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Risk Factors for Accident Death in the U.S. Army, 2004–2009

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Abstract

Background—Accidents are one of the leading causes of death among U.S. active duty Army soldiers. Evidence-based approaches to injury prevention could be strengthened by adding person-level characteristics (e.g., demographics) to risk models tested on diverse soldier samples studied over time.

Purpose—To identify person-level risk indicators of accident deaths in Regular Army soldiers during a time frame of intense military operations, and to discriminate risk of not-line-of-duty (NLOD) from line-of-duty (LOD) accident deaths.

Methods—Administrative data acquired from multiple Army/Department of Defense sources for active duty Army soldiers during 2004–2009 were analyzed in 2013. Logistic regression modeling was used to identify person-level sociodemographic, service-related, occupational, and mental health predictors of accident deaths.

Results—Delayed rank progression or demotion and being male, unmarried, in a combat arms specialty, and of low rank/service length increased odds of accident death for enlisted soldiers. Unique to officers was high risk associated with aviation specialties. Accident death risk

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decreased over time for currently deployed, enlisted soldiers while increasing for those never deployed. Mental health diagnosis was associated with risk only for previous and never-deployed, enlisted soldiers. Models did not discriminate NLOD from LOD accident deaths.

Conclusions—Adding more refined person-level and situational risk indicators to current models could enhance understanding of accident death risk specific to soldier rank and deployment status. Stable predictors could help identify high risk of accident deaths in future cohorts of Regular Army soldiers.

Introduction

Accidents are a leading cause of active duty deaths in the U.S. Military, exceeding suicides and, in most years, combat fatalities.^{1,2} For the Army, accidents caused over one half of all deaths in active duty, male soldiers between 1990 and 1998,³ and motor vehicle accidents were one of the top three causes of deaths for active duty soldiers from 2000 to 2010.⁴

The U.S. Department of Defense (DoD) is applying an evidence-based approach to develop interventions to prevent injury.^{5,6} This includes use of military data to generate injury death rates, track trends, and identify common situational causes.⁷ This approach would be strengthened by adding person-level characteristics (e.g., demographics, mental health diagnosis)³ to risk models predicting accident death.

Risk models containing person-level and situational predictors of accident death require data from multiple sources.⁸ The Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) integrates key data from numerous DoD and Army sources for its Historical Administrative Data Study (HADS) of over 1.6 million soldiers on active duty during 2004–2009.⁹ These data provide unprecedented capacity to develop refined models for predicting accident deaths in the Army.

Prior Research

Military research^{3,10,11} has replicated risk factors for accident deaths in general population studies. These include being young, male, unmarried, of lower SES, and less educated.¹² U.S. national rates suggest lower risk for minorities,¹³ but race effects vary when factors such as age, gender, and accident cause are controlled.¹⁴ Situational risk factors include dangerous jobs, long work shifts,¹⁵ and adjustment to new situations.¹⁶

The most recent, large, epidemiologic study of accident death in male Army soldiers used administrative data from 1990 to 1998 to conduct a case-control analysis of sociodemographic, military service, and health-related main effects of accident fatalities.³ The study found higher risk for unmarried soldiers, and those having less education, prior deployment experience, combat-related jobs, prior hospitalizations for injuries and mental disorders, and health-risk behaviors (e.g., not wearing safety belt) documented in medical records. In the current study, a model predicting accident deaths in U.S. Regular Army soldiers is also developed using Army and DoD administrative data. However, this study focuses on a more recent risk period (2004–2009), includes women in addition to men, models risk factors separately for officers and enlisted soldiers, and examines interactions of risk predictors with time and deployment experience.

Current models include person-level sociodemographics, military service indicators, deployment status, military occupation specialty (MOS), and mental disorder diagnosis. The study also evaluates effects of time and risk factors for groups stratified by rank and deployment status during a time period of intense military operations in Iraq and Afghanistan. Additionally, it examines whether model predictors discriminate different risk profiles for accident deaths classified as line-of-duty (LOD) or not-line-of-duty (NLOD). The NLOD classification requires evidence of soldier misconduct (e.g., driving while intoxicated) whereas LOD accident deaths do not (e.g., death as aircraft passenger).¹⁸ Although LOD/NLOD classification may be partially confounded with other soldier characteristics, differences in LOD/NLOD risk profiles could improve understanding of the role of personal culpability in soldier accident deaths.

Methods

Sample

Data were from eight Army and DoD administrative data sets compiled for the Army STARRS HADS.⁹ DoD Defense Manpower Data Center (DMDC) Master Personnel and Transaction Files (MPTF), as well as the Defense Enrollment Eligibility Reporting System (DEERS), provided sociodemographic and Army service data; the DMDC Contingency Tracking System (CTS) provided data on deployments in support of Operations Enduring Freedom (OEF) in Afghanistan and Iraqi Freedom (OIF); the Armed Forces Medical Examiner Tracking System (AFMETS) and Defense Casualty Information Processing System (DCIPS) provided date of accident death and Army LOD/NLOD determination; and the Medical Data Repository (MDR), Theater Medical Data Store (TMDS), and Transportation Command (TRANSCOM) Regulating and Command and Control Evacuation System (TRAC2ES) provided medical encounter data.

The current study focused on Regular Army soldiers who served on active duty between January 1, 2004 and December 31, 2009. Over this period, the AFMETS classified 1,331 active duty Regular Army soldier deaths as accident deaths, arising from unintentional injury while on active military duty but unrelated to hostile action. LOD/NLOD classification, governed by Army Regulation 600-8-4, was assigned post-mortem; accident death is considered LOD unless formal investigation determines that willful or intentional negligence or misconduct was a causal factor.¹⁸

Procedures employed in the construction of the HADS database and secondary analyses of data reported here were approved by the IRBs of the University of Michigan and Uniform Services University of the Health Sciences (representing DoD).

Outcome Measures and Analysis Units

A case-control framework and unconditional logistic regression were used to analyze the association between accident death and predictors of risk for the 2004–2009 observation period. A binary outcome Y was defined for each “soldier-month” of service. An “event case” (Y=1) was defined by the accident death of the soldier within that month (n=1,331). A “control” (Y=0) was a soldier-month in which no death occurred (n=37,006,254). Without

loss of generality in the case-control logistic modeling, to reduce the computational demands of the analysis, a 1:400 random sampling of control months was performed, yielding a sample of just fewer than 96,000 control months for the analysis.

Predictors of Risk

Predictors included sociodemographics (age, gender, race/ethnicity, religion, education level, and marital status), military service characteristics (age at entry, years of service, deployment status [never, previously, or current], number of deployments, prior or current stop-loss status [involuntary extension of original service obligation], length of deployment, rank, ever promoted [since January 2000], and ever demoted [since January 2000]), Armed Forces Qualification Test (AFQT) score, MOS in the Army, and primary diagnosis for mental disorder specified by ICD-9-CM codes (past 12 months). Current age and age of entry were dropped from risk models to avoid multicollinearity with rank/length of service and education level. Non-significant predictors examined in initial models but dropped from final models included: religion, prior and current stop-loss, AFQT scores, length of deployment, and promotion.

A standard classification of soldiers' MOS was used: combat arms (e.g., Cannon Crew Member), combat support (e.g., Radio Operator-Maintainer), and combat service support (e.g., Food Service Specialist).^{3,19,20} In final models, MOS categorization was collapsed to combat arms and other. Aviation MOS was also included as a predictor given that 51% of the 130 officer accident deaths were among pilots or other aviation specialists.

Statistical Analysis

Analysis using administrative data from Army soldiers on active duty during 2004–2009 was conducted in 2013. The association between accident death and predictors of risk was modeled using unconditional logistic regression analysis.²¹ Models were fit separately for officers and enlisted soldiers by deployment status, providing a more granular look at accident death risk within groups with different military backgrounds and experiences. For the logistic regression modeling, accidents associated with more than three soldier deaths were removed ($n=149$) to ensure that a single catastrophic event did not exert an extreme clustering effect on the modeling of individual risks.

Logistic regression coefficients were exponentiated to obtain ORs and 95% CIs. Estimated ORs can be interpreted as measures of the average “within-month” association between accident death and the individual predictors, assuming that effects of other predictors in the model remain constant. To control for any secular trends in the 2004–2009 study period, indicator variables for year were included in the logistic regression model. First-order interaction tests were conducted for risk factors by time, MOS, and deployment status (officer model only).

Finally, logistic regression was employed to test predictor discrimination of NLOD and LOD deaths. Statistical significance is reported at the $\alpha=5\%$ level. All analyses were conducted using SAS, version 9.3 (SAS Institute Inc., Cary NC).

Results

Descriptive Summary

Between 2004 and 2009, a total of 1,331 Regular Army soldiers (95% men) died from accidents and 68% were rank E4 or higher. Crude rates of death due to accidents were highest for soldiers who were young, male, less educated, single, delayed in rank progression, and had deployment experience (Table 1).

As shown in Figure 1, an average of 55 Regular Army accident deaths occurred in each 3-month period (range, 38–85). Removal of multiple fatality events reduced quarterly peaks in total accident deaths from 2004 to 2008.

For currently deployed, enlisted soldiers, unadjusted odds of accident death declined while an increasing trend was observed for never-deployed, enlisted soldiers (Figure 2). Risk for previously deployed, enlisted soldiers appeared stable over time. Officer accident deaths showed an increase in 2006 before returning to a downward trend.

Logistic Model Predicting Accident Deaths: Enlisted Soldiers

For currently deployed, enlisted soldiers, higher odds of accident death were associated with years 2004 and 2005 (versus 2009), and being male or unmarried. Deployed E1/E2 soldiers were at higher risk of accident death compared to enlisted soldiers with more than 5 service years. Deployed, enlisted soldiers who were demoted in rank or in combat arms MOS were also at high risk of accident death. MOS effects did not vary by time. Controlling for other model predictors, primary diagnosis of mental disorder in the preceding 12 months was not related to high risk of accident death for this group.

For previously deployed soldiers, risk of accident death did not vary over time (Table 2 and Figure 2). Soldiers at high risk within this group were male, unmarried, and had less than a high school education, an alternative education certificate, or a General Educational Development certificate. Previously deployed, E1/E2 soldiers had higher odds of accident death compared to E3s with 13–60 service months, E5s with 13–60 service months, or enlisted soldiers with more than 5 service years. Previously deployed, enlisted soldiers in combat arms or who had been demoted in rank had high odds of dying from an accident. MOS effects did not vary by time. Previously deployed, enlisted soldiers with a primary diagnosis of mental disorder in the past 12 months were almost twice as likely as those without a diagnosis to die from an accident.

Controlling for other model predictors, never-deployed, enlisted soldiers showed increasing odds of accident death over time, reaching a peak in 2008 before declining in 2009 (Figure 2). Soldiers in this group with less formal education were at higher risk of accident death compared to those with at least some college education. Odds of accident death were also higher for male and unmarried soldiers in this group. Relative to never-deployed E1/E2 soldiers in their first year, never-deployed E1/E2 soldiers in their second through fifth year and E3 soldiers in their third through fifth year of service had higher odds of accident death. Senior enlisted soldiers with more than 5 service years had lower odds compared to E1/E2s in their first year. Being in combat arms MOS was associated with higher risk of accident

death whereas aviation specialty showed a protective effect within this never-deployed, enlisted group. Controlling for other model predictors, never-deployed, enlisted soldiers with a primary diagnosis of mental disorder were almost three times as likely as those without a diagnosis to die from an accident. This effect did not vary by time or MOS specialty.

Logistic Model Predicting Accident Deaths: Officers

Time was not a significant predictor of officer accident death; risk of officer accident death was higher for men than women. A main effect was found for officer deployment status, with higher odds of accident death for those currently deployed compared to never deployed. The strongest service predictor of accident death risk for officers was being in an aviation occupation, and this effect did not vary by time or deployment status. Controlling for other model predictors, a primary diagnosis of mental disorder in the previous 12 months was not related to high risk of officer accident death.

Model Discrimination of Line-of-Duty and Not-Line-of-Duty Accident Deaths

Overall, model predictors did not discriminate risk of NLOD compared to LOD accident deaths for previously deployed, enlisted soldiers. Being non-Hispanic, white compared to black was associated with higher odds of NLOD (versus LOD) accident death in never-deployed, enlisted soldiers (OR=2.5, 95% CI=1.3, 5.0). More notable is that deployed, enlisted soldiers with a mental disorder diagnosis had a 5-fold increase in the odds that the accident death was classified as NLOD (OR=5.1, 95% CI=1.9, 14.1). Low NLOD accident death counts ($n=12$) precluded modeling LOD/NLOD differences for officers (results available on request).

Discussion

Accident death risk predictors were identified for officers and enlisted soldier subgroups. Being male, unmarried, or in combat arms specialties increased odds of accident death for all enlisted soldier groups and is consistent with risk indicators found in prior research.^{3,11,12, 17} Being male was also a risk predictor of accident death for officers. However, unique to officers was high risk associated with aviation occupations.

High risk associated with occupational specialties may relate to personal characteristics associated with self-selection (e.g., risk-seekers) or the nature of the job. Knowing that a soldier is in a combat arms specialty does not indicate whether or not an accident death occurred on or off duty, or during a dangerous task. Future work is needed to disentangle both person-level and task-related predictors of accident death for soldiers with high-risk MOSs.

Fluctuations in accident deaths over time could be driven by event circumstances.

However, when controlling for other model predictors, chronologic time period was a risk predictor only for enlisted soldiers currently or never deployed. The decrease in accident deaths over time for deployed, enlisted soldiers could reflect DoD-initiated improvements in safety training (e.g., escaping overturned vehicles) and equipment (e.g., improved

armor),^{22–25} or could partially reflect situational changes occurring during the last half of this time frame (e.g., U.S. combat surge resulting in reduced violence in Iraq and troop allocation to Afghanistan).²⁶

Never-deployed, enlisted soldiers showed increased risk of accident death over this time period of increased deployments across all Army commands and could be associated with reasons for deployment ineligibility (e.g., health concerns, new to service, inadequate training). High risk in this group was also associated with mental disorder diagnosis and delayed rank progression, suggesting soldier adjustment difficulties.¹⁶ Aviation jobs were protective for soldiers in this never-deployed group, possibly reflecting advanced specialty training or low-risk job assignments.

Overall, a prior 12-month diagnosis of a mental disorder did not predict accident death in currently deployed soldiers. This is not surprising given the health screenings and command assessments required to establish deployment readiness. However, among deployed, enlisted soldiers, a prior 12-month mental disorder diagnosis was associated with classification of accident death as NLOD. Mental disorder diagnosis was a risk factor for previously deployed, enlisted soldiers and could reflect underlying conditions related to health-risk perceptions (e.g., sense of invincibility) and behaviors (e.g. willingness to drive fast) associated with combat exposure.²⁷ Examining refined indicators of health risk behaviors (e.g., record of pre-deployment risk taking, type of psychiatric diagnosis)^{28,29} and timing of mental health diagnoses relative to deployment would strengthen the ability to target preventive interventions.

Finally, demographic and service characteristic risk factors identified for all soldier groups did not vary by time, MOS, or deployment status (for officers). Inclusion of these stable indicators in models would aid the Army in predicting risk of accident deaths in future cohorts of soldiers. It is notable that stable predictors of accident deaths (e.g., being male, delayed rank progression) also identified risk for cases of completed suicide in Army soldiers from the same cohort^{30,31} and may share common underlying causes.^{32,33}

The failure to find a remarkable person-level risk profile for NLOD compared to LOD accident deaths may be due to unmeasured determination biases (e.g., classify as LOD to ensure survivor benefits), but no key data were available to empirically test this assumption. Also, it is difficult to interpret the two significant main effects given potential endogeneity of factors associated with both NLOD/LOD determination criteria and model predictors (e.g., alcohol abuse).

Strengths and Limitations

Study strengths include the large sample and extensive personal data for Regular Army soldiers spanning a 6-year (2004–2009) period of intense Army operations in Iraq and Afghanistan.

The fixed study time frame presents a potential limitation in interpretation. Classifying soldiers as “deployed,” “previously deployed,” or “never deployed” is time dependent, and the analysis ignored the temporal censoring in the experience of soldiers that can occur at

the beginning and end of the observational period. For example, all else being equal, the chance that a soldier is “previously deployed” in 2004 is lower than for a soldier with similar characteristics in 2007.

Additional limitations include the exclusion of Army National Guard and Army Reserve soldiers, more refined person-level risk factors (e.g., risk-taking behavior, physical health conditions) and specific categories of mental disorders (e.g., depression, post-traumatic stress disorder). Unmeasured biases could be present in the interpretation of Army regulations for LOD/NLOD determinations that affect survivor benefits, use of administrative data may contain data entry or reporting errors, and AFMETS cause of death could be subject to some misclassification.^{34,35}

Next Steps

Future work will add more refined person-level predictors such as prior non-fatal injuries, specific categories of mental disorder diagnoses, pre-existing health risk behaviors, and personality characteristics associated with risk taking to identify potential underlying explanations for accident death risk profiles that are both shared and unique to enlisted subgroups. A more detailed analysis of occupational tasks and circumstances associated with accident death events would also help target prevention efforts. Generalizability of findings to Army Reserve and Army National Guard components will be tested and results compared with investigations of suicide death in Army soldiers^{30,31} to possibly inform coordinated preventive interventions.^{33,36}

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In the past 5 years, Dr. Kessler has been a consultant for Eli Lilly & Company, Glaxo, Inc., Integrated Benefits Institute, Ortho-McNeil Janssen Scientific Affairs, Pfizer Inc., Sanofi-Aventis Groupe, Shire U.S. Inc., and Transcept Pharmaceuticals Inc. and served on advisory boards for Johnson & Johnson. Dr. Kessler had research support for studies over this time period from Eli Lilly & Company, EPI-Q, GlaxoSmithKline, Ortho-McNeil Janssen Scientific Affairs, Sanofi-Aventis Groupe, Shire U.S., Inc., and Walgreens Co. Dr. Kessler owns a 25% share in DataStat, Inc. Stein has in the last 3 years been a consultant for Healthcare Management Technologies and had research support for pharmacologic imaging studies from Janssen.

References

1. Leland, A.; Oboceanu, MJ. CRS Report for Congress. Congressional Research Service (US); Washington, DC: Feb 26. 2010 American war and military operations casualties: Lists and statistics.. Report No.: RL32492
2. Kasindorf, M. Accidental deaths exceed those in combat.. USA Today. Mar 26. 2003
www.usatoday.com/news/world/iraq/2003-03-26-count_usat_x.htm
3. Garvey-Wilson AL, Lange JL, Brundage JF, Frommelt RA. Behavioral, demographic, and prior morbidity risk factors for accidental death among men: A case-control study of soldiers. *Prev Med.* 2003; 36(1):124–30. [PubMed: 12473433]
4. Chervak, M. Information Paper. Army Institute of Public Health (US); Aberdeen Proving Ground, MD: May 10. 2012 Deaths among active duty Army soldiers, 2000-2010.. MCHB-IP_DI
5. Gunlicks JB, Patton JT, Miller SF, Atkins MG. Public health and risk management: a hybridized approach to military injury prevention. *Am J Prev Med.* 2010; 38(1):S214–6. [PubMed: 20117596]
6. Jones BH, Canham-Chervak M, Sleet DA. An evidence-based public health approach to injury priorities and prevention: recommendations for the U.S. Military. *Am J Prev Med.* 2010; 38(1):S1–10. [PubMed: 20117582]
7. Canham-Chervak M, Jones B, Sleet DA. Public health approach to injury prevention: The U.S. military experience. *Am J Prev Med.* 2010; 38(S1):S1–S222. [PubMed: 20117582]
8. Angello JJ, Smith JW. The military accident and injury prevention challenge: Setting a foundation for the future. *Am J Prev Med.* 2010; 38(1):S212–S213. [PubMed: 20117595]
9. Kessler RC, Colpe LJ, Fullerton CS, et al. Design of the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). *Int J Methods Psychiatr Res.* 2013; 22(4):267–275. [PubMed: 24318217]
10. Stenbacka M, Leifman A, Dalal K, Jansson B. Early predictors of injury mortality among Swedish conscripts: a 35-year cohort study. *Accid Anal Prev.* 2011; 43(1):228–234. [PubMed: 21094318]
11. Garvey AL, Washington SC. Mortality trends among active duty military servicemembers, 1990-1997. *MSMR.* 1999; 5(2):13–15.
12. Baker, SP.; O'Neill, B.; Ginsburg, MJ.; Li, G. The injury fact book. 2nd ed.. Oxford University Press; New York: 1992.
13. Rockett IR, Regier MD, Kapusta ND, et al. Leading causes of unintentional and intentional injury mortality: United States, 2000–2009. *Am J Public Health.* 2012; 102(11):e84–e92. [PubMed: 22994256]
14. Hu G, Baker SP. Trends in unintentional injury deaths, U.S., 1999–2005: age, gender and racial-ethnic differences. *Am J Prev Med.* 2009; 37(3):188–94. [PubMed: 19595555]

15. Chiron M, Bernard M, Lafont S, Lagarde E. Tiring job and work related injury road crashes in the GAZEL cohort. *Accid Anal Prev*. 2008; 40(3):1096–104. [PubMed: 18460378]
16. Institute for Work and Health. Issue briefing: “Newness” and the risk of occupational injury. Institute for Work and Health; Toronto, ON: 2009.
17. Hooper TI, DeBakey SF, Bellis KS, et al. Understanding the effect of deployment on the risk of fatal motor vehicle crashes: a nested case-control study of fatalities in Gulf War era veterans, 1991–1995. *Accid Anal Prev*. 2006; 38(3):518–25. [PubMed: 16405857]
18. US. Headquarters, Department of the Army. Line of duty policy, procedures, and investigations. AR 600-8-4. HQDA; Washington, DC: Sep 4. 2008
19. US. Headquarters, Department of the Army. Personnel Authorizations Module (PAMXXI). Office of the Army Human Resources Command; Washington, DC: Jan.. 2013
20. Levy, CM.; Thie, H.; Sollinger, JM.; Kawata, JH. Army Perstempo in the Cold War Era. RAND; Arlington, VA: 2001.
21. Heeringa, SG.; West, BT.; Berglund, PA. Applied Survey Analysis. Chapman & Hall/CRC; Boca Raton, FL: 2010.
22. Jennings J. Humvee rollover trainer. *Prof Saf*. 2010; 55(7):24–30.
23. Bender, B. Accidental deaths plaguing US in Iraq: Military aiming to reduce toll.. *Boston Globe*. May 3. 2009 www.boston.com/news/nation/washington/articles/2009/05/03/accidental_deaths_plaguing_us_in_iraq/
24. Fabey M. Military accidents: Non-combat fatalities show dangers of equipment failures. Investigative Reporters and Editors, Inc. *The IRE Journal*. 2005; 28(2):25–26.
25. Army adding armor in Iraq.. *USA Today*. Jan 8. 2005 usatoday30.usatoday.com/news/world/iraq/2005-01-08-army-armor_x.htm#
26. Belasco, A. CRS Report for Congress. Congressional Research Service (US); Washington, DC: Jul 9. 2009 Troop levels in the Afghan and Iraq wars, FY2001-FY2012: Cost and other potential issues.. Report No.: R40682
27. Kilgore WDS, Cotting DI, Thomas JL, et al. Post-combat invincibility: violent combat experiences are associated with increased risk-taking propensity following deployment. *J Psychiatr Res*. 2008; 42(13):1112–21. [PubMed: 18291419]
28. Kelley AM, Athy JR, Cho TH, Erickson B, King M, Cruz P. Risk propensity and health risk behavior in U.S. Army soldiers with and without psychological disturbances across the deployment cycle. *J Psychiatr Res*. 2012; 46(5):582–9. [PubMed: 22305118]
29. Thomsen CJ, Stander VA, McWhorter SK, Rabenhors MM, Milner JS. Effects of combat deployment on risky and self-destructive behavior among active duty military personnel. *J Psychiatr Res*. 2011; 45(10):1321–31. [PubMed: 21549392]
30. Gilman S, Cox K, Colpe LJ, et al. Career history and suicide mortality in the United States Army 2004-2009. *PLOS Med*. In Press.
31. Schoenbaum M, Kessler RC, Gilman S, et al. Predictors of suicide and accident death in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). *JAMA Psychiatry*. 2014; 71(5):493–503. [PubMed: 24590048]
32. Thoresen S, Mehlum L. Risk factors for fatal accidents and suicides in Peacekeepers: Is there an overlap? *Mil Med*. 2004; 169(12):988–93. [PubMed: 15646193]
33. Stea JB, Anderson MA, Bishop JM, Griffith LJ. Behavioral health force protection: Optimizing injury prevention by identifying shared risk factors for suicide, unintentional injury and violence. *Mil Med*. 2002; 167(11):944–9. [PubMed: 12448624]
34. Pompili M, Serafini G, Innamorati M, et al. Car accidents as a method of suicide: a comprehensive overview. *Forensic Sci Int*. 2012; 223(1–3):1–9. [PubMed: 22576104]
35. Donaldson AE, Larsen GY, Fullerton-Gleason L, Olson LM. Classifying undetermined poisoning deaths. *Inj Prev*. 2006; 12(5):338–43. [PubMed: 17018678]
36. Neeleman J. A continuum of premature death. Meta-analysis of competing mortality in the psychosocially vulnerable. *Int J Epidemiol*. 2001; 30(1):154–62. [PubMed: 11171878]

Figure 1.
Any accidental death and multiple death (>3) dates excluded, by quarter 2004 – 2009

Figure 2. Unadjusted odds ratio of accidental death over time (2009 is reference) for enlisted by deployment status and officers, U.S. soldiers serving on active duty 2004-2009

Table 1

Accidental deaths for regular army U.S. soldiers serving on active duty 2004-2009

Army Soldier Population	Person Months 2004-2009	All Accidents	Crude Rates of Accident Death Per Year/ 100,000
All Soldiers	37007585	1331	43.2
Age Categories			
<=20 Years	4624660	225	58.4
21-24 Years	9841710	494	60.2
25-29 Years	8479537	309	43.7
30-44 Years	12781129	275	25.8
45+ Years	1280549	28	26.2
Gender			
Male	31818171	1266	47.7
Female	5189414	65	15.0
Race/Ethnicity			
White (not Hispanic)	22984089	909	47.5
Black (not Hispanic)	7793546	237	36.5
Hispanic	3909282	126	38.7
All Other	2320668	59	30.5
Education Level			
Less than HS	633708	33	62.5
Alternative Education Certificate	3110190	172	66.4
General Educational Development (GED)	286440	15	62.8
High School	23963743	944	47.3
Some College	1927773	56	34.9
College and Higher	7085731	111	18.8
Marital Status			
Married	21121658	604	34.3
Divorced, Widowed	1617769	51	37.8
Single	14268158	676	56.9
Rank/ Service Months			
E1 or E2, <=12 Months	3074268	134	52.3
E1 or E2, 13-60 Months	717801	90	150.5
E3, <=24 Months	3714233	152	49.1
E3, 25-60 Months	623751	47	90.4
E4, <=60 Months	6986755	311	53.4
E5, <=60 Months	2164348	77	42.7
Enlisted > 60 Months	13660000	390	34.3
Officers, Any Length	6065690	130	25.7
Deployment Status			
Currently Deployed	8383029	328	47.0
Previous Deployed	13817561	535	46.5
Never Deployed	14806995	468	37.9

Table 2

Estimated odds ratios for accidental death, enlisted U.S. soldiers serving on active duty 2004-2009

Effect	Category of Effect ^a	Enlisted: Currently Deployed Odds Ratio (95% CI)	Enlisted: Previously Deployed Odds Ratio (95% CI)	Enlisted: Never Deployed Odds Ratio (95% CI)
Time	2004	2.0 (1.2, 3.2)	1.2 (0.8, 1.7)	0.8 (0.5, 1.1)
	2005	1.9 (1.2, 3.1)	1.2 (0.9, 1.6)	1.1 (0.8, 1.6)
	2006	1.4 (0.8, 2.2)	1.4 (1.0, 1.9)	1.0 (0.7, 1.5)
	2007	1.1 (0.7, 1.7)	1.2 (0.9, 1.6)	1.2 (0.9, 1.8)
	2008	1.0 (0.6, 1.6)	1.3 (1.0, 1.8)	1.4 (1.0, 2.0)
Gender	Male	2.7 (1.3, 5.9)	4.4 (2.4, 7.8)	1.9 (1.4, 2.7)
Race/Ethnicity	Black	0.8 (0.5, 1.2)	1.1 (0.9, 1.4)	1.1 (0.8, 1.4)
	Hispanic	1.3 (0.9, 1.8)	0.8 (0.6, 1.1)	0.9 (0.6, 1.2)
	Other	1.0 (0.6, 1.8)	0.6 (0.3, 1.0)	1.0 (0.6, 1.6)
Education	Less than High School/ Alternative Education Certificate/General Educational Development (GED)	1.4 (0.6, 3.1)	1.7 (1.1, 2.6)	1.7 (1.0, 2.8)
	High School	1.8 (0.9, 3.6)	1.2 (0.8, 1.8)	1.7 (1.1, 2.7)
Marital Status	Married	0.6 (0.5, 0.9)	0.6 (0.5, 0.7)	0.7 (0.5, 0.9)
Demoted	Yes	1.8 (1.3, 2.5)	1.5 (1.2, 1.9)	0.8 (0.6, 1.2)
Rank/Length of Service	E1, E2: 13-60 months	-	-	2.4 (1.7, 3.5)
	E3: 13-24 months	0.9 (0.5, 1.6)	0.7 (0.3, 1.3)	0.8 (0.6, 1.1)
	E3: 25-60 months	1.0 (0.5, 2.1)	0.5 (0.2, 1.0)	2.0 (1.2, 3.2)
	E4: 13-60 months	0.7 (0.4, 1.2)	0.6 (0.4, 1.0)	0.7 (0.5, 1.0)
	E5: 13-60 months	0.5 (0.3, 1.1)	0.4 (0.2, 0.8)	0.6 (0.3, 1.2)
	Enlisted: >60 months	0.5 (0.3, 0.9)	0.4 (0.3, 0.7)	0.6 (0.4, 0.8)
Total Deployments		1.2 (1.0, 1.4)	1.0 (0.9, 1.1)	-
Aviation	Yes	0.6 (0.3, 1.1)	0.8 (0.5, 1.2)	0.5 (0.3, 0.9)
MOS Categories	Combat Arms	1.7 (1.3, 2.3)	1.6 (1.3, 1.9)	1.9 (1.5, 2.3)
Mental Health Diagnosis- Past 12 Months		1.3 (0.9, 1.8)	1.9 (1.6, 2.3)	2.9 (2.4, 3.6)

Boldface indicates statistical significance (p<0.05).

^aReference Categories are: 2009, Female, White, Previously/Never Married, Not Demoted, E1/E2 ≤60 for Currently and Previously Deployed and E1/E2 ≤12 Months for Never Deployed, Combat Service/Support, Not Aviation and No Mental Health Diagnosis, past 12 months.

Table 3

Estimated odds ratios for accidental death, U.S. army officers on active duty 2004-2009

Effect	Category of Effect ^a	Odds Ratio (95% CI)
Time	2004	1.4 (0.7, 2.7)
	2005	1.4 (0.7, 2.7)
	2006	1.5 (0.8, 2.9)
	2007	0.8 (0.4, 1.7)
	2008	0.7 (0.3, 1.5)
Gender	Male	7.1 (1.7, 29.6)
Race/Ethnicity	Black	1.7 (1.0, 3.1)
	Hispanic	1.2 (0.5, 2.7)
	Other	1.1 (0.5, 2.4)
Marital Status	Married	0.7 (0.4, 1.0)
Deployment Status	Currently Deployed	2.0 (1.0, 3.8)
	Previously Deployed	1.3 (0.7, 2.3)
Demoted	Yes	0.7 (0.2, 2.7)
Officer Rank	1st or 2nd Lieutenant	1.4 (0.8, 2.5)
	Warrant Officers	1.5 (0.9, 2.5)
Total Deployments		0.9 (0.7, 1.2)
Aviation	Yes	3.9 (2.1, 7.0)
MOS Categories	Combat Arms	1.7 (1.0, 3.0)
Any Mental Health Diagnosis—Past 12 Months		1.4 (0.9, 2.3)

Boldface indicates statistical significance (p<0.05, two-sided).

^a Reference Categories are: 2009, Female, White, Previously/Never Married, Never Deployed, Not Demoted, Captain and Higher Rank, Not Aviation, Combat Service/Support, and No Mental Health Diagnosis, Past 12 Months.