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**NAVAL  
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**MONTEREY, CALIFORNIA**

**THESIS**

**THE EFFECT OF DEPLOYMENT ON THE RATE OF  
MAJOR DEPRESSION AND SUBSTANCE ABUSE IN  
ACTIVE DUTY MILITARY FROM 2001–2006**

by

Melissa K. Burke

March 2011

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**THE EFFECT OF DEPLOYMENT ON THE RATE OF MAJOR DEPRESSION  
AND SUBSTANCE ABUSE IN ACTIVE DUTY MILITARY FROM 2001–2006**

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Submitted in partial fulfillment of the  
requirements for the degree of

**MASTER OF SCIENCE IN MANAGEMENT**

from the

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## **ABSTRACT**

Operation Iraqi Freedom and Operation Enduring Freedom have affected the mental health of the U.S. military, as evidenced by an increasing trend in mental health illness. This thesis evaluates the effects of deployment history on major depression and substance abuse in the active duty population from 2001 to 2006. The research specifically evaluates cumulative effects of deployment (location, total days, frequency of separate tours) on major depression and substance abuse across the different branches of the military.

Probit regressions were used to estimate the effects of deployment characteristics on the rate of major depression and substance abuse using 2001–2006 data from TRICARE and DMDC, and all models control for service members' demographic and service characteristics, as well as time trend.

In general, the results support that deployments, especially to Iraq and Afghanistan, significantly affect the probability of active duty personnel across all services being diagnosed with major depression or substance abuse. Furthermore, personnel deployed only once under OEF/OIF have the highest probability of both conditions compared to those with multiple deployments, indicating a selection bias: those diagnosed were excluded from future deployments. Lastly, the risk of both conditions, in particular substance abuse, increases as cumulative days of deployment increases.



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## LIST OF ACRONYMS AND ABBREVIATIONS

AFSC	Air Force Specialty Codes
CHCS	Composite Health Care system
CTS	Contingency Tracking System
DEERS	Defense Eligibility Enrollment Reporting System
DMAVA	The New Jersey Department of Military and Veterans Affairs
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DSM-IV	Diagnostic and Statistical manual of Mental Disorders
EDIPN	Electronic Data Interchange Person Numbers
GWOT	Global War on Terrorism
HRBS	Health Related Behaviors Among Active Duty Military Personnel Surveys
ICD–9 Codes	International Classification of Diseases, 9th Revision, Clinical Modification
LPM	Linear Probability Models
MD	Major Depression
MOS	Military Occupational Specialty Codes
NEC	Naval Enlisted Classification
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PDHA	Post-Deployment Health Assessment
PDHRA	Re-Assessment Post-Deployment Health Assessment
PHQ-9	nine-item Patient Health Questionnaire
PTSD	Post Traumatic Stress Disorder
SA	Substance Abuse
SIDR	Standard Inpatient Data Record
TEDI	TRICARE Encounter Data—Institutional
TICS	Two-Item Conjoint Screen for Alcohol

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# **I. INTRODUCTION**

## **A. PURPOSE**

In response to the attacks of September 11, 2001, the United States entered combat operations in Afghanistan and Iraq in 2003. The all-volunteer force entered into its first major post-cold war conflict and one of the largest combat operations since the Vietnam Conflict. Nearly nine years have passed since the United States started combat operations in Afghanistan and Iraq, with an estimated 1.6 million wartime veterans (Seal, 2010) deployed to two theaters.

Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) have affected the mental health of the entire military, as evidenced by an increasing trend in mental health illness, depression, and substance abuse being the top two diagnoses. Mental health illness affects readiness, and the cost of care to military and society. Mental health illness is not isolated to military communities; it affects all of society. The increasing trend in mental health illness, particularly depression and substance abuse pose important issues that need to be addressed by military planners. Planners and leadership need to be able to respond to demands of increased care related to mental health illness, as well as better manage the incidence and prevalence of mental health illness. Understanding the risk factors associated with mental health illness and targeting preventative treatment by optimizing tour length, location, and rotation should alleviate some of the concerns surrounding mental health illness in the military. Understanding and concentrating on preventative measures for those at risk will improve readiness. Knowing how deployment length and frequency affects military members, leadership and policy makers will help improve decisions regarding deployments to minimize the risk of mental health illness.

## **B. RESEARCH QUESTIONS**

Existing studies provide important information on major depression and substance abuse in OEF and OIF environments, but they do have some limitations. The objective of

this thesis is to provide military planners, leadership and policy makers with expanded and more comprehensive information to aid in the rising concerns of substance abuse and major depression effects across the branches of service by analyzing the following research questions.

- What are the rates of major depression and substance abuse among all active duty enlisted personnel and how do the rates differ by service and deployment?
- How do deployment location (specifically, Iraq and Afghanistan) affect the probability of being diagnosed with major depression and substance abuse?
- Is there a cumulative effect of deployments (i.e., frequency of separate tours and total days in theater) on major depression and substance abuse?

To examine the research questions, multivariate analysis is used for active duty enlisted personnel from 2001 to 2006 for the Army, Marine Corps, Air Force, and Navy. A separate analysis is performed for each branch of service and the results compared.

### **C. STUDY OVERVIEW AND SIGNIFICANCE**

The empirical approach for this thesis is a combination of descriptive statistics and multivariate analytical methods to examine the rate of major depression and substance abuse, the probability of being diagnosed with either in the face of deployment, and the cumulative effects deployments have on major depression and substance abuse. This thesis embodies four main sections to address the importance of this subject. The first section focuses on an overview of major depression and substance abuse and a review of existing relevant literature on the effects of these two mental health conditions on military members. The focus is centered on the impact of deployments to OEF and OIF have on U.S. fighting forces; thus, providing a framework to understand the risks faced by military members and the significance of identifying, treating, and tackling the issues of the two mental health conditions, major depression and substance abuse.

The second and third section of this thesis concentrates on the data and methodology used for analysis. TRICARE, Defense Enrollment Eligibility Reporting System (DEERS) and Defense Manpower Data Center's (DMDC) Contingency Tracking

System (CTS) data are formulated into analytical working files allowing the analysis of major depression and substance abuse from 2001 to 2006 across the four branches of service. To perform the analysis, the preferred methodology and multivariate models describing key variables of interest is described. The methodology and multivariate analysis is vital to analyze the effects deployments have on enlisted active duty military members' risks of diagnosis with major depression or substance abuse.

The final sections of this thesis address the results and discuss the findings compared across the branches of service. The inherent dangerous nature of deployments under OEF and OIF and the effect on active duty military members places them at risk of being diagnosed with either of the two mental health illness. The final sections provide military planners invaluable data and information to arm them with the knowledge to address concerns of mental health amongst deployed military members. The hope is that military planners will use the information provided in this thesis to evaluate deployment structures to minimize the risks to active duty enlisted personnel in the Army, Marine Corps, Air Force, and Navy of being diagnosed with either or both of the mental health illnesses, major depression or substance abuse.



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## **II. LITERATURE REVIEW**

### **A. INTRODUCTION**

This chapter presents an overview of current literature on the mental health disorders depression and substance abuse in the military population that has deployed to Afghanistan and Iraq. Section B addresses the definitions of depression and its symptoms and treatment, and section C addresses the definitions of substance abuse symptoms and treatments. In Section D, past studies on depression and substance abuse are reviewed. Section E evaluates shortcomings in the current literature in depression and substance abuse. Finally, Section F summarizes this chapter and key points, as well as address how this thesis helps the current literature in depression and substance abuse in the deployed military population.

In 2001, in response to the attacks on September 11, the United States entered combat operations in Afghanistan and in 2003 Iraq. The all-volunteer force entered into its first post-cold war conflict and one of the largest combat operations since the Vietnam Conflict. Nearly nine years have passed since the United States started combat operations in Afghanistan and Iraq, with an estimated 1.6 million wartime veterans (Seal, 2010) deployed to two theaters.

Given the sustained operations and nature of combat, there are mounting concerns and growing evidence that combat operations impact the mental health of troops, affecting readiness and productivity, and increasing costs to the military and society as a whole. Recent studies support the theory that deployment to Afghanistan—Operation Enduring Freedom (OEF)—and Iraq—Operation Iraqi Freedom (OIF)—may place troops at increased risk for mental health illnesses, such as Post Traumatic Stress Disorder (PTSD), depression and substance abuse. The effect of mental health issues on troops is not as clearly identifiable as physical wounds, thus complicating the overall impact. Military leadership and policy makers are exceedingly concerned with the escalating rates of mental health issues arising from sustained military operations. In response to concerns about the mental health of military personnel, multiple studies have been

conducted. A major report conducted by the RAND Corporation focused on some of these “invisible” wounds, and their impacts on deploying troops. The RAND report focused on PTSD, major depression and traumatic brain injury diagnosed in OEF and OIF veterans and intended to help shape the decisions of mental health treatment providers, health policymakers, particularly those charged with caring for veterans, active service personnel, their families and the concerned public (Tanielian, 2008). Of course, the concerns of mental health impacts on troops are not limited to only the United States, but also of U.S. allies.

The increased operational tempos seen with OIF and OEF have resulted in variable deployment lengths, multiple deployments and unpredictable time at home. “Dwell time” (Harben, 2009) between deployments impacts the readiness and mental health of our troops (Harben; Hoge et al., 2004; Kline et al., 2010). Several things are suspected in contributing to depression and substance abuse in military personnel who have been deployed. A possible contributing factor may be the nature in which the current conflicts are fought. Past conflicts relied on draftees to augment the force; however, today’s military structure is an all-voluntary force. Gaps in the “need and use of care” impact mental health outcomes of military personnel. For example, as pointed out in the RAND report, “there is a large gap between the need for mental health services and the use of such services—a pattern that appears to stem from structural aspects of services (wait times, availability of providers), as well as from personal and cultural factors” (Tanielian, 2008). The stigma of mental health illness is a challenge faced by all branches of the military and extensively addressed in the Rand report. Length of tours is also suspected to increase the risk for developing a mental health illness, such as PTSD, depression and substance abuse (Tanielian, 2008). Deployment duration greater than 13 months was found to increase the use of alcohol in UK Armed Forces personnel, supporting that length of tours increases risk of mental health illness (Rona et al., 2008). The number of deployments and the location of deployment appear to have an impact on the risk of developing a mental health illness. Tanielian (2008), remarks, “troops are seeing more-frequent deployments, of greater lengths...factors thought to create a more stressful environment for servicemembers.” Interestingly, Rona et al. found that the

number of deployments was less consistent than the duration of deployments for UK Armed Forces personnel and may actually decrease the likelihood of mental health symptoms in future deployments. The branch of service, preparation for deployment, leadership environment, age of personnel and marital status are also factors that appear to contribute to the possible risk for mental health issues in troops. Additionally, full time active duty status versus reserve component status seems to have an impact on the prevalence of mental health illness, such as depression and substance abuse.

The objective of this chapter is to examine literature that addresses the effects of depression and substance abuse amongst military personnel. Of particular interest are the effects of depression and substance abuse related to deployment length, and location affecting the four branches, Navy, Marine Corps, Army and Air Force, as well as the impact on reserve and National Guard.

## **B. DEFINITIONS OF DEPRESSION, SYMPTOMS AND TREATMENT**

Depression is a common psychological disorder that affects about 121 million people worldwide and is among the leading causes of disability (World Health Organization, 2010b). Depression can occur in people of all ages, gender, socio-economic backgrounds and lifestyles. A number of factors may contribute to depression, such as the death of loved ones, history of violent crime or physical/mental abuse, medications, genetics, change in job or income, and natural disasters. In addition, witnessing or experiencing traumatic events, such as war or divorce, could lead to depression. Depression may lead to substantial long-term effects on individuals and society, manifested by recurrent problems adapting to the demands of normal life and increased costs of health care to the individuals and society. Typically, depression is not a life threatening disease; however, in severe cases, it may lead to suicide. Diagnosis of depression is characterized by an episode of depression lasting more than two weeks while meeting at least five of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) requirements (ALLPSYCH Online, 2004). Symptoms of depression include

feelings of sadness or emptiness, reduced interest in activities that used to be enjoyed, loss of energy, difficulty concentrating, difficulty holding conversations or paying attention and suicidal thoughts or intentions.

Depression is often diagnosed in primary care settings with treatment consisting of a combination of pharmacotherapy and psychotherapy. Tables 1 and 2 represent the diagnostic criteria from the DSM-IV that health care providers must use to assign a diagnosis of depression. The specificity of the diagnostic criteria is precise and illustrates the differences between types of depression diagnoses. Pharmacotherapy treatment consists of anti-depression medications, such as Prozac, Paxil, Welbutrin and Zoloft. Symptomatology is a vital aspect of the treatment and medication prescription selection.

Table 1. Criteria for Major Depressive Episode (From: American Psychiatric Association, 1994)

Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.
<ul style="list-style-type: none"><li>• Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful).</li><li>• Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others).</li><li>• Significant weight loss when not dieting or weight gain (e.g., a change of more than 5 percent of body weight in a month), or decrease or increase in appetite nearly every day.</li><li>• Insomnia or hypersomnia nearly every day.</li><li>• Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down).</li><li>• Fatigue or loss of energy nearly every day.</li><li>• Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick).</li><li>• Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others).</li><li>• Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan</li></ul>

Table 2. Diagnostic criteria for 296.2x major Depressive Disorder, Single Episode (From: American Psychiatric Association, 1994)

<ul style="list-style-type: none"> <li>• Presence of criteria for Major Depressive Episode</li> <li>• The Major Depressive Episode is not better accounted for by Schizoaffective Disorder and is not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder Not Otherwise Specified.</li> <li>• There has never been a Manic Episode, a Mixed Episode, or a Hypomanic Episode. This exclusion does not apply if all the manic-like, mixed-like, or hypomanic-like episodes are substance or treatment induced or are due to the direct physiological effects of a general medical condition.</li> </ul>
<p>Diagnostic criteria for 296.3x Major Depressive Disorder, Recurrent</p> <ul style="list-style-type: none"> <li>• Presence of two or more Major Depressive Episodes (see Table 1.1). Note: To be considered separate episodes, there must be an interval of at least two consecutive months in which criteria are not met for a Major Depressive Episode.</li> <li>• The Major Depressive Episodes are not better accounted for by Schizoaffective Disorder and are not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder Not Otherwise Specified.</li> <li>• There has never been a Manic Episode, a Mixed Episode, or a Hypomanic Episode. This exclusion does not apply if all the manic-like, mixed-like, or hypomanic-like episodes are substance or treatment induced or are due to the direct physiological effects of a general medical condition</li> </ul>

An important component of the epidemiology of depression is the pattern of comorbidities. People diagnosed with depression may be at risk for other disorders; current literature identifies common comorbidities, such as Post-Traumatic Stress Disorder (PTSD), adjustment disorders with mixed emotional features, anxiety disorders and substance abuse (Riddle, 2008). In a study by Riddle et al. that evaluated self-reported combat stress indicators, findings showed that, during a six-month period, in addition to depression there were (25 percent) adjustment disorders with mixed emotional features, (10 percent) anxiety disorders, (20 percent) occupational problems, (5 percent) combat stress, (5 percent) bereavement and (10 percent) other diagnoses. In a recent study, the rates of comorbidity with veterans diagnosed with clinical depression found the rate of PTSD was 36 percent–51 percent (Chan, 2009).

### **C. DEFINITIONS OF SUBSTANCE ABUSE, SYMPTOMS AND TREATMENT**

Substance abuse, the harmful or hazardous use of psychoactive substances, is a psychological disorder that clusters around behavioral, cognitive and physiological phenomena where a desire to continue taking a particular substance persists despite potential harmful consequences. Substances range from prescription drugs to legal substances, such as cigarettes and alcohol to illegal drugs; however, the most common substance abused in the military is alcohol. An estimated 78.3 million people worldwide have an alcohol disorder and 15.3 million people worldwide have a drug disorder (World Health Organization, 2010a). While genetic predisposition is a primary factor in substance abuse, other contributing factors can play a role in development (World Health Organization, 2010a). Some additional contributing factors often confused as symptoms, are exposure to a trauma, relationship issues, stress, witnessing a violent crime, military combat and peer pressure. To effectively treat and identify those at risk, it is crucial to distinguish between indicators as symptoms of substance abuse and indicators as determining risk factors. Table 3 contains the DSM-IV diagnostic criteria of substance abuse and demonstrates the difference between what is a symptom and what is a factor. The characteristic features of substance abuse are a pattern of use leading to significant impairment in functioning including recurrent failure to meet work obligations, engaging in physically hazardous activities while under the influence of a substance, legal problems and social and/or family problems. Treatment of substance abuse typically is focused on social support systems and the individual accepting that there is a problem (ALLPSYCH Online, 2004). The most widely used treatment options are organizations, such as Alcoholics Anonymous (AA) and other rehabilitation programs, such as outpatient and inpatient treatment. Long-term care and follow-up are important in the treatment of substance abuse disorders.

Table 3. Criteria for Substance Abuse (From: American Psychiatric Association, 1994)

<p>A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12-month period:</p>
<ul style="list-style-type: none"> <li>• Recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home (e.g., repeated absences or poor work performance related to substance use, substance-related absences, suspensions, or expulsions from school, neglect of children or household)</li> <li>• Recurrent substance use in situations in which it is physically hazardous (e.g., driving an automobile or operating a machine when impaired by substance use).</li> <li>• Recurrent substance-related legal problems (e.g., arrests for substance-related disorderly conduct).</li> <li>• Continued substance use despite having persistent or recurrent effects of the substance (e.g., arguments with spouse about consequences of intoxication, physical fights).</li> </ul> <p>Note: the symptoms have never met the criteria for substance dependence for this class of substance.</p>
<p>Criteria for Substance Dependence</p> <p>A maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three (or more) of the following.</p> <ul style="list-style-type: none"> <li>• Tolerance, as defined by either of the following:             <ul style="list-style-type: none"> <li>• A need for markedly increased amounts of the substance to achieve intoxication or desired effect</li> <li>• Markedly diminished effect with continued use of the same amount of the substance.</li> </ul> </li> <li>• Withdrawal, as manifested by either of the following:             <ul style="list-style-type: none"> <li>• The characteristic withdrawal syndrome for the substance.</li> <li>• The same (or a closely related) substance is taken to relieve or avoid withdrawal symptoms.</li> </ul> </li> <li>• The substance is often taken in larger amounts or over a longer period than was intended.</li> <li>• There is a persistent desire or unsuccessful efforts to cut down or control substance use.</li> <li>• A great deal of time is spent in activities necessary to obtain the substance (e.g., visiting multiple doctors or driving long distances), use of the substance (e.g., chain-smoking), or recover from its effects.</li> <li>• Important social, occupational, or recreational activities are given up or reduced because of substance use.</li> <li>• The substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance (e.g., current cocaine use despite recognition of cocaine-induced depression, or continued drinking despite recognition that an ulcer was made worse by alcohol consumption).</li> </ul>



An important component of the epidemiology of substance abuse is its pattern of comorbidities. A current article in *Military Medicine* recommended that abstinence or responsible alcohol use be encouraged as an intervention due to the comorbidity of anxiety, depression and PTSD as conditions known to increase alcohol use (Bray, 2010). However, according to recent literature, substance abuse is linked to other mental health disorders. In a study conducted on the relationship of combat experiences to alcohol misuse in soldiers returning from OIF, the authors found that soldiers that screened positive for alcohol misuse had significantly more mental health problems than those who had not deployed (Wilk, 2010). Substance abuse as a comorbidity of other disorders is not as commonly referenced in current literature as PTSD or anxiety disorders; however, this may be a limitation of diagnosis or comprehensive evaluation in research.

#### **D. PAST RESEARCH ON DEPRESSION AND SUBSTANCE ABUSE**

Epidemiological studies on substance abuse and depression look at the incidence and prevention of these disorders. Depression is currently a leading cause of disability globally and may have substantial long-term effects on individuals and society (World Health Organization, 2010). In addition, substance abuse is often a co-occurring mental health disorder. Since the start of OEF and OIF, a multitude of studies have been conducted that support the theory that combat operations lead to an increased probability of mental health disorders in returning veterans, thus increasing the demand for mental health utilization (Seal, 2009). Wilk et al. also found that deployments and combat exposure result in a greater incidence of depression and substance abuse, which further supports the findings of past research.

The sustained and increased tempo of deployments to OEF and OIF have provided unequivocal evidence of increased rates of depression and substance use in military personnel. All of the current studies conducted on the prevalence of substance abuse and depression demonstrate consistency in methodology, sampling restrictions and time period of study. Common methods found in the current studies include using diagnostic codes (ICD-9 codes), screening tools to identify persons with specific disorders, and diagnostic interviews conducted either by a clinical specialist or by trained

individuals (Tanielian, 2008). Most studies clearly focus on the time periods covering OEF and OIF. Lengths of the current studies typically target post deployment time frames of three months, six months and one year post deployment, and focus primarily on OEF and OIF. The 2008 RAND report titled *Invisible Wounds of War*, provides an excellent extensive and comprehensive review of the prominent current literature on the prevalence of PTSD, depression and traumatic brain injury amongst the military population. Although the focus for this thesis is on depression and substance abuse, the RAND report is a valuable source of current research and thinking regarding the impact of mental health illness amongst military personnel that have deployed in OEF and OIF.

Current studies addressing depression in current and former active duty, reserve and National Guard members use similar screening tools that have been tested and validated to assess the incidence of depression and substance abuse. The majority of current studies use survey methods focusing primarily on Army and Marine active duty personnel. Typical survey time frames are between 2004 and 2007 with prevalence rates identified at the three and 12-months time points (Thomas, 2010). Additionally, many of the studies suggest that three and 12 months are widely accepted points in time where deployed personnel will manifest mental health issues or begin to seek treatment or be referred to treatment. The tools used for many of the studies for depression are based off of the DSM-IV and include a nine-item Patient Health Questionnaire (PHQ-9) (Kline, 2010), and the Beck Depression Inventory (BDI-II) (Bray, 2010; Ferrier-Auerbach, 2009). Substance abuse tools used include the two-item Conjoint Screen for Alcohol (TICS) (Thomas, 2010; Wilk, 2010), four item questions adopted from the National Council on Alcohol Consumption Questions and two item questions indicating alcohol use (Ferrier-Auerbach, 2009) and the Alcohol Use disorders Identification test (AUDIT), a ten-item self-reported measurement screen (Reger, 2009).

The study conducted by Bray et al. looked at findings from the 2008 Department of Defense (DoD) Health Related Behaviors Among Active Duty Military Personnel Surveys (HRBS) to analyze trends observed in various mental health issues. The results of the 2008 HRBS were compared to previous HRBS studies going back to 1980. Bray et al. note that the 2008 survey permits them to look at the total force, including personnel

who have deployed to OEF and OIF, thus giving some insight into health related behaviors since the start of OEF and OIF. To capture the combat deployment measure, they assessed questions to specifically place personnel in three categories: “those who had been combat deployed and served in OEF and OIF, those who had been combat deployed to other theaters, and those who had not been combat deployed” (Bray et al., 2010) since September 11, 2001. For the 2008 HRBS, they took a random sample of 64 worldwide installations then randomly selected 600 personnel, regardless of deployment status, at each of the installations to take the 2008 HRBS. Their key measures used multiple definitions to measure substance use and mental health. The measures for substance abuse included subcategories, such as alcohol, drugs and cigarettes. For mental health measures, they used stress, anxiety, depression, PTSD and suicidal ideation and attempts. The specific defining key measures for the study are similar to the same tools found in other studies. Regarding alcohol and depression, they found that heavy alcohol use was steady from 1988 to 1998, but increased from 15 percent in 1998 to 20 percent in 2008. They also found that for depression and anxiety, real changes occurred from 2005 to 2008, but the need for further PTSD evaluation increased 12.4 percent for those deployed to OEF and OIF versus 8.2 percent for those not deployed.

Several studies looked at the pre-deployment and post-deployment time frame to better understand and evaluate mental health relating to post-deployment. Thomas et al. (2010) looked at the broad effects of combat deployments in the first year after returning from Iraq and Afghanistan. Focusing on three months and 12 months post-deployment time periods, they examine the prevalence of rates of depression, PTSD and evaluate alcohol misuse, which is considered a comorbid condition in this study. Similar to the majority of studies using survey-based analysis, they use many of the same tools previously discussed to define their key indicators of PTSD, depression, functional impairment, alcohol misuse, aggressive behaviors and demographics. Between 2004 and 2007, they anonymously surveyed 18,305 personnel from four active component Infantry Brigade Combat Teams and two National Guard Infantry Brigade Combat Teams, out of which 13,226 were identified as veterans of OIF, and therefore, used for analysis. One of the objectives of the study was to compare the post-deployment rates of the Active Duty

components and National Guard. The analysis included simple frequency, descriptive statistics and logistic regression to determine whether differences were observed from the three months and 12 months post deployment time frames. They found the active duty component personnel had rates of depression at the three months post-deployment return date estimated at 16 percent, and 11.5 percent for the National Guard. Additionally, they found that alcohol misuse was 12.4 percent at the three months post-deployment date for the active duty component personnel, and 14.5 percent for National Guard. The 12 months time frame was 9.9 percent for active duty component personnel, and 15.0 percent for National Guard.

Another study conducted by Kline et al. assessed the effects of prior deployments in OIF on New Jersey Army National Guard members preparing for deployments to Iraq. Kline et al. specifically “compared the health status of soldiers with previous OEF and OIF deployments with that of soldiers experiencing their first deployment...compared the present survey with New Jersey’s pre-deployment health assessments on identification rates of key mental health problems.” Their study consisted of 2,543 anonymous pre-deployment surveys collected in 2008. The original number surveyed was 2,665, 122 were omitted due to startup delays, non-completes and poor data quality. In addition to the survey, they collected “de-identified” health data from the New Jersey Department of Military and Veterans Affairs (DMAVA), which provided relevant pre-deployment medical assessment information. The soldiers were placed into two groups; one consisted of those who had no prior OEF and OIF deployments and one consisting of those who had deployed one or more times to OEF and OIF. The study measured PTSD, depression, alcohol use and other drugs, other mental health, physical health and reports of mental health symptoms. Using logistic regression, they found that deployed soldiers were three times more likely than non-deployed soldiers to screen positive for major depression, and to meet DSM-IV criteria for alcohol dependence (Kline et al., 2010). The survey comparison to DMAVA data revealed lower results in mental health conditions. The DMVA National Guard assessment, sample size of 2,995 identified depression at 0.8

percent (n=25) whereas the survey, sample size of 2,543 identified depression at 3.4 percent (n=86) and for substance use problems DMVA identified 0.3 percent (n=8), the survey 7.2 percent (n=183).

The study conducted by Wilk et al. focused on alcohol misuse in soldiers from Brigade Combat Infantry Teams during the first three to four months following OIF deployment. They anonymously surveyed soldiers from a large Army installation in 2006 with an available population of 2,200. Out of the available soldiers, they received surveys from 1,221, identifying 1,120 who were OIF post-deployed and 1,080 who responded to alcohol related questions. The key dependent variable in the study was a positive screen for alcohol misuse as identified with the TICS tool. Four logistic models were used for analysis to evaluate the associations of reported combat exposure, demographics, unit cohesion and mental health problems. The overall findings according to Wilk et al. were that “one in four soldiers screened positive for an alcohol misuse problem three to four months post deployment to Iraq.” In addition to finding positive screening for alcohol misuse, they also noted that combat experiences were also strongly related to alcohol misuse problems. The authors comment that the positive combat relationship to alcohol misuse may be a result of the threatening nature of combat, and may be a reliable predictor of post-deployment alcohol misuse.

The study conducted by Jacobson et al. (2008) focused specifically on pre and post deployment alcohol use amongst active duty and reserve component personnel. The study is uniquely different from other research in the fact that they look at all four branches of service, Army, Marine Corps, Navy and Air Force in the analysis. They use data from the Millennium Cohort Study covering the time frames from 2001 to 2006. Statistical analysis used in the study consisted of univariate and multivariate modeling to capture the associations of alcohol use. Outcome measures were heavy weekly drinking, binge drinking and alcohol related problems. Baseline and follow-up assessments were based on the validated tools, similar to previous research studies, of which further information can be found in the actual study. Their results are consistent with other research, finding that active duty personnel are more likely to have a higher prevalence of post-deployment drinking than those who have not deployed for all three of their

outcomes. Specifically, they found that Marine Corps personnel display a higher prevalence of new onset alcohol use out of the four services. Marine Corps percent of alcohol use as compared to the Air Force, which had the lowest prevalence are: heavy weekly drinking Marine Corps 7.3 percent, Air Force 3.7 percent; binge drinking Marine Corps 24.8 percent, Air Force 18.4 percent; < 1 drinking-related problem Marine Corps 7.6 percent, and Air Force 2.3 percent (Jacobson et al., 2008). Reserve personnel with combat deployment were also found to have a higher likelihood of new onset alcohol use in all outcomes compared to deployed to non-combat exposure. The odd ratio for combat deployed were, heavy weekly drinking 1.63, binge drinking odds ratio 1.46 and alcohol-related problems odd ratio 1.63. For the non-combat deployed reserve personnel, the odd ratios' were heavy weekly drinking 1.09, binge drinking odds ratio 1.10 and alcohol-related problems odds ratio 0.88. Additionally, the study found that personnel who had baseline symptoms of depression, PTSD or other mental health disorders were at an increased risk of a new onset alcohol-related problem. The authors of the study point out that "combat deployment in support of the wars in Iraq and Afghanistan was significantly associated with new-onset heavy weekly drinking, binge drinking, and other alcohol-related problems among Reserve/Guard and younger personnel after return from deployment" (Jacobson et al., 2008). Again, this is consistent with previous studies.

Milliken et al. conducted a longitudinal assessment study from 2005 to 2006 that was population based with a substantial initial cohort of 88,235 personnel returning from Iraq. They looked at two key time frames, the Post-Deployment Health Assessment (PDHA) immediately upon return from deployment and the Re-Assessment Post-Deployment Health Assessment (PDHRA) conducted three to six months following return. Key measures for the study consisted of a positive screening for PTSD, major depression, alcohol misuse, other mental health problems and referral and use of mental health services (Milliken et al., 2007). To make comparisons with active duty components, they used odds ratios with 95 percent confidence intervals and x testing. Milliken et al. found that military personnel indicate more mental health issues on the PDHRA and on the PDHA. PDHA/PDHRA results for active duty personnel for depression went from 4.7 percent to 10.3 percent, and for reserve personnel 3.8 percent to

13.0 percent. According to their study, National Guard and Army reserve soldiers had similar results as active duty personnel, but reported higher rates of mental health problems as compared to active component soldiers. However, the precise nature of the higher rates is not clearly understood. Milliken et al. suggest that one reason for this observation is that at re-assessment, National Guard and Army Reserve soldiers are frequently beyond the DoD benefit window, and therefore, tend to report mental health problems more frequently.

In general, most of the studies have made attempts to evaluate pre and post OEF and OIF deployment effects on the mental health of soldiers. The general consensus is that higher rates of depression and substance abuse occur in populations that have deployed to combat zones as compared to those that have not deployed. Another common trend in the current literature is that National Guard and Army reserve service members have higher rates of mental health disorders, such as depression and substance abuse as contrasted to their active service member counterparts.

#### **E. SHORT-COMINGS IN CURRENT STUDIES**

Recent literature consists of retrospective studies. Most of the studies use survey methods targeting Army and Marine soldiers, which make sense due to their exposure to combat situations, but Navy and Air Force are underrepresented in the literature. The majority of the current literature about substance abuse and depression is limited by survey methods and focus primarily on Army and Marine personnel. A couple of studies address the National Guard and reserve components, but they differ on sample selection. The vast majority of studies conclude that increased operational tempos in Afghanistan and Iraq increase the prevalence of depression and substance abuse for those who have deployed. One of the predominant weaknesses of current studies is a lack of diversity in sample selection. Although it is clear that many studies focus on Army and Marine personnel, they are not the only groups subject to deployment to combat regions. The Navy and Air Force have also been deployed to Iraq and Afghanistan, but are poorly represented in the current literature. The focus on Army and Marines makes it difficult to generalize about the other branches.

The common theme of the surveys also shows limitations in the accurate representation of samples. The majority of survey methods focus on self-reported outcomes to measure for mental health screening. Members may opt out and not take the survey or may not be truthful in response to survey questions as opposed to clinical diagnostics. A common acknowledgment of limitations in the literature is that active duty personnel may not be willing to divulge information for fear of being “labeled.” Fear of being labeled with a mental health disorder is a common theme in many studies and presents some barriers to measuring true mental health disorder prevalence. This method also poses a challenge for making generalized assumptions on the impact of deployment on military personnel.

The screening tools used in most studies present limitations in making accurate assumptions. Although many of the tools have been validated, AUDIT, Beck Depression Inventory and TICS, for example, they are not diagnostic tools. Other tools used may not be as well defined and may lack appropriate validation. Thus, they may not be sufficient to capture diagnostic procedures accurately. Given the complicated nature of capturing the mental health and cognitive conditions associated with substance abuse and depression, the tools that have been used may inadvertently underestimate the true prevalence of these disorders.

## **F. SUMMARY**

The current literature provides considerable insight into the prevalence of depression and substance abuse in the military population after completion of deployments to OEF and OIF. The mounting evidence in the literature supports the hypothesis that a sustained combat operation negatively affects the mental health of soldiers who have been deployed. The long-term implications and costs of increased utilization of healthcare services, prevention and better screening are clearly an important and vital aspect in addressing the mental health needs of military personnel, either active component, National Guard or reserve. The remainder of this thesis examines the effects of deployment length, and location on major depression and substance abuse affecting the



four branches of service, Navy, Marine Corps, Army and Air Force from fiscal years 2001 to 2006, as well as discussion on the impact on reserve and National Guard. The inclusion of the four branches of service will further current literature.

### **III. DATA AND DESCRIPTIVE STATISTICS**

#### **A. INTRODUCTION**

This chapter provides a description of the data and their different sources. Section B provides a description of the data sources and the agencies that provided the respective data. Section C describes the deployment data. Sections D and E provide sample descriptions and an explanation of how the data has been organized for the study and acknowledges the restrictions associated with the data files used in this study. Finally, section F summarizes the key points of the chapter. Additionally, in this chapter, the summary statistics are presented with demographics for substance abuse models and major depression models.

#### **B. DATA SOURCES**

The data for this thesis come from two main sources, TRICARE and Defense Manpower Data Center (DMDC). A random sample of active duty service personnel from the four service branches (Army, Navy, Marine Corps and Air Force) from 2001 to 2006 is used for this study. The TRICARE Defense Eligibility Enrollment Reporting System (DEERS) data contains basic demographic and service information for each service members and are broken into nine files (four for the Army, two for the Air Force, two for the Navy and one for the Marine Corps), which are combined into four files for the respective branches of service for easier processing and for analysis. The TRICARE DEERS data files contain all the same variables for each respective data set model. TRICARE DEERS data was merged with the DMDC Contingency Tracking System (CTS) data, which contains information on the deployment characteristics for active duty service personnel from 2001 to 2006. To answer the research questions for this study and execute the models, two different data files were created to account for the variables of a diagnosis of substance abuse and major depression.

DEERS is a worldwide, computerized database of uniformed service members and their families (TRICARE, 2010). To be eligible for TRICARE benefits, active duty personnel and eligible family members must be registered in DEERS. Active duty personnel (sponsor) are automatically registered in DEERS for military benefits to include enrollment in TRICARE. TRICARE uses International Classification of Diseases, 9<sup>th</sup> Revision, Clinical Modification (ICD-9-CM) diagnostic codes in TRICARE claims. The ICD-9 is a standardized classification system that allows physicians to code disease, injuries and cause of death by its etiology and anatomic location. The ICD-9 diagnostic coding system is recognized nationally and internationally providing for standardization of disease classification and coding. Major depression ICD-9 codes used for this study are 296.2 (major depressive disorder, single episode) and 296.3 (major depressive disorder, recurrent episode). For substance abuse the ICD-9 codes used are 291 (alcohol-induced mental disorders), 303 (alcohol dependency syndrome) and 305 (nondependent abuse of drugs).

The TRICARE data contains the main DEERS data that provides basic demographic information and diagnostic codes for substance abuse and major depression for the Army, Air Force, Navy and Marine Corps active duty service population from 2001 to 2006. The Electronic Data Interchange Person Numbers (EDIPN)—personnel unique identifier—in the DEERS data files, connects all subsequent files together. Table 4 shows the descriptive statistics for the data set variables for major depression and substance abuse for all the services.

Table 4. Descriptive Statistics of Major Depression and Substance Abuse Data Set Variables

Descriptive Statistics for Major Depression and Substance Abuse	Total Population	SA Population	SA (%)	Non-SA Population	Non-SA (%)	Total Population	DP Population	DP (%)	Non-DP Population	Non-DP (%)
Sample										
Number of observations	776,709	52,344	6.74%	724,365	93.26%	777,447	18,484	2.38%	758,963	97.62%
Female	92,559	5,413	5.85%	87,146	94.15%	92,551	6,107	6.60%	86,444	93.40%
Male	684,150	46,931	6.86%	637,219	93.14%	684,896	12,377	1.81%	672,519	98.19%
Single	407,745	28,761	7.05%	378,984	92.95%	407,127	7,844	1.93%	399,283	98.07%
married	368,964	23,583	6.39%	345,381	93.61%	370,320	10,640	2.87%	359,680	97.13%
Army	383,428	26,794	6.99%	356,634	93.01%	383,977	9,178	2.39%	374,799	97.61%
Air Force	135,434	7,133	5.27%	128,301	94.73%	135,527	4,023	2.97%	131,504	97.03%
Marine Corps	107,648	6,074	5.64%	101,574	94.36%	107,688	1,796	1.67%	105,892	98.33%
Navy	150,199	12,343	8.22%	137,856	91.78%	150,255	3,487	2.32%	146,768	97.68%
Officer and Warrant Officer	95,940	1,840	1.92%	94,100	98.08%	96,078	1,526	1.59%	94,552	98.41%
Enlisted	680,769	50,504	7.42%	630,265	92.58%	681,369	16,958	2.49%	664,411	97.51%
White	521,479	36,961	7.09%	484,518	92.91%	522,002	12,753	2.44%	509,249	97.56%
Black	130,761	7,805	5.97%	122,956	94.03%	130,924	2,981	2.28%	127,943	97.72%
Hispanic	47,076	2,887	6.13%	44,189	93.87%	47,044	1,016	2.16%	46,028	97.84%
Asian	28,952	1,195	4.13%	27,757	95.87%	28,914	446	1.54%	28,468	98.46%
Other Race	48,441	3,496	7.22%	44,945	92.78%	48,563	1,288	2.65%	47,275	97.35%

In addition to the basic information obtained from DEERS data, this study uses the TRICARE claims data merged with the CTS data to analyze the prevalence of major depression and substance abuse in the four branches of the military active duty population. The TRICARE data consists of four fundamental data sets containing outpatient data and inpatient data records.

### 1. Inpatient Medical Records for Major Depression and Substance Abuse

Inpatient is defined as a patient that receives care in an authorized institution and occupies a bed for receiving the necessary medical care. The minimum period of inpatient classification is 24 hours requiring a registration number and assignment of inpatient number (TRICARE Management Activity, 2006, p. 21). Active duty service personnel are authorized to receive care through military treatment facilities or authorized institutions. The primary route of care for active duty service personnel is a military treatment facility; however, if no facility is available or referral is necessary, service members are permitted to use authorized institutions. The data files relevant to inpatient

care are the standard inpatient data record (SIDR) and the TRICARE Encounter Data—Institutional (TEDI). The SIDR data contains records of active duty service personnel treated as inpatients at a military treatment facility. TRICARE encounter data consists of data for all care received and delivered under contract (TRICARE Management Activity, 2006, p. 37). TEDI contains data that may describe beneficiary identification, provider identification, and health information, such as place and type of service, diagnosis and treatment-related data, units of service and financial information. Each record for the TEDI identifies a single treatment record for active duty personnel treated in an authorized institution other than a military treatment facility.

## **2. Outpatient Medical Records for Major Depression and Substance Abuse**

TRICARE defines an outpatient as a patient who has not been admitted to a hospital or other authorized institution as an inpatient (TRICARE Management Activity, 2001, Appendix A, p. 44). Active duty service personnel are authorized to receive care through military treatment facilities or authorized civilian professional medical services for outpatient care. The primary route of care for active duty service personnel is a military treatment facility. According to TRICARE, eligible service members are permitted to seek care outside the military treatment facility if required medical services are not available in the military treatment facility or if there is a lack of adequate support services available to the service member. Referral from the primary care coordinator is required and noted in the service member's DEERS and Composite Health Care system (CHCS) records (TRICARE Management Activity, 2006, p. 38).

Non-institutional care for major depression and substance abuse data found in the TEDN2 data set data consists of care received by active duty service personnel from authorized providers for treatment.

The four data files from TRICARE (SADR, SIDR2, TEDI2, TEDN2) are instrumental in the merge process to identify individuals diagnosed with substance abuse and major depression. Merging the TRICARE data files creates major depression and

substance abuse variables with the unique EDIPN, which permits this data to be merged with the Defense Manpower Data Center data to create a working analytical file for the models in this study.

### **C. DEPLOYMENT DATA FROM DEFENSE MANPOWER DATA CENTER**

Defense Manpower Data Center (DMDC) data contains the Contingency Tracking System (CTS) data, which provides information on active duty service personnel deployment characteristics. A major focus of this study is the effects of deployment location and length on major depression and substance abuse across the four branches of service. The DMDC CTS data contains military specialty codes (MOS), deployment information for location and number of deployments from 2001 to 2006. Using the DMDC CTS data, it is possible to track personnel with multiple deployments and pair it with the TRICARE DEERS data for initial diagnosis date. For the purpose of this study, deployment focus is on Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). Deployment locations are categorized into the following three categories: (1) Iraq or Afghanistan, (2) classified or unknown locations, and (3) any other known countries under OEF and OIF. Navy personnel models have additional variables that account for ship versus shore deployments. Total days of deployment (from all deployments) are categorized into the following, 1 to 120 days, 121 to 180 days, 181 to 365 days and greater than 365 days. To evaluate deployment frequency, deployments is categorized by number of deployments, one, two and three or more to any location under OEF and OIF and Afghanistan or Iraq.

The DMDC CTS data set was merged with the DEERS data, which yields two working analytical files for model analysis.<sup>1</sup> Since major depression and substance abuse are the two major dependent variables, two analytical data files are required to answer the research questions. The merged dataset for major depression consists of 808,885 observations, of which 18,766 are diagnosed with major depression. The dataset for

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<sup>1</sup> Dennis Mar was the programmer that worked to create the base analytical files used for the foundation of this thesis.

substance abuse contains 808,135 observations for all active duty service personnel, out of which 52,869 are identified with a diagnosis of substance abuse. All duplicate observations with missing values are dropped.

#### **D. DATA SAMPLES**

To perform the analysis on the research questions for this thesis, the merged TRICARE DEERS and DMDC data is sub-organized into eight separate working analytical data files. Two files each for the Army, Marine Corps, Navy and Air Force. Each of the sub-organized data files contains the EDIPN, which is the unique personnel identifier that links all data. Those files missing EDIPN and date of birth were dropped from the data files. The purpose of the eight data files chiefly permits analysis of the research questions for the four respective branches of active duty service Army, Marine Corp, Navy and Air Force. Four of the working analytical data files are for analysis of the dependent variable of major depression diagnosis for each branch of active duty service personnel from 2001 to 2006, and four of the data files are for the dependent variable of substance abuse diagnosis for each branch of the active duty service personnel from 2001 to 2006. Each dataset contains the variables obtained by merging the TRICARE DEERS and DMDC data for demographics, diagnosis, year, military rank, specialty and deployment locations and length.

#### **E. RESTRICTIONS**

One restriction in this study was missing information in the TRICARE and DMDC data. There was a significant number of missing EDIPNS and missing dates of birth within the TRICARE DEERS data from 2001 to 2006. The missing EDIPNs and dates of birth affect the size of the sample since they were omitted from the study. A more precisely estimated analysis may have been possible with more observations. In addition to the missing dates of birth and EDIPNS, there were some observations with missing demographic information; however, they were not as significant. These observations are clearly omitted from the analysis.

A second restriction is the omission of the officer population in this study. The focus of this study is on the enlisted population from 2001 to 2006 deployed in the Global War on Terrorism (GWOT). Inclusion of officer observations would provide a more comprehensive view of the effects of major depression and substance abuse rates on deployment characteristics. However, since the focus is on the effects on enlisted personnel in the four active duty service branches, officers are not factored into the models for analysis.

## **F. SUMMARY**

Two main analytical files, one for major depression and one for substance abuse were generated from the merged data files from TRICARE and DMDC. Out of the two main analytical files, eight sub-data files were created to perform analysis on the research questions in this thesis. Each of the eight sub-data files were divided into four independent working data files for the Army, Marine Corps, Navy and Air Force.

Four of the active duty service data files have the dependent variables of major depression while the other four have substance abuse. The separate data files permits analysis of the three research questions. Each file contains all respective variables.



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## **IV. ANALYTICAL METHODOLOGY**

### **A. INTRODUCTION**

This chapter outlines the analytical methodology and the models used to perform the analysis for this thesis. Section B contains the research questions for this thesis and section C describes the research hypotheses. Section D discusses the empirical model for this thesis and provides details of the independent and dependant variables used. Finally, section E summarizes the key points of the chapter.

Additionally in this chapter, the summary statistics are presented with demographics for the substance abuse models and major depression models.

### **B. RESEARCH QUESTIONS**

The three research questions analyzed in this thesis focus on the diagnosis of major depression and substance abuse and the role this diagnosis plays in the Global War on Terrorism (GWOT). The research questions are described below.

- What are the rates of major depression and substance abuse amongst all active duty enlisted personnel and how do the rates differ by service and deployment?
- How does deployment location (specifically, Iraq and Afghanistan) affect the probability of being diagnosed with major depression and substance abuse?
- Is there a cumulative effect of deployments (i.e., frequency of separate tours and total days in theater) on major depression and substance abuse?

The remainder of this chapter focuses on the analytical methodology and models used to analyze the research questions presented in this thesis.

### **C. RESEARCH HYPOTHESES**

One of the main objectives of this thesis is to analyze the rates of major depression and substance abuse in the active duty population. Specifically, how the rates of these two mental health conditions differ across the four different branches of service.

Previous research indicates that deployment to Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) do indeed place active duty personnel at higher risk for mental health disorders. The author hypothesizes that the rate of major depression and substance abuse will increase for active duty enlisted personnel in the four service branches, as the result of OEF and OIF. The rate of major depression or substance abuse will mostly likely be higher for the Army and Marine Corps active duty enlisted personnel who have deployed to OEF and OIF than it will be for the Navy and Air Force. However, also hypothesized is that Navy and Air Force personnel deployed to OEF and OIF will also have a higher probability of being diagnosed with major depression and substance abuse as compared to those who have not been deployed to OEF or OIF. Both Army and Marine Corps personnel are more likely to be deployed to combat locations and in greater numbers. Navy and Air Force enlisted personnel are clearly deployed to OEF and OIF combat operations, but in smaller numbers and typically not as front line combat operations. However, Navy and Air Force personnel still experience the stressors associated with deployment to combat operations. Therefore, the author expects that they will have a higher probability of major depression and substance abuse diagnosis when compared to personnel who have never deployed to OEF and OIF operations. Additionally, it is suspected that for Navy personnel who have deployed, the probability of diagnosis might be higher because certain Navy ratings, such as medical personnel, often deploy with Marine Corps units.

Next, the author hypothesizes that the deployment location, specifically to Iraq, Afghanistan, or classified or unknown locations will increase the probability of being diagnosed with major depression and substance abuse relative to deployment to other locations. Lastly, also hypothesized is that there will be cumulative effect of deployments to OEF and OIF on major depression and substance abuse. The nature of deployment to combat locations poses stressors to military personnel. Threat of death, injury, witnessing the death or major injury of fellow personnel, along with the inherent stress of combat warfare, places deployed men and women at a risk for being diagnosed with major depression or substance abuse. Multiple deployments to OEF and OIF, the author

hypothesizes, will increase the probability of active duty service personnel being diagnosed with major depression or substance abuse. The cumulative effects of these deployments will positively affect the probability of being diagnosed.

To answer the three research questions and analyze the hypotheses regarding the effects of major depression and substance abuse amongst the enlisted population across the four services, the author implements descriptive and multivariate analyses. To isolate the effects of major depression and substance abuse, the multivariate analysis involves separate regressions conducted for each respective branch of service. The multivariate analysis for each branch of service uses the same models. The results and findings are discussed later in this thesis.

#### **D. EMPIRICAL MODEL**

The empirical model used for analysis is Non-Linear Probability, probit regression with binary indicators. Probit regression is used to perform the analysis and to estimate the effects of deployment location and duration (total days deployed and frequency of deployments) of deployment. The dependent variable, major depression or substance abuse, has the value of one or zero. A value of one represents a person being diagnosed with major depression or substance abuse, zero otherwise. Models are estimated separately for the Army, Marine Corps, Navy, and Air Force, and separately for each condition. In other words, each model described below is estimated eight times for the two different conditions and the four difference services.

##### **1. Independent Variables**

The base model used for probit regression is described below:

$$\Pr(y=1|x) = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

$X_1$  = Deployment characteristics

$X_2$  = Service and demographic characteristics

The vector of regressors  $X_1$ , which are assumed to influence the outcome  $Y$ , contains the key variables for deployment characteristics in the probit model. Deployment location, duration, and type of deployment (ship or shore for Navy) are different depending on the branch of service. Therefore, they are slightly different for the Navy model.

The vector of regressors  $X_2$ , which are assumed to influence the outcome  $Y$ , contains the variables for demographic and service characteristics in the probit model. Unlike the vector of  $X_1$ , these control variables do not change within the models. They remain constant through all regression models and for each branch of service.

**a. Deployment Characteristics**

The deployment characteristics contain the key variables of deployment used in the probit models. The key variables of interest are deployment locations, type of deployment (ship or shore) and duration of deployments (i.e., frequency of separate tours and the total days deployed in theater), which are described further below.

(1) Effect of Deployment Location. For the first model, *ever-deployed location* is used to estimate the effect of being diagnosed with major depression or substance abuse. *Ever-deployed location* is represented by an individual who has ever deployed to a location prior to a diagnosis of major depression or substance abuse from 2001 to 2006. The key variables used are binary variables of ever deployed under any OEF and OIF location, ever deployed to Iraq and Afghanistan, ever deployed to classified or unknown location, and ever deployed to shore (Navy specific). The location variables for the third model represent the frequency of deployments to any location under OEF and OIF and Afghanistan or Iraq. The key variables used are deployed only once, twice, and three or more times to any location under OEF and OIF and deployed to Iraq or Afghanistan only once, twice and three or more times. The reference group for the deployment location is those individuals who have not deployed. The expected findings are that individuals who have ever deployed under OEF and OIF will have a higher probability of being diagnosed with major depression or substance abuse.

In addition to the deployment location, the model also includes whether the service member is deployed ashore or on ship. This ship/shore indicator is only included in the Navy models. The reference group is those individuals who have ship deployments. The author anticipates that Navy personnel who have shore deployments will be more likely to have a diagnosis of major depression or substance abuse due the increased threats that they will encounter on shore deployments as opposed to shipboard deployments.

(2) Deployment Duration. The second model focuses on the effect of cumulative days of deployment on mental health readiness. Deployment duration consists of variables delineating total days deployed from all tours. For a person with only one tour, this represents the total days from that particular deployment. For a person with multiple tours, this represents the summation of all days from all tours. For ease of interpretation, the author further categorizes total days into the following: 1 to 120 days deployed, 121 to 180 days deployed, 181 to 365 days deployed, and 366 or more days deployed. Location of deployment is included in the model, consists of the ever-deployed variables to Iraq or Afghanistan and ever deployed to classified or unknown locations. The reference group is individuals who have no deployments. The expectation is that individuals who have the greatest number of days deployed will be more likely to have a diagnosis of major depression or substance abuse.

(3) Deployment Frequency. For the third model, the focus is analyzing the effect of frequency of separate deployments on mental health readiness. The key variables used are binary variables categorized as, deployed only once, twice, and three or more times under any OEF and OIF location and deployed to Iraq or Afghanistan only once, twice, and three or more times. In addition to model three, the author includes a comparison, 3.a, which includes total days deployed as a continuous variable to show the effects of frequency of deployments when total days is held constant. The reference group is individuals who have not been deployed. The expectation is that individuals who have the most deployments will be more likely to have a diagnosis of major depression or substance abuse.

***b. Service Characteristics***

Military Occupational Specialty (MOS) codes specify what a military member's occupation or job is within the given branch of service. An MOS will differ across the four service branches since the services code jobs differently. For the Marine Corps and the Army, the term military occupation code represents the specific job title and job function. The Navy uses a system to specify jobs called the Naval Enlisted Classification (NEC), and the Air Force uses a system termed Air Force Specialty Codes (AFSC). To ensure consistency for model analysis, MOS were categorized in specific and measurable binary variables. Although each branch of service does have its own military occupational code, they can be categorized to provide the consistency needed to perform analysis. The categories used are as follows: combat arms, combat support, combat service support, aviation, medical, and other MOS. Not all branches have observations for each category and some categories are merged due to the small number of observations. For analysis, combat arms is the reference group.

Pay grade is the second service specific characteristic that remains consistent throughout the models. Pay grade represents observations categorized into binary variables for enlisted personnel. The categories used for this analysis are E-1 to E-3(one variable), E-4, E-5, E-6, and E-7 to E-9 (one variable).The variable E-7 to E-9 is used as the reference group in all models.

***c. Demographic Characteristics***

The demographic characteristics used in the probit models consist of age, gender race, marital status, and fiscal year variables, which do not change through the course of the models.

(1) Age. The age variable is a continuous variable and is the age of the individual at the time of diagnosis with major depression or substance abuse. Any missing age observations take on the average of the age variable from non-missing observations.

(2) Gender. Gender is a binary variable that represents male or female observations. The variable used in analysis is female, which takes on the value of one. The reference group for analysis in all models is male.

(3) Race. Race variables consist of white, black, Hispanic, Asian, and others where each respective race variable takes on the value of one. The reference group for analysis in all models is the variable white.

(4) Marital Status. The marital status variables represent whether an individual is married or single. The variable single, which takes on the value of one, is used in all models. Therefore, the reference group is married for all models.

(5) Fiscal Year. The fiscal year is a binary variable that represents the years FY01, FY02, FY03, FY04, FY05, and FY06, and is intended to capture the macro trend in the two conditions over the years. The reference year for analysis in all models is FY01.

The pay grade service characteristics and all demographic characteristic remain constant through all of the models, unlike the key deployment variables of interest.

## **E. SUMMARY**

This chapter described the methodological approach to be used for multivariate analysis, as well as the prevalence of major depression and substance abuse. The four models combined with descriptive statistics were used to answer the research questions presented in this thesis. Descriptive statistics were evaluated to determine the overall probability of being diagnosed with major depression or substance abuse, which revealed that major depression rates were highest amongst Air Force personnel, while substance abuse rates were highest amongst the Navy enlisted. In addition, probit analysis models established the probability of enlisted personnel being diagnosed with major depression or substance abuse in the four branches of service. The results of the models described in this chapter are discussed in the next chapter.



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## **V. ANALYSIS RESULTS**

### **A. INTRODUCTION**

This chapter outlines the results of the descriptive statistics and the four probit models used to analyze the effects of deployment on the probability of being diagnosed with major depression or substance abuse. The results are compared across the Army, Marine Corps, Air Force and Navy to examine how the effects of deployment location and duration differ. Section B restates the research questions for this thesis. Sections C and D of this chapter discuss the descriptive statistics analysis and show the findings for the rate of diagnosis across the services. Section E presents the multivariate probit analysis and the findings across the four branches of service for major depression and substance abuse. Finally, section F summarizes the key points and findings of the chapter.

### **B. RESEARCH QUESTIONS**

The three research questions analyzed in this thesis focus on the diagnosis of major depression and substance abuse and the role these diagnoses have on the Global War on Terrorism (GWOT). The research questions are described below.

- What are the rates of major depression and substance abuse amongst all active duty enlisted personnel and how do the rates differ by service and deployment?
- How does deployment location (specifically, Iraq and Afghanistan) affect the probability of being diagnosed with major depression and substance abuse?
- Is there a cumulative effect of deployments (i.e., frequency of separate tours and total days in theater) on major depression and substance abuse?

The remainder of this chapter focuses on the analytical methodology and models used to analyze the research questions presented in this thesis.

## **C. DESCRIPTIVE STATISTICS ANALYSIS**

The purpose of this section is to first describe and analyze any trends in observations within the sample populations of major depression and substance abuse across the Army, Marines, Navy, and Air Force. The first section provides the basis for further analysis and contains descriptive statistics for the variables used for regression analysis. The second part of this section analyzes the rate of major depression and substance abuse across the four branches of service.

### **1. Descriptive Statistics for the Major Depression Sample Population**

Table 5 shows the descriptive statistics for deployment characteristics of location and duration of the major depression population across all four branches of service. The population sample comprises those service members who have at any time been deployed under OEF and OIF and called in this paper ever deployed under OEF and OIF, and represents the highest percentage of the population for location with the exception of the Navy. For the Navy, being deployed to classified or unknown locations represents the second largest percentage, 28.3 percent of the deployment location characteristics. Frequency of deployments represents the average number of deployments specified by never being deployed, deploying once, twice, or three or more deployments. Frequency of first deployments for the Marines, Navy, and Air Force tends to be highest, and then decreases as frequency of deployments increase. For the Army sample population, the trend is different, three or more deployments represent the highest percentage in the sample with first deployments representing the smallest percentage of deployments. Days deployed 1 to 120 is the largest percentage for duration of deployment across all four services. This trend, when compared with the average number of deployments, is consistent considering that first deployments represent the highest percentage in the sample population.

Table 5. Descriptive Statistics of Deployment Characteristics for Major Depression Samples of the Four Branches of Service

<b>Major Depression Deployment Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,871	98,808	134,734	112,956
<b>Location of OEF/OIF Deployment History</b>				
Ever Deployed under OEF/OIF	22.4%	24.7%	35.1%	37.9%
Ever Deployed to Afghanistan or Iraq	12.3%	8.9%	1.1%	5.7%
Ever Deployed to Classified or Unknown Location	2.4%	6.0%	28.3%	11.7%
Ever Deployed to Shore			28.4%	
<b>Frequency of Deployment</b>				
Not Deployed	77.6%	75.3%	64.9%	62.1%
Deployed Once	8.2%	11.5%	20.9%	18.8%
Deployed Twice	4.7%	7.1%	11.1%	11.3%
Deployed Three or More Times	9.5%	6.1%	3.1%	7.7%
Not Deployed to Afghanistan or Iraq	88.5%	91.3%	98.9%	94.7%
Deployed Afghanistan or Iraq Once	3.3%	3.8%	0.6%	2.7%
Deployed Afghanistan or Iraq Twice	3.1%	2.2%	0.3%	1.8%
Deployed Afghanistan or Iraq Three or More	5.2%	2.6%	0.1%	0.8%
Not Deployed to Classified Location	98.0%	95.5%	72.3%	90.1%
Deployed to Classified Location Once	0.8%	2.0%	16.5%	4.5%
Deployed to Classified Location Twice	0.5%	1.4%	8.9%	2.8%
Deployed to Classified Location Three or More Times	0.8%	1.1%	2.3%	2.6%
<b>Categories of Total Days Deployed</b>				
Days Deployed 0 (not deployed)	75.2%	73.7%	64.0%	61.4%
Days Deployed 1 to 120	22.6%	24.9%	35.3%	38.0%
Days Deployed 121 to 180	0.2%	0.2%	0.2%	0.2%
Days Deployed 181 to 365	1.1%	0.8%	0.5%	0.2%
Days Deployed 366 Plus	1.0%	0.4%	0.1%	0.1%
<b>Total Days of Deployment</b>				
Total Days Deployed	579	345	226	206
Total Days Deployed to Afghanistan or Iraq	397	282	223	172
Total Days Deployed to Classified Location	127	164	199	129

Table 6 shows the descriptive statistics of deployment characteristics for location and duration for the substance abuse sample population across all four branches of service. Those who were ever deployed under OEF and OIF ranges from 22.7 percent (Army) to 37.9 percent (Air Force). For the Army sample, those who were ever deployed to Afghanistan or Iraq (12.3 percent) is the largest percentage for this category; whereas, the trend for the Marines, Navy, and Air Force, for those who were ever deployed to a classified or unknown location, shows the largest percentage for deployment history by location. Frequency of deployment is highest for first deployments for the Marines, Navy, and Air Force. Subsequent frequency of deployments decreases. However, for the Army, the trend in frequency of deployments is greatest when deployed three or more times. For the Army, days deployed 1 to 120 is 22.9 percent of the sample population. Being deployed more than 365 days for the Army is 1.0 percent, which is much greater than the other three services for deployments greater than 365 days (Marines -0.4 percent, Navy -0.1 percent, and Air Force -0.1 percent). This may be an indication of more frequent or longer deployment for Army personnel.

Deployment characteristic descriptive statistics for major depression and substance abuse trends are very similar for each sample. The trends for both diagnoses show, those who were ever deployed under OEF and OIF is greatest across all branches. Deployment duration by total days of deployment is consistent for both sample populations. The percentage of the populations for days deployed across all branches is highest for 1 to 120 days of deployment with days of deployment of 181 to 365 days being the second highest group for both sample populations.

Table 6. Descriptive Statistics of Deployment Characteristics for Substance Abuse Samples of the Four Branches of Service

<b>Substance Abuse Deployment Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,434	98,778	134,711	112,846
<b>Location of OEF/OIF Deployment History</b>				
Ever Deployed under OEF/OIF	22.7%	24.9%	35.3%	37.9%
Ever Deployed to Afghanistan or Iraq	12.6%	9.0%	1.1%	5.7%
Ever Deployed to Classified or Unknown Location	2.4%	6.0%	2.8%	11.8%
Ever Deployed to Shore			28.4%	
<b>Frequency of Deployment</b>				
Not Deployed	77.3%	75.1%	64.7%	62.1%
Deployed Once	8.3%	11.7%	20.9%	18.9%
Deployed Twice	4.7%	7.2%	11.2%	11.4%
Deployed Three or More Times	9.7%	6.1%	3.1%	7.6%
Not Deployed to Afghanistan or Iraq	88.2%	91.2%	99.0%	94.7%
Deployed Afghanistan or Iraq Once	3.4%	3.8%	0.6%	2.6%
Deployed Afghanistan or Iraq Twice	3.1%	2.3%	0.3%	1.8%
Deployed Afghanistan or Iraq Three or More	5.3%	2.6%	0.1%	0.8%
Not Deployed to Classified Location	98.0%	95.6%	72.1%	90.1%
Deployed to Classified Location Once	0.8%	2.0%	16.5%	4.5%
Deployed to Classified Location Twice	0.4%	1.3%	9.0%	2.8%
Deployed to Classified Location Three or Times	0.8%	1.0%	2.4%	2.6%
<b>Categories of Total Days Deployed</b>				
Days Deployed 0 (not deployed)	74.8%	73.4%	63.8%	61.4%
Days Deployed 1 to 120	22.9%	25.1%	35.4%	38.0%
Days Deployed 121 to 180	0.2%	0.2%	0.2%	0.2%
Days Deployed 181 to 365	1.1%	0.8%	0.5%	0.2%
Days Deployed 366 Plus	1.0%	0.4%	0.1%	0.1%
<b>Total Days of Deployment</b>				
Total Days Deployed	578.8	344.5	226.0	205.1
Total Days Deployed to Afghanistan or Iraq	396.8	281.8	223.5	170.8
Total Days Deployed to Classified Location	126.2	166.3	199.3	127.5

*a. Service Characteristics*

Table 7 shows descriptive statistics for Military Occupational Service Codes (MOS) and rank for the major depression sample population for all four services. Table 8 is the descriptive statistics for the substance abuse sample population. Combat arms and combat support service tend to represent the highest percentage of the sample population for the Army and Marines. This would be an expected finding since both services tend to have more personnel who fall into these categories. The Navy’s highest percentage of representation is within the Other MOS category while the Air Force has combat service support, at 76.8 percent as the highest representation in the sample. The sample population tends toward E-1 to E-3 representing the highest number of the population with E-7 to E-9 the lowest. Of course, this tendency is entirely in line with active duty military structures showing higher percentages of lower ranking enlisted and lower percentages of higher ranking enlisted.

Table 7. Descriptive Statistics of Service Characteristics for Major Depression Samples of the Four Branches of Service

<b>Major Depression Service Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,871	98,808	134,734	112,956
<b>Military Occupational Specialty</b>				
Combat Arms	27.7%	37.0%	4.6%	10.4%
Combat Support	10.3%	16.1%	9.3%	0.2%
Combat Service Support	25.4%	26.9%	5.4%	76.8%
Aviation	0.0%	14.6%	3.3%	0.0%
Medical	9.7%	0.1%	2.9%	0.4%
Other MOS	26.8%	5.4%	74.5%	12.2%
<b>Rank</b>				
E1-E3	34.1%	62.0%	38.8%	32.8%
E4	28.7%	17.0%	19.9%	18.5%
E5	17.7%	10.9%	20.5%	22.9%
E6	11.3%	5.6%	13.5%	14.3%
E7-E9	8.2%	4.4%	7.4%	11.5%

Table 8. Descriptive Statistics of Service Characteristics for Substance Abuse Samples of the Four Branches of Service

<b>Substance Abuse Service Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,434	98,778	134,711	112,846
<b>Military Occupational Specialty*</b>				
Combat Arms	27.9%	37.2%	4.6%	10.3%
Combat Support	10.4%	16.2%	9.3%	0.2%
Combat Service Support	25.4%	26.9%	5.4%	76.7%
Aviation	0.0%	14.6%	3.3%	0.1%
Medical	9.8%	0.1%	2.9%	0.4%
Other MOS	26.6%	5.2%	74.6%	12.4%
<b>Rank</b>				
E1-E3	34.0%	62.2%	38.8%	32.7%
E4	28.8%	16.9%	20.0%	18.7%
E5	17.7%	10.9%	20.4%	22.9%
E6	11.3%	5.6%	13.5%	14.2%
E7-E9	8.2%	4.4%	7.3%	11.5%

*b. Demographic Characteristics*

Demographic characteristics encompass race, gender, marital status, and average age of the sample population for major depression and substance abuse. Tables 9 and 10 show the descriptive statistics for the demographic characteristics of each sample population across the four branches of service. The sample population trends across all branches of service show single, white, and male represent the largest demographic groups. The Marines gender difference is the greatest across all branches of service with only 4.0 percent of females represented in both the major depression and substance abuse sample populations. The mean age is 27 for both major depression and substance abuse sample populations.



Table 9. Descriptive Statistics of Demographic Characteristics for Major Depression Samples of the Four Branches of Service

<b>Major Depression Demographic Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,871	98,808	134,734	112,956
<b>Gender</b>				
Male	88.2%	96.0%	86.4%	83.0%
Female	11.8%	4.0%	13.6%	17.0%
<b>Marital Status</b>				
Single	53.2%	69.2%	55.0%	48.3%
Married	46.8%	30.8%	45.0%	51.7%
<b>Race</b>				
White	63.8%	71.3%	57.3%	74.0%
Black	19.6%	10.2%	21.5%	15.4%
Hispanic	6.8%	8.1%	7.2%	3.4%
Asian	3.8%	2.8%	5.9%	2.2%
Other races	6.0%	7.6%	8.0%	5.0%
<b>Age</b>	28	23	27	28

Table 10. Descriptive Statistics of Demographic Characteristics for Substance Abuse Samples of the Four Branches of Service

<b>Substance Abuse Demographic Characteristics</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
<b>Sample Size</b>	334,434	98,778	134,711	112,846
<b>Gender</b>				
Male	88.2%	96.0%	86.3%	83.0%
Female	11.8%	4.0%	13.7%	17.0%
<b>Marital Status</b>				
Single	53.3%	69.1%	55.2%	48.4%
Married	46.7%	30.9%	44.8%	51.6%
<b>Race</b>				
White	63.8%	71.2%	57.3%	74.1%
Black	19.6%	10.2%	21.5%	15.4%
Hispanic	6.8%	8.1%	7.3%	3.4%
Asian	3.8%	2.8%	5.9%	2.2%
Other races	5.9%	7.6%	8.0%	5.0%
<b>Age</b>	28	23	27	28

## D. RATE OF MAJOR DEPRESSION AND SUBSTANCE ABUSE DIAGNOSIS

### 1. Overall Rate of Diagnosis for Major Depression and Substance Abuse

Figures 1 and 2 show the overall rates of diagnosis for major depression and substance abuse across the four branches of service. The differences in rate of diagnosis for major depression and substance abuse are noticeable in the sample populations. The overall rate of major depression diagnosis is highest for the Air Force, 3.0 percent whereas the highest overall rate of substance abuse is largest for the Navy at 8.8 percent. Substance abuse rates are significantly higher than rates of diagnosis for major depression for the sample populations. The average rate of diagnosis across the four services for substance abuse is 7.2 percent as compared to major depression diagnosis with an average rate of 2.3 percent. The higher rate of substance abuse diagnosis may be due to aggressive screening and awareness of substance abuse issues in the military.

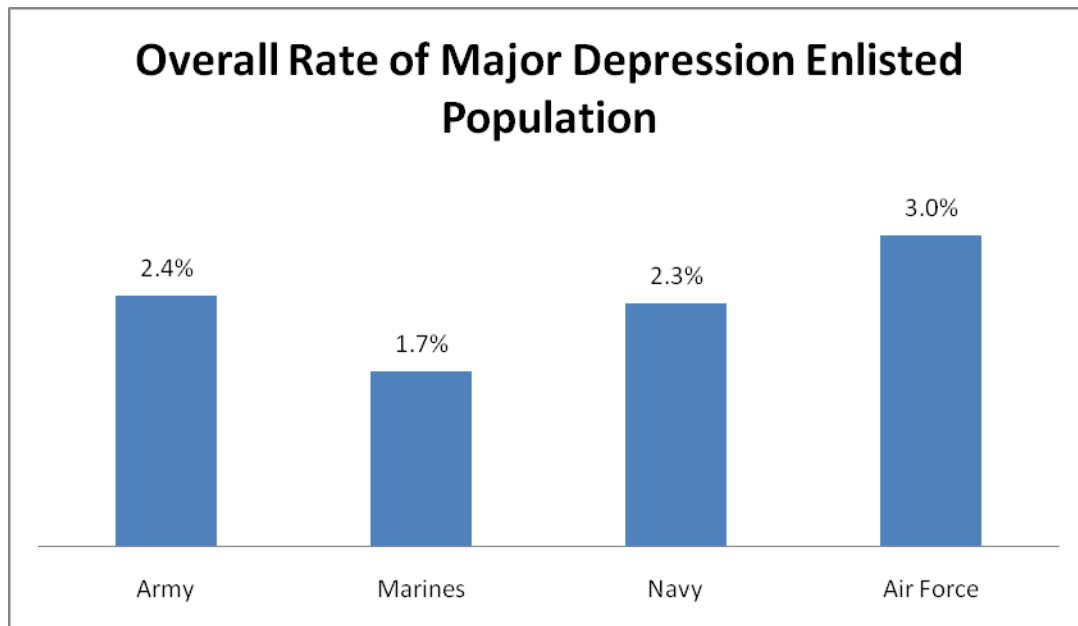


Figure 1. Overall Rate of Diagnosis of Major Depression

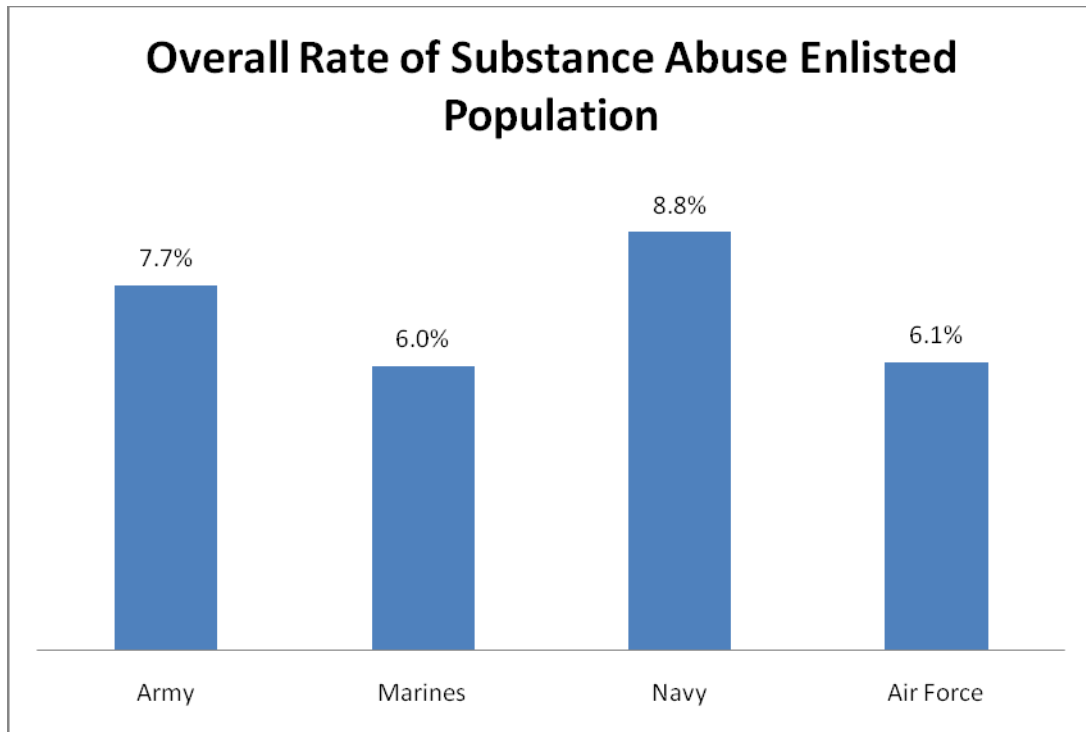


Figure 2. Overall Rate of Diagnosis of Substance Abuse

*a. Rate of Deployment Characteristics for Major Depression*

The overall rates of major depression and the major depression rate by deployment history are shown in Table 11.

Table 11. Rate of Major Depression Diagnosis by Deployment Duration and Location

<b>Rate of Major Depression Diagnosis</b>	<b>Army</b>	<b>Marines</b>	<b>Navy</b>	<b>Air Force</b>
Sample Size with Major Depression	8,366	1,703	3,222	3,667
<b>Based on Deployment History</b>				
Non-Deployed Population	1.5%	1.1%	2.0%	2.9%
Ever Deployed under OEF/OIF	5.1%	3.4%	2.7%	3.4%
Ever Deployed to Afghanistan or Iraq	3.0%	2.4%	2.5%	2.5%
Ever Deployed to Classified or Unknown Location	1.9%	1.1%	1.7%	2.1%

The rate of major depression diagnosis is similar across the four services. Generally, the percentage of non-deployed personnel diagnosed with major depression is less than 3 percent. The rate of diagnosis for personnel who were ever deployed under OEF and OIF (regardless of locations) for the sample population is highest for Army enlisted personnel at a 5.1 percent for the study period, and lowest among the Navy personnel at a 2.7 percent. For people who were ever deployed to Afghanistan or Iraq, the rate of major depression diagnosis is highest for the Army at 3.0 percent diagnosed. Across the four services, the rate of diagnosis for major depression when those who were deployed to a classified or unknown location is smallest out of all categories evaluated. Marines show the smallest rate of diagnosis at 1.1 percent of the sample population.

***b. Rate of Deployment Duration (Total Days Deployed) for Major Depression***

Analysis of the total days deployed under OEF and OIF shows (Figure 3) that rates of diagnosis with major depression increase considerably after 120 days of deployment. This is not to say, that rates of diagnosis for non-deployed or deployment of 1 to 120 days are trivial. Simply, that in the sample population, the rates of diagnosis tend to increase with total days of deployment. The Air Force, for example, tends to show the greatest increase, 26.6 percent in major depression diagnosis for those who have deployments of 121 to 180 days as compared to total days of deployment greater than one year—24.0 percent. The same trend is noted with the other three branches of service. The highest rate of diagnosis in the Army sample population is 11.1 percent for total days of deployment, 121 to 180 days. The Marines show a 6.5 percent rate of major depression diagnosis for both total days deployed of 121 to 180 days and greater than one year 7.2 percent. The Navy sample population experiences the highest rate of diagnosis at 121 to 180 days of deployment. Overall, the greatest effect on the increase in rates of major depression diagnosis across the four branches of service comes from total days of deployment of 121 to 180 days.

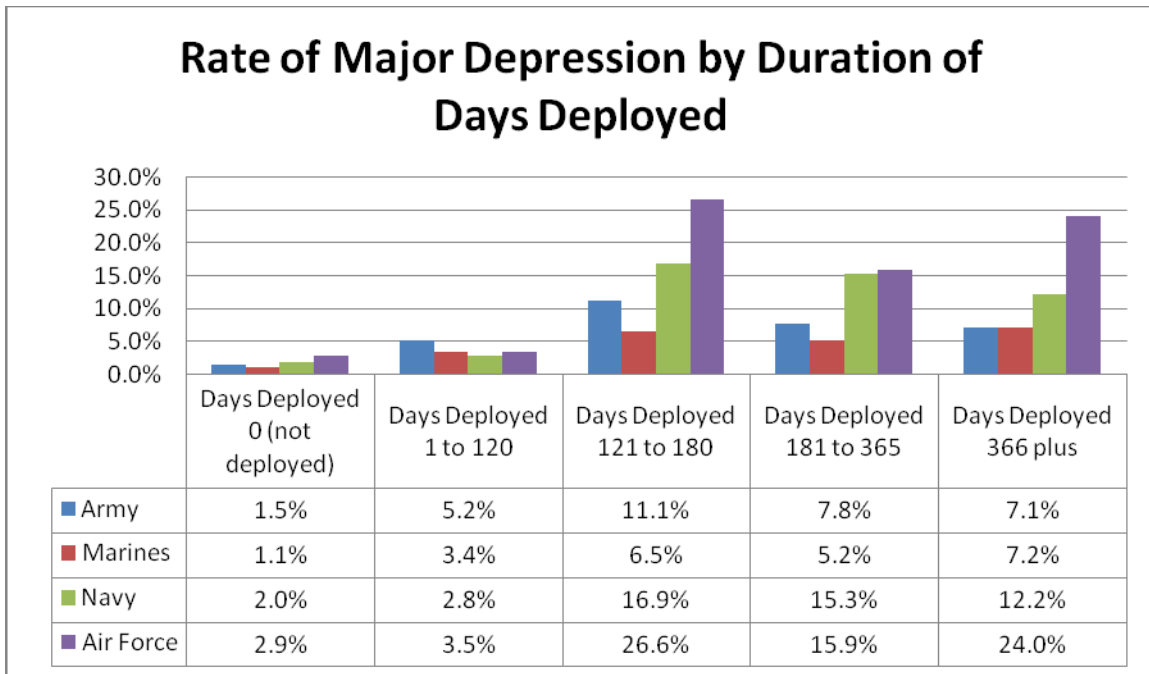


Figure 3. Rate of Major Depression Diagnosis by Duration of Total Days Deployed

*c. Rate of Deployment Characteristics for Substance Abuse*

Table 12 shows the rates of substance abuse diagnosis for deployment location and duration (total days deployed). The table represents the total sample population across the four service branches that have a diagnosis of substance abuse.

Table 12. Rate of Substance Abuse Diagnosis by Deployment Duration and Location

Rate of Substance Abuse Diagnosis	Army	Marines	Navy	Air Force
Sample Size with Substance Abuse	25,804	5,931	11,898	6,871
<b>Based on Deployment History</b>				
Non-Deployed Population	5.7%	4.8%	7.8%	5.8%
Ever Deployed under OEF/OIF	13.4%	8.9%	10.4%	6.3%
Ever Deployed to Afghanistan or Iraq	14.8%	9.4%	8.7%	7.1%
Ever Deployed to Classified or Unknown Location	5.7%	9.1%	10.4%	4.6%
Days Deployed 0 (not deployed)	5.7%	4.8%	7.8%	5.8%

Table 12 shows the rate of substance abuse diagnosis is slightly different from the major depression rates. Generally, the percentage of the non-deployed personnel diagnosed with substance abuse is less than 8 percent. For enlisted personnel who were ever deployed under any OEF and OIF (regardless of locations), the Army and Navy show the highest rates of substance abuse. Army enlisted personnel who were ever deployed to Afghanistan or Iraq for the study period show the highest rate of diagnosis out of the four branches. Similar to the major depression rates, substance abuse rates of diagnosis for those people who were ever deployed to a classified or unknown location is generally smaller than the deployment to other locations. Navy personnel who were ever deployed under OEF and OIF (regardless of locations) and those who were ever deployed to a classified or unknown location have the largest rates at 10.4 percent, which is only 1.7 percentage points greater than those who were ever deployed to Afghanistan or Iraq at 8.7 percent. Dissimilar to the other three services, Navy rates of diagnosis appear equally great for any OEF or OIF, and a classified or unknown location.

*d. Rate of Deployment Duration (Total Days Deployed) for Substance Abuse*

Figure 4 shows the rate of substance abuse diagnosis for the duration of deployment (total days deployed) for all four branches of service. Similar to the major depression trend, the percentage of substance abuse diagnosis is greatest for the sample population that has deployed greater than 121 to 180 days in total. There is a consistent trend for increases in rate of diagnosis for the Army, Navy, and Air Force with increased number of days deployed. The Navy, on the other hand, experiences the highest rate of diagnosis for deployments greater than 365 days, at 20.8 percent.

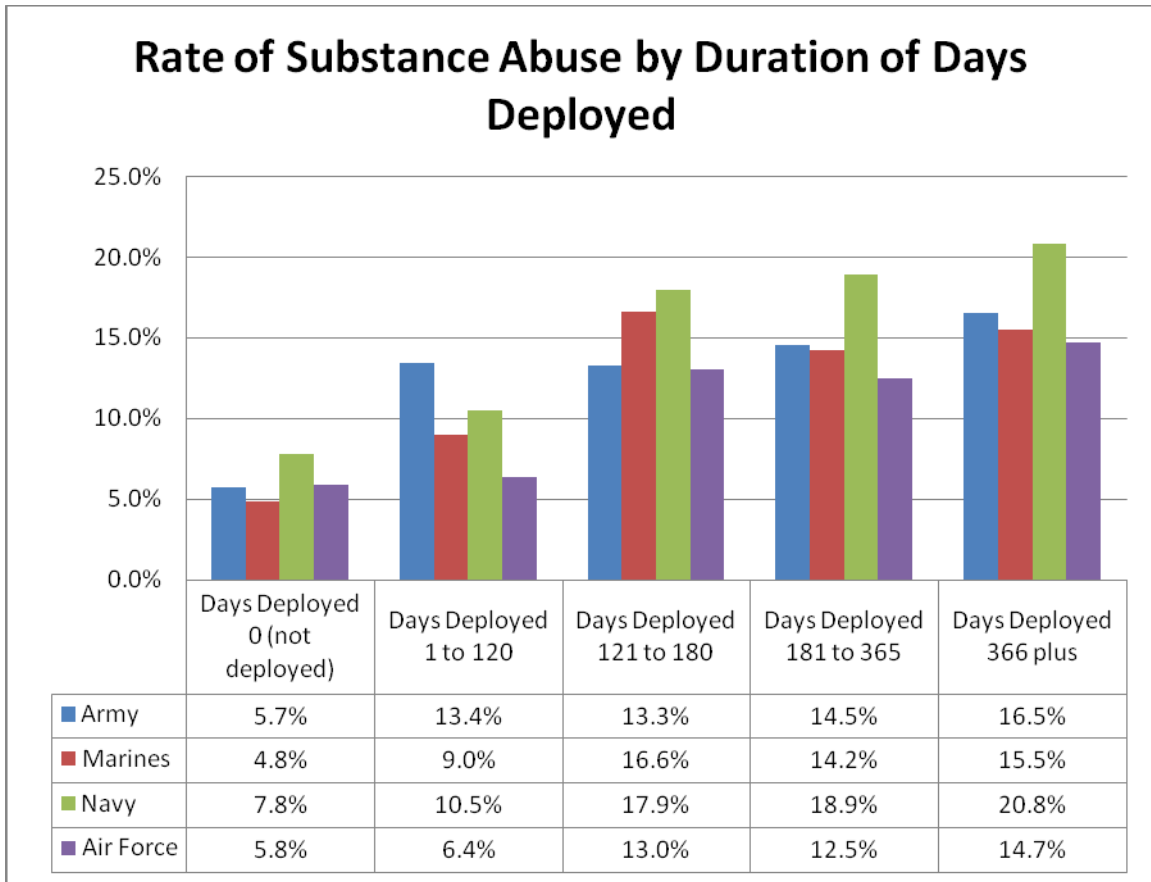


Figure 4. Rate Substance Abuse Diagnosis Duration of Total Days Deployed

**E. RESULTS OF REGRESSION ANALYSIS: EFFECT OF DEPLOYMENT ON PROBABILITY OF BEING DIAGNOSED WITH MAJOR DEPRESSION OR SUBSTANCE ABUSE**

This section discusses the results of the multivariate probit models used to estimate the effects of deployment on the probability of being diagnosed with major depression or substance abuse. Independent analyses were conducted for each model across the four branches of service for the enlisted population between 2001 and 2006. The results were then compared across the services to evaluate whether differences exist in the sample populations.

Four multivariate probit models were used in this thesis, with each model analyzed separately for the Army, Marines Corps, Navy, and Air Force enlisted study

population. The key variables of interest used to estimate deployment effects on the probability of being diagnosed with major depression or substance abuse naturally change with each model (i.e., the ever being deployed variables, frequency of deployment variables and total days of deployment variables). Service characteristics, such as MOS and rank, and demographic variables, such as marital status, gender, race, age, and year dummies, remain constant for all four models. One probit model contains frequency variables as the key variables and uses total days deployed as the continuous variable. This model is used with the third multivariate model to show the effect of the frequency of tours. A brief description of the three main models used for analysis is provided below.

## **1. Model Descriptions**

### ***a. Model 1: Effect of Ever Being Deployed by Location***

The first model estimates the effect of ever being deployed to a location on the probability of being diagnosed with major depression or substance abuse. Ever deployed refers to an individual who has at any time been deployed under OEF and OIF prior to a diagnosis of major depression or substance abuse. Model 1 also examines whether a sailor has ever been deployed to ship or shore.

### ***b. Model 2: Effect of Total Days Deployed and Ever Being Deployed***

The second model considers the effect of total days of deployment, while controlling for deployment location on the probability of being diagnosed with major depression or substance abuse. The total days of deployment is divided into categories for easier interpretation.



*c. Model 3 and 3.a: Effect of Frequency of Deployment Under OEF/OIF*

The third model estimates the effect of frequency of deployment under OEF and OIF on the probability of being diagnosed with major depression or substance abuse. The model uses variables to estimate the effect of the number of deployments under OEF and OIF and to Afghanistan or Iraq during the study period.

**2. Results of Model 1: Effect of Ever Being Deployed By Location for Major Depression and Substance Abuse**

*a. Model 1 Results for Major Depression*

The first multivariate probit model estimates the effects of those who were ever deployed on the probability of being diagnosed with major depression and substance abuse. In addition to this model, the effect on Navy sailors who were deployed to shore is analyzed. Table 13 shows the results of the probit model for major depression across the four branches of service and Table 14 shows the results for the substance abuse sample population.

Table 13. Model 1: Effects of Ever Being Deployed on Major Depression

Effect of Ever Being Deployed on Major Depression	<b>Model 1</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Location of Deployment (reference group is not deployed under OEF/OIF)</b>				
Ever Deployed	0.037*** (0.001)	0.018*** (0.001)	0.014*** (0.001)	0.023*** (0.002)
Ever Deployed to Afghanistan or Iraq	0.002** (0.001)	0.006*** (0.001)	0.001 (0.002)	0.011*** (0.004)
Ever Deployed to Classified Location	-0.011*** (0.001)	-0.004*** (0.001)	-0.007*** (0.001)	-0.005*** (0.001)
Ever Deployed to Shore				-0.013*** (0.001)
Sample size	334,871	98,808	112,956	134,734

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

All deployment variables are statistically significant at the conventional level, except for Air Force when comparing deployment to Afghanistan and Iraq to deployment to other locations. The reference group is comprised of those who were never deployed.

The effect of those who were ever deployed for the average enlisted person in the Army is a 0.037 or 3.7 percentage points change in the probability of being diagnosed with major depression. Among those who deployed, being deployed to Afghanistan or Iraq results in an even higher rate of major depression compared to those who deployed to other known locations. Specifically, this location category raises the probability of major depression by 0.2 percentage points on top of the 3.7 percentage point increase. The final coefficient ever deployed to a classified or unknown location is negative (-0.011, p<0.01), indicating that the effect of those soldiers who deployed to a classified or unknown location is a 2.6 percentage points change (3.7-1.1=2.6).

The Marines Corps results show the effect of those who were ever deployed for the average Marines is a 0.018 or 1.8 percentage points change in the probability of being diagnosed with major depression. Deployment to Afghanistan or Iraq further increases that probability by another 0.6 percentage points change. Deployment to a classified or unknown location has a moderating effect, reducing the rate of major depression by a -0.4 percentage points compared to those who deployed to other known locations (i.e., the average rate of major depression among those Marine Corp personnel is  $1.8-0.4=1.4$  percent).

For the Air Force, the effect of those who were ever deployed for the average enlisted is a 0.014 or 1.4 percentage points change in the probability of being diagnosed with major depression. Deployment to Afghanistan or Iraq only slightly increases the probability by a 0.01 percentage point, thus making the probability a 1.5 percentage points change. Like the Army and Marines, the probability of those airmen who were deployed, regardless of location is significant. However, Air Force personnel exhibit the smallest increases, which is perhaps related to the difference in front line combat exposure between the services. The coefficient ever deployed to a classified or unknown location shows airmen have a much lower probability of being diagnosed with major depression as compared to the other categories with a 0.7 percentage points effect in the probability in diagnosis with major depression.

Results show for the Navy, being deployed to Afghanistan or Iraq is the largest probability of diagnosis with major depression for all deployment location categories at a 3.5 percentage points change, this is a 1.1 percentage point increase over personnel who were ever deployed under OEF and OIF. The effect of those who were ever deployed to any OEF and OIF location for the average sailor is a 0.024 or 2.4 percentage points change in the probability of being diagnosed with major depression. The coefficient ever deployed to a classified or unknown location and deployed to shore, has a moderating effect. Deployed to a classified or unknown location shows the average sailor has a negative coefficient, -0.005, the adjusted percentage points difference is a 1.9 percentage points change in the probability of being diagnosed with major depression;

deployed to shore is a 1.1 percentage points change. This indicates sailors have a smaller risk of major depression when deployed to shore or a classified location as compared to deployments to other OEF and OIF locations.

***b. Summary of Model 1 Major Depression Across the Four Branches of Service***

Table 13 shows that the average active duty enlisted person for the Army, Marine Corps, Air Force, and Navy has a higher probability of being diagnosed with major depression if they were ever deployed under OEF and OIF between 2001 and 2006 than those who were never deployed. Deployment to Afghanistan and Iraq increases the probability of major depression even more compared to those who deployed to other known locations for all services, except for the Air Force. On the other hand, deployment to a classified or unknown location or shore for Navy, appear to moderate the rate of major depression diagnosis compared to deployment to other locations, although this group of enlisted still has a higher rate of diagnosis as compared to the non-deployed population.

***c. Model 1 Results for Substance Abuse***

The first multivariate probit model estimates the effects of ever being deployed on the probability of being diagnosed with substance abuse. In addition to this model, the effects of Navy sailors deployed to shore are analyzed. Table 14 shows the results of the probit model for substance abuse for all four branches of service.

Table 14. Model 1: Effects of Ever Being Deployed on Substance Abuse

Effect of Ever Being Deployed on Substance Abuse	Model 1			
	Army	Marines	Air Force	Navy
<b>Location of Deployment (reference group is not deployed under OEF/OIF)</b>				
Ever Deployed	0.116*** (0.002)	0.061*** (0.003)	0.030*** (0.002)	0.074*** (0.005)
Ever Deployed to Afghanistan or Iraq	0.016*** (0.002)	0.023*** (0.004)	0.008** (0.003)	-0.008 (0.007)
Ever Deployed to Classified Location	-0.043*** (0.001)	0.004 (0.003)	-0.017*** (0.002)	-0.002 (0.003)
Ever Deployed to Shore				-0.021*** (0.003)
Sample size	334,434	98,778	112,846	134,711

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

All deployment variables are statistically significant at the conventional level, except for Navy when comparing deployment to Afghanistan and Iraq to deployment to other locations and for deployments to a classified or unknown location for Marines and Navy. The reference group is comprised of those who were never deployed.

The effect of those who were ever deployed for the average enlisted person in the Army is a 0.116 or 11.6 percentage points change in the probability of being diagnosed with substance abuse. The probability increases among those who were deployed to Afghanistan or Iraq by an additional 1.6 percentage points. This represents the highest probability of diagnosis, totaling 13.2 percentage points, indicating that deployment, specifically to Afghanistan or Iraq poses a significant risk to Army personnel. The final coefficient ever deployed to a classified or unknown location is a -4.3, meaning that it has a moderating effect and that those soldiers who were deployed to

a classified or unknown location have a 7.3 percentage points higher probability of being diagnosed with substance abuse compared to the non-deployed population ( $11.6-4.3=7.3$  percentage points).

For Marines the effect of those who were ever deployed for the average enlisted person is a 6.1 percentage points change in the probability of being diagnosed with substance abuse. Deployments to Afghanistan or Iraq increases the probability of diagnosis by a added 2.3 percentage points change, the adjusted difference increases the probability to an 8.4 percentage points change, showing that deployments to Afghanistan or Iraq have a much higher effect for Marines.

The Air Force results show that airmen who were ever deployed is a 3.0 percentage point change in the probability of being diagnosed with substance abuse. For the Air Force deployments solely to Afghanistan or Iraq is the highest probability of diagnosis with substance abuse, 3.8 percentage points ( $3.0+0.8=3.8$ ). Deployments to Afghanistan or Iraq, specifically places airmen at the greatest risk for a diagnosis of substance abuse. However, the rate of diagnosis is smaller than the other services, which may be due to less frontline combat exposure. Similar to the other services deployment to a classified or unknown location shows a moderating effect, reducing the rate of substance abuse for the average person in the Air Force. The effect has a negative coefficient, (-1.7,  $p.<0.01$ ), with the adjusted difference of a 1.3 percentage points change in the probability of being diagnosed with substance abuse for deployment to a classified or unknown location, indicating this deployment category has a smaller risk of diagnosis for airmen.

For the Navy results show two statistically significant coefficients, ever deployed and ever deployed to shore. The effect for the average sailor who was ever deployed is a 0.074 or 7.4 percentage points change in the probability of being diagnosed with substance abuse. Among those who deployed to shore the results are lower rates of substance abuse as compared to those who were deployed to sea under OEF and OIF. Specifically the probability of being diagnosed with substance abuse for those who were deployed to shore is a negative, -2.1, indicating the effect of shore deployment is a 5.3 percentage points change. For the Navy, the magnitude is smallest for those sailors who

were deployed to shore, and is consistent with the major depression shore deployments finding, indicating no significant difference exists in the probability of diagnosis for shore deployments.

*d. Summary of Model 1 Substance Abuse Across the Four Branches of Service*

Table 14 shows that the average active duty enlisted person for the Army, Marine Corps, Air Force, and Navy has a higher probability of being diagnosed with substance abuse if they were ever deployed under OEF and OIF between 2001 and 2006 than those who never deployed. The magnitude of the effect is even bigger than those reported in Table 13 (major depression). The effect of location is similar to the results from Table 13, in that deployment to Afghanistan and Iraq increases the probability of substance abuse even more compared to those who deployed to other known locations for all services, except for Air Force. On the other hand, deployment to a classified or unknown location or shore for Navy, appear to moderate the rate of substance abuse diagnosis compared to deployment to other locations, although this group of enlisted still has a higher rate of diagnosis as compared to the non-deployed population.

**3. Results of Model 2: Effect of Total Days Deployed**

The second model considers the total days of deployment and evaluation between ever being deployed to a specific location on the probability of being diagnosed with major depression or substance abuse. The total days of deployment is isolated into groups to estimate whether the number of days deployed affects the probability of being diagnosed with either of the dependent variables. Table 15 shows the results of the probit model for major depression for all branches of service and Table 16 shows the results for the substance abuse sample population.

Table 15. Model 2: Effects of Total Days of Deployment on Major Depression

Effects of Total Days of Deployment on Major Depression	Model 2			
	Army	Marines	Air Force	Navy
<b>Deployment Days (reference group not deployed)</b>				
Days Deployed 1 to 120	0.040*** (0.001)	0.018*** (0.001)	0.016*** (0.001)	0.013*** (0.002)
Days Deployed 121 to 180	0.079*** (0.011)	0.013* (0.007)	0.103*** (0.017)	0.077*** (0.016)
Days Deployed 181 to 365	0.053*** (0.004)	0.006* (0.003)	0.034*** (0.011)	0.077*** (0.011)
Days Deployed 366 Plus	0.048*** (0.004)	0.017*** (0.006)	0.077*** (0.025)	0.074*** (0.021)
Ever Deployed to Afghanistan or Iraq	0.001* (0.001)	0.006*** (0.001)	0.001 (0.002)	0.011*** (0.004)
Ever Deployed to Classified Location	-0.011*** (0.001)	-0.004*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)
Sample size	334,871	98,808	112,956	134,734

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

*a. Model 2 Results for Major Depression*

All deployment variables are statistically significant at the conventional level, except for Air Force when comparing deployment to Afghanistan and Iraq to the total days deployment variables. The reference group is zero days deployed, or otherwise stated never deployed.

The effect of those who were deployed from 1 to 120 days for the average active duty enlisted Army service member is a 0.04 or 4.0 percentage point change in the probability of being diagnosed with major depression. For those who deployed from 121 to 180 days the probability is a 7.9 percentage points change. Deployment for four to six months shows the highest probability of diagnosis with major depression for soldiers. Deployments of 181 to 365 days the coefficient is 0.053 meaning that the percentage points change is 5.3. This indicates that, for the Army, six months to a year of deployment has the second highest probability of diagnosis. Finally, the effect of those who deployed greater than 365 days is a 0.048 or 4.8 percentage points change in the probability of being diagnosed with major depression.



The analysis shows that for the Marines, the largest effect of those who were deployed from 1 to 120 days is a 1.8 percentage points change in the probability of being diagnosed with major depression whereas, the smallest probability of being diagnosed with major depression is when deployment is 181 to 365 days, a 0.6 percentage points change. A possible theory is a selection bias issue exists in the first few months of the deployment for enlisted Marines.

The Air Force's largest effect is similar to the Army results. Those airmen who were deployed for 121 to 180 days show a 0.103 or 10.3 percentage points change in the probability of being diagnosed with major depression. The smallest effect for airmen is deployment from 1 to 120 days, which is a 1.6 percentage points change in the probability of being diagnosed with major depression. The Air Force's probability of major depression is generally highest out of all the services. It is unclear, but this may be a reflection of deployment tempos specific to the Air Force.

For the Navy the largest effect of being deployed, is similar to the Army and the Air Force. For those sailors who were deployed for 121 to 180 days the results show a 7.7 percentage points change in the probability of being diagnosed with major depression. However, for those who deployed for 181 to 365 days the result is equally as high, 7.7 percentage points change. Deployment greater than 365 days is slightly lower at a 7.4 percentage points change in the probability of diagnosis. The smallest coefficient is deployment for 1 to 120 days, with a 0.013 or 1.3 percentage points change in the probability of being diagnosed with major depression. The larger effects for the Navy, deployed essentially for 121 to 365 days may be attributed to the deployment tempos Navy personnel experience. Longer deployments appear to increase the probability of diagnosis with major depression.

***b. Summary of Model 2 Major Depression Across the Four Branches of Service***

Model 2 shows that multiple days of deployment increases the probability of being diagnosed with major depression for the average active duty enlisted person across the four branches of service. Total days deployed of 121 to 180 for the Army, Air

Force and Navy are the highest probability of being diagnosed. However, for the Marine Corps deployed for 1 to 120 days and greater represents the highest probability of diagnosis. It appears that deployments ranging from six months to a year have a more pronounced effect on service personnel. The slight variability in the findings may be a reflection of duration of deployments for each service. Interestingly, the Air Force shows the largest increase in probability of diagnosis with major depression with a 10.3 percentage points change. The large magnitude for the Air Force is unclear, but the significantly larger probability could be attributed to a selection bias or to deployment tempos, which differ across the services. Furthermore, the more days deployed in general increases the probability of diagnosis of major depression regardless of branch of service.

*c. Model 2 Results for Substance Abuse*

Table 16 shows the results of the probit model for substance abuse across the four branches of service.

Table 16. Model 2: Effects of Total Days of Deployment on Substance Abuse

Effects of Total Days of Deployment on Substance Abuse	<b>Model 2</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Deployment Days (reference group is not deployed)</b>				
Days Deployed 1 to 120	0.119***	0.064***	0.031***	0.058***
	(0.002)	(0.003)	(0.002)	(0.004)
Days Deployed 121 to 180	0.070***	0.080***	0.050***	0.077***
	(0.013)	(0.022)	(0.018)	(0.023)
Days Deployed 181 to 365	0.094***	0.074***	0.039**	0.093***
	(0.006)	(0.012)	(0.017)	(0.015)
Days Deployed 366 plus	0.100***	0.080***	0.053**	0.116***
	(0.007)	(0.016)	(0.027)	(0.029)
Ever Deployed to Afghanistan or Iraq	0.016***	0.022***	0.008**	-0.007
	(0.002)	(0.003)	(0.003)	(0.007)
Ever Deployed to Classified Location	-0.042***	0.003	-0.017***	-0.004
	(0.001)	(0.003)	(0.002)	(0.003)
Sample size	334,434	98,778	112,846	134,711

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

All deployment variables are statistically significant at the conventional level, except for Navy when comparing deployment to Afghanistan and Iraq to the frequency of deployment variables and for deployments to a classified locations for Marines and Navy. The reference group is those who were never deployed.

Analysis results for the Army show that the largest effects are for those who deployed from 1 to 120 days and those who deployed greater than 365 days. Soldiers who deployed from 1 to 120 days have a 11.9 percentage points change in the probability of being diagnosed with substance abuse. This indicates soldiers who were deployed from 1 to 120 days have the highest risk of being diagnosed with substance abuse out of all the categories. Those who deployed greater than 365 days show a 10.0 percentage points effect in the probability of being diagnosed with substance abuse. Being deployed greater than a year indicates the second highest risk for being diagnosed with substance abuse. For soldiers who deployed from 121 to 180 days, the probability is a 7.0 percentage points change in probability of being diagnosed and is the smallest effect on diagnosis for soldiers. For deployments from 181 to 365 days, the coefficient is 0.094 meaning that the percentage points change is 9.3.

The Marines show the effect of those who were deployed from 121 to 180 days and those who were deployed more than 365 days for the average active duty enlisted person is a 0.080 or 8.0 percentage points change in the probability of being diagnosed with substance abuse. This represents the largest probability of substance abuse diagnosis for the Marine Corps sample population. This result is a striking difference from the major depression findings, suggesting that there may be more than a selection bias issue. In general the results for the Marines indicate that more days deployed increases the probability of diagnosis with substance abuse.

Air Force results show the effect of those airmen who were deployed more than 365 days is a 5.3 percentage points change in the probability of being diagnosed with substance abuse. The second largest coefficient is deployed from 121 to 180 days at a 0.050 or 5.0 percentage points change in probability of diagnosis with substance abuse. The Air Force findings are slightly different from the Army and Marines, which may be attributed to deployment tempo's specific to each branch.

Navy results indicate the effect of those who were deployed more than 365 days for the average sailor is an 11.6 percentage points change in the probability of being diagnosed with substance abuse. This represents the largest probability of diagnosis for the Navy, and mirrors the findings from the Marines and Air Force. The Navy deployment days show a clear trend in the probability of substance abuse diagnosis. The greater the number of days deployed, the higher the probability of substance abuse diagnosis, indicating the linear relationship is strong. This may be a result of Navy personnel turning to alcohol or other substances to cope with deployment.

*d. Summary of Model 2 Substance Abuse Across the Four Branches of Service*

Table 16 shows that in general multiple days of deployment increase the probability of being diagnosed with substance abuse for the average active duty enlisted person across the four branches of service. However, the results differ considerably from the major depression model, in that deployed greater than 365 days for the Marine Corps, Air Force and Navy has the highest probability of being diagnosed, whereas for major depression, generally, 121 to 180 days had the highest probability. The Army experiences the highest probability at an 11.9 percentage point change for those who deployed for 1 to 120 days, but for those who deployed greater than 365 days the probability is a 10.0 percentage point increase. This indicates that for the Army the highest probability is 1 to 120 days deployed, but like the other branches of service deployed greater than 365 days is relatively high. The more days deployed in general increases the probability of being diagnosed with substance abuse across the service branches. For the Navy in particular there is a strong linear relation.

**4. Results of Model 3: Effect of Frequency of Deployments under OEF and OIF**

The third model estimates the effect of frequency of deployment under OEF and OIF on the probability of being diagnosed with major depression or substance abuse. The model uses variables to estimate the effect of frequency of deployment under OEF and OIF and to Afghanistan or Iraq during the study period 2001–2006. Table 17 shows the

results of the probit model for major depression across the four branches of service and Table 18 shows the same model but using total days as a continuous variable. Tables 19 and 20 show the results for the substance abuse sample population.

Table 17. Model 3: Effects of Frequency of Deployments and Location on Major Depression

Effects of Frequency of Deployments and Location on Major Depression	Model 3			
	Army	Marines	Air Force	Navy
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed Only Once	0.064*** (0.002)	0.034*** (0.003)	0.026*** (0.002)	0.010*** (0.001)
Deployed Twice	0.019*** (0.003)	0.003 (0.002)	0.001 (0.002)	-0.004*** (0.001)
Deployed Three or More Times	0.014*** (0.002)	0.003 (0.002)	-0.006*** (0.002)	-0.008*** (0.002)
Deployed to Afghanistan or Iraq Only Once	0.001 (0.001)	0.006*** (0.002)	0.004 (0.003)	0.028*** (0.006)
Deployed to Afghanistan or Iraq Twice	0.025*** (0.003)	0.004 (0.003)	-0.002 (0.004)	0.014 (0.009)
Deployed to Afghanistan or Iraq Three or More Times	0.001 (0.001)	0.012*** (0.004)	-0.002 (0.006)	-0.010 (0.008)
Sample size	334,871	98,808	112,956	134,734

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 18. Model 3a: Effects of Frequency of Deployments and Location on Major Depression Controlling for Total Days

Effects of Frequency of Deployments and Location on Major Depression Controlling for Total Days	<b>Model 3.a</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed Only Once	0.067*** (0.002)	0.035*** (0.003)	0.026*** (0.002)	0.011*** (0.001)
Deployed Twice	0.021*** (0.003)	0.003* (0.002)	0.002 (0.002)	-0.004*** (0.001)
Deployed Three or More Times	0.015*** (0.002)	0.003 (0.002)	-0.005*** (0.002)	-0.008*** (0.002)
Deployed to Afghanistan or Iraq Only Once	0.001 (0.001)	0.006*** (0.002)	0.003 (0.003)	0.027*** (0.006)
Deployed to Afghanistan or Iraq Twice	0.024*** (0.003)	0.004 (0.003)	-0.002 (0.004)	0.014 (0.009)
Deployed to Afghanistan or Iraq Three or More Times	0.000 (0.001)	0.012*** (0.004)	-0.002 (0.006)	-0.010 (0.008)
Total Days Deployed	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Sample size	334,871	98,808	112,954	134,724

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

*a. Model 3 Results for Major Depression*

The coefficients deployed only once and deployed three or more times under OEF and OIF are statistically significant at the conventional level for all branches of service. Deployed twice under any OEF and OIF is only significant for the Army and Navy, while deployed to Afghanistan or Iraq only once is statistically significant for the Marine Corps and Navy. The coefficient deployed to Afghanistan or Iraq only twice is

only significant for the Army at the conventional level and deployed to Afghanistan or Iraq three or more times is significant only for the Marine Corps. The reference group is comprised of those who have never deployed.

Looking at the results for the Army the effect of those who were deployed only once for the average enlisted soldier is 0.064 or a 6.4 percentage points change in the probability of being diagnosed with major depression. This is the highest probability of diagnosis for the Army and suggests that first deployments affect future readiness. The effect of those who had two deployments under OEF and OIF on the average soldier is a 1.9 percentage point change in the probability of being diagnosed with major depression and those who were deployed three or more times is a 1.5 percentage point change in the probability of being diagnosed with major depression. For soldiers who deployed to Afghanistan or Iraq twice, the effect further exacerbates the probability of being diagnosed with major depression by an additional 2.5 percentage points. This indicates soldiers have an even higher risk when deployed to Afghanistan or Iraq compared to those who deployed to other OEF or OIF locations.

The Marine Corps analysis shows the effect of the average enlisted person who was deployed only once has a 0.034 or 3.4 percentage points change in the probability of being diagnosed with major depression. Among those who were deployed once to Afghanistan or Iraq the probability is even higher, a 4.0 percentage points change (i.e., the adjusted difference is  $3.4+0.6=4.0$ ). Similar to the Army, those Marines who ever deployed, regardless of location have the greatest likelihood of diagnosis with major depression. For Marines who had three or more deployments to Afghanistan or Iraq the effect is a 1.5 percentage points change and in the probability of being diagnosed with major depression, indicating that more deployments have a smaller effect than the initial deployment.

For the Air Force, those who were deployed only once for the average enlisted person is a 0.026 or a 2.6 percentage points change in the probability of being diagnosed with major depression. The finding is similar to the Army and Marine Corps—deployed only once has the highest probability of diagnosis. Those airmen who had three or more deployments under OEF and OIF show a lower probability of being diagnosed

with major depression (-.06 percentage point,  $p < 0.01$ ). The results indicate that the first deployment has the most significant influence on the probability of diagnosis. This may be evidence of a selection bias, meaning that those individuals who are found unfit for additional deployments are not sent on in future deployments.

Analysis of the results for the Navy show the effect of the average sailor who deployed only once is a 1.0 percentage points change in the probability of being diagnosed with major depression. Two deployments and those who had three or more deployments under OEF and OIF have a lower the probability of being diagnosed with major depression by a - 0.4 and a - 0.08 percentage points, respectively. This indicates that when compared to one deployment the probability of being diagnosed with major depression is nearly insignificant. For sailors who deployed to Afghanistan or Iraq only once, the probability of being diagnosed with major depression increases by 2.8 percentage points. This further supports that the initial deployment pose the greatest risk of diagnosis for major depression.

***b. Summary of Model 3 Major Depression Across the Four Branches of Service***

Table 17 shows that multiple deployments increase the probability of being diagnosed with major depression for the average active duty enlisted person for the Army, Marine Corps, Air Force, and Navy. For the Air Force and Navy, the rate of diagnosis with major depression appears to be moderated for three or more deployments. More importantly, analysis of deployment frequencies highlights the selection bias when using deployment history. The results indicate that personnel deployed only once under OEF and OIF (regardless of location) have the highest probability of being diagnosed across all four branches of service. This may again be due to a selection bias—those diagnosed after the first deployment were found unfit for future deployments, thus excluding them from subsequent deployment. Model 3.a demonstrates results are similar whether total days deployed were included as the control variable.



c. *Model 3 Results for Substance Abuse*

Table 19 shows the results of the probit model for substance abuse across the four branches of service. Table 20 shows the same model, but using total days as a continuous variable.

Table 19. Model 3: Effects of Frequency of Deployments and Location on Substance Abuse

Effects of Frequency of Deployments and Location on Substance Abuse	Model 3			
	Army	Marines	Air Force	Navy
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed Only Once	0.169***	0.102***	0.041***	0.072***
	(0.004)	(0.005)	(0.003)	(0.003)
Deployed Twice	0.042***	0.042***	0.020***	0.036***
	(0.005)	(0.005)	(0.003)	(0.003)
Deployed Three or More Times	0.080***	0.042***	0.001	0.018***
	(0.003)	(0.006)	(0.003)	(0.005)
Deployed to Afghanistan or Iraq Only Once	0.012***	0.033***	0.017***	0.001
	(0.003)	(0.005)	(0.005)	(0.010)
Deployed to Afghanistan or Iraq Twice	0.112***	0.005	0.004	-0.001
	(0.008)	(0.006)	(0.006)	(0.013)
Deployed to Afghanistan or Iraq Three or More Times	0.024***	0.014**	0.008	-0.038**
	(0.003)	(0.007)	(0.010)	(0.019)
Sample size	334,434	98,778	112,846	134,711

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 20. Model 3a: Effects of Frequency of Deployments and Location on Substance Abuse Controlling for Total Days

Effects of Frequency of Deployments and Location on Substance Abuse Controlling for Total Days	Model 3.a			
	Army	Marines	Air Force	Navy
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed Only Once	0.173*** (0.004)	0.103*** (0.005)	0.041*** (0.003)	0.073*** (0.003)
Deployed Twice	0.045*** (0.005)	0.043*** (0.005)	0.020*** (0.003)	0.036*** (0.003)
Deployed Three or More Times	0.082*** (0.003)	0.043*** (0.006)	0.001 (0.003)	0.019*** (0.005)
Deployed to Afghanistan or Iraq Only Once	0.011*** (0.003)	0.033*** (0.005)	0.017*** (0.005)	0.001 (0.010)
Deployed to Afghanistan or Iraq Twice	0.110*** (0.008)	0.005 (0.006)	0.004 (0.006)	-0.001 (0.013)
Deployed to Afghanistan or Iraq Three or More Times	0.023*** (0.003)	0.013** (0.007)	0.008 (0.010)	-0.038** (0.019)
Total Days Deployed	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Sample size	334,434	98,778	112,842	134,705

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The variables deployed only once, and deployed twice under OEF and OIF are statistically significant at the conventional level all four branches of service. The variable deployed three or more times under OEF/OIF is significant for the Army, Marine Corps and Navy. Deployed to Afghanistan or Iraq once is statistically significant for all branches except for the Navy. Deployed to Afghanistan or Iraq twice is statistically significant only for the Army and deployed to Afghanistan or Iraq three or more times is significant for the Army, Marine Corps and Navy. The reference group is comprised of those who were never deployed.

For the Army, the effect of those who were deployed only once for the average active duty enlisted person is a 16.9 percentage point change in the probability of being diagnosed with substance abuse. For those who were deployed once to Afghanistan or Iraq the results are even higher at an 18.1 percentage points change (adjusted percentage point difference is  $16.9+1.2=18.1$ ). Similar to the major depression findings for model 3, one deployment greatly increases the probability of substance abuse diagnosis for soldiers. The effect of those soldiers who had two deployments under OEF and OIF is a 0.042 or 4.2 percentage points change in the probability of being diagnosed with substance abuse. The effect of three or more deployments is a an 8.0 percentage points change in the probability of diagnosis. The effect for soldiers on the probability of being diagnosed with substance abuse for those who had two deployments to Afghanistan or Iraq—a 15.4 percentage point change. Deployments of three or more under OEF and OIF is a 0.8 percentage points change and to Afghanistan or Iraq an added 2.4 percentage points change. This may indicate that due to past exposure to combat in Afghanistan or Iraq, Army personnel attempt to compensate with increased use of alcohol or other substances.

The Marine Corps results indicate that those who were deployed only once for the average active duty enlisted Marine is a 0.102 or 10.2 percentage points change in the probability of being diagnosed with substance abuse. Deployed once to Afghanistan or Iraq further increases the probability of substance abuse by a 3.3 percentage points. The finding is consistent with the Army findings, that initial deployments pose the greatest risk of diagnosis with substance abuse. The effect of Marines who had two or more deployments under OEF and OIF has a 4.2 percentage points change in the probability of being diagnosed with substance abuse. Three or more deployments to any OEF or OIF location have a 4.2 percentage points effect on the probability of diagnosis. Among those who were deployed three or more times to Afghanistan or Iraq, the probability of diagnosis of substance abuse further increases by 1.4 percentage points or otherwise adjusted to 5.6 percentage points. This indicates that the initial deployment, similar to the Army, exhibits the greatest risk of diagnosis for substance abuse for Marines.

Looking at the Air Force analysis, one deployment to OEF and OIF shows the highest probability of diagnosis with a 4.1 percentage point change in the probability of being diagnosed with substance abuse. Initial deployments to Afghanistan or Iraq are even higher at a 5.8 percentage points change on the diagnosis of substance abuse. This shows that the largest risk for airmen is the initial deployment, specifically for those who were deployed to Afghanistan or Iraq. The final variable, two deployments under OEF and OIF shows the effect is a 2.0 percentage point change in the probability of being diagnosed with substance abuse, which is lower than the initial deployment probability.

Results show that for the Navy the effect of the average sailor after their first deployment is a 0.072 or 7.2 percentage points increase in the probability of being diagnosed with substance abuse. Curiously, the effect of those who were deployed twice under OEF and OIF is only a 3.6 percentage points change. This indicates that similar to the other services, additional deployments decrease the risk of diagnosis with substance abuse. Sailors who deployed three or more times under OEF and OIF have only a 1.8 percentage points change from the baseline (compared to those who never deployed) in the probability of diagnosis with substance abuse, while those who were deployed strictly to Afghanistan or Iraq three or more times is negative (-3.8 percentage points,  $p < 0.05$ ). The result indicates that being deployed three or more times specifically to Afghanistan or Iraq for sailors has a -2.0 percentage points change, thus moderating the effect on being diagnosed with substance abuse.

The findings support that the first deployment has the largest effect on substance abuse diagnosis in the Navy. While it would seem obvious that even more deployments (specifically to Afghanistan or Iraq) would increase the probability of diagnosis, this was shown to not be the case.

***d. Summary of Model 3 for Substance Abuse Across the Four Branches of Service***

Similar to the findings for major depression, these results demonstrate that multiple deployments increase the probability of being diagnosed with substance abuse for the average active duty enlisted person for the Army, Marine Corps, Air Force, and

Navy. The greatest probability of substance abuse issues occurs after the first deployment. There was actually a decrease in substance abuse problems with further deployments. For the Navy the negative coefficient, (-0.38), suggests there is no significant change in probability of being diagnosed with substance abuse for three or more deployments to Afghanistan or Iraq. Like the major depression findings, the results for substance abuse highlight the selection bias issue when using deployment history. Furthermore, deployment frequencies for all services indicate that personnel who deployed only once under OEF and OIF (regardless of location) have the highest probability of being diagnosed with substance abuse. This may be due to the same selection bias issue seen in the major depression model. Service members who were diagnosed with substance abuse after the first deployment were found unfit for future deployments. They were therefore, excluded from follow on deployment. Model 3.a demonstrates that the results are similar whether total days deployed were included as the control variable.

## **F. SUMMARY**

In this chapter, the descriptive statistics were presented and analyzed. The rate of diagnosis for major depression and substance abuse populations for deployment locations and durations (total days deployed) were analyzed and compared. Additionally key variables of the three multivariate probit models were presented and then analyzed.

The descriptive statistics showed that the sample populations for major depression and substance abuse were similar in make-up and size. However, the overall rate of diagnosis for each sample was strikingly different. The rate of diagnosis for major depression tended to be a smaller percentage of the population, less than 3 percent whereas, substance abuse diagnosis was a much higher percentage, about 10 percent. The branch of service was also different for each diagnosis. The one exception, Marines, represent the lowest rate of diagnosis for major depression and substance abuse. The major depression overall rate was highest for the Air Force, but for substance abuse they had the second smallest overall rate of diagnosis. The Navy, on the other hand, represented the highest overall rate of diagnosis for substance abuse. Furthermore,

diagnosis by deployment characteristics showed that, for major depression and substance abuse, having ever deployed under any OEF and OIF location clearly increased the rate of diagnosis across the four branches of service.

The multivariate analyses showed that for active duty military personnel who were ever deployed under OEF and OIF regardless of location, the probability was higher for being diagnosed with major depression or substance abuse compared to those who were never deployed. Those who were ever deployed to Afghanistan or Iraq had an even higher risk of being diagnosed with the two mental health conditions compared to those deployed to other known locations. Moreover, the analysis showed that deployments to a classified or unknown location and shore deployments for Navy, moderates the effect of being deployed under OEF and OIF.

Multiple deployments for all branches of service increase the probability of being diagnosed with major depression or substance abuse. Deployment frequencies showed that active duty personnel who deployed only once under OEF and OIF had the highest probability of being diagnosed. This may again be a reflection of a selection bias. Those who were diagnosed after the first deployment were found unfit for future deployments, thus excluding them from subsequent deployment. The results for the Navy in particular showed the frequency of deployment to Afghanistan or Iraq of three or more times significantly decreased the probability of having a substance abuse diagnosis. When the total days of deployment were controlled for, the results were similar.

The multivariate analyses also showed that the number of days deployed affects the rate of diagnosis for major depression and substance abuse. The magnitudes of the variables were highest for enlisted personnel who were deployed between 121 to 365 days with two exceptions. Army and Marine enlisted showed the largest magnitude of substance abuse diagnosis for deployments for 1 to 120 days.

Deployments increase the probability of being diagnosed with either of the mental health conditions compared to those who were never deployed, as was hypothesized. I also hypothesized that deployments to a classified or unknown location would increase the probability of being diagnosed with a mental health condition. However, the increases

were moderated. Enlisted personnel who were deployed to a classified or unknown location were still more likely to be diagnosed, but at a considerably smaller magnitude than deployments to other locations.

The author hypothesized that the cumulative effect of deployments would increase the probability of diagnosis with substance abuse and major depression. The results showed that deployments do indeed raise the probability of diagnosis for either of the mental health issues, but the largest effect was for those who only had one deployment. The probability of diagnosis with substance abuse for the Army was when enlisted personnel who were deployed for 1 to 120 days, which may correspond to one deployment. Navy, Marines, and Air Force showed the largest magnitude for substance abuse diagnosis for deployments greater than 365 days, having the largest effect. The author speculates that onset of illness and time to diagnosis may be an unobservable factor for substance abuse. The magnitude for major depression was slightly different revealing that deployments ranging from 121 to 180 days had a greater effect on the probability of diagnosis.

In summary, the three multivariate analyses allowed the author to compare the effect of major depression and substance abuse across the four branches of service. Using multivariate analysis, it was possible to evaluate the effects of deployments by location and various lengths of deployment while holding other factors constant. The results supported what was hypothesized, but also provided valuable insights into the prevalence of major depression and substance abuse on the enlisted population who were deployed under OEF and OIF during 2001 to 2006.

## **VI. CONCLUSIONS**

### **A. CONCLUSIONS**

The results found in this study are consistent with existing literature that the prevalence of major depression and substance abuse adversely affects active duty military personnel despite the branch of service. Most existing literature focuses on Army and Marine Corps personnel and how these two mental health illnesses affect them. Similar to previous studies, the Army did indeed demonstrate a larger effect, placing them at the highest risk. This thesis expanded the analysis to include all four branches of service to analyze the prevalence of major depression and substance abuse to the total military. Evaluating deployment locations and durations of deployment during 2001 to 2006 provides a broader understanding of how the two key mental health diagnoses affect the men and women who serve in the military.

Chapter V presented the results of the multivariate analysis conducted for this thesis. Analysis showed that active duty enlisted personnel who were ever deployed under Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) between 2001 and 2006 have a higher probability of being diagnosed with major depression or substance abuse than those who were never deployed. Those who were ever deployed to Iraq or Afghanistan have an even higher risk of being diagnosed with the two mental health conditions compared to deployment to other locations. On the other hand, deployment to a classified or unknown location appear to moderate the rate of major depression or substance abuse compared to deployment to other locations, although this group of enlisted still has a higher rate of the two mental health conditions compared to the non-deployed population.

Deployments, clearly increase the risk of being diagnosed with major depression or substance abuse. The magnitude of risk varies depending on the number of days deployed per service and the diagnosis. For example, the probability of substance abuse diagnosis for the Army is greatest for deployments of 1 to 120 days whereas, the largest



risk of a major depression diagnosis is 121 to 180 days. The same trend is seen with the other branches of service. This appears to be a reflection of the different deployment tempos for each service.

Multiple deployments increase the probability of being diagnosed with major depression and substance abuse. Moreover, deployment frequencies indicate that personnel who were deployed only once under OEF and OIF (regardless of location) have the highest probability of being diagnosed across all four branches of service. This may be a reflection of a selection bias: those who were diagnosed after the first deployment were found unfit for future deployments, thus excluding them from subsequent deployment.

In general, the results support the finding that, across all four branches of service, deployments, especially to Iraq and Afghanistan, adversely affect the probability of active duty personnel being diagnosed with major depression or substance abuse.

## **B. LIMITATIONS OF THE STUDY**

One limitation in this study was in the TRICARE and DMDC data. A significant number of missing EDIPNs and missing dates of birth existed within the TRICARE DEERS data from 2001 to 2006. The missing EDIPNs and dates of birth affect the size of the sample since they were omitted from the study. A more accurate analysis may have been possible with more observations. In addition to the missing dates of birth and EDIPNS, there were some observations with missing demographic information. However, they were not as significant. Given the large sample of major depression and substance abuse, it is unfortunate that a more in depth analysis is not possible because of the missing data.

The reliance on clinical diagnosis information for major depression and substance abuse presents another limitation. While the clinical data from TRICARE is invaluable, it represents only active duty personnel who have sought or been referred to treatment. Individuals who may have sought treatment outside of the military or who never receive

treatment are not represented in the data samples. Essentially, a selection bias may have occurred with individuals opting out of divulging the need for mental health evaluation and treatment.

A limitation and area of improvement would be the omission of the officer population in this study. Inclusion of officer observations would provide a more comprehensive view of the effects of major depression and substance abuse rates on deployment characteristics.

### **C. RECOMMENDATIONS**

This thesis has provided valuable information on the rate of two significant mental health illnesses for the Army, Marine Corps, Air Force, and Navy active duty enlisted personnel for the study period. The detailed information regarding the effects of major depression and substance abuse are of particular importance to the Air Force and Navy, since they are underrepresented in much of the literature. The evident increase in the probability of being diagnosed with major depression or substance abuse in the deployed population should encourage military planners to evaluate the number and lengths of deployment for each branch of service. Educational programs for service personnel provided pre- and post-deployment and centered on symptom identification, could help active duty personnel better understand and recognize when treatment might be needed. Given the significant probability of diagnosis with first deployments, aggressive educational preparation may be wise for these groups of individuals. An additional advantage of pre-educational programs may act as an “inoculation” for some service members against future development of major depression or substance abuse. Moreover, educational programs will aid in combating the negative perceptions surrounding mental health illness; thus, encouraging treatment at its earliest stage. Awareness is a powerful tool for combating and preventing diagnosis with major depression and substance abuse. Encouraging early treatment for major depression or substance abuse ensures readiness is not adversely impacted. Major depression and substance abuse are treatable!

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## APPENDIX A. EFFECT OF DEPLOYMENT ON RATE OF MAJOR DEPRESSION DIAGNOSED

Table 21. Model 1: Major Depression

	Model 1—Major Depression			
	Army	Marines	Air Force	Navy
<b>Location of Deployment (reference group is not deployed under OEF/OIF)</b>				
Ever Deployed	0.037***	0.018***	0.014***	0.023***
	(0.001)	(0.001)	(0.001)	(0.002)
Ever Deployed to Afghanistan or Iraq	0.002**	0.006***	0.001	0.011***
	(0.001)	(0.001)	(0.002)	(0.004)
Ever Deployed to Classified Location	-0.011***	-0.004***	-0.007***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Ever Deployed to Shore				-0.013***
				(0.001)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	0.000	-0.000		0.002
	(0.001)	(0.001)		(0.002)
Combat Service Support	0.001*	0.002**	0.008***	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Aviation		0.005***		-0.001
		(0.001)		(0.003)
Medical	-0.002***		-0.021***	0.013***
	(0.001)		(0.001)	(0.003)
Other MOS	0.009***	0.043***	0.058***	0.007***
	(0.001)	(0.003)	(0.004)	(0.002)
<b>Rank (reference group is E7–E9)</b>				
E1 E3	0.011***	0.018***	0.021***	0.002
	(0.001)	(0.002)	(0.004)	(0.002)
E4	0.011***	0.023***	0.029***	0.009***
	(0.001)	(0.005)	(0.004)	(0.002)
E5	0.005***	0.035***	0.023***	0.008***
	(0.001)	(0.006)	(0.003)	(0.002)
E6	0.003***	0.027***	0.012***	0.004**
	(0.001)	(0.005)	(0.003)	(0.002)

**Model 1–Major Depression**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.006***	-0.004***	-0.008***	-0.010***
	(0.000)	(0.001)	(0.001)	(0.001)
Hispanic	-0.004***	-0.003***	-0.007***	-0.004***
	(0.001)	(0.001)	(0.002)	(0.001)
Asian	-0.006***	-0.004***	-0.012***	-0.010***
	(0.001)	(0.001)	(0.002)	(0.001)
Other races	-0.000	-0.004***	-0.004**	-0.002*
	(0.001)	(0.001)	(0.002)	(0.001)
<b>Gender (reference group is male)</b>				
Female	0.037***	0.045***	0.053***	0.054***
	(0.001)	(0.004)	(0.002)	(0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.009***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
<b>Age</b>				
Age at MD diagnosis date	0.001***	0.001***	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Age at MD diagnosis or DEERS extraction date is missing	0.145***	0.028***	0.136***	0.116***
	(0.012)	(0.008)	(0.018)	(0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.003***	-0.002	-0.008***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
FY03	-0.008***	-0.005***	-0.007***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
FY04	-0.010***	-0.001	-0.007***	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
FY05	-0.008***	-0.001	-0.011***	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
FY06	-0.012***	-0.007***	-0.015***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)

**Model 1–Major Depression**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
Sample size	334,871	98,808	112,956	134,734
Note: Year dummies are included.				
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table 22. Model 2: Major Depression

**Model 2–Major Depression**

Effect of Total Days Deployed on Rate of Major Depression	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Deployment Days (reference group 0 days deployed)</b>				
Days Deployed 1 to 120	0.040***	0.018***	0.016***	0.013***
	(0.001)	(0.001)	(0.001)	(0.002)
Days Deployed 121 to 180	0.079***	0.013*	0.103***	0.077***
	(0.011)	(0.007)	(0.017)	(0.016)
Days Deployed 181 to 365	0.053***	0.006*	0.034***	0.077***
	(0.004)	(0.003)	(0.011)	(0.011)
Days Deployed 365 plus	0.048***	0.017***	0.077***	0.074***
	(0.004)	(0.006)	(0.025)	(0.021)
Ever Deployed to Afghanistan or Iraq	0.001*	0.006***	0.001	0.011***
	(0.001)	(0.001)	(0.002)	(0.004)
Ever Deployed to Classified Location	-0.011***	-0.004***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	0.000	-0.000		0.002
	(0.001)	(0.001)		(0.002)
Combat Service Support	0.001*	0.002**	0.008***	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Aviation		0.004***		-0.001
		(0.001)		(0.003)
Medical	-0.002***		-0.020***	0.013***
	(0.001)		(0.002)	(0.003)
Other MOS	0.006***	0.036***	0.054***	0.007***
	(0.001)	(0.003)	(0.004)	(0.002)
<b>Rank (reference group is E7–E9)</b>				
E1 E3	0.010***	0.017***	0.021***	0.003
	(0.001)	(0.002)	(0.004)	(0.002)

Effect of Total Days Deployed on Rate of Major Depression	<b>Model 2—Major Depression</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
E4	0.010***	0.023***	0.028***	0.009***
	(0.001)	(0.005)	(0.004)	(0.002)
E5	0.005***	0.034***	0.023***	0.008***
	(0.001)	(0.006)	(0.003)	(0.002)
E6	0.003***	0.025***	0.012***	0.004**
	(0.001)	(0.005)	(0.003)	(0.002)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.006***	-0.004***	-0.008***	-0.009***
	(0.000)	(0.001)	(0.001)	(0.001)
Hispanic	-0.003***	-0.003***	-0.008***	-0.005***
	(0.001)	(0.001)	(0.002)	(0.001)
Asian	-0.006***	-0.004***	-0.011***	-0.010***
	(0.001)	(0.001)	(0.002)	(0.001)
Other races	-0.000	-0.004***	-0.004**	-0.002*
	(0.001)	(0.001)	(0.002)	(0.001)
<b>Gender (reference group is male)</b>				
Female	0.037***	0.045***	0.051***	0.052***
	(0.001)	(0.004)	(0.002)	(0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
<b>Age</b>				
Age at MD diagnosis date	0.001***	0.001***	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Age at MD diagnosis or DEERS extraction date is missing	0.152***	0.033***	0.135***	0.113***
	(0.012)	(0.009)	(0.018)	(0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.003***	-0.002	-0.008***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
FY03	-0.007***	-0.005***	-0.007***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
FY04	-0.010***	-0.000	-0.007***	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
FY05	-0.008***	-0.001	-0.011***	0.000
	(0.001)	(0.001)	(0.001)	(0.001)

Effect of Total Days Deployed on Rate of Major Depression	<b>Model 2–Major Depression</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
FY06	-0.010***	-0.007***	-0.015***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Sample size	334,871	98,808	112,956	134,734

Note: Year dummies are included.

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 23. Model 3: Major Depression

	<b>Model 3–Major Depression</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed only once	0.064***	0.034***	0.026***	0.010***
	(0.002)	(0.003)	(0.002)	(0.001)
Deployed twice	0.019***	0.003	0.001	-0.004***
	(0.003)	(0.002)	(0.002)	(0.001)
Deployed three or more times	0.014***	0.003	-0.006***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Deployed to Afghanistan or Iraq at only once	0.001	0.006***	0.004	0.028***
	(0.001)	(0.002)	(0.003)	(0.006)
Deployed to Afghanistan or Iraq twice	0.025***	0.004	-0.002	0.014
	(0.003)	(0.003)	(0.004)	(0.009)
Deployed to Afghanistan or Iraq three or more times	0.001	0.012***	-0.002	-0.010
	(0.001)	(0.004)	(0.006)	(0.008)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	0.000	-0.000		0.001
	(0.001)	(0.001)		(0.002)
Combat Service Support	0.001	0.002*	0.007***	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Aviation		0.004***		-0.001
		(0.001)		(0.003)
Medical	-0.002***		-0.020***	0.014***
	(0.001)		(0.001)	(0.003)
Other MOS	0.008***	0.042***	0.055***	0.007***
	(0.001)	(0.003)	(0.004)	(0.001)
<b>Rank (reference group is E7–E9)</b>				
E1_E3	0.010***	0.017***	0.021***	0.003
	(0.001)	(0.002)	(0.004)	(0.002)
E4	0.010***	0.021***	0.028***	0.010***
	(0.001)	(0.005)	(0.004)	(0.002)



**Model 3–Major Depression**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
E5	0.006***	0.032***	0.024***	0.008***
	(0.001)	(0.006)	(0.003)	(0.002)
E6	0.004***	0.026***	0.013***	0.004**
	(0.001)	(0.005)	(0.003)	(0.002)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.006***	-0.004***	-0.008***	-0.010***
	(0.000)	(0.001)	(0.001)	(0.001)
Hispanic	-0.004***	-0.003***	-0.007***	-0.005***
	(0.001)	(0.001)	(0.002)	(0.001)
Asian	-0.006***	-0.004***	-0.011***	-0.010***
	(0.001)	(0.001)	(0.002)	(0.001)
Other races	0.000	-0.004***	-0.004**	-0.002*
	(0.001)	(0.001)	(0.002)	(0.001)
<b>Gender (reference group is male)</b>				
Female	0.036***	0.044***	0.051***	0.053***
	(0.001)	(0.004)	(0.002)	(0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.009***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
<b>Age</b>				
Age at MD diagnosis date	0.000***	0.001***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Age at MD diagnosis or DEERS extraction date is missing	0.147***	0.026***	0.135***	0.115***
	(0.012)	(0.008)	(0.018)	(0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.003***	-0.002	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
FY03	-0.007***	-0.005***	-0.006***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
FY04	-0.010***	-0.001	-0.007***	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
FY05	-0.008***	-0.002	-0.011***	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
FY06	-0.011***	-0.007***	-0.016***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Sample size	334,871	98,808	112,956	134,734

Note: Year dummies are included.

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 24. Model 3.a: Major Depression

	<b>Model 3.a</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed only once	0.067***	0.035***	0.026***	0.011***
	(0.002)	(0.003)	(0.002)	(0.001)
Deployed twice	0.021***	0.003*	0.002	-0.004***
	(0.003)	(0.002)	(0.002)	(0.001)
Deployed three or more times	0.015***	0.003	-0.005***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Deployed to Afghanistan or Iraq at only once	0.001	0.006***	0.003	0.027***
	(0.001)	(0.002)	(0.003)	(0.006)
Deployed to Afghanistan or Iraq twice	0.024***	0.004	-0.002	0.014
	(0.003)	(0.003)	(0.004)	(0.009)
Deployed to Afghanistan or Iraq three or more times	0.000	0.012***	-0.002	-0.010
	(0.001)	(0.004)	(0.006)	(0.008)
Total Days Deployed	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	0.000	-0.000		0.001
	(0.001)	(0.001)		(0.002)
Combat Service Support	0.001	0.002*	0.007***	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Aviation		0.004***		-0.001
		(0.001)		(0.003)
Medical	-0.002***		-0.020***	0.014***
	(0.001)		(0.001)	(0.003)
Other MOS	0.006***	0.037***	0.052***	0.006***
	(0.001)	(0.003)	(0.004)	(0.001)
<b>Rank (reference group is E7–E9)</b>				
E1 E3	0.009***	0.017***	0.020***	0.002
	(0.001)	(0.002)	(0.004)	(0.002)
E4	0.010***	0.020***	0.028***	0.009***
	(0.001)	(0.005)	(0.004)	(0.002)
E5	0.005***	0.031***	0.023***	0.008***
	(0.001)	(0.006)	(0.003)	(0.002)
E6	0.003***	0.025***	0.012***	0.004**
	(0.001)	(0.005)	(0.003)	(0.002)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.006***	-0.004***	-0.008***	-0.010***
	(0.000)	(0.001)	(0.001)	(0.001)
Hispanic	-0.003***	-0.003***	-0.007***	-0.004***
	(0.001)	(0.001)	(0.002)	(0.001)

**Model 3.a**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
Asian	-0.006*** (0.001)	-0.004*** (0.001)	-0.011*** (0.002)	-0.010*** (0.001)
Other races	0.000 (0.001)	-0.004*** (0.001)	-0.003** (0.002)	-0.002** (0.001)
<b>Gender (reference group is male)</b>				
Female	0.036*** (0.001)	0.044*** (0.004)	0.050*** (0.002)	0.052*** (0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.009*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)
<b>Age</b>				
Age at MD diagnosis date	0.000*** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.000*** (0.000)
Age at MD diagnosis or DEERS extraction date is missing	0.153*** (0.012)	0.028*** (0.008)	0.133*** (0.018)	0.112*** (0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.003*** (0.001)	-0.002 (0.001)	-0.008*** (0.001)	-0.006*** (0.001)
FY03	-0.007*** (0.001)	-0.005*** (0.001)	-0.006*** (0.001)	-0.005*** (0.001)
FY04	-0.010*** (0.001)	-0.001 (0.001)	-0.007*** (0.001)	-0.002* (0.001)
FY05	-0.007*** (0.001)	-0.002 (0.001)	-0.011*** (0.001)	0.000 (0.001)
FY06	-0.010*** (0.001)	-0.007*** (0.001)	-0.015*** (0.001)	-0.006*** (0.001)
Sample size	334,871	98,808	112,954	134,724

Note: Year dummies are included.

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## APPENDIX B. EFFECT OF DEPLOYMENT ON RATE OF SUBSTANCE ABUSE DIAGNOSED

Table 25. Model 1: Substance Abuse

	Model 1–Substance Abuse			
	Army	Marines	Air Force	Navy
<b>Location of Deployment (reference group is not deployed under OEF/OIF)</b>			-	
Ever Deployed	0.116*** (0.002)	0.061*** (0.003)	0.030*** (0.002)	0.074*** (0.005)
Ever Deployed to Afghanistan or Iraq	0.016*** (0.002)	0.023*** (0.004)	0.008** (0.003)	-0.008 (0.007)
Ever Deployed to Classified Location	-0.043*** (0.001)	0.004 (0.003)	-0.017*** (0.002)	-0.002 (0.003)
Ever Deployed to Shore				-0.021*** (0.003)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	-0.000 (0.002)	0.007*** (0.002)		-0.012*** (0.004)
Combat Service Support	-0.003** (0.001)	0.009*** (0.002)	0.014*** (0.002)	-0.010** (0.004)
Aviation		0.011*** (0.002)		0.010* (0.006)
Medical	-0.007*** (0.001)		-0.018** (0.009)	0.002 (0.005)
Other MOS	-0.011*** (0.001)	0.031*** (0.004)	0.033*** (0.004)	-0.002 (0.004)
<b>Rank (reference group is E7–E9)</b>				
E1_E3	0.064*** (0.003)	0.082*** (0.005)	0.039*** (0.006)	0.052*** (0.005)
E4	0.052*** (0.003)	0.100*** (0.011)	0.045*** (0.006)	0.055*** (0.006)
E5	0.027*** (0.003)	0.090*** (0.010)	0.037*** (0.005)	0.040*** (0.005)
E6	0.016*** (0.003)	0.052*** (0.009)	0.013*** (0.004)	0.011*** (0.004)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.012*** (0.001)	-0.019*** (0.002)	-0.023*** (0.002)	-0.038*** (0.002)
Hispanic	-0.019*** (0.001)	-0.012*** (0.002)	-0.012*** (0.003)	-0.014*** (0.003)
Asian	-0.023*** (0.002)	-0.025*** (0.003)	-0.030*** (0.003)	-0.050*** (0.002)
Other races	-0.005*** (0.002)	-0.008*** (0.002)	-0.016*** (0.003)	-0.013*** (0.002)
<b>Gender (reference group is male)</b>				
Female	-0.017*** (0.001)	0.007** (0.004)	0.002 (0.002)	-0.019*** (0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.007*** (0.001)	0.000 (0.002)	0.001 (0.002)	0.003 (0.002)

	<b>Model 1–Substance Abuse</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Age</b>				
Age at SA diagnosis date	-0.000*** (0.000)	0.003*** (0.000)	-0.001*** (0.000)	0.000** (0.000)
Age at SA diagnosis or DEERS extraction date is missing	0.045*** (0.010)	0.098*** (0.020)	0.022* (0.013)	0.043*** (0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.018*** (0.001)	-0.003 (0.003)	-0.020*** (0.002)	-0.012*** (0.002)
FY03	-0.046*** (0.001)	-0.030*** (0.002)	-0.029*** (0.002)	-0.038*** (0.002)
FY04	-0.059*** (0.001)	-0.037*** (0.002)	-0.034*** (0.002)	-0.042*** (0.002)
FY05	-0.065*** (0.001)	-0.046*** (0.002)	-0.038*** (0.002)	-0.052*** (0.002)
FY06	-0.078*** (0.001)	-0.059*** (0.002)	-0.044*** (0.002)	-0.069*** (0.002)
Sample size	334,434	98,778	112,846	134,711

Note: Year dummies are included.  
Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 26. Model 2: Substance Abuse

Effect of Total Days Deployed on Rate of Substance Abuse

	<b>Model 2–Substance Abuse</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Deployment Days (reference group 0 days deployed)</b>				
Days Deployed 1 to 120	0.119*** (0.002)	0.064*** (0.003)	0.031*** (0.002)	0.058*** (0.004)
Days Deployed 121 to 180	0.070*** (0.013)	0.080*** (0.022)	0.050*** (0.018)	0.077*** (0.023)
Days Deployed 181 to 365	0.094*** (0.006)	0.074*** (0.012)	0.039** (0.017)	0.093*** (0.015)
Days Deployed 365 plus	0.100*** (0.007)	0.080*** (0.016)	0.053** (0.027)	0.116*** (0.029)
Ever Deployed to Afghanistan or Iraq	0.016*** (0.002)	0.022*** (0.003)	0.008** (0.003)	-0.007 (0.007)
Ever Deployed to Classified Location	-0.042*** (0.001)	0.003 (0.003)	-0.017*** (0.002)	-0.004 (0.003)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	-0.000 (0.002)	0.007*** (0.002)		-0.012*** (0.004)
Combat Service Support	-0.003** (0.001)	0.009*** (0.002)	0.013*** (0.002)	-0.010** (0.004)

Effect of Total Days Deployed on Rate of Substance Abuse

**Model 2—Substance Abuse**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
Aviation		0.011***		0.011*
		(0.002)		(0.006)
Medical	-0.007***		-0.016*	0.002
	(0.001)		(0.009)	(0.005)
Other MOS	-0.016***	0.013***	0.031***	-0.003
	(0.001)	(0.004)	(0.004)	(0.004)
<b>Rank (reference group is E7–E9)</b>				
E1_E3	0.061***	0.081***	0.039***	0.053***
	(0.003)	(0.005)	(0.006)	(0.005)
E4	0.049***	0.097***	0.045***	0.056***
	(0.003)	(0.011)	(0.006)	(0.006)
E5	0.026***	0.087***	0.037***	0.040***
	(0.003)	(0.010)	(0.005)	(0.005)
E6	0.015***	0.050***	0.013***	0.011***
	(0.002)	(0.008)	(0.004)	(0.004)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.011***	-0.019***	-0.023***	-0.038***
	(0.001)	(0.002)	(0.002)	(0.002)
Hispanic	-0.018***	-0.012***	-0.012***	-0.015***
	(0.001)	(0.002)	(0.003)	(0.003)
Asian	-0.022***	-0.025***	-0.030***	-0.050***
	(0.002)	(0.003)	(0.003)	(0.002)
Other races	-0.005***	-0.008***	-0.016***	-0.014***
	(0.002)	(0.002)	(0.003)	(0.002)
<b>Gender (reference group is male)</b>				
Female	-0.017***	0.007**	0.001	-0.020***
	(0.001)	(0.004)	(0.002)	(0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.006***	0.000	0.001	0.002
	(0.001)	(0.002)	(0.002)	(0.002)
<b>Age</b>				
Age at SA diagnosis date	-0.000***	0.003***	-0.001***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Age at SA diagnosis or DEERS extraction date is missing	0.051***	0.130***	0.022*	0.039***
	(0.010)	(0.023)	(0.013)	(0.012)

Effect of Total Days Deployed on Rate of Substance Abuse

	<b>Model 2–Substance Abuse</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>FYI (reference group is 2001)</b>				
FY02	-0.018***	-0.004	-0.020***	-0.013***
	(0.001)	(0.003)	(0.002)	(0.002)
FY03	-0.045***	-0.030***	-0.029***	-0.040***
	(0.001)	(0.002)	(0.002)	(0.002)
FY04	-0.058***	-0.037***	-0.034***	-0.043***
	(0.001)	(0.002)	(0.002)	(0.002)
FY05	-0.063***	-0.046***	-0.038***	-0.051***
	(0.001)	(0.002)	(0.002)	(0.002)
FY06	-0.076***	-0.058***	-0.044***	-0.067***
	(0.001)	(0.002)	(0.002)	(0.002)
Sample size	334,434	98,778	112,846	134,711

Note: Year dummies are included.

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 27. Model 3: Substance Abuse

	<b>Model 3–Substance Abuse</b>			
	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed only once	0.169***	0.102***	0.041***	0.072***
	(0.004)	(0.005)	(0.003)	(0.003)
Deployed twice	0.042***	0.042***	0.020***	0.036***
	(0.005)	(0.005)	(0.003)	(0.003)
Deployed three or more times	0.080***	0.042***	0.001	0.018***
	(0.003)	(0.006)	(0.003)	(0.005)
Deployed to Afghanistan or Iraq at only once	0.012***	0.033***	0.017***	0.001
	(0.003)	(0.005)	(0.005)	(0.010)
Deployed to Afghanistan or Iraq twice	0.112***	0.005	0.004	-0.001
	(0.008)	(0.006)	(0.006)	(0.013)
Deployed to Afghanistan or Iraq three or more times	0.024***	0.014**	0.008	-0.038**
	(0.003)	(0.007)	(0.010)	(0.019)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	-0.000	0.006**		-0.013***
	(0.002)	(0.002)		(0.004)

**Model 3–Substance Abuse**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
Combat Service Support	-0.003*** (0.001)	0.007*** (0.002)	0.013*** (0.002)	-0.010** (0.004)
Aviation		0.010*** (0.002)		0.010* (0.006)
Medical	-0.007*** (0.001)		-0.018** (0.009)	0.003 (0.005)
Other MOS	-0.012*** (0.001)	0.029*** (0.004)	0.032*** (0.004)	-0.002 (0.004)
<b>Rank (reference group is E7–E9)</b>				
E1 E3	0.061*** (0.003)	0.082*** (0.005)	0.040*** (0.006)	0.054*** (0.005)
E4	0.051*** (0.003)	0.096*** (0.011)	0.046*** (0.006)	0.056*** (0.006)
E5	0.027*** (0.003)	0.086*** (0.010)	0.038*** (0.005)	0.040*** (0.005)
E6	0.016*** (0.003)	0.053*** (0.009)	0.014*** (0.004)	0.011*** (0.004)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.011*** (0.001)	-0.019*** (0.002)	-0.023*** (0.002)	-0.038*** (0.002)
Hispanic	-0.018*** (0.001)	-0.012*** (0.002)	-0.012*** (0.003)	-0.014*** (0.003)
Asian	-0.023*** (0.002)	-0.025*** (0.003)	-0.029*** (0.003)	-0.050*** (0.002)
Other races	-0.004** (0.002)	-0.009*** (0.002)	-0.016*** (0.003)	-0.014*** (0.002)
<b>Gender (reference group is male)</b>				
Female	-0.018*** (0.001)	0.007* (0.004)	0.002 (0.002)	-0.019*** (0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.007*** (0.001)	0.001 (0.002)	0.000 (0.002)	0.002 (0.002)
<b>Age</b>				
Age at SA diagnosis date	-0.001*** (0.000)	0.003*** (0.000)	-0.001*** (0.000)	0.000* (0.000)
Age at SA diagnosis or DEERS extraction date is missing	0.048*** (0.010)	0.098*** (0.020)	0.023* (0.013)	0.043*** (0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.018*** (0.001)	-0.003 (0.003)	-0.019*** (0.002)	-0.012*** (0.002)
FY03	-0.045*** (0.001)	-0.030*** (0.002)	-0.028*** (0.002)	-0.039*** (0.002)



**Model 3–Substance Abuse**

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
FY04	-0.059*** (0.001)	-0.037*** (0.002)	-0.034*** (0.002)	-0.043*** (0.002)
FY05	-0.064*** (0.001)	-0.046*** (0.002)	-0.038*** (0.002)	-0.052*** (0.002)
FY06	-0.077*** (0.001)	-0.059*** (0.002)	-0.045*** (0.002)	-0.068*** (0.002)
Sample size	334,434	98,778	112,846	134,711

Note: Year dummies are included.

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 28. Model 3.a: Substance Abuse

	<b>Army</b>	<b>Marines</b>	<b>Air Force</b>	<b>Navy</b>
<b>Duration of Deployment (reference group is not deployed)</b>				
Deployed only once	0.173*** (0.004)	0.103*** (0.005)	0.041*** (0.003)	0.073*** (0.003)
Deployed twice	0.045*** (0.005)	0.043*** (0.005)	0.020*** (0.003)	0.036*** (0.003)
Deployed three or more times	0.082*** (0.003)	0.043*** (0.006)	0.001 (0.003)	0.019*** (0.005)
Deployed to Afghanistan or Iraq at only once	0.011*** (0.003)	0.033*** (0.005)	0.017*** (0.005)	0.001 (0.010)
Deployed to Afghanistan or Iraq twice	0.110*** (0.008)	0.005 (0.006)	0.004 (0.006)	-0.001 (0.013)
Deployed to Afghanistan or Iraq three or more times	0.023*** (0.003)	0.013** (0.007)	0.008 (0.010)	-0.038** (0.019)
Total Days Deployed	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
<b>Military Occupational Specialty (reference group is Combat Arms)</b>				
Combat Support	0.000 (0.002)	0.006** (0.002)		-0.013*** (0.004)
Combat Service Support	-0.003*** (0.001)	0.007*** (0.002)	0.013*** (0.002)	-0.010** (0.004)
Aviation		0.010*** (0.002)		0.010* (0.006)
Medical	-0.007*** (0.001)		-0.017** (0.009)	0.003 (0.005)
Other MOS	-0.015*** (0.001)	0.017*** (0.004)	0.031*** (0.004)	-0.003 (0.004)
<b>Rank (reference group is E7–E9)</b>				
E1_E3	0.059*** (0.003)	0.080*** (0.005)	0.039*** (0.006)	0.053*** (0.005)
E4	0.049*** (0.003)	0.093*** (0.011)	0.045*** (0.006)	0.056*** (0.006)

Model 3.a

	Army	Marines	Air Force	Navy
E5	0.026*** (0.003)	0.083*** (0.010)	0.038*** (0.005)	0.040*** (0.005)
E6	0.015*** (0.002)	0.050*** (0.008)	0.013*** (0.004)	0.011*** (0.004)
<b>Demographics</b>				
<b>race (reference group is White)</b>				
African-American	-0.011*** (0.001)	-0.019*** (0.002)	-0.023*** (0.002)	-0.038*** (0.002)
Hispanic	-0.018*** (0.001)	-0.012*** (0.002)	-0.012*** (0.003)	-0.014*** (0.003)
Asian	-0.022*** (0.002)	-0.025*** (0.003)	-0.029*** (0.003)	-0.049*** (0.002)
Other races	-0.004** (0.002)	-0.009*** (0.002)	-0.016*** (0.003)	-0.014*** (0.002)
<b>Gender (reference group is male)</b>				
Female	-0.018*** (0.001)	0.007* (0.004)	0.001 (0.002)	-0.020*** (0.002)
<b>Marital status (reference group is married)</b>				
Single	-0.007*** (0.001)	0.000 (0.002)	0.001 (0.002)	0.003 (0.002)
<b>Age</b>				
Age at SA diagnosis date	-0.001*** (0.000)	0.003*** (0.000)	-0.001*** (0.000)	0.000* (0.000)
Age at SA diagnosis or DEERS extraction date is missing	0.051*** (0.010)	0.117*** (0.022)	0.022* (0.013)	0.040*** (0.012)
<b>FYI (reference group is 2001)</b>				
FY02	-0.018*** (0.001)	-0.004 (0.003)	-0.019*** (0.002)	-0.012*** (0.002)
FY03	-0.045*** (0.001)	-0.030*** (0.002)	-0.028*** (0.002)	-0.039*** (0.002)
FY04	-0.058*** (0.001)	-0.037*** (0.002)	-0.034*** (0.002)	-0.042*** (0.002)
FY05	-0.063*** (0.001)	-0.046*** (0.002)	-0.038*** (0.002)	-0.051*** (0.002)
FY06	-0.075*** (0.001)	-0.058*** (0.002)	-0.044*** (0.002)	-0.068*** (0.002)
Sample size	334,434	98,778	112,842	134,705

Note: Year dummies are included.  
Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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