, or face; this could have led to an overestimate of head injury compared to previous conflicts. Due to the high percentage of blast injuries, however, and the likelihood of blast injury leading to a head injury, it is likely that the prevalence of head injury is indeed higher during OIF compared to previous conflicts. The primary outcome measures utilized were ascertained from an electronic
database that tracks, among other things, medical encounters. Previous studies in the area of TBI and mental health have, for the most part, utilized survey instruments with all participants to ascertain a diagnosis. Memory for the event, a potential mediator in the relationship between TBI and mental health, was not measured in the present study. Utilization of medical encounter data likely led to an underestimate of psychological morbidity due to either an aversion to seek treatment or only the most severe cases presenting. Toward the end of the follow-up for this study, data from CHAMPS may not have been fully updated due to a lag in entering ICD-9 codes. In order to account for the lag, the analysis was repeated including only outcomes diagnosed through August 2006 and similar results were found. A larger problem is the high rate of loss to follow-up via military discharge due to the nature of the CHAMPS database, and the inability of CHAMPS to track personnel post-discharge.

The primary strength of the current study is that, to our knowledge, it is the first population based study from OIF to examine the prevalence of TBI and its relationship to later psychiatric morbidity. Additionally, the injury-specific information available from the Navy-Marine Corps CTR, including injury mechanism and injury severity, has never before been thoroughly documented within a military combat population. Because this information is collected at baseline, issues such as recall bias are avoided. The use and high matching rate of the CHAMPS database allowed for assessment of demographic variables, as well as previous mental health diagnoses. Additionally, CHAMPS allowed for the alternate method of defining TBI, reducing the risk of misclassification.
In conclusion, the present study identified an overall head injury rate of 53.8% among a cohort of male, injured OIF combatants; rates of mild and moderate-severe TBI were 18.7% and 2.3%, respectively. Compared to non-head injuries, rates of mental health diagnosis, particularly PTSD and mood/anxiety disorder, were lower among those with mild and moderate-severe TBI; this association was only found among those with overall moderate-severe injuries (ISS ≥ 4). Due to potential bias from loss to follow up, as well as a small number of outcomes for those with moderate-severe TBI, results should be interpreted with caution. Future studies should utilize Veterans Administration data to follow the course of TBI post-discharge. Traumatic brain injury is prevalent during the current military conflict in Iraq, and long-term psychological outcomes of such injuries need to be further elucidated.

The text of Chapter IV, in part, will be submitted for publication as:


The dissertation author was the primary researcher and author.
Figure 2 – Traumatic Brain Injury (TBI) among Injured Male Combatants (n=831), Operation Iraqi Freedom
Figure 3 – Incidence of Traumatic Brain Injury by Mechanism of Injury

* Significantly different from gunshot wounds after adjusting for multiple comparisons
Table 9 - Descriptive Statistics by Head Injury Status, Male Battle Injured Combatants (n=831), Operation Iraqi Freedom

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<th>Demographics</th>
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<th>Traumatic Brain Injury</th>
<th>Other Injuries</th>
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<td></td>
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<td>Moderate-Severe (n=19)</td>
<td>Other Head {n=273}</td>
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<td>24.6 (5.6)</td>
<td>21.5 (3.0)</td>
<td>23.8 (5.1)</td>
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<td>352 (42.4)</td>
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<td>Army</td>
<td>158 (19.0)</td>
<td>16 (10.3)</td>
<td>4 (21.1)</td>
<td>59 (21.6)</td>
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<td>637 (76.7)</td>
<td>133 (85.8)</td>
<td>14 (73.7)</td>
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<td>Other/Unknown</td>
<td>36 (4.3)</td>
<td>6 (3.9)</td>
<td>1 (5.3)</td>
<td>10 (3.7)</td>
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<td>Married (%)</td>
<td>365 (43.9)</td>
<td>64 (41.3)</td>
<td>6 (31.6)</td>
<td>114 (41.8)</td>
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<td>AFQT (score)‡</td>
<td>58.9 (18.9)</td>
<td>61.3 (20.2)</td>
<td>63.6 (16.8)</td>
<td>58.9 (18.3)</td>
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<td>Previous MH diagnosis (%)</td>
<td>49 (5.9)</td>
<td>8 (5.2)</td>
<td>1 (5.3)</td>
<td>18 (6.6)</td>
</tr>
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</table>

| Injury-Specific       |               |                        |                |           |            | <.01 |
| Injury Mechanism (%)  |               |                        |                |           |            |      |
| Improvised Explosive Device | 343 (41.3)   | 96 (61.9)              | 12 (63.2)      | 149 (54.6) | 86 (22.4)  |      |
| Grenade               | 56 (6.7)      | 3 (1.9)                | 0 (0.0)        | 20 (7.3)   | 33 (8.6)   |      |
| Mortar                | 68 (8.2)      | 11 (7.1)               | 1 (5.3)        | 20 (7.3)   | 36 (9.4)   |      |
| Blast, Other          | 159 (19.1)    | 33 (21.3)              | 0 (0.0)        | 50 (18.3)  | 75 (19.5)  |      |
| Gunshot Wound         | 147 (17.7)    | 10 (6.5)               | 5 (26.3)       | 17 (6.2)   | 114 (29.7) |      |
| Fragment/Shrapnel     | 41 (4.9)      | 1 (0.7)                | 0 (0.0)        | 12 (4.4)   | 30 (7.8)   |      |
| Other                 | 17 (2.1)      | 1 (0.7)                | 1 (5.3)        | 5 (1.8)    | 10 (2.6)   |      |
| Injury Severity (ISS groupings) |          |                        |                |           |            | <.01 |
| Minor (1-3)           | 538 (64.7)    | 75 (48.4)              | 0 (0.0)        | 202 (74.0) | 261 (68.0) |      |
| Moderate (4-8)        | 155 (18.7)    | 37 (23.9)              | 0 (0.0)        | 44 (16.1)  | 74 (19.3)  |      |
| Serious (9-15)        | 93 (11.2)     | 27 (17.4)              | 7 (36.8)       | 20 (7.3)   | 39 (10.2)  |      |
| Severe (>15)          | 45 (5.4)      | 16 (10.3)              | 12 (63.2)      | 7 (2.6)    | 10 (2.6)   |      |

† examining differences across categories
‡ due to missing data, N size is 360, 263, 149, 19 for non-head, other head, mild TBI, and moderate-severe TBI, respectively
### Table 10 - Mental Health Outcome by Head Injury Status, Male Battle Injured Combatants (n=831), Operation Iraqi Freedom

<table>
<thead>
<tr>
<th></th>
<th>Total (n=831)</th>
<th>Traumatic Brain Injury</th>
<th>Other Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mild (n=155)</td>
<td>Moderate-Severe (n=19)</td>
</tr>
<tr>
<td>Post-traumatic Stress Disorder</td>
<td>141 (17.0)</td>
<td>25 (16.1)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td>Any Mental Health Diagnosis*</td>
<td>260 (31.3)</td>
<td>52 (33.6)</td>
<td>9 (47.4)</td>
</tr>
<tr>
<td>Mood/Anxiety Disorders</td>
<td>189 (22.7)</td>
<td>34 (21.9)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td>Mood only</td>
<td>16 (1.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Anxiety only</td>
<td>114 (13.7)</td>
<td>24 (15.5)</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td>Comorbid</td>
<td>59 (7.1)</td>
<td>10 (6.5)</td>
<td>3 (15.8)</td>
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<tr>
<td>Adjustment Disorders</td>
<td>80 (9.6)</td>
<td>12 (7.7)</td>
<td>3 (15.8)</td>
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<tr>
<td>Substance Abuse Disorders</td>
<td>56 (6.7)</td>
<td>12 (7.7)</td>
<td>2 (10.5)</td>
</tr>
<tr>
<td>Other</td>
<td>106 (12.8)</td>
<td>23 (14.8)</td>
<td>9 (47.4)**</td>
</tr>
</tbody>
</table>

† Follow-up time ranged from 90 to 820 days  
‡ examining differences across all categories  
* patients can have more than one diagnosis  
** significantly different from other head and non-head injuries after adjusting for multiple comparisons
<table>
<thead>
<tr>
<th>Head Injury Status</th>
<th>Any Mental Health Outcome* OR (95% C.I.)</th>
<th>Mood and Anxiety Disorders** Diagnosis +/- OR (95% C.I.)</th>
<th>Post Traumatic Stress Disorder*** Diagnosis +/- OR (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-head</td>
<td>1.00</td>
<td>1.00 (0.60, 1.81)</td>
<td>1.00 (0.57, 1.93)</td>
</tr>
<tr>
<td>Other head</td>
<td>1.08 (0.67, 1.77)</td>
<td>1.62 (0.79, 3.32)</td>
<td>1.68 (0.77, 3.70)</td>
</tr>
<tr>
<td>TBI</td>
<td>1.43 (0.74, 2.74)</td>
<td>0.19</td>
<td>0.20</td>
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</table>

Minor Injuries, ISS 1-3 (n=538)

<table>
<thead>
<tr>
<th>Head Injury Status</th>
<th>Any Mental Health Outcome* OR (95% C.I.)</th>
<th>Mood and Anxiety Disorders** Diagnosis +/- OR (95% C.I.)</th>
<th>Post Traumatic Stress Disorder*** Diagnosis +/- OR (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-head</td>
<td>1.00</td>
<td>1.00 (0.60, 1.81)</td>
<td>1.00 (0.57, 1.93)</td>
</tr>
<tr>
<td>Other head</td>
<td>0.67 (0.35, 1.29)</td>
<td>0.62 (0.32, 1.21)</td>
<td>0.73 (0.35, 1.51)</td>
</tr>
<tr>
<td>TBI</td>
<td>0.53 (0.28, 1.01)</td>
<td>0.34 (0.17, 0.70)</td>
<td>0.37 (0.17, 0.81)</td>
</tr>
<tr>
<td>Moderate-Severe TBI</td>
<td>0.31 (0.10, 0.96)</td>
<td>0.13 (0.04, 0.50)</td>
<td>0.29 (0.08, 1.06)</td>
</tr>
</tbody>
</table>

Moderate-Severe Injuries, ISS 4 or greater (n=293)

<table>
<thead>
<tr>
<th>Head Injury Status</th>
<th>Any Mental Health Outcome* OR (95% C.I.)</th>
<th>Mood and Anxiety Disorders** Diagnosis +/- OR (95% C.I.)</th>
<th>Post Traumatic Stress Disorder*** Diagnosis +/- OR (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-head</td>
<td>1.00</td>
<td>1.00 (0.60, 1.81)</td>
<td>1.00 (0.57, 1.93)</td>
</tr>
<tr>
<td>Other head</td>
<td>0.23</td>
<td>0.16</td>
<td>0.39</td>
</tr>
<tr>
<td>Mild TBI</td>
<td>0.05</td>
<td>&lt;.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Moderate-Severe TBI</td>
<td>0.04</td>
<td>&lt;.01</td>
<td>0.06</td>
</tr>
</tbody>
</table>

† adjusted for injury severity, injury mechanism, and age
* includes anxiety, mood, adjustment, substance abuse, and other disorders
** excludes adjustment, substance abuse, and other disorders
*** includes only post traumatic stress disorder diagnosis
REFERENCES


V: DISCUSSION

Physical injury and psychological morbidity are prevalent among military personnel in wartime situations and their relationship is potentially important. Physical injury has been linked to subsequent development of post traumatic stress disorder (PTSD) and other psychological outcomes among military populations.1-6 With the advancements made in field medicine over the years, individuals who would have previously died of war injuries are now surviving and are at risk for potential mental health sequelae of their injuries.7 This research, conducted among a population of male, injured combatants during Operation Iraqi Freedom, elucidated: (a) the role of battle versus non-battle injury in the development of psychological morbidity; (b) post-injury predictors of psychological morbidity; and (c) the role of traumatic brain injury in the development of psychological morbidity. These studies focused primarily on 831 battle-injured personnel, with one incorporating a comparison group of 1137 non-battle injured personnel.

BATTLE VERSUS NON-BATTLE INJURY

Rates of PTSD and other mental health outcomes were reported for 831 and 1137 battle and non-battle injured personnel, respectively. Based on Injury Severity Score (ISS), battle injuries were divided into 538 minor (ISS 1-3), 155 moderate (ISS 4-8), 93 serious (ISS 9-15), and 45 severe (ISS ≥16) injuries.8-10 Rates of all mental health outcomes, including PTSD, were significantly higher among battle injuries compared to non-battle injuries, with most of the effect coming from moderate-severe battle injuries. Minor battle injuries also had significantly higher rates compared to non-battle injuries for a majority of the mental health outcomes, including PTSD. An
age-adjusted predictive logistic regression model showed a greater risk of PTSD diagnosis among battle injuries compared to non-battle injuries, ranging from a two to four-fold greater risk among minor and moderate battle injuries to an eight-fold greater risk among serious and severe battle injuries. Similar associations were found for any mental health outcome, mood/anxiety disorder, and self-reported mental health symptoms.

The identified associations may be due to battle injuries being more likely to impede the psychological recovery process by acting as a constant reminder of the traumatic event. The primary limitation of this study was the inability to quantify and adjust for combat exposure. It was expected that non-battle injured personnel would not have as much combat exposure than battle-injured personnel; this may have influenced the results if the associations found with battle injury compared to non-battle injury were actually an indicator of greater combat exposure. When examining rates of self-reported mental health symptoms, those with a non-battle injury who did not have documented combat experiences were able to be restricted from analysis. Although similar results were found, documentation of combat experience was limited to ‘yes’ or ‘no’ answers, and quantification of combat experience was not available.

**POST-INJURY PREDICTORS**

Among the 831 battle injured personnel, physiological and injury-specific predictors of psychological morbidity were assessed. Physiological measurements included post-injury heart rate, systolic blood pressure, and diastolic blood pressure. Injury-specific predictors included injury severity (measured with ISS), injury mechanism, and injury location on the face. In multivariate modeling, injury severity
was positively associated with both PTSD and any mental health outcome, and injury mechanism was associated with any mental health outcome. Experiencing a moderate-severe injury conferred a two to five-fold greater risk of any mental health outcome compared to minor injury, and a serious-severe injury conferred a three-fold greater risk of PTSD. Compared to other injury mechanisms, those injured via gunshot wound were twice as likely to be diagnosed with any mental health outcome.

The post-injury measure of diastolic blood pressure was associated with any mental health outcome, and this association was modified by injury severity. Increasing diastolic blood pressure was inversely associated with any mental health outcome among minor and moderate injuries, and positively associated among severe injuries.

The association found with injury severity may be a result of increasing risk of physical problems or disability associated with the injury.\textsuperscript{12-15} Alternatively, it may be due to medical utilization bias, or the increased use of health services by more severely injured individuals. Figure 4 outlines the median time to first mental health diagnosis by injury severity. The lower median times for moderate-severe injuries may reflect the medical utilization bias.

Gunshot wounds may be associated with mental health outcome due to the trauma of visualizing the attacker, or as a result of those injured via gunshot wounds being more likely to have a higher degree of combat exposure (e.g. involved in a greater number of firefights). Similar to the first study, there was no measure of degree of combat exposure. The lack of a finding with post-injury heart rate was unexpected, as literature supports such an association with PTSD.\textsuperscript{16-24} The heart rate measurements may have been limited by field measurement methods, or military
personnel may have a different stress response than the general population. The association found with diastolic blood pressure and any mental health outcome, and the effect modification with injury severity, was also unexpected. More research is needed to replicate this finding.

Figures 5 and 6 further examine the relationship between any mental health outcome and injury severity and injury mechanism. Rates of specific disorders – anxiety, mood, adjustment, and substance abuse disorders – were compared among all four levels of injury severity and the three different categories of injury mechanism. Anxiety and adjustment disorders were consistently higher among moderate, serious, and severe injuries compared to minor injuries, and anxiety, mood, and adjustment disorders were higher among those injured via gunshot wound compared to other mechanisms of injury. Overall, no specific diagnosis was solely responsible for the observed associations between injury severity, injury mechanism, and any mental health outcome.

TRAUMATIC BRAIN INJURY

Overall, 53.8% (n=447) of the battle-injured personnel had a head injury, and 21.0% (n=174) were classified as suffering a traumatic brain injury (TBI). The frequency of head injury among this population was higher than that found in previous military conflicts, but consistent with other studies from OIF. Rates of any mental health outcome among TBI appeared similar to previous estimates among a non-military population. Among those with moderate-severe overall injuries (ISS ≥ 4), those with both mild and moderate-severe TBI had a lower risk of mental health
diagnosis, particularly PTSD and mood/anxiety disorder. Similar associations were not present among minor overall injuries (ISS 1-3).

The aforementioned negative association between TBI and mental health outcome may be explained by 1) psychological symptoms being attributed to the TBI; 2) preponderance of extremity injuries in the non-head injury comparison group; 3) selection bias (a higher percentage of TBI were lost to follow-up within the first year compared to non-head injuries); or 4) TBI causing impaired memory of the event.

It is also possible that TBI severity was affected by other injuries. In the present study, only the head AIS is used to indicate TBI severity. Therefore the effect of multiple trauma, very common in this population among moderate-severe injuries (ISS ≥ 4), is not taken into account; a head AIS score of 2 or less will be classified as a mild TBI regardless of whether or not there are serious injuries to other body regions. If the other injuries are serious enough to cause hypoxia, the severity of the TBI may be exacerbated.

Two potentially important secondary findings from the TBI analysis include: 1) the higher rates of other mental health disorders among those with moderate-severe TBI, and 2) the non-significant positive associations found between TBI and psychological morbidity among minor injuries (ISS 1-3). The significantly higher rates of other mental health disorders among those with moderate-severe TBI was somewhat expected. Many of these diagnoses were post-concussion disorder and organic conditions likely attributable to the head injury. These diagnoses may have been used in place of more traditional mental health diagnoses; research has shown that post-concussion disorder, specifically, can mimic symptoms of mood and anxiety
disorders, as well as PTSD.\textsuperscript{33-37} Although not significant, it is interesting to note that, among minor injuries (ISS 1-3), the odds ratios for the association between TBI and psychological morbidity were in the direction toward a positive association. It could be that the non-head injury group with minor overall injuries does not contain disabling extremity injuries, thus reducing the possibility of the comparison group being at higher risk for psychological morbidity. Alternatively it may suggest an effect modification between TBI and overall injury severity.

**FALLUJAH – PROXY FOR COMBAT EXPOSURE?**

Operation Phantom Fury was a major combat operation undertaken by U.S. forces in Iraq. The primary dates for this operation were November 7, 2004 through November 15, 2004, and were included in the study period for the injured cohort. Interestingly, nearly 30\% of the injuries in the cohort occurred over this 9-day period in November. Among those injured during this period, there was a higher percentage of injuries caused by gunshot wounds and a lower percentage caused by IED. Injury severity, however, did not differ significantly by those injured during this period compared to those injured outside this period. In addition, rates of any mental health diagnosis and PTSD did not differ significantly for those injured during this 9-day period.

For the analysis of injury-specific predictors and traumatic brain injury, this 9-day period was investigated as a possible proxy indicator for combat exposure. In all analyses, inclusion of a dichotomous variable, injured between November 7 and 15 or not, did not significantly alter the results and was thus not included as a confounder. This variable was additionally analyzed as a potential effect modifier, and the results
were not statistically significant. A potential problem with this variable is that we do not know for sure whether each individual was involved in Operation Phantom Fury, only that the individual was injured somewhere in Iraq between the dates of the operation.

**LIMITATIONS OF THE PDHA**

Post Deployment Health Assessments (PDHA) were utilized in the first part of the present study, comparing battle to non-battle injuries.\(^{38}\) It was initially planned to utilize PDHA data for the analyses on injury specific predictors and traumatic brain injury, but response issues with the PDHA data precluded its use.

Figure 7 shows PDHA response for non-battle injury, minor battle injury, and moderate-severe battle injury. A larger percentage of moderate-severe battle injuries did not complete a PDHA. This may be due to an apprehension to screen severely injured individuals for deployment-related exposures, as many of the questions regarding traumatic exposures would be considered redundant and possibly offensive based on their current injured situation. Also, it may be that providers may assume the PDHA is not necessary if the individual is currently hospitalized with an injury and under supervision. It should be emphasized to all providers that the PDHA is necessary for all personnel to document deployment-related exposures, and that presence of an injury does not preclude the requirement of completing a PDHA.

**FUTURE STUDIES**

The data sources utilized in this study had limitations which may have influenced the results. The CHAMPS database only follows individuals while on active duty.\(^{39}\) Department of Veterans Administration databases should be utilized in
future studies to account for those who are discharged before the end of the follow-up period, as these individuals may be more apt to develop mental health conditions. The PDHA information is limited in its timing of measurement; mental health symptoms may not be realized immediately following deployment. The Post Deployment Health Re-assessment was instituted in late 2005, and asks similar questions as the PDHA only 90 days after returning from deployment.40

Future studies on the relationship between TBI and PTSD should incorporate a measure for memory of the event, which has been identified as a potential mediator,41-43 as well as examine the role of injuries to other body regions that might affect the severity of the TBI. The possible relationship between post-injury diastolic blood pressure and psychological morbidity needs to be elucidated. Those injured specifically during Operation Phantom Fury in Fallujah should be further examined, possibly by identifying the specific units involved in the operation and matching to the Navy-Marine Corps CTR; this analysis may elucidate the psychological effects of being injured during a distinct combat event. The present study was unable to assess injured female combatants due to low representation. Due to the overall higher rate of PTSD in females, it is important that future studies attempt to identify rates of PTSD and other psychological outcomes among injured female combatants. To ensure adequate representation of females, injuries over a longer period of time than the 6-month period in the present study should be assessed.

CONCLUSION

The present research examined the relationship between physical injury and psychological morbidity by comparing battle to non-battle injuries, assessing
predictive capability of post-injury factors, and further defining the role of traumatic brain injury. There was a significantly higher rate of post-injury psychological morbidity following battle injury compared to non-battle injury. Injury severity was a significant predictor of both PTSD and any mental health outcome, and gunshot wounds additionally predicted any mental health outcome. Diastolic blood pressure measured post-injury was associated with any mental health outcome, with the effect modified by injury severity. The prevalence of traumatic brain injury among those battle injured was 21%, and those with traumatic brain injury and overall injury severity of moderate or higher exhibited lower rates of mental health diagnosis compared to non-head injuries. Further research is needed to correct for biases such as medical utilization bias, and potential confounding factors such as combat exposure.

Individuals are surviving their injuries at a greater rate during OIF compared to previous conflicts. The identification and management of injury-related psychological morbidity is essential, as problems may persist long after OIF combat operations have ceased.
Figure 4 – Medical Utilization by Injury Severity
Figure 5 – Prevalence of Any Mental Health Outcome by Injury Severity

*Significantly different from minor injuries after adjusting for multiple comparisons
Figure 6 – Prevalence of Any Mental Health Outcome by Injury Mechanism

*Significantly different from other mechanism after adjusting for multiple comparisons
Figure 7 – Post Deployment Health Assessments, Distribution of Injury Status by Response Time Since Injury
REFERENCES


Name (Last, First M.I.):  

Medications Administered:  

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Med. Category: Unknown  

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Subjective (Chief Complaint):  

Objective (Exam):  

Laboratory Results:  

X-ray Results:  

Assessment / Diagnosis:  

Primary -  

Secondary -  

Tertiary -  

Plan / Procedure(s) / Treatment / Operative Notes / Nursing Notes / etc.:  

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</tbody>
</table>

Final Category: N/A  

CystoUrol:  

Injury, Wound / Trauma:  

Injury, Other:  

Rehab:  

Therapy:  

Psych., Mental Disorders:  

All Other Meds:  

Neur / Neuro:  

Ear:  

Neurological:  

Definitive:  

Medical / Follow-up:  

Dental:  

Diagnosis: N/A  

R/T:  

Up C/I (Aviation):  

Esc to:  

S/I S x ___ days:  

S/I C/I (Aviation):  

Amit to x ___ days:  

N/A  

Routine:  

Urgent (Surgical):  

Prophylactic:  

Convenience:  

Final Time of Death: N/A  

ANATOMICAL:  

Artery:  

Head:  

Neck:  

Chest:  

Abdomen:  

Extremity (Upper/Lower):  

Other, specify:  

PATHOLOGICAL:  

Brain:  

CNS:  

Hemorrhage:  

Total Body Disruption:  

Sepsis:  

Multi-Organ Failure:  

Other, specify:  

Provider Signature:  

Provider Name (Printed or Typed):  

Date/Time:  

DD/MM/YY/Time:  

MD/MD
VII: APPENDIX II

POST-DEPLOYMENT Health Assessment

Authority: 10 U.S.C. 136 Chapter 55, 1074f, 3013, 5013, 8013 and E.O. 9397

Principal Purpose: To assess your state of health after deployment outside the United States in support of military operations and to assist military healthcare providers in identifying and providing present and future medical care to you.

Routine Use: To other Federal and State agencies and civilian healthcare providers, as necessary, in order to provide necessary medical care and treatment.

Disclosure: (Military personal and DoD civilian Employees Only) Voluntary. If not provided, healthcare WILL BE furnished, but comprehensive care may not be possible.

INSTRUCTIONS: Please read each question completely and carefully before marking your selections. Provide a response for each question. If you do not understand a question, ask the administrator.

Demographics

Last Name
First Name
MI
Name of Your Unit or Ship during this Deployment

Gender
○ Male
○ Female

Service Branch
○ Air Force
○ Army
○ Coast Guard
○ Marine Corps
○ Navy
○ Other

Component
○ Active Duty
○ National Guard
○ Reserves
○ Civilian Government Employees

Location of Operation
○ Europe
○ SW Asia
○ SE Asia
○ Asia (Other)
○ Australia
○ Africa
○ Central America
○ Other

To what areas were you mainly deployed:
(mark all that apply - list where/when arrived)

Kuwait
Qatar
Afghanistan
Bosnia
On a ship

Name of Operation:

Occupational specialty during this deployment
(MOS, NEC or AFSC)

Combat specialty:

Today's Date (dd/mm/yyyy)
Social Security Number
DOB (dd/mm/yyyy)

Date of arrival in theater (dd/mm/yyyy)
Date of departure from theater (dd/mm/yyyy)

Pay Grade
○ E1
○ 001
○ W1
○ 002
○ 003
○ 004
○ W2
○ 005
○ 006
○ W3
○ 007
○ 008
○ W4
○ 009
○ 010

Administrator Use Only
Indicate the status of each of the following:
Yes No N/A
○ ○ ○ Medical threat debriefing completed
○ ○ ○ Medical information sheet distributed
○ ○ ○ Post Deployment serum specimen collected

Reset

DD FORM 2796, APR 2003
PREVIOUS EDITION IS OBSOLETE.

ASD(HA) APPROVED
Please answer all questions in relation to THIS deployment

1. Did your health change during this deployment?
   - ● Health stayed about the same or got better
   - ○ Health got worse

2. How many times were you seen in sick call during this deployment?
   - No. of times: [ ]

3. Did you have to spend one or more nights in a hospital as a patient during this deployment?
   - ● No
   - ○ Yes, reason/dates: 

4. Did you receive any vaccinations just before or during this deployment?
   - ● Smallpox (leaves a scar on the arm)
   - ● Anthrax
   - ● Botulism
   - ● Typhoid
   - ● Meningococcal
   - ● Other, list: ___________________________
   - ○ Don't know
   - ○ None

5. Did you take any of the following medications during this deployment?
   (mark all that apply)
   - ● PB (pyridostigmine bromide) nerve agent pill
   - ● Mark-1 antidote kit
   - ● Anti-malarial pills
   - ● Pills to stay awake, such as dexedrine
   - ● Other, please list ___________________________
   - ○ Don't know

6. Do you have any of these symptoms now or did you develop them anytime during this deployment?

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<tr>
<td>●</td>
<td>○</td>
<td>Muscle aches</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Numbness or tingling in hands or feet</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>Skin diseases or rashes</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>Redness of eyes with tearing</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Dimming of vision, like the lights were going out</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>Chest pain or pressure</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Dizziness, fainting, light-headedness</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Difficulty breathing</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Still feeling tired after sleeping</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Difficulty remembering</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Diarrhea</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Frequent indigestion</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Vomiting</td>
</tr>
<tr>
<td>●</td>
<td>○</td>
<td>Ringing of the ears</td>
</tr>
</tbody>
</table>

7. Did you see anyone wounded, killed or dead during this deployment?
   (mark all that apply)
   - ● No
   - ○ Yes - Coalition
   - ○ Yes - enemy
   - ○ Yes - civilian

8. Were you engaged in direct combat where you discharged your weapon?
   - ● No
   - ○ Yes (○ land ○ see ○ air )

9. During this deployment, did you ever feel that you were in great danger of being killed?
   - ● No
   - ○ Yes

10. Are you currently interested in receiving help for a stress, emotional, alcohol or family problem?
    - ● No
    - ○ Yes

11. Over the LAST 2 WEEKS, how often have you been bothered by any of the following problems?

<table>
<thead>
<tr>
<th>None</th>
<th>Some</th>
<th>A Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
<td>Little interest or pleasure in doing things</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>Feeling down, depressed, or hopeless</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>Thoughts that you would be better off dead or hurting yourself in some way</td>
</tr>
</tbody>
</table>

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12. Have you ever had any experience that was so frightening, horrible, or upsetting that, IN THE PAST MONTH, you ....

No  Yes  Unsure
☐  ☐  ☐ Have had any nightmares about it or thought about it when you did not want to?
☐  ☐  ☐ Tried hard not to think about it or went out of your way to avoid situations that remind you of it?
☐  ☐  ☐ Were constantly on guard, watchful, or easily startled?
☐  ☐  ☐ Felt numb or detached from others, activities, or your surroundings?

15. On how many days did you wear your MOPP over garments?

☐  ☐  ☐ No of days

16. How many times did you put on your gas mask because of alerts and NOT because of exercises?

☐  ☐  ☐ No of times

17. Were you in or did you enter or closely inspect any destroyed military vehicles?

☐  ☐  ☐ No  ☐ Yes

13. Are you having thoughts or concerns that ...

No  Yes  Unsure
☐  ☐  ☐ You may have serious conflicts with your spouse, family members, or close friends?
☐  ☐  ☐ You might hurt or lose control with someone?

18. Do you think you were exposed to any chemical, biological, or radiological warfare agents during this deployment?

☐  ☐  ☐ No  ☐ Don’t know  ☐ Yes, explain with date and location

14. While you were deployed, were you exposed to:

(mask all that apply)

☐  ☐  ☐ DEET insect repellent applied to skin
☐  ☐  ☐ Pesticide-treated uniforms
☐  ☐  ☐ Environmental pesticides (like area fogging)
☐  ☐  ☐ Rain or tick collars
☐  ☐  ☐ Pesticide strips
☐  ☐  ☐ Smoke from all fires
☐  ☐  ☐ Smoke from burning trash or feces
☐  ☐  ☐ Vehicle or truck exhaust fumes
☐  ☐  ☐ Tent heater smoke
☐  ☐  ☐ JP-8 or other fuels
☐  ☐  ☐ Fog oil (smoke screen)
☐  ☐  ☐ Solvents
☐  ☐  ☐ Paints
☐  ☐  ☐ Ionizing radiation
☐  ☐  ☐ Radar/microwaves
☐  ☐  ☐ Lasers
☐  ☐  ☐ Loud noises
☐  ☐  ☐ Excessive vibration
☐  ☐  ☐ Industrial pollution
☐  ☐  ☐ Sand/dust
☐  ☐  ☐ Depleted Uranium if yes, explain
☐  ☐  ☐ Other exposures
Health Care Provider Only

Post-Deployment Health Care Provider Review, Interview, and Assessment

Interview

1. Would you say your health in general is:  ○ Excellent  ○ Very Good  ○ Good  ○ Fair  ○ Poor

2. Do you have any medical or dental problems that developed during this deployment?  ○ Yes  ○ No

3. Are you currently on a profile or light duty?  ○ Yes  ○ No

4. During this deployment have you sought, or do you now intend to seek, counseling or care for your mental health?  ○ Yes  ○ No

5. Do you have concerns about possible exposures or events during this deployment that you feel may affect your health?  ○ Yes  ○ No
Please list concerns:  

6. Do you currently have any questions or concerns about your health?  ○ Yes  ○ No
Please list concerns:  

Health Assessment

After my interview/exam of the service member and review of this form, there is a need for further evaluation as indicated below. (More than one may be noted for patients with multiple problems. Further documentation of the problem evaluation to be placed in the service member’s medical record.)

REFERRAL INDICATED FOR:  EXPOSURE CONCERNS (During deployment):

- None  ○ GI
- Cardiac  ○ GU
- Combat/Operational Stress Reaction  ○ GYN
- Dental  ○ Mental Health
- Dermatologic  ○ Neurologic
- ENT  ○ Orthopedic
- Eye  ○ Pregnancy
- Family Problems  ○ Pulmonary
- Fatigue, Malaise, Multisystem complaint  ○ Other
- Audiology

Comments:  

I certify that this review process has been completed.  
This visit is coded by:  V70.5 __ 8
Provider’s signature and stamp:  

Date (dd/mm/yy):  

End of Health Review

DD FORM 2796, APR 2003  
ASO/HAI APPROVED  