

Suicide Incidence and Risk Factors in an Active Duty US Military Population

Jeffrey Hyman, PhD, Robert Ireland, MD, Lucinda Frost, PsyD, and Linda Cottrell, MS

The rate of suicide among those serving in the military has been an increasing focus of concern for the respective Military Departments, Members of Congress, and Department of Defense (DoD) senior leadership. This has been of special concern for the US Army because their rate of completed suicides has markedly increased since 2006.¹ There has been a concerted effort by each Military Department to implement suicide prevention initiatives, especially those targeting early identification of manifest risk factors that may indicate a need for treatment. Self-recognition of indicators of distress and a willingness to seek help have also been emphasized. The Air Force Suicide Prevention program is an example. Initiated in the late 1990s, it is now listed as a best practice by the Centers for Disease Control.²

This study was initiated by the Secretary of the Army to examine potential risk factors associated with completed suicides. The goal was to determine what caused the marked increase in the rate of suicides in the Army between 2005 and 2007. The initial study population included the Marine Corp as a comparison population for the active duty Army. At the request of the Office of the Assistant Secretary of Defense for Health Affairs and the DoD Suicide Prevention and Risk Reduction Committee (SPARRC), the original study was expanded to include active duty Air Force and Navy personnel.

Before 2008, risk factor analyses for DoD completed suicides were performed for relatively small populations, primarily at the Military Department level using service-unique databases. Each department used a different data collection tool and information system. This made it extremely difficult to electronically merge the data for comparison or aggregate reporting. Available department level data were also subject to the statistical limitations that were associated with smaller populations and relatively rare events.

Objectives. The goal of this study was to investigate and identify risk factors for suicide among all active duty members of the US military during 2005 or 2007.

Methods. The study used a cross-sectional design and included the entire active duty military population. Study sample sizes were 2 064 183 for 2005 and 1 981 810 for 2007. Logistic regression models were used.

Results. Suicide rates for all services increased during this period. Mental health diagnoses, mental health visits, selective serotonin reuptake inhibitors (SSRIs), sleep prescriptions, reduction in rank, enlisted rank, and separation or divorce were associated with suicides. Deployments to Operation Enduring Freedom or Operation Iraqi Freedom were also associated with elevated odds ratios for all services in the 2007 population and for the Army in 2005.

Conclusions. Additional research needs to address the increasing rates of suicide in active duty personnel. This should include careful evaluation of suicide prevention programs and the possible increase in risk associated with SSRIs and other mental health drugs, as well as the possible impact of shorter deployments, age, mental health diagnoses, and relationship problems. (*Am J Public Health.* 2012;102:S138–S146. doi:10.2105/AJPH.2011.300484)

This study was the first to combine DoD standardized suicide data, DoD-wide personnel data including deployments and marital status, and DoD-wide medical data with diagnoses and medical treatments. The goal of this study was to use all available quantitative data to investigate a wide range of potential risk factors that might be associated with suicides and the increase of suicides among active duty military personnel.

METHODS

This was a cross-sectional study that included all individuals on active duty in the US military at any time during the years 2005 or 2007. The study sample size was 2 064 000 control and 183 case individuals in 2005 and 1 981 587 control and 223 case individuals in 2007.

Analysis

The study used a case–control analysis. The analysis was performed using Stata Statistical software (version SE 10; Stata Corp LP, College

Station, Texas) and SAS software (version 9.1; SAS Institute Inc., Cary, North Carolina). For 2007, all study variables other than deployments and suicides were based on events that occurred between January 1, 2006, and December 31, 2007. Similarly, events for the 2005 cohort were included if they occurred between January 1, 2004, and 31 December 31, 2005. Deployments and deployed time in Operation Enduring Freedom or Operation Iraqi Freedom (OEF/OIF) were counted beginning on September 11, 2001 and ending December 31, 2005, and December 31, 2007, for the 2005 and 2007 cohorts, respectively.

Because this study included the entire population for each military service rather than samples, there were no inferences to be made from a sample to the underlying population. Accordingly, statistical measures such as *P* values and confidence intervals had no interpretation and were not reported. Odds ratios (ORs) and population attributable fractions (PAFs)³ were used as effect measures. The formula used for PAF was $PAF = pd((RR-1)/RR)$, where *pd* = the proportion of cases exposed

to the risk factor, and RR was an estimate of the relative risk.

In the absence of reported *P* values, the reader must interpret the importance, or clinical significance, of these study results. This is no less the case when *P* values are reported because statistical significance often offers only limited insight into the clinical significance of study results.

ORs greater than 1.0 and PAFs greater than 0 suggested an increase in risk. In this study, we considered ORs of 1.5 and above to be meaningful.

Logistic regressions were limited to 3 independent variables because of the statistically small number of cases. The variables included were: any mental health diagnosis, number of deployments to OEF/OIF, and selective serotonin reuptake inhibitor (SSRI) prescriptions. These were chosen as the variables of greatest interest based on the univariate results.

Variables

The variable “mental health diagnosis” included all *International Classification of Disease-9th Revision-Clinical Modification (ICD-9-CM)* diagnosis codes in the Mental Disorders range of 290–319,⁴ as well as suicide ideation and previous suicide attempts. Traumatic brain injury (TBI) diagnoses and tobacco dependency were excluded.

The variable “mental health visit” included all appointment encounters with a psychiatrist, psychologist, psychiatric nurse practitioner, or social worker who provided mental health services within the Military Healthcare System. Because this variable included some encounters that were for administrative purposes, screenings, or psychoeducational prevention activities and were coded using V-codes, it modestly overestimated the number of mental health visits that were related to possible mental health issues. V-codes are *ICD-9* codes used to record factors influencing health or contact with health services other than diseases or injuries.⁵

The drug classes included in this study (based on the 5-digit generic code number)⁶ were: mental health prescriptions, SSRI prescriptions, and sleep prescriptions.

RESULTS

The suicide rate increased for all services between 2005 and 2007. The increase was

greatest for the Regular Army and National Guard. The rate decreased for the Army Reserve based on a very small number of case individuals, as shown in Table 1.

Demographics

Tables 2 to 5 contain the study demographics and univariate findings for each service. In 2005, the mean year of birth for the active duty population ranged from 1975.2 to 1979.6. In 2007, the range was 1976.3 to 1981.7. In 2005, the percentage of the active duty population that was male ranged from 80.3 to 93.9. For 2007, the range was 79.9 to 93.8. In 2005, 35.7% of Marines and 52.8% of Air Force personnel had children. In 2007, the corresponding percentages were 29.6% and 47.6%, respectively. Similarly, 42.5% of Marines and 60.5% of Air Force personnel were married in 2007 compared with 42.8% and 60.1%, respectively, in 2007. Of the active duty Army, 36.3% were members of the Reserves and National Guard in 2005 compared with 6.7% for the Navy. In 2007, 32% of the active duty Army were Reserve or Guard personnel.

Suicide Risk

A mental health diagnosis was a very strong suicide risk factor, as seen in Tables 2 to 5 (also see Table A, available as a supplement to the online version of this article at <http://www.ajph.org>). Mental health visits, SSRIs, and sleep prescriptions also showed consistent associations, as did reduction in rank and separation or divorce. Deployments to OEF/OIF were associated with elevated ORs for all services in the 2007 population and for the Army in 2005.

The Marines tended to demonstrate weaker associations in many risk factors than were seen in the other services, including the effects of deployments.

Deployments

Through 2007, the Army had the highest percentage of active duty personnel with any deployments to OEF/OIF, followed by the Marines, Navy, and Air Force, as shown in Tables 2 to 5.

Table B (available as a supplement to the online version of this article at <http://www.ajph.org>) shows that 1 or more OEF/OIF deployments was associated with an increased risk of suicide for all services in 2007. In some cases, those with more than 1 deployment had a somewhat smaller increase in ORs. In 2005, deployments to OEF/OIF were only associated with elevated ORs for the 3 Army components (Regular Army, Army Reserve, or National Guard).

Between 2005 and 2007, the percentage of the study population with positive findings for either mental health visits, prescriptions, or mental health diagnoses increased across all services, as shown in Table A. In 2007, approximately 61% of suicides in the Regular Army, 57% in the Air Force, 46% in the Navy, and 18% in the Marines had 1 or more of these findings. These exposures were a consistent risk factor. However, there was no association between the number of deployments through 2007 and the prevalence of a mental health diagnosis, as shown in Table C (available as a supplement to the online version of this article at <http://www.ajph.org>).

TABLE 1—Suicide Rates Among Active Duty Personnel, by Calendar Year: 2005 and 2007

	2005		2007		% Change
	Population, ^a No.	Suicide Rate ^b	Population, ^a No.	Suicide Rate ^b	
Army	916 411	11.56	875 621	16.37	41.56
Regular Army	583 617	12.43	595 496	17.87	43.71
National Guard	217 892	10.62	181 857	15.80	48.76
Army Reserve	114 907	7.08	98 268	4.78	-32.47
Marines	244 905	14.00	244 829	16.50	17.87
Navy	432 764	9.38	416 920	10.71	14.20
Air Force	470 103	9.27	444 440	9.83	6.03

^aIncludes those who were on active duty at any time during the year.

^bRates are per 100 000 person-years of active duty

TABLE 2—Demographics and Odds Ratios for Suicide for the Army (Including Army Reserve and National Guard): 2005 and 2007

	2005 Army			2007 Army		
	Not a Suicide (n = 916 329), %	Suicides (n = 82), %	OR	Not a Suicide (n = 875 507), %	Suicides (n = 114), %	OR
Mean year of birth	1975.2	1976.6	...	1977.4	1978.3	...
Gender (male)	85.20	96.34	4.57	85.06	96.49	4.83
Race						
White	69.17	73.17	1.00	70.80	81.58	1.00
Asian	5.11	2.44	0.45	5.31	2.63	0.43
Black	19.99	21.95	1.04	19.09	11.40	0.52
American Indian	0.84	1.22	1.38	0.90	0.88	0.85
Other	4.13	1.22	0.28	3.15	3.51	0.97
Unknown	0.76	0	...	0.75	0	...
Any children	51.10	48.78	0.91	46.68	48.25	1.06
Member category						
Regular	63.68	76.83	1.00	68.01	82.46	1.00
National Guard	23.78	17.07	0.60	20.77	14.91	0.59
Reserve	12.54	6.10	0.40	11.22	2.63	0.19
Marital status						
Divorced	6.03	10.98	1.00	6.34	2.63	1.00
Married	54.68	53.66	0.54	54.96	58.77	2.57
Single	39.01	35.37	0.50	38.55	38.60	2.41
Other	0.27	0	...	0.15	0	...
Marital change						
Stay single	37.96	35.37	1.00	38.13	38.60	1.00
Stay married	43.93	41.46	1.01	44.14	42.11	0.94
Got married	10.57	12.20	1.24	10.75	16.67	1.53
Separated/divorced	2.83	6.10	2.31	2.65	1.75	0.65
Other	4.71	4.88	1.11	4.32	0.88	0.20
Rank						
Enlisted	85.28	91.46	1.00	84.78	89.47	1.00
Officer	14.71	8.54	0.54	15.21	10.53	0.66
Rank change						
Improvement	42.09	39.02	1.00	40.87	47.37	1.00
Reduction	2.26	2.44	1.14	2.38	5.26	1.91
No change	56.65	58.54	1.09	56.76	47.37	0.72
Mental health visit	19.86	37.80	2.45	25.73	47.37	2.60
Mental health diagnosis	13.50	29.27	2.14	18.20	40.10	3.01
Mental health prescription	17.27	23.17	1.44	20.18	35.09	2.14
TBI DoD	0.91	4.88	5.59	1.42	7.89	5.94
TBI AMSA	1.65	6.10	3.88	2.31	12.28	5.92
PTSD diagnosis	1.33	2.44	1.86	2.31	9.65	4.51
Depression diagnosis	5.90	15.85	3.01	7.14	21.05	3.47
Substance misuse diagnosis	9.95	24.39	2.92	17.37	26.32	1.70
Suicide attempt	0.15	2.44	17.13	0.23	7.89	37.21
Ideation diagnosis	0.52	3.66	1.47	0.82	7.02	9.14
STD diagnosis	1.93	3.66	1.93	1.92	2.63	1.38
SSRI prescription	8.21	17.07	2.30	9.61	24.56	3.06
Sleep prescription	4.97	6.10	1.24	7.22	17.54	2.74
No. of deployments to OEF/OIF						
0	45.94	31.71	1.00	43.88	27.19	1.00
1	40.27	51.22	1.84	35.07	51.75	2.38
≥ 2	13.79	17.07	1.79	21.05	21.05	1.61

Note. AMSA = Army Medical Surveillance Activity; DoD = Department of Defense; OEF/OIF = Operation Enduring Freedom/Operation Iraqi Freedom; OR = odds ratio; PTSD = posttraumatic stress disorder; SSRI = selective serotonin reuptake inhibitor; STD = sexually transmitted disease; TBI = traumatic brain injury.

TABLE 3—Demographics and Odds Ratios for Suicide for the Marines: Suicide Incidence and Risk Factors in an Active Duty United States Military Population, 2005 and 2007

	2005 Marines			2007 Marines		
	Not a Suicide (n = 244 877), %	Suicide (n = 28), %	OR	Not a Suicide (n = 244 796), %	Suicide (n = 33), %	OR
Mean year of birth	1979.65	1980.14	...	1981.7	1983.2	...
Gender (male)	93.95	100	...	93.77	100	...
Race						
White	79.86	96.43	1.00	82.17	93.94	1.00
Asian	3.09	0	...	3.10	3.03	0.85
Black	11.60	3.57	0.25	10.65	3.03	0.25
Other	2.96	0	...	1.92	0	...
Any children	35.70	32.14	0.85	29.62	24.24	0.64
Member category						
Regular	86.62	89.29	1.00	89.13	100.00	...
National Guard	0.04	0.00	...	0.00	0.00	...
Reserve	13.34	10.71	0.78	10.87	0.00	...
Marital status						
Divorced	3.24	3.57	1.00	3.39	3.03	1.00
Married	42.48	46.43	0.99	42.76	42.42	1.11
Single	53.97	50.00	0.84	53.69	54.55	1.14
Other	0.32	0	...	0.16	3.03	...
Marital change						
Stay single	52.86	50.00	1.00	53.40	54.55	1.00
Stay married	29.39	21.43	0.77	29.33	27.27	0.91
Got married	12.86	25.00	2.05	13.36	15.15	1.11
Separated/divorced	2.23	0	...	1.92	3.03	1.55
Other	2.66	3.57	1.42	2.00	0	...
Rank						
Enlisted	90.45	96.43	1.00	88.84	100	...
Officer	9.53	3.57		11.16	0	...
Rank change						
Improvement	55.46	42.86	1.00	57.01	72.73	1.00
Reduction	3.56	17.86	6.49	3.15	6.06	1.51
No change	40.99	39.29	1.24	39.84	21.21	0.42
Mental health visit	8.24	17.86	2.42	9.25	9.09	0.98
Mental health diagnosis	9.23	25.00	1.99	11.04	13.33	1.24
Mental health prescription	11.49	17.86	1.67	10.23	9.09	0.68
TBI DoD	1.18	7.14	6.43	1.34	15.15	13.10
TBI AMSA	2.21	14.29	7.39	2.53	18.18	8.57
PTSD diagnosis	0.97	0	...	1.63	0	—
Depression diagnosis	3.52	7.14	2.11	3.94	3.03	0.76
Substance misuse diagnosis	6.13	21.43	4.17	8.41	18.18	2.42
Suicide attempt	0.14	7.14	53.28	0.16	12.12	84.27
Ideation diagnosis	0.56	3.57	6.57	0.70	3.03	4.43
STD diagnosis	1.25	3.57	2.94	1.26	3.03	2.45
SSRI prescription	5.05	14.29	3.14	5.92	0	...
Sleep prescription	2.83	7.14	2.64	4.03	3.03	0.74
No. of deployments to OEF/OIF						
0	51.36	60.71	1.00	47.73	42.42	1.00
1	32.16	28.57	0.75	30.02	33.33	1.25
≥ 2	16.48	10.71	0.55	22.25	24.24	1.23

Note. AMSA = Army Medical Surveillance Activity; DOD = Department of Defense; OEF/OIF = Operation Enduring Freedom/Operation Iraqi Freedom; OR = odds ratio; PTSD = posttraumatic stress disorder; SSRI = selective serotonin reuptake inhibitor; STD = sexually transmitted disease; TBI = traumatic brain injury.

TABLE 4—Demographics and Odds Ratios for Suicide for the Air Force: 2005 and 2007

	2005 Air Force			2007 Air Force		
	Not a Suicide (n = 470 066), %	Suicide (n = 37), %	OR	Not a Suicide (n = 444 403), %	Suicide (n = 37), %	OR
Mean year of birth	1974.22	1974.76	—	1976.25	1976.81	...
Gender (male)	80.26	89.19	2.03	79.94	100.00	...
Race						
White	77.52	83.78	1.00	77.09	72.97	1.00
Asian	3.03	2.70	0.82	3.43	2.70	0.83
Black	14.70	13.51	0.85	14.46	16.22	1.18
American Indian	0.64	0	...	0.68	2.70	4.17
Other	3.43	0	...	3.61	5.41	1.58
Unknown	0.69	0	...	0.71	0	...
Any children	52.77	51.35	0.95	47.60	51.35	1.16
Member category						
Regular	83.60	82.86	1.00	83.61	91.89	1.00
National Guard	10.70	5.71	0.54	10.86	2.70	0.23
Reserve	5.71	11.43	2.02	5.53	5.41	0.89
Marital status						
Divorced	7.24	13.51	1.00	7.44	8.11	1.00
Married	60.51	51.35	0.45	60.06	59.46	0.91
Single	31.78	35.14	0.59	32.13	32.43	0.93
Other	0.47	0		0.37	0	
Marital change						
Stay single	30.90	32.43	1.00	31.79	32.43	1.00
Stay married	50.27	45.95	0.87	50.37	54.05	1.05
Got married	9.94	5.41	0.52	9.55	5.41	0.55
Separated/divorced	3.27	10.81	3.15	3.02	8.11	1.51
Other	5.62	5.41	0.92	5.27		
Rank						
Enlisted	80.66	91.89	1.00	80.50	83.78	1.00
Officer	19.34	8.11	0.37	19.49	16.22	0.80
Rank change						
Improvement	43.16	24.32	1.00	41.22	29.73	1.00
Reduction	1.24	13.51	19.39	1.20	2.70	3.13
No change	55.60	62.16	1.98	57.58	67.57	1.63
Mental health visit	20.58	45.95	3.28	23.46	48.65	3.09
Mental health diagnosis	12.97	48.57	2.53	14.44	37.10	3.49
Mental health prescription	20.26	48.65	3.73	23.44	35.14	1.77
TBI DoD	0.72	2.70	3.85	0.68	13.51	22.86
TBI AMSA	1.37	2.70	2.00	1.41	13.51	10.90
PTSD diagnosis	0.37	2.70	7.40	0.54	5.41	10.57
Depression diagnosis	5.70	21.62	4.56	5.63	29.73	7.10
Substance misuse diagnosis	10.22	32.43	4.22	13.39	35.14	3.50
Suicide attempt	0.06	2.70	47.98	0.08	13.51	184.52
Ideation diagnosis	0.36	5.41	15.75	0.39	10.81	31.29
STD diagnosis	1.95	2.70	1.40	1.99	2.70	1.37
SSRI prescription	8.13	24.32	3.63	7.90	24.32	3.75
Sleep prescription	6.23	18.92	3.51	10.57	24.32	2.72
No. of deployments to OEF/OIF						
0	57.81	72.97	1.00	51.43	32.43	1.00
1	25.09	16.22	0.51	25.32	35.14	2.20
≥ 2	17.10	10.81	0.50	23.25	32.43	2.21

Note. AMSA = Army Medical Surveillance Activity; DOD = Department of Defense; OEF/OIF = Operation Enduring Freedom/Operation Iraqi Freedom; OR = odds ratio; PTSD = posttraumatic stress disorder; SSRI = selective serotonin reuptake inhibitor; STD = sexually transmitted disease; TBI = traumatic brain injury.

TABLE 5—Demographics and Odds Ratios for Suicide for the Navy: 2005 and 2007

	2005 Navy			2007 Navy		
	Not a Suicide (n = 432 728), %	Suicide (n = 36), %	OR	Not a Suicide (n = 416 881), %	Suicide (n = 39), %	OR
Mean year of birth	1975.79	1975.75	...	1977.67	1977.15	...
Gender (male)	85.05	97.22	6.15	84.76	87.18	1.22
Race						
White	67.59	75.00	1.00	66.36	76.92	1.00
Asian	5.97	8.33	1.26	6.32	2.56	0.35
Black	19.29	11.11	0.52	18.83	7.69	0.35
American Indian	3.22	5.56	1.56	4.14	7.69	1.60
Other	2.85	0	...	3.15	2.56	0.70
Unknown	1.07	0	...	1.21	2.56	1.83
Any children	50.00	33.33	0.50	44.15	46.15	1.08
Member category						
Regular	93.32	97.22	1.00	91.84	97.44	1.00
National Guard	0	0	...	0	0	...
Reserve	6.66	2.78	0.40	8.16	2.56	0.30
Marital status						
Divorced	3.71	5.56	1.00	3.67	5.13	1.00
Married	55.13	41.67	0.50	54.38	61.54	0.81
Single	40.76	52.78	0.86	41.58	33.33	0.57
Other	0.40	0	...	0.37	0	...
Marital change						
Stay single	38.77	44.44	1.00	39.69	28.21	1.00
Stay married	42.88	36.11	0.73	43.20	51.28	1.67
Got married	12.08	5.56	0.41	11.09	10.26	1.30
Separated/divorced	2.69	8.33	2.70	2.51	7.69	4.31
Other	3.58	5.56	1.36	3.51	2.56	1.03
Rank						
Enlisted	85.42	88.89	1.00	84.91	84.62	1.00
Officer	14.58	11.11	0.73	15.04	15.38	1.03
Rank change						
Improvement	43.01	36.11	1.00	43.36	33.3	1.00
Reduction	2.30	2.78	1.44	2.12	7.69	4.72
No change	54.69	61.11	1.33	54.52	58.97	1.41
Mental health visit	12.99	16.67	1.34	13.79	33.33	3.13
Mental health diagnosis	11.89	19.44	1.69	12.88	37.25	4.01
Mental health prescription	15.39	19.44	1.33	15.99	25.64	1.81
TBI DoD	0.75	2.78	3.76	0.69	7.69	12.00
TBI AMSA	1.49	13.89	10.65	1.53	12.82	9.47
PTSD diagnosis	0.50	0	...	0.72	0	...
Depression diagnosis	4.66	2.78	0.59	4.94	20.51	4.96
Substance misuse diagnosis	8.77	22.22	2.97	11.53	25.64	2.65
Suicide attempt	0.12	5.56	48.06	0.13	5.13	41.83
Ideation diagnosis	0.58	2.78	4.93	0.77	10.26	14.78
STD diagnosis	2.17	0	*	1.93	2.56	1.33
SSRI prescription	6.82	8.33	1.24	6.93	15.38	2.44
Sleep prescription	4.18	5.56	1.35	5.24	5.13	0.98
No. of deployments to OEF/OIF						
0	44.97	72.22	1.00	51.27	38.46	1.00
1	34.19	16.67	0.44	30.16	28.21	1.25
≥ 2	20.84	11.11	0.70	18.57	33.33	2.39

Note. AMSA = Army Medical Surveillance Activity; DOD = Department of Defense; OEF/OIF = Operation Enduring Freedom/Operation Iraqi Freedom; OR = odds ratio; PTSD = posttraumatic stress disorder; SSRI = selective serotonin reuptake inhibitor; STD = sexually transmitted disease; TBI = traumatic brain injury.

Suicide, SSRIs, and Sleep Medications

Of those who completed suicide, 17.5% of Army and 24% of Air Force personnel had a history of sleep prescriptions in 2007. More than 24% of Army and Air Force suicide completers also had previous SSRI prescriptions, as shown in Tables 2 to 5.

Sleep Medications, SSRIs, and Deployments

Table D (available as a supplement to the online version of this article at <http://www.ajph.org>) shows that through 2007, the use of sleep medications increased with the number of deployments for all services. SSRIs were more heavily prescribed by the Army than the other services. An association between prescriptions and deployments was only seen for the Army and Marines.

Logistic Regression Analysis

After adjustment, mental health diagnosis, deployments to OEF/OIF, and any SSRI prescriptions all showed a consistent association with suicide across all services during both study years, as seen in Table E (available as a supplement to the online version of this article at <http://www.ajph.org>). In 2005, the association with deployments was strongest for the Army Reserve and National Guard. SSRIs were associated with suicide risk in the Regular Army and the Air Force for both study years, and in the other services for 1 of the study years. A history of mental health diagnosis was also positively associated with suicide across all services in both study years. The association was strongest for the Army Reserve, National Guard, and the Air Force.

DISCUSSION

In univariate analyses, mental health diagnoses, especially TBI, posttraumatic stress disorder (PTSD) and depression, suicidal ideation, previous suicide attempts, mental health visits, and mental health prescriptions (especially SSRIs and sleep prescriptions) had relatively high ORs across all services. Separation or divorce also had generally elevated ORs.

The increase in suicide risk associated with deployments through 2005 was limited to the Army, especially the National Guard and Army Reserve. In 2007, all the services experienced

an increase in risk associated with 1 or more deployments.

In multivariate models, there were consistent associations between a mental health diagnosis and suicide across all services during both study years. Deployments were consistently associated with suicides in 2007. In 2005, the association was primarily seen in the Army, especially the National Guard and Army Reserve. An elevated OR was associated with a history of SSRI prescriptions in 7 of the 10 logistic regression models.

The observed association between SSRIs and suicide are a concern. Population studies showed that SSRI use was associated with fewer suicides in both adolescents and for all ages of adult veterans.⁷ In univariate analyses, SSRI prescriptions were consistently associated with elevated ORs of suicide. Prescriptions written at mobile medical facilities were generally not available for this study. The actual association between these drugs and suicide might be higher than the observed association because differential misclassification of exposure status would bias estimates of ORs toward the null.⁸

Conversely, it was also possible that the observed association might, in part, be an artifact if those with more severe mental health issues were more likely to receive the drugs. Because data on the severity of mental health conditions were not available to us, we were unable to investigate this.

Sleep prescriptions were also a potential cause for concern. However, this association must be evaluated in the context of operational risk management. For example, the Air Force approves their use for flight crews and support personnel at noisy bases to assure crew rest, reduce fatigue, and prevent accidents.

Relationship issues were frequently mentioned as major suicide risk factors.^{9,10} Changes in marital status were the only relationship variables available for this study. Separation or divorce appeared to have a fairly consistent association with suicide. The strength of association was roughly comparable to 1 deployment. In addition to failed relationships, US military analyses consistently mentioned financial and legal problems, as well as substance misuse (usually alcohol) as significant risk factors.

The strengths of this study included the careful identification of case individuals through use of the SPARRC suicide data from

the Office of the Armed Forces Medical Examiner, voluminous medical data, and detailed deployment histories.

Limitations

The major study weaknesses centered on the variables that were not available for analysis. These included legal and financial problems, job-related problems other than loss of rank, personal relationship issues other than separation or divorce, battle stress, unit relationships, and relationships with superiors, participation in suicide prevention training, and the nature of such training. There were also no data available on religion and the severity of mental health diagnoses. Data on medical encounters and prescriptions in theater at mobile facilities were incomplete.

The dose and duration of medication taken (as opposed to prescribed) was unknown, as were the identities of those who might have taken these drugs without a prescription. This study also did not investigate the existence of potential early adverse effects of SSRI use in those who died by suicide, including akathisia, anxiety, and psychomotor activation.¹¹

Although the increasing number of active duty suicides represents a huge cost in lives lost, in statistical terms, the numbers were small, and this made multivariate analyses difficult. Many of the effect measure estimates might also be unstable (i.e., with some exposures, 1 additional suicide could have had a major effect on the outcome measures).

Accordingly, inferences based on the magnitude of the effect measures in this study should be made with care.³ With a rare, multifactorial, pathological outcome (such as suicide), many of the univariate measures might be subject to varying levels of confounding. The possible presence of effect modification could not be assessed.

The reasons for the lower increase in risk with 2 or more deployments versus 1 deployment (observed in the Regular Army, National Guard, and Army Reserve) were unknown, and might represent the “healthy warrior” effect because of diminished likelihood of deployment if less fit.¹² Individuals might have been better prepared emotionally for a second deployment. They might also have received increased training, increased suicide prevention efforts, or encountered different stress levels in OEF/OIF.

The increase in prevalence of depression associated with multiple deployments that the Mental Health Advisory Team V⁹ reported for the Army was not replicated in these results, and might be related to the Mental Health Advisory Team methodology using small convenience samples of combatants, as well as the absence of medical data being reported from mobile facilities in OEF/OIF or limited access to care. If this was the case, it was suggested that the mental health status of the active duty military (especially the Army) might be worse than what was reflected in this study.

The results from this study were generally in agreement with previous studies on suicide risk in this population and in other military populations. Between 1980 and 1992, active duty suicide rates were highest for the 17 to 24 years age group, for enlisted personnel, and for men.¹³ Military suicide rates have traditionally been lower than those of the civilian population. This was demonstrated in the United Kingdom,¹⁴ among military recruits,¹⁵ in Canada,¹⁶ and in the Army active duty population.¹

Suicide rates in the active duty US military increased during and after the period covered by this study. The Army reported a rate of 20.2/100 000 in 2008, which was higher than the civilian rate for the first time since the Vietnam war.¹⁸ The Navy also had an elevated suicide rate compared with the general population.¹⁹ By January 2009, more soldiers died from suicide than from combat.²⁰

An increase in mental illness associated with the stress and associated activities was also reported. Canadian military personnel in combat and peacekeeping experienced increases in PTSD and other mental disorders. A sizable portion of the mental health outcomes were attributable to the deployments.²¹

In a longitudinal study of an Army brigade combat team during OIF, the unit experienced a suicide rate of 58 per 100 000 person-years, based on a very small number of case individuals. Psychiatric disorders were the second most common nonbattle injury.²² A study of Scottish soldiers in World War II also found an increase in suicide rates.²³

We speculated that the increased risk associated with deployments in 2007 compared with 2005 resulted from the extended duration of the war and the increasing lengths of individual deployments for Army and Air

Force personnel. The Army increased deployment lengths from 12 to 15 months in early 2007, and the Air Force increased them from 4 to 6 months. Marine deployment lengths remained at 7 months. In addition to increased levels of stress on the deployed service member, lengthened deployments also increased stress on families and partners, which may have contributed to failed relationships.

The findings regarding the Marine Corps were unexpected. They are the service that is closest to the Army in terms of ground combat experience. However, their increase in suicide rates between 2005 and 2007 was much lower than the increases seen in the Regular Army, National Guard, or Army Reserve.

Lower percentages of Marines had mental health visits, mental health diagnoses, or mental health prescriptions in 2005 and 2007. A higher percentage of Marines were single, and a much lower percentage had children. A lower percentage were separated or divorced. They also had lower increases in suicides associated with deployments to OEF/OIF. Their deployments to OEF/OIF were shorter than the Army's. In addition, a lower percentage of Marine suicide completers were deployed in 2007 than those of any other service.

It was not known if any of the observed differences in suicide trends in the Army and Marines resulted from self selection, differences in training or leadership, differences in suicide prevention programs, unmeasured sources of stress, or any of the other differences noted in this study.

Conclusions

Mental health diagnoses, deployments (especially in 2007), mental health visits, SSRIs and sleep prescriptions, reduction in rank, enlisted rank, and separation or divorce were found to be consistently associated with suicide. Additional research is needed to address the increasing rates of suicide in the active duty military population. This should include a careful evaluation of the effectiveness of suicide prevention programs and the possible increase in risk associated with SSRI and other mental health drugs.

Further studies are also needed to evaluate the possible impact of shorter deployments, age, mental health diagnoses, and relationship problems. The differences between services in

the distribution of suicide risk factors and suicide rates should also be investigated. If unique protective factors can be identified in any of the services, they might be useful for risk mitigation in the entire active duty population. ■

About the Authors

Jeffrey Hyman is with *Tricare Management Activity, Falls Church, VA*. Robert Ireland is with the *Office of the Assistant Secretary of Defense/Health Affairs, Falls Church*. Lucinda Frost is with *Behavioral Health Program Policy Integration, Office of the Assistant Secretary of Defense/Health Affairs Clinical and Program Policy, Falls Church*. Linda Cottrell is with *Kennell, Inc., Falls Church*.

Correspondence should be sent to Jeffrey Hyman, PhD, TMA OBEA, Suite 810, 5111 Leesburg Pike, Falls Church, VA 22041 (e-mail: jeff307@gmail.com). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints/Eprints" link.

This article was accepted September 28, 2011.

Contributors

J. Hyman designed the study, obtained institutional review board approval, did most of the analysis, and much of the writing. R. Ireland assisted with the analysis, provided guidance on psychiatric questions, and did some of the writing. L. Frost worked on the institutional review board process, coordinated with other government organizations, worked on the analysis, and did some of the writing. L. Cottrell assembled the study dataset from a variety of sources and provided additional data as needed.

Human Participant Protection

The study was granted Exempt Status from the Human Research Protection Office, Office of Research Protections, Army Medical Research and Materiel Command. A data use agreement was obtained from the Tricare Management Activity Privacy Office to allow access to their medical records and protected health information data.

References

1. Army Health Promotion Risk Reduction and Suicide Prevention Report 2010. Available at: http://usarmy.vo.llnwd.net/e1/HPRRSP/HP-RR-SPReport2010_v00.pdf. Accessed February 15, 2011.
2. SAMHSA National Registry of Evidence-based Programs and Practices. Available at: <http://www.nrepp.samhsa.gov/ViewIntervention.aspx?id=121>. Accessed February 18, 2011.
3. Rockhill B, Newman B, Weinberg C. Use and misuse of population attributable fractions. *Am J Public Health*. 1998;88:15-19.
4. National Center for Health Statistics Centers for Disease Control and Prevention. Available at: <http://www.cdc.gov/nchs/icd/icd9cm.htm>. Accessed February 18, 2011.
5. *ICD-9-CM Expert for Hospitals*. Volumes 12 and 3. Sixth Ed. Eden Prairie, MN: Ingenix; 2006.
6. National Drug Data File (NDDF) Plus. San Bruno (CA): First Databank Inc. National Drug Data File (NDDF)

- Plus. Available at: <http://www.firstdatabank.com/products/nddf>. Accessed February 22, 2011.
7. Gibbons RD, Brown CH, Hur K, Marcus SM, Bhaumik DK, Mann JJ. Relationship between antidepressants and suicide attempts: an analysis of the Veterans Health Administration data sets. *Am J Psychiatry*. 2007;164:1044–1049.
 8. Flegal KM, Keyl PM, Nieto FJ. Differential misclassification arising from nondifferential errors in exposure measurement. *Am J Epidemiol*. 1991;134:1233–1244.
 9. Mental Health Advisory Team [MHAT] Report V Available at: http://www.armymedicine.army.mil/reports/mhat/mhat_v/mhat-v.cfm. Accessed on February 22, 2011.
 10. American Association of Suicidology. Suicide in the USA Available at: http://www.suicidology.org/c/document_library/get_file?folderId=232&name=DLFE-159.pdf. Accessed on February 18, 2011.
 11. Akagi H, Kumar TM. Lesson of the week: akathisia: overlooked at a cost. *BMJ*. 2002;324:1506–1507.
 12. Hoge CW. Re: “Psychiatric diagnoses in historic and contemporary military cohorts: combat deployment and the healthy warrior effect.” *Am J Epidemiol*. 2008;168:1095–1096, author reply 1096–1098.
 13. Helmkamp JC. Suicides in the military: 1980-1992. *Mil Med*. 1995;160:45–50.
 14. Fear NT, Ward VR, Harrison K, Davison L, Williamson S, Blatchley NF. Suicide among male regular UK Armed Forces personnel 1984-2007. *Occup Environ Med*. 2009;66:438–441.
 15. Scoville SL, Gubata ME, Potter RN, White MJ, Pearse LA. Deaths attributed to suicide among enlisted U.S. Armed Forces recruits 1980-2004. *Mil Med*. 2007;172:1024–1031.
 16. Belik SL, Stein MB, Asmundson GJ, Sareen J. Are Canadian soldiers more likely to have suicidal ideation and suicide attempts than Canadian civilians? *Am J Epidemiol*. 2010;172(11):1250–1258.
 17. Gibbons RD, Brown CH, Hur K, et al. Early evidence on the effects of regulators’ suicidality warnings on SSRI prescriptions and suicide in children and adolescents. *Am J Psychiatry*. 2007;164(9):1356–1363.
 18. Lizette Alvarez. “Suicides of Soldiers Reach High of Nearly 3 Decades”. *The New York Times*. January 29, 2009;Sect A:19.
 19. Kang HK, Bullman TA. Is there an epidemic of suicides among current and former US military personnel? *Ann Epidemiol*. 2009;10:757–760.
 20. Bell NS, Harford TC, Amoroso PJ, Hollander IE, Kay AB. Prior health care utilization patterns and suicide among US Army soldiers. *Suicide Life Threat Behav*. 2010;40:407–415.
 21. Sareen J, Belik SL, Afifi TO, et al. Canadian military personnel’s population attributable fractions of mental disorders and mental health service use associated with combat and peacekeeping operations. *Am J Public Health*. 2008;12:2191–2198.
 22. Belmont PJ, Goodman GP, Waterman B, DeZee K, Burks R, Owens BD. Disease and nonbattle injuries sustained by a US Army Brigade Combat Team during Operation Iraqi Freedom. *Mil Med*. 2010;175:469–476.
 23. Henderson R, Stark C, Humphry RW, Selvaraj S. Changes in Scottish suicide rates during the Second World War. *BMC Public Health*. 2006;6:167.