

**THE ARMY STUDY TO ASSESS RISK AND RESILIENCE IN SERVICEMEMBERS  
(Army STARRS)  
and  
THE STUDY TO ASSESS RISK AND RESILIENCE IN SERVICEMEMBERS – LONGITUDINAL STUDY  
(STARRS-LS)  
2009 – 2020**

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*This document is an ongoing continuous summary of Army STARRS and STARRS-LS publications*

## **INTRODUCTION:**

Army STARRS (2009-2015) was the largest and most comprehensive research project of mental health ever conducted in the U.S. Army. The project was designed to examine a broad range of risk and resilience (protective) factors across a complex set of outcomes. Army STARRS scientists created a series of extensive databases with the potential to achieve groundbreaking results. These databases allow scientists to investigate a diverse combination of factors from demographic, psychological, biological, neurological, behavioral, and social domains to help identify risk and resilience factors for Soldier suicidal behaviors and associated mental health issues. The project was designed using an adaptive approach which means it evolved as new information became available over the course of the project. With the goal of generating actionable findings, the research team shared preliminary findings with the Army as they become available so that the Army could apply them to its ongoing health promotion, risk reduction, and suicide prevention efforts.

Army STARRS included the following component studies:

- 1) the Historical Administrative Data Study (HADS) of Army and Department of Defense (DoD) administrative data systems (including records of suicidal behaviors) for all Soldiers on active duty from 2004 to 2009 aimed at finding administrative record predictors of suicides;
- 2) two retrospective case-control studies of fatal and nonfatal suicidal behaviors;
- 3) a study of new Soldiers assessed just before beginning basic combat training (BCT) with self-administered questionnaires (SAQ), neurocognitive tests, and blood samples;
- 4) a cross-sectional study of Soldiers representative of all other active duty Soldiers (exclusive of BCT);
- 5) a pre-post deployment study (with blood samples) of Soldiers in Brigade Combat Teams about to deploy to Afghanistan, with sub-samples assessed again one, three, and nine months after returning from deployment.

Army STARRS Component Studies and Soldier Sample Size:

Historical Administrative Data Study (HADS)	>1.6 million
Soldier Health Outcomes Study A (SHOS-A)	186 cases and 375 controls
Soldier Health Outcomes Study B (SHOS-B)	150 cases and 270 controls
New Soldier Study (NSS)	55,814
All Army Study (AAS)	41,210
Pre-Post Deployment Study (PPDS)	10,116

Army/DoD administrative data were linked prospectively to the large-scale survey samples to examine predictors of subsequent suicidality and related mental health outcomes.

STARRS-LS (2015-2020) is continuing and extending the Army STARRS research to discover additional findings for the Army and the DoD. STARRS-LS also includes a longitudinal follow-up study to collect additional data from a subset of Soldiers who participated in Army STARRS.

## **SUMMARY OF FINDINGS:**

The following is a brief summary of published findings to-date from Army STARRS and STARRS-LS. Findings followed by an asterisk (\*) were included in USU press releases.

### **1. The Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Ursano, et al 2014)**

- Component study cooperation rates are comparatively high.
- Sample biases are relatively small.
- Inefficiencies introduced into parameter estimates by using nonresponse adjustment weights and time-space clustering are small.
- Initial findings show that the suicide death rate, which rose over 2004–2009, increased for those deployed, those never deployed, and those previously deployed.
- Analyses of administrative records show that those deployed or previously deployed were at greater suicide risk.
- Receiving a waiver to enter the Army was not associated with increased risk.
- Being demoted in the past two years was associated with increased risk.
- Time in current deployment, length of time since return from most recent deployment, total number of deployments, and time interval between most recent deployments (known as dwell time) were not associated with suicide risk.
- Initial analyses of survey data show that 13.9% of currently active non-deployed regular Army Soldiers considered suicide at some point in their lifetime, while 5.3% had made a suicide plan, and 2.4% had attempted suicide.\*
- 47–60% of these outcomes first occurred prior to enlistment.\*
- Prior mental disorders (in particular major depression and intermittent explosive disorder) were the strongest predictors of these self-reported suicidal behaviors.
- Most onsets of plans-attempts among ideators (58.3–63.3%) occurred within the year of onset of ideation.
- About 25.1% of non-deployed U.S. Army personnel met 30-day criteria for a DSM-IV anxiety, mood, disruptive behavior, or substance disorder (15.0% an internalizing disorder; 18.4% an externalizing disorder) and 11.1% for multiple disorders.\*

- Three-fourths of these disorders had pre-enlistment onsets.\*
- Integration across component studies creates strengths going well beyond those in conventional applications of the same individual study designs.
- These design features create a strong methodological foundation from which Army STARRS can pursue its substantive research goals.
- The early findings reported here illustrate the importance of the study and its approach as a model of studying rare events particularly of national security concern.
- Continuing analyses of the data will inform suicide prevention for the U.S. Army.

## **2. Sociodemographic and Career History Predictors of Suicide Mortality in the United States Army 2004–2009 (Gilman, et al 2014)**

- Several novel results were found that could have intervention implications.
- Significantly elevated suicide rates among enlisted Soldiers deployed either during their first year of service or with less than expected (based on time in service) junior enlisted rank (69.6–80.0 suicides per 100,000 person-years compared with 18.5 suicides per 100,000 person-years in the total Army)
- Substantially greater rise in suicide among women than men during deployment
- Protective effect of marriage against suicide only during deployment.
- Career history approach produces several actionable insights missed in less textured analyses of administrative data predictors.
- Expansion of analyses to a richer set of predictors might help refine understanding of intervention implications.

## **3. Predictors of Suicide and Accident Death in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Schoenbaum, et al, 2014)**

- The suicide rate rose between 2004 and 2009 among never deployed and currently and previously deployed Regular Army Soldiers.
- The accident death rate fell sharply among currently deployed Soldiers, remained constant among the previously deployed, and trended upward among the never deployed.

- Increased suicide risk was associated with being a man (or a woman during deployment), white race/ethnicity, junior enlisted rank, recent demotion, and current or previous deployment.
- Sociodemographic and Army experience predictors were generally similar for suicides and accident deaths.
- Time trends in these predictors and in the Army's increased use of accession waivers (which relaxed some qualifications for new Soldiers) do not explain the rise in Army suicides.
- Predictors of Army suicides were largely similar to those reported elsewhere for civilians, although some predictors distinct to Army service emerged that deserve more in-depth analysis.
- The existence of a time trend in suicide risk among never-deployed Soldiers argues indirectly against the view that exposure to combat-related trauma is the exclusive cause of the increase in Army suicides.

#### **4. Thirty-Day Prevalence of DSM-IV Mental Disorders among Nondeployed Soldiers in the U.S. Army: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Kessler, et al 2014)**

- A total of 25.1% of respondents met criteria for any 30-day disorder (15.0% internalizing; 18.4% externalizing) and 11.1% for multiple disorders.
- A total of 76.6% of cases reported pre-enlistment age at onset of at least one 30-day disorder (49.6% internalizing; 81.7% externalizing).\*
- 12.8% of respondents reported severe role impairment.
- Controlling for sociodemographic and Army career correlates (which were broadly consistent with other studies) 30-day disorders with pre-enlistment and post-enlistment ages at onset both significantly predicted severe role impairment
- Pre-enlistment disorders were more consistent powerful predictors than post-enlistment disorders.
- Population-attributable risk proportions of severe role impairment were 21.7% for pre-enlistment disorders, 24.3% for post-enlistment disorders, and 43.4% for all disorders.

- Interventions to limit accession or increase resilience of new Soldiers with pre-enlistment mental disorders might reduce prevalence and impairments of mental disorders in the U.S. Army.

#### **5. Prevalence and Correlates of Suicidal Behavior among Soldiers: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Nock, et al 2014)**

- The lifetime prevalence estimates of suicidal ideation, suicide plans, and suicide attempts are 13.9%, 5.3%, and 2.4%.\*
- Most reported cases (47.0%-58.2%) had pre-enlistment onsets.\*
- Pre-enlistment onset rates were lower than in a prior national civilian survey (with imputed/simulated age at enlistment).
- Post-enlistment onsets of ideation and plans were higher, and post-enlistment first attempts were equivalent to civilian rates.
- Most reported onsets of plans and attempts among ideators (58.3%-63.3%) occur within the year of onset of ideation.
- Post-enlistment attempts are positively related to being a woman, lower rank, and previously deployed, and are negatively related to being unmarried and assigned to Special Operations Command.
- Five mental disorders predict post-enlistment first suicide attempts in multivariate analysis:
  - pre-enlistment panic disorder
  - pre-enlistment posttraumatic stress disorder
  - post-enlistment depression
  - pre-enlistment intermittent explosive disorder
  - post-enlistment intermittent explosive disorder
- 4 of these 5 (posttraumatic stress disorder is the exception) predict ideation.
- Only post-enlistment intermittent explosive disorder predicts attempts among ideators.
- Population-attributable risk proportions of lifetime mental disorders predicting post-enlistment suicide attempts are:
  - 31.3% for pre-enlistment onset disorders

- 41.2% for post-enlistment onset disorders
- 59.9% for all disorders
- The fact that approximately one-third of post-enlistment suicide attempts are associated with pre-enlistment mental disorders suggests that pre-enlistment mental disorders might be targets for early screening and intervention.
- The possibility of higher fatality rates among Army suicide attempts than among civilian suicide attempts highlights the potential importance of means control (i.e., restricting access to lethal means [such as firearms]) as a suicide prevention strategy.

**6. Risk Factors for Accident Death in the U.S. Army, 2004-2009 (Lewandowski-Romps, et al 2014)**

- 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 decreased over time for currently deployed, enlisted Soldiers and increased for those never deployed.
- Mental health diagnosis was associated with risk only for previous and never-deployed, enlisted Soldiers.
- Models did not discriminate not-line-of-duty from line-of-duty accident deaths.
- 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.

**7. Predicting Suicides after Psychiatric Hospitalization in U.S. Army Soldiers: The Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Kessler, et al 2015)**

- Sixty-eight Soldiers died by suicide within 12 months of hospital discharge (12.0% of all U.S. Army suicides), equivalent to 263.9 suicides per 100,000 person-years compared with 18.5 suicides per 100,000 person-years in the total U.S. Army.

- The strongest predictors included sociodemographics:
  - male sex
  - late age of enlistment
  - criminal offenses (verbal violence and weapons possession)
  - prior suicidality
  - aspects of prior psychiatric inpatient and outpatient treatment (e.g., number of antidepressant prescriptions filled in the past 12 months), and disorders diagnosed during the focal hospitalizations (e.g., non-affective psychosis)
- A total of 52.9% of post-hospitalization suicides occurred after the 5% of hospitalizations with highest predicted suicide risk (3,824.1 suicides per 100,000 person-years).\*
- These highest-risk hospitalizations also accounted for significantly elevated proportions of several other adverse post-hospitalization outcomes (unintentional injury deaths, suicide attempts, and subsequent hospitalizations).\*
- The high concentration of risk of suicide and other adverse outcomes might justify targeting expanded post-hospitalization interventions to Soldiers classified as having highest post-hospitalization suicide risk, although final determination requires careful consideration of intervention costs, comparative effectiveness, and possible adverse effects.

**8. Lifetime Prevalence of DSM-IV Mental Disorders among New Soldiers in the U.S. Army: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Rosellini, et al 2015)**

- Lifetime prevalence of having at least one internalizing, externalizing, or either type of disorder did not differ significantly between new Soldiers and civilians
- Three specific disorders (generalized anxiety, posttraumatic stress, and conduct disorders) and multi-morbidity were significantly more common among new Soldiers than civilians.
- Several socio-demographic characteristics were significantly associated with disorder prevalence and persistence (these associations were uniformly weak).
- New Soldiers differ somewhat, but not consistently, from civilians.



**9. Prevalence and Correlates of Suicidal Behavior among New Soldiers in the U.S. Army: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Ursano, et al 2015)**

- Lifetime prevalence estimates of pre-enlistment suicide ideation, plans, and attempts were 14.1, 2.3, and 1.9%, respectively.
- Most reported onsets of suicide plans and attempts (73.3–81.5%) occurred within the first year after onset of ideation.
- Odds of these lifetime suicidal behaviors among new Soldiers were positively, but weakly associated with being female, unmarried, religion other than Protestant or Catholic, and a race/ethnicity other than non-Hispanic White, non-Hispanic Black, or Hispanic.
- Lifetime prevalence estimates of suicidal behaviors among new Soldiers are consistent with retrospective reports of pre-enlistment prevalence obtained from Soldiers later in their Army careers.
- Given that prior suicidal behaviors are among the strongest predictors of later suicides, consideration should be given to developing methods of obtaining valid reports of pre-enlistment suicidality from new Soldiers to facilitate targeting of preventive interventions.

**10. Mental Disorders, Comorbidity, and Pre-enlistment Suicidal Behavior Among New Soldiers in the U.S. Army: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Nock, et al 2015)**

- Most new Soldiers with a pre-enlistment history of suicide attempt reported a prior mental disorder (59.0%).
- Each disorder examined was associated with increased odds of suicidal behavior.
- Only PTSD and disorders characterized by irritability and impulsive/aggressive behavior (i.e., bipolar disorder, conduct disorder, oppositional defiant disorder, and attention-deficit/hyperactivity disorder) predicted unplanned attempts among ideators.
- Mental disorders are important predictors of pre-enlistment suicidal behavior among new Soldiers and should figure prominently in suicide screening and prevention efforts.

## **11. Understanding the Elevated Suicide Risk of Female Soldiers during Deployments (Street, et al 2015)**

- The suicide rate of currently deployed women (14.0/100,000 person-years) was 3.1 to 3.5 times the rates of other (i.e., never-deployed/previously deployed) women.
- The suicide rate of currently deployed men (22.6/100,000 person years) was 0.9 to 1.2 times the rates of other men.
- The adjusted (for time trends, sociodemographics, and Army career variables) female to male odds ratio comparing the suicide rates of currently deployed vs. other women vs. men was 2.8 (95% confidence interval 1.1–6.8), became 2.4 after excluding Soldiers with Direct Combat Arms occupations, and remained elevated (in the range 1.9–2.8) after adjusting for the hypothesized explanatory variables.
- None of the explanatory variables considered could fully account for the disproportionately elevated female suicide rate during deployment among Regular Army enlisted Soldiers over the years 2004–2009.
- These results are valuable in excluding otherwise plausible hypotheses for the elevated suicide rate of deployed women and point to the importance of expanding future research on the psychological challenges of deployment for women.

## **12. Nonfatal Suicidal Behaviors in U.S. Army Administrative Records, 2004-2009: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Ursano, et al 2015)**

- U.S. Army suicide rate is known to have risen sharply over the past decade, but information about medically documented, non-fatal suicidal behaviors (suicide attempts, suspicious injuries, and suicide ideation) is far more limited.
- There were 21,740 unique Regular Army Soldiers with a non-fatal suicidal event at some point during 2004-2009.
- There were substantial increases in the annual incidence rates of suicide attempts (179–400/100,000 person-years) and suicide ideation (557–830/100,000 person-years), but not suspicious injuries.
- Using hierarchical classification rules to identify the first instance of each Soldier's most severe behavior, there was an increased risk of all outcomes among those who were female, Non-Hispanic White, never married, lower-ranking enlisted, less educated, and of younger age when entering Army service.

- Socio-demographic associations significantly differed across outcomes, despite some patterns that appear similar.

### **13. Suicide Attempts in the U.S. Army during the Wars in Afghanistan and Iraq, 2004-2009 (Ursano, et al 2015)**

- The study included 9,791 medically documented suicide attempts among Regular Army Soldiers during the period 2004 to 2009. Predictor variables were constructed from Army personnel and medical records.
- Enlisted Soldiers accounted for 98.6% of all suicide attempts, with an overall rate of 377/100,000 person-years, versus 27.9/100,000 person-years for officers.\*
- Significant predictors among enlisted Soldiers included socio-demographic characteristics (female gender, older age at Army entry, younger current age, lower education, non-Hispanic white), short length of service, never or previously deployed, and the presence and recency of mental health diagnoses. Risk was highest early in the Army career.\*
- Among officers, only socio-demographic characteristics (female gender, older age at Army entry, younger current age, and low education) and the presence and recency of mental health diagnoses were significant.\*
- The results represent the most comprehensive accounting of U.S. Army suicide attempts to date and reveal unique risk profiles for enlisted Soldiers and officers, and highlight the importance of focusing research and prevention efforts on enlisted Soldiers in their first tour of duty.\*

### **14. Occupational Differences in U.S. Army Suicide Rates (Kessler, et al 2015)**

- Military research has found elevated suicide rates in combat arms occupations, but has not evaluated variation in this pattern by deployment history which is the indicator of occupational stress widely considered responsible for the recent rise in military suicide rates.
- This study analyzed associations of Army occupation and deployment history in predicting suicide among 729,337 male enlisted Regular Army Soldiers in 2004-2009.
- There were 496 suicides (22.4/100,000 person-years) during the study period and only two occupational categories (both in combat arms) had significantly elevated suicide rates: infantrymen (37.2/100,000 person-years) and combat engineers (38.2/100,000 person-years).

- Suicide rates in these two occupational categories were significantly lower when currently deployed (30.6/100,000 person-years) than never deployed or previously deployed (41.2-39.1/100,000 person years).
- The suicide rate of other Soldiers was significantly higher when currently deployed and previously deployed (20.2-22.4/100,000 person-years) than never deployed (14.5/100,000 person-years).
- Adjusted suicide rate for infantrymen and combat engineers was most elevated when never deployed (OR=2.9, 95% CI=2.1-4.1), less so when previously deployed (OR=1.6, 95% CI=1.1-2.1) and not at all when currently deployed (OR=1.2, 95% CI=0.8-1.8).
- Adjustment for a differential “healthy warrior effect” cannot explain this variation in the relative suicide rates of never deployed infantrymen and combat engineers by deployment status.

**15. Prospective Longitudinal Evaluation of the Effect of Deployment-Acquired Traumatic Brain Injury on Posttraumatic Stress and Related Disorders: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Stein, et al 2015)**

- Approximately one in five Soldiers reported exposure to TBI during the index deployment (mild TBI 18.0% and more-than-mild TBI 1.2%).
- Even after adjusting for other risk factors (e.g., pre-deployment mental health status, severity of deployment stress, prior TBI history), deployment-acquired TBI was associated with elevated adjusted odds of PTSD, generalized anxiety disorder, and major depressive episode.

**16. Predicting Non-Familial Major Physical Violent Crime Perpetration in the U.S. Army from Administrative Data (Rosellini, et al 2015)**

- A machine learning model was developed aimed at predicting which Soldiers would subsequently commit a severe, physical violent crime.
- Model was based on an analysis of administrative data for all 975,057 Regular Army Soldiers on active duty from 2004 to 2009. Hundreds of potential predictors were examined from the extensive administrative records available.
- 5,771 of these Soldiers committed a first founded major physical violent crime (murder-manslaughter, kidnapping, aggravated arson, aggravated assault, robbery) over that time period.

- The 5% of Soldiers classified by the model as having highest predicted risk accounted for 36.2% of all major physical violent crimes committed by men, and 33.1% by women, over the six years of study.
- When the model was applied to a more recent cohort in 2011-2013 (a validation sample), the 5% of Soldiers with highest predicted risk accounted for 50.5% of all major physical violent crimes.
- Key predictors were indicators of disadvantaged social/socio-economic status, early career stage, prior crime, and mental disorder treatment. Area under the receiver operating characteristic curve was .80-.82 in 2004-2009 and .77 in 2011-2013.
- Although these results suggest that the model could be used to target Soldiers at high risk of violent crime perpetration for preventive interventions, final implementation decisions would require further validation and weighing of predicted effectiveness against intervention costs and competing risks.

#### **17. Mental Health Treatment among Soldiers with Current Mental Disorders in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Colpe, et al 2015)**

- This analysis included a representative sample of 5,428 non-deployed Regular Army Soldiers who completed a self-administered questionnaire (SAQ) and consented to linking SAQ data with administrative records.
- The SAQ included information about prevalence and treatment of mental disorders among respondents with current Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) internalizing (anxiety, mood) and externalizing (disruptive behavior, substance) disorders.
- 21.3% of Soldiers with any current disorder reported current treatment.
- Seven significant predictors of being in treatment were identified.
  - Four were indicators of psychopathology (bipolar disorder, panic disorder, post-traumatic stress disorder, 8 or more months duration of disorder).
  - Two were sociodemographics (history of marriage, not being non-Hispanic Black).
  - The final predictor was history of deployment.

- Treatment rates varied between 4.7 and 71.5% depending on how many positive predictors the Soldier had. The vast majority of Soldiers had a low number of these predictors.
- These results document that most non-deployed Soldiers with mental disorders are not in treatment and that untreated Soldiers are not concentrated in a particular segment of the population that might be targeted for special outreach efforts. Analysis of modifiable barriers to treatment is needed to help strengthen outreach efforts.

**18. Prognostic Indicators of Persistent Post-Concussive Symptoms after Deployment-Related Mild Traumatic Brain Injury: A Prospective Longitudinal study in U.S. Army Soldiers (Stein, et al 2016)**

- Persistent and severe post-concussive symptoms (PCS) were found among Soldiers who experienced a mild TBI while deployed to Afghanistan.
- The study sample consisted of 4,518 Soldiers from three Brigade Combat Teams who deployed an average of 10 months to Afghanistan in 2012. Of these Soldiers, 822 experienced a mild TBI during the deployment.
- Based on surveys administered 1, 3, and 9 months following redeployment, the Soldiers with mild TBI were three times more likely to report PCS than other Soldiers in the BCTs.
- More severe symptoms were reported by Soldiers with a history of TBI(s) or mental health problems (depression, anxiety, irritability, etc.) prior to this deployment, or more severe deployment-related stress.
- Persistent and more severe symptoms were also more likely when there was loss of consciousness or memory problems associated with the TBI (versus being “dazed” only).
- Female Soldiers were more likely than male Soldiers to experience poor recovery following mild TBI.

**19. Genome-Wide Association Studies of Posttraumatic Stress Disorder in 2 Cohorts of U.S. Army Soldiers (Stein, et al 2016)**

- The analysis was designed to discover genetic loci associated with lifetime PTSD risk in the U.S. Army. Two coordinated genome-wide association studies (GWAS) of mental health were conducted for nearly 13,700 consenting Soldiers in two cohorts from Army STARRS.\*
- These were the largest genome-wide association studies (GWAS) of PTSD to date.\*

- GWAS were performed on 3,167 Soldiers with PTSD (cases) and 4,607 trauma-exposed control Soldiers from the New Soldier Study (NSS), and 947 Soldiers with PTSD (cases) and 4,969 trauma-exposed control Soldiers from the Pre/Post Deployment Study (PPDS). The primary analysis compared lifetime DSM-IV PTSD cases to trauma-exposed controls without lifetime PTSD.\*
- Two statistically significant genetic variants were found associated with PTSD among Soldiers who were part of the NSS. One variant, in samples from African American Soldiers with PTSD, was in a gene (ANKRD55) on chromosome 5. In prior research, this gene has been found to be associated with various autoimmune and inflammatory disorders, including multiple sclerosis, type 2 diabetes, celiac disease, and rheumatoid arthritis. The other variant was found on chromosome 19 in European American samples.\*
- There were no significant genetic correlations observed between PTSD and six mental disorders and nine immune-related disorders. However there was significant evidence of pleiotropy (i.e., genetic factors having effects on multiple traits) for PTSD and rheumatoid arthritis, and to a lesser extent, psoriasis.\*
- Further efforts are needed to replicate the genome-wide significant association researchers found with the gene ANKRD55, and to clarify the nature of the genetic overlap observed between PTSD and rheumatoid arthritis and psoriasis.\*

## **20. Risk Factors, Methods, and Timing of Suicide Attempts among U.S. Army Soldiers (Ursano, et al 2016)**

- This analysis used Army STARRS historical administrative data for more than 1.6 million Soldiers on active duty from 2004 to 2009. The study identified 9,650 incident suicide attempts among regular Army Soldiers (excluding National Guard and Reserve) during 2004-2009.\*
- The 40% of enlisted Soldiers who had never deployed accounted for 61% of enlisted suicide attempters. Regardless of deployment status, suicide attempts were more likely among Soldiers who were female, in their first 2 years of service, or had recently received a mental health diagnosis.\*
- Risk among never deployed Soldiers was highest the 2nd month of service. Risk among currently deployed Soldiers on their 1st deployment was highest at the 6th month of deployment. Previously deployed Soldiers were at highest risk at 5 months after return.\*

- Drug overdose was the most common method of suicide attempt and accounted for more than 50% of all attempts. Although not overall very frequent, the use of firearms was most likely to occur among currently deployed (21/100,000 person-years) or previously deployed Soldiers (14/100,000 person-years), compared to 5/100,000 person-years among Soldiers who had never deployed.\*
- As in other studies, a history of any mental health diagnosis was associated with suicide attempts in all deployment groups. The highest odds occurred in the month following the most recent diagnosis and then decreased over time.\*
- Soldiers with depression in the previous month had the highest odds of suicide attempt across the deployment groupings.\*
- PTSD and substance use disorder were associated with suicide attempts, but varied by deployment status with the greatest risk among the never deployed Soldiers.
- The odds of a suicide attempt increased with the number of mental health diagnoses a Soldier received. The effect of multiple diagnoses was most pronounced among currently deployed Soldiers.
- Suicide attempt has rarely been studied with data as comprehensive as the data used in this research. The findings highlight the complexity of risk and protective factors in different settings and contexts, and the importance of life and career history in understanding suicide attempts in the U.S. Army.
- A better understanding of suicide attempts may provide opportunities for the prevention of suicidal behavior in the Army as well as in other populations.

## **21. Predicting Suicides after Outpatient Mental Health Visits in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Kessler, et al 2016)**

- Given that clinician-based assessments are not known to be strong predictors of suicide, this study investigated whether a precision medicine model using administrative data after outpatient mental health specialty visits could be developed to predict suicides among outpatients.
- This analysis used Army STARRS historical administrative data for more than 1.6 million Soldiers on active duty from 2004 to 2009 and focused on male non-deployed Regular U.S. Army Soldiers because they account for the vast majority of such suicides.
- The study calculated the observed proportions of suicide deaths within 5 weeks of each ventile (5% grouping) of specialty mental health outpatient visits ranked by



predicted suicide risk based on the optimal prediction model out of the population of all such visits made by male non-deployed Regular U.S. Army Soldiers in 2004-2009.

- 41.5% of Army suicides in 2004-2009 occurred among the 12.0% of Soldiers seen as outpatient by mental health specialists, with risk especially high within 26 weeks of visits.
- An elastic net classifier with 10-14 predictors optimized sensitivity (45.6% of suicide deaths occurring after the 15% of visits with highest predicted risk).
- The 5% of visits with highest risk included only 0.1% of Soldiers (1047.1 suicides/100,000 person-years in the 5 weeks after the visit).
- This is a high enough concentration of risk to have implications for targeting preventive interventions. An even better model might be developed in the future by including the enriched information on clinician-evaluated suicide risk mandated by the VA/DoD CPG to be recorded.

## **22. Cross-Phenotype Polygenic Risk Score Analysis of Persistent Post-Concussive Symptoms in U.S. Army Soldiers with Deployment-Acquired Traumatic Brain Injury (Polimanti, et al 2016)**

- This study used a prospective longitudinal survey of three Brigade Combat Teams to assess deployment-acquired TBI and persistent physical, cognitive, and emotional post-concussive symptoms (PCS).
- A cross-phenotype high-resolution polygenic risk score (PRS) analysis of persistent post-concussive symptoms (PCS) was conducted in 845 U.S. Army Soldiers who sustained TBI during deployment.
- PRS was derived from summary statistics of large genome-wide association studies of Alzheimer's disease, Parkinson's disease, schizophrenia, bipolar disorder, and major depressive disorder; and for years of schooling, college completion, childhood intelligence, infant head circumference (IHC), and adult intracranial volume.
- Although the study had more than 95% of statistical power to detect moderate-to-large effect sizes, no association was observed with neurodegenerative and psychiatric disorders, suggesting that persistent PCS does not share genetic components with these traits to a moderate-to-large degree.
- Subjects with high IHC PRS recovered better from cognitive/emotional persistent PCS than the other individuals.

- Enrichment analysis identified two significant Gene Ontology (GO) terms related to this result: GO:0050839~Cell adhesion molecule binding and GO:0050905~Neuromuscular process.
- The study indicated that the genetic predisposition to persistent PCS after TBI does not have substantial overlap with neurodegenerative and psychiatric diseases, but mechanisms related to early brain growth may be involved.

### **23. An Examination of Potential Misclassification of Army Suicides: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Cox, et al 2016)**

- Systematic review of CID investigative files for 510 suicides, and 488 accident, homicide and undetermined deaths from 2005-2009.
- Using research criteria, 35 of 488 (8.2%) of non-suicides were reclassified to “definite, probable, or possible” suicide.
- Only 1 of 488 (0.2%) was reclassified to definite suicide.
- CID investigative practices reflect the “true” population of Army suicides. Flagrant misclassification was uncommon.

### **24. Barriers to Initiating and Continuing Mental Health Treatment Among Soldiers in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Naifeh, et al 2016)**

- Army Soldiers with mental disorders report a variety of barriers to initiating and continuing treatment.
- This study involved a representative sample of 5,428 non-deployed Regular Army Soldiers who completed a self-administered questionnaire and consented to linking their questionnaire data with administrative records.
- The study examined reported treatment barriers (perceived need, structural reasons, attitudinal reasons) among respondents with current Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, mental disorders who either did not seek treatment in the past year (n = 744) or discontinued treatment (n = 145).
- 82.4% of Soldiers who did not initiate treatment, and 69.5% of Soldiers who discontinued treatment, endorsed at least two barriers.
- 69.8% of never-treated Soldiers reported no perceived need.

- Attitudinal reasons were cited more frequently than structural reasons among never-treated Soldiers with perceived need (80.7% vs. 62.7%) and Soldiers who discontinued treatment (71.0% vs. 37.8%).
- Multivariate associations with socio-demographic, Army career, and mental health predictors varied across barrier categories.
- These findings suggest most Soldiers with mental disorders do not believe they need treatment and those who do typically face multiple attitudinal and, to a lesser extent, structural barriers.
- Improved understanding of these treatment barriers can help direct mental health services to Soldiers in need.

## **25. Developing a Risk Model to Target High-Risk Preventive Interventions for Sexual Assault Victimization Among Female U.S. Army Soldiers (Street, et al 2016)**

- Sexual violence victimization is a significant problem among female U.S. military personnel. Preventive interventions for high-risk individuals might reduce prevalence but would require accurate targeting.
- This study attempted to develop a targeting model for female Regular U.S. Army Soldiers based on theoretically guided predictors abstracted from administrative data records.
- Because administrative reports of sexual assault victimization are known to be incomplete, parallel machine learning models were developed to predict administratively recorded (in the population) and self-reported (in a representative survey) victimization. Capture–recapture methods were used to combine predictions across models.
- Key predictors included low status, crime involvement, and treated mental disorders.
- Area under the receiver operating characteristic curve was .83–.88.
- Between 33.7% and 63.2% of victimizations occurred among Soldiers in the highest risk ventile (5%).
- This high concentration of risk suggests that the models could be useful in targeting preventive interventions, although final determination would require careful weighing of intervention costs, effectiveness, and competing risks.

## **26. Using Administrative Data to Identify U.S. Army Soldiers at High-Risk of Perpetrating Minor Violent Crimes (Rosellini, et al 2016)**

- Interventions exist to reduce violent crimes in high-risk populations, but optimal implementation requires evidence-based targeting.
- The goal of this study was to use machine learning methods to develop models to predict minor violent crime perpetration among U.S. Army Soldiers.
- Predictors were abstracted from administrative data available for all 975,057 Soldiers in the U.S. Army from 2004 to 2009. There were 25,966 men and 2,728 women who committed a first founded minor violent crime (simple assault, blackmail-extortion-intimidation, rioting, or harassment).
- Temporally prior administrative records measuring socio-demographic, Army career, criminal justice, medical/pharmacy, and contextual variables were used to build separate male and female prediction models that were then tested in an independent sample of U.S. Army Soldiers from 2011 to 2013.
- Final model predictors included young age, low education, early career stage, prior crime involvement, and outpatient treatment for diverse emotional and substance use problems.
- 30.5–28.9% (men-women) of all administratively-recorded crimes in 2004–2009 were committed by the 5% of Soldiers having highest predicted risk, with similar proportions (28.5–29.0%) when the 2004–2009 coefficients were applied to the 2011–2013 test sample.
- These results suggest that it may be possible to target Soldiers at high-risk of violence perpetration for preventive interventions.
- Final decisions about such interventions would require weighing predicted effectiveness against intervention costs and competing risks.

## **27. Neurocognitive Function and Suicide in U.S. Army Soldiers (Naifeh, et al 2016)**

- This study used administrative data from 2004 to 2009 to examine associations between neurocognitive functioning and subsequent suicidal events among Regular Army enlisted Soldiers.
- Cases were all Soldiers who completed the Army’s Automated Neuropsychological Assessment Metrics (ANAM) computerized testing battery prior to documented suicide attempt (n = 607), ideation (n = 955), or death (n = 57). Controls were an equal-probability sample of 9,893 person-months from other Soldiers.
- Exploratory factor analysis of five ANAM tests identified a general neurocognitive factor that excluded the mathematic processing test (MTH). When examined

separately in logistic regression analyses that controlled for sociodemographics and prior mental health diagnosis, both the general neurocognitive factor and MTH were associated with all outcomes.

- When both predictors were examined simultaneously, the general neurocognitive factor continued to be associated with all outcomes and MTH continued to be associated with suicide attempt and ideation.
- These small but robust associations suggest that future research must continue to examine the extent to which objective neurocognitive tests may enhance understanding and prediction of suicide risk.

## **28. Alcohol Misuse and Co-Occurring Mental Disorders Among New Soldiers in the U.S. Army (Stein, et al 2016)**

- This study used cross-sectional survey data from Soldiers reporting for basic combat training to retrospectively assess lifetime alcohol consumption and substance abuse/dependence, enabling estimation of the prevalence of lifetime binge drinking and heavy drinking in a sample of 30,583 Soldiers and of probable alcohol use disorder (AUD) among 26,754 Soldiers with no or minimal lifetime use of other drugs.
- Co-occurrence of mental disorders and other adverse outcomes with binge drinking, heavy drinking, and AUD was examined. Discrete-time survival analysis, with person-year the unit of analysis and a logistic link function, was used to estimate associations of AUD with subsequent onset of mental disorders and vice versa.
- Prevalence of lifetime binge drinking was 27.2% among males and 18.9% among females; respective estimates for heavy drinking were 13.9% and 9.4%.
- Among Soldiers with no or minimal drug use, 9.5% of males and 7.2% of females had lifetime AUD.
- Relative to no alcohol misuse, binge drinking, heavy drinking, and AUD were associated with increased odds of all mental disorders and other adverse outcomes under consideration.
- Prior mental disorders and suicidal ideation were associated with onset of AUD, and prior AUD was associated with onset of mental disorders and suicidal ideation.
- Strong bidirectional associations between alcohol misuse and mental disorders were observed. Recognition of alcohol misuse and mental disorders upon enlistment may provide opportunities for risk mitigation early in a Soldier's career.

## **29. Medically Documented Suicide Ideation Among U.S. Army Soldiers (Ursano, et al 2016)**

- This study used administrative data to examine predictors of medically documented suicide ideation (SI) among Regular Army Soldiers from 2006 through 2009. The study included 10,466 ideators and 124,959 control person-months.
- Enlisted ideators (97.8% of all cases) were more likely than controls to be female, younger, older when entering service, less educated, never or previously deployed, and have a recent mental health diagnosis.
- Officer ideators were more likely than controls to be female, younger, younger when entering service, never married, and have a recent mental health diagnosis.
- Risk among enlisted Soldiers peaked in the second month of service then declined steadily, whereas risk among officers remained relatively stable over time.
- Risk of SI is highest among enlisted Soldiers early in Army service, females, and those with a recent mental health diagnosis.
- Most cases of medically documented SI in the U.S. Army occurred among enlisted Soldiers in their first tour of duty.
- Risk was particularly elevated among enlisted Soldiers during the initial months of training, and among Soldiers with a mental health diagnosis recorded during a recent health care encounter.
- Given apparent similarities between our findings on SI and recently published evidence on suicide attempts, it is important for future studies to examine how risk may differ across suicide-related outcomes of increasing severity.

## **30. Genetic Risk Variants for Social Anxiety (Stein, et al 2017)**

- This study used genome-wide association analysis (GWAS) to determine SNP-based heritability of social anxiety, discern genetic risk loci for social anxiety, and determine shared genetic risk with neuroticism and extraversion.
- GWAS were conducted within ancestral groups, European Americans (EUR), African Americans (AFR) and Latin Americans (LAT), using linear regression models for each of the three component studies in Army STARRS, and then meta-analyzed across studies.
- SNP-based heritability for social anxiety was significant in EUR. One meta-analytically genome-wide significant locus was seen in each of the EUR and AFR samples.

- Social anxiety was significantly genetically correlated (negatively) with extraversion but not with neuroticism or with an anxiety disorder factor score from external GWAS meta-analyses.
- This first GWAS of social anxiety confirms a genetic basis for social anxiety, shared with extraversion but possibly less so with neuroticism.

### **31. Frequency of Improvised Explosive Devices and Suicide Attempts in the U.S. Army (Ursano, et al 2017)**

- This study examined the association of monthly IED rates with risk of Soldier suicide attempt among those deployed and non-deployed among all active duty Regular Army suicide attempters 2004-2009 (n = 9,791) and an equal-probability sample of control Soldiers.
- Logistic regression analyses examined Soldiers' risk of attempting suicide as a function of monthly IED frequency, controlling for socio-demographics, service-related characteristics, rate of deployment/redeployment, combat deaths and injuries. The association of IED frequency with suicide attempt was examined overall and by time in service and deployment status.
- Soldiers' risk of suicide attempt increased with increasing numbers of IEDs. Suicide attempt was 26% more likely for each 1,000 IED increase in monthly frequency.
- The association of IED frequency with suicide attempt was greater for Soldiers in their first 2 years of service than for those with 3 or more years of service.
- Among Soldiers in their first 2 years of service, the association was constant, regardless of deployment status. Among soldiers with 3 or more years of service, the association was higher for those never deployed and currently deployed than for those previously deployed.
- To our knowledge, this is the first study to examine and demonstrate an association between the aggregate frequency of IEDs and risk of suicide attempts among U.S. Army Soldiers. The findings suggest that the threat of new weapons may increase stress burden among Soldiers. Targeting risk perception and perceived preparedness, particularly early in a Soldier's career, may improve psychological resilience and reduce suicide risk.

### **32. A Genome-Wide Gene-by-Trauma Interaction Study of Alcohol Misuse in Two Independent Cohorts Identifies PRKG1 as a Risk Locus (Polimanti, et al 2017)**

- Traumatic life experiences are associated with alcohol use problems, an association that is likely to be moderated by genetic predisposition.
- To better understand these interactions, a gene-by-environment genome-wide interaction study (GEWIS) of alcohol use problems was conducted in two independent cohorts: Army STARRS (N=16,361) and Yale-Penn (N=8,084).
- In African-American subjects, an interaction of PRKG1 with trauma exposure in the STARRS cohort was identified and replicated in the Yale-Penn cohort.
- PRKG1 encodes cyclic GMP-dependent protein kinase 1, which is involved in learning, memory and circadian rhythm regulation.
- Considering the loci identified in stage-1 that showed same effect directions in stage-2, the gene ontology (GO) enrichment analysis showed several significant results, including calcium-activated potassium channels, cognition, locomotion and Stat3 protein regulation.
- This was the largest GEWIS performed in psychiatric genetics, and the first GEWIS examining risk for alcohol misuse. The results add to a growing body of literature highlighting the dynamic impact of experience on individual genetic risk.

### **33. Sexual Assault Victimization and Mental Health Treatment, Suicide Attempts, and Career Outcomes among Women in the U.S. Army (Rosellini, et al 2017)**

- This study examined associations of administratively recorded sexual assault victimization during military service with subsequent mental health and negative career outcomes among U.S. Army women controlling for non-random victimization exposure.
- Used propensity score methods to match all 4,238 female Regular Army Soldiers with administratively recorded sexual assault victimization during 2004 to 2009 to five controls per case with similar composite victimization risk.
- Examined associations of this victimization measure with administratively recorded mental health treatment, suicide attempt, and Army career outcomes over the subsequent 12 months by using survival analysis for dichotomous outcomes and conditional generalized linear models for continuous outcomes.



- Women with administratively recorded sexual assault had significantly elevated odds ratios of subsequent mental health treatment, posttraumatic stress disorder treatment, suicide attempt, demotion, and attrition.
- Conclusion was sexual assault victimization is associated with considerable suffering and likely decreased force readiness.

#### **34. Health Care Contact and Suicide Risk Documentation Prior to Suicide Death: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Ribeiro, et al 2017)**

- Prior research has shown that a substantial portion of suicide decedents access health care in the weeks and months before their death. This study examined whether this is true among Soldiers.
- The sample included the 569 Regular Army Soldiers in the U.S. Army who died by suicide on active duty between 2004 and 2009 compared to 5,690 matched controls.
- Analyses examined the prevalence and frequency of health care contacts and documentation of suicide risk (i.e., the presence of prior suicidal thoughts and behaviors) over the year preceding suicide death. Predictors of health care contact and suicide risk documentation were also examined.
- Approximately 50% of suicide decedents accessed health care in the month prior to their death, and more than 25% of suicide decedents accessed health care in the week prior to their death.
- Mental health encounters were significantly more prevalent among suicide decedents. Despite this, risk documentation was rare among suicide decedents (4 weeks: 13.8%; 52 weeks: 24.5%).
- Suicide decedents who were male, never married, and non-Hispanic Black were less likely to access care prior to death. Number of mental health encounters was the only predictor of suicide risk documentation among decedents at 4 weeks and 52 weeks prior to their death.
- Conclusion was many Soldiers who die by suicide access health care shortly before death, presenting an opportunity for suicide prevention. However, in most cases, there was no documentation of prior suicidal thoughts or behaviors, highlighting the need for improvements in risk detection and prediction. Increasing the frequency, scope, and accuracy of risk assessments, especially in mental health care settings, may be particularly useful.

### **35. Associations of Childhood Bullying Victimization with Lifetime Suicidal Behaviors among New U.S. Army Soldiers (Campbell-Sills, et al 2017)**

- Prior studies have documented associations of childhood bullying victimization with suicidal behaviors. Many failed to adjust for concomitant risk factors and none investigated this relationship in military personnel. The aim of this study was to estimate independent associations of childhood bullying victimization with suicidal behaviors among U.S. Army soldiers.
- Soldiers reporting for basic training completed a cross-sectional survey assessing mental disorders, suicidal behaviors, and childhood adversities including two types of bullying victimization: (1) Physical Assault/Theft and (2) Bullying Comments/Behaviors.
- Associations of childhood bullying experiences with suicidal behaviors were estimated using discrete-time survival analysis of person–year data from 30,436 Soldiers. Models adjusted for sociodemographic factors, childhood maltreatment by adults, and mental disorders.
- After comprehensive adjustment for other risk factors, more frequent Physical Assault/Theft by peers during childhood was associated with increased odds of lifetime suicidal ideation and attempt.
- More frequent Bullying Comments/Behaviors were associated with increased risk of ideation, plan, attempt, and onset of plan among ideators.
- Relative to no bullying victimization, exposure to the most persistent bullying was associated with two- to fourfold increase in risk for suicidal behaviors.
- The conclusion was childhood bullying victimization is associated with lifetime suicidal behaviors in new Soldiers. Exposure to Bullying Comments/Behaviors during childhood is associated with progression from suicidal ideation to plan. Improved recognition of these relationships may inform risk mitigation interventions for Soldiers.

### **36. Using Self-Report Surveys at the Beginning of Service to Develop Multi-Outcome Risk Models for New Soldiers in the U.S. Army (Rosellini, et al 2017)**

- The Army uses universal preventive interventions for several negative outcomes (e.g., suicide, violence, sexual assault) with especially high risks in the early years of service. More intensive interventions exist, but would be cost-effective only if targeted at high-risk Soldiers. This study developed models for such targeting from self-report surveys administered at the beginning of Army service.

- The study included 21,832 new Soldiers who completed a self-administered questionnaire (SAQ) in 2011–2012 and consented to link administrative data to SAQ responses. Penalized regression models were developed for 12 administratively recorded outcomes occurring by December 2013: suicide attempt, mental hospitalization, positive drug test, traumatic brain injury (TBI), other severe injury, several types of violence perpetration and victimization, demotion, and attrition.
- The best-performing models were for TBI, major physical violence perpetration, sexual assault perpetration, and suicide attempt. Although predicted risk scores were significantly correlated across outcomes, prediction was not improved by including risk scores for other outcomes in models.
- 40.5% of suicide attempts occurred among the 10% of new Soldiers with highest predicted risk, 57.2% of male sexual assault perpetrations among the 15% with highest predicted risk, and 35.5% of female sexual assault victimizations among the 10% with highest predicted risk.
- The conclusion was data collected at the beginning of service in self-report surveys could be used to develop risk models that define small proportions of new Soldiers accounting for high proportions of negative outcomes over the first few years of service.

**37. Childhood Adversity, Adult Stress, and the Risk of Major Depression or Generalized Anxiety Disorder in U.S. Soldiers: a Test of the Stress Sensitization Hypothesis (Bandoli, et al 2017)**

- The stress sensitization theory hypothesizes that individuals exposed to childhood adversity will be more vulnerable to mental disorders from proximal stressors. This study aimed to test this theory with respect to risk of 30-day major depressive episode (MDE) and generalized anxiety disorder (GAD) among new U.S. Army Soldiers.
- The sample consisted of 30,436 new Soldier recruits in the Army Study to Assess Risk and Resilience (Army STARRS). Generalized linear models were constructed, and additive interactions between childhood maltreatment profiles and level of 12-month stressful experiences on the risk of 30-day MDE and GAD were analyzed.
- Stress sensitization was observed in models of past 30-day MDE and GAD. This sensitization only occurred at high (3+) levels of reported 12-month stressful experiences.
- In pairwise comparisons for the risk of 30-day MDE, the risk difference between 3+ stressful experiences and no stressful experiences was significantly greater for all maltreatment profiles relative to no maltreatment.

- Similar results were found with the risk for 30-day GAD with the exception of the risk difference for episodic emotional and sexual abuse, which did not differ statistically from no maltreatment.
- This study found that new Soldiers are at an increased risk of 30-day MDE or GAD following recent stressful experiences if they were exposed to childhood maltreatment.
- Particularly in the military with an abundance of unique stressors, attempts to identify this population and improve stress management may be useful in the effort to reduce the risk of mental disorders.

### **38. Psychological Autopsy Study Comparing Suicide Decedents, Suicide Ideators, and Propensity Score Matched Controls: Results from the Study to Assess Risk and Resilience in Service Members (Army STARRS) (Nock, et al 2017)**

- The suicide rate has increased significantly among U.S. Army Soldiers over the past decade. This study reports the first results from a large psychological autopsy study using two control groups designed to reveal risk factors for suicide death among Soldiers beyond known socio-demographic factors and the presence of suicide ideation.
- Informants were next-of-kin and Army supervisors for 135 suicide cases, 137 control Soldiers propensity-score-matched on known socio-demographic risk factors for suicide and Army history variables, and 118 control Soldiers who reported suicide ideation in the past year.
- Results revealed that most (79.3%) Soldiers who died by suicide have a prior mental disorder; mental disorders in the prior 30-days were especially strong risk factors for suicide death.
- Approximately half of suicide decedents tell someone that they are considering suicide.
- Virtually all of the risk factors identified in this study differed between suicide cases and propensity-score-matched controls, but did not significantly differ between suicide cases and suicide ideators.
- The most striking difference between suicides and ideators was the presence in the former of an internalizing disorder (especially depression) and multi-morbidity (i.e., 3+ disorders) in the past 30 days.

- This study found that most Soldiers who die by suicide have identifiable mental disorders shortly before their death and tell others about their suicidal thinking, suggesting that there are opportunities for prevention and intervention. However, few risk factors distinguish between suicide ideators and decedents, pointing to an important direction for future research.

### **39. Childhood Maltreatment and Lifetime Suicidal Behaviors among New Soldiers in the U.S. Army: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Stein, et al 2017)**

- Understanding suicide risk is a priority for the U.S. military. This study aimed to estimate associations of childhood maltreatment with pre-enlistment suicidal behaviors in new Army Soldiers using cross-sectional survey data from 38,237 Soldiers reporting for basic training from April 2011 through November 2012.
- Scales assessing retrospectively reported childhood abuse and neglect were derived and subjected to latent class analysis, which yielded 5 profiles: No Maltreatment, Episodic Emotional Maltreatment, Frequent Emotional/Physical Maltreatment, Episodic Emotional/Sexual Abuse, and Frequent Emotional/Physical/Sexual Maltreatment.
- Discrete-time survival analysis was used to estimate associations of maltreatment profiles with suicidal behaviors (assessed with a modified Columbia-Suicide Severity Rating Scale), adjusting for socio-demographics and mental disorders.
- Nearly 1 in 5 new Soldiers was classified as experiencing childhood maltreatment.
- Relative to No Maltreatment, all multivariate maltreatment profiles were associated with elevated odds of lifetime suicidal ideation, attempt, and onset of plan among those with ideation.
- Several profiles also predicted attempts among those with plans, and Frequent Emotional/Physical/Sexual Maltreatment predicted unplanned attempts among ideators.
- Adjustment for mental disorders attenuated but did not eliminate these associations.
- Childhood maltreatment is strongly associated with suicidal behavior among new Soldiers, even after adjusting for intervening mental disorders.
- Among soldiers with lifetime ideation, certain maltreatment profiles are associated with elevated odds of subsequently planning and/or attempting suicide.

- Focus on childhood maltreatment might reveal avenues for risk reduction among new Soldiers.

#### **40. Suicide Attempts in U.S. Army Combat Arms, Special Forces and Combat Medics (Ursano, et al 2017)**

- The U.S. Army suicide attempt rate increased sharply during the wars in Iraq and Afghanistan. Risk may vary according to occupation, which significantly influences the stressors that Soldiers experience.
- Using administrative data from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS), this study identified person-month records for all active duty Regular Army enlisted Soldiers who had a medically documented suicide attempt from 2004 through 2009 (n = 9,650) and an equal-probability sample of control person-months (n = 153,528).
- Logistic regression analyses examined the association of combat occupation (combat arms, special forces, combat medics) with suicide attempt, adjusting for socio-demographics, service-related characteristics, and prior mental health diagnosis.
- In adjusted models, the odds of attempting suicide were higher in combat arms and combat medics, but lower in special forces, compared to all other occupations.
- Combat arms and combat medics had higher odds of suicide attempt than other occupations if never deployed or previously deployed, but not when currently deployed.
- Occupation was associated with suicide attempt in the first ten years of service, but not beyond.
- In the first year of service, primarily a time of training, combat medics had higher odds of suicide attempt than both combat arms and other occupations.
- Discrete-time hazard functions revealed that these occupations had distinct patterns of monthly risk during the first year of service.
- This study found that military occupation can inform the understanding suicide attempt risk among Soldiers.

#### **41. Lifetime Suicidal Behaviors and Career Characteristics Among U.S. Army Soldiers (Millner, et al 2017)**

- This study presented data on lifetime prevalence of suicide ideation and non-fatal attempts as reported by the large representative sample of U.S. Army Soldiers who participated in the Consolidated All Army Study (n = 29,982). The study also examined associations of key Army career characteristics with these outcomes.
- Prevalence estimates for lifetime suicide ideation were 12.7% among men and 20.1% among women, and for lifetime suicide attempts were 2.5% and 5.1%, respectively.
- Retrospective age-of-onset reports suggested that 53.4% to 70% of these outcomes had pre-enlistment onsets.
- Results revealed that, for both men and women, being in the Regular Army, compared with being in the National Guard or Army Reserve, and being in an enlisted rank, compared with being an officer, is associated with increased risk of suicidal behaviors and that this elevated risk is present both before and after joining the Army.

#### **42. Risk of Suicide Attempt Among Soldiers in Army Units With a History of Suicide Attempts (Ursano, et al 2017)**

- This study examined whether a Soldier's risk of suicide attempt is influenced by previous suicide attempts in that Soldier's unit.
- Using administrative data from the Army Study to Assess Risk and Resilience in Servicemembers (STARSS), this study identified person-month records for all active-duty, regular U.S. Army, enlisted Soldiers who attempted suicide from January 1, 2004 through December 31, 2009 (n = 9,650), and an equal-probability sample of control person-months (n = 153,528).
- Logistic regression analyses examined the number of past-year suicide attempts in a Soldier's unit as a predictor of subsequent suicide attempt, controlling for socio-demographic features, service-related characteristics, prior mental health diagnosis, and other unit variables, including suicide-, combat-, and unintentional injury-related unit deaths.
- The study also examined whether the influence of previous unit suicide attempts varied by military occupational specialty (MOS) and unit size.

- Of the final analytic sample of 9,512 enlisted Soldiers who attempted suicide and 151,526 control person-months, most were male (86.4%), 29 years or younger (68.4%), younger than 21 years when entering the Army (62.2%), white (59.8%), high school educated (76.6%), and currently married (54.8%).
- In adjusted models, Soldiers were more likely to attempt suicide if 1 or more suicide attempts occurred in their unit during the past year (odds ratios [ORs], 1.4-2.3;  $P < .001$ ), with odds increasing as the number of unit attempts increased.\*
- The odds of suicide attempt among Soldiers in a unit with 5 or more past-year attempts was more than twice that of Soldiers in a unit with no previous attempts (OR, 2.3; 95%CI, 2.1-2.6).
- The association of previous unit suicide attempts with subsequent risk was significant whether Soldiers had a combat arms MOS or other MOS (ORs, 1.4-2.3;  $P < .001$ ) and regardless of unit size, with the highest risk among those in smaller units (1-40 Soldiers) (ORs, 2.1-5.9;  $P < .001$ ).\*
- The population-attributable risk proportion for 1 or more unit suicide attempts in the past year indicated that, if this risk could be reduced to no unit attempts, 18.2% of attempts would not occur.
- Units with a history of suicide attempts may be important targets for preventive interventions.

#### **43. Predicting Sexual Assault Perpetration in the U.S. Army Using Administrative Data (Rosellini, et al 2017)**

- This study developed actuarial models to identify male U.S. Army Soldiers at high risk of administratively recorded sexual assault perpetration.
- This study investigated administratively recorded sexual assault perpetration among the 821,807 male Army Soldiers serving 2004–2009.
- Penalized discrete-time (person-month) survival analysis was used to select the smallest possible number of stable predictors to maximize number of sexual assaults among the 5% of Soldiers with highest predicted risk of perpetration (top-ventile concentration of risk). Separate models were developed for assaults against non-family and intra-family adults and minors.
- There were 4,640 male Soldiers found to be perpetrators against non-family adults, 1,384 against non-family minors, 380 against intra-family adults, and 335 against intra-family minors.



- Top-ventile concentration of risk was 16.2%–20.2% predicting perpetration against non-family adults and minors, and 34.2%–65.1% against intra-family adults and minors. Final predictors consisted largely of measures of prior crime involvement and the presence and treatment of mental disorders.
- Administrative data can be used to develop actuarial models that identify a high proportion of sexual assault perpetrators. If a system is developed to consolidate administrative predictors routinely, then predictions could be generated periodically to identify those in need of preventive intervention. Whether this would be cost effective, though, would depend on intervention costs, effectiveness, and competing risks.

#### **44. Genome-wide Association Studies of Suicide Attempts in U.S. Soldiers (Stein, et al 2017)**

- This study utilized population-based non-clinical cohorts of U.S. military personnel (discovery: n = 473 cases and n = 9778 control subjects; replication: n = 135 cases and n = 6879 control subjects) and a clinical case-control sample of recent suicide attempters (n = 51 cases and n = 112 control subjects) to conduct GWAS of suicide attempts (SA).
- Genome-wide association was evaluated within each ancestral group (European-, African-, Latino-American) and study using logistic regression models.
- Meta-analysis of the European ancestry discovery samples revealed a genome-wide significant locus in association with SA near MRAP2 (melanocortin 2 receptor accessory protein 2) and CEP162 (centrosomal protein 162); 12 genome-wide significant SNPs in the region; peak SNP rs12524136-T, OR = 2.88, p = 5.24E-10.
- These findings were not replicated in the European ancestry subsamples of the replication or suicide attempters samples. However, the association of the peak SNP remained significant in a meta-analysis of all studies and ancestral subgroups (OR = 2.18, 95%CI 1.70, 2.80).
- Polygenic risk score (PRS) analyses showed some association of SA with bipolar disorder.
- The association with SNPs encompassing MRAP2, a gene expressed in brain and adrenal cortex and involved in neural control of energy homeostasis, points to this locus as a plausible susceptibility gene for suicidality that should be further studied. Larger sample sizes will be needed to confirm and extend these findings.

#### **45. Prior Mental Disorders and Lifetime Suicidal Behaviors among U.S. Army Soldiers in the Army Study to Assess Risk and Resilience in Servicemembers (Millner, et al 2017)**

- This study examined associations of prior mental disorders and Army career characteristics with subsequent first onset of suicidal behaviors in a large, representative sample of U.S. Army Soldiers from the consolidated All Army Study (n=29,982).
- Among men and women, all self-reported lifetime disorders measured (some assessed with screening scales) are associated with subsequent onset of suicide ideation.
- Among men, three disorders characterized by agitation and impulsiveness (intermittent explosive disorder, panic disorder, and substance disorders) predict the transition from suicide ideation to attempt.
- For both men and women, being in the Regular Army (vs. National Guard or Army Reserve) predicts suicide attempts in the total sample.
- For men, a history of deployment and junior rank are predictors of suicide attempts after adjusting for pre-enlistment disorders but not accounting for pre- and post-enlistment disorders, suggesting that post-enlistment disorders account for some of the increased suicide risk among these career characteristics.
- The results highlight associations between mental disorders and suicidal behaviors, but underscore limitations predicting which people with ideation attempt suicide.

#### **46. Documented Family Violence and Risk of Suicide Attempt among U.S. Army Soldiers (Ursano, et al 2017)**

- Person-month records of active duty, Regular Army, enlisted Soldiers with medically documented suicide attempts (SA) (n=9,650), and a sample of control person-months (n=153,528), were selected from administrative data in 2004 to 2009 to examine associations of family violence (FV) history with SA risk among Soldiers. Logistic regression analyses were used to examine associations of FV with SA, adjusting for socio-demographics, service-related characteristics, and prior mental health diagnosis.
- Odds of SA were higher in Soldiers with a FV history and increased as the number of FV events increased.
- Soldiers experiencing past-month FV were almost five times as likely to attempt suicide as those with no FV history.

- Odds of SA were elevated for both perpetrators and those who were exclusively victims. Male perpetrators had higher odds of SA than male victims, whereas female perpetrators and female victims did not differ in SA risk.
- A discrete-time hazard function indicated that SA risk was highest in the initial months following the first FV event.
- Findings indicate that FV is an important consideration in understanding risk of SA among Soldiers.

#### **47. Prospective Risk Factors for Post-Deployment Heavy Drinking and Alcohol or Substance Use Disorder among U.S. Army Soldiers (Campbell-Sills, et al 2017)**

- This study estimated prevalence of alcohol misuse among 4,645 U.S. Army Soldiers who participated in a longitudinal survey.
- Assessment occurred 1–2 months before Soldiers deployed to Afghanistan in 2012 (T0), upon their return to the U.S. (T1), 3 months later (T2), and 9 months later (T3).
- Weights-adjusted logistic regression was used to evaluate associations of hypothesized risk factors with post-deployment incidence and persistence of heavy drinking (HD) (consuming 5 + alcoholic drinks at least 1–2×/week) and alcohol or substance use disorder (AUD/SUD).
- Prevalence of past-month HD at T0, T2, and T3 was 23.3% (S.E. = 0.7%), 26.1% (S.E. = 0.8%), and 22.3% (S.E. = 0.7%); corresponding estimates for any binge drinking (BD) were 52.5% (S.E. = 1.0%), 52.5% (S.E. = 1.0%), and 41.3% (S.E. = 0.9%).
- Greater personal life stress during deployment (e.g., relationship, family, or financial problems) – but not combat stress – was associated with new onset of HD at T2 [per standard score increase: adjusted odds ratio (AOR) = 1.20, 95% CI 1.06–1.35,  $p = 0.003$ ]; incidence of AUD/SUD at T2 (AOR = 1.54, 95% CI 1.25–1.89,  $p < 0.0005$ ); and persistence of AUD/SUD at T2 and T3 (AOR = 1.30, 95% CI 1.08–1.56,  $p = 0.005$ ).
- Any BD pre-deployment was associated with post-deployment onset of HD (AOR = 3.21, 95% CI 2.57–4.02,  $p < 0.0005$ ) and AUD/SUD (AOR = 1.85, 95% CI 1.27–2.70,  $p = 0.001$ ).
- Alcohol misuse is common during the months preceding and following deployment. Timely intervention aimed at alleviating/managing personal stressors or curbing risky drinking might reduce risk of alcohol-related problems post-deployment.

#### **48. Predictive Validity and Correlates of Self-Assessed Resilience among U.S. Army Soldiers (Campbell-Sills, et al 2017)**

- This study evaluated the validity of self-assessed resilience among U.S. Army Soldiers, including whether pre-deployment perceived resilience predicted post-deployment emotional disorder.
- Resilience was assessed via self-administered questionnaire among 35,807 new Soldiers reporting for basic training and 8,558 experienced Soldiers preparing to deploy to Afghanistan. Concurrent validity of self-assessed resilience was evaluated among recruits by estimating its association with past-month emotional disorder.
- Predictive validity was examined among 3,526 experienced Soldiers with no lifetime emotional disorder pre-deployment. Predictive models estimated associations of pre-deployment resilience with incidence of emotional disorder through 9 months post-deployment and with marked improvement in coping at 3 months post-deployment.
- Soldiers characterized themselves as very resilient on average [ $M = 14.34$ ,  $SD = 4.20$  (recruits);  $M = 14.75$ ,  $SD = 4.31$  (experienced Soldiers); theoretical range = 0-20].
- Demographic characteristics exhibited only modest associations with resilience, while severity of childhood maltreatment was negatively associated with resilience in both samples.
- Among recruits, resilience was inversely associated with past-month emotional disorder [adjusted odds ratio (AOR) = 0.65, 95% CI = 0.62-0.68,  $P < .0005$  (per standard score increase)].
- Among deployed Soldiers, greater pre-deployment resilience was associated with decreased incidence of emotional disorder (AOR = 0.91; 95% CI = 0.84-0.98;  $P = .016$ ) and increased odds of improved coping (AOR = 1.36; 95% CI = 1.24-1.49;  $P < .0005$ ) post-deployment.
- Findings supported validity of self-assessed resilience among Soldiers, although its predictive effect on incidence of emotional disorder was modest. In conjunction with assessment of known risk factors, measurement of resilience could help predict adaptation to foreseen stressors like deployment.

#### **49. Medical-encounter Mental Health Diagnoses, Non-fatal Injury and Polypharmacy Indicators of Risk for Accident Death in the U.S. Army Enlisted Soldiers, 2004-2009 (Lewandowski-Romps, et al 2017)**

- Accidents are a leading cause of deaths in active duty personnel and understanding accident deaths during wartime could facilitate future operational planning and inform risk prevention efforts.
- This study used 2004-2009 military records for enlisted, active duty, Regular Army Soldiers to identify mental health, injury, and polypharmacy (multiple narcotic and/or psychotropic medications) predictors of accident deaths for current, previously, and never deployed groups during the Afghanistan and Iraq wars.
- Deployed Soldiers with anxiety diagnoses showed higher risk for accident deaths. More than half had anxiety diagnoses prior to being deployed, suggesting anticipatory anxiety or symptom recurrence may contribute to high risk.
- Traumatic brain injury (TBI) indicated higher risk for accident deaths among previously deployed Soldiers. Two-thirds of these Soldiers had first TBI medical-encounter while non-deployed, but mild, combat-related TBIs may have been undetected during deployments.
- Post-Traumatic Stress Disorder (PTSD) predicted higher risk of accident death for never deployed Soldiers, as did polypharmacy which may relate to reasons for deployment ineligibility.
- The higher risk of accident death predicted by PTSD among those never deployed suggests the importance of identification, treatment, and prevention of non-combat traumatic events.
- Accident death risk predictors overlapped with those identified for suicides which suggests effective intervention might reduce both types of deaths.

#### **50. Trauma Exposure Interacts with the Genetic Risk of Bipolar Disorder in Alcohol Misuse of U.S. Soldiers (Polimanti, et al 2017)**

- This study investigated whether trauma exposure modified the association of genetic risks for mental disorders with alcohol misuse and nicotine dependence (ND) symptoms by calculating high-resolution polygenic risk scores (PRSs) for 10,732 U.S. Army Soldiers (8,346 trauma-exposed and 2,386 trauma-unexposed) based on genome-wide association studies of bipolar disorder (BD), major depressive disorder, and schizophrenia.

- The study found a significant BD PRS-by-trauma interaction with respect to alcohol misuse; a positive correlation between BD PRS and alcohol misuse in trauma-exposed Soldiers; and a negative correlation in trauma-unexposed Soldiers.
- The variants included in the BD PRS-by-trauma interaction showed significant enrichments for gene ontologies related to high voltage-gated calcium channel activity and for Beta1/Beta2 adrenergic receptor signaling pathways.
- The results indicated that the genetic overlap between alcohol misuse and BD is significantly moderated by trauma exposure. This study provides molecular insight into the complex mechanisms that link substance abuse, psychiatric disorders, and trauma exposure.

### **51. Genome-Wide Analysis of Insomnia Disorder (Stein, et al 2018)**

- Insomnia is a worldwide problem with substantial deleterious health effects. Twin studies have shown a heritable basis for various sleep-related traits, including insomnia, but robust genetic risk variants have just recently begun to be identified.
- This study involved genome-wide association studies (GWAS) of Soldiers in Army STARRS. GWAS were carried out separately for each ancestral group (EUR, AFR, LAT) using logistic regression for each of the STARRS component studies (including 3,237 cases and 14,414 controls), and then meta-analysis was conducted across studies and ancestral groups.
- Heritability (SNP-based) for lifetime insomnia disorder was significant in EUR. A meta-analysis including three ancestral groups and three study cohorts revealed a genome-wide significant locus on Chr 7 and a genome-wide significant gene-based association in EUR for RFX3 on Chr 9. Polygenic risk for sleeplessness/insomnia severity in UK Biobank was significantly positively associated with likelihood of insomnia disorder in STARRS.
- Genetic contributions to insomnia disorder in STARRS were significantly positively correlated with major depressive disorder and type 2 diabetes, and negatively with morningness chronotype and subjective well-being in external datasets.
- Insomnia associated loci may contribute to the genetic risk underlying a range of health conditions including psychiatric disorders and metabolic disease.

## **52. Risk Factors for the Transition from Suicide Ideation to Suicide Attempt: Results from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) (Nock, et al 2018)**

- Prior research has shown that most known risk factors for suicide attempts in the general population actually predict suicide ideation rather than attempts among ideators. Yet clinical interest in predicting suicide attempts often involves the evaluation of risk among patients with ideation.
- This study examined a number of characteristics of suicidal thoughts hypothesized to predict incident attempts in a retrospective analysis of lifetime ideators (N = 3,916) drawn from a large (N = 29,982), representative sample of U.S. Army Soldiers.
- The most powerful predictors of first nonfatal lifetime suicide attempt in a multivariate model controlling for previously known predictors (e.g., demographics, mental disorders) were: recent onset of ideation, presence and recent onset of a suicide plan, low controllability of suicidal thoughts, extreme risk-taking or “tempting fate,” and failure to answer questions about the characteristics of one’s suicidal thoughts.
- A predictive model using these risk factors had strong accuracy (area under the curve [AUC] = .93), with 66.2% of all incident suicide attempts occurring among the 5% of Soldiers with highest composite predicted risk.
- This high concentration of risk in this retrospective study suggests that a useful clinical decision support model could be constructed from prospective data to identify those with highest risk of subsequent suicide attempt.

## **53. Improving risk prediction accuracy for new soldiers in the U.S. Army by adding self-report survey data to administrative data (Bernecker, et al 2018)**

- The Army STARRS New Soldier Survey was administered to 21,790 Regular Army Soldiers who agreed to have their survey data linked to their administrative data. Machine-learning models using administrative data as predictors found that small proportions of high-risk Soldiers accounted for high proportions of negative outcomes including mental disorders, suicidality, and interpersonal violence.
- This study examined the extent to which this survey information increased prediction accuracy, over models based solely on administrative data, for these outcomes.

- The study used discrete time survival analysis to estimate a series of models predicting first occurrence, assessing how model fit improved and concentration of risk increased when adding the predicted risk score based on survey data to the predicted risk score based on administrative data.
- The addition of survey data improved prediction significantly for all outcomes. In the most extreme case, the percentage of reported sexual violence victimization among the 5% of female soldiers with highest predicted risk increased from 17.5% using only administrative predictors to 29.4% adding survey predictors, a 67.9% proportional increase in prediction accuracy. Other proportional increases in concentration of risk ranged from 4.8% to 49.5% (median = 26.0%).
- The researchers concluded that the Army may benefit from routinely administering surveys that assess additional risk factors, such as the New Soldier Survey, because the data from the surveys could substantially improve accuracy of risk models compared to models based exclusively on administrative predictors.

#### **54. Associations of Time-Related Deployment Variables with Risk of Suicide Attempt Among Soldiers (Ursano, et al 2018)**

- This study was designed to determine whether risk of suicide attempt (SA) among Soldiers is associated with time-related deployment characteristics such as time in service prior to first deployment, length of deployment, and length of time between deployments (dwell time).\*
- It was a longitudinal, retrospective cohort study that used administrative data from 2004 through 2009 to identify person-month records of active-duty Regular Army enlisted Soldiers who had served continuously in the Army for at least 2 years. Study included 593 medically-documented suicide attempters and 19,034 control person-months for Soldiers who deployed exactly twice.\*
- Findings indicate the risk of SA during or after second deployment was higher for those who initially deployed within the first 12 months of service, and for those with a dwell time of 6 months or less.\*
- Length of first deployment was not associated with subsequent SA.
- Time in service prior to first deployment and dwell time are modifiable risk factors for SA risk among Soldiers.\*
- The Army's continued focus on dwell time may help mitigate a range of negative outcomes and reduce risk of suicidal behavior.



## **55. Nonfatal Suicidal Behaviors in the Administrative Records of Activated U.S. Army National Guard and Army Reserve Soldiers, 2004–2009 (Ursano, et al 2018)**

- The Army suicide rate increased sharply during the wars in Iraq and Afghanistan. There is limited information about medically-documented, nonfatal suicidal behaviors among Soldiers in the Army's Reserve Component (RC), which is composed of the Army National Guard and Army Reserve.
- This study used administrative records for all Soldiers on active duty for the years 2004 through 2009 (n = 1.66 million) to examine trends and socio-demographic correlates of suicide attempts, suspicious injuries, and suicide ideation among activated RC Soldiers. The study identified 2,937 unique RC Soldiers with a documented nonfatal suicidal event.
- The study found increases in the annual incidence rates of suicide attempts (71 to 204/100,000 person-years) and suicide ideation (326 to 425/100,000 person years). Incidence rates for suspicious injuries also generally increased but were more variable.
- Using hierarchical classification rules, the study identified the first instance of each Soldier's most severe behavior (suicide attempt versus suspicious injury versus suicide ideation). For each of those suicide- or injury-related outcomes, the study found increased risk among those who were female, younger, non-Hispanic White, less educated, never married, and lower-ranking enlisted.
- The socio-demographic associations differed significantly across outcomes, although the patterns were similar.
- The results provide a broad overview of nonfatal suicidal trends in the RC during the period 2004 through 2009, and demonstrate that integration of multiple administrative data systems enriches analysis of the predictors of such events.

## **56. Pre-deployment Predictors of Psychiatric Disorder-Symptoms and Interpersonal Violence during Combat Deployment (Rosellini, et al 2018)**

- Preventing suicides, mental disorders, and noncombat-related interpersonal violence during deployment are priorities of the U.S. Army.
- This study used pre-deployment survey and Army administrative data to develop actuarial models to identify Soldiers at high risk of these outcomes during combat deployment. The models were developed for Soldiers in the Pre-Post Deployment Study, a panel study of Soldiers deployed to Afghanistan in 2012–2013 who completed self-administered questionnaires before deployment and one month (T1), three

months (T2), and nine months (T3) after deployment, and consented to linking their survey data to their Army administrative data.

- Seven “during-deployment” outcomes were assessed using post-deployment surveys either at T1 (n = 7,048) or at T2–T3 (n = 7,081). Machine learning was used to develop a model for each outcome from 273 pre-deployment predictors which were compared to simple logistic regression models.
- The relative improvement in area under the receiver operating characteristic curve (AUC) obtained by machine learning compared to the logistic models ranged from 1.11 (major depression) to 1.83 (suicidality). The best-performing machine learning models were for major depression (AUC=0.88), suicidality (0.86), and generalized anxiety disorder (0.85).
- Roughly 40% of these outcomes occurred among the 5% of Soldiers with highest predicted risk.
- Actuarial models could be used to identify high risk Soldiers either for exclusion from deployment or preventive interventions. The ultimate value of this approach depends on the associated costs, competing risks (e.g., stigma), and effectiveness of to-be-determined interventions.

#### **57. Risk Factors Associated with Attempted Suicide among U.S. Army Soldiers without a History of Mental Health Diagnosis**

- This study was designed to examine predictors of suicide attempt among Soldiers without a previous mental health diagnosis.
- Using Army and DoD administrative data from 2004-2009, the study identified person-month records for all active duty Regular Army enlisted Soldiers who had a medically documented suicide attempt (n=9,650), and an equal-probability sample of control person-months (n=153,528), then examined whether predictors of suicide attempt varied by history of mental health diagnosis.
- Suicide attempts were identified using DoD Suicide Event Report records and ICD-9 E95x diagnostic codes. Mental health diagnoses and related codes (as well as socio-demographic, service-related, physical healthcare, crime, and family violence variables) were constructed from Army personnel, medical, legal, and family services records.
- The study found 36.3% (n=3,507) of Soldiers who attempted suicide did not have a previous mental health diagnosis.\*

- Among Soldiers with no previous diagnosis, the highest adjusted odds of suicide attempt were for females, less than high school education, in first year of service, previously deployed, promotion delayed 2 months or less, past-year demotion, 8 or more outpatient physical health care visits in the past 2 months, past-month injury-related outpatient and inpatient health care visit, previous combat injury, minor violent crime victimization, major violent crime perpetration, and family violence.\*
- Most of these variables were also associated with suicide attempts among Soldiers with a previous mental health diagnosis, although the strength of associations differed.\*
- The study concluded that suicide attempt risk among Soldiers with unrecognized mental health problems is a significant and important challenge, and administrative records from personnel, medical, legal, and family services systems can assist in identifying Soldiers at risk.\*

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## **PUBLICATIONS FROM COLLABORATION WITH THE PSYCHIATRIC GENOMICS CONSORTIUM:**

The following publications represent an example of the broader impact of STARRS resulting from our collaboration and data sharing. STARRS investigators shared STARRS GWAS and other data with the NIMH Psychiatric Genomics Consortium (PGC) to yield the largest sample ever examined of the GWAS of PTSD. STARRS was the largest contributor of GWAS data to this effort. These publications are based on analyses of pooled data from a consortium of investigators conducting genetic studies on PTSD and other psychiatric disorders.

1. Dunn, E. C., Sofer, T., Gallo, L. C., Gogarten, S. M., Kerr, K. F., Chen, C. Y., Stein, M. B., Ursano, R. J., Guo, X., Jia, Y., Qi, Q., Rotter, J. I., Argos, M., Cai, J., Penedo, F. J., Ferreira, K., Wassertheil-Smoller, S., & Smoller, J. W. Genome-wide association study of generalized anxiety symptoms in the Hispanic Community Health Study/Study of Latinos. (2017). *Am J Med Genet B Neuropsychiatr Genet.* Mar; 174(2): 132-143.
  - This study aimed to discover potential loci by conducting a genome-wide analysis of GAD symptoms in a large, population-based sample of Hispanic/Latino adults using data from 12,282 participants, aged 18-74, of the Hispanic Community Health Study/Study of Latinos.
  - Using a shortened Spielberger Trait Anxiety measure, the study analyzed: (1) a GAD symptoms score restricted to the three items tapping diagnostic features of GAD as defined by DSM-V; and (2i) a total trait anxiety score based on summing responses to all ten items. Study first calculated the heritability due to common variants (h<sup>2</sup>SNP ) and then conducted a genome-wide association study (GWAS) of GAD symptoms. Replication was attempted in three independent Hispanic cohorts (Multi-Ethnic Study of Atherosclerosis, Women's Health Initiative, Army STARRS).
  - The GAD symptoms score showed evidence of modest heritability while the total trait anxiety score did not. One genotyped SNP (rs78602344) intronic to thrombospondin 2 (THBS2) was nominally associated in the primary analysis adjusting for psychiatric medication use and significantly associated with the GAD symptoms score in the analysis excluding medication users. Meta-analysis of the replication samples did not support this association.
  - The study identified a genome-wide significant locus in this sample, but was unable to replicate this finding. Evidence for heritability was also only detected for GAD symptoms, and not the trait anxiety measure, suggesting differential genetic influences within the domain of trait anxiety.

2. Wolf, E. J., Maniates, H., Nugent, N., Maihofer, A. X., Armstrong, D., Ratanatharathorn, A., Ashley-Koch, A. E., Garrett, M., Kimbrel, N. A., Lori, A., VA Mid-Atlantic Mirecc Workgroup, Aiello, A. E., Baker, D. G., Beckham, J. C., Boks, M. P., Galea, S., Geuze, E., Hauser, M. A., Kessler, R. C., Koenen, K. C., Miller, M. W., Ressler, K. J., Risbrough, V., Rutten, B. P. F., Stein, M. B., Ursano, R. J., Vermetten, E., Vinkers, C. H., Uddin, M., Smith, A. K., Nievergelt, C. M., & Logue, M. W. (2017). Traumatic stress and accelerated DNA methylation age: A meta-analysis. *Psychoneuroendocrinology*. doi: 10.1016/j.psyneuen.2017.12.007.
  - This study involved a meta-analysis of trauma exposure, PTSD diagnosis, and symptom severity in association with accelerated DNA methylation age using data from 9 cohorts contributing to the PGC-PTSD Epigenetics Workgroup (combined N = 2186). The study also examined associations between demographic and cellular variables and accelerated DNA methylation age.
  - The results revealed that childhood trauma exposure, measured with the Childhood Trauma Questionnaire, and lifetime PTSD severity show significant meta-analytic associations with accelerated DNA methylation age. The study also found that sex, CD4T cell proportions, and natural killer cell proportions were significantly associated with accelerated DNA methylation age.
  - Findings suggest that traumatic stress is associated with advanced epigenetic age and raises the possibility that cells integral to immune system maintenance and responsivity play a role in this. The study highlights the need for additional research into the biological mechanisms linking traumatic stress to accelerated DNA methylation age and the importance of furthering our understanding of the neurobiological and health consequences of PTSD.
3. Dunn, E. C., Sofer, T., Wang, M., Soare, T. S., Gallo, L. C., Gogarten, S. M., Kerr, K. F., Chen, C., Stein, M. B., Ursano, R. J., Guo, X., Jia, Y., Yao, J., Rotter, J. I., Argos, M., Cai, J., Ferreira, K., Wassertheil-Smoller, S., & Smoller, J. W. Genome-wide association study (GWAS) of depressive symptoms in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). (2018). *Journal of Psychiatric Research*, 99, 167-176.
  - This study involved a genome-wide analysis of depression in a large, population-based sample of Hispanics/Latinos. This is the largest GWAS of depression related phenotypes in Hispanic/Latino adults ever conducted.
  - Three phenotypes were examined: a total depression score, a total score modified to account for psychiatric medication use, and a score excluding antidepressant medication users. The study included a GWAS of the three phenotypes and attempted replication in three independent Hispanic/Latino cohorts.

- Sex-stratified analyses were performed, a binary trait indicating probable depression was analyzed, and three trans-ethnic analyses were conducted. The three phenotypes exhibited significant heritability in the total sample. No SNPs were genome-wide significant in analyses of the three phenotypes or the binary indicator of probable depression. Sex-stratified analyses identified seven genome-wide significant SNPs (one in females; six in males), although none were supported through replication. Four out of 24 loci identified in prior GWAS were nominally associated. No evidence of overlap in genetic risk factors across ancestry groups was found, although this may have been due to low power.
4. Ratanatharathorn, A., Boks, M. P., Maihofer, A. X., Aiello, A. E., Amstadter, A. B., Ashley-Koch, A. E., Baker, D.G., Beckham, J. C., Bromet, E., Dennis, M., Garrett, M. E., Geuze, E., Guffanti, G., Hauser, M. A., Kilaru, V., Kimbrel, N. A., Koenen, K. C., Kuan, P. F., Logue, M. W., Luft, B. J., Miller, M.W., Mitchell, C., Nugent, N.R., Ressler, K. J., Rutten, B.P.F., Stein, M.B., Vermetten, E., Vinkers, C.H., Youssef, N. A., VA Mid-Atlantic MIRECC Workgroup, PGC PTSD Epigenetics Workgroup, Uddin, M., Nievergelt, C. M., Smith, A.K. Epigenome-wide association of PTSD from heterogeneous cohorts with a common multi-site analysis pipeline. (2017). *Am J Med Genet B Neuropsychiatr Genet. Sep*; 174(6):619-630. doi: 10.1002/ajmg.b.32568. Epub 2017 Jul 10.
- Evidence suggests that epigenetic mechanisms such as DNA methylation play a role in stress regulation and in the etiologic basis of stress related disorders such as PTSD. This study describes the purpose and methods of an international consortium developed to study the role of epigenetics in PTSD.
  - Based on the PGC, this study brought together investigators representing seven cohorts with a collective sample size of N = 1147 that included detailed information on trauma exposure, PTSD symptoms, and genome-wide DNA methylation data. The objective of the consortium is to increase the analytical sample size by pooling data and combining expertise so that DNA methylation patterns associated with PTSD can be identified. Several quality control and analytical pipelines were evaluated for their control of genomic inflation and technical artifacts with a joint analysis procedure established to derive comparable data over the cohorts for meta-analysis.
  - The study proposed methods to deal with ancestry population stratification and type I error inflation, and discussed advantages and disadvantages of applying robust error estimates.
  - To evaluate the pipeline, study reported results from an epigenome-wide association study (EWAS) of age, which is a well-characterized phenotype with known epigenetic associations. While EWAS is highly complex and subject to similar challenges as genome-wide association studies (GWAS), the study demonstrated that an epigenetic meta-analysis with a relatively modest sample size can be well-powered

to identify epigenetic associations. The pipeline can be used as a framework for consortium efforts for EWAS.

### **STARRS-RELATED PUBLICATIONS:**

The following are STARRS-related publications that summarize or review previously published STARRS findings.

1. Gonzalez, O. I., Naifeh, J. A., Mash, H. H. (2018, June). Interpersonal Violence and Suicide Risk Among U.S. Army Soldiers. *ISTSS Stress Points*, 32(3). Retrieved from <http://sherwood-istss.informz.net/admin31/content/template.asp?sid=60943&brandid=4463&uid=1044618441&mi=7664760&mfqid=40875668&ptid=&ps=60943>
2. Naifeh, J. A., Mash, H. B. H., Stein, M. B., Fullerton, C. S., Kessler, R. C., & Ursano, R. J. (2018). The Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS): Progress toward understanding suicide among soldiers. *Mol Psychiatry*. doi:10.1038/s41380-018-0197-z