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| <b>14. ABSTRACT</b><br>One of the most important questions in military suicide research at this time is whether deployment in support of Operations Iraqi or Enduring Freedom (OIF/OEF) is associated with an increased risk of suicide. The equivocal research conducted to date on this topic creates a confusing picture for military senior leaders and the American public. The Report of the Blue Ribbon Workgroup on Suicide Prevention in the Veteran Population (Peake, 2008) reviewed this body of literature and concluded that significant limitations and biases in many of the epidemiological approaches conducted to date contribute to the current confusion. The funded study is specifically designed to address many of the recommendations of that report in order to generate seminal results that will fill what is arguably the most important gap in the epidemiological study of military suicide. This collaborative DoD-VA study will utilize multiple enterprise level databases to determine whether a history of deployment in support of OIF/OEF is a risk factor for suicide. In addition, the proposed study will examine the suicide rates of post-deployed National Guard members and Reservists to determine whether these cohorts are at increased risk of suicide. Furthermore, it will examine rates of deaths of undetermined intent in military and civilian populations to determine whether potential misclassifications of deaths may confound military and civilian comparisons of suicide rates. In examining these suicide rates, the funded study will also specifically account for the potential confounding effect of service members who have not completed a full term of service (e.g., because of misconduct, substance abuse, etc.) and thus may be more likely to have risk factors for suicide. |                         |                                        |                                   |                                                                  |                                                  |
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## **INTRODUCTION**

One of the most important questions in military suicide research at this time is whether deployment in support of Operations Iraqi or Enduring Freedom (OIF/OEF) is associated with an increased risk of suicide. The equivocal research conducted to date on this topic creates a confusing picture for military senior leaders and the American public. The Report of the Blue Ribbon Workgroup on Suicide Prevention in the Veteran Population (Peake, 2008) reviewed this body of literature and concluded that significant limitations and biases in many of the epidemiological approaches conducted to date contribute to the current confusion. The funded study is specifically designed to address many of the recommendations of that report in order to generate seminal results that will fill what is arguably the most important gap in the epidemiological study of military suicide. This collaborative Department of Defense (DoD) – Veterans Affairs (VA) study utilized multiple enterprise level databases to determine whether a history of deployment in support of OIF/OEF is a risk factor for suicide. In addition, the proposed study examined the suicide rates of post-deployed National Guard members and Reservists to determine whether these cohorts are at increased risk of suicide. Furthermore, it examined rates of deaths of undetermined intent in military and civilian populations to determine whether potential misclassifications of deaths may confound military and civilian comparisons of suicide rates. In examining these suicide rates, the funded study also specifically accounted for the potential confounding effect of service members who did not complete a full term of service (e.g., because of misconduct, substance abuse, etc.) and thus may be more likely to have risk factors for suicide.

## **BODY**

The Madigan Army Medical Center (MAMC) Institutional Review Board (IRB) granted continuing review of the research protocol on January 6, 2014. The Human Research Protection Office (HRPO) IRB subsequently granted continuing review on February 6, 2014, and the Department of Veterans Affairs (VA) IRB granted continuing review on November 1, 2013. All other regulatory documentation has been previously approved in accordance with the granting agency. A biostatistician was interviewed and hired.

Over the course of the second year, the T2 study team signed a Memorandum of Understanding (MOU) with the Defense Manpower Data Center (DMDC) and Centers for Disease Control's (CDC) National Death Index (NDI) Program. The MOU went into effect March 1, 2011. Additionally, the DMDC was incorporated into the CDC's NDI application to format and submit data on T2's behalf. As per the MOU, T2 did not receive personally identifiable information (PII) for any service member known to be alive. As a result, T2 assessed the matched NDI results with limited identifiers to preserve the identity of the presumed alive population.

The DMDC designated a DMDC file manager to the T2 data request to assist in compiling the data to be sent to the NDI. The initial DMDC data pull was comprised of PII of all Service Members who have served in the military during calendar years (CY) 2001-2007.

Consequently, the DMDC sent two datasets to the NDI for matching. The first dataset included all service members who had been confirmed deceased verified by the DMDC's Casualty file and Defense Casualty Information Processing System's (DCIP) file, as well as the Social Security Administration's (SSA) – Death Master File (DMF). The "Known Decedent" dataset contains approximately 42,000 individual records. The second dataset includes all service members presumed alive, through January 2011, containing roughly 4.2 million records. The NDI performed matching procedures after the 2009 decedent records were released from the CDC in August 2011. The funding agency completed payment to the CDC's NDI program for their services in the amount of \$1,156,046.00.

The CDC's National Death Index (NDI) completed the matching of data from the Defense Manpower Data Center (DMDC). T2 performed quality control (QC) assessments of decedent data using the current SSA-DMF. T2 documented the procedures and workflow to ensure consistent and accurate data quality. T2 thoroughly researched the manual review process in assessing the accuracy of NDI matched records. A Statistical Analysis Software (SAS) application, which works in conjunction with Microsoft (MS) Access, was obtained and reviewed. The study team modified the SAS code to work with the study data and tested against the sample data.

T2 merged all data and conducted quality control procedures. T2 met regularly with our VA collaborators and other researchers familiar with using both DMDC and NDI data to ensure all variables were being correctly identified and to discuss potential complications of, and solutions to, combining multiple enterprise level data sources. Initial analyses for suicide rates were conducted and results were presented at the VA/DoD Suicide Conference in Washington, DC in June/2012.

At the MOMRP IPR meeting, May 2013, a question arose regarding sources for death data. As a result of this, the PI submitted an amendment to the IRB to access additional data from AFMES to further validate the conclusions presented. Data was received for AFMES on 13 August 2013.

In addition, one of the goals of the grant is to transition this project to a DoD resource that can be updated in the future. The PI was the DoD Lead for the VA/DoD Suicide Nomenclature and Data Working Group. This Workgroup reported directly to the Joint Executive Council (JEC; Co-Chaired by USDP&R). The JEC asked the Workgroup to develop an implementation plan and cost estimate for a joint DoD-VA suicide repository. The PI was able to present to the Workgroup this grant's methodology as a potential best practice. The Workgroup concurred with this general approach and the PI led the writing of the DoD-VA Suicide Repository plan. The plan for the Repository was presented to the HEC and JEC (which includes the ASD (HA) and USD (P&R)). The Secretary of Defense personally announced the development of the Repository at the DoD-VA Suicide Prevention Conference. The Defense Suicide Prevention Office (DSPO) was asked to take the lead in implementing the plan, and the PI continues to serve on the DoD-VA's Suicide Data Repository's Board of Governance. The Repository is now active and saving the DoD and VA many thousands of dollars (soon millions) in National Death Index costs. Therefore, the efforts of this grant have been leveraged

significantly to help move that effort forward. This represents a major accomplishment in transitioning the benefits of this research to a more permanent DoD solution.

Finally, it is particularly noteworthy that the Center for a New American Security wrote a policy brief in which they praised this research project as an example of what the DoD should be doing. This brief can be found in, "Losing the Battle: The Challenge Military Suicide by Margaret Harrell and Nancy Berglass", published October, 2011 by the Center for a New American Security. The author also testified before the House Committee on Veterans' Affairs on the findings of this Policy Brief on 12/2/2011.

### *Modifications*

The research protocol was modified to obtain death data from the AFMES, this was submitted on 01 July 2013, and approval of amendment was received on 05 August 2013.

A No Cost Extension was requested in order to allow for presentation of data/findings at MHSRS 17 Aug 2014- 22 Aug 2014 and at AMSUS 05 Dec 2014 – 08 Dec 2014 and approved.

### *Challenges*

Even though a longer than anticipated time period to receive data from both the DMDC and CDC's NDI program was encountered, data cleaning, validation and analysis of the original data was completed.

The Research team completed data cleaning, validation and analysis of additional data from AFMES and prepared a matched comparison of the civilian dataset and initiated analyses to examine suicide rates among US Service Members and civilians (secondary hypothesis).

## **KEY RESEARCH ACCOMPLISHMENTS**

### *Administrative and Logistical Matters*

1. Personnel
  - a. PI attended IPR meeting on 14 -15 May 2014
2. Equipment
3. Materials, supplies and consumables
  - a. Purchased office supplies (paper and CDs for data)
4. Institutional Review Board (IRB)
  - a. MAMC IRB continuing review approved on January 31, 2014.
  - b. HRPO IRB continuing review approved on February 06, 2014.
  - c. VA IRB continuing review approved on November 01, 2013.

- d. HRPO IRB continuing review approved for VA on December 12, 2013.

## **REPORTABLE OUTCOMES**

The main paper exploring the primary hypotheses related to deployment and suicide was submitted to the New England Journal of Medicine on 12 August 2014. The paper was reviewed but not accepted and was then submitted to JAMA. Notification was received on 24 July 2014, that the paper was forwarded to JAMA Psychiatry for review. A second paper was submitted by the VA collaborators to Annals of Epidemiology and is under review. Two additional papers are in development: (1) a methods paper that details a novel death validation process is close to submission for publication and will inform the literature on this topic, and (2) a manuscript that compares the rates of suicide and deaths of undetermined intent to a standardized civilian population.

## **CONCLUSION**

The overall results of this research indicated that OEF/OIF deployment was not associated with increased suicide risk, even after separation from military service. However, increased suicide risk was observed for service members who had separated prior to four years of service and those who separated with other than honorable discharge. These findings suggest the need to investigate factors associated with early discharge and less than honorable discharge that may relate to increased suicide risk. Rates of suicide in this cohort increased over the years of observation, but only approached the age-, race-, and sex-adjusted rates of the civilian population by 2009. The adjusted rates of deaths of undetermined intent were similar to those of the civilian population for all years of observation.

## **REFERENCES**

Peake, J. B. (2008). The Blue Ribbon Work Group of Suicide Prevention in the Veteran Population. Chartered by Secretary of Veterans Affairs James B. Peake, May 5, 2008.

## **APPENDICIES**

Main paper Appendix A

VA paper Appendix B

Risk of Suicide Following OEF/OIF Deployment and  
Separation from the U.S. Military

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## ABSTRACT

### Background

A pressing question in military suicide prevention research is whether deployment in support of Operations Enduring or Iraqi Freedom (OEF/OIF) relates to suicide risk. We evaluated this question in a cohort comprising all 4.1 million US military personnel who served during the first 7 years of OEF/OIF to address long-standing methodological limitations and gaps in this literature.

### Methods

This is a retrospective cohort that used administrative data to identify dates of deployment for all service members (2001 – 2007) and death data from the Services and the National Death Index (2001 – 2009) to estimate rates of suicide-specific mortality. Hazard ratios were estimated from time-dependent Cox proportional hazard regression models to compare deployed Service members to those who did not deploy.

### Results

Deployment was not associated with the rate of suicide (HR = 1.01; 99% CI = .90, 1.12). Among cohort members who had separated from service, a prior history of deployment was similarly independent from suicide rates (HR = .85; 99% CI = .71, 1.02). Rates of suicide were elevated for Service members who separated with less than 4 years of service or who did not separate with an honorable discharge.

### Conclusions

Findings do not support an association between deployment and suicide mortality in this cohort. Early military separation (< 4 years) and discharge that is not honorable were suicide risk factors.

## Risk of Suicide Following OEF/OIF Deployment and Separation from the U.S. Military

The U.S. military has traditionally experienced lower suicide rates compared to the general U.S. population.<sup>1,2</sup> The suicide rate among the active duty U.S. military, however, has increased in the last decade, almost doubling in the Army and Marines Corps.<sup>3</sup> Research on the potential impact of deployments to Operations Enduring or Iraqi Freedom (OEF/OIF) is limited. Department of Defense (DoD) reports show that about half of the suicide cases that occur on active duty did not have a history of deployment.<sup>4</sup> However, these descriptive DoD studies are generally unable to track mortality among service members after they separate from military service (when DoD “jurisdiction” ends). Any analysis of deployment as a risk factor for suicide must account for service member deaths after separation from service, especially since service members who screen positive for mental health concerns following a deployment are more likely to separate from military service.<sup>5</sup>

Research on veteran suicide risk factors has increased in recent years<sup>6</sup>, but much of the research is limited to veterans who access health care from the Veterans Affairs (VA).<sup>7,8</sup> This subgroup represents only about 35% of all veterans.<sup>9</sup> Furthermore, some epidemiological research relies upon death certificates to classify veteran status;<sup>10</sup> this approach relies upon funeral directors and others who use methods that vary widely from state to state.<sup>11</sup> In addition, length of military service may be an important factor in considering suicide rates among those who have separated from the military, as each year thousands of U.S. military personnel fail to complete basic or advanced training or are discharged because of legal problems, adjustment reactions, alcohol and drug-related problems, and other administrative reasons.<sup>10</sup>

Several systematic reviews of military suicide prevention have noted these methodological problems in the epidemiological literature and have called for efforts to link multiple federal databases to address these concerns.<sup>10,12</sup> The impact of combat deployments on suicide risk is an issue of national and international importance.<sup>13-15</sup>

Two recent DoD studies have partially addressed these methodological limitations<sup>16-17</sup>; unfortunately, they came to conflicting conclusions about the association between suicide and deployment. One included only Army Regular component service members and only included suicides that occurred during military service<sup>16</sup> The other included only 83 suicides from a survey sample with a low response rate.<sup>17</sup>

The current study examined the association between deployment and suicide among all 4.1 million service members who served in the U.S. military from 2001 to 2007. Suicide mortality was followed through 2009, regardless of separation from military service. To our knowledge, this is the most comprehensive study to date to examine suicide risk in relation to OEF/OIF deployment.

## **Method**

### *Study Population*

This retrospective cohort study included all uniformed Service personnel that were in the military at any time between January 1, 2001 and December 31, 2007. All Service members who were in the Active or Reserve components of the Air Force, the Army, the Marine Corps, or the Navy at any point between January 1, 2001 and December 31, 2007 were eligible for inclusion in the cohort. The initial population included 4,108,552 Service members. Data related to Service characteristics and demographics were ascertained from records provided by the Defense

Manpower Data Center (DMDC)<sup>18</sup>. Data on mortality covered the cohort eligibility window and extended through December 31, 2009.

#### *Exposure Variables –Deployment and Separation from Service*

The primary exposure variable was a deployment in support of OEF or OIF between October 7, 2001 and December 31, 2007. We identified deployments in the Contingency Tracking System (CTS) records provided by the DMDC. Deployments were defined in accordance with standard DoD surveillance practice: (1) duration of at least 30 days per the parent (primary) start and end dates and (2) a separation of at least 30 days between parent deployments to distinguish two deployments as separate deployments. Furthermore, deployments in support of OEF and OIF were identified by having a location assignment at any time during a parent deployment to any of the following land locations: Afghanistan, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Yemen, Djibouti, Iraq, Kyrgyzstan, and Uzbekistan.<sup>14</sup> Water locations included designations for the Red Sea, the Gulf of Aden, the Gulf of Oman, and the Arabian Sea.<sup>14</sup>

The secondary exposure variable, separation from service, was defined as a separation to civilian life from either the regular or reserve components without a subsequent record of return to service.<sup>19</sup> Therefore, individuals serving in uniform with the National Guard or Reserves (e.g., performing weekend training and periodic duty assignments) were considered in the military (not separated) while personnel separated to the Inactive National Guard or Individual Ready Reserve (minimal annual requirements, such as keeping personal contact information current) were considered separated. Time in service was defined as the difference between date of a final separation from service and the pay entry base date.

#### *Ascertainment of deaths*

The primary outcome for the study was death by suicide. We used data from the Medical Mortality Surveillance Division of the Armed Forces Medical Examiner System (AFMES) as a gold standard source of mortality data for Service members.<sup>20</sup> AFMES maintains the DoD Medical Mortality Registry (DMMR), which tracks all deaths that occur among uniformed service members while in an “active” status regardless of geographic location. The National Death Index (NDI) identified deaths in the entire cohort from January 1, 2001 to December 31, 2009 as a secondary source. Death records in the NDI include all deaths that occurred within the United States. This source provided cause of death data for cohort members who were not eligible to be included in the AFMES death data because of a separation from service. International Statistical Classification of Diseases and Related Health Problems codes were used to identify suicides in accordance with the National Vital Statistics Report standard.<sup>21</sup>

We examined the sensitivity of the NDI to AFMES records among cohort members who could have been in both sources at the time of death (i.e. active duty deaths that occurred in the United States). Sensitivity for the active duty subpopulation that died in the U.S. was 97.1%, and overall agreement on suicide as the manner of death between AFMES and the NDI was 98.2% ( $\kappa = .94, p < .001$ ). Prior studies have also successfully identified military suicides with NDI and AFMES data.<sup>17,22</sup>

### *Statistical Analysis*

We used two time structures to examine the hazard of suicide associated with deployment. The first structure allowed us to estimate the hazard ratios between suicide and deployment among Service members while still in the Service. Service members entered the risk window on January 1, 2001 or at their pay entry base date if they entered the Service after January 1, 2001. Service members exited the risk window on the date of death, the date of exit

from the Service, or on December 31, 2009, whichever occurred first. We accounted for the time-varying of deployment by splitting person-time between not exposed and exposed periods. For this analysis, once a service member had a deployment, they were considered exposed for the duration of the cohort observation period. The time scale for the model was calendar time.

The second structure focused only on Service members with a known separation from service. This allowed us to examine the association between a history of deployment and suicide among Service members who resumed a civilian status. Service members in this structure entered the risk window on the date of separation from the military and remained at risk until the date of death or December 31, 2009. The time scale was years since separation from the military. A history of deployment was specified as a time-invariant determinant of suicide since the exposure preceded entry into the risk window.

We used Cox proportional hazards regression models for both time structures to estimate the hazard ratios of deployment with the rate of suicide. Additional determinants included in the model for cohort members who had separated from the military included the time in service prior to separation and the characterization of service at separation. For individuals with a recorded death, causes other than suicide were censored at the date of death. Effect measure modification of the association between deployment and suicide as a function of Service branch affiliation was evaluated using likelihood ratio tests and stratification of the model. Baseline covariates included in the models were age at cohort entry, sex, race/ethnicity, education, marital status, component, service branch, and military rank. For all models, we evaluated the proportional hazards assumption using graphical methods and goodness-of-fit tests.<sup>23</sup> For all descriptive rates and hazard ratios, we evaluated precision using 99% confidence intervals. We chose to use the more stringent  $\alpha = .01$  given the large size of the cohort and potential for statistical significance of

otherwise trivial associations. Given the lack of exposure data between 2007 and 2009, we estimated the regression models using December 31, 2007 as the end of the risk window to evaluate the consistency of the hazard ratios. We used Stata Version 12.1 to conduct all statistical analyses.<sup>24</sup>

## Results

After excluding 3,293 individuals for data quality problems (e.g., incompatible dates of birth and service entry, no date of birth), the final dataset included 4,105,259 Service members and a total of 30,918,938 person-years of observation. A total of 35,159 deaths occurred – of which 5,520 were identified as suicides – by the end of the observation period.

Table 1 displays the distribution of suicide cases, person-years, and crude rates by several demographic characteristics of the cohort. We observed higher crude rates of suicide for service members who were younger, male, not married, and identified as non-Hispanic White, Native American, or unspecified racial/ethnic category. Crude suicide rates were slightly elevated for Active component as compared to Reserve component Service members. Service members in the Army and the Marine Corps had the higher crude rates of suicide than Service members from the Air Force and the Navy. Finally, consistent with the baseline age pattern for suicide rates, service members in junior enlisted ranks had the highest rate of suicide.

Using the first specification of the time structure, the hazard function showed that the rate of suicide is increasing in a largely monotonic fashion (Figure 1). Table 2 displays the results of the regression model that examined the association between deployment and suicide using this time structure. There was no association between deployment and the rate of suicide; having more than one deployment was also not associated with the rate of suicide. A formal test of effect measure modification by Service branch was not statistically significant ( $\chi^2 = 2.1$ ,  $df = 3$ ,  $p$



= .544). Estimation of separate regression models by baseline branch affiliation showed consistent hazard ratios that were close to unity.

The rate of suicide among service members after separation from service was 71% greater than for those who remained in service through the end of 2007 (HR = 1.71; 99% CI = 1.58, 1.85). In focusing on cohort members who separated from the military, the hazard function showed that the rate of suicide was highest during the first two years after leaving the Service (Figure 2). A history of one or more deployments was associated with a small reduction in the hazard of suicide that was not statistically significant at  $\alpha = .01$ . The likelihood ratio test of effect measure modification by Service branch suggested heterogeneity between the Services ( $\chi^2 = 10.7$ ,  $df = 3$ ,  $p = .013$ ). The estimates of association for the Army and the Air Force were consistent with each other and with the overall estimate. The hazard ratio for the Marine Corps indicates a substantial reduction in the hazard of suicide as a function of deployment, but this estimate is based on a small number of cases. Similarly, the estimate for the Navy suggests an increase in the hazard of suicide. It is not statistically significant and, similar to the Marine Corps estimate, is based on a small number of cases.

In contrast to deployment, time in service and the characterization of service at separation from the military both had associations with the hazard of suicide (Table 4). We observed a monotonic decrease in the rate of suicide associated with increased time in service. Of note, the hazard of suicide for service members who completed between four and twenty years of service was approximately half that for service members who only completed up to one to service members with up to one year of service prior to separation. Among the service members who reverted to a civilian status at separation, we examined the characterization of the separation. Compared to service members who left with an “honorable” characterization, those with

characterizations that were not “honorable” (which includes general/under honorable conditions, bad conduct, other than honorable conditions, and dishonorable) and those with uncharacterized separations (e.g., separation initiated following less than 180 days of military service)<sup>25</sup> had an increased hazard of suicide. Estimation of all models reported above using December 31, 2007 as the end of the risk window did not alter the results reported above.

### **Discussion**

This is the first study, to our knowledge, designed to examine the association between deployment and suicide among all 4.1 million U.S. military personnel who served during the first 7 years of OEF/OIF. These data showed that service members who deployed in support of OEF/OIF were not at increased risk of suicide compared to service members who never deployed in support of these conflicts. In addition, those with two or more deployments did not show a higher risk of suicide compared to those with no deployments. It is important to note that service members undergo pre-deployment health screenings, including mental health screening, to ensure that they are fit to deploy.<sup>26</sup> Therefore, the cohort that deploys may be healthier than the general military population. It is possible that future research with the OEF/OIF cohort will replicate findings from prior war eras that showed increased suicide risk among subgroups of veterans with risk factors such as mental health conditions or being wounded in combat.<sup>27,28</sup>

These results are consistent with a recent prospective longitudinal study that included 83 suicides from the Millennium Cohort Study.<sup>17</sup> They did not find increased suicide risk associated with any deployment-related factors such as combat experience, number of days deployed, or number of deployments.

The results are inconsistent with a recent study from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS).<sup>16</sup> They reported an elevated suicide risk

among currently and previously deployed soldiers. The discrepancy in results is likely due to methodological differences. The Army STARRS study included only Army personnel, excluded Army National Guard and Army Reservists, examined a 6 year period, included only suicides that occurred during military service, and included data on exposure and mortality from 2004 to 2009. Our study included all military services (Air Force, Army, Navy, Marines Corps), included National Guard and the Reservists, used data on exposures from 2001 to 2007 and mortality from 2001 to 2009. Analytically, the Cox proportional hazards regression models compared time to suicide, whereas the discrete time survival analysis used by Army STARRS assessed risk of suicide based on the presence or absence of deployment.

The results of this study showed that those who separated from military service were at increased risk of suicide compared to those who had not separated. Among those who had separated from service, both those who deployed and had not deployed showed similarly elevated risks for suicide. In contrast, those who deployed but were not separated did not have higher rates than those who did not deploy and were not separated.

Consistent with research conducted with the Armed Forces in the United Kingdom (UK's), the risk for suicide was highest among those who separated after shorter periods of military service.<sup>15</sup> Compared to those with 4 or more years of military service, individuals with less than 4 years of service had an increased rate of suicide. There are several possible explanations for these findings. It is possible that the transition from the military (structured work with a team focused on a mission) to civilian life may have increased risk for suicide. It is possible that individual characteristics, experiences, or other factors that existed prior to military service increased suicide risk for this cohort. Alternatively, it is possible that military experiences that we are currently unable to identify in our data conferred risk for suicide. For

some, it is possible that the factors that led to early discharge may continue to be problematic (e.g., legal problems, mental health disorders, medical problems, disciplinary issues, and disability). For example, Iverson and colleagues found that veterans with mental health problems were more likely to be discharged early and also were at elevated risk for unemployment following discharge.<sup>29</sup> We did find that service members discharged under Not Honorable conditions had modestly higher rates of suicide than those discharged under Honorable conditions. The Army STARRS study<sup>16</sup> reported elevated suicide rates among soldiers who were demoted within the prior 2 years. Additional research is needed to clarify the circumstances surrounding early discharges and how these factors may be related to suicide. Protective factors may also differ for some who are discharged early. For example, individuals who separate with a dishonorable discharge are not entitled to VA services.

We did not use the term “veteran” to describe those who separated from military service in our cohort to avoid confusion. Prior Veterans Health Administration (VHA) studies typically define veterans as those individuals who are eligible for VA benefits,<sup>30,31</sup> including some individuals who are still serving in the Reserve component. Our findings are not inconsistent with prior research on U.S. veteran populations from prior war eras. Such research indicated that when veterans are considered as a whole, their rate of suicide was not significantly elevated compared to the general population.<sup>30-32</sup> More recent research on VHA patients show a 42% to 66% increase in suicide rates compared to controls,<sup>33,34</sup> but these studies did not include the majority of veterans who do not access VHA services.<sup>9</sup> Veterans who seek care from the VA likely represent a vulnerable subpopulation. A strength of the current research is that it provided suicide risk estimates inclusive of the entire population of veterans within our study cohort.

Additional research is needed to describe deployment risk among veterans eligible for VHA benefits.

The multi-faceted and idiosyncratic nature of suicide renders suicide prevention a complex challenge. This study suggests that, taken as a whole, the deployed OEF/OIF cohort is not at increased suicide risk as compared to the non-deployed OEF/OIF cohort members. Our findings indicate that preventionists should consider opportunities to intervene among those who separate from service early, especially those with less than four years of service.

Strengths of this study include a comprehensive analysis of suicide in relation to deployment among a very large, well-defined military cohort that served during the first 7 years of OEF/OIF. Limitations include the use of death certificates to classify suicides which may result in a misclassification bias.<sup>35</sup> However, this is a widely used and accepted approach to classifying suicides.<sup>36, 37</sup> It is possible that suicides were underestimated, as some service members with suicidal intentions may place themselves in harm's way while deployed. In sum, the accelerated rate of suicide among members of the U.S. Armed Forces and veterans in recent years is concerning. Though there has been speculation that deployment to the OEF/OIF combat theaters may be associated with military suicides, the results of this research do not support that hypothesis. Future research is needed to examine combat injuries, mental health, and other factors that may increase suicide risk. It is possible that such factors alone and in combination with deployment increase suicide risk.

Table 1. Rates of suicide by demographic and military service characteristics

| Variable                      | No. suicides | Person-years | Rate <sup>a</sup> | 99% CI       |
|-------------------------------|--------------|--------------|-------------------|--------------|
| Age at baseline, years        |              |              |                   |              |
| 17 - 21                       | 2,325        | 9,375,682    | 24.80             | 23.51, 26.16 |
| >21 - 25                      | 1,159        | 6,400,412    | 18.11             | 16.79, 19.53 |
| >25 - 35                      | 1,228        | 8,293,244    | 14.81             | 13.76, 15.94 |
| >35 - 45                      | 639          | 5,232,894    | 12.21             | 11.03, 13.52 |
| >45                           | 169          | 1,626,706    | 10.45             | 8.57, 12.74  |
| Sex                           |              |              |                   |              |
| Male                          | 5,200        | 25,800,584   | 20.15             | 19.45, 20.89 |
| Female                        | 320          | 5,118,328    | 6.25              | 5.41, 7.22   |
| Missing                       | 0            | 27           | 0.00              |              |
| Race/ethnicity                |              |              |                   |              |
| Non-Hispanic                  |              |              |                   |              |
| White                         | 3,825        | 19,375,382   | 19.74             | 18.94, 20.58 |
| Black                         | 523          | 5,091,157    | 10.27             | 9.18, 11.50  |
| Asian/Pacific Islander        | 138          | 1,052,037    | 13.12             | 10.53, 16.33 |
| Native American               | 105          | 338,113      | 31.05             | 24.15, 39.93 |
| Hispanic                      | 333          | 2,807,252    | 11.86             | 10.30, 13.66 |
| Other                         | 379          | 1,355,304    | 27.96             | 24.50, 31.92 |
| Missing                       | 217          | 899,694      | 24.12             | 20.25, 28.73 |
| Education                     |              |              |                   |              |
| No high school/alternative HS | 940          | 3,185,360    | 29.51             | 27.13, 32.10 |
| High school graduate          | 3,744        | 20,605,832   | 18.17             | 17.42, 18.95 |
| Some college                  | 358          | 2,394,224    | 14.95             | 13.05, 17.13 |
| Four-year college degree      | 286          | 3,067,040    | 9.33              | 8.01, 10.86  |
| Postgraduate degree           | 112          | 1,355,060    | 8.27              | 6.48, 10.54  |
| Missing                       | 80           | 311,423      | 25.69             | 19.26, 34.26 |
| Marital status                |              |              |                   |              |
| Never married                 | 3,789        | 17,525,813   | 21.62             | 20.73, 22.54 |
| Married                       | 1,511        | 12,120,351   | 12.47             | 11.67, 13.32 |
| Separated, divorced, widowed  | 203          | 1,229,255    | 16.51             | 13.78, 19.79 |
| Missing                       | 17           | 43,520       | 39.06             | 20.91, 72.96 |
| Component                     |              |              |                   |              |
| Regular                       | 3,585        | 19,297,967   | 18.58             | 17.80, 19.39 |
| Reserve                       | 1,935        | 11,620,972   | 16.65             | 15.70, 17.66 |
| Service branch                |              |              |                   |              |
| Army                          | 2,870        | 14,808,362   | 19.38             | 18.47, 20.34 |
| Air Force                     | 908          | 6,567,233    | 13.83             | 12.69, 15.06 |

|                 |       |            |       |              |
|-----------------|-------|------------|-------|--------------|
| Marine Corps    | 770   | 3,391,568  | 22.70 | 20.69, 24.91 |
| Navy            | 972   | 6,151,698  | 15.80 | 14.55, 17.16 |
| Missing         | 0     | 78         | 0.00  |              |
| <b>Rank</b>     |       |            |       |              |
| Junior enlisted | 4,149 | 18,674,871 | 22.22 | 21.35, 23.12 |
| Senior enlisted | 1,066 | 8,501,060  | 12.54 | 11.59, 13.57 |
| Officer         | 305   | 3,743,008  | 8.15  | 7.03, 9.44   |

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*Note:* CI = confidence interval; <sup>a</sup> Rate per 100,000 person-years

Table 2. Association between deployment in support of Operation Enduring Freedom (OEF) or Operation Iraqi Freedom (OIF) between 2001 – 2007 and suicide (2001 – 2009) for all Service members prior to separation, overall and by Service branch.

| Variable                 | No. suicides | Person-years | Rate <sup>a</sup> | HR <sup>b</sup> | 99% CI     |
|--------------------------|--------------|--------------|-------------------|-----------------|------------|
| <b>All Services</b>      |              |              |                   |                 |            |
| No OEF/OIF deployment    | 2,305        | 16,975,128   | 13.58             | Ref.            |            |
| Any OEF/OIF deployment   | 948          | 5,340,076    | 17.75             | 1.01            | 0.90, 1.12 |
| One deployment           | 711          | 4,109,449    | 17.30             | 1.00            | 0.89, 1.13 |
| More than one deployment | 237          | 1,230,627    | 19.26             | 1.03            | 0.85, 1.24 |
| <b>Army</b>              |              |              |                   |                 |            |
| No OEF/OIF deployment    | 1,088        | 7,212,624    | 15.09             | Ref.            |            |
| Any OEF/OIF deployment   | 578          | 3,116,484    | 18.55             | 0.98            | 0.85, 1.14 |
| <b>Air Force</b>         |              |              |                   |                 |            |
| No OEF/OIF deployment    | 439          | 4,099,358    | 10.71             | Ref.            |            |
| Any OEF/OIF deployment   | 149          | 1,050,347    | 14.19             | 1.10            | 0.84, 1.43 |
| <b>Marine Corps</b>      |              |              |                   |                 |            |
| No OEF/OIF deployment    | 320          | 1,702,778    | 18.79             | Ref.            |            |
| Any OEF/OIF deployment   | 178          | 778,002      | 22.88             | 1.01            | 0.78, 1.30 |
| <b>Navy</b>              |              |              |                   |                 |            |
| No OEF/OIF deployment    | 458          | 3,960,360    | 11.56             | Ref.            |            |
| Any OEF/OIF deployment   | 43           | 395,244      | 10.88             | 0.87            | 0.56, 1.33 |

*Note:* HR = hazard ratio; CI = confidence interval

<sup>a</sup> Rate per 100,000 person-years

<sup>b</sup> Adjusted for baseline demographic and service covariates: age, sex, race/ethnicity, education, marital status, component, service branch, and rank.



Table 3. Association between deployment in support of Operation Enduring Freedom (OEF) or Operation Iraqi Freedom (OIF) between 2001 – 2007 and suicide (2001 – 2009) for all Service members who separated from Service, overall and by Service branch.

| Variable                 | No. suicides | Person-years | Rate <sup>a</sup> | HR <sup>b</sup> | 99% CI     |
|--------------------------|--------------|--------------|-------------------|-----------------|------------|
| <b>All Services</b>      |              |              |                   |                 |            |
| No OEF/OIF deployment    | 2,034        | 7,703,032    | 26.41             | Ref.            |            |
| Any OEF/OIF deployment   | 233          | 900,703      | 25.87             | 0.85            | 0.71, 1.02 |
| One deployment           | 197          | 761,854      | 25.86             | 0.86            | 0.70, 1.05 |
| More than one deployment | 36           | 138,849      | 25.93             | 0.80            | 0.52, 1.24 |
| <b>Army</b>              |              |              |                   |                 |            |
| No OEF/OIF deployment    | 1,041        | 3,904,269    | 26.66             | Ref.            |            |
| Any OEF/OIF deployment   | 163          | 574,984      | 28.35             | 0.88            | 0.70, 1.11 |
| <b>Air Force</b>         |              |              |                   |                 |            |
| No OEF/OIF deployment    | 292          | 1,280,052    | 22.81             | Ref.            |            |
| Any OEF/OIF deployment   | 28           | 137,477      | 20.37             | 0.78            | 0.46, 1.32 |
| <b>Marine Corps</b>      |              |              |                   |                 |            |
| No OEF/OIF deployment    | 253          | 791,057      | 31.98             | Ref.            |            |
| Any OEF/OIF deployment   | 19           | 119,731      | 15.87             | 0.47            | 0.25, 0.88 |
| <b>Navy</b>              |              |              |                   |                 |            |
| No OEF/OIF deployment    | 448          | 1,727,583    | 25.93             | Ref.            |            |
| Any OEF/OIF deployment   | 23           | 68,511       | 33.57             | 1.33            | 0.76, 2.31 |

*Note:* HR = hazard ratio; CI = confidence interval.

<sup>a</sup>Rate per 100,000 person-years

<sup>b</sup>All HRs adjusted for baseline demographic and service covariates: age, sex, race/ethnicity, education, marital status, component, service branch, rank, and history of deployment.

Table 4. Association between service characteristics at separation (2001 – 2007) and suicide (2001 – 2009) for all Service members who separated from Service

| Variable                                     | No. suicides | Person-years | Rate <sup>a</sup> | HR <sup>b</sup> | 99% CI                |
|----------------------------------------------|--------------|--------------|-------------------|-----------------|-----------------------|
| Time in service at time of separation, years |              |              |                   |                 |                       |
| <1                                           | 591          | 1,269,071    | 46.57             | Ref.            |                       |
| 1 – <2                                       | 305          | 690,949      | 44.14             | 0.98            | 0.82, 1.19            |
| 2 – <4                                       | 379          | 943,853      | 40.15             | 0.88            | 0.73, 1.05            |
| 4 – <8                                       | 403          | 1,852,988    | 21.75             | 0.47            | 0.39, 0.57            |
| 8 – <20                                      | 336          | 1,599,032    | 21.01             | 0.51            | 0.40, 0.65            |
| ≥20                                          | 253          | 2,247,840    | 11.26             | 0.24            | 0.16, 0.36            |
|                                              |              |              |                   |                 | <i>p</i> -trend <.001 |
| Characterization of separation <sup>c</sup>  |              |              |                   |                 |                       |
| Honorable                                    | 683          | 3,002,055    | 22.75             | Ref.            |                       |
| Not honorable                                | 465          | 962,919      | 48.29             | 1.51            | 1.27, 1.80            |
| Uncharacterized                              | 459          | 977,302      | 46.97             | 1.51            | 1.26, 1.81            |
| Unknown/Not applicable                       | 367          | 1,537,634    | 23.87             | 1.15            | 0.94, 1.42            |

*Note:* HR = hazard ratio; CI = confidence interval; IRR = inactive ready reserve; ING = inactive national guard.

<sup>a</sup>Rate per 100,000 person-years

<sup>b</sup>All HRs adjusted for baseline demographic and service covariates: age, sex, race/ethnicity, education, marital status, component, service branch, rank, and history of deployment.

Figure 1. Hazard of suicide and 99% confidence interval as a function of calendar time for all members of the cohort prior to separation from the military.

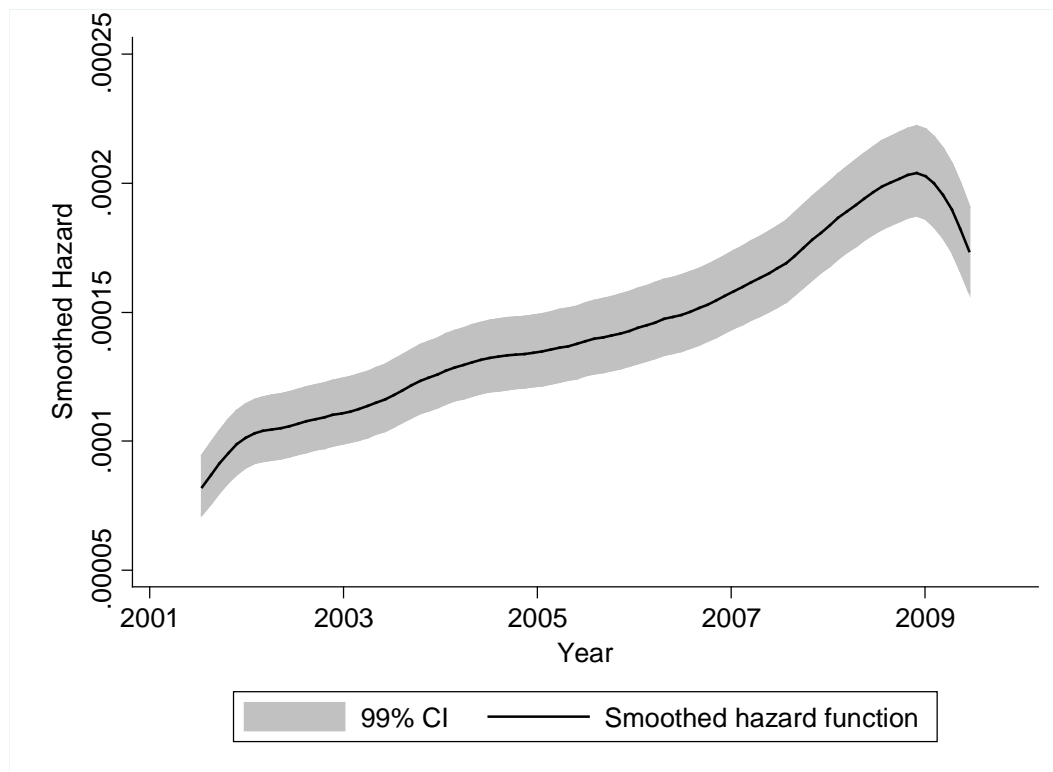


Figure 2. Hazard of suicide and 99% confidence interval as a function of years since separation among service members who separated from the military.



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Suicide Risk among 1.3 Million Veterans Who Were on Active Duty During the Iraq  
and Afghanistan War

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## ABSTRACT

**PURPOSE:** We conducted a retrospective cohort mortality study to determine the post service suicide risk of recent wartime veterans.

**METHODS:** Veterans were identified from the Defense Manpower Data Center records and deployment to Iraq or Afghanistan war zone was determined from the Contingency Tracking System. Vital status of 317,581 deployed and 964,493 non-deployed veterans was followed from the time of discharge to December 31, 2009. Underlying causes of death were obtained from the National Death Index Plus.

**RESULTS:** Based on 9,353 deaths (deployed, 1,650; non-deployed, 7,703), of which 1,868 were suicide deaths (351; 1,517), both veteran cohorts had 24-25% lower mortality risk from all causes combined, but had 41-61% higher risk of suicide relative to the US general population. However, the suicide risk was not associated with a history of deployment to the war zone. After controlling for age, sex, race, marital status, branch of service, and rank, deployed veterans showed a lower risk of suicide compared to non-deployed veterans (hazard ratio, 0.84; 95% confidence interval, 0.75- 0.95).

**CONCLUSIONS:** Veterans exhibit significantly higher suicide risk compared to the US general population. However, deployment to the Iraq or Afghanistan war, by itself, was not associated with the excess suicide risk.

**Keywords:** Suicide, Veterans, Standardized Mortality Ratios, Hazard Ratios, Iraq and Afghanistan War

**List of abbreviations:** CI, confidence interval; CDC, Centers for Disease Control and Prevention; DMDC, Defense Manpower Data Center; DOD, US Department of Defense; NDI, National Death Index; HR, hazard ratio; SMR, standardized mortality ratio; VA, US Department of Veterans Affairs

## INTRODUCTION

The reported increased risk of suicide among recent U.S. military veterans, particularly those who have served in either the Afghanistan or Iraq War, has been of concern among veterans, the public and policy makers. The US Department of the Army reported that the suicide rates in soldiers almost doubled between 2005 and 2009 (1). Prior to the Iraq and Afghanistan War, the suicide rates among active duty and former military personnel had been 20-30% lower than that of U.S. general population, adjusting for difference in demographic composition by gender, age, and race (2-5).

The recent wars in Iraq and Afghanistan are substantially different from prior wars in Vietnam (1965-1973) or the Persian Gulf (1990-1991). Recent war veterans had been deployed repeatedly and for a longer tour than those from previous wars. The types of warfare and injuries sustained by today's troops are also different than those seen in previous wars (6). Today's military service members are all volunteers, older, and more likely to be married with children. Women make up a greater percentage of service members than their Vietnam-era counterparts as well. While many post service health issues of female veterans are likely to mirror those of male veterans, there may be gender specific mental health consequences of military service and battlefield deployment (7).

There have been several studies that compare suicide risk between those who were deployed in Iraq or Afghanistan and those who were not deployed. A few studies reported no higher risk among service members with a history of deployment than others who were not deployed (1, 8-9), while another recent study suggested elevated suicide risk among currently and previously deployed soldiers (10). Among veteran patients receiving care at VA medical facilities, the suicide rate for Iraq and Afghanistan veteran patients was not significantly different than other veteran patients when adjusted for their psychiatric conditions and demographic variables (age, sex, geographic region) (11).

There has not been a large population based cohort study that compares post service suicide risk between Iraq and Afghanistan War veterans and contemporary veterans who were not deployed. It has been reported that those who remained in service after deployment are believed to be healthier than those who were discharged (12). Therefore, a study of post service suicide risk among veterans would complement a study of military population still on active duty, and may elucidate longer-term health consequences of wartime service in Iraq and Afghanistan.

Given that many returning veterans screened positive for a mental disorder (13-15), and that certain mental disorders, especially the presence of major depressive disorder and PTSD, are significant risk factors for suicide (9,16-19), we attempted to determine whether or not 1) the post service suicide risk among recent military veterans is similar to that of U.S. population; and whether or not 2) risk of suicide

among Iraq and Afghanistan War veterans is similar to that of veteran peers who were not deployed. To this end, we conducted a post service mortality study of all former Active Component service members who were discharged from the military service through 2007.

## METHODS

### Study Participants

Study subjects were identified from 4.1 million individuals who served in the U.S. military from 2001 to 2007. Among these, 1,282,074 served with an Active Component unit and separated from active duty before the end of 2007. Deployment to Iraq or Afghanistan War Theater was determined from the DMDC Contingency Tracking System (CTS) records and defined by service location in Iraq, Afghanistan, and surrounding countries or waterways (the Red Sea, the Gulf of Aden, the Gulf of Oman, and the Arabian Sea).

The Defense Manpower Data Center (DMDC) provided electronic personal records of these service members. Service information on the records included service branch, unit component, service dates, deployment locations and dates, and rank. Demographic information on the records included birth date, gender, race/ethnicity, and marital status.

### Determination of Vital Service and Cause of Death Data Collection

Vital status of each veteran following his/her discharge from active duty was determined by matching social security numbers of the veterans with the Social Security Administration Death Master File and the National Center for Health Statistics (NCHS) National Death Index (20). The follow-up period ended at either the veteran's date of death or on December 31, 2009, whichever came earlier. Underlying cause of death information was obtained from the NDI Plus. The NDI Plus is a service available since 1997, in which NCHS provides cause-of-death codes using the International Classification of Diseases, Ninth Revision, or Tenth Revision (21, 22).

### Statistical Analysis

Crude suicide rates were computed by dividing observed suicide numbers by person-years at risk of dying per 100,000 persons. Person-years at risk were counted beginning at separation from active duty and ending upon death or December 31, 2009, whichever came first. The National Institute for Occupational Safety and Health Life Table Analysis System (LTAS) version 3.0.3, software was used to obtain standardized mortality ratios (SMRs) and 95% confidence intervals (CIs) for each cause-of-death category (23). The SMR is the ratio of the observed deaths among veterans to the expected deaths calculated from the mortality rates

for the U.S. general population (referent population) adjusted for gender, race, age, and calendar period.

Multivariable Cox Proportional Hazards regression was used to obtain hazard ratio (HR) and 95% confidence interval (CI) for suicide associated with deployment, accounting for possible confounding and the effect of selected covariates (24). The covariates considered in the model were age at the start of follow-up, race, gender, marital status, service branch (Army, Marines/Air Force, Navy), and rank (Enlisted/Officer).

Analyses were also repeated for male and female veterans separately because female veterans may have had different experiences than male counterparts during their battlefield deployment or post service readjustment to civilian life.

We used the calendar year of separation as a proxy for degree of combat stress for Iraq and Afghanistan war veterans. We assumed those who left active duty service during the earlier years of war would have less combat related stress than those who left during the peak years of hostility in 2006-7. DOD casualty data for the period from 2001 to 2007 indicated that all three measures of combat related casualties - incidence of PTSD, severe or penetrating traumatic brain injuries (TBI), and major limb amputations due to battle injuries - had steadily and significantly increased over the period (25). The Cochran-Armitage trend test was conducted to look for trends in suicide rates associated with the discharge year (26). The same test for trend was conducted for suicide rates associated with years since being discharged from military service for both deployed and non-deployed veterans.

Except for the Life Table Analysis System software output, the estimates and procedures described in this paper were generated by using SAS software, version 9.3 (24). Two-tailed statistical tests were conducted. Any SMRs and HRs for which 95% confidence intervals did not include 1.00 were considered statistically significant.

The Washington VA Medical Center Institutional Review Board and Madigan Medical Center IRB approved this study.

## RESULTS

### Characteristics of Deployed and non-Deployed Veteran Cohorts (Table 1 and 2)

The demographic and military characteristics of the deployed veterans were somewhat different than the non-deployed veteran counterparts. Deployed veterans were slightly younger, included fewer women, fewer non-whites, and fewer non-married. A larger portion of deployed veterans served with the Army and Marine Corps units and conversely, fewer with the Navy.

Among the 317,581 deployed veterans, 1,650 died through the end of follow up on December 31, 2009. Of these deaths 351 were from suicides. Likewise, among the 964,493 non-deployed veterans, 7,703 died and 1,517 were from suicides. Cause of death information was available for 94% of the deployed and 96% of non-deployed veteran deaths (Table 2).

#### Veteran Suicide Risk Compared to US General Population (Table 3)

Among all veterans, overall mortality risk was significantly lower (SMR, 0.76; 95% CI, 0.74-0.77) and suicide risk was significantly higher (SMR, 1.57; 95% CI, 1.50-1.64) than comparable US general population. While overall mortality risk was 25% lower, suicide risk was 41% higher among deployed veterans. Likewise, among non-deployed veterans, overall mortality risk was 24% lower, but suicide risk was 61% higher.

Comparing suicide rates between male and female veterans, female rate was about a third that of male veterans (male, 33.4/100,000; female, 11.2/100,000). However, in comparison to their respective US gender specific population, the magnitude of suicide risk was higher among female veterans (SMR, 2.19-2.36) than male veterans (SMR, 1.38-1.57) regardless of their deployment status.

#### Effects of Deployment on the Suicide Risk (Table 4)

Hazard ratios (HR) derived from the Cox proportional hazards model for male and female veterans are shown in Table 4. After controlling for potential confounders (age, sex, race, marital status and military service variables such as branch and rank), the deployed veterans had a lower risk of suicide compared to non-deployed veterans (HR, 0.84; 95% CI, 0.75-0.95). Regardless of deployment status, the suicide risk was higher among younger, male, white, unmarried, enlisted, and Army/Marine veterans. Predictors of suicide were similar between male and female veterans.

#### Suicide Rates as Function of Calendar Year When Veterans were Discharged and the Length of Time Since Discharge (Table 5)

There is no significant trend in suicide rates among 6 groups of deployed veterans leaving military service in different calendar years during the period of 2001 to 2007 ( $Z=-0.28$ ,  $p>0.30$ ). The rates were 25.5, 29.5, 25.6, 29.4, and 28.7/100,000 for discharge cohort of  $\leq 2002$ , 2003, 2004, 2005, 2006, and 2007, respectively. In both deployed and non-deployed veterans, the suicide rate was the highest during the first three years after leaving military service (deployed veterans, 29.7; non-deployed veterans, 33.1). The rates decreased over the next two 3-year periods. This trend was statistically significant only for non-deployed veteran cohorts ( $Z=3.92$ ,  $p<0.001$ )

## DISCUSSION

Many health studies of veterans of two prior war periods, Vietnam era and Gulf War era, showed that the risks of overall mortality and suicide were significantly lower among veterans than those of the US general population irrespective of their place of service (2-5, 27-29). The current study also supports these earlier findings in that mortality risk from all causes combined was 25% lower in deployed veterans (SMR, 0.75; 95% CI, 0.71-0.79) and 24% lower in non-deployed veterans (0.76; 0.74-0.78) compared to the US general population.

This lower mortality risk has been attributed to the “healthy soldier effect”, similar to the healthy worker effect. A veteran population during the earlier years of separation from active duty is believed to be healthier than the US general population because of the initial physical screening for military service, requirements to maintain certain standards of physical fitness and better access to medical care during and after military service.

What is remarkably different among these recent wartime veterans is that their risk of suicide was significantly higher (41% to 61%) than that of the US general population. We reported a similar finding earlier from a study of 212,664 former Active Component service personnel of Iraq and Afghanistan War. Suicide risk of these veterans as of December 31, 2005 was 33% higher than that of the US population (SMR, 1.33; 95% CI, 1.03-1.69) (30).

Rising suicide rates during the period of 2002 to 2009 among active duty military personnel, especially those who were in the Army and Marine Corps, have been reported in official Department of Defense reports (1, 8). While the rates among Navy and Air Force personnel were still significantly below civilian rates, the rates for active duty soldiers in the Army and Marine Corps surpassed the rates for comparable civilian peers in 2008 (Army, 20.2 vs. civilians, 19.2) reaching a peak rate of 23-25 per 100,000 in 2009.

It has been a generally accepted belief that the steady rise in suicide rate in military personnel since the start of wars in Afghanistan and Iraq could be in part attributable to physical and mental stressors associated with their deployment. Indirect evidence of possible pathways from deployment exposure to increased suicide risk arises from a link between combat exposure and PTSD, and observations of increased suicide risk among veterans with PTSD. It has been reported that the rates of PTSD among war veterans were proportional to the degree of combat experience they had (31, 32). Also, when comparing war veterans with PTSD to those without PTSD, veterans with PTSD had significantly higher rates of suicide (33, 34), suicide attempts (35), and suicidal ideation (19).

The current study, however, fails to provide evidence to support this belief in that deployment to the war zone by itself did not contribute to the excess suicides in veterans. After controlling for age, sex, race, marital status and military service variables such as branch and rank, the deployed veterans had a lower risk of suicide



compared to non-deployed veterans. In keeping with known demographic risk factors for suicide in civilians, the suicide risk was higher among younger, male, white, and unmarried veterans. The risk was also higher among enlisted and Army/Marine veterans. The risk factors associated with suicide were similar between male and female veterans.

A few studies reported similar findings of no significant association between war zone deployment and excess suicide (1, 9, 11) while another study of active duty Army soldiers indicated an elevated suicide risk among currently and previously deployed soldiers (10). In the current study, not only was there no excess suicide among the deployed compared to the non-deployed veterans, there was no significant variation in suicide rates by the calendar year when they left military service. Those individuals who left the service in the earlier phase of the Afghanistan or Iraq war would have different combat experiences in the battlefield than those who were separated from the service in the latter years of the war when combat casualties from hostile actions were at their peak. In another study, none of the Iraq and Afghanistan deployment related factors (self-reported combat experience, cumulative days deployed, or number of deployments) were associated with the excess suicide risk (9). Had there been a variation in suicide rates by these proxy measures of battlefield exposure, it would have been consistent with a possibility of association between deployment history and suicide in a subgroup of deployed veterans who were likely to have had a more intensive battlefield experience.

A recent study of two samples of deployed military personnel showed that greater combat exposure was directly related to fearlessness about death and PTSD symptom severity, but failed to show effect on suicide risk as measured using the 4-item Suicidal Behaviors Questionnaire-Revised (31). According to the interpersonal-psychological theory of suicide (36), for a service member to die of suicide, three separate variables must be present: perceived burdensomeness, thwarted belongingness, and acquired capability. It is not clear how much individual deployment experiences account for the variance in each of the three variables. It could be that the effect of combat on suicide risk is so small and indirect that unless one studied a group of veterans who already exhibited a mental disorder linked to combat exposure (e.g., depression, PTSD, substance abuse), the study would likely fail to detect the direct effect of combat on suicide.

The underlying reasons for the excess suicide rates among the new generation of both deployed and non-deployed veterans compared to the US general population were not explored in this study. However, one may speculate that the recent protracted war in Iraq and Afghanistan could have attracted more young adults who may have a higher level of risk taking behaviors. Also, economic stress associated with transition to civilian life and employment difficulties following the transition could have all contributed to family relationship and readjustment problems. One could also speculate that some veterans having adopted the military culture where mental toughness is seen as a sign of strength may have avoided seeking help from

mental health professionals and others. Substance abuse among recent veterans stemming from military life could also be a factor in the excess suicide risk. A recent study of 83 suicides among 151,560 US military personnel confirmed that having mental conditions such as depression, binge drinking or having alcohol related problems are risk factors for suicide (9).

Serious flaws in the design and execution of the study are an unlikely explanation for the failure to find an excess suicide risk among deployed veterans compared to non-deployed veteran peers. To minimize statistical variation due to sampling, the study included all 1.3 million former Active Component troops. Given the large number of study subjects and as many as nine years of follow-up, the statistical power of the study would be about 80% to detect a 10% increase and over 95% to detect a 20% increase in suicide rate among deployed veterans relative to non-deployed veterans (37).

The interpretation of the study finding of no association between war zone deployment and suicide risk is somewhat attenuated by the possibility that military personnel who were ill or recovering from major surgery would not have been deployed to Iraq or Afghanistan. How much this potential selection bias contributed to our failure to detect an excess suicide among deployed veterans is unknown. Their all-cause SMR values are about the same (Deployed, 0.75; non-Deployed, 0.76), which suggests, if there were any selection bias, it would have been very small. Our reliance on death certificates rather than medical records for information on causes of death could be another possible limitation. The accuracy of cause of death recorded in the certificates is variable depending on underlying cause of death. However, the agreement between medical records and death certificates was reported to be good for external causes of death (38). The small, but possible misclassification of suicide death would have been applied to deaths from both veteran cohorts as well as the US general population statistics because all three groups' cause of death information was derived from official death certificates.

In summary, both deployed and non-deployed veterans exhibit significantly higher suicide risk compared to the US general population. However, a history of deployment to the Iraq or Afghanistan war was not associated with the excess suicide risk among veterans.

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TABLE 1. Demographic and military characteristics of veterans who were on active duty in the US Armed Forces, 2001-2007

| Demographic Characteristics | Active Component             |         |                                  |         |
|-----------------------------|------------------------------|---------|----------------------------------|---------|
|                             | Deployed Veterans (N=317581) |         | Non-Deployed Veterans (N=964493) |         |
|                             | Number                       | Percent | Number                           | Percent |
| Year Born                   |                              |         |                                  |         |
| LE 1966                     | 42693                        | 13.4    | 211919                           | 22.0    |
| 1967-1977                   | 76221                        | 24.0    | 230922                           | 23.9    |
| 1978-1981                   | 103719                       | 32.6    | 266635                           | 27.7    |
| 1982-1990                   | 94948                        | 30.0    | 255017                           | 26.4    |
| Mean Age at entry           | 28.7                         |         | 29.2                             |         |
| Sex                         |                              |         |                                  |         |
| Male                        | 281114                       | 88.5    | 777571                           | 80.6    |
| Female                      | 36467                        | 11.5    | 186922                           | 19.4    |
| Race                        |                              |         |                                  |         |
| White                       | 248375                       | 78.2    | 725117                           | 75.2    |
| Non-White                   | 69206                        | 21.8    | 239376                           | 24.8    |
| Marital Status*             |                              |         |                                  |         |
| Married                     | 163053                       | 51.3    | 469036                           | 48.6    |
| Not Married                 | 154528                       | 48.7    | 495457                           | 51.4    |
| Year of Discharge           |                              |         |                                  |         |
| 2001                        | 5202                         | 1.6     | 119373                           | 12.4    |
| 2002                        | 7777                         | 2.5     | 123728                           | 12.8    |
| 2003                        | 18703                        | 5.9     | 124595                           | 12.9    |
| 2004                        | 42276                        | 13.3    | 141018                           | 14.6    |
| 2005                        | 63026                        | 19.9    | 151653                           | 15.7    |
| 2006                        | 81431                        | 25.6    | 150007                           | 15.5    |
| 2007                        | 99166                        | 31.2    | 154119                           | 16.0    |

\*Last recorded through end of 2007. Not Married category includes single, divorced, and separated individuals.

TABLE 1(continued): Demographic and military service characteristics

| Military Service Characteristics | Active Component                |         |                                     |         |
|----------------------------------|---------------------------------|---------|-------------------------------------|---------|
|                                  | Deployed Veterans<br>(N=317581) |         | Non-Deployed Veterans<br>(N=964493) |         |
|                                  | Number                          | Percent | Number                              | Percent |
| Branch Of Service*               |                                 |         |                                     |         |
| Army                             | 170206                          | 53.6    | 326327                              | 33.8    |
| Marines                          | 61065                           | 19.2    | 130054                              | 13.5    |
| Air Force                        | 62263                           | 19.6    | 207473                              | 21.5    |
| Navy                             | 24047                           | 7.6     | 300633                              | 31.2    |
| Missing                          | 0                               |         | 6                                   |         |
| Rank*                            |                                 |         |                                     |         |
| Enlisted                         | 281237                          | 88.6    | 863941                              | 89.6    |
| Officer                          | 36344                           | 11.4    | 100552                              | 10.4    |

\*Last recorded through end of 2007.



TABLE 2. Numbers of post service deaths and suicides by gender and deployment status of veterans, 2001-2009

| Vital Status          | Active Component                |                                     |
|-----------------------|---------------------------------|-------------------------------------|
|                       | Deployed Veterans<br>(N=317581) | Non-Deployed Veterans<br>(N=964493) |
| All Deaths            | 1650                            | 7703                                |
| Male                  | 1582                            | 6965                                |
| Female                | 68                              | 738                                 |
| Cause of death, Known | 1546                            | 7420                                |
| Suicide               | 351                             | 1517                                |
| Male                  | 336                             | 1408                                |
| Female                | 15                              | 109                                 |

TABLE 3. All-cause mortality and suicide risk of veterans compared to the US population by gender and deployment status of veterans

|                 | Deployed Veterans |           | Non-Deployed Veterans |           |
|-----------------|-------------------|-----------|-----------------------|-----------|
|                 | SMR               | 95% CI    | SMR                   | 95% CI    |
| All Veterans    |                   |           |                       |           |
| All Causes      | 0.75              | 0.71-0.79 | 0.76                  | 0.74-0.78 |
| Suicide         | 1.41              | 1.26-1.56 | 1.61                  | 1.53-1.69 |
| Male Veterans   |                   |           |                       |           |
| All Causes      | 0.76              | 0.72-0.80 | 0.76                  | 0.74-0.77 |
| Suicide         | 1.38              | 1.24-1.54 | 1.57                  | 1.49-1.65 |
| Female Veterans |                   |           |                       |           |
| All Causes      | 0.56              | 0.44-0.71 | 0.82                  | 0.76-0.88 |
| Suicide         | 2.19              | 1.22-3.61 | 2.36                  | 1.94-2.85 |

TABLE 4. Hazard ratios (95% confidence interval) associated with potential suicide risk factors among male and female veterans

| Potential risk factors               | HR (95% CI)                      |                                   |                                 |
|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|
|                                      | Male Veterans<br>(1744 suicides) | Female Veterans<br>(124 suicides) | All Veterans<br>(1868 suicides) |
| Deployment (Y/N)                     | 0.83 (0.74-0.94)                 | 0.99 (0.57-1.71)                  | 0.84 (0.75-0.95)                |
| Sex (Male/Female)                    | -                                | -                                 | 3.12 (2.60-3.74)                |
| Race (White/Other)                   | 1.44 (1.27-1.64)                 | 1.40 (0.94-2.10)                  | 1.43 (1.27-1.62)                |
| Army/Marines<br>(Y/N)                | 1.08 (0.98-1.19)                 | 1.37 (0.95-1.97)                  | 1.10 (1.00-1.21)                |
| Marital Status<br>(Unmarried/Others) | 1.27 (1.13-1.42)                 | 1.77 (1.19-2.65)                  | 1.30 (1.17-1.45)                |
| Age (year)                           | 0.95 (0.94-0.96)                 | 0.97 (0.94-0.99)                  | 0.96 (0.95-0.96)                |
| Rank (E/O)                           | 1.92 (1.48-2.48)                 | 1.91 (0.75-4.85)                  | 1.91 (1.50-2.45)                |

TABLE 5: Suicide rate by year since discharge by deployment status of veterans

| Years Since Discharge | Deployed Veterans* |                 | Non-Deployed Veterans* |                 |
|-----------------------|--------------------|-----------------|------------------------|-----------------|
|                       | Suicides           | Rate/<br>100000 | Suicides               | Rate/<br>100000 |
| <3 years              | 232                | 29.7            | 788                    | 33.1            |
| 3 to <6years          | 106                | 24.7            | 542                    | 27.3            |
| 6 to <9 years         | 13                 | 26.1            | 187                    | 25.6            |
| Total                 | 351                | 27.9            | 1517                   | 29.9            |

\*Cochran-Armitage trend test: Deployed Veterans,  $Z = 1.445$ ,  $p > 0.05$ ; non-Deployed Veterans,  $Z = 3.928$ ,  $p < 0.001$ .