NON-BATTLE INJURY & NON-BATTLE PSYCHIATRIC ILLNESS IN DEPLOYED AIR FORCE MEMBERS

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The view expressed in this dissertation are those of the author and do not reflect the official policy of the United States Air Force, Department of Defense, or the U.S. Government.

ABSTRACT

MELINDA EATON: Non-battle injury & non-battle psychiatric illness in deployed Air Force members
(Under the direction of Stephen W. Marshall)

With the ongoing conflict in the Middle East, researchers have developed studies to examine combat injuries and posttraumatic stress disorder. However, there are few published studies examining non-battle injuries and non-battle psychiatric illness for deployed United States Air Force members. This study examines the relationship between component status (Active Duty, Guard, or Reserve) and all non-battle injuries in a deployed environment. Additionally, the study examines the association between non-battle psychiatric illness and operational phases (buildup, invasion, and two stabilization phases) in all deployed Air Force members.

A historical prospective cohort study of approximately 480,000 individual Air Force deployments in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 through 31 October 2006 was conducted. Data regarding illness and injuries diagnosed during clinical visits was obtained through the Global Expeditionary Medical System. Total deployment time was obtained from the Defense Manpower Data Center. Poisson regression was utilized to compare incidence rate ratios.

The overall unadjusted incidence rate of non-battle injuries in deployed members for the study period (2001-2006) was 93.49 non-battle injuries per 1,000 person-years deployed. The most common non-battle injuries were sprains and strains (53.0%) followed by open wounds (27.3%). The youngest age group (17-24 years) had the highest rate of non-battle injury and higher ranking personnel had the lowest rate of non-battle injuries. Guard and Reserve members had a lower rate of

orthopedic and superficial non-battle injuries than Active Duty members when incidence rate ratios were adjusted for age and occupation.

The overall incidence of non-battle non-drug psychiatric illness in deployed Air Force members was 7.76 non-battle non-drug psychiatric illnesses per 1,000 person-years deployed. The incidence of non-battle non-drug psychiatric illness increased as the operations progressed with the invasion phase and both stabilization phases having a higher incidence rate than the buildup phase. Higher incidence rates were also seen in females, junior officers, and the Reserve members.

Results from this study are intended to facilitate the development of proper training and prevention programs to maximize operational efficiency as well as to reduce non-battle injuries and non-battle psychiatric illnesses in a deployed environment.

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LIST OF ABBREVIATIONS

AFHSC	Armed Forces Health Surveillance Center
AFSC	Air Force Specialty Code
BAMC	Brooke Army Medical Center
BAS	Battalion Aid Station
CDC	Centers for Disease Control and Prevention
CENTCOM	United States Central Command
CHCS II-T	Composite Health Care System version II-Theater
CIREN	Crash Injury Research and Engineering Network
CRTS	Casualty Receiving and Treatment Ships
CSH	Combat Support Hospital
CTS	Contingency Tracking System
DMDC	Defense Manpower Data Center
DNBI	Disease and Non-Battle Injuries
DOD	Department of Defense
EMEDS	Expeditionary Medical Support
FRSS	Forward Resuscitative Surgical System
FST	Forward Surgical Team
GAO	United States Government Accountability Office
GEMS	Global Expeditionary Medical System
GHQ	General Headquarters (Army)
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification Coding
IED	Improvised Explosive Device
IOM	Institute of Medicine

IRB	Institutional Review Board
ISR	Intelligence, Surveillance, and Reconnaissance
JCS	Joint Chiefs of Staff
JMeWS	Joint Medical Workstation
JPTA	Joint Patient Tracking Application
LRMC	Landstuhl Regional Medical Center
MAJCOM	Major Command
MFST	Mobile Field Surgical Team
MTF	Medical Treatment Facility
NAP	National Academies Press
NIH	National Institutes of Health
NIMH	National Institute of Mental Health
NNMC	National Naval Medical Center
ODS/DS	OPERATION DESERT SHIELD/DESERT STORM
OEF	OPERATION ENDURING FREEDOM
OIF	OPERATION IRAQI FREEDOM
PARRTS	Patient Accounting and Reporting Real-time Tracking System
PTSD	Post-Traumatic Stress Disorder
SAMS	Shipboard Automated Medical System
SAS	Statistical Analysis Software
SES	Socioeconomic Status
SSN	Social Security Number
TMDS	Theater Medical Data Store
TRAC2ES	TRANSCOM Regulating and Command and Control Evacuation System
UNC-CH	University of North Carolina at Chapel Hill

USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAF	United States Air Force
USAFSAM	United States Air Force School of Aerospace Medicine
VA	Veterans Affairs
WHMC	Wilford Hall Medical Center
WRAMC	Walter Reed Army Medical Center

CHAPTER 1

REVIEW OF THE LITERATURE

1.1. Historical Background of the United States Air Force

Aviation has been a part of the United States military since the Civil War, initially in the form of military ballooning as part of the Signal Corps (1). Mechanical aircrafts were incorporated into the military shortly before World War I leading to the development of the Army Air Service (1). As technology and world events progressed, so did the Army Air Service which transitioned into the Air Corps as part of the Air Corps Act of 1926 (1). At this time, the Air Corps was still an organization within the United States Army. Aviation became increasingly more useful throughout the 1930s leading to greater prominence in the Army as the Air Corps became the General Headquarters (GHQ) Air Force in the late 1930s and the Army Air Forces prior to World War II (1).

The Army Air Forces continued to be a driving force during World War II. At the conclusion of the war, the Army Air Forces strove for independence and a separate, but equal, position in the War Department, along with the Army and Navy (1). The National Security Act of 1947 enabled the United States Air Force (USAF) to become a separate entity (2) and established the Department of Defense (DOD) as the lead agency for United States Armed Forces by creating a Department of the Air Force, retaining the Department of the Navy, and converting the War Department to the Department of the Army (3). Further structural changes in the United States Armed Forces occurred in 1973, when the total force policy was put into action (4). This policy combined active, National Guard, and reserve forces throughout the DOD (4).

Over the past forty years, the USAF has continued to grow in strength and has provided support to the other Armed Forces in the conflicts that have ensued since World War II. The USAF has been a vital component in the Korean War, Vietnam War, Cold War skirmishes, and most recently the Persian Gulf conflicts.

The mission of the USAF is "to *fly, fight* and *win*...in air, space and cyberspace" (2). The USAF is divided into three separate components. These components include Air Force Active Duty, Air National Guard, and Air Force Reserve. These three components serve to fulfill the vision of the USAF:

> The United States Air Force will be a trusted and reliable joint partner with our sister services known for integrity in all of our activities, including supporting the joint mission first and foremost. We will provide compelling air, space, and cyber capabilities for use by the combatant commanders. We will excel as stewards of all Air Force resources in service to the American people, while providing precise and reliable Global Vigilance, Reach and Power for the nation. (5)

The USAF has served in a wide range of operations since its inception. These operations ranged from war to non-war operations such as humanitarian and support missions. Typically, an individual will travel from a home station to another location to participate in these operations. This deployment occurs anytime that an individual departs from their home station to another location, generally greater than thirty days; however this definition may be flexible for individuals who participate in missions that last less than thirty days (such as pilots and navigators).

Air Force Active Duty (hereafter referred to as Active Duty) conduct the majority of the day-to-day operations for the USAF while responsibilities in a deployed environment are shared with Air National Guard and Air Force Reserve members. As of May 2009, the core functions of the USAF are: "nuclear deterrence operations, air superiority, space superiority, cyberspace superiority, global precision attack, rapid global mobility, special operations, global integrated Intelligence, Surveillance, and Reconnaissance (ISR), command and control, personnel recovery, building partnerships, and agile combat support" (6). The Active Duty members fulfill these core functions through supportive operations at bases around the world. Table 1 provides the total population of the DOD in 2007.

Table 1. Total population of the Department of Defense for 2007. (7)

Component	Air Force	Army	Marine Corps	Navy	Total
Active Duty	329,094	517,783	186,425	332,269	1,365,571
Reserve	120,552	266,430	100,787	128,421	616,190
Guard	106,254	354,992	--	--	461,246
Total	555,900	1,139,205	287,212	460,690	2,443,007

The Air Force Reserve (hereafter referred to as Reserve) was officially established in 1948 (8) and currently provides roughly 20% of the Air Force's capability (9). The mission of the Reserve is to provide strength to the Active Duty as necessary (10). Reservists typically maintain a civilian occupation and perform Air Force duties on a part-time basis (10). Reserve members are available to fulfill the following missions: "space, command and control, communications and cyberspace, ISR, support, and flying" (10).

There are three categories of individuals within the Reserve: Ready Reserve, Standby Reserve, and Retired Reserve (10). The Ready Reserve is composed of individuals or units who are available to join the Active Duty during time of war or other national emergencies (10). In comparison, the members of the Standby Reserve are individuals that maintain military training; however are unavailable for Active Duty due to various limitations unless ordered by the Secretary of Defense (10). The Retired Reserve consists of members who have fulfilled their 20-year service obligation or otherwise meet the requirements for retirement and may serve with the Active Duty under special circumstances (10).

The Air National Guard (hereafter referred to as Guard) was established in 1947 along with the creation of the USAF (11). The mission of the Guard is two-fold. The Guard serves a federal mission to support the USAF as necessary as well as a state mission to support the governor of the state during emergencies and other disasters, including civil unrest (12). When mobilized, the Guard is a voluntary force that supports the missions of the Active Duty forces. While some members of the Guard may have a full-time commitment to the Air Force, many members maintain a civilian occupation.

It is important to understand the characteristics and roles of the various components to ensure that accurate comparisons can be drawn across the components. Prior research has focused on the impact of deployment primarily on Army Reserve and Guard forces (4, 13-16); however additional research is recommended for Air Force members (17-19). This research will strive to expand the literature by focusing on Air Force Reserve and Guard forces in a deployed environment.

Clearly, many differences between Active Duty, Guard, and Reserve members exist outside the deployed environment. Once the members are sent to a deployed environment, they have the same exposures and are expected to support Air Force operations regardless of component status. However, these members enter the deployed environment with different backgrounds. Active Duty members are constantly in a military environment and are expected to fulfill Air Force missions on a daily basis wherever they are stationed. In contrast, Guard and Reserve members typically have a civilian aspect to their lives and only fulfill Air Force obligations on a part-time basis. This civilian status can lead to additional stress for the Guard and Reserve members as they strive to find a balance between military and civilian life (13). There are also assumed to be differences in physical fitness, an important risk factor for injury (20).

While all three components undergo similar training in preparation for military duties, the length of training can vary between Active Duty and Reserve components. A study conducted by Lakhani and Fugitia among United States Army members reported that Reserve and Guard forces train for only thirty-nine days per year while Active Duty forces train for two hundred and forty days per year (14).

Additional differences among components include full-time occupation status, age, sex, race/ethnicity, length of deployment, and fitness levels. This research will strive to evaluate these differences and incorporate potential risk factors into models for non-battle injury and non-battle psychiatric illness prevention during military operations as well as different phases within the current conflict.

It is important to examine the different stressors that may be experienced by the different Air Force components. Active Duty members spend the majority of their time training for military operations and participating in military culture. Guard and Reserve members spend the majority of their time in a civilian culture. There may some additional stressors placed on these members as they adjust to full-time military support within a deployed environment. Additionally these members may have the additional stress of maintaining a civilian occupation while in a deployed environment. It is difficult to leave a position for an extended period of time (six to twelve months) and expect to reintegrate easily upon return. An individual who is self-employed may not be able to retain their business while deployed.

Using the milestones outlined in section 1.4, as an additional research aim of this study, the current operations (Operations Iraqi and Enduring Freedom) were separated into four phases to examine the impact of non-battle psychiatric illness during each of these phases. These phases encompass different time periods. During each phase, the time an individual may serve in the deployed may vary and may be extended for operational and political reasons. A member may expect to serve only three to four months in the deployed environment and end up serving six to eight months. For Guard and Reserve members this may impact the possibility of maintaining their civilian occupation and create additional stress for the individual.

1.2. Organization of Military Medicine

The armed services utilize a very rigid combat medical structure consisting of five echelons or levels of care (Level I - V or Level 1 - 5) (21-23). Each level of care builds on the previous level and is increasingly more advanced as medical care progresses (22). This structure begins in the combat zone with Level 1. At this level, immediate medical care is initiated by a fellow soldier, trained lifesaver (combat medic for Army, corpsman for Navy, and/or independent duty medical technician for Air Force), or other emergency medical personnel at the location of

the injury/illness (i.e. battlefield) (21, 22). This level of care is further continued at a battalion aid station (BAS) or shock trauma platoon where medical care can be initiated by trained medical professionals such as a physician or physician's assistant (21, 22). If further care is required, then the patient is transferred to a level 2 facility.

The level 2 facility typically has greater medical care and surgical options. This level can have different designations and capabilities depending on the service providing the medical care. For the Army, level 2 care is administered by a forward surgical team (FST) (21, 22, 24) or medical treatment facility (MTF) (23), while a forward resuscitative surgical system (FRSS) provides care for the Marine Corps (22), mobile field surgical team (MFST) or expeditionary medical support (EMEDS) provide care for the Air Force (22), and casualty receiving and treatment ships (CRTS) provide care for the Navy (23). These additional surgical capabilities typically include ten to twenty-five additional medical personnel as well as upwards of sixty beds (depending on service and capabilities) (22). This level is mobile and designed to follow combat operations to provide support.

Combat support hospitals (CSH) for Army bases, Navy fleet hospitals, and USAF theater hospitals provide level 3 care within the deployed environment (22). These facilities are fixed, meaning they are located within a deployed base and are not mobile. Generally these hospitals can contain specialized services (neurosurgery, laboratory, radiology, etc.) as necessary (22).

Level 4 care is generally completed outside the deployed environment. For Operations Iraqi Freedom and Enduring Freedom, this level of care is accomplished at Landstuhl Regional Medical Center (LRMC) in Germany (21, 22). At this level, patients are stabilized for transfer to a level 5 facility within the United States. Patients are generally kept for no more than 72 hours at a level 4 facility (22). The highest level of care is at one of the level 5 facilities in the United States including Walter Reed Army Medical Center (WRAMC), Brooke Army Medical Center (BAMC), National Navel Medical Center (NNMC), or Wilford Hall Medical Center (WHMC) (22). Wounded/ill military members are kept at these facilities throughout the recovery period.

1.3. Deployed Medical Surveillance and Disease/Non-Battle Injuries

Tracking the number wounded and killed in action has been a fundamental element in conflicts since the battles of the ancient world. In Gabriel and Metz's *A History of Military Medicine*, the *Iliad* is cited as an early source in which battle injuries were recorded (25). An independent study of the *Iliad* reports that 77.6% of the wounds inflicted in battle were fatal (25). In more modern times, medical advancements have improved the mortality rate of battle injuries. From the Civil War to the Korean War, the number of United States troops wounded in action has ranged from 46.6% to 42.9%, respectively (25).

Throughout military operations, it has been vital to conduct health surveillance to protect the troops and maintain operational efficiency. As medical technology improves, disease and non-battle injuries (DNBI) have a larger impact on deployed troops than battle injuries (26). Table 2 provides reported rates for battle injuries compared with disease and non-battle injuries for Navy and Marine Corps personnel serving in four major conflicts (26).

Table 2. Comparison of battle injuries and disease/non-battle injuries rates for Navy and Marine Corps per 1,000 individuals per year. (26)

Conflict	Killed-In-Action Rate	Battle Injury Rate	Disease/Non-battle Injury Rate
World War I	4.4	45	731
World War II	3.7	65*	534
Korea	3.0	3.7	309
Vietnam	3.2	11.7	196

*approximation

The Joint Chiefs of Staff (JCS) have defined nineteen categories to classify disease and non-battle injuries for tracking and analysis purposes. Initially in 2002, disease and non-battle injuries (DNBI) rates were categorized based on the best judgment of the medical provider in the deployed setting (27). As individual patient tracking surveillance systems became available, patients were grouped into the JCS categories based on International Classification of Diseases, ninth revision, clinical modification coding (ICD-9-CM) (28). Table 3 provides the category headings and major

groupings of the ICD-9-CM codes. A complete description of each category can be found in Appendix 1.

Table 3. JCS disease and non-battle injury categories. (27, 28)

JCS Category	Major ICD-9-CM Codes
Combat/Operational Stress Reactions	308 – 309
Dermatological	680 – 709
Gastrointestinal, infectious	1 – 40, 122 -130
Gynecological	614 – 674
Heat/Cold Injuries	991 - 992
Injury, Recreational/Sports	E886, E910, E917
Injury, Motor Vehicle Accidents	E800 – E848
Injury, Work/Training	993
Injury, Other	800 - 959
Neurological*	290 – 359, 386
Ophthalmologic	360 - 379
Psychiatric, Mental Disorders	295 - 316
Respiratory	460 -519
Sexually Transmitted Diseases	90 - 99
Fever, Unexplained	780.6
All Other, Medical/Surgical	2 – 999.99 (various)
Dental	520 – 529
Miscellaneous/Administrative/Follow-up	V codes
Definable	Tailored by deployment

*not an original JCS category

A number of studies have reported DNBI rates for various operations (26, 29-41) (Table 4a). These studies have provided a wide variety of DNBI rates depending on collection methods, population included, and analysis method. These differences do not allow the DNBI rates to be directly comparable or a baseline rate to be established. When DNBI rates are presented, disease and non-battle injuries are often combined into one category. As a result, it can be difficult to separate the diseases from the non-battle injuries. As part of this research, a systematic review of the current literature has been conducted to summarize historical DNBI rates. Only seven of the fourteen studies listed in table 4a mentioned that the rate was calculated based on person-days of deployment. A comparison rate for these studies is included in table 4b with rates converted to events per 1000 persons per day where necessary.

Table 4a. Summary of disease and non-battle injury rates by operation. (26, 29-41)

Operation	Service	Collection Method	Dates of Inclusion	DNBI Rate	Ref
World War I	Navy/Marines	Annual Reports	6 April 1917 – 11 November 1918	731 admissions/1000 strength/year	26
World War II	Navy/Marines	Annual Reports	1942 – 1945	534 admissions/1000 strength/year	26
Korea	Navy/Marines	Annual Reports	1950 – 1953	309 admissions/1000 strength/year	26
Vietnam	Navy/Marines	Annual Reports	1966 – 1971	196 admissions/1000 man years	26
Okinawa	Marines (combat)	Unit Diaries/Data Extract	April – June 1945	4.56 presentations /1000 strength/day	29
Okinawa	Marines (support)	Unit Diaries/Data Extract	April – June 1945	0.93 presentations /1000 strength/day	29
Korea	Marines (combat)	Unit Diaries/Data Extract	February – June 1951	3.31 presentations/1000 strength/day	29
Korea	Marines (support)	Unit Diaries/Data Extract	February – June 1951	0.76 presentations/1000 strength/day	29
Vietnam	Marines (combat)	Unit Diaries/Data Extract	May – August 1968	1.78 presentations/1000 strength/day	29
Vietnam	Marines (support)	Unit Diaries/Data Extract	May – August 1968	1.18 presentations/1000 strength/day	29
Falklands	UK ground troops	Unit Diaries/Data Extract	21 May – 14 June 1982	1.27 presentations/1000 strength/day	29
Okinawa	Marines (hostilities)	Data Extract	April – June 1945	4.21 admissions/1000 men/day	30
Okinawa	Marines (occupation)	Data Extract	April – June 1945	0.73 admissions/1000 men/day	30
Korea	Marines	Data Extract	February – June 1951	3.31 admissions/1000 men/day	30
Korea	Marines (China)	Data Extract	February – June 1951	2.24 admissions/1000 men/day	30
Vietnam	Navy Aircraft Carriers	Field Surveillance	1967 – 1972	7.73 visits/1000 strength/day	31
Vietnam	Navy Aircraft Carriers	Field Surveillance	1973	8.46 visits/1000 strength/day	31
Vietnam	Navy Destroyers/Frigates	Field Surveillance	1971- 1972	12.6 visits/1000 strength/day	31
Vietnam	Navy Destroyers/Frigates	Field Surveillance	1973	21.37 visits/1000 strength/day	31
Vietnam	Navy Destroyers/Frigates	Field Surveillance	1975	25.26 visits/1000 strength/day	31
Peacetime	Navy	Field Surveillance	October 2000 – September 2001	41 initial visits/1000 person-weeks	32
CABANAS	Multi-national	Field Surveillance	August – September 2000	4.1 patients/100 soldiers/week	33
JTF Haiti	Tri-Service	Field Surveillance	2004	5.1%/100 person-weeks	34
Somalia	Army, Navy, Marines	Field Surveillance	January – March 1993	0.059 (9-week mean)	35
Fifth Fleet	Navy	Field Surveillance	2000 – 2001	4.38 visits/100 person-weeks	36
UN Haiti	UN peacekeepers	Field Surveillance	June – October 1995	9.2% to 13% / UN personnel/week	37
Joint Guard	Tri-Service	Field Surveillance	1997	8.1 events/100 strength/week	38
Joint Endeavor	Tri-Service	Field Surveillance	March – October 1996	7.09 events/100 soldiers/week	39
ODS/DS	Army	Reference		5.81 events/100 soldiers/week	39
ODS/DS	Marines	Reference		6.48 events/100 soldiers/week	39
Somalia	Tri-Service	Reference		10.65 events/100 soldiers/week	39
Bosnia-Herzegovina	Tri-Service	Field Surveillance	1 July 2000 – 30 September 2001	5.2-12.2 visits/100 members/week	40
Kosovo	Tri-Service	Field Surveillance	1 July 2000 – 30 September 2001	5.0-10.1 visits/100 members/week	40
Southwest Asia	Tri-Service	Field Surveillance	1 July 2000 – 30 September 2001	2.6-7.3 visits/100 members/week	40
Afghanistan	Army	Field Surveillance	September 2001 – 31 December 2004	0.67 inpatient/1000 soldier-days*	41
Iraq	Army	Field Surveillance	1 September 2002 – 31 December 2004	0.72 inpatient/1000 soldier-days*	41

*Prevalence rate

Table 4b. Converted rates for available disease and non-battle injury rates by operation. (29, 30, 32, 34 -36, 41)

Operation	Service	Dates of Inclusion	DNBI Rate per 1000 persons per day	Ref
Okinawa	Marines (combat)	April – June 1945	4.56 presentations /1000 strength/day	29
Okinawa	Marines (support)	April – June 1945	0.93 presentations /1000 strength/day	29
Korea	Marines (combat)	February – June 1951	3.31 presentations/1000 strength/day	29
Korea	Marines (support)	February – June 1951	0.76 presentations/1000 strength/day	29
Vietnam	Marines (combat)	May – August 1968	1.78 presentations/1000 strength/day	29
Vietnam	Marines (support)	May – August 1968	1.18 presentations/1000 strength/day	29
Falklands	UK ground troops	21 May – 14 June 1982	1.27 presentations/1000 strength/day	29
Okinawa	Marines (hostilities)	April – June 1945	4.21 admissions/1000 men/day	30
Okinawa	Marines (occupation)	April – June 1945	0.73 admissions/1000 men/day	30
Korea	Marines	February – June 1951	3.31 admissions/1000 men/day	30
Korea	Marines (China)	February – June 1951	2.24 admissions/1000 men/day	30
Peacetime	Navy	October 2000 – September 2001	5.86 initial visits/1000 persons/day	32
JTF Haiti	Tri-Service	2004	7.23 events/1000 persons/day	34
Somalia	Army, Navy, Marines	January – March 1993	14.95 events/1000 persons/day	35
Fifth Fleet	Navy	2000 – 2001	6.26 visits/1000 persons/day	36
Afghanistan	Army	September 2001 – 31 December 2004	0.67 inpatient/1000 soldiers/day*	41
Iraq	Army	1 September 2002 – 31 December 2004	0.72 inpatient/1000 soldiers/day*	41

*Prevalence rate

DNBI data can be collected at each echelon of care. At level 1 and 2, DNBI has been typically collected as aggregate data. Level 3 and higher can provide DNBI as individual patient level data. For the purposes of this study, the DNBI data will be from Air Force clinics/hospitals from level 3. During the study period (2001-2006), the majority of Air Force personnel were stationed at fixed facilities within the deployed area (Middle East).

Researchers have used a variety of methods for collecting medical surveillance data in a deployed setting, ranging from medical records extraction to onsite electronic databases (26, 29-41). The different members of the Department of Defense (Army, Navy, Marines, and Air Force) have each employed different methods for collecting medical surveillance data, especially with the current operations in the Middle East, such as Operations Iraqi Freedom and Enduring Freedom (42). The most beneficial DNBI collection system starts by collecting data at the unit level and transferring the data through supporting preventive medicine units. The Major Command (MAJCOM) of higher headquarters then receives the data and uses it for reporting and analysis (43). This is usually accomplished through an electronic tracking system.

Initially, the USAF chose the Global Expeditionary Medical Surveillance (GEMS) as the main electronic records collection system for deployed outpatient clinical visits. This system has been in operation since the start of the current combat operations (2001). The system served to collect basic information regarding demographics, symptoms, diagnosis, and other clinical information at the time of an outpatient visit.

If a patient required more extensive inpatient care or medical evacuation, the data was entered into a different electronic system, such as the Joint Patient Tracking Application (JPTA) or the TRANSCOM Regulating and Command and Control Evacuation System (TRAC2ES). The JPTA was primarily used for inpatient care while the TRAC2ES was used for medical evacuation. Other electronic systems, such as the Composite Health Care System version II-Theater (CHCS II-T), Shipboard Automated Medical System (SAMS), and Patient Accounting and Reporting Real-time Tracking System (PARRTS) were also available (42).

Technical issues with an updated version of GEMS limited the availability and reliability of deployed Air Force clinical data for 2007. Recently, the USAF moved towards a joint data collection system called the Joint Medical Workstation (JMeWS) which will enable medical surveillance for all Department of Defense branches to be collected in a similar manner (44). JMeWS was designed to incorporate data from the Army, Navy, and Air Force sources into one data system (44). Medical records for deployed personnel are maintained in the Theater Medical Data Store (TMDS) which are transmitted to the JMeWS system as necessary for DNBI reporting and other medical surveillance activities (45, 46).

While collection of medical surveillance data is important in a deployed setting, it is also vital to monitor personnel movement. The Defense Manpower Data Center (DMDC) serves as the repository for all deployed personnel data for the Department of Defense (47, 48). This allows all USAF deployments to be tracked and essentially enumerates the cohort to be studied. For the purposes of this research, the outpatient medical surveillance data will be restricted to calendar years 2001 through 2006 for all Air Force members deployed in support of Operations Iraqi Freedom and Enduring Freedom.

1.4. Operations Iraqi Freedom and Enduring Freedom

In order to assist with war and operations other than war across the globe, the DOD has divided the globe into several structured geographical commands. United States Central Command (CENTCOM) was established in 1983 to cover Southwest Asia (49). This command was initially created to prepare for potential conflict with the Soviet Union; however in 1990, the threat from Iraq became apparent (49). When Iraq invaded Kuwait in 1990, the DOD responded with Operation Desert Shield (August 7, 1990) and Operation Desert Storm (January 17, 1991) (50). The cease-fire negotiations began on March 1, 1991 and took effect on April 11, 1991 (50).

The DOD continued to have a presence in Southwest Asia throughout the 1990's in the form of operations such as Operation Southern Watch and Operation Northern Watch (49).

The war on terror began with the attacks on the United States on September 11, 2001. Operation Enduring Freedom (OEF) began on October 7, 2001 when U.S. troops were sent into Afghanistan to fight against the Taliban. Operation Iraqi Freedom (OIF) was initiated on March 19, 2003 through a U.S. airstrike on Iraq. Additional milestone events in the current operations included: President Bush declared the end of major combat operations in Iraq (May 1, 2003); Saddam Hussein captured (December 13, 2003); an interim constitution signed in Iraq (March 8, 2004); initial elections in Iraq (January 31, 2005); general elections for Iraqi National Assembly (December 15, 2005); permanent Iraqi government established (May 20, 2006); and Saddam executed (December 20, 2006) (51).

1.5. Combat Injuries

Injuries sustained as a direct result of combat are a vital element in war and peacetime operations. Historically, disease has been the root cause of more casualties that direct battle injuries; however, with recent conflicts (World War II, Korea, Vietnam, and the Gulf War), combat has been the cause of more casualties than diseases (52). The increased availability and sophistication of technology has allowed more individuals to be at risk for a combat injury by reducing hand-to-hand combat and increasing the use of weapons that cause mass destruction (53, 54). Mechanisms for combat injuries sustained during the current operations (Operations Iraqi and Enduring Freedom) include explosions through improvised explosive devices (IED), mortar, and rocket propelled grenades; gunshot wounds, and motor vehicle collisions (54, 55).

According to the most recent statistics for casualties from the Defense Manpower Data Center, the number of Air Force members killed in action for Operation Iraqi Freedom (19 March 2003 through 31 October 2009 is 29 and the number of Air Force members wounded in action is 427

(56). The number of Air Force members killed in action for Operation Enduring Freedom (7 October 2001 through 31 October 2009) is 20 and the number of individuals wounded in action is 117 (56). Table 5 provides a detailed summary of Air Force casualties as a result of current operations. In comparison, the reported mortality for Operations Desert Shield and Desert Storm was 147 deaths due to battle-related trauma and an additional 225 non-battle deaths (57).

Table 5. Air Force casualties for Operations Iraqi Freedom and Enduring Freedom. (56)

	Dates	Killed in Action	Non-hostile Deaths	Wounded in Action
Operation Iraqi Freedom	19 March 2003 – 31 October 2009	29	22	427
Operation Enduring Freedom	7 October 2001 – 31 October 2009	20	23	117

Some deployed individuals sustain injuries requiring medical evacuation to a higher level of care in order to speedily receive treatment necessary to preserve life or limb. Table 6 provides a summary of Air Force members medically evacuated from the deployed setting to a higher echelon of care for Operations Iraqi Freedom and Enduring Freedom.

Table 6. Air Force medical evacuation for Operations Iraqi Freedom and Enduring Freedom. (56)

	Dates	Battle Injury	Non-battle Injury	Disease/Other
Operation Iraqi Freedom	19 March 2003 – 31 October 2009	99	463	1,406
Operation Enduring Freedom	7 October 2001 – 31 October 2009	59	295	921

1.6. Non-battle Injuries

Non-battle injuries are an important element in combat operations and peacetime operations. These injuries occur while a service member is stationed in a deployed setting rather than at their home base. Non-battle injuries are defined as injuries sustained at a deployed location, but not during direct combat. During the Gulf War, non-battle injuries were found to account for the majority of all deaths (81%) and a high percentage (39%) of all hospital admissions (58, 59). The most common

types of injuries related to hospitalizations were orthopedic in nature (i.e., fractures, sprain/strains, dislocations) (58).

The reported percentage of non-battle injuries reported during Operations Iraqi Freedom and Enduring Freedom ranges from 11% to 34%, depending on data source and method of analysis (60, 61). These data came from a convenience sample of deployed Navy personnel (60) and deployed soldiers returning home through select airport terminals (61); therefore these samples do not represent the overall experience of all members deployed. These percentages translate into non-battle injury rates of 2.5 events per 100 person-months to 8.6 events per 100 person-months (60, 61). In comparison, 48.1% of the medical evacuations from January-November 2003 were a result of both battle and non-battle injuries (59).

Studies have shown that combat-related injuries are caused by gunshot wounds or shrapnel from landmines or ordinances (62 -64) as well as injuries sustained from blasts or burns (53, 64). In comparison, non-battle injuries are often caused by motor vehicle crashes, falls, sports/recreation, poisons/fire, machines/tools, or result from a pre-existing condition (20, 65). Examples of non-battle injuries include fractures, dislocations, sprains or strains, open wounds, burns, concussions, and contusions.

While current deployment medical surveillance systems often record the diagnosis of an injury that occurs in a deployed environment, the exact cause of the injury is often not recorded. For example, a recent analysis found that only 53.3% of non-battle injury computerized admissions records entries for the Persian Gulf War included a cause of the injury (20). Tables 7 through 9 summarize leading mechanisms of injury for the general United States population, general United States military population, and deployed United States military population, respectively (20, 58, 59, 61, 65 - 73).

Table 7. Summary of leading mechanisms for injury in the general U.S. population. (66-69)

Leading Mechanisms of Injury*	References
Drowning	66, 68, 69
Falls	66, 67, 69
Firearms	68, 69
Fires/burns	66, 69
Motor vehicle accidents	66 -69
Overexertion	67
Poisoning by solids/liquids	66

*within top five leading mechanisms

Table 8. Summary of leading mechanisms for injury in the general U.S. military population. (20, 70-72)

Leading Mechanisms of Injury*	References
Combat-related	72
Falls or jumps	20, 70-72
Industrial mishaps	72
Machines/tools	20, 70
Motor vehicle accidents	20, 70-72
Poison/fire	20
Sports and athletics	20, 70-72

*within top five leading mechanisms

Table 9. Summary of leading mechanisms for injury in the deployed U.S. military population. (58, 59, 61, 65, 73)

Leading Mechanisms of Injury*	References
Aircraft accident	65
Combat-related	65, 73
Crushing or blunt trauma	59
Falls	58, 59, 73
Lifting, pushing, pulling	59
Machinery and tools	58
Motor vehicle accidents	58, 59, 65, 73
Other land transport	58
Preexisting condition	65
Sports and physical training	58, 59, 61, 65

*within top five leading mechanisms

From a prevention standpoint, it is essential to evaluate important risk factors for injuries. Table 10 outlines some risk factors for injuries in the general United States population and related specifically to the military environment (20, 60, 66, 67, 74-103).

Table 10. Summary of risk factors identified in current literature for injuries, by population. (20, 60, 66, 67, 74-103)

Risk Factor	Population			References
	General U.S.	U.S. Active Duty	U.S. Deployed	
Age	X	X	X	20, 59, 66, 67, 74-77, 82, 84, 86, 88, 90, 92, 95, 97, 103
Alcohol	X	X		67, 82, 90, 91, 94, 99, 101
Body Mass Index		X		76, 93, 102, 103
Component		X		20
Deployment Status		X	X	99
Education Level		X		99
Fitness Level		X		20, 75-77, 80, 81, 85, 92, 93, 102
Flexibility	X	X		20, 89, 92, 95, 96
Marital Status		X		86, 88, 99
Occupation	X	X		20, 87, 99, 102
Operational Phase			X	100
Previous Injury		X		75, 77, 95
Race	X	X		66, 82, 84, 92, 99
Rank		X	X	20, 59, 70, 82, 84, 90, 95
Seat Belt Use		X		82, 99
SES	X			66
Service		X	X	74, 90, 100
Sex	X	X		20, 66, 74, 76, 79, 84, 88, 92, 97, 98, 100
Smoking/Tobacco		X		20, 75, 77, 83, 92, 93, 95
Temporal	X	X	X	60, 66, 78
Unit		X		95, 97

Injuries accounted for 81% of non-hostile deaths and 12.3% to 19.7% of all hospitalizations in the Armed Forces between 1980 and 1992 (71, 104). During the Persian Gulf War, 81.3% of unintentional non-battle deaths in deployed troops and 24.8% of hospitalizations were due to injuries (20). The total number of deaths and hospitalizations due to injuries for the Operations Iraqi Freedom and Enduring Freedom are not yet available, due to the continued conflict. However, in a survey conducted by Sanders et al, (for troops deployed between 2003 and 2004) it was estimated that 34.7% of the troops sustained non-combat injuries (61).

A review of the current literature (20, 60, 66, 67, 74-103) indicates that injury prevention research in the military has focused primarily on identifying risk factors associated with injuries in a non-deployed environment. This research has lead to the implementation of injury prevention programs within the Armed Forces as a whole (20, 72, 75, 92). Specifically, the review conducted by Jones et al in 2000 (72) recommended the creation of a comprehensive injury surveillance system to review and monitor injuries in the Armed Forces.

This comprehensive system is being developed through the creation of the Armed Forces Health Surveillance Center (AFHSC), a repository for all health surveillance data in the Armed Forces (105). Additionally, deployed medical surveillance data has been consolidated into a single repository for collection and analysis for all deployed members of the Armed Forces in the form of the Theater Medical Data Store (TMDS) (45). Through the use of the joint system, injury prevention research will continue and will focus on the entire Armed Forces in the deployed and non-deployed environments.

While injuries reduce combat readiness in a deployed environment, they can also ultimately impact the cost of Veterans Affairs (VA) health care. An individual who returns from a deployment with an injury or illness faces the possibility that they may not be able to continue their service in the Armed Forces as a result of this illness or injury. This individual may be subject to a disability package using the Veterans Affairs Schedule for Rating Disabilities which is based on the severity of the injury or illness (106). A large number of injuries and psychiatric illness (both related directly to battle and non-battle) can produce a strain on the already over-crowded VA system as well as generate an enormous cost for the care of the individual throughout their lifetime.

Several studies have been conducted recently to estimate the long-term costs associated with injuries. A study conducted by the Maryland Crash Injury Research and Engineering Network (CIREN) Center found that the median cost in a civilian setting for a lower extremity injury (ankle/foot fracture) is approximately $76,904, including hospitalization, professional, and rehabilitation fees (107). A further study by MacKenzie et al, found that the cost for a severe lower extremity injury in civilians including reconstruction and/or amputation ranged from $81,316 to $91,106 for immediate care with a projected lifetime cost of $163,282 to $509,275 (108). These costs do not include lost wages, mental stress, and/or additional medical expenses that may result as a consequence of the injury (i.e. osteoarthritis). These costs are not specific to the military. It is currently unknown how military costs compare to civilian costs.

An additional consideration as a result of a battle or non-battle injury is the psychological impact of the injury. Post-traumatic stress disorder (PTSD) and depression have been shown to be associated with incidence of injury in a deployed setting (109-111). Combat injuries have been shown to have a greater risk of development of PTSD and other psychiatric disorders than non-battle injuries, especially when the severity is considered (109). This association can also increase the long-term cost associated with injuries.

1.7. Non-battle Psychiatric Illnesses

Recent studies have focused on posttraumatic stress disorder (PTSD), especially in reference to the Gulf War, as a result of combat and/or deployment (112-129). Few studies have examined other psychiatric illnesses that may occur in a deployed environment in military members. These psychiatric illnesses may include schizophrenic disorders, mood disorders, delusional disorders, personality disorders, drug or alcohol dependence, adjustment reaction, and depression (130).

The DOD has developed screening programs to identify members who may experience mental health problems during deployment or shortly after return to their home station (117, 120, 131). In addition, a service member is medically screened prior to deployment to identify preexisting medical conditions that may prohibit the service member from operating in a deployed environment. While military members have access to mental health services within a deployed environment, members may not seek mental health care in a deployed environment due to various reasons, most commonly due to social stigmas, perceived impact on career, effect on the unit, and impact on relationships with peers (112-114, 132). This lack of mental health care seeking behavior may result in underreporting of psychiatric illnesses in a deployed environment.

Combat stressors (i.e. potential loss of life) and non-combat stressors (i.e. separation from family) have been found to lead to the development of psychiatric illnesses among deployed service men and women, particularly following deployment (114-117). Additional stressors that stem from

these combat and non-combat situations include acute and chronic stressors. Acute stressors may include situations in which the deployed member receives bad news from home (death of a family member or termination of a marriage), experiences the loss of a friend or colleague at the deployed setting, or is directly involved in a battle situation. Chronic stressors may include financial strain, marriage/personal problems, heightened emotional state from expected combat, and tension within the deployed unit. The majority of Air Force members who participate in a deployment will not likely experience direct combat; however all deployed members will experience stress related to the threat of potential combat.

It is essential to evaluate important risk factors for psychiatric illness. Table 11 outlines some risk factors for psychiatric illness in the general United States population that relate specifically to the military environment (113-129, 131-152). The majority of the studies that pertained to the U.S. deployed population focused on combat-related mental health or PTSD.

This research will develop a model of deployment-related factors, focusing on those among Air Force members in a non-battle or support environment. Data on stressors such as training, personal issues, separation from family, and financial burden will not be available for this study. However, the study will focus on demographic differences between components (Guard, Reserve, and Active Duty) and the association between psychiatric illness and different operational phases using available clinical information. An additional risk factor that will be considered for this study is the time from start of deployment to time of event, expressed as person-days of exposure during each operational phase.

Table 11. Summary of risk factors identified in current literature for psychiatric illness, by population. (113-129, 131-152)

Risk Factor	Population			References
	General U.S.	U.S. Active Duty	U.S. Deployed	
Age	X	X	X	115, 120, 137, 138, 145-148
Alcohol			X	113, 114, 119
Childhood Adversity			X	121, 124
Combat -related		X	X	113-115, 117-119, 124, 127, 128, 134, 135
Component		X	X	114, 115, 120, 131, 133, 145, 147
Deployment Social Support			X	115
Difficult Environment		X	X	114, 115
Education Level	X	X	X	136, 138, 142, 146-148
Environmental	X			136
Genetic Vulnerability	X			136
Lack of Preparedness/Transition	X		X	114, 115, 136, 144
Length of Service		X		144, 147, 148
Location			X	114, 117, 132, 150
Loss of Relationship	X		X	114, 136
Marital Status	X	X	X	136, 138, 142, 146-148
Occupation			X	120, 139
Parent with Illness	X			136
Perceived Environmental			X	125
Perceived Threat			X	114, 115, 124, 125
Preexisting Diagnosis	X		X	118, 136
Prior Deployment		X	X	140, 142
Race	X	X	X	119, 137, 145, 148
Rank		X	X	114, 120, 132, 142, 144, 145, 148
SES	X	X	X	136, 144, 148
Service		X	X	114, 120, 126, 135, 138, 142, 144, 147
Separation from Family	X	X	X	114, 115, 136
Sex	X	X	X	114, 115, 116, 120, 129, 135, 136, 141, 142, 145, 147-149, 151, 152
Sexual Harassment			X	115
Smoking	X		X	119, 136, 144
Temporal			X	122, 123

The prevalence of mental illness in the United States is estimated to be 26% for a 12-month period (148, 153). In comparison, an estimated 6% of the 1.4 million members of the Armed Forces were provided outpatient treatment for a mental disorder during roughly the same time period (2003) (154). The lower prevalence in the military is likely due to a healthy worker effect. Military members are clinically screened for mental illness prior to entry into military service.

A recent commentary by Matthew J. Friedman suggested that PTSD has been reported in 15.6 to 17.1 percent of members returning from Operations Iraqi Freedom and Enduring Freedom (112). The majority of studies conducted for the current operations as well as past conflicts, notably the Vietnam and Persian Gulf Wars, have focused on risk factors for combat-related psychiatric

illness rather than non-battle psychiatric illness (113-129, 131-152). The use of deployed medical surveillance systems has allowed for the collection of data within the deployed settings. This information was not available for prior conflicts or was only available in limited amounts.

Specifically, several studies have focused on psychiatric illness and the long-term consequences as a result of participation as a military member in the Gulf War (115, 122-129, 133, 142, 144, 150, 151). The Iowa Persian Gulf Study Group conducted a telephone survey in 1995 and 1996 of Iowa veterans and non-veterans of the Persian Gulf War (133). This study found that Persian Gulf War veterans were more likely to report psychiatric illness than veterans not involved in the Persian Gulf conflict (133). Additional studies have also found that Persian Gulf veterans are more likely to experience psychiatric illness, such as anxiety, posttraumatic stress disorder, depression, and alcohol abuse than veterans that did not deploy in support of the Persian Gulf War (112, 129, 144, 150). It is highly likely that veterans returning from the current operations will also exhibit symptoms consist with psychiatric diagnoses in the years following a deployment.

As indicated above, the DOD has implemented screening programs for identifying psychiatric illnesses in members returning from a deployment (117, 120, 131); however these programs have not been fully implemented in the deployed environment. The number of non-battle psychiatric illnesses is likely to be underreported due to stigmas associated with mental health care as stated previously (112-114, 132). It is important to conduct research to identify risk factors in non-battle military members to better focus prevention programs.

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CHAPTER 2

STATEMENT OF SPECIFIC AIMS

2.1. Specific Aims

The current conflict in the Middle East (Operations Iraqi Freedom and Enduring Freedom) has provided data for researchers to explore combat related clinical topics such as battle injuries and posttraumatic stress disorder. Non-battle injuries and non-battle psychiatric illness are also an important element in combat operations and peacetime operations; however very few studies examining these topics have been published. This research addressed this knowledge gap by examining the impact of non-battle injuries and non-battle psychiatric illnesses among deployed Air Force members.

In part, this research explored the differences in incidence in non-battle injuries in the various Air Force components (Active Duty, Guard, and Reserve). While all three components undergo similar training, the population in each component may vary by full-time occupation, age, sex, race and ethnicity, length of deployment, and fitness levels. The role of some of these covariates as potential confounders/effect measure modifiers was explored. Additionally, this research examined non-battle psychiatric illness and a shift in operations through four major stages based on military and political milestones (buildup, invasion, stabilization prior to Iraqi elections, and stabilization after Iraqi elections) in all deployed Air Force members.

The Specific Aims of this study were:

1. Enumerate the disease and non-battle injury rates for the Armed Forces in combat operations and operations other than war.

2. Describe and analyze non-battle injuries in deployed Air Force members by component (Active Duty, Guard, and Reserve).

3. Describe the association between non-battle psychiatric illnesses in all deployed Air Force members and current operational phases.

2.2. Hypotheses

Due to potential differences in training and experience, it was expected that the Guard and Reserve service members will have a higher number of non-battle injuries in a deployed environment than the Active Duty service members. Additionally, it was hypothesized that a higher number of non-battle injuries will occur in older members of the Air Force.

It was hypothesized that the incidence of non-battle psychiatric illnesses increased in latter operational phases of Operations Iraqi Freedom and Enduring Freedom, as stressors associated with improvised explosive devices (IED) and other hazards have increased over the course of the occupation. The rate of non-battle psychiatric illness was hypothesized to be higher in the invasion phase than the buildup or stabilization phases. However, the invasion encompassed less time than the other three phases. Individuals may have postponed clinical visits of less severe psychiatric illnesses until after the invasion phase is complete.

2.3. Rationale

In part, this research focused on non-battle injuries in relation to component status. This research also examined the relationship between non-battle psychiatric illnesses and shift in operations due to major events over the course of the campaign. Previous studies have focused on injuries in a non-deployed military setting or combat-related trauma. Results from this research may provide information for the development of additional training and prevention programs to reduce non-battle injuries in a deployed environment that may need to be tailored by component.

This study may inform development of programs for the prevention of non-battle psychiatric illnesses. It is important to determine the stressors and risk factors that impact those members not engaged in a direct combat role to maximize operational efficiency and decrease injury and illness. Previous studies have focused strictly on combat-related psychiatric illnesses such as PTSD. It will be useful to identify additional risk factors for non-battle psychiatric illnesses to better focus prevention programs for those deployed to a non-battle setting.

While this study may not directly benefit the individuals who provided data to the analysis, it will benefit current Air Force members by allowing additional focus of training programs towards the various components (Guard, Reserve, or Active Duty) to prevent injuries and illness in the deployed environment. Additionally, this research has determined prominent injuries and psychiatric illness that occur in a non-battle setting within the deployed environment. This will assist the development of intervention programs that focus on reducing the impact of these injuries and illnesses on the service members.

CHAPTER 3

METHODS

3.1. Overview of Methods

This study utilizes a historical prospective cohort of deployed Air Force members. The study has been conducted using secondary data analysis of clinical visits and personnel data. Poisson regression has been used to calculate incidence rate for non-battle injuries and non-battle psychiatric illnesses in a deployed environment. Poisson regression is useful for count data that follows a Poisson distribution (1-3). The mean and variance of the Poisson model are assumed to be equal (3). The form of the Poisson model (3) that will be used for this study is:

$$\log(\#\text{ events}) = \log(person - time) + \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k$$

Another alternative to Poisson regression is Cox proportional hazards models. Cox regression allows time-dependent covariates to be taken into account within the model (4). Cox regression also allows an individual's time at risk to be variable (4). In this study, the period of exposure is relatively short (less than a year); therefore we would expect possible variation in time-dependent covariates, such as age, to be minimal.

The difference between the use of Cox and Poisson regression depends on the assumptions made by each method. Poisson regression assumes that the log of the outcome rate has an equally spaced linear relationship as the exposure variable changes (5). Cox regression also assumes a similar linear relationship between the outcome and the exposure variables (4).

Additionally, the Cox model assumes that a baseline hazard must be taken into account in the model (4); however it is considered semi-parametric because a probability distribution is not selected to represent the baseline hazard or survival times (4). The Poisson regression method does not explicitly account for the baseline hazard and is parametric.

3.2. Subject Identification

3.2.1 Source Population

Data on a cohort of deployed Air Force members was obtained from the Department of Defense personnel database maintained by the Defense Manpower Data Center (DMDC). The data was accessed through the United States Air Force School of Aerospace Medicine (USAFSAM) located in San Antonio, Texas. A data use agreement was completed to access these data.

The study population includes all Air Force members deployed in support of Operations Iraqi Freedom and Enduring Freedom. There were 513,942 Air Force deployments between 11 September 2001 and 31 December 2006. After application of inclusion and exclusion criteria, the total number of Air Force members deployed is 275,843 and the total number of Air Force deployments is 479,774. Deployment start and stop dates are used to calculate person-time. An individual may contribute person-time for multiple deployments during the study period. Table 12 provides the total number of individual Air Force deployments during this time period that met the inclusion/exclusion criteria.

Table 12. Total deployments for USAF Active Duty, Reserve, and Guard deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

Component	Deployments (%)
Active Duty	313,816 (65.4)
Reserve	70,003 (14.6)
Guard	95,955 (20.0)
Total	479,774 (100)

Table 13 illustrates the demographic characteristics of the study population. This cohort includes predominantly white non-Hispanic enlisted males aged 25 - 34 years. The most striking difference is the age range for Active Duty, Guard, and Reserve members. Additionally, the Guard and Reserve have more males and a higher percentage of white and non-Hispanic members than the Active Duty. One noticeable variation between the Guard and Reserve is that the Guard has a higher percentage of enlisted service members. The rank distribution of the Guard is closer to Active Duty than Reserve.

Table 13. Demographics of USAF Active Duty, Reserve, and Guard deployments in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

	Active Duty (% of total)* (N = 313,816)	**Guard (% of total)*** (N = 95,955)	**Reserve (% of total)*** (N = 70,003)	**Total(% of total)*** (N = 479,774)
Age				
17 - 24 years	118,123 (38)	12,900 (13)	4,128 (6)	135,151 (28)
25 - 34 years	126,042 (40)	27,981 (29)	17,585 (25)	171,608 (36)
35 - 44 years	63,012 (20)	36,645 (38)	32,943 (47)	132,600 (28)
45 + years	6,639 (2)	18,429 (19)	15,347 (22)	40,415 (8)
Sex				
Male	270,694 (86)	87,144 (91)	63,085 (90)	420,923 (88)
Female	43,122 (14)	8,811 (9)	6,918 (10)	58,851 (12)
Race				
White	241,344 (77)	84,633 (88)	59,414 (85)	385,391 (80)
Black	43,357 (14)	6,132 (6)	6,031 (9)	55,520 (12)
Other	7,063 (2)	1,911 (2)	949 (1)	9,923 (2)
Missing	22,052 (7)	3,279 (3)	3,609 (5)	28,940 (6)
Ethnicity				
Hispanic	17,956 (6)	4,563 (5)	3,653 (5)	26,172 (5)
Non-Hispanic	291,751 (93)	91,248 (95)	66,149 (94)	449,148 (94)
Missing	4,109 (1)	144 (<0)	201 (<0)	4,454 (1)
Rank				
Officer	56,232 (18)	15,973 (17)	19,947 (28)	92,152 (19)
Enlisted	257,584 (82)	79,982 (83)	50,056 (72)	387,622 (81)

*Total % may not equal 100 due to rounding

3.2.2. Inclusion/Exclusion Criteria

This study requires that all participants be members of the United States Air Force and deployed and returned during the study period, 11 September 2001 to 31 October 2006. Due to availability of data, members of the other Armed Forces (i.e. Army, Navy, and Marines) have not been included in this study. Entry into the military is age restricted; therefore this study does not

include individuals less than seventeen years of age or those older than sixty-five years of age. Sixteen individuals did not have a recorded date of birth; therefore they were excluded from the study population.

The population has not been restricted by gender, race, or ethnicity. Pregnant women are not allowed to serve in a deployed environment for medical reasons and thus have not been included in this study; however this exclusion assumes that women are identified as pregnant prior to deployment. Women who become pregnant during the deployment are not able to be clearly identified in the available dataset. It is assumed that once a woman becomes pregnant, she is removed from the deployed environment as soon as possible. The stop date of deployment should reflect this evacuation from the deployed environment.

3.3. Data Description

This study was based on existing surveillance data collected on-site at deployed locations in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006. Current databases capture medical information for deployed Air Force population including clinical visits that occurred in the deployed environment. Data regarding illness and injuries diagnosed during clinical visits have been obtained through GEMS using the International Classification of Diseases, ninth revision, clinical modification coding (ICD-9-CM). Due to a lack of available complete data for November and December 2006, the study period ends on 31 October 2006 rather than 31 December 2006 (as was originally intended).

The GEMS system was designed as an electronic medical record-keeping system for all deployed Air Force members and used by clinics established in support of operations in the Middle East. Individual clinical visits are entered into the electronic interface in the deployed environment and then batched together electronically and sent to a central storage location in the continental United States for additional storage and analysis. Clinical visits in GEMS are mostly outpatient

visits; however there may be some overlap with inpatient visits and medical evacuations. The majority of the data entered into the GEMS system is by medical providers (i.e. doctors, nurses, physician assistants) and medical support staff.

Clinical visits entered into the GEMS system consist of initial and follow-up medical visits. Initial visits are typically due to an injury or illness that occurred in a deployed setting. Service members are medically screened prior to deployment and thus these visits are unlikely to be a result of a routine medical examination. Follow-up visits are used for injuries or illnesses that require medical supervision on an out-patient basis. In this research, non-battle injuries and non-battle psychiatric illnesses have been selected from all clinical visits based on ICD-9-CM category coding.

Total deployment time between 11 September 2001 and 31 October 2006 has been obtained from the Defense Manpower Data Center (DMDC) database. The DMDC database is considered the "gold standard" for deployed Air Force personnel. This system assumes 100% capture of all deployed Air Force personnel. The deployment start and stop dates were used to calculate the total number of days deployed as well as time spent in each operational phase.

The data was accessed through the United States Air Force School of Aerospace Medicine (USAFSAM) located in San Antonio, Texas. USAFSAM is primarily an Air Force institution and the available data is limited to Air Force members only. The primary investigator was stationed at USAFSAM as a public health consultant prior to enrolling at the University of North Carolina at Chapel Hill (UNC-CH) and assisted with the initial data acquisition for USAFSAM. Additionally, Dr. Eaton assisted with several preliminary studies which led to the development of this project.

A data use agreement has been completed in order to comply with data regulations. An original copy of the dataset has been maintained on a compact disc in a locked cabinet. The data has been kept on the primary investigator's personal laptop with password protection and encryption. All personal identifiers had been stripped from the data prior to receipt by the

primary investigator, except for the last four digits of the Social Security Number (SSN) and the date of birth.

The date of birth has been used to calculate the age of the service member at the time of the deployment. A secondary variable for age had been calculated by using the difference between date of birth and date of clinical visit to determine age at time of the injury or illness event. Once age was calculated, the identifying data was removed from the dataset. In addition, the last four digits of the SSN were removed from the dataset once a unique identifier had been assigned by the primary investigator.

All other materials relating to the study were kept in a locked file cabinet. Follow-up beyond 2006 has not been conducted for this study and the investigators have had no contact with the subjects. The study proposal was reviewed the University of North Carolina Institutional Review Board (IRB) and received approval for continuation of the research in May 2009 with a renewal granted in March 2010.

3.3.1. Data Quality

A validation study of the GEMS software was conducted in 2000 on a previous iteration of GEMS (Desert Care II) (6). The study analyzed data from March 1997 through January 1999 for completeness of diagnosis, ICD-9-CM code, and DNBI categorization (6). Overall, 19% of the records from the Medical/Other category could have been more accurately categorized in the correct DNBI category (6). This finding is consistent with the primary investigator's experience with GEMS; therefore DNBI category codes will not be utilized for this study. However, only 0.7% of patient records had an irrational ICD-9-CM code (6). The authors report an overall accuracy of greater than 98% for the GEMS software (6).

While this study addresses the validity of patient data that has been entered into GEMS, it does not include information on complete capture of patient data at a deployed location. It is possible

that patients with mild symptoms stop by the base clinic for a "quick consult" and will not be entered into the GEMS system.

Other than the base clinic, there are generally no other medical treatment locations for deployed Air Force members to receive medical care. However, alternatives for medical care may arise if the Air Force base is co-located with another branch of the military. If an individual seeks care with another service, their medical record may be entered into their patient care system (CHCS II-T or PARRTS). Additionally, if the injury or illness is severe, the patient may require immediate aeromedical evacuation from the deployed environment, which would require the patient's medical encounter to be recorded in an alternative system such as JPTA or TRAC2ES.

The DMDC database, specifically the portion of the system that tracks individual movements called the Contingency Tracking System (CTS), was reviewed in 2006 by the United States Government Accountability Office (GAO) for completeness of deployed Reserve (including Guard) personnel tracking (7). The investigation found that the overall reporting of deployed Reserve personnel in the DMDC system was deficient; however the Air Force corrected this problem by submitting a "rebaselined" or replacement of all Reserve personnel in the DMDC database prior to publication of the final report (7). For Active Duty personnel, the DMDC database has an automatic feed from each service's personnel system to maintain an up-to-date deployment database (7, 8).

3.3.2. Data Linkage

The data linkage had been performed by USAFSAM prior to transfer of the data to Dr. Eaton. The statistical program Stata (9) was utilized to complete the linkage between the GEMS and DMDC datasets. For non-battle injury data, all injury data was selected from GEMS and transferred to Stata (9). All battle injury data was removed and leading zeros were added to all SSNs. Any unidentifiable SSN were deleted.

Each clinical entry was matched to the corresponding entry in the DMDC database by SSN and range of deployment dates. All non-Air Force entries in GEMS were deleted. Data was de-identified by replacing each SSN with a unique numerical value. Individual visits were linked by the unique value to identify follow-up visits. Non-battle psychiatric illnesses were obtained in the same manner using the appropriate ICD-9-CM code range specified by the Office of the Assistant Secretary of Defense (Health Affairs).

The total deployment time was obtained from the DMDC database at USAFSAM. The database was examined for unidentifiable entries and the identifying information (i.e. SSN) was removed prior to transfer of the data to the primary investigator. Individuals may have more than one entry in this database if they served more than one deployment during the time period between 11 September 2001 and 31 October 2006.

The initial data linkage procedures were created by the primary investigator and co-investigator, Dr. Scott A. Fujimoto, while they were employed at USAFSAM. The linkage for this study was based on these procedures; however, Dr. Eaton was directly involved in the data linkage that took place at USAFSAM. The data received by the primary investigator only includes the date of birth and the last four digits of SSN as identifiers.

3.4. Classification of Exposure

3.4.1. Component Status

Component was the exposure of interest for Specific Aim 2. Component can be divided into three categories: Active Duty, Guard, and Reserve. In most analyses of Air Force data, Guard and Reserve members are typically grouped together while Active Duty is kept separate. Guard and Reserve members typically maintain civilian status full-time and participate in military activities on a part-time basis unless deployed. Active Duty members serve full-time as military members. For this study, the components have been kept as separate entities.

Component status obtained from the DMDC database is expected to be highly reliable. The DMDC database captures completed data on multiple deployments by the same person. It accounts the fact that individuals with multiple deployments sometimes switch components between deployments (i.e., an individual may have been Active Duty on his/her first deployment and then switched to Guard/Reserve before his/her second deployment, or vice versa).

According to the DMDC, each year an estimated 16.8% of Air Force Active Duty officers and 10.2% of Air Force Active Duty enlisted transferred from Active Duty to Reserve status between 1996 and 2006 (10). It is very unusual for an individual to switch components during a deployment. As individual clinical encounters will be considered independent of a previous deployment, this is not expected to impact the analysis. An individual will provide exposure time to the correct component category during each deployment. Figure 1 provides a hypothetical example from the DMDC dataset of an individual who changed component status during the study period.

Figure 1. Example of potential change in component for an individual with multiple deployments.

Date of Birth	Component	Sex	Ethnicity	Race	Start Date	Stop Date	Rank	PAFSC	DAFSC	SSN_Last 4
1-Jan-78	AD	M	H	3	1/21/2003	7/27/2003	E03	1C431	1C431	1234
1-Jan-78	R	M	H	3	12/4/2003	4/9/2004	E04	J1C451	1C431	1234

3.4.2. Operational Phase

Deployed bases usually increase their operational tempo during times of change (i.e. political milestones). Therefore, there is likely to be greater stress and possible risk for injury or illness during this these time periods. Using these military and political milestones and dates of data available for this study, four operational phases were designated to address Specific Aim 3 (Table 14).

Table 14. Operational phases for Operations Iraqi Freedom and Enduring Freedom.

Phase	Period	Length (days)
Buildup	11 September 2001 - 18 March 2003	554
Invasion	19 March 2003 - 1 May 2003	44
Stabilization Phase I	2 May 2003 - 31 January 2005	641
Stabilization Phase II	1 February 2005 - 31 October 2006	637

The unit of observation is time from start of deployment to time of clinical visit measured in days, which can then be separated by phase of operation. All Air Force members are grouped together to examine the relationship between non-battle psychiatric illness and phase of operation. This analysis has been restricted to one illness per service member per deployment, since these illnesses are typically chronic within a deployment. In contrast, for Specific Aim 2, which deals with acute outcomes, a single deployment was allowed to contribute multiple injury events.

3.5. Classification of Outcomes

3.5.1. Non-battle Injuries

The outcome of interest for Specific Aim 2 was non-battle injuries. Non-battle injuries from individual patients can be defined using ICD-9-CM coding (11). For the purposes of this study, the ICD-9-CM code range that will be utilized for non-battle injuries is from 800 - 929. Table 15 provides a summary of coding that will be utilized for non-battle injuries.

Table 15. ICD-9-CM codes for non-battle injuries. (11)

ICD-9-CM	Description
800 – 804	Fracture of skull
805 – 809	Fracture of neck and trunk
810 – 819	Fracture of the upper limb
820 – 829	Fracture of the lower limb
830 – 839	Dislocation
840 – 848	Sprains and strains of joints and adjacent muscles
850 – 854	Intracranial injury, excluding those with skull fracture
860 – 869	Internal injury of thorax, abdomen, and pelvis
870 – 879	Open wound of head, neck, and trunk
880 – 887	Open wound of upper limb
890 – 897	Open wound of lower limb
900 – 904	Injury to blood vessels
905 – 909	Late effects of injuries, poisonings, toxic effects, and other external causes
910 – 919	Superficial injury
920 – 924	Contusion with intact skin surface
925 – 929	Crushing injury

Non-battle injuries were obtained by restricting all clinical visits recorded in GEMS from 11 September 2001 through 31 October 2006 using the ICD-9-CM codes and the category classification of "non-battle injury". Clinical visits classified as non-battle injuries have been matched with the corresponding entry in the DMDC data by SSN in order to acquire additional demographic variables.

There were 17,826 non-battle injury clinical visits recorded between 11 September 2001 and 31 December 2006. For this study, data has been cleaned to remove duplicate entries, restricted to non-battle injuries using ICD-9-CM codes in range 800 - 929 with corresponding decimals, and restricted to only include those non-battle injuries that occurred within the study period (11 September 2001 through 31 October 2006). After application of the inclusion/exclusion criteria, the total number of non-battle injuries was 13,575, with 12,598 individuals experiencing an injury during a deployment. Duplicate visits may occur if an individual is seen more than once for a particular injury.

An individual may have multiple ICD-9-CM codes for an event if they sustain more than one injury during the event (the codes must be different during the same clinical visit), an individual may have more than one injury event per deployment, and an individual may have

more than one deployment in the study period. However, an individual may not sustain the same injury during an individual deployment. For example, an individual diagnosed with lower back pain (ICD-9-CM code 846.9) will only have one visit for lower back pain for an individual deployment. The data has been restricted by ICD-9-CM codes; therefore if a provider used a different ICD-9-CM code for a separate clinical visit for the same injury, the injury event may be counted more than once in the dataset. For example, a provider may specify knee sprain (844.9) for the initial event and sprain not otherwise specified (848.9) at a later visit. It is difficult to determine if these are related or separate events based solely on the available data. For this study, these have been considered as separate events.

It is difficult to strictly separate non-battle injuries from "battle-related" injuries solely based on the ICD-9-code. The "non-battle injury" category code was utilized to remove all individuals that sustained a combat-related injury during a deployment. This non-battle status was determined by the medical provider that saw the patient in the deployed environment and is subject to clinical variation (i.e. there are no fixed criteria in GEMS for defining non-battle injuries).

3.5.2. Non-battle Psychiatric Illnesses

The second outcome of interest for the study was non-battle psychiatric illness (Specific Aim 3). It is difficult to strictly separate psychiatric diagnoses based on the potential to be related to combat/non-battle stressors. ICD-9-CM codes can be utilized to separate battle-related diagnoses from non-battle psychiatric illnesses. In the interest of comparability with other DOD-initiated research, this study will utilize these same ICD-9-CM codes to distinguish battle from non-battle psychiatric diagnoses. According to Colonel (Retired) Kenneth L. Cox (formerly affiliated with the Office of the Assistant Secretary of Defense for Health Affairs), the current DOD ICD-9-CM

mapping for non-battle psychiatric illness includes the codes outlined in Table 16 while combat/operational stress is defined using codes 308, V62.83, and V62.89 (personal communication, 30 September 2008). Additional codes for organic psychoses (290-294), specific mental disorders due to brain damage (310), hallucinations (780.1), convulsions (780.39), and unspecified sleep disturbances (780.5) were also included.

Table 16. ICD-9-CM codes for non-battle psychiatric illnesses. (11)

ICD-9-CM	Description
290 – 294	Organic psychoses
295 – 299	Other psychoses (schizophrenia, depressive disorder, etc.)
300 – 307	Neurotic disorders (anxiety, personality disorders, alcohol or drug dependence, etc.)
309	Adjustment reaction
310	Specific disorders due to brain damage
311 – 316	Other nonpsychotic mental disorders (disturbance of conduct, emotions, etc.)
317 – 319	Mental retardation
780.1	Hallucinations
780.39	Convulsions
780.5	Sleep disturbance, unspecified
V11	Personal history of mental disorder
V15.4	Psychological trauma
V40.0 - 40.3, V40.9	Mental and behavioral problems
V62.85	Other psychosocial circumstances
E950 - 959	Suicide and self-inflicted injury

Non-battle psychiatric illness clinical data was obtained from all clinical visits recorded in GEMS from 11 September 2001 through 31 October 2006. These include clinical visits for those illnesses diagnosed while the service member was located at the deployed station. Members with pre-existing conditions should have been screened prior to deployment and not allowed to deploy if the condition was severe. Due to this pre-screening, these should be incident psychiatric illnesses.

Those clinical visits coded as an non-battle psychiatric illness using ICD-9-CM codes in range 290-294, 295-307, 310, 311-319, 780.1, 780.39, 780.5, V11, V15.4, V40.0-40.3, V40.9, V62.85, V65.49, and E950-959 with corresponding decimals have been matched with the corresponding entry in the DMDC data by SSN in order to acquire additional demographic variables. There were 3,452 psychiatric illness clinical visits recorded between 11 September 2001 and 31 October 2006. Additional subsets of the non-battle psychiatric illness data include V codes related to

stressors (V61, V62, V65, V69, and V79) and combat stressors (308, 309) with the appropriate decimal places. There were 1,677 observations with V codes related to stressors and 329 observations designated as combat stressors.

For this research, data has been cleaned to remove duplicate entries and apply inclusion/exclusion criteria giving a total number of 1,446 non-battle psychiatric illnesses. The dataset for the analysis includes one ICD-9-CM code per person per deployment. Follow-up visits were not included. Non-battle psychiatric illnesses have been analyzed as overall number of individuals experiencing a non-battle psychiatric illness in a deployed environment for the study period.

3.5.3. Outcome Misclassification

The main source of error with non-battle injuries and non-battle psychiatric illness is outcome misclassification by the physician/technician entering the clinical visit into the electronic database. A provider may use the incorrect ICD-9-CM code or a vague ICD-9-CM code. These codes may not be part of the specific ICD-9-CM codes designated for each outcome. However, the error is expected to be nondifferential with respect to phase and component and it is expected that this misclassification should not detract from the study validity, since no bias in the rate ratio exists if the outcome misclassification is nondifferential and outcome ascertainment is highly specific (12).

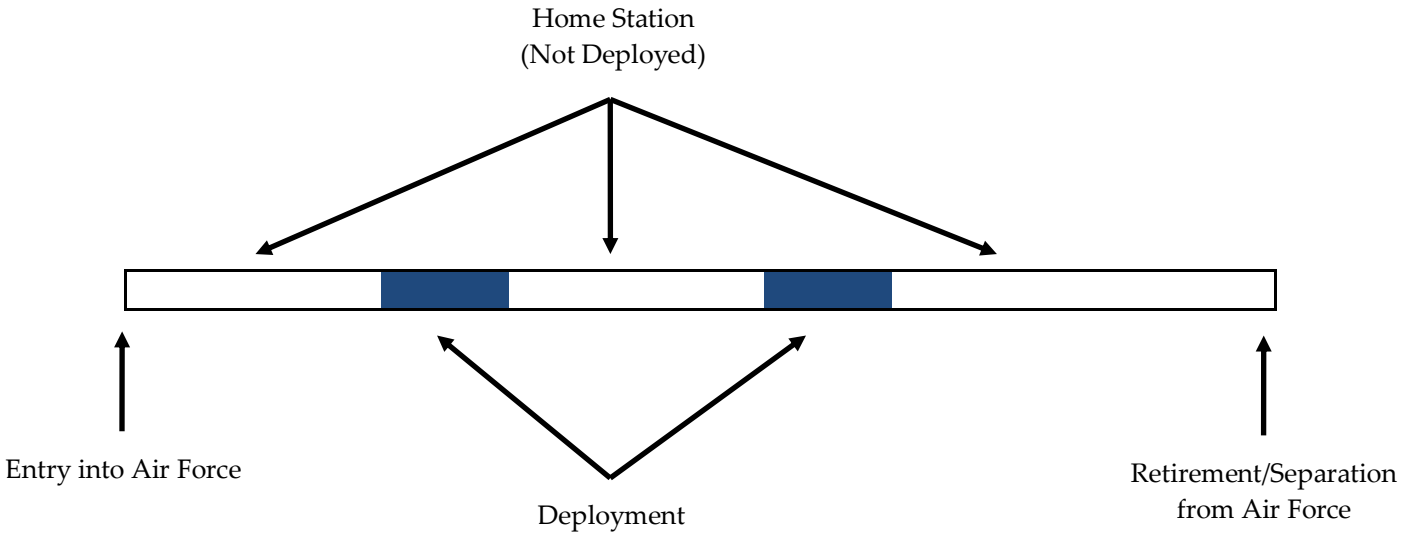
In order to determine reliability of the outcome information, multiple providers would need to evaluate the same patient and individually determine the ICD-9-CM codes that should be assigned. The individual codes could then be compared for accuracy. Unfortunately, this would not be feasible for this study. Alternatively, a validation study of the electronic system could be conducted by comparing individual medical records with the corresponding entry in the database.

No such validation study is available for GEMS for this period. As previously discussed, a validation of an earlier GEMS iteration indicated high reliability.

Any injuries or illnesses occurring during a non-deployed period are outside the scope of the study dataset and will not be included. Therefore, an individual may develop a non-battle psychiatric illness during the course of a deployment and not seek medical care until after the deployment ends. This would also create outcome misclassification, again, it is expected to be largely nondifferential, or weakly differential, with regard to phase and component.

Given the current length of operations in the Middle East, an individual may experience multiple deployments during the study period. Figure 2 provides an illustration of the potential course of an individual's career that could include multiple deployments. Additionally, an individual may contribute more than one illness or injury during the deployment period; however these events will not be linked for analysis. A small percentage of recurrence of injuries or illnesses is expected.

Figure 2. Timeline of a military career.



There is potential for bias relating to a prior illness or injury. A prior injury or illness can be related to a current injury or illness. For this study, information on prior injuries or psychiatric illnesses is not available. This study assumes that the injury or illness that occurs in the deployed environment is the initial injury or illness for that individual. Individuals are screened and considered fit for deployment at the time of the deployment, so this assumption is reasonable.

3.6. Covariates

Based on availability of data, the following demographic variables have been included in the study: age, sex, rank, Air Force Specialty Code, race, and ethnicity. The suggested coding for these variables is outlined in Table 17. Medical treatment facility, treatment location, and disposition have not been included in this study. Medical treatment facility and treatment location convey similar information. However, they have not been included in the analysis due to the sensitive nature of the current conflict. The number of troops at each deployed base is typically classified to reduce the vulnerability of the base. While disposition is a result of the outcome and may reflect severity of the injury/illness, it is not a risk factor for the outcome.

As stated above, information on previous injuries or illnesses is not available for this study. Other risk factors not available for inclusion in this study include fitness level, body mass index, training completed, alcohol use, smoking status, and other stressors such as personal issues, separation from family, financial burden, etc. However, an additional variable (previous deployment) was included in the analysis.

Age was originally coded as a continuous variable obtained from subtracting the date of the start of deployment from the birth date of the individual to determine age at the start of deployment in whole years. After exploration of the data, age was coded as categorical. For the non-battle injury analysis, age was additionally coded in the form of linear splines with the knots at each category

cutpoint. An additional age variable available is the age at the time of clinical visit; however this did not seem useful in the analysis as it only applied to a minority of the deployments.

Sex was coded as a binary variable using Male and Female as the two categories. The dataset did not contain any unknown values for sex.

Rank was originally categorized into twenty-nine different categories reflecting individual rank and status of Officer and Enlisted. For the purposes of this study, rank has been changed to a binary variable including Officer and Enlisted. Additional coding of rank includes division of rank into categories of officer and enlisted ranks using standard Air Force divisions. Due to low numbers of general officers, the senior officers combined field grade officers and general officers.

One proxy variable used in this analysis is Air Force Specialty Code (AFSC). AFSC is the designation given to an Air Force member for occupational specialty and can be used to represent occupation. The original dataset contains two AFSC fields: primary AFSC and duty AFSC. Primary AFSC typically refers to the occupational specialty to which the individual completes their primary duties. Duty AFSC is an additional code that may reflect duties outside of the individual's primary status. An individual may perform additional duties in a deployed environment; therefore the primary AFSC and duty AFSC may not be identical.

AFSC has been categorized based on the general occupational specialty of each individual according to the Air Force standard. The nine general categories that are used for AFSC are: Operations, Logistics, Support, Medical, Professional, Acquisition and Financial Management, Special Investigations, Special Duty, and Other. For the purposes of the study, duty AFSC has been used to measure occupation and reflect current duties at the time of the injury/illness event. Due to small numbers in many of the categories, AFSC has been coded into four categories: Operations, Support, Logistics, and Other. For the non-battle injury analysis, a more specific AFSC coding was utilized to reflect specific career fields during the examination of effect measure modification and confounding. These additional categories are listed in Table 17.

Race was originally categorized into thirty-one different categories. Ethnicity was originally categorized into twenty-three different categories. For the purposes of this study, race has been combined with ethnicity into the following four categories: Non-Hispanic White, Hispanic White, Black, and Other. In cases of mixed race, these designations have been classified as Other.

An additional risk factor considered in the analysis is the number of previous deployments in the study period. An individual could have no previous deployments, one previous deployment, or two or more previous deployments. Information on deployments prior to the study period was not available for this study; therefore the analysis was limited to deployments occurring in support of Operations Iraqi and Enduring Freedom.

Length of deployment has been used as the primary measure of person-time at risk for the non-battle injury analysis. Length of deployment was not specified in the original dataset, however, the number of days deployed has been obtained from subtracting the date the deployment ended from the date that the deployment began. This calculation provides the number of days deployed as a whole number and has been examined as a continuous variable.

Length of deployment has been further disaggregated into time in operational phase (also considered as a continuous variable). Time in each phase was calculated in whole days for the duration of the deployment that occurred in that time period. If an individual was diagnosed with a non-battle psychiatric illness during a particular phase, then the calculation of time in the operational phase ceased on the day of the clinical visit. The day of the clinical visit counted as a half day, since the exact time of the clinical visit is unknown. Once a clinical visit occurred, the individual did not contribute any person-time at risk for the remainder of the deployment; however they could contribute time on a separate deployment.

The date of the clinical visit was used as a proxy for the date the injury or illness occurred. This date may be fairly accurate for injury events. It is assumed that if an injury event is severe enough to warrant medical care, then the injury happened close to the time of the clinical visit (at least within 24-48 hours). The clinical date may not be a good proxy for non-battle psychiatric

illness. These illnesses tend to be chronic in nature and may not have begun at a time close to the clinical date; however the clinical date may indicate a time in which the illness became severe enough to warrant medical care.

In a deployed setting, it is difficult to clearly distinguish between time at risk for combat injury and time at risk for non-battle injury. An individual could be considered at constant risk for a combat injury, since the base could be attacked at any time. In this study, we have been unable to distinguish time at risk for expected combat injury (i.e. convoy duty) and time at risk for a non-battle injury (i.e. off-duty); therefore time at risk for a non-battle injury or illness will be considered from all time the individual spends in a deployed environment.

Another variable considered for the non-battle psychiatric illness analysis was previous mental health diagnosis on a previous deployment. This variable could have been calculated based on the available information; however it likely would not have been able to capture fully the incidence of prior mental health visits. The study did not include clinical visits that occurred between deployments (at the individual's permanent base). If an individual sustained a non-battle psychiatric illness on a deployment and did not seek medical care during the deployment itself, then the information would not have been captured by the data sources utilized for this study.

Table 17 provides a summary of coding options that have been used to evaluate the variables in this study. Various coding alternatives have been considered in model-building for non-battle injuries and non-battle psychiatric illnesses.

Table 17. Summary of coding for primary variables.

Variable	Description	Coding	Referent
Component Status (exposure)	Nominal	Active Duty = 0 Guard = 1 Reserve = 2	Active Duty
Operational Phase (exposure)	Ordinal	Buildup = 0 Invasion = 1 Stabilization I = 3 Stabilization II = 4	Buildup
Age (also coded with linear splines)	Ordinal	17 - 24 years = 0 25 - 29 years = 1 30 - 34 years = 2 35 - 39 years = 3 40 - 44 years = 4 45 + years = 5	17 - 24 years
Sex	Dichotomous	Male = 0 Female = 1	Male
Air Force Specialty Code	Nominal	Operations = 0 Logistics = 1 Support = 2 Other = 3	Operations
Air Force Specialty Code (specific career fields)	Nominal	Aircrew = 0 Command and Control = 1 Intelligence = 2 Aircrew Protection = 3 Operations Other = 4 Aerospace Maintenance = 5 Communications = 6 Fuels = 7 Logistics Other = 8 Supply = 9 Transportation = 10 Weapons and Munitions = 11 Information Technology = 12 Civil Engineering = 13 Support Other = 14 Security Forces = 15 Mission Support/Manpower = 16 Professional = 17	Aircrew
Rank	Dichotomous	Enlisted = 0 Officer = 1	Enlisted
Rank (categorical)	Nominal	Airmen = 0 Junior Enlisted (NCO) = 1 Senior Enlisted (SNCO) = 2 Junior Officer (CGO) = 3 Senior Officer (FGO/GO) = 4	Airmen
Race/Ethnicity	Nominal	Non-Hispanic White = 0 Hispanic White = 1 Black = 2 Other = 3	Non-Hispanic White
Previous Deployment	Nominal	No previous deployment = 0 1 previous deployment = 1 2 or more previous deployments = 2	No previous deployment
Length of Deployment	Continuous	N/A	N/A
Time in Operational Phase	Continuous	N/A	N/A

3.7. Quality Assurance/Quality Control

A full examination of the data was conducted to assess the accuracy and quality of the data. The clinical and personnel datasets were examined to evaluate the percentage of missing variables. Additionally, the personnel dataset was compared with a subset of data from the TRAC2ES dataset to determine the accuracy the date a person returned from their deployment. It is assumed that if an individual experiences a severe medical event (injury or illness) that requires medical evacuation from the deployed area, the individual is not longer considered deployed. However, there may be some variation in the medical evacuation dates and stop date for deployment if an individual is taken to higher level of care within the deployed environment prior for treatment rather than immediate return to the United States continent or another permanent duty location. An examination of the TRAC2ES data indicated that there were 344 Air Force individuals medically evacuated from June 2002 through November 2006. Of these individuals recorded in the TRAC2ES database, only 148 (43%) had a recorded entry in GEMS for the same event. Individuals who are medically evacuated for an injury represent a small portion (less than 2%) of the total number of non-battle injuries seen in a deployed Air Force environment.

A comparison of the personnel data with the TRAC2ES data indicated a mean difference of 67.43 days (standard deviation = 55.35) between the medical evacuation date and the recorded date of return from deployment. The median difference between these dates was 55 days. It is difficult to determine from the available data if the individual returned to their home station following the medical evacuation or if they were able to return to the deployed environment to continue their current deployment. Further analysis would be necessary to accurately describe the accuracy of the stop dates for deployment in the case of medical evacuation.

The missingness of the data is minimal (Table 18). Race is the only variable with a high percentage of missing data in the two main datasets (approximately 6%). The missing race values do not appear to be associated with the outcome, exposure, or other covariates. The missing values were

likely not reported to the Air Force Personnel system or were reported in the system as Unknown. Other missing variables with less than 1% missing data include ethnicity, primary AFSC, duty AFSC, rank (include officer/enlisted designation, but not specific rank), visit type, disposition, and treatment location. Primary AFSC and duty AFSC may be classified information and therefore not included in the dataset (or given a generic code of ZZZZ). For this study, these AFSC's have been placed in the Other category.

Table 18. Evaluation of missingness of combined datasets.

Variable	Deployments (N = 479,774) Number missing (%)
ID	0 (0)
Age	0 (0)
Component	0 (0)
Sex	0 (0)
Ethnicity	4,454 (0.93)
Race	28,940(6.03)
Rank	13 (<0.01)
Primary AFSC*	933 (0.19)
Duty AFSC*	2,877 (0.60)
Diagnosis	0 (0)
ICD-9-CM Code	0 (0)
Deployment Start	0 (0)
Deployment Stop	0 (0)
Visit Date	0 (0)

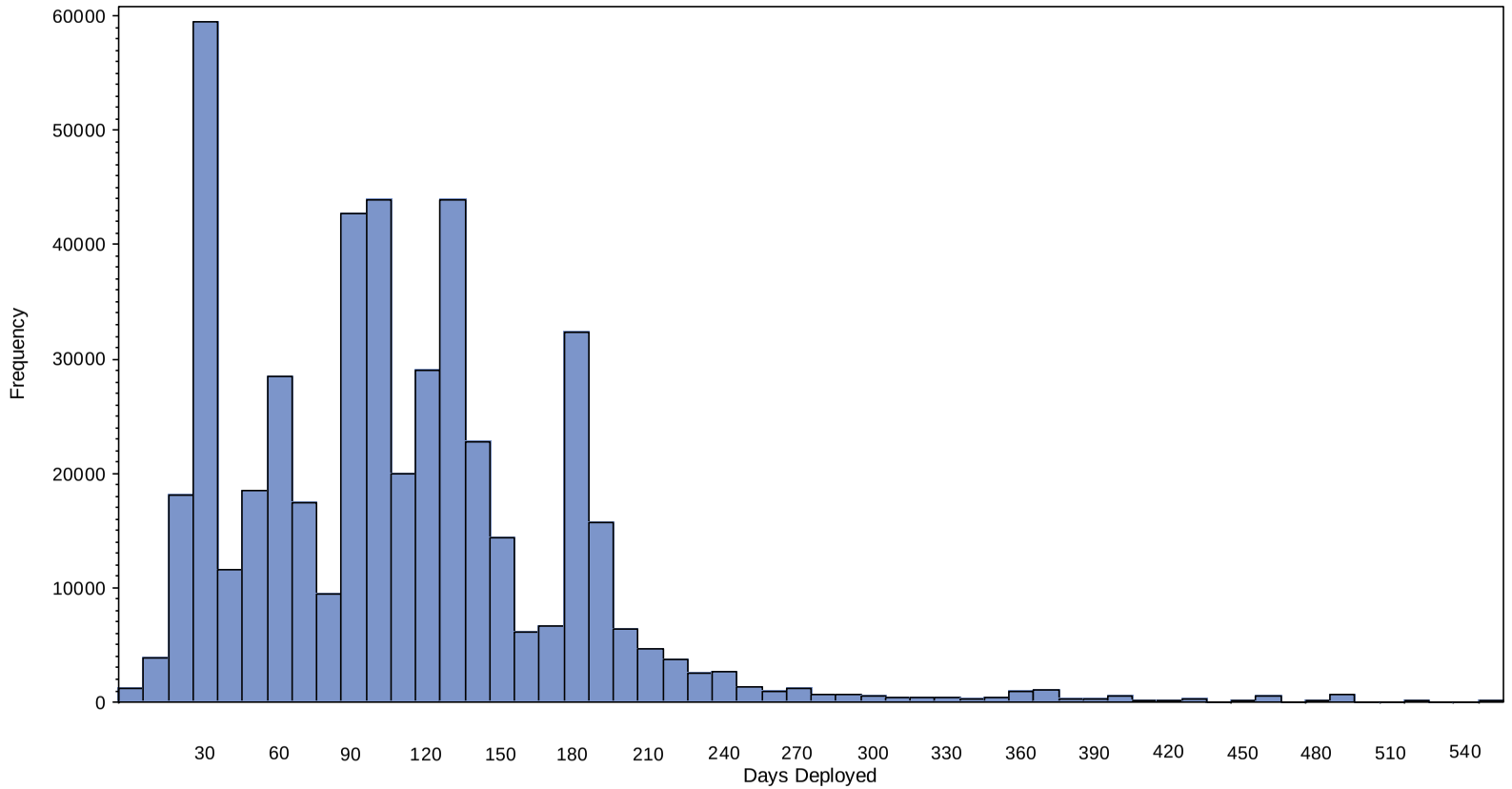
*Air Force Specialty Code (AFSC) used as a proxy for occupation

The data was assessed using Statistical Analysis Software (SAS) version 9.2 (13). Frequency tables have been used to examine the distribution of each variable and determine general characteristics (i.e., number of observations, percentage, mean, median, standard deviation, percentage missing, range, quartiles, minimum/maximum, skewness, and kurtosis as applicable) for each variable as well as evaluate the data for outliers. All variables are categorical except for length of deployment and length in operational phase.

One variable containing outliers is length of deployment. For all observations, the mean is 110.32 days (standard deviation = 78.21) with a spread of 1 - 1,753 days and a range of 1,752 days. The median is 100 days. The skewness is 3.29 with a kurtosis of 26.65. Length of deployment is skewed toward the right and is multi-modal. The longest deployment is 1,753 days (over 4 years) is

definitely an outlier. While it is possible that this individual was deployed for 4 years to the Middle East, the deployment would not be classified as a deployment and likely be considered a permanent change of assignment. Figure 3 illustrates length of deployment with days deployed rounded to the nearest 10 days and deployments over 18 months excluded (N = 1644).

Figure 3. Length of deployment for Air Force members deployed in support of Operations Iraqi and Enduring Freedom, 11 September 2001 through 31 October 2006.



3.8. Effect Measure Modification/Confounding

Covariates for this analysis were determined through previous literature review and availability of data. Potential covariates include age, sex, rank, Air Force Specialty Code, race, ethnicity, and previous deployment. A crude bivariate analysis was conducted for each exposure and outcome (component status and non-battle injury; operational phase and non-battle psychiatric illness).

Effect measure modifiers were assessed by examining incidence rate ratios and chi-square homogeneity tests. Stratum-specific rates and 95% confidence intervals have been calculated for each covariate using the coding determined during data examination. Effect measure modification has been examined by confidence interval overlap and a formal test of homogeneity. My *a priori* criterion for a strong effect measure modifier is that the chi-square homogeneity p-value must be <0.10. A weak effect measure modifier could have a p value between 0.10 and 0.20.

After the assessment of effect measure modification, confounders were identified through the examination of the directed acyclic graph, bivariate analyses, and change-in-estimate calculations using incidence rates. The *a priori* criterion for confounding using a change-in-estimate calculation is a 8% change-in-estimate as well as evaluation of the incidence rate ratio with the following criteria: strong confounder ($IRR \geq 3.0$ or $IRR \leq 0.33$); possible confounder ($1.5 < IRR < 3.0$ or $0.33 < IRR < 0.67$); or unlikely confounder ($0.67 \leq IRR \leq 1.5$).

3.9. Data Analysis

Once the data had been cleaned and restructured with the appropriate coding of covariates, the data was analyzed in SAS 9.2 (13) using a variety of techniques. Each specific aim was evaluated separately; however the model building and assessment for confounding and effect measure modification was similar for Specific Aims 2 and 3.

3.9.1. Overview for Specific Aim 1

Specific Aim 1 (enumerate the disease and non-battle injury rates for the Armed Forces in combat operations and operations other than war) has been accomplished through a systematic review of data available in the current literature and reported in section 1.3. Studies reporting disease and non-battle injury (DNBI) rates have been identified through the review of the current literature using the PubMed search engine located within the National Institutes of Health (NIH) using search terms disease and non-battle injury rates, DNBI, and battle injury rates. Additional articles were obtained by reviewing the references section of relevant articles. Articles were examined using the abstracts and titles to determine if a disease, non-battle, or battle injury rate would be mentioned in the article. Articles not referencing a specific disease, non-battle injury, or injury rate were excluded.

Due to differences in collection methods, operation, and service, it is difficult to provide a single baseline DNBI rate. Further investigation in this area is warranted. An additional manuscript relating this information and a summary of the systematic review will be conducted at a later date.

3.9.2. Overview for Specific Aim 2

For Specific Aim 2, the non-battle injury incidence rate was modeled using Poisson regression. Overdispersion was assessed by Pearson's chi-square statistics. Analyses were conducted using age, sex, rank, Air Force Specialty Code, race/ethnicity, and previous deployment as covariates. Data on non-battle injuries was obtained from the GEMS database. Person-years of exposure (i.e., deployment length) was obtained from the DMDC database. The GEMS and DMDC datasets were combined for this analysis for a total number of 13,575 non-battle injuries and 479,774 deployments.

The full model for the rate of non-battle injury was:

$$\text{Log (non-battle injury)} = \beta_0 + \beta_1(\text{Guard}) + \beta_2(\text{Reserve}) + \beta_3(25 - 29 \text{ years of age}) + \beta_4(30 - 34 \text{ years of age}) + \beta_5(35 - 39 \text{ years of age}) + \beta_6(40 - 44 \text{ years of age}) + \beta_7(45 + \text{ years of age}) + \beta_8(\text{Logistics AFSC}) + \beta_9(\text{Support AFSC}) + \beta_{10}(\text{Other AFSC}) + \beta_{11}(\text{NCO}) + \beta_{12}(\text{SNCO}) + \beta_{13}(\text{CGO}) + \beta_{14}(\text{FGO/GO}) + \beta_{15}(\text{Hispanic White}) + \beta_{16}(\text{Black}) + \beta_{17}(\text{Other Race/ethnicity}) + \beta_{18}(\text{Female}) + \beta_{19}(1 \text{ Previous Deployment}) + \beta_{20}(2 \text{ or more Previous Deployments}) + \beta_{21}(25-29 \text{ years of age *Guard}) + \beta_{22}(30-34 \text{ years of age *Guard}) + \beta_{23}(35-39 \text{ years of age *Guard}) + \beta_{24}(40-44 \text{ years of age *Guard}) + \beta_{25}(45+ \text{ years of age *Guard}) + \beta_{26}(\text{Logistics AFSC *Guard}) + \beta_{27}(\text{Support AFSC*Guard}) + \beta_{28}(\text{Other AFSC *Guard}) + \beta_{29}(\text{Female *Guard}) + \beta_{30}(\text{NCO *Guard}) + \beta_{31}(\text{SNCO *Guard}) + \beta_{32}(\text{CGO *Guard}) + \beta_{33}(\text{FGO/GO *Guard}) + \beta_{34}(1 \text{ Previous Deployment*Guard}) + \beta_{35}(2 \text{ or more Previous Deployments*Guard}) + \beta_{36}(25-29 \text{ years of age *Reserve}) + \beta_{37}(30-34 \text{ years of age *Reserve}) + \beta_{38}(35-39 \text{ years of age *Reserve}) + \beta_{39}(40-44 \text{ years of age *Reserve}) + \beta_{40}(45+ \text{ years of age *Reserve}) + \beta_{41}(\text{Logistics AFSC *Reserve}) + \beta_{42}(\text{Support AFSC*Reserve}) + \beta_{43}(\text{Other AFSC *Reserve}) + \beta_{44}(\text{Female *Reserve}) + \beta_{45}(\text{NCO *Reserve}) + \beta_{46}(\text{SNCO *Reserve}) + \beta_{47}(\text{CGO *Reserve}) + \beta_{48}(\text{FGO/GO *Reserve}) + \beta_{49}(1 \text{ Previous Deployment*Reserve}) + \beta_{50}(2 \text{ or more Previous Deployments*Reserve}) + \log(\text{Person-time deployed})$$

Initial analyses focused on overall rate of non-battle injuries as the outcome variable. An overall incidence rate was obtained; then the data was stratified by component (Active Duty, Guard, and Reserve) to calculate stratum-specific incidence rate measures. The incidence rate ratio was used to assess the strength of an association between the main exposure (component) and the outcome (non-battle injury). Likelihood ratio tests were used to evaluate the fit of the models with a p-value of 0.10.

The model-building strategy utilized results from preliminary analysis as well as backwards elimination with three steps: assessment of interaction, assessment of alternate coding, and assessment of confounding.

Step 1. Assessment of interaction: The full model with all the variables was compared to a reduced model with only the interaction terms removed. A likelihood ratio test was used to evaluate the null hypothesis that the interaction term should be included in the model. If the interaction term was removed from the model, then the reduced model would become the "gold standard" model for the remainder of the model building process.

Step 2. Assessment of alternate coding: Alternate coding options were included to evaluate the goodness of fit of the model for age (as a continuous variable) and rank (as a binary variable). These were evaluated using the likelihood ratio test.

Step 3. Assessment of confounding: The change in estimate procedure consisting of the calculation of |ln[CoIRR| was used to assess for confounding. Variables were sequentially removed from the model. If the removal of the variable resulted in a greater than 10% change in the incidence rate ratio for the component, the variable would be replaced in the model. The variables would be chosen to be removed and returned by selection of the variables with the lowest change in estimate.

The final model obtained after applying the model building strategy for non-battle injuries was:

Log (non-battle injury) = Log (non-battle injury) = β_0 + β_1(Guard) + β_2(Reserve) + β_3(25 - 29 years of age) + β_4(30 - 34 years of age) + β_5(35 - 39 years of age) + β_6(40 - 44 years of age) + β_7(45 + years of age) + β_8(Logistics AFSC) + β_9(Support AFSC) + β_{10}(Other AFSC) + β_{11}(1 Previous Deployment) + β_{12}(2 or more Previous Deployments) + β_{13}(25-29 years of age *Guard) + β_{14}(30-34 years of age *Guard) + β_{15}(35-39 years of age *Guard) + β_{16}(40-44 years of age *Guard) + β_{17}(45+ years of age *Guard) +β_{18}(Logistics AFSC *Guard) + β_{19}(Support AFSC*Guard) + β_{20}(Other AFSC *Guard) + β_{21}(1 Previous Deployment*Guard) + β_{22}(2 or more Previous Deployments*Guard) + β_{23}(25-29 years of age *Reserve) + β_{24}(30-34 years of age *Reserve) + β_{25}(35-39 years of age *Reserve) + β_{26}(40-44 years of age *Reserve) + β_{27}(45+ years of age *Reserve) + β_{28}(Logistics AFSC *Reserve) + β_{29}(Support AFSC*Reserve) + β_{30}(Other AFSC *Reserve) + β_{31}(1 Previous Deployment*Reserve) + β_{32}(2 or more Previous Deployments*Reserve) + log (Person-time deployed)

Effect measure modification for age, AFSC, and previous deployment was apparent in the final model for non-battle injuries. As an additional element of the analysis for non-battle injuries, tables describing the interactions for age by component and AFSC by component were created with different reference cells for comparison. Table 19 provides a list of the values used to develop the interaction tables. Tables 20 and 21 illustrates the incidence rate ratios for Guard and Reserve members compared to Active Duty members when stratified by age and AFSC while Tables 22 and 23 also compare Active Duty, Guard, and Reserve members utilizing a common reference cell (Active Duty service members ages 17-24 years employed in operations).

Table 19. Beta values used to develop interaction tables.

Final Model

	β #	β (SE)
Component Status (Exposure)		
Guard	1	-0.4885 (0.0981)
Reserve	2	-0.7404 (0.1344)
Age		
25 - 29 years	3	-0.1338 (0.0250)
30 - 34 years	4	-0.2278 (0.0310)
35 - 39 years	5	-0.3228 (0.0336)
40 - 44 years	6	-0.1196 (0.0407)
45 + years	7	-0.2077 (0.0753)
Air Force Specialty Code		
Logistics	8	0.4924 (0.0333)
Support	9	0.6907 (0.0334)
Other	10	0.3444 (0.0443)
Interaction*Component		
Guard		
Age		
25 - 29 years	11	0.2072 (0.0885)
30 - 34 years	12	0.2699 (0.0867)
35 - 39 years	13	0.3585 (0.0849)
40 - 44 years	14	0.1763 (0.0909)
45 + years	15	0.3382 (0.1084)
Air Force Specialty Code		
Logistics	16	0.1889 (0.0861)
Support	17	0.4557 (0.0870)
Other	18	0.4779 (0.1239)
Reserve		
Age		
25 - 29 years	19	-0.2621 (0.1511)
30 - 34 years	20	-0.1423 (0.1373)
35 - 39 years	21	0.0596 (0.1281)
40 - 44 years	22	0.0750 (0.1282)
45 + years	23	0.1236 (0.1433)
Air Force Specialty Code		
Logistics	24	0.6030 (0.0995)
Support	25	1.1190 (0.1032)
Other	26	0.3458 (0.1418)

Table 20. Outline of values for non-battle injuries in USAF Active Duty, Reserve, and Guard members stratified by age and AFSC.

Guard vs. Active Duty Members				
	Air Force Specialty Code			
	Operations	**Logistics**	**Support**	**Other**
	β	**β**	**β**	**β**
Age				
17 - 24 years	1	1 + 16	1 + 17	1 + 18
25 - 29 years	1 + 11	1 + 11 + 16	1 + 11 + 17	1 + 11 + 18
30 - 34 years	1 + 12	1 + 12 + 16	1 + 12 + 17	1 + 12 + 18
35 - 39 years	1 + 13	1 + 13 + 16	1 + 13 + 17	1 + 13 + 18
40 - 44 years	1 + 14	1 + 14 + 16	1 + 14 + 17	1 + 14 + 18
45 + years	1 + 15	1 + 15 + 16	1 + 15 + 17	1 + 15 + 18

Reserve vs. Active Duty Members				
	Air Force Specialty Code			
	Operations	**Logistics**	**Support**	**Other**
	β	**β**	**β**	**β**
Age				
17 - 24 years	2	2 + 24	2 + 25	2 + 26
25 - 29 years	2 + 19	2 + 19 + 24	2 + 19 + 25	2 + 19 + 26
30 - 34 years	2 + 20	2 + 20 + 24	2 + 20 + 25	2 + 20 + 26
35 - 39 years	2 + 21	2 + 21 + 24	2 + 21 + 25	2 + 21 + 26
40 - 44 years	2 + 22	2 + 22 + 24	2 + 22 + 25	2 + 22 + 26
45 + years	2 + 23	2 + 23 + 24	2 + 23 + 25	2 + 23 + 26

Table 21. Incidence rate ratios for non-battle injuries in USAF Active Duty, Reserve, and Guard members stratified by age and AFSC.

Guard vs. Active Duty Members								
	Air Force Specialty Code							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
Age								
17 - 24 years	0.61	0.51, 0.74	0.74	0.65, 0.84	0.97	0.85, 1.10	0.99	0.79, 1.24
25 - 29 years	0.75	0.62, 0.92	0.91	0.79, 1.05	1.19	1.03, 1.37	1.22	0.97, 1.52
30 - 34 years	0.80	0.67, 0.97	0.97	0.85, 1.11	1.27	1.11, 1.45	1.30	1.04, 1.62
35 - 39 years	0.88	0.73, 1.05	1.06	0.93, 1.21	1.39	1.21, 1.58	1.42	1.14, 1.76
40 - 44 years	0.73	0.60, 0.89	0.88	0.77, 1.02	1.15	0.99, 1.34	1.18	0.94, 1.48
45 + years	0.86	0.68, 1.08	1.04	0.86, 1.25	1.36	1.12, 1.64	1.39	1.08, 1.78

Reserve vs. Active Duty Members								
	Air Force Specialty Code							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
Age								
17 - 24 years	0.48	0.37, 0.62	0.87	0.70, 1.09	1.46	1.18, 1.81	0.67	0.50, 0.91
25 - 29 years	0.37	0.28, 0.48	0.67	0.53, 0.85	1.12	0.89, 1.41	0.52	0.38, 0.70
30 - 34 years	0.41	0.33, 0.52	0.76	0.62, 0.92	1.27	1.04, 1.54	0.58	0.44, 0.77
35 - 39 years	0.51	0.41, 0.62	0.93	0.78, 1.09	1.55	1.30, 1.85	0.72	0.55, 0.93
40 - 44 years	0.51	0.42, 0.63	0.94	0.80, 1.11	1.57	1.32, 1.88	0.73	0.56, 0.94
45 + years	0.54	0.42, 0.69	0.99	0.80, 1.21	1.65	1.33, 2.06	0.76	0.58, 1.01

Table 22. Outline of values for non-battle injuries in USAF Active Duty, Reserve, and Guard members stratified by age and AFSC using a common reference (Active Duty, 17 – 24 years old in Operations AFSC).

Active Duty Members				
		Air Force Specialty Code		
	Operations	**Logistics**	**Support**	**Other**
	β	**β**	**β**	**β**
Age				
17 - 24 years	REF	8	9	10
25 - 29 years	3	3 + 8	3 + 9	3 + 10
30 - 34 years	4	4 + 8	4 + 9	4 + 10
35 - 39 years	5	5 + 8	5 + 9	5 + 10
40 - 44 years	6	6 + 8	6 + 9	6 + 10
45 + years	7	7 + 8	7 + 9	7 + 10
Guard Members				
		Air Force Specialty Code		
	Operations	**Logistics**	**Support**	**Other**
	β	**β**	**β**	**B**
Age				
17 - 24 years	1	1 + 8 + 16	1 + 9 + 17	1 + 10 + 18
25 - 29 years	1 + 3 + 11	1 + 3 + 8 + 11 + 16	1 + 3 + 9 + 11 + 17	1 + 3 + 10 + 11 + 18
30 - 34 years	1 + 4 + 12	1 + 4 + 8 + 12 + 16	1 + 4 + 9 + 12 + 17	1 + 4 + 10 + 12 + 18
35 - 39 years	1 + 5 + 13	1 + 5 + 8 + 13 + 16	1 + 5 + 9 + 13 + 17	1 + 5 + 10 + 13 + 18
40 - 44 years	1 + 6 + 14	1 + 6 + 8 + 14 + 16	1 + 6 + 9 + 14 + 17	1 + 6 + 10 + 14 + 18
45 + years	1 + 7 + 15	1 + 7 + 8 + 15 + 16	1 + 7 + 9 + 15 + 17	1 + 7 + 10 + 15 + 18
Reserve Members				
		Air Force Specialty Code		
	Operations	**Logistics**	**Support**	**Other**
	β	**β**	**β**	**β**
Age				
17 - 24 years	2	2 + 8 + 24	2 + 9 + 25	2 + 10 + 26
25 - 29 years	2 + 3 + 19	2 + 3 + 8 + 19 + 24	2 + 3 + 9 + 19 + 25	2 + 3 + 10 + 19 + 26
30 - 34 years	2 + 4 + 20	2 + 4 + 8 + 20 + 24	2 + 4 + 9 + 20 + 25	2 + 4 + 10 + 20 + 26
35 - 39 years	2 + 5 + 21	2 + 5 + 8 + 21 + 24	2 + 5 + 9 + 21 + 25	2 + 5 + 10 + 21 + 26
40 - 44 years	2 + 6 + 22	2 + 6 + 8 + 22 + 24	2 + 6 + 9 + 22 + 25	2 + 6 + 10 + 22 + 26
45 + years	2 + 7 + 23	2 + 7 + 8 + 23 + 24	2 + 7 + 9 + 23 + 25	2 + 7 + 10 + 23 + 26

Table 23. Unadjusted incidence rate ratios for non-battle injuries in USAF Active Duty, Reserve, and Guard members stratified by age and AFSC using a common reference (Active Duty, 17 – 24 years old in Operations AFSC).

Active Duty Members								
	Air Force Specialty Code							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
Age								
17 - 24 years	1.00		1.64	1.53, 1.75	2.00	1.87, 2.13	1.41	1.29, 1.54
25 - 29 years	0.87	0.83, 0.92	1.43	1.32, 1.56	1.75	1.60, 1.90	1.23	1.12, 1.36
30 - 34 years	0.80	0.75, 0.85	1.30	1.19, 1.43	1.59	1.45, 1.75	1.12	1.01, 1.25
35 - 39 years	0.72	0.68, 0.77	1.18	1.08, 1.30	1.44	1.31, 1.59	1.02	0.92, 1.14
40 - 44 years	0.89	0.82, 0.96	1.45	1.30, 1.62	1.77	1.59, 1.97	1.25	1.11, 1.41
45 + years	0.81	0.70, 0.94	1.33	1.13, 1.57	1.62	1.37, 1.91	1.15	0.97, 1.36
Guard Members								
	Air Force Specialty Code							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
Age								
17 - 24 years	0.61	0.51, 0.74	1.21	1.05, 1.40	1.93	1.68, 2.22	1.40	1.12, 1.74
25 - 29 years	0.66	0.54, 0.80	1.31	1.13, 1.51	2.08	1.79, 2.41	1.50	1.20, 1.88
30 - 34 years	0.64	0.53, 0.76	1.26	1.10, 1.45	2.01	1.75, 2.31	1.46	1.17, 1.81
35 - 39 years	0.64	0.54, 0.76	1.26	1.10, 1.43	2.00	1.75, 2.28	1.45	1.17, 1.79
40 - 44 years	0.65	0.54, 0.78	1.28	1.12, 1.47	2.04	1.77, 2.35	1.48	1.19, 1.83
45 + years	0.70	0.58, 0.84	1.38	1.22, 1.57	2.20	1.92, 2.52	1.59	1.29, 1.96
Reserve Members								
	Air Force Specialty Code							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
Age								
17 - 24 years	0.48	0.37, 0.62	1.43	1.14, 1.79	2.91	2.34, 3.63	0.95	0.71, 1.28
25 - 29 years	0.32	0.25, 0.42	0.96	0.76, 1.22	1.96	1.55, 2.48	0.64	0.47, 0.87
30 - 34 years	0.33	0.26, 0.41	0.99	0.81, 1.20	2.01	1.65, 2.45	0.66	0.50, 0.86
35 - 39 years	0.37	0.30, 0.45	1.10	0.93, 1.29	2.24	1.88, 2.67	0.73	0.57, 0.94
40 - 44 years	0.46	0.37, 0.56	1.36	1.17, 1.60	2.79	2.35, 3.31	0.91	0.71, 1.17
45 + years	0.44	0.36, 0.54	1.31	1.12, 1.53	2.68	2.25, 3.19	0.87	0.69, 1.11

In order to fully explore the relationship between age and AFSC, age was modeled as linear splines with cutpoints at each of the categories. AFSC was expanded to include additional career fields (see Table 17). This alteration in coding did not significantly change the incidence rate ratios comparing Guard and Reserve members to Active Duty member (Tables 24 and 25.)

Table 24. Examination of variations in coding of age and AFSC for non-battle injury data.

	Age (Categorical)			Age (Linear Splines)			AFSC (4 Categories)			AFSC (17 Categories)		
	IRR	95% CI	CLR	IRR	95% CI	CLR	IRR	95% CI	CLR	IRR	95% CI	CLR
Guard vs. AD	1.01	0.96, 1.07	1.11	1.01	0.96, 1.06	1.10	0.97	0.92, 1.02	1.11	0.97	0.92, 1.02	1.11
Reserve vs. AD	0.77	0.72, 0.82	1.14	0.77	0.71, 0.82	1.15	0.83	0.78, 0.89	1.14	0.85	0.80, 0.91	1.14

Table 25. Adjusted incidence rate ratios for Guard and Reserve members vs. Active Duty members.

	Adjusted for Age (categorical) and AFSC (4 categories)			Adjusted for Age (linear splines) and AFSC (17 categories)			Original adjustment*			Revised adjustment**		
	IRR	95% CI	CLR	IRR	95% CI	CLR	IRR	95% CI	CLR	IRR	95% CI	CLR
Guard vs. AD	1.00	0.95, 1.06	1.12	1.00	0.95, 1.06	1.12	0.99	0.94, 1.05	1.12	0.99	0.94, 1.04	1.11
Reserve vs. AD	0.87	0.81, 0.93	1.15	0.89	0.83, 0.95	1.14	0.86	0.80, 0.93	1.16	0.88	0.82, 0.95	1.16

* Adjusted for age(categorical), previous deployment, AFSC (4 categories), race/ethnicity, and sex

** Adjusted for age (linear splines), previous deployment, AFSC (17 categories), race/ethnicity, and sex

3.9.3. Overview of Specific Aim 3

For Specific Aim 3, Poisson regression has been used to determine the overall rates of non-battle psychiatric illnesses. The buildup phase was defined as beginning on 11 September 2001 (first date of available data) and concluding on 18 March 2003. The invasion phase was defined as beginning with the first airstrike in Iraq on 19 March 2003 and concluding on 1 May 2003 with the cease of operations in Iraq declared by President George W. Bush. The first stabilization phase was defined as beginning on 2 May 2003 through the initial Iraqi elections on 31 January 2005. The second stabilization phase was defined as beginning on 1 February 2005 and concluding with the end of available data (31 October 2006).

Poisson regression was used to model the data. Overdispersion was assessed by Pearson's chi-square statistics. Analyses were conducted using age, sex, rank, Air Force Specialty Code, race/ethnicity, and previous deployment as covariates. Clinical information regarding non-battle psychiatric illnesses was obtained from the GEMS database. Person-years of exposure in each operational phase was obtained from the DMDC database. The GEMS and DMDC datasets were combined for this analysis for a total number of 1,446 non-battle psychiatric illnesses and 479,774 deployments.

When divided by operational phase (each deployment had a separate entry for each phase, even if they contributed zero person-time in that phase), the total number of observations in the final non-battle psychiatric illness dataset was 1,919,096. Once the observations in which individuals did not contribute person-time to the operational phase were removed from the dataset, the final dataset contained 625,630 observations. Time in each operational phase was calculated using an individual's start and stop dates for each deployment; the beginning and end date of the operational phase; and the date of the clinical visit. Once an individual experienced a clinical visit for a non-battle psychiatric illness during the deployment, the person-time at risk ceased.

The full model for the rate of non-battle psychiatric illness was:

Log (non-battle psychiatric illness) = β_0 + β_1(Invasion Phase) + β_2(Stabilization Phase I) + β_3(Stabilization Phase II) + β_4(Guard) + β_5(Reserve) + β_6(25 - 29 years of age) + β_7(30 - 34 years of age) + β_8(35 - 39 years of age) + β_9(40 - 44 years of age) + β_{10}(45 + years of age) + β_{11}(Logistics AFSC) + β_{12}(Support AFSC) + β_{13}(Other AFSC) + β_{14}(NCO) + β_{15}(SNCO)+ β_{16}(CGO)+ β_{17}(FGO/GO)+ β_{18}(Hispanic White) + β_{19}(Black) + β_{20}(Other Race/ethnicity) + β_{21}(Female) + β_{22}(1 Previous Deployment) + β_{23}(2 or more Previous Deployments) + β_{24}(Guard*Invasion Phase) + β_{25}(Reserve*Invasion Phase) + β_{26}(25 - 29 years of age*Invasion Phase) + β_{27}(30 - 34 years of age*Invasion Phase) + β_{28}(35 - 39 years of age*Invasion Phase) + β_{29}(40 - 44 years of age*Invasion Phase) + β_{30}(45 + years of age*Invasion Phase) + β_{31}(Logistics AFSC *Invasion Phase) + β_{32}(Support AFSC*Invasion Phase) + β_{33}(Other AFSC *Invasion Phase) + β_{34}(Female *Invasion Phase) + β_{35}(NCO *Invasion Phase) + β_{36}(SNCO *Invasion Phase) + β_{37}(CGO *Invasion Phase) + β_{38}(FGO/GO *Invasion Phase) + β_{39}(1 Previous Deployment *Invasion Phase) + β_{40}(2 or more Previous Deployments*Invasion Phase) + β_{41}(Guard*Stabilization Phase I) + β_{42}(Reserve*Stabilization Phase I) + β_{43}(25 - 29 years of age*Stabilization Phase I) + β_{44}(30 - 34 years of age*Stabilization Phase I) + β_{45}(35 - 39 years of age*Stabilization Phase I) + β_{46}(40 - 44 years of age*Stabilization Phase I) + β_{47}(45 + years of age*Stabilization Phase I) + β_{48}(Logistics AFSC *Stabilization Phase I) + β_{49}(Support AFSC*Stabilization Phase I) + β_{50}(Other AFSC *Stabilization Phase I) + β_{51}(Female *Stabilization Phase I) + β_{52}(NCO *Stabilization Phase I) + β_{53}(SNCO *Stabilization Phase I) + β_{54}(CGO *Stabilization Phase I) + β_{55}(FGO/GO *Stabilization Phase I) + β_{56}(1 Previous Deployment *Stabilization Phase I) + β_{57}(2 or more Previous Deployments*Stabilization Phase I) + β_{58}(Guard*Stabilization Phase II) + β_{59}(Reserve*Stabilization Phase II) + β_{60}(25 - 29 years of age*Stabilization Phase II) + β_{61}(30 - 34 years of age*Stabilization Phase II) + β_{62}(35 - 39 years of age*Stabilization Phase II) + β_{63}(40 - 44 years of age*Stabilization Phase II) + β_{64}(45 + years of age*Stabilization Phase II) + β_{65}(Logistics AFSC *Stabilization Phase II) + β_{66}(Support AFSC*Stabilization Phase II) + β_{67}(Other AFSC *Stabilization Phase II) + β_{68}(Female *Stabilization Phase II) + β_{69}(NCO *Stabilization Phase II) + β_{70}(SNCO *Stabilization Phase II) + β_{71}(CGO *Stabilization Phase II) + β_{72}(FGO/GO *Stabilization Phase II) + β_{73}(1 Previous Deployment *Stabilization Phase II) + β_{74}(2 or more Previous Deployments*Stabilization Phase II) + log (Person-time at risk in each phase)

The model-building strategy utilized results from preliminary analysis as well as backwards elimination with three steps: assessment of interaction, assessment of alternate coding, and assessment of confounding. The steps of this strategy have already been outlined in the overview for Specific Aim 2. Non-battle psychiatric illness was used as the outcome of interest and operational phase was the exposure of interest.

The final model obtained after applying the model building strategy for non-battle psychiatric illnesses was:

$$\text{Log (non-battle psychiatric illness)} = \beta_0 + \beta_1(\text{Invasion Phase}) + \beta_2(\text{Stabilization Phase I}) + \beta_3(\text{Stabilization Phase II}) + \beta_4(\text{25 - 29 years of age}) + \beta_5(\text{30 - 34 years of age}) + \beta_6(\text{35 - 39 years of age}) + \beta_7(\text{40 - 44 years of age}) + \beta_8(\text{45 + years of age}) + \beta_9(\text{Logistics AFSC}) + \beta_{10}(\text{Support AFSC}) + \beta_{11}(\text{Other AFSC}) + \beta_{12}(\text{NCO}) + \beta_{13}(\text{SNCO}) + \beta_{14}(\text{CGO}) + \beta_{15}(\text{FGO/GO}) + \beta_{16}(\text{Female}) + \beta_{17}(\text{1 Previous Deployment}) + \beta_{18}(\text{2 or more Previous Deployments}) + \beta_{19}(\text{Logistics AFSC *Invasion Phase}) + \beta_{20}(\text{Support AFSC*Invasion Phase}) + \beta_{21}(\text{Other AFSC *Invasion Phase}) + \beta_{22}(\text{Female *Invasion Phase}) + \beta_{23}(\text{NCO *Invasion Phase}) + \beta_{24}(\text{SNCO *Invasion Phase}) + \beta_{25}(\text{CGO *Invasion Phase}) + \beta_{26}(\text{FGO/GO *Invasion Phase}) + \beta_{27}(\text{1 Previous Deployment *Invasion Phase}) + \beta_{28}(\text{2 or more Previous Deployments*Invasion Phase}) + \beta_{29}(\text{Logistics AFSC *Stabilization Phase I}) + \beta_{30}(\text{Support AFSC*Stabilization Phase I}) + \beta_{31}(\text{Other AFSC *Stabilization Phase I}) + \beta_{32}(\text{Female *Stabilization Phase I}) + \beta_{33}(\text{NCO *Stabilization Phase I}) + \beta_{34}(\text{SNCO *Stabilization Phase I}) + \beta_{35}(\text{CGO *Stabilization Phase I}) + \beta_{36}(\text{FGO/GO *Stabilization Phase I}) + \beta_{37}(\text{1 Previous Deployment *Stabilization Phase I}) + \beta_{38}(\text{2 or more Previous Deployments*Stabilization Phase I}) + \beta_{39}(\text{Logistics AFSC *Stabilization Phase II}) + \beta_{40}(\text{Support AFSC*Stabilization Phase II}) + \beta_{41}(\text{Other AFSC *Stabilization Phase II}) + \beta_{42}(\text{Female *Stabilization Phase II}) + \beta_{43}(\text{NCO *Stabilization Phase II}) + \beta_{44}(\text{SNCO *Stabilization Phase II}) + \beta_{45}(\text{CGO *Stabilization Phase II}) + \beta_{46}(\text{FGO/GO *Stabilization Phase II}) + \beta_{47}(\text{1 Previous Deployment *Stabilization Phase II}) + \beta_{48}(\text{2 or more Previous Deployments*Stabilization Phase II}) + \log(\text{Person-time at risk in each phase})$$

The model contained interaction terms to account for effect measure modification from AFSC, sex, rank, and previous deployment as well as confounding identified through the directed acyclic graph for age and rank. The model accounted for repeated measures with an unstructured correlation matrix.

3.10. References

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CHAPTER 4

MANUSCRIPTS

4.1. Non-battle injuries in Air Force personnel deployed in support of Operation Enduring Freedom and Operation Iraqi Freedom

4.1.1. Abstract

There are substantial differences in physical training, conditioning, and medical fitness between US Air Force Guard, Reserve, and Active Duty; it has been speculated that this may lead to differences in injury rates in a deployed environment. This study examines non-battle injuries among United States Air Force members deployed during Operations Iraqi Freedom and Enduring Freedom. A cohort study of 275,843 Active Duty, Guard, and Reserve Air Force members was conducted during the period 11 September 2001 through 31 October 2006. Data on injuries were obtained from military medical surveillance systems and deployment time was obtained from Air Force manpower records. Poisson regression was used to estimate adjusted incidence rate ratios. The most common non-battle injuries were sprains and strains (53%) followed by open wounds (27%). Guard and Reserve members had a lower rate of orthopedic non-battle injuries than Active Duty members in crude analyses and after adjustment for age, previous deployment, sex, race/ethnicity, and occupation (IRR = 0.95; 95% CI = 0.89, 1.02 and IRR = 0.85; 95% CI = 0.77, 0.93). Results from this study are intended to facilitate the development of proper training and prevention programs to reduce non-battle injuries in a deployed environment.

4.1.2. Introduction

Non-battle injuries are an important source of morbidity and mortality in the armed forces, occurring while an armed forces service member is stationed in a deployed setting rather than at his/her home base. The service member is not involved in direct combat at the time of the injury. Most injuries during deployment are non-battle in nature. For example, during the first Gulf War (Operations Desert Shield and Desert Storm), non-battle injuries accounted for the majority of deaths (81%) and a high percentage (39%) of all hospital admissions (1, 2). Non-battle injuries may result from a variety of causes including: motor vehicle crashes, falls, sports/recreation, poisons/fire, machines/tools, or a pre-existing condition (3, 4). In comparison, battle-related injuries tend to be caused by gunshot wounds or shrapnel from landmines or ordinances (5-7) as well as blasts or burns (7, 8).

There has been speculation within the Armed Forces that major differences in injury and other health outcomes exist between Guard, Reserve, and Active Duty members in a deployed environment. These are assumed to result from differences in physical training & conditioning, medical fitness, and social and psychosocial issues (3). The United States Government Accountability Office (GAO) has released several reports stressing the need for studies addressing the health needs of Guard & Reserve service members in deployed environments (9 - 11).

Within the Air Force, there are major differences in mission and personnel between Active Duty, Guard, and Reserve service members. Air Force Active Duty (hereafter referred to as Active Duty) conduct the majority of the day-to-day operations for the USAF while responsibilities in a deployed environment are shared with Air National Guard and Air Force Reserve members. Reservists typically maintain a civilian occupation and perform Air Force duties on a part-time basis or as requested by the Department of Defense (12). The Air National Guard (hereafter referred to as Guard) has a two-fold mission: a federal mission to support the USAF as necessary as well as a state

mission to support the governor of the state during emergencies and other disasters, including civil unrest (13).

Once personnel are sent to a deployed environment, they are expected to support Air Force operations regardless of component status. Therefore, we expect that there would be more similarity between components in terms of exposure to occupational and non-occupational to injury hazards in the deployed environment than in the non-deployed setting. However, these men and women enter the deployed environment with different backgrounds and this plausibly could influence their incidence of non-battle injury. A study conducted by Lakhani and Fugitia among United States Army members reported that Reserve and Guard forces train for only thirty-nine days per year while Active Duty forces train for two hundred and forty days per year (14). Potentially, these variations in the length of training may lead to different incidence rates for injury.

The purpose of this study was to describe and analyze non-battle injuries in deployed United States Air Force (USAF) members by component (Active Duty, Guard, and Reserve). It was hypothesized that Guard and Reserve members would have a greater rate of non-battle injuries than Active Duty members, due to reduced pre-deployment opportunities for training and conditioning.

4.1.3. Methods

A cohort of deployed Air Force members was created using records from the Department of Defense personnel database maintained by the Defense Manpower Data Center (DMDC) through the United States Air Force School of Aerospace Medicine (USAFSAM) located in San Antonio, Texas. The cohort comprised all Air Force personnel (Active Duty, Guard, and Reserve) deployed to the Middle East in support of Operations Enduring Freedom and Iraqi Freedom from 11 September 2001 to 31 October 2006. Length of deployment and demographic information was obtained from the DMDC database. An individual was included in the analysis if they started their deployment during the study period; however they did not need to complete the deployment during this period. An

individual ceased to contribute deployment time to the study in one of three ways: the deployment ended and the individual returned to their home station; the study period ended (31 October 2006); or a competing risk occurred (i.e. death or medical evacuation from the deployed environment).

Data on non-battle injuries was obtained from medical surveillance data collected on-site at deployed locations in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006. These databases capture all medical information for the deployed Air Force population including clinical visits that occurred in the deployed environment. Data regarding injuries diagnosed during clinical visits were obtained through the Global Expeditionary Medical System (GEMS) and were coded to the International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) (15). All injuries with an assigned ICD-9-CM diagnosis code in the range 800-929 were included (Table 26). External cause of injury (E-code) is not reliably captured by this data source and therefore E-codes were not utilized in the analysis. Non-battle injuries were defined using a database indicator for combat vs. non-combat injury assigned in the clinic at the time of visit. Only the first visit for each injury episode was included. These injuries include both work-related and non-work-related events.

Severe injuries that required immediate evacuation were recorded in the TRANSCOM Regulating and Command and Control Evacuation System (TRAC2ES). There were 344 Air Force individuals medically evacuated from June 2002 through November 2006 for non-battle injuries. Of these individuals recorded in the TRAC2ES database, less than 50% had a recorded entry in GEMS. Injuries not severe enough to require immediate evacuation, but resulted in the member returning early from a deployed environment should have been included in GEMS.

In this study, Air Force Specialty Code (AFSC) was used to identify the person's assigned occupational area and skill level (16, 17). For example, an individual with the AFSC of 1N355A is a crypto linguist in the Intelligence field (Operations category) whose specialty is Middle Eastern language, specifically Arabic, at a journeyman or skilled level (16). AFSC was categorized in this study into 4 categories: Operations (e.g. aircrew operations, intelligence,

safety, weather, pilots and navigators); Logistics (e.g. aerospace maintenance, fuels, supply, vehicle management, and munitions/weapons); Support (e.g. information management, computers systems, civil engineering, services, public affairs, security forces, and mission support); and Other (e.g. medical/dental, legal, contracting, finance, and special investigations) according to standard Air Force grouping (16, 17). Each AFSC category is composed of enlisted and officers. Junior enlisted members (including airmen) tend to perform more of the physical duties while senior enlisted and officers tend to perform more administrative duties.

Table 26. ICD-9-CM codes for non-battle injuries in USAF Active Duty, Reserve, and Guard deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006. (15)

Type of Injury	ICD-9 Codes	Total Incident Injuries N (% of total)*	Incident Injuries by Component: Active Duty N (% of total)*	Guard N (% of total)*	Reserve N (% of total)*
Orthopedic injury (excluding head)					
Fractures and dislocations	805 – 839	655 (4.8)	537 (5.1)	79 (4.1)	39 (3.9)
Sprains and strains (upper limb)	840 – 842	1,408 (10.4)	1,127 (10.6)	180 (9.3)	101 (10.0)
Sprains and strains (lower limb)	843 – 845	1,733 (12.8)	1,288 (12.1)	302 (15.6)	143 (14.2)
Other sprains and strains	846 – 848	4,060 (29.9)	3,215 (30.2)	535 (27.6)	310 (30.8)
Subtotal for orthopedic injury		**7,856 (57.9)**	**6,167 (58.0)**	**1,096 (56.6)**	**593 (58.9)**
Head injury	800 – 804, 850 – 854	71 (0.5)	56 (0.5)	10 (0.5)	5 (0.5)
Open wounds					
Head and neck	870 – 874	1,384 (10.2)	943 (8.9)	272 (14.1)	169 (16.8)
Trunk	875 – 879	2,089 (15.4)	1,721 (16.2)	262 (13.5)	106 (10.5)
Upper and lower limb	880 – 887, 890 – 897	227 (1.7)	183 (1.7)	34 (1.8)	10 (1.0)
Subtotal for open wounds		**3,700 (27.3)**	**2,847 (26.8)**	**568 (29.4)**	**285 (28.3)**
Superficial injury					
Head, neck, and trunk	910 – 911, 918	676 (5.0)	550 (5.2)	76 (3.9)	50 (5.0)
Upper and lower limb	912 – 917	279 (2.1)	209 (2.0)	52 (2.7)	18 (1.8)
Other superficial injury	900 – 904, 919 – 924	838 (6.2)	677 (6.4)	114 (5.9)	47 (4.7)
Subtotal for superficial injury		**1,793 (13.2)**	**1,436 (13.5)**	**242 (12.5)**	**115 (11.4)**
Other injury (including internal injury)	860 – 869, 905 – 909, 925 – 929	155 (1.1)	127 (1.2)	19 (1.0)	9 (0.9)
Total non-battle injuries		**13,575**	**10,633**	**1,935**	**1,007**

*Total percentages may not equal 100 due to rounding

4.1.3.1. Statistical Methods

Initially, frequency tables were used to examine the distribution of each variable. Incidence rates were estimated using Poisson regression. For the non-battle injury data, all variables were modeled as categorical variables except for length of deployment, which was kept as continuous and utilized as the offset variable for the model. Additional evaluation of age included the use of linear splines with knots at each categorical cutpoint. One variable of note is AFSC, which contains values for some individuals that perform duties which are secret or classified and therefore not included in the dataset (or given a generic code). For this study, these AFSC's have been placed in the Other category. AFSC was categorized into 4 categories for general grouping. To further examine the data, AFSC was also coded into more specific categories to reflect individual career fields.

The data were also stratified by component (Active Duty, Guard, and Reserve) to calculate stratum-specific incidence rate measures. This model was also used to explore effect-measure modification and control for relevant covariates. Overdispersion was assessed by Pearson's chi-square statistic; however the data showed no evidence of overdispersion. Length of deployment was used as a measure of person-time at risk. A single individual could be deployed multiple times and sustain multiple injuries per deployment. For analysis, an individual deployment was considered as an observation with the number of non-battle injuries summed over the length of the deployment. Previous deployment reflects the number of the deployments that an individual has served for the current operations (i.e. after 11 September 2001).

Likelihood ratio tests were used to compare nested models using a p-value of 0.10. The covariates of age, sex, rank, Air Force Specialty Code (AFSC), race/ethnicity, and previous deployment were examined to see if they were effect measure modifiers or confounders of the association between component and injury rate. Effect measure modifiers were assessed by examining stratum-specific incidence rate ratios and using chi-square homogeneity tests. The *a priori* criterion for a strong effect measure modifier was a chi-square homogeneity p-value <0.10. After the

assessment of effect measure modification, confounders were identified through the examination of the directed acyclic graph (DAG) as well as stepwise evaluation. A model was created to account for confounding illustrated in the DAG, including adjustment for age, AFSC, previous deployment, race/ethnicity, and sex.

4.1.4. Results

4.1.4.1. Descriptive Analyses

There were a total of 275,843 individuals deployed for a total of 479,774 deployments (an individual could contribute more than one deployment to the cohort during the study period). White non-Hispanic enlisted males aged 25 - 34 years contributed most of the person-time (Table 27). Race was the variable with a high percentage of missing data in the two main datasets (approximately 6%). The missing race values did not appear to be associated with the outcome, exposure, or other covariates through direct comparison of percentage of missing values. Other variables had less than 1% missing data.

The mean length of deployment was 110 days (SD 78.21) with a minimum of 1 day and a maximum of 1,753 days. While it is possible that this individual was deployed for over 4 years to the Middle East, this would have been better classified as a permanent change of assignment. Active Duty deployments were approximately 50% longer in duration (mean length of deployment = 127 days; SD = 79.8), than Guard and Reserve deployments (mean = 80 days; SD 66.0 and 77 days; SD 61.8, respectively).

When length of deployment is examined by AFSC (as a proxy for occupation), the mean length of deployment varied between category of AFSC with Operations having the lowest mean days deployed (89.8 days with SD = 68.7 days) and Support having the highest mean days deployed (132.9 days with SD = 78.9 days. In comparison, Logistics and Other AFSC had a

mean length of deployment of 106.8 days (SD = 75.9 days) and 123.7 days (SD = 93.9 days), respectively. When each AFSC is examined by the distribution of junior enlisted vs. senior enlisted/officers, the highest percentage of junior enlisted are in the Logistics and Support categories (79% and 82%, respectively) while the Operations and Other categories have a lower percentage of junior enlisted (40% and 49%, respectively).

The total number of person-deployments experiencing a non-battle injury during a deployment was 12,598 and the total number of injuries was 13,575 (since some individuals experienced multiple injuries in a single deployment). The most common non-battle injuries were sprains and strains (53.0%) followed by open wounds (27.3%) (Table 26). When examined by length of deployment, 65.7% of the non-battle injuries occurred when an individual was deployed between 90 and 179 days. This is the typical length of an Air Force deployment with 48.3% of all Air Force deployments between 90 and 179 days. Additionally, 22.1% of all non-battle injuries occurred within the first 30 days of the deployment.

Table 27. Characteristics of USAF Active Duty, Reserve, and Guard deployments in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

	Active Duty (N = 313,816) Person-years (% of total)**	**Guard (N = 95,955) Person-years (% of total)****	**Reserve (N = 70,003) Person-years (% of total)****	**Total (N = 479,774) Person-years (% of total)****
Age				
17 - 24 years	42,306 (39)	3,106 (15)	941 (6)	46,353 (32)
25 - 29 years	26,056 (24)	2,684 (13)	1,374 (9)	30,114 (21)
30 - 34 years	16,377 (15)	3,520 (17)	2,351 (16)	22,248 (15)
35 - 39 years	14,435 (13)	4,316 (21)	3,654 (25)	22,405 (15)
40 - 44 years	7,608 (7)	3,554 (17)	3,183 (22)	14,345 (10)
45 + years	2,282 (2)	3,804 (18)	3,245 (22)	9,331 (6)
Sex				
Male	93,182 (85)	19,069 (91)	13,175 (89)	125,426 (87)
Female	15,881 (15)	1,917 (9)	1,572 (11)	19,369 (13)
Race				
White	82,673(76)	18,446 (88)	12,404 (84)	113,523 (78)
Black	16,116 (15)	1,390 (6)	1,387 (9)	18,893 (13)
Other	2,549 (2)	404 (2)	204 (1)	3,157 (2)
Missing	7,725 (7)	745 (4)	752 (5)	9,222 (6)
Ethnicity				
Hispanic	6,299 (6)	1,002 (5)	808 (5)	8,109 (6)
Non-Hispanic	101,301 (93)	19,947 (95)	13,895 (94)	135,143 (93)
Missing	1,463 (1)	36 (<0.1)	44 (<0.1)	1,543 (1)
Rank				
Officer	17,599 (16)	3,258 (16)	3,764 (26)	24,620 (17)
Enlisted	91,465 (84)	17,728 (84)	10,983 (74)	120,175 (83)
Rank (categorical)				
Airmen	44,346 (41)	3,782 (18)	1,489 (10)	49,617 (34)
Junior Enlisted (NCO)	38,524 (35)	9,134 (44)	5,950 (40)	53,608 (37)
Senior Enlisted (SNCO)	8,592 (8)	4,811 (23)	3,544 (24)	16,947 (12)
Junior Officer (CGO)	11,411 (10)	1,069 (5)	1,032 (7)	13,512 (9)
Senior Officer (FGO/GO)	6,187 (6)	2,188 (10)	2,732 (19)	11,107 (8)
Missing	4 (<0.1)	<1 (<0.1)	<1 (<0.1)	5 (<0.1)
Air Force Specialty Code				
Operations	20,088 (18)	4,482 (21)	5,837 (40)	30,406 (21)
Logistics	42,930 (40)	9,669 (46)	5,255 (36)	57,854 (40)
Support	34,965 (32)	5,633 (27)	2,072 (14)	42,670 (29)
Other	11,081 (10)	1,201 (6)	1,583 (11)	13,865 (10)
Previous Deployment				
No previous deployment	70,107 (64)	12,530 (60)	7,100 (48)	89,737 (62)
1 previous deployment	26,274 (24)	4,941 (24)	3,115 (21)	34,330 (24)
2 or more previous deployments	12,683 (12)	3,514 (17)	4,531 (31)	20,729 (14)

*Total % may not equal 100 due to rounding
**Person-years rounded to nearest whole number

4.1.4.2. Model-based Analyses

The overall unadjusted incidence rate of non-battle injuries in deployed members for the study period (2001-2006) was 93.49 non-battle injuries per 1,000 person-years deployed. When stratified by component, the unadjusted incidence rate of non-battle injuries for Active Duty members was 97.49 non-battle injuries per 1,000 person-years deployed. In comparison, the unadjusted incidence rates for Guard and Reserve members were lower (92.21 non-battle injuries per 1,000 person-years deployed and 68.29 non-battle injuries per 1,000 person-years deployed, respectively). The distribution of injuries by diagnosis was very similar between the Active Duty, Guard, and Reserve, with sprains and strains predominating (Table 26). The proportion of injuries that were open wounds of the head and neck was higher in the Reserve (17%) and Guard (14%) than in Active Duty members (9%).

This trend was reversed for open wounds of the trunk (a higher proportion in Active Duty than in Guard and Reserve).The covariates of age (at the start of the deployment), sex, AFSC, rank, race/ethnicity, and previous deployment were examined as risk factors for non-battle injury using unadjusted incidence rate ratios (IRR) (Table 28). The youngest age group had the highest rate of non-battle injury across all components; however the Guard members had much less variation in the non-battle injury rate by age than Active Duty and Reserve. In all three components, higher ranking personnel had a lower rate of non-battle injuries. The greatest variation in rate of non-battle injuries was seen in AFSC, with Logistics, Support, and Other occupations having a higher rate of injuries than Operations across all three components. In all three components, the highest rates of non-battle injury were in Support personnel, specifically in the Support Other career fields (183.6 non-battle injuries per 1,000 person-years deployed) followed by civil engineering and fuels (166.6 non-battle injuries per 1,000 person-years deployed and 138.3 non-battle injuries per 1,000 person-years deployed, respectively). More Active Duty members had previous deployment experience for Operations Iraqi and Enduring Freedom than Guard or Reserve members.

Relative to a common reference category of Active Duty service members aged 17-24 years employed in Operations, rates in Guard and Reserve were lower for all ages employed in operations (Table 29). Within the Logistics and Other occupation categories, IRRs were lower or similar in Guard and Reserve, relative to Active Duty. However, members of the Support category appeared to have a higher rate of non-battle injury relative to Active Duty in primarily Support fields.

Guard and Reserve members had similar or lower rates of orthopedic, open wound, and superficial non-battle injuries than Active Duty members (Table 30) when incidence rate ratios were adjusted for age, previous deployment, race/ethnicity, sex, and AFSC (without interaction terms). When the incidence rate ratios were adjusted for age, previous deployment, sex, race/ethnicity, and AFSC, Guard and Reserve members had a higher incidence rate of head injuries than Active Duty members, but the confidence intervals for these incidence rates are very wide as head injuries are rare. These results remained consistent when age was modeled using linear splines and AFSC was modeled using more specific categorization of career fields. When the head injuries were combined for Guard and Reserve members, the adjusted incidence rate ratio for Guard/Reserve vs. Active Duty was 1.73 with a 95% confidence interval of 0.91 to 3.28.

When the incidence rate ratio for Guard/Reserve vs. Active Duty head injuries was examined separately for effect measure modification by age and AFSC, the greatest change in the IRR occurred when age was removed from the model (AFSC only) (IRR = 0.92 with 95% CI 0.52 to 1.64) compared to removal of AFSC from the model (age only) (IRR = 1.49 with 95% CI 0.80 to 2.76). Upon stratification of head injuries by age, AFSC, and component, the highest percentage of head injuries (45%) were in Active Duty members 17 -24 years old in the Support AFSC.

Table 28. Unadjusted incidence rate ratios for non-battle injuries in USAF Active Duty, Reserve, and Guard deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

	Active Duty Members			Guard Members			Reserve Members		
	IR*	**IRR**	**95% CI**	**IR***	**IRR**	**95% CI**	**IR***	**IRR**	**95% CI**
Age									
17 - 24 years	114.5	1.00		96.6	1.00		102.0	1.00	
25 - 29 years	93.6	0.81	0.78, 0.86	96.5	1.00	0.85, 1.18	61.9	0.61	0.45, 0.81
30 - 34 years	82.9	0.72	0.68, 0.77	89.5	0.93	0.79, 1.09	57.4	0.56	0.43, 0.73
35 - 39 years	76.4	0.67	0.63, 0.71	86.6	0.90	0.77, 1.04	58.6	0.57	0.45, 0.73
40 - 44 years	92.3	0.81	0.75, 0.87	88.1	0.91	0.78, 1.07	75.1	0.74	0.58, 0.93
45 + years	81.5	0.71	0.62, 0.82	98.3	1.02	0.87, 1.18	73.4	0.72	0.57, 0.91
Sex									
Male	98.1	1.00		90.0	1.00		67.9	1.00	
Female	94.1	0.96	0.91, 1.01	114.3	1.27	1.10, 1.46	71.9	1.06	0.87, 1.29
Air Force Specialty Code									
Operations	58.3	1.00		44.0	1.00		26.7	1.00	
Logistics	99.7	1.71	1.60, 1.82	87.1	1.98	1.70, 2.31	81.4	3.05	2.54, 3.66
Support	122.3	2.09	1.96, 2.23	137.6	3.13	2.68, 3.66	162.6	6.08	5.03, 7.36
Other	81.8	1.40	1.29, 1.53	100.8	2.29	1.83, 2.88	54.3	2.03	1.56, 2.65
Rank (categorical)									
Airmen	118.7	1.00		108.4	1.00		106.8	1.00	
Junior Enlisted (NCO)	95.2	0.80	0.77, 0.84	103.9	0.96	0.86, 1.08	81.2	0.76	0.64, 0.91
Senior Enlisted (SNCO)	91.8	0.77	0.72. 0.83	85.8	0.79	0.69, 0.91	66.3	0.62	0.51, 0.76
Junior Officer (CGO)	52.0	0.44	0.40, 0.48	50.5	0.47	0.35, 0.62	35.9	0.34	0.23, 0.48
Senior Officer (FGO/GO)	51.2	0.43	0.39, 0.48	49.8	0.46	0.37, 0.57	34.0	0.32	0.25, 0.41
Race/ethnicity									
Non-Hispanic White	96.0	1.00		88.8	1.00		67.4	1.00	
Hispanic White	110.5	1.15	1.02, 1.29	124.6	1.40	1.12, 1.77	91.0	1.35	1.00, 1.82
Black	103.4	1.08	1.02, 1.13	108.6	1.22	1.04, 1.45	62.7	0.93	0.75, 1.16
Other	106.3	1.11	0.98, 1.25	108.9	1.23	0.91, 1.66	68.6	1.02	0.60, 1.73
Previous Deployment									
No previous deployment	96.9	1.00		106.5	1.00		87.2	1.00	
1 previous deployment	100.7	1.04	0.99, 1.09	76.3	0.72	0.64, 0.80	70.9	0.81	0.70, 0.95
2 or more previous deployments	93.9	0.97	0.91, 1.03	63.5	0.60	0.52, 0.69	36.9	0.42	0.34, 0.50

* Rates per 1,000 person-years deployed

Table 29. Unadjusted incidence rate ratios for non-battle injuries in USAF Active Duty, Reserve, and Guard members deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006 stratified by age and Air Force Specialty Code.

	Air Force Specialty Code							
	Active Duty							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
17 - 24 years	1.00		1.64	1.53, 1.75	2.00	1.87, 2.13	1.41	1.29, 1.54
25 - 29 years	0.87	0.83, 0.92	1.43	1.32, 1.56	1.75	1.60, 1.90	1.23	1.12, 1.36
30 - 34 years	0.80	0.75, 0.85	1.30	1.19, 1.43	1.59	1.45, 1.75	1.12	1.01, 1.25
35 - 39 years	0.72	0.68, 0.77	1.18	1.08, 1.30	1.44	1.31, 1.59	1.02	0.92, 1.14
40 - 44 years	0.89	0.82, 0.96	1.45	1.30, 1.62	1.77	1.59, 1.97	1.25	1.11, 1.41
45 + years	0.81	0.70, 0.94	1.33	1.13, 1.57	1.62	1.37, 1.91	1.15	0.97, 1.36
	Guard							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
17 - 24 years	0.61	0.51, 0.74	1.21	1.05, 1.40	1.93	1.68, 2.22	1.40	1.12, 1.74
25 - 29 years	0.66	0.54, 0.80	1.31	1.13, 1.51	2.08	1.79, 2.41	1.50	1.20, 1.88
30 - 34 years	0.64	0.53, 0.76	1.26	1.10, 1.45	2.01	1.75, 2.31	1.46	1.17, 1.81
35 - 39 years	0.64	0.54, 0.76	1.26	1.10, 1.43	2.00	1.75, 2.28	1.45	1.17, 1.79
40 - 44 years	0.65	0.54, 0.78	1.28	1.12, 1.47	2.04	1.77, 2.35	1.48	1.19, 1.83
45 + years	0.70	0.58, 0.84	1.38	1.22, 1.57	2.20	1.92, 2.52	1.59	1.29, 1.96
	Reserve							
	Operations		**Logistics**		**Support**		**Other**	
	IRR*	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**	**IRR***	**95% CI**
17 - 24 years	0.48	0.37, 0.62	1.43	1.14, 1.79	2.91	2.34, 3.63	0.95	0.71, 1.28
25 - 29 years	0.32	0.25, 0.42	0.96	0.76, 1.22	1.96	1.55, 2.48	0.64	0.47, 0.87
30 - 34 years	0.33	0.26, 0.41	0.99	0.81, 1.20	2.01	1.65, 2.45	0.66	0.50, 0.86
35 - 39 years	0.37	0.30, 0.45	1.10	0.93, 1.29	2.24	1.88, 2.67	0.73	0.57, 0.94
40 - 44 years	0.46	0.37, 0.56	1.36	1.17, 1.60	2.79	2.35, 3.31	0.91	0.71, 1.17
45 + years	0.44	0.36, 0.54	1.31	1.12, 1.53	2.68	2.25, 3.19	0.87	0.69, 1.11

*Compared to Active Duty, age 17 – 24 years in operations AFSC

Table 30. Incidence rates and rate ratios for deployed Air Force members among Guard and Reserve members compared to Active Duty members, USAF members deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

Type of Injury	Active Duty IR*	Guard IR*	Reserve IR*	Guard vs. Active Duty				Reserve vs. Active Duty			
				Unadjusted IRR	95% CI	Adjusted IRR**	95% CI	Unadjusted IRR	95% CI	Adjusted IRR**	95% CI
Orthopedic Injury (excluding head)											
Fractures and dislocations	4.92	3.76	2.64	0.76	0.60, 0.97	0.95	0.73, 1.23	0.54	0.39, 0.75	0.91	0.64, 1.29
Sprains and strains (upper limb)	10.33	8.58	6.85	0.83	0.71, 0.97	0.88	0.74, 1.05	0.66	0.54, 0.81	0.86	0.68, 1.07
Sprains and strains (lower limb)	11.81	14.39	9.70	1.22	1.08, 1.38	1.31	1.14, 1.51	0.82	0.69, 0.97	1.06	0.87, 1.28
Other sprains and strains	29.48	25.49	21.02	0.86	0.79, 0.95	0.84	0.76, 0.93	0.71	0.63, 0.80	0.77	0.67, 0.87
Subtotal	**56.55**	**52.22**	**40.21**	**0.92**	**0.87, 0.98**	**0.95**	**0.89, 1.02**	**0.71**	**0.65, 0.77**	**0.85**	**0.77, 0.93**
Head Injury	0.51	0.48	0.34	0.93	0.47, 1.82	1.72	0.84, 3.52	0.66	0.26, 1.65	1.76	0.65, 4.78
Open Wounds											
Head and neck	8.65	12.96	11.46	1.50	1.31, 1.72	1.18	1.02, 1.38	1.33	1.13, 1.56	1.04	0.86, 1.25
Trunk	15.78	12.49	7.19	0.79	0.69, 0.90	0.94	0.82, 1.09	0.46	0.37, 0.55	0.72	0.58, 0.89
Upper and lower limb	1.68	1.62	0.68	0.97	0.67, 1.39	1.37	0.92, 2.03	0.40	0.21, 0.76	0.79	0.40, 1.60
Subtotal	**26.10**	**27.07**	**19.33**	**1.04**	**0.95, 1.13**	**1.05**	**0.95, 1.16**	**0.74**	**0.66, 0.84**	**0.87**	**0.76, 1.00**
Superficial Injury											
Head, neck, and trunk	5.04	3.62	3.39	0.72	0.57, 0.91	0.84	0.65, 1.10	0.67	0.50, 0.90	0.94	0.68, 1.30
Upper and lower limb	1.92	2.48	1.22	1.29	0.95, 1.75	1.35	0.97, 1.89	0.64	0.39, 1.03	0.80	0.48, 1.36
Other superficial injury	6.21	5.43	3.19	0.88	0.72, 1.07	1.13	0.91, 1.40	0.51	0.38, 0.69	0.88	0.64, 1.21
Subtotal	**13.17**	**11.53**	**7.80**	**0.88**	**0.76, 1.00**	**1.05**	**0.91, 1.22**	**0.59**	**0.50, 0.72**	**0.89**	**0.72, 1.10**
Other Injury (including internal injury)	1.16	0.91	0.61	0.78	0.48, 1.26	0.87	0.50, 1.50	0.52	0.27, 1.03	0.85	0.39, 1.83
Total Non-battle Injuries	**97.49**	**92.21**	**68.29**	**0.95**	**0.90, 0.99**	**0.99**	**0.94, 1.05**	**0.70**	**0.66, 0.75**	**0.86**	**0.80, 0.93**

*Rates per 1,000 person-years deployed

** Adjusted for age, previous deployment, AFSC, race/ethnicity, and sex

4.1.5. Discussion

While troops have to function as a combined unit, it is important to identify possible differences in injury rates between component, since these differences may suggest potential improvements in training and preparation. We hypothesized that Guard and Reserve members would have a greater rate of non-battle injuries than Active Duty members, since Active Duty members are immersed in military training and physical fitness on a daily basis while Guard and Reserve members may only train a few days a month and thus may have lower physical conditioning and skills preparation.

When adjusted for age and AFSC, Guard and Reserve members tended to have similar or lower rates of non-battle injuries than Active Duty members for younger military members (less than 30 years old); however, older Guard and Reserve members had higher incidence rates than Active Duty members, especially in the Support AFSC. It is possible that these members have a lower level of physical fitness or training that makes them different than Active Duty members in the same age range. When age is stratified by AFSC, the Logistics and Support AFSC tend to have higher percentages of younger members (17-24 years), than the Operations and Other AFSC (47% and 34% compared with 13% and 6%, respectively). This confounding was addressed in the model that adjusted for age, previous deployment, AFSC, race/ethnicity, and sex.

Active Duty and Guard members had a similar rate of non-battle injuries; however, it is difficult to determine a complete explanation for the lower rate of non-battle injuries in Reserve members. One limitation of this study is the lack of data pertaining to the event directly prior to the injury or the cause of the injury. It is possible that Active Duty and Guard members participate in higher-risk work activities and/or are more likely to participate in strenuous physical fitness activities, such as football or basketball. Overall, the Active Duty members tend to be younger (by approximately ten years); however, lower rates were still evident after adjustment for age. The Reserve has a higher percentage of officers than the Active Duty and

Guard, so it is possible that Reserve members are performing duties that are less likely to have the potential for an occupational injury.

This study did not have data directly pertaining to an individual's combat experience and potential to be directly involved in a combat situation. There may be the presence of differential misclassification if one component is more likely to be involved in combat that may result in an injury, especially if the injury has been miscoded as a non-battle injury. It would be useful to include medical evacuations and battle injuries for further description of all injuries that occur in a deployed environment. Additionally, it would be useful to better define the cultural & behavioral differences between Active Duty, Guard, and Reserve members and how these impact injury rates. It would also be useful to examine non-battle injuries across the other armed services to see if this finding is true for all services.

The occupational tasks performed during deployment differed between the three components. Reserve members accumulated a lower percentage of person-time in the Support category (14% compared to 27% and 32% for Guard and Active Duty respectively; Table 27). Interestingly, this is the only AFSC category in which both Guard and Reserve had higher rates of non-battle injury than Active Duty (Table 28). It is possible improvements in training could better prepare Guard and Reserve for Support tasks, which include tasks that may be more physically demanding and have a greater potential for on-duty injuries, such as civil engineering, security forces, and mission support. It is also important to remember that some non-battle injuries occur off-duty and thus are not related to the service member's work tasks. The proportion of non-battle injuries that are off-duty was not available from this data source and are not yet available in the current data sources.

While current research and media coverage has focused on combat-related injuries in deployed troops, Air Force members are more likely to experience non-battle injuries in a deployed environment. According to the most recent statistics for casualties from the Defense Manpower Data Center, the number of Air Force members killed in action for Operation Iraqi Freedom through 31 October 2009 is 29 and the number of Air Force members wounded in action is 427 (18). The

number of Air Force members killed in action for Operation Enduring Freedom through 31 October 2009 is 20 and the number of individuals wounded in action is 117 (18). In comparison, this study determined that deployed Air Force members experienced 13,575 non-battle injuries between 11 September 2001 and 31 October 2006.

An area of recent research interest is traumatic brain injury and other consequences of head injuries that are occurring in deployed military members, particularly in troops most likely to be involved in combat operations (Army and Marines). Recently published studies have estimated the number of head injuries sustained by Army and Marines involved in combat range from 2% to 51% , depending on the cohort and analysis utilized for the study (19 -22). In comparison, less than 1% of the non-battle injuries in this study were head injuries. It is difficult to determine if this lower percentage was due to difference in services (Air Force vs. Army/Marines) or the environment in which the head injury was sustained (combat vs. non-combat).

There were wide variations in the incidence rates for Air Force members when comparing the components by type of non-battle injury (Table 30). The recognition of this variation can be very important in regards to long-term care. An orthopedic or head injury may require additional care once an individual returns from a deployed environment. An Active Duty member returns to their home station, where their medical care is covered directly by the military system (TRICARE); however 180 days after the return from deployment, a Guard or Reserve member is no longer eligible for full TRICARE coverage and they become subject to private insurance or health care through the Veterans Affairs system (23).

While injuries reduce combat readiness in a deployed environment, they can also ultimately impact the cost of Veterans Affairs (VA) health care. An individual who returns from a deployment with an injury or illness faces the possibility that they may not be able to continue their service in the Armed Forces as a result of this illness or injury, regardless of their component. This individual may be subject to a disability package using the Veterans Affairs Schedule for Rating Disabilities which may vary according to the severity of the injury or illness (24). A large number of injuries in

deployed personnel can produce a strain on the already over-crowded VA system as well as generate an enormous cost to society for the care of the individual throughout their lifetime.

4.1.6. Conclusions

There are various risk factors that affect non-battle injuries that occur during deployment. Despite an expectation that Guard & Reserve would be less well-prepared for the physical demands of deployment, their non-battle injury rates are in fact lower than Active Duty. Additional research into the relationship between injury rates and military components is warranted as non-battle injuries continue to represent a significant health risk to deployed military members and can affect mission readiness.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

4.1.7. References

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4.2. Non-battle non-drug psychiatric illnesses in Air Force members deployed in support of Operation Iraqi Freedom and Enduring Freedom, 11 September 2001 – 31 October 2006.

4.2.1. Abstract

Recent studies have focused on posttraumatic stress disorder (PTSD), among members of the US military as a result of combat and/or deployment in the Gulf War; however, little is known about the incidence of other psychiatric illness in the deployed setting. A cohort study was conducted to examine non-battle psychiatric illness in deployed Air Force members during various operational phases relating to Operations Iraqi and Enduring Freedom, including buildup, invasion, and stabilization after the invasion of Iraq and Afghanistan from 11 September 2001 through 31 October 2006. Poisson regression was utilized to estimate the association between the incidence of non-battle non-drug psychiatric illness and operational phase. A total of 1,112 cases were identified during the study period. The incidence of non-battle non-drug psychiatric illness steadily increased as the operation progressed with the invasion (IRR = 1.54, 95% CI = 1.06, 2.23), primary stabilization phase (IRR = 2.63, 95% CI = 2.16, 3.19), and secondary stabilization phase (IRR = 3.71; 95% CI = 3.06, 4.50) relative to the incidence rate during the buildup phase; however, the differences were not significant. Incidence rates were higher among females, junior officers, and Reserve members. Screening programs have been implemented to identify members returning from deployment with mental health concerns; however, it is important to identify acute and chronic stressors that impact deployed military members and find ways to encourage health-care seeking and treatment for mental health illnesses in the deployed setting.

4.2.2. Introduction

Combat stressors (i.e. life-threatening events) and non-combat stressors (i.e. separation from family) have been found to lead to the development of psychiatric illnesses among deployed service men and women (1 - 4). Recent studies have focused on posttraumatic stress disorder (PTSD), especially in reference to the Gulf War, as a result of combat and/or deployment (1 - 18), but few studies have examined other psychiatric illnesses that may occur in a deployed environment in military members. These psychiatric illnesses may include schizophrenic disorders, mood disorders, delusional disorders, personality disorders, drug or alcohol dependence, adjustment reaction, sleep disorders, and depression (19).

Military personnel in a deployed setting are exposed to a range of acute and chronic stressors. Acute stressors may include situations in which the deployed member receives bad news from home (death of a family member or termination of a marriage), experiences the loss of a friend or colleague at the deployed setting, or is directly involved in a battle situation. Chronic stressors may include financial strain, marriage/personal problems, heightened emotional state from expected or actual combat, and tension within the deployed unit. The majority of Air Force members who participate in a deployment will not likely experience direct combat; however all deployed members will experience stress related to the threat of potential combat. Screening programs have been implemented by the Department of Defense (DOD) to identify psychiatric illness in members as they return from a deployed environment; however screening programs for psychiatric illness and stressors in the deployed environment are not consistently utilized.

Deployed bases usually increase their operational tempo during times of change (i.e. political milestones). Therefore, there is likely to be greater stress and possible risk for injury or illness during certain time periods. The purpose of this study was to examine non-battle psychiatric illness in deployed Air Force members during various operational phases relating to Operations Iraqi and Enduring Freedom. The study population was all Air Force members deployed in support of

Operation Iraqi Freedom and Operation Enduring Freedom between 11 September 2001 and 31 October 2006. The study focused on demographic differences between deployed individuals and the association between non-battle psychiatric illness and different operational phases using available clinical information. Data on timing of specific individual stressors such as training, personal issues, separation from family, and financial burden were not available for this study. It was hypothesized that the incidence of non-battle psychiatric illnesses would be higher in the later operational phases of Operations Iraqi Freedom and Enduring Freedom, as stressors associated with the threat of improvised explosive devices (IEDs) and other hazards have increased over the course of the occupation.

4.2.3. Methods

This cohort study used clinical and personnel data collected on-site at deployed locations in support of Operation Iraqi Freedom and Operation Enduring Freedom from 11 September 2001 through 31 October 2006. Data regarding psychiatric illnesses diagnosed during clinical visits were obtained through the Global Expeditionary Medical System (GEMS) data system, a patient tracking system used by all Air Force clinics in the Middle East. Outpatient visits were entered into the electronic interface in the deployed environment and then batched together to be sent electronically to a central storage location in the United States for additional analysis and storage. Additional personnel data on deployment dates and deployed location (i.e. time at risk or denominator data) were obtained through the Defense Manpower Data Center (DMDC). Both GEMS and DMDC data were provided by the United States Air Force School of Aerospace Medicine (USAFSAM).

It is complex to distinguish battle-related psychiatric diagnoses from non-battle psychiatric diagnoses. In the interest of comparability with other DOD-initiated research, this study utilized the International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) codes to distinguish battle from non-battle psychiatric diagnoses (19). For the

purposes of this study, non-battle psychiatric illness were defined according to DOD standards as ICD-9-CM codes in range 295-307, 311-319, V11, V15.4, V40.0-40.3, V40.9, V62.85, V65.49, and E950-959 with corresponding decimals. In addition to DOD standard codes for non-battle psychiatric illness, this study also included codes 290, 293-294, 310, and 780.Use of all the included ICD-9-CM codes attempted to include individuals that experienced anxiety, depression, suicide events, sleep disorders, or other psychiatric illnesses during the deployment. In comparison, the ICD-9-CM codes used to designate combat or operational stress reaction are 308 (acute reaction to stress) and 309 (adjustment reaction) (with corresponding decimals). For reference, posttraumatic stress disorder is coded using the ICD-9-CM code 309.81. These individuals were not included in the analysis. Additional members were given various V codes for counseling purposes. Unless previously specified, these codes were not included in the analysis.

Using military and political milestones and dates of data available for this study, four operational phases were designated for Operations Iraqi Freedom and Enduring Freedom (Table 31).

Table 31. Operational phases for Operations Iraqi Freedom and Enduring Freedom.

Phase	Duration	Length (days)
Buildup	11 September 2001 - 18 March 2003	554
Invasion	19 March 2003 - 1 May 2003	44
Stabilization Phase I	2 May 2003 - 31 January 2005	641
Stabilization Phase II	1 February 2005 - 31 October 2006	637

We elected to characterize the buildup phase as beginning on 11 September 2001 and concluding on 18 March 2003 and the invasion phase beginning with the first airstrike in Iraq on 19 March 2003 and concluding on 1 May 2003 with the declaration of the end of combat operations by President George W. Bush. We also decided to define two stabilization phases: the first stabilization phase from 2 May 2003 through the initial Iraqi elections on 31 January 2005,

and the second stabilization phase from 1 February 2005 through the last date from which data was available (31 October 2006).

To be included in this study, an individual must have been a member of the United States Air Force who was deployed during the study period, 11 September 2001 and 31 October 2006. An individual did not need to complete the deployment during the study period. Additionally an individual must not have been less than 17 years of age or older than 65 years of age at the start of the deployment. Pregnant women are not allowed to serve in a deployed environment, and thus, they are not included in this study.

Time at risk in each operational phase was calculated using an individual's beginning and end dates for each deployment; the beginning and end date of the operational phase; and the date of the clinical visit (if any) for non-battle psychiatric illnesses. The day of the clinical visit was counted as a half day, since the exact time of the clinical visit is unknown. An individual could contribute time at risk in more than one phase during a single deployment, however once an individual experienced a clinical visit for a non-battle psychiatric illness during that deployment, they were considered to have sustained the outcome of interest and therefore ceased to contribute person-time at risk during that deployment. An individual could contribute additional person-time at risk to the study if they experienced multiple deployments during the study period; however they could only contribute one clinical visit per deployment.

4.2.3.1. Statistical Methods

Poisson regression was used to model the incidence of non-battle psychiatric illness by operational phase. Overdispersion was assessed using Pearson's chi-square statistic. Age, sex, rank, Air Force Specialty Code (AFSC), race/ethnicity, and previous deployment were coded as categorical variables and examined as model covariates. Air Force Specialty Code was used as a proxy for occupation and was coded into 4 major categories. Previous deployment was utilized to indicate a

previous deployment for the current operations (after 11 September 2001). Initial analyses focused on modeling the overall rate of non-battle psychiatric illnesses. Once an overall incidence rate was obtained, the data were stratified by operational phase to calculate stratum-specific incidence rates. An incidence rate ratio was used to compare the phases with the buildup phase as the reference. Likelihood ratio tests were used to evaluate the fit of the models.

The analysis began with creation of a directed acyclic graph (DAG) to identify potential confounders through the literature review (20). Effect measure modification was then examined by confidence interval overlap and a Wald test of homogeneity using a p-value of <0.10 to identify variables that would be treated as modifiers. Additional confounders were then identified through bivariate analyses and change-in-estimate calculations using incidence rate ratios and an *a priori* criterion of a 10% change-in-estimate. The DAG identified rank and age as potential confounders. AFSC, previous deployment, sex, and rank were identified as potential effect measure modifiers. Confidence limit ratios (CLR) using the upper limit of the 95% confidence interval divided by the lower limit were calculated as an estimate of precision (21).

Individuals who experienced multiple deployments contributed data on each deployment. The GEE Poisson model with an unstructured working correlation matrix was used to account for these "repeat" observations. Although an individual could contribute more than one deployment during the study period, they could only contribute one non-battle psychiatric illness per deployment.

4.2.4. Results

The total number of psychiatric illnesses for the study period was 3,452; however, only 1,446 met the criteria for non-battle psychiatric illnesses (Figure 4). Additionally, 334 individuals were given an ICD-9 code relating to tobacco use disorder (305.1), nondependent abuse of drugs (305.0), or alcohol or drug induced mental disorders (291-292). For the majority of these members, it is difficult to determine if these individuals actually experienced tobacco use disorder or if the code was

used as an indication that the individual was a smoker or participated in a smoking cessation program. For the remainder of the analysis, only those non-abusive drug related non-battle psychiatric illnesses were utilized (N = 1,112). Table 32 provides a description of the non-battle non-drug psychiatric illnesses included in the analysis.

A total of 275,843 individuals were deployed during the study period for a total of 479,774 deployments; however, once individuals experiencing a combat psychiatric illness or other counseling were excluded the total number of individuals deployed was 274,535 with 477,434 deployments. Table 33 provides the characteristics of all individuals deployed as well as person-time contributed during each operational phase. Young (17-24 years) Active Duty non-Hispanic white enlisted males accounted for the majority of the person-time at risk. The risk of non-battle non-drug psychiatric illness was 1 psychiatric illness per 435 deployments.

Younger age groups had a higher incidence of non-battle non-drug psychiatric illness while senior officers and senior enlisted members had a lower incidence of non-battle non-drug psychiatric illness (Table 34); however, the differences were not significant. Personnel with two or more previous deployments during this study period had a higher incidence of non-battle non-drug psychiatric illness, relative to those with only one (or no) previous deployments. Women had a higher incidence of non-battle non-drug psychiatric illness than males and Reserve members had a higher incidence of non-battle non-drug psychiatric illness than Active Duty or Guard members.

The incidence rate of non-battle non-drug psychiatric illness increased with each level of operational phase (Table 35). When compared with the buildup phase, the invasion phase and both stabilization phases had a higher incidence of non-battle non-drug psychiatric illness. This effect of the highest incidence in the second stabilization phase was consistent across all demographic subgroups (Table 36). Females consistently had a higher incidence of non-battle non-drug psychiatric illness than males across all operational phases. Personnel with two or more deployments had a higher incidence rate in the first stabilization phase when compared to the buildup phase.

Figure 4. Flow chart for psychiatric illness data for 11 September 2001 through 31 October 2006.

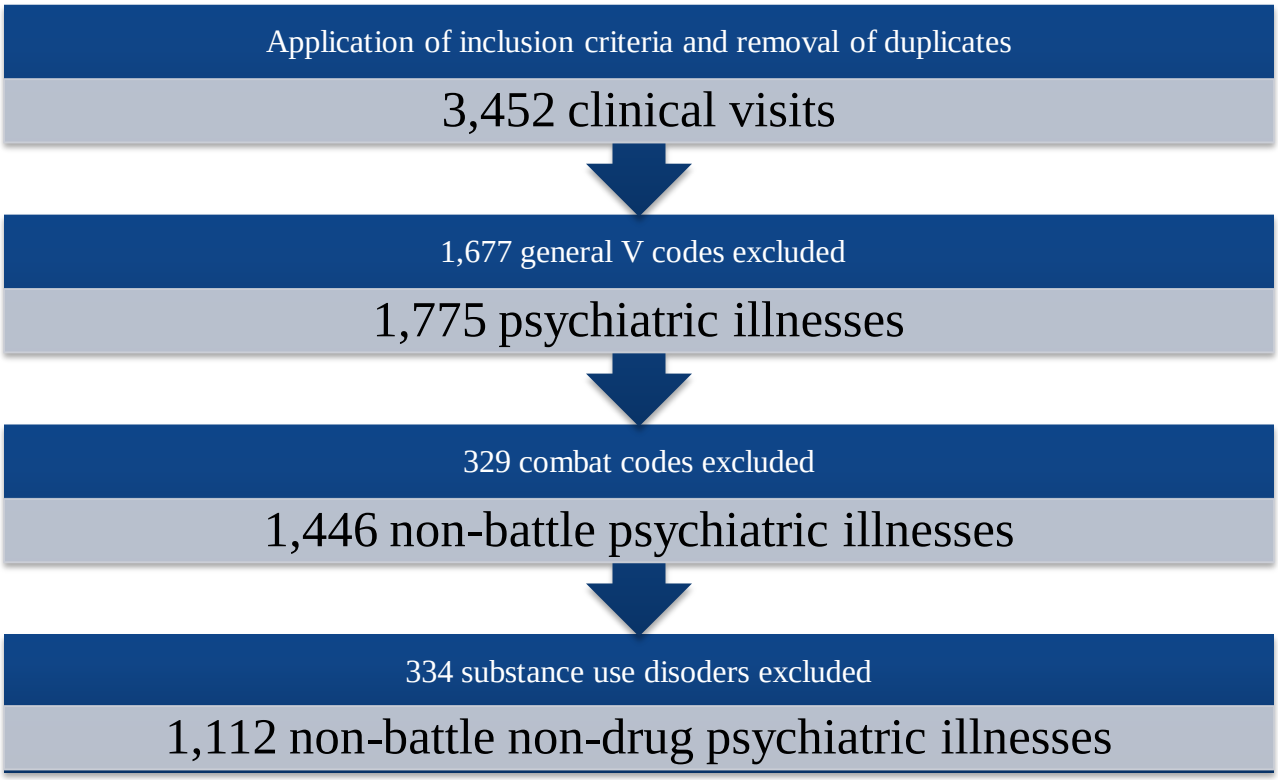

Table 32. ICD-9-CM codes for non-battle non-drug psychiatric illnesses in United States Air Force members deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006. (19)

ICD-9-CM Code	Description	Non-Battle Non-Drug Psychiatric Illnesses	Operational Phase			
			Buildup	Invasion	Stabilization I	Stabilization II
		N (% of total)*	N (% of total)*	N (% of total)*	N (% of total)*	N (% of total)*
290	Dementias	1 (0.09)	0	1 (2.86)	0	0
293 – 294	Mental disorders not elsewhere classified	2 (0.18)	1 (0.76)	0	0	1 (0.20)
295	Schizophrenic diseases	0	---	---	---	---
296	Episodic mood disorders	0	---	---	---	---
297	Delusional disorders	0	---	---	---	---
298 – 299	Other nonorganic psychoses	0	---	---	---	---
300	Anxiety, dissociative, and somatoform disorders	0	---	---	---	---
301 – 302	Personality and sexual/gender identity disorders	0	---	---	---	---
306 – 307	Other physiological malfunction or symptoms	0	---	---	---	---
310	Specific mental disorders due to brain damage	9 (0.81)	2 (1.53)	0	4 (0.88)	3 (0.61)
311	Depressive disorder	205 (18.44)	16 (12.21)	8 (22.86)	79 (17.40)	102 (20.73)
312 – 316	Disturbance of conduct or emotions	0	---	---	---	---
317 – 319	Mental retardation	0	---	---	---	---
780.1	Hallucinations	1 (0.09)	0	0	1 (0.22)	0
780.39	Convulsions	7 (0.63)	0	2 (5.71)	3 (0.66)	2 (0.41)
780.5	Sleep disturbances	880 (79.14)	112 (85.50)	20 (57.14)	365 (80.40)	383 (77.85)
V11	Personal history of mental disorder	0	---	---	---	---
V15.4	Psychological trauma	0	---	---	---	---
V40.0 - 40.3, V40.9	Mental and behavioral problems	2 (0.18)	0	1 (2.86)	1 (0.22)	0
V62.85	Other psychosocial circumstances	0	---	---	---	---
E950 - 959	Suicide and self-inflicted injury	5 (0.45)	0	3 (8.57)	1 (0.22)	1 (0.20)
Total		**1,112**	**131**	**35**	**454**	**492**

*Total percentage may not equal 100 due to rounding

Table 33. Characteristics of United States Air Force individuals deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

		Operational Phase			
		Buildup	**Invasion**	**Stabilization I**	**Stabilization II**
	All deployed individuals (N = 274,535)	**Person-years at risk**	**Person-years at risk**	**Person-years at risk**	**Person-years at risk**
	N (% of total)*	**(% of total)****	**(% of total)****	**(% of total)****	**(% of total)****
Age					
17 - 24 years	93,393 (34)	12,543 (31)	2,076 (29)	17,192 (32)	14,014 (34)
25 - 29 years	52,720 (19)	8,258 (20)	1,416 (20)	10,828 (20)	9,280 (22)
30 - 34 years	40,287 (15)	6,822 (17)	1,154 (16)	8,001 (15)	6,063 (15)
35 - 39 years	42,027 (15)	6,932 (17)	1,222 (17)	8,428 (16)	5,618 (14)
40 - 44 years	26,897 (10)	3,858 (9)	755 (11)	5,670 (11)	3,980 (10)
45 + years	19,211 (7)	2,475 (6)	490 (7)	3,862 (7)	2,449 (6)
Component					
Active Duty	195,865 (71)	30,748 (75)	5,020 (71)	39,092 (72)	32,983 (80)
Guard	50,852 (19)	6,420 (16)	1,378 (19)	8,455 (16)	4,606 (11)
Reserve	27,818 (10)	3,719 (9)	714 (10)	6,435 (12)	3,815 (9)
Sex					
Male	234,784 (86)	35,708 (87)	6,247 (88)	46,705 (87)	35,614 (86)
Female	39,751 (15)	5,179 (13)	865 (12)	7,277 (13)	5,789 (14)
Race/ethnicity					
Non-Hispanic White	207,588 (76)	31,451 (77)	5,530 (78)	40,520 (75)	30,477 (74)
Hispanic	7,026 (3)	804 (2)	152 (2)	1,479 (3)	1,248 (3)
Black	35,642 (13)	5,422 (13)	847 (12)	7,095 (13)	5,342 (13)
Other	5,440 (2)	138 (0.34)	69 (1)	1,258 (2)	1,671 (4)
Missing	18,839 (7)	3,073 (8)	514 (7)	3,630 (7)	2,665 (6)
Rank					
Officer	44,954 (16)	6,499 (16)	1,273 (18)	9,503 (18)	7,166 (17)
Enlisted	229,581 (84)	34,388 (84)	5,839 (82)	44,479 (82)	34,237 (83)
Rank					
Airmen	102,908 (37)	13,915 (34)	2,214 (31)	18,084 (34)	14,825 (36)
Junior Enlisted (NCO)	94,899 (35)	15,625 (38)	2,726 (38)	19,834 (37)	14,867 (36)
Senior Enlisted (SNCO)	31,766 (12)	4,846 (12)	899 (13)	6,560 (12)	4,545 (11)
Junior Officer (CGO)	25,346 (9)	3,669 (9)	662 (9)	4,943 (9)	4,131 (10)
Senior Officer (FGO/GO)	19,605 (7)	2,828 (7)	611 (9)	4,560 (8)	3,035 (7)
Missing	11 (<0.01)	3 (0.01)	0 (<0.01)	1 (<0.01)	0 (<0.01)
Air Force Specialty Code					
Operations	49,838 (18)	8,377 (20)	1,606 (23)	11,737 (22)	8,555 (20)
Logistics	117,435 (43)	16,641 (41)	3,061 (43)	21,847 (40)	15,742 (38)
Support	78,270 (29)	12,052 (29)	1,725 (24)	15,071 (28)	13,358 (32)
Other	28,992 (11)	3,817 (9)	721 (10)	5,328 (10)	3,849 (9)

*Total % may not equal 100 due to rounding

**Person-years rounded to nearest whole number

Table 34. Unadjusted incidence rate ratios for non-battle non-drug psychiatric illnesses in United States Air Force members deployed in support of Operations Iraqi Freedom and Enduring Freedom from 11 September 2001 to 31 October 2006.

	All Air Force deployments (N = 477,434)			
	N	**IR***	**Unadjusted IRR**	**95% CI**
Age				
17 - 24 years	397	8.64	1.00	
25 - 29 years	266	8.91	1.03	0.73, 1.46
30 - 34 years	166	7.51	0.87	0.58, 1.30
35 - 39 years	142	6.37	0.74	0.48, 1.13
40 - 44 years	81	5.67	0.65	0.38, 1.11
45 + years	60	6.46	0.75	0.41, 1.37
Component				
Active Duty	845	7.81	1.00	
Guard	146	7.00	0.90	0.61, 1.32
Reserve	121	8.24	1.06	0.69, 1.61
Sex				
Male	895	7.19	1.00	
Female	217	11.31	1.58	1.14, 2.19
Air Force Specialty Code				
Operations	285	9.44	1.00	
Logistics	383	6.67	0.71	0.51, 0.99
Support	311	7.35	0.78	0.55, 1.10
Other	133	9.65	1.03	0.66, 1.60
Rank				
Airmen	425	8.64	1.00	
Junior Enlisted (NCO)	379	7.12	0.82	0.61, 1.12
Senior Enlisted (SNCO)	75	4.45	0.51	0.30, 0.87
Junior Officer (CGO)	142	10.58	1.22	0.81, 1.86
Senior Officer (FGO/GO)	91	8.24	0.95	0.58, 1.57
Race/ethnicity				
Non-Hispanic White	877	8.10	1.00	
Hispanic White	27	7.31	0.90	0.39, 2.08
Black	116	6.18	0.76	0.49, 1.16
Other	21	6.70	0.83	0.32, 2.13
Missing	71	--		
Previous Deployment				
No previous deployment	631	7.08	1.00	
1 previous deployment	255	7.49	1.06	0.78, 1.44
2 or more previous deployments	226	11.00	1.55	1.12, 2.14

* Rates per 1,000 person-years deployed based on length of deployment or time to clinical visit

Table 35. Incidence rate ratios for deployed Air Force members between operational phases for non-battle non-drug psychiatric illnesses using GEE Poisson model.

		Unadjusted			Adjusted**		
Phase	IR*	IRR	95% CI	CLR	IRR	95% CI	CLR
Buildup	3.2	1.00			1.00		
Invasion	4.9	1.54	1.06, 2.23	2.10	1.54	1.06, 2.23	2.10
Stabilization I	8.4	2.63	2.16, 3.19	1.48	2.58	2.12, 3.13	1.48
Stabilization II	11.9	3.71	3.06, 4.50	1.47	3.54	2.90, 4.32	1.49

* Rates per 1,000 person-years deployed based on length of deployment or time to clinical visit
**Adjusted for Air Force Specialty Code (occupation), age, previous deployment, rank, and sex

Table 36. Unadjusted incidence rate ratios for deployed Air Force members by operational phase.

	Buildup Phase				Invasion Phase				Stabilization Phase I				Stabilization Phase II			
	N	IR*	IRR**	95% CI	N	IR*	IRR**	95% CI	N	IR*	IRR**	95% CI	N	IR*	IRR**	95% CI
Age																
17 - 24 years	41	3.5	1.00	(ref)	18	5.5	1.55	1.07, 2.25	156	9.3	2.63	2.16, 3.19	182	13.0	3.67	3.03, 4.45
25 - 29 years	28	3.6	1.03	0.88, 1.21	5	5.6	1.60	1.07, 2.39	94	9.6	2.71	2.11, 3.48	139	13.4	3.79	2.96, 4.85
30 - 34 years	19	3.2	0.91	0.76, 1.09	8	4.9	1.40	0.93, 2.12	66	8.4	2.38	1.82, 3.11	73	11.7	3.32	2.54, 4.34
35 - 39 years	24	2.8	0.78	0.64, 0.94	3	4.3	--		58	7.2	2.05	1.56, 2.70	57	10.1	2.86	2.17, 3.77
40 - 44 years	11	2.3	0.66	0.52, 0.84	1	3.6	--		47	6.2	1.75	1.28, 2.37	22	8.6	2.44	1.79, 3.31
45 + years	8	2.7	0.76	0.58, 1.00	0		--		33	7.1	2.00	1.43, 2.78	19	9.8	2.79	1.99, 3.89
Component																
Active Duty	106	3.2	1.00	(ref)	33	4.9	1.54	1.06, 2.23	306	8.4	2.62	2.16, 3.18	400	11.9	3.70	3.05, 4.49
Guard	13	3.1	0.95	0.80, 1.14	2	4.7	--		75	8.0	2.49	1.92, 3.24	56	11.3	3.52	2.70, 4.60
Reserve	12	3.4	1.05	0.87, 1.27	0		--		73	8.9	2.76	2.11, 3.61	36	12.5	3.89	2.97, 5.11
Sex																
Male	110	3.1	1.00	(ref)	27	4.3	1.40	0.92, 2.14	372	8.0	2.59	2.09, 3.20	386	10.8	3.52	2.85, 4.35
Female	21	4.1	1.32	0.83, 2.10	8	9.3	3.00	1.47, 6.16	82	11.3	3.66	2.75, 4.87	106	18.3	5.94	4.55, 7.76
Air Force Specialty Code																
Operations	24	2.9	1.00	(ref)	2	1.2	--		161	13.7	4.79	3.12, 7.35	98	11.6	4.05	2.60, 6.32
Logistics	45	2.7	0.94	0.58, 1.55	10	3.3	1.14	0.55, 2.38	138	6.3	2.20	1.43, 3.40	190	12.1	4.21	2.76, 6.44
Support	50	4.1	1.45	0.89, 2.36	16	9.3	3.24	1.72, 6.10	112	7.4	2.59	1.67, 4.03	133	10.0	3.48	2.25, 5.37
Other	12	3.1	1.10	0.55, 2.19	7	9.7	3.39	1.46, 7.87	43	8.1	2.82	1.71, 4.64	71	18.4	6.44	4.05, 10.23
Rank																
Airmen	50	3.6	1.00	(ref)	19	8.6	2.39	1.41, 4.05	155	8.6	2.39	1.73, 3.28	201	13.6	3.77	2.77, 5.14
Junior Enlisted (NCO)	49	3.1	0.87	0.59, 1.29	14	5.1	1.43	0.79, 2.59	142	7.2	1.99	1.44, 2.75	174	11.7	3.26	2.38, 4.46
Senior Enlisted (SNCO)	11	2.3	0.63	0.33, 1.21	0		--		32	4.9	1.36	0.87, 2.12	32	7.0	1.96	1.26, 3.05
Junior Officer (CGO)	10	2.7	0.76	0.38, 1.50	1	1.5	--		64	12.9	3.60	2.49, 5.22	67	16.2	4.51	3.13, 6.51
Senior Officer (FGO/GO)	11	3.9	1.08	0.56, 2.08	1	1.6	--		61	13.4	3.72	2.56, 5.41	18	5.9	1.65	0.96, 2.83
Race/ethnicity																
Non-Hispanic White	101	3.3	1.00	(ref)	22	5.0	1.51	1.03, 2.24	373	9.0	2.69	2.20, 3.29	381	12.5	3.75	3.07, 4.59
Hispanic White	1	2.8	--		1	4.2	--		12	7.5	2.25	1.46, 3.46	13	10.4	3.14	2.04,4.82
Black	19	2.5	0.76	0.63, 0.92	9	3.8	1.15	0.74, 1.78	41	6.8	2.05	1.55, 2.70	47	9.5	2.85	2.16, 3.77
Other	0		--		0		--		4	5.7	--		17	8.0	2.39	1.50, 3.81
Missing	10		--		3		--		24		--		34		--	
Previous Deployment																
No previous deployment	112	3.3	1.00	(ref)	25	5.3	1.58	1.02, 2.44	237	7.7	2.32	1.85, 2.90	257	13.0	3.92	3.14, 4.88
1 previous deployment	16	2.9	0.87	0.51, 1.46	10	5.1	1.53	0.80, 2.92	105	7.0	2.11	1.62, 2.74	124	10.8	3.25	2.52, 4.19
2 or more previous deployments	3	1.3	--		0		--		112	13.5	4.04	3.11, 5.24	111	10.8	3.25	2.51, 4.23

* Rates per 1,000 person-years deployed based on time at risk in each phase

**The first listed category during the buildup phase is the common reference within each covariate. For N < 5, an IRR was not calculated.

4.2.5. Discussion

This study examined non-battle non-drug psychiatric illness (principally sleep disorders) in Air Force personnel deployed in support of Operations Iraqi and Enduring Freedom. The incidence of these conditions increased in all demographic subgroups with increasing operational phase. We hypothesized that acute and chronic stressors were more prevalent in the later phases of this campaign, as hazards such as IEDs increased, domestic support waned, and insurgent resistance became more organized and sophisticated.

The prevalence of mental illness in the United States is estimated to be 26% for any occurrence over a 12-month period (22, 23); with prevalence estimates of 5.3% for major depressive disorder (24) and at least 10% for sleep disorders in the United States (25). In comparison, an estimated 6% of the 1.4 million members of the Armed Forces were provided outpatient treatment for an incident mental disorder during roughly the same time period (2003) (26). This difference is due in part to a healthy worker effect. Military members are clinically screened for mental illness prior to entry into military service as well as deployment.

The DOD has implemented screening programs for identifying psychiatric illnesses in members returning from a deployment (4, 9, 27); however these programs have not been fully implemented within the deployed environment. In a study examining one screening program of returning Army and Marine members, it was determined that approximately 19.1% of individuals serving in Iraq as well as 11.3% of members serving in Afghanistan reported a mental health concern upon return from deployment, likely related to experiences in a combat setting (4). A recent commentary by Matthew J. Friedman suggested that PTSD has been reported in 15.6 to 17.1 % of members returning from Operations Iraqi Freedom and Enduring Freedom (5). The majority of studies conducted for the current operations as well as past conflicts, notably the Vietnam and Persian Gulf Wars, have focused on risk factors for combat-related psychiatric illness rather than non-battle psychiatric illness (1 - 9, 11 - 18, 22, 27 - 48). Clearly incidence rates for those illnesses appear to be

much lower in the deployed setting; however, it is probable that the field diagnoses represent more severe illness. The use of deployed medical surveillance systems has allowed for the greater and more consistent collection of data within the deployed setting. This information was not available for prior conflicts or was only available in limited amounts. While improvements in the amount and quality of medical data in a deployed setting have been made, there are still some limitations in the data, stemming from the nature of psychiatric illness.

The rate of non-battle psychiatric illness was expected to be higher in the invasion phase than the buildup or stabilization phases. However, the invasion phase encompasses less time than the other three phases. It is possible that individuals may have postponed clinical visits of less severe illnesses until after the invasion phase was complete. Additionally, members may not seek mental health care in a deployed environment due to various reasons, most commonly due to social stigmas, perceived impact on career, effect on the unit, and impact on relationships with peers (1, 5, 6, 48). This lack of mental health care seeking behavior may result in underreporting of psychiatric illnesses in a deployed environment.

A sensitivity analysis was conducted to evaluate the possibility of potential changes in psychiatric illness ICD-9-CM coding practices and underreporting of psychiatric illness that may have occurred as the operations progressed. Assuming that all diagnoses for non-battle non-drug psychiatric illnesses were truly psychiatric illness (specificity of 100%), substantial bias would have to be present in order for the observed elevations in the rate ratio to be spurious, i.e., completely due to bias alone. Specifically, if the true (unobserved) rate ratios were null (1.0) then the underreporting of non-battle non-drug psychiatric illness (1-sensitivity) would have to have been greater than 35% higher in the invasion phase, 62% higher in the first stabilization phase, and 73% higher in the second stabilization phase when compared with the buildup phase in order to generate the observed rate ratios. Temporal variations in the under-reporting of such magnitude are implausible.

Additionally, it is unusual that this database did not include any members that were diagnosed with anxiety or other mood disorders. It is difficult to determine if individuals did not experience

these diagnoses in the deployed setting, the providers miscoded the clinical visit within GEMS, or there is data missing from the GEMS database. The high number of individuals that sought medical care who only received a general counseling (V code) may represent miscoding of more severe psychiatric illness. In many Air Force clinics in the deployed setting, individuals seeking care are seen by a general medical practitioner that may not be fully trained in recognizing psychiatric illness. In order to fully examine these issues, the data from GEMS could be compared with an alternate data source for quality control. If an alternate source is not readily available, the data within GEMS could be evaluated by examining clinical diagnoses by individual provider to determine if difference between providers existed.

For this study, the date of the clinical visit was used as a proxy for the date the non-battle psychiatric illness occurred. This date may be fairly accurate for immediate events such as an injury; however, it may not be a good proxy for non-battle psychiatric illness. These illnesses tend to be chronic in nature and may not have begun at a time close to the clinical date; however the clinical date may indicate a time in which the illness became severe enough to warrant medical care.

There is potential for bias relating to a prior illness. A prior illness can be directly related to the current illness. This study included only those non-battle non-drug psychiatric illnesses diagnosed while the service member was located in the deployed environment. Therefore, psychiatric illnesses diagnosed after the service member returned to their home station were not included in the dataset. If an individual sustained a non-battle non-drug psychiatric illness on a deployment and did not seek medical care during the deployment itself, then the information would not have been captured by the data sources utilized for this study and the incidence would have been underreported. Additionally, an individual may have had a pre-existing psychiatric condition that was exacerbated by stressors in the deployed event and subsequently resulted in the member seeking medical care.

While battle-related psychiatric illness have been shown to be associated with acute and chronic stressors, non-battle psychiatric illnesses are likely also related to both acute and chronic

stressors of deployment; thus it is important to describe non-battle psychiatric illness as well as battle-related psychiatric illness. This notion is supported by our finding that incidence of non-battle non-drug psychiatric illness increased with operational phase. This study found that 0.23% of Air Force deployments resulted in a non-battle non-drug psychiatric illness diagnosis in the deployed setting. This study was limited to only psychiatric illnesses classified as "non-battle" by the Department of Defense. Data relating to "battle" psychiatric illnesses including PTSD, acute reaction to stress, combat fatigue, and adjustment reaction/depressive disorder related to combat, were not available for this study.

A potential future study design would be a longitudinal data analysis connecting pre-deployment, deployment, and post-deployment information. This study would require linkage of several military databases and would be useful for establishing a timeline of injury/illness occurrence as well as incorporating several risk factors that are missing in the databases available for this study, such as experience of perceived threat, difficult living and working environment, lack of preparedness for deployment, separation from family/friends, financial burden, and substance abuse. Additionally, it would be helpful to examine the occurrence and diagnosis of psychiatric illness in a deployed setting as a result of acute and chronic stressors, which may differ between individuals as well as deployment locations. Given the evidence presented here of an increasing rate over time, these is a clear need for both ongoing monitoring and for more detailed longitudinal analyses.

4.2.6. Conclusions

The incidence of non-battle non-drug psychiatric illness was observed to increase with increasing duration of operation. This effect was observed in all demographic subgroups. It is vital to continue to monitor the mental health of deployed military members as the current conflict continues. It is important to conduct research to identify risk factors in non-battle military members

to better focus prevention programs and provide better assistance to the military members while located in the deployed environment.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

4.2.7. References

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CHAPTER 5

CONCLUSIONS

5.1. Relevant Issues

While this dissertation focused exclusively on military members in a deployed environment, civilians are also present in deployed settings working in conjunction with the military to accomplish the goals of the Department of Defense (DOD). Civilians are primarily employed in occupations such as security, contracting, civil engineering, and food services. Few studies have been completed to examine the physical and psychological effects of deployment on contractors and civilian personnel. A study conducted by Feinstein and Botes found that approximately 10% of civilian contractors that choose to work in a combat environment may be experiencing psychological problems (1). Currently, the DOD does not routinely collect medical surveillance data on civilians that support military operations in a deployed environment. It would be useful to collect this data to fully understand the injuries and illnesses sustained by these civilians to provide treatment and support to civilians when they return to their home environment as well as enhance military research.

Civilians working in a deployed environment could also be utilized as a comparison group to deployed members as well as provide additional generalizability to the analysis performed in this dissertation. Additionally, civilian members and military members that participate in natural and man-made disaster response efforts can also be utilized as a comparison group. These individuals provide assistance in emergency situations that often involve unexpected hazards and unpredictable risks, potentially similar to soldier's experiences in a combat zone. While these response workers may not be involved in a "battle" situation, there is

the potential for injuries and psychiatric illness to occur as a result of the acute stress of the situation that may persist for years after the event. Several studies have been conducted examining the injury and illness rate in individuals that have participated in the response and recovery efforts for the bombing of the World Trade Center in 2001 and the flooding as a result of Hurricane Katrina in 2005 (2-5). Two of these studies indicated that stress-related illnesses continued to occur up to a year after the initial event (2, 5). These findings are similar to long-term psychological studies in the military and may reflect the need for additional follow-up care for individuals who have participated in a traumatic situation such as war or a disaster (6, 7).

This research found that the overall incidence rate for non-battle injuries in a deployed environment for the study period (11 September 2001through 31 October 2006) was 93.49 non-battle injuries per 1,000 person-years deployed. If examined by gender, the overall incidence of non-battle injuries for females was 31.04 non-battle injuries per 1,000 persons and 27.91 non-battle injuries per 1,000 persons deployed for males. In comparison, civilian rates of injuries for females and males with a similar age range (17-65 years) for 2001 through 2006 were 86.50 injuries per 1,000 persons and 111.94 injuries per 1,000 persons, respectively (8). The injury incidence rates by gender are considerably lower than civilian rates for a similar time period. When examined by age, the civilian rates are also higher than non-battle injury rates for the deployed Air Force members for the similar time period (Table 37); however the trend is similar for deployed Air Force and United States civilians with younger ages (17-24 years) having a higher incidence of injuries (i.e. the incidence of injuries decreases by age).

Table 37. Comparison of incidence rates of injuries for deployed Air Force members and United States civilians for 2001 through 2006.

	Deployed Air Force **IR****	United States Civilian* **IR****
Age		
17 - 24 years	38.78	146.22
25 - 29 years	28.98	124.42
30 - 34 years	23.93	109.61
35 - 39 years	21.46	102.16
40 - 44 years	23.30	91.92
45 + years	19.75	69.32

*Calculated using WISQARS (8)
**Incidence rate per 1,000 persons

These rates are not directly comparable, due to a slight difference in the dates of the data. The CDC WISQARS data includes the entire calendar years of 2001 and 2006, while this research only includes a portion of 2001 and 2006. Additionally, the WISQARS data includes all causes of injury while this research includes those injuries that were captured in the GEMS system. For example, the WISQARS system includes intentional injuries, such as homicide and suicide. The GEMS data for the Air Force would capture this data if an intentional injury occurred at the deployed setting; however relatively few events have been reported in the GEMS system.

To fully describe the outcomes associated with the GEMS data system, it would be ideal to determine the exact percentage of deployed injuries that are non-battle in nature. The primary investigator was not able to access data related to combat injuries from the GEMS data system for this research; however, it has been estimated by the Defense Manpower Data Center that the number of Air Force members wounded in action for Operations Iraqi and Enduring Freedom from 7 October 2001 through 31 October 2009 is 544 (9). If the data is averaged by year, approximately 340 combat injuries occurred in Air Force members for the study period (11 September 2001 through 31 October 2006). This is a rough estimate and does not account for potential changes in combat during this time period (i.e. invasion phase vs. war phase vs. stabilization phases). When compared with the number of non-battle injuries reported in GEMS, approximately 98% of the injuries experienced by deployed Air Force members were non-battle injuries.

For the study period, 329 individuals were coded with a combat or operational stress psychiatric disorder (ICD-9-CM codes 308 or 309, with corresponding decimals). The total number of non-battle psychiatric illnesses reported through the GEMS system is 1,446 (including drug-use and tobacco-use disorders). Approximately 81% of the psychiatric illnesses reported in GEMS are non-battle. However, this number is probably prone to underreporting bias. Many individuals may wait until their return home from a deployed environment to seek help for a psychiatric illness or decide not to seek help at all. Care-seeking behavior is likely influenced by the perceived stigmas previously discussed that may occur in the military as a result of seeking mental health care (i.e. impact on career or unit).

Given the joint nature of Operations Iraqi and Enduring Freedom, the Air Force is not the only branch of the DOD that has been providing manpower to support these operations. Members of the Army, Navy (including Coast Guard), and Marine Corps have been instrumental in maintaining operations in the Middle East, especially the Army and Marines who are more likely to be directly involved in combat operations. According to the Defense Manpower Data Center, the number of casualties has been the highest for the Army, followed by the Marine Corps (10). A comparison of casualties for the different DOD branches is found in Table 38.

Table 38. DOD casualties for Operations Iraqi Freedom and Enduring Freedom by branch of service.(10)

	Operation Iraqi Freedom*			Operation Enduring Freedom**		
	Killed in Action	Non-hostile Deaths	Wounded in Action	Killed in Action	Non-hostile Deaths	Wounded in Action
Army	2,526	676	22,067	558	189	4,057
Air Force	29	22	444	23	23	142
Navy	65	38	635	35	21	104
Marine Corps	851	171	8,624	135	42	1,207
Total	**3,471**	**907**	**31,770**	**751**	**275**	**5,510**

*Estimated from 19 March 2003 through 3 April 2010
**Estimated from 7 October 2001 through 3 April 2010

Deployed members from these branches are susceptible to non-battle injuries in a manner similar to the Air Force. While comparable data from clinical records for the other DOD branches was not available for this research, medical evacuation statistics have been published by the Defense Manpower Data Center. A summary of these events has been included in Table 39.

Table 39. DOD medical evacuations for Operations Iraqi Freedom and Enduring Freedom by branch of service. (10)

	Operation Iraqi Freedom*			Operation Enduring Freedom**		
	Battle Injury	Non-battle Injury	Disease/Other	Battle Injury	Non-battle Injury	Disease/Other
Army	6,677	7,885	24,281	1,528	1,691	5,279
Air Force	97	471	1,472	62	297	1,000
Navy	162	381	1,045	52	134	329
Marine Corps	1,974	1,306	2,004	396	255	441
Total	**8,910**	**10,043**	**28,802**	**2,038**	**2,377**	**7,049**

*Estimated from 19 March 2003 through 3 April 2010
**Estimated from 7 October 2001 through 3 April 2010

Using the above data, the number of casualties and evacuations for Air Force members can be estimated (Table 40). These numbers do not take into account changes in the operations that may have resulted in an increase or decrease in combat deaths or injuries (i.e. invasion phase vs. stabilization phase). Using the medical evacuation database (TRAC2ES), it can be estimated that approximately 57% of those injuries requiring a medical evacuation were not entered into GEMS prior to evacuation from the deployed setting. Given this estimate, approximately 298 of the non-battle injuries requiring medical evacuation were not included in the GEMS data and thus were not included in the analysis. The medical evacuation data does not expressly identify psychiatric illness, so a comparison rate for non-battle psychiatric illness is not able to be determined.

Table 40. Estimated Air Force casualties and medical evacuations for the study period, 11 September 2001 through 31 October 2006 using the Defense Manpower Data Center casualty/evacuation data.

	Killed in Action	Non-hostile Deaths	Wounded in Action	Battle Injury	Non-battle Injury	Disease/Other
Air Force	35	30	410	108	523	1,679

Current research for injuries sustained by deployed military members has focused on combat injuries, particularly combat injuries experienced by members of the Army and Marine Corps (11 – 22). Non-battle injuries have not been extensively studied for the current operations; although they have been included in several descriptive studies of combat injuries (17 - 19) or described in select populations such as at a single combat hospital (23), a convenience sample of deployed Navy personnel (24), and a sample of deployed soldiers returning home through select airport terminals (25). Several peer-review journals have devoted entire issues to injuries relevant to deployed military members, specifically The Journal of Head Trauma Rehabilitation (traumatic brain injury) (26) and the American Journal of Preventive Medicine (27, 28). Further research is needed for the examination of the mechanisms of non-battle injuries in the deployed environment, not only in Air Force members, but all branches of the DOD.

Military research for psychiatric illness has examined mental health care and combat-related stress for the current operations in the Middle East, predominantly among deployed Army soldiers that have returned to their home base (6, 29-36). Other research has focused on the mechanisms of psychiatric illness as a result of combat stressors (37, 38). This research is vital to support deployed military members in order to assist them in returning to their home environment, as well as assist with mental health issues that may arise as a result of their experiences in a combat environment. It is also essential to conduct research and develop prevention programs for those individuals who are deployed to a "non-combat" environment. These individuals may also

experience acute and chronic stressors in the deployed environment and benefit from mental health care and support systems as well.

5.2. Realization of Specific Aims

Specific Aim 1 (enumerate the disease and non-battle injury rates for the Armed Forces in combat operations and operations other than war) was accomplished by a literature search that gathered all the DNBI rates available in the published literature and was included in Chapter 1 of this dissertation. Rates were variable between operations due to difference in the service studied (Army, Air Force, Marines, or Navy) and the data collection method. Due to these differences, a baseline summary rate was not provided. This chapter will form the basis for future research and a forthcoming manuscript.

Specific Aim 2 (describe and analyze non-battle injuries in deployed Air Force members by component (Active Duty, Guard, and Reserve)) was accomplished through extensive data analysis including Poisson regression modeling. Non-battle injuries were examined by component as well as specific type of injury (orthopedic, head, open wounds, etc.). The results indicated that overall Guard members had a similar rate of non-battle injuries and Reserve members had lower rates of non-battle injury, relative to Active Duty members. The results of this specific aim have been incorporated into a manuscript (Chapter 4) that will be submitted for publication.

Specific Aim 3 (describe the association between non-battle psychiatric illnesses in all deployed Air Force members and current operational phases) was also accomplished through Poisson regression modeling and data analysis. The rate of non-battle psychiatric illnesses was modeled using operational phase as the exposure variable. When compared to the buildup phase, the invasion phase and stabilization phases had higher incidence rates of non-battle psychiatric illness. The results of

the third specific aim have also been written up in manuscript form (Chapter 4) and will be submitted to a peer-reviewed journal for publication.

5.3. Strengths

This study includes a complete cohort. The personnel database essentially has 100% capture of person-time for deployed Air Force members. This database provided the denominator data for this study. All Air Force members are closely monitored to ensure that the mission can be properly completed and day-to-day operations are fulfilled. This data may not accurately reflect the time that an individual serves in a combat zone vs. a non-combat zone; however the strict definition of combat exposure vs. non-combat exposure in a deployed setting is questionable. A military member in the deployed setting has the potential for combat at any time; therefore it may not be necessary to strictly account for time in a combat environment vs. time in a non-combat environment.

The numerator data used for this study has been evaluated using a validation study. This validation study of GEMS data indicated >98% overall accuracy for the GEMS software (39). While technical difficulties prohibited the complete capture of clinical data for the later months of 2006 (November and December), it is plausible that the clinical data is complete for the remainder of the study period.

This dataset has a low percentage of missing variables. All variables had less than 1% of their values missing, with the exception of race (6% missing). Race (combined with ethnicity) was not found to be in an effect measure modifier or confounder in either the non-battle injury or non-battle psychiatric illness analysis; therefore the vast majority of the observations (over 99%) in each data were able to be utilized for modeling and analysis.

5.4. Limitations

This study population is exclusively Air Force and contains all members who have deployed in support of operations in the Middle East for the proposed time period. One important aspect of the study population is that they have been pre-selected for deployment through a medical screening process to ensure that they are able to function in a deployed environment. As such, this population should be healthier than the general military population.

This population was medically screened prior to entry into the military; therefore, preexisting medical conditions would exclude the individual from military service. The results of this study may reduce the generalizability to the civilian population or the Air Force population due to a healthy worker effect. The members of this study should be healthier than those in the general civilian population, though they should be similar when compared to a deployed military population (i.e. Army, Navy, Marine Corps).

Although battle injuries can generally be readily distinguished form non-battle injuries based on the injury circumstance and event details, it is more problematic to distinguish battle from non-battle psychiatric illnesses. Following DOD standards, this study utilized ICD-9-CM codes to make this distinction. As mentioned earlier, it is also problematic to fully distinguish time at risk for combat vs. time at risk for non-combat. It is assumed that an individual in a deployed environment has the potential for combat exposure at any point in the deployment.

This study was limited to only those non-battle injuries and non-battle psychiatric illnesses diagnosed while the service member was located in the deployed environment. Therefore, any injuries or illnesses diagnosed after the service member returned to their home station were not included in the dataset and were thus omitted from the study. In the case of psychiatric illnesses, this might have resulted in underestimation of the rate. This potential bias likely did not affect the injury analyses, since injury is an acute event.

Additionally, there are some concerns with using the GEMS data for the non-battle psychiatric illness analysis. There seems to be less depressive disorders than expected and no reporting of anxiety or mood disorders. It is difficult to determine if this data is truly missing from the database, were not experienced by members in the deployed environment, or a result of provider miscoding diagnoses. It is possible that psychiatric illnesses are being coded using general V codes for counseling or even more general ICD-9 coding based on symptoms rather than an actual diagnosis that may result in the diagnoses being counted in the All Other Medical/Surgical JCS DNBI category and not as a psychiatric illness. In order to fully explore these issues, it is proposed that future studies utilize a comparison of GEMS data with an alternate data source for quality control; however, if an alternate data source is not readily available, then the data within GEMS can be examined by provider or medical facility location to identify any potential miscoding.

A sensitivity analysis was conducted to further explore potential underreporting in the GEMS data by operational phase. It is possible that coding practices or the overall degree of underreporting changed as the operations progressed. Under the assumption that the incidence rate of non-battle non-drug psychiatric illness was relatively low and that all recorded diagnoses of non-battle non-drug psychiatric illnesses were accurately diagnosed, an evaluation of sensitivity and sensitivity is displayed in Tables 41-43. If the misclassification was nondifferential by phase, then the observed incidence rate ratios are unbiased. In order for observed rate rations to be entirely due to differential misclassification by phase (i.e. assuming a null set of true rate ratios) the difference in underreporting of non-battle non-drug psychiatric illness would have to have been greater than 35% in the invasion phase, 62% in the first stabilization phase, and 73% in the second stabilization phase when compared with the buildup phase.

Table 41. Corrected incidence rate ratios for the invasion vs. buildup phase under various assumptions about underreporting or miscoding of non-battle non-drug psychiatric illness, with the specificity held constant at 1.00 for both phases (observed rate ratio=1.54).

Buildup Phase Sensitivity	Invasion Phase Sensitivity 1.00	0.90	0.80	0.70
1.00	1.54	1.71	1.92	2.19
0.90	1.38	1.54	1.73	1.97
0.80	1.23	1.37	1.54	1.76
0.70	1.08	1.19	1.34	1.54

Table 42. Corrected incidence rate ratios for stabilization phase I vs. buildup phase under various assumptions about underreporting or miscoding of non-battle non-drug psychiatric illness, with the specificity held constant at 1.00 for both phases (observed rate ratio=2.63).

Buildup Phase Sensitivity	Stabilization Phase I Sensitivity 1.00	0.90	0.80	0.70
1.00	2.63	2.92	3.28	3.75
0.90	2.36	2.62	2.95	3.37
0.80	2.10	2.33	2.62	3.00
0.70	1.84	2.04	2.30	2.62

Table 43. Corrected incidence rate ratios for stabilization phase II vs. buildup phase under various assumptions about underreporting or miscoding of non-battle non-drug psychiatric illness, with the specificity held constant at 1.00 for both phases (observed rate ratio=3.71).

Buildup Phase Sensitivity	Stabilization Phase II Sensitivity 1.00	0.90	0.80	0.70
1.00	3.71	4.12	4.64	5.30
0.90	3.34	3.71	4.17	4.77
0.80	2.97	3.30	3.71	4.24
0.70	2.60	2.88	3.25	3.71

5.5. Future Directions

The study produced two papers (Specific Aims 2 and 3) to be published in a peer-reviewed scientific journal, such as the *American Journal of Epidemiology, Epidemiology,* or *Military Medicine*. A third paper regarding a systematic review of published disease and non-battle injury rates (Specific Aim 1) is expected to be completed at a later date.

A potential future study design for future research in this area would be a longitudinal data analysis connecting pre-deployment, deployment, and post-deployment information. This study would require linkage of several military databases and would be useful for establishing a timeline of injury/illness occurrence as well as incorporating several risk factors that are missing in the databases available for this study. Additionally, this analysis would allow researchers to connect multiple deployments (those in support of combat operations as well as humanitarian aid) for an individual. This approach would require additional time and resources which were not feasible at this time.

While research conducted through a longitudinal data analysis may not be entirely feasible at this time, it may be useful to identify specific populations for primary data collection through questionnaire sent directly to the injured Air Force members or a review of the injured member's medical record. A nested case-control study may be useful to acquire details related to the specific event that resulted in the non-battle injury in the deployed Air Force member. Through examination of the medical records or direct interaction with the injured members, investigators would be able to identify the nature and circumstances of the injury event to better develop prevention programs for injuries that occur in a deployed environment.

In order to fully examine the extent to which non-battle psychiatric illnesses occur in a deployed setting, it would be useful to develop a case-crossover study to identify specific acute and chronic stressors that lead to psychiatric illness in an individual Air Force member. This study design would allow researchers to determine a more acute timeline of when the illness

event occurred rather than basing the initial occurrence on the date of clinical diagnosis, which is potentially inaccurate due to the long-term nature of psychiatric illnesses and the presence of stressors that accumulate over time. This would also allow researchers to identify sudden stressors such as a combat situation or death of a family member/friend.

It is important to examine non-battle injuries across the other armed services for enumeration of all non-battle injuries that occur in a deployed environment. Ideally this data would include mechanisms of injury to be able to provide better focus for training and prevention programs. Furthermore, it would be useful to include medical evacuations and battle injuries in this study for further description of all injuries that occur in a deployed environment. Additionally, it would be beneficial to combine the non-battle injury data and non-battle psychiatric illness data to create a study dataset that would allow the association between injury and mental health to be further examined. This data may be focused to specifically examine the association between non-battle injury and combat stress reactions such as PTSD, depression, and anxiety disorders.

This research examined the incidence of non-battle injuries and non-battle psychiatric illnesses in deployed Air Force members for Operations Iraqi and Enduring Freedom. Overall, Active Duty and Guard members were more likely to experience non-battle injuries than Reserve members. The incidence of non-battle psychiatric illnesses increased as the time spent in Operations Iraqi and Enduring Freedom increased. The results from this research can be utilized to improve screening and prevention programs to support deployed military members.

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APPENDIX

1. Description of JCS Disease and Non-battle Injury categories. (23)

Category	Description
Combat/Operational Stress Reactions	Includes acute debilitating mental, behavioral, or somatic symptoms thought to be caused by operational or combat stressors, that are not adequately explained by physical disease, injury, or a preexisting mental disorder, and that can be managed with reassurance, rest, physical replenishment, and activities that restore confidence.
Dermatological	Diseases of the skin and subcutaneous tissue, including heat rash, fungal infection, cellulitis, impetigo, contact dermatitis, blisters, ingrown toenails, unspecified dermatitis, etc. Includes sunburn.
Gastrointestinal, infectious	All diagnoses consistent with infection of the intestinal tract. Includes any type of diarrhea, gastroenteritis, "stomach flu," nausea/vomiting, hepatitis, etc. Does NOT include non-infectious intestinal diagnoses such as hemorrhoids, ulcers, etc.
Gynecological	Menstrual abnormalities, vaginitis, pelvic inflammatory disease, or other conditions related to the female reproductive system. Does not include pregnancy.
Heat/Cold Injuries	Climatic injuries, including heat stroke, heat exhaustion, heat cramps, dehydration, hypothermia, frostbite, trench foot, immersion foot, and chilblain.
Injury, Recreational/Sports	Any injury occurring as a direct consequence of the pursuit of personal and/or group fitness, excluding formal training.
Injury, Motor Vehicle Accidents	Any injury occurring as a direct consequence of a motor vehicle accident.
Injury, Work/Training	Any injury occurring as a direct consequence of military operations/duties or of an activity carried out as part of formal military training, to include organized runs and physical fitness programs.
Injury, Other	Any injury not included in the previously defined injury categories.
Ophthalmologic	Any acute diagnosis involving the eye, including pink-eye, conjunctivitis, sty, corneal abrasion, foreign body, vision problems, etc. Does not include routine referral for glasses (non-acute).
Psychiatric, Mental Disorders	Debilitating mental, behavioral or somatic symptoms that meet diagnostic criteria for or have been previously diagnosed as a psychiatric/mental disorder. Does NOT include symptoms due to identified physical disease or injury, or symptoms better explained as a transient combat/operational stress reaction.
Respiratory	Any diagnosis of the: lower respiratory tract, such as bronchitis, pneumonia, emphysema, reactive airway disease, and pleurisy; or the upper respiratory tract, such as "common cold," laryngitis, tonsillitis, tracheitis, otitis and sinusitis.
Sexually Transmitted Diseases	All sexually transmitted infections including chlamydia, HIV, gonorrhea, syphilis, herpes, chancroid, and venereal warts.
Fever, Unexplained	Temperature of 100.50F or greater for 24 hours, or history of chills and fever without a clear diagnosis (this is a screening category for many tropical diseases such as malaria, dengue fever, and typhoid fever). Such fever cannot be explained by other inflammatory/infectious processes such as respiratory infections, heat, and overexertion.
All Other, Medical/Surgical	Any medical or surgical condition not fitting into any category above.
Dental	Any disease of the teeth and oral cavity, such as periodontal and gingival disorders, caries, and mandible anomalies.
Miscellaneous/Administrative/ Follow-up	All other visits to the treatment facility not fitting one of the above categories, such as profile renewals, pregnancy, immunizations, prescription refills, and physical exams or laboratory tests for administrative purposes.
Definable	An additional category established for a specific deployment based upon public health concerns (e.g., malaria, dengue, airborne/HALO injuries, etc.).