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Suicide without warning: Results from the Army Study to Assess Risk and Resilience in Servicemembers (STARRS)☆

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ABSTRACT

Objectives: The rate of suicide increased in members of the United States Army since 2011 after the Iraq and Afghanistan wars and continues to be a major concern. In order to reverse this disturbing trend, it is vital to understand the risk and protective factors for suicide death in servicemembers.

Methods: Data were obtained from a case-control psychological autopsy study, which compared U.S. Army suicide decedent cases (n = 135) to a probability sample of living controls (n = 255) who are also service members weighted to be representative of the Army. Interviews were conducted with next-of-kin (NOK) and supervisor (SUP) informants. Multivariable logistic regressions models were constructed using predictors significant after controlling for multiple comparisons.

Results: The most parsimonious multivariable model controlling for deployment status, as reported by SUP predicting suicide death consisted of four significant variables: a spouse or partner left him or her in the past month (OR = 28.5 [95% CI = 1.8, 442.7] $\chi^2 = 5.72$, $p = .0168$); a smaller social network (OR = 4.2 [95% CI = 1.0, 17.3] $\chi^2 = 3.97$, $p = .0462$), less likely to seek help from a mental health counselor (OR = 3.4 [95% CI = 1.2, 9.7] $\chi^2 = 5.35$, $p = .0207$) and more likely to be described as incautious (OR = 3.8 [95% CI = 1.2, 11.7] $\chi^2 = 5.42$, $p = .0199$). The AUC = .88 [95%CI = 0.82, 0.94] for this regression model suggests strong prediction.

Conclusions: Our findings suggest that recent relationship problems, especially in soldiers who are less likely to seek out support from others, may be warning signs for detection and prevention of imminent risk of suicide and according to supervisor informant surveys, had neither evidence of a mental health disorder, nor disclosed suicidal ideation or self-harm. Implications for suicide prevention are discussed.

1. Introduction

Rates of suicide gradually increased in active-duty service members of the United States Army in the previous decade and remain higher than civilians of the same demographics [1,2]. Although, rates in the last two years are slightly lower than in 2020 [3]. In order to reverse this disturbing trend, it is vital to understand the risk and protective factors for suicide and suicidal behavior in service members.

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The Army Study to Assess Risk and Resilience in Servicemembers (STARRS) project was developed to address this important goal and includes use of administrative data and a prospective study of soldiers to identify predictors of suicidal behavior [1]. Because suicide is still a rare outcome, the Army STARRS project also took a complementary approach to understand suicide in soldiers, namely through the use of a psychological autopsy procedure, a reliable and valid method to identify the risk and protective factors for suicide in soldiers who died by suicide and matched controls [4]. The psychological autopsy component of the Army STARRS, the Soldiers Health Outcomes Study (SHOS-B) is the largest psychological autopsy study every conducted in a military population to date. The psychological autopsy methodology provides the unique opportunity to interview those who knew the suicide decedent well, right before their death, and compare these reports to those of living controls who are also active-duty soldiers. Using a structured interview approach, SHOS_B informants (next of kin [NOK] and supervisor [SUP]) reported on the psychological aspects of the suicide decedents life. The suicide cases (i.e., suicide decedents) were provided by the Armed Forces Medical Examiner and then entered into the Department of Defense Suicide Event Report (DODSER) system. Our study team addressed the potential for misclassification of suicides and found from a review of 998 Army deaths that misclassification is uncommon and surveillance reports likely reflect the "true" population of Army suicides [5].

In previous analyses from the SHOS-B study, NOK and SUP informants identified similar risk factors: the presence of a diagnosis of a mental health disorder in the suicide decedents' lifetime, at least a diagnosis of 3 mental health disorders, and disclosure of lifetime suicidal ideation or plans [6]. While over half (63.6%) of those who died by suicide had at least one of these characteristics according to SUP, there were a substantial proportion of individuals who neither had lifetime mental health disorder (i.e., whose observed behavior or reported concerns were not consistent with any mental disorder diagnosis), nor reported lifetime suicidal ideation or plans from the self-harm section of the SUP survey. Therefore, in this paper, we restrict the sample to those with SUP reports (n = 107) and seek to understand if there are other factors that might help to identify the 37.4% (n = 40/107) individuals who died by suicide, and according to supervisor informant surveys, had neither evidence of a mental health disorder, nor disclosed suicidal ideation or self-harm.

More recent research from the SHOS-B parent study identified significant risk factors of suicide death: 1) recent stressful events (e.g., relationships problems, military punishment, perceived humiliation/failure); 2) firearms behavioral practices (e.g., owning a gun, carrying it in public, and storing it loaded); barriers to treatment seeking [7–9], and less perceived social support [8]. The purpose of the current study is to identify risk and protective factors of suicide death among the subsample of soldiers (n = 40/107) who died by suicide without warning signs, previously established in the literature (e.g., history of a mental disorder, history of 3 or more disorders, or reported suicidal ideation). Further, we will explore other risk and protective factors identified in recent research (e.g., recent stressful events, social networks and help seeking) as secondary hypotheses in this study.

2. Methods

2.1. Sample

The methods for this psychological autopsy study, the SHOS-B have been described in detail elsewhere [6,8] and in the Supplemental Materials S1. Recruitment and data collection procedures were approved by the Humans Subjects Committees of The University of Michigan, Ann Arbor, MI; the Uniformed Services University, Bethesda, MD; and all other collaborating organizations. The sample consisted of n = 135 unique cases who were soldiers in the U.S. Army who died by suicide while on active-duty between August 01, 2011 and November 01, 2013. Soldiers who died by suicide while deployed in Operation Enduring Freedom and Operation Iraqi Freedom, as well as those serving in the Army Reserve and National Guard were excluded given these soldiers were also excluded from the pool of available control soldiers based on the design of Army STARRS [10]. The suicide cases (i.e., suicide decedents) were provided by the Armed Forces Medical Examiner and then entered into the Department of Defense Suicide Event Report (DODSER) system. Our study team addressed the potential for misclassification of suicides and found from a review of 998 Army deaths that misclassification is uncommon and surveillance reports likely reflect the "true" population of Army suicides [5]. The research team interviewed a next-of-kin (NOK) and/or first-line Army supervisor (SUP) for $n = 135$ suicides. The response rates for the NOK and SUP cases were 61.6% and 69.5% respectively.

2.2. Recruitment procedures

2.2.1. Cases

Cases were soldiers in the U.S. Army who died by suicide while on active-duty between August 01, 2011 and November 01, 2013. A total of 290 cases (suicide decedents) were identified and for approximately half of available cases (135/290, 46.6%), a NOK and/or first-line Army SUP provided information for this study. The 135 cases did not differ from the 155 excluded suicides on age, sex, race/ethnicity, marital status, number of dependents, rank, education, or age of entry into the Army. During the study period from January 2012 to March 2014, 213 family members (NOK) of suicide decedents within the past 2–3 months were contacted by the Army Casualty and Mortuary Affairs Operation Center. Of the 290 families contacted during this process, 101 NOK were identified. Of those 2 two were ineligible due to a language barrier and being deceased. Of eligible (n = 99 NOK), n = 61 (61%) completed an interview, 13 (12.1%) refused to participate and 25 (25.3%) could not be reached. Army supervisors (n = 213) were identified by the Office of the Deputy Under Secretary of the Army (ODUSA). Of those, 59 said that they did not know the decedent and so were deemed ineligible. Of the 154 eligible supervisors, n = 107 (69.5% agreed to participate; seven (4.5%) refused to participate, and 40 (26.0%) could not be reached.

2.2.2. Controls

Living control soldiers were selected from participants in the Army STARRS All Army Study (AAS) [1] a large ($N = 5428$), representative sample of soldiers. Controls did not differ from eligible AAS respondents who did not participate on: sex, race/ethnicity, marital status, or age of entry into the Army. However, controls were slightly older, had more dependents, were higher rank, and had higher educational attainment; although these effects were small in magnitude ($rs = .09$–$.18$).

738 U.S. Regular Army Soldiers were identified via our matching procedures and were invited to participate in this study via email or telephone. 293 of those soldiers (39.7%) completed a screener and identified a next-of-kin and supervisor, 110 (14.9%) refused to participate, and 335 (45.4%) did not respond and could not be reached/contacted. Of those 236 (80.5%) control NOK completed interviews, 17 (5.8%) refused to participate, and 40 (13.7%) could not be reached/contacted or not complete an interview. Of the 293 supervisors identified, 30 said they did not know the identified control and were deemed ineligible. Of the eligible 263 supervisors, 153 (58.2%) completed interviews; 25 (9.5%) refused to participate and 92 (35.0%) could not be reached/located or did not complete an interview.

2.3. Identified subsample

The defined inclusion criteria for the subsample included:

1. No survey based reported mental health diagnosis (according to the SUP survey)

2. Supervisor responder answered "No" to all of the following items from the Self-Harm section of the SHOS-B Supervisor survey:
3. To the best of your knowledge, did the Soldier ever tell someone that he/she: 1) *wished he/she were dead or would go to sleep and never wake up; 2) had thoughts of killing himself/herself, might kill himself/herself (for example, taking pills, shooting himself/herself) or tell someone about working out a plan of how to kill himself/herself; 3) was thinking of making a suicide attempt?*
4. A dichotomous version was created for this variable (Yes/No).

A total of (37.4%) n = 40 SUP cases met the above criteria out of the n = 107 SUP total cases, and (66%) n = 101 SUP controls met criteria out of 153 SUP controls from the total sample, respectively. We contrasted this subgroup of suicide decedents to a stratified probability sample of living controls weighted to be representative of the Army on a wide range of characteristics known to be associated with suicidal behaviors. A detailed description of the stratification of the controls is provided in the Supplemental materials. These controls also met the criteria of the cases, in that they had no evidence of a survey mental health disorder within the past 30 days, and according to supervisor reports, had not ever disclosed suicidal ideation or intent per the self-harm section of the SHOS-B Supervisor survey.

2.4. Subsample informants

The SUP was the person who had been the soldier's direct and immediate Army supervisor for a minimum of 60 days. SUP informants consisted of enlisted soldiers with a rank of E5 to E9 (n = 72; 68%) and officers with a rank of O1 to O6 (n = 30; 28%). Relatively few of those cases with SUP interviews also had NOK (n = 15) and (n = 54) controls, but we examined the convergence and divergence between SUP and NOK in this small group.

3. Measures

The domains that were surveyed by interview were chosen to harmonize with those of the larger AAS study and to reflect best practices in psychological autopsy studies [11,12]. Psychopathology (lifetime and in the past 30 days) was assessed using an adaptation of the Composite International Diagnostic Interview-Screening Scales calibrated to measure several different types of mental health disorders in this population [13,14] as well as a screening version of the Post-traumatic Stress Disorder (PTSD) Checklist [15], with evidence of validity of this interview [13]. Recent and lifetime suicidal ideation and behavior were assessed using the Columbia Suicide Severity Rating Scale (C-SSRS)[16]. In addition, the interview surveyed other potential risk and protective factors for suicide: 1) lifetime, deployment, and recent (past week, past month and past year) stressful events adapted from the Life Event Questionnaire [17] and the Department of Defense Health Survey of Health Related Behaviors among Active Duty Military Personnel [18]; 2) social networks and social support, 3) treatment history, 4) unit experiences and cohesion, 5) personality traits, 6) spirituality, and 7) ownership of weapons using items from the World Health Organization Composite International Diagnostic Interview Screening Scales (CIDI-SC), along with items created for the purpose of the Army STARRS study [10,19,20].

3.1. Interviewer training

Telephone interviews were conducted by trained lay-interviewers from the Survey Research Center in the Institute for Social Research at the University of Michigan. Each professional interviewer completed a General Interviewer Training course as well as refresher courses on a periodic basis during data collection to prevent interviewer drift [21].

3.2. Statistical analyses

3.2.1. Weighting procedures

Post-stratification weights were developed based on the analysis of the Historical Administrative Data Study (HADS). Cases were adjusted to match the population of all deaths in the Army whereas controls were weighted to be representative of the Army on a wide range of characteristics know to be associated with suicidal behaviors. The steps involved in creating post-stratification weights are published elsewhere. Item-level missing data were handled in a process described in the Army STARRS study design and methodology publications [10,22].

Each variable was examined, comparing suicide deaths (cases) to a stratified probability sample of controls using Wald- chi-square tests with a Firth correction for small cells and calculating odds ratios (ORs), and 95% confidence intervals (CI). If a construct had multiple forms, the dichotomous form was selected. P-values were then corrected using False Discovery Rate (FDR) procedures, correcting across questions for each domain. Ten items differentiated the two groups after FDR correction. We used these items to create a risk score, with 1 point for each positive response. These 10 items were then submitted to further logistic regression to identify the most parsimonious set of items that differentiated between cases and controls. We also conducted a multivariable logistic regression with significant variables from the univariable analyses after FDR correction and calculated AUC to identify the most parsimonious set of variables that differentiate between cases and controls.

3.2.2. Univariable analyses

Univariable logistic regression models, tested the significance of each item examined in the SHOS-B subsample, comparing suicide deaths (cases) to the probability sample of controls while adjusting for deployment status (never, previous). Items tested were those observable by the supervisors and included: demographics from the military medical record, lifetime, deployment and recent stressful events, stress reactions, amount of stress, ability to handle stress, social networks, treatment history, unit experiences and cohesion, personality traits and descriptions, spirituality, ownership of weapons, bullying, lifetime mental health disorders from the military medical record, and lifetime and past 30 day mental health symptoms from the Supervisor informant survey.

For analytic categories with $n < 5$, logistic regression with Firth's bias correction was applied, with a penalized regression model, in which a penalty term is placed on the standard ML function to generate parameter estimates [23]. To correct for multiple comparisons, p-values were adjusted using the false discovery rate (FDR) [24].

3.2.3. Multivariable analyses

We built a series of multivariable models comparing cases to the stratified probability sample of controls while adjusting for deployment status. The model included the significant variables from "univariable" analyses into the same model while adjusting for deployment. We examined tetrachoric item correlations, and items that were highly correlated were not included in the final MVA. **See** Table S1. After fitting this model, any variable that remained significant was kept and the model was re-run. This process was repeated until only significant items were left.

3.2.4. Risk scores

For the risk score and multivariable models, we used items significant at FDR p-value < 0.05. Analyses were conducted in R V3.6.0 [25]. Items that continued to have a significant relationship with the outcome of suicide death even after the FDR adjustment were used to create a "risk score." This variable was constructed by giving a point for each item that a soldier was said to have the characteristic that put them at a greater risk of suicide death. For example, if the item gender had a positive odds ratio for males as compared to females, then a Soldier

would get a "+ 1" added to their score if they were male. After creating the score construct, a logistic regression model was fitted using this score construct variable as an independent variable while adjusting for deployment status. A ROC curve for this predictor was obtained from the model results.

4. Results

4.1. Demographics

The sample consisted of 40 suicide cases, and 99 controls. There were no differences with respect to age, sex, race, ethnicity, or educational level. There were also no differences with respect to age upon entry into the Army, history of deployment, recency of deployment, years of active service, or AFTQ score. The majority of the sample were male (95%), White (62%), over half E1–E4(55%), with a high-school diploma (62%), between the ages of 25–29 (35%), and with 1–4 years of active service (38%) and a history of prior deployment (77%). Cases were less likely to be married than controls, but this result did not persist after FDR adjustment (48%; OR = 2.7, [95% CI = (1.2, 6.1)] $\chi^2 = 6.21$, $p = .0449$, $q = 0.5126$). While SUP did not report diagnosable mental health disorders, the majority of cases (60%) had a history of a mental health diagnosis from the military medical record compared to 40% controls OR = 3.5, [95% CI = (1.5, 8.2)] $\chi^2 = 8.69$, $p = .0032$, $q = 0.0446$). **See** Table 1**.**

4.2. Univariable analyses

All of the variables examined in the univariable analyses are provided in Table S2. Variables significant after FDR correction are described below. **See** Table 2.

4.2.1. Social networks and help-seeking

Suicide decedents (cases) were more likely to have a small social network (< 5 people) with whom he/she could do things (OR = 3.1 [95% CI = 1.3, 7.4] $\chi^2 = 6.86$, $q = 0.0284$), or to whom they felt close compared to controls (OR = 3.5 [95% CI = 1.3, 9.2] $\chi^2 = 6.41$, $q = 0.0284$). Suicide decedents reported that they were less likely to seek help from a spouse or partner (OR = 4.1 [95% CI = 1.8, 9.4] $\chi^2 = 11.34$, $q = 0.0038$) or from a mental health counselor (OR = 4.8 [95% CI = 2.1, 11.1] $\chi^2 = 13.45$, q = 0.0024).

4.2.2. Lifetime stressors

There were no differences among the groups with respect to lifetime stressors, including child maltreatment, assault, witnessing a death, or loss of a close friend or relative. However, supervisors rated cases as having experienced more life stress overall (OR = 9.4 [95% CI = 2.0, 43.3] $\chi^2 = 8.21$, $q = 0.0459$) compared to controls.

4.2.3. Recent (within the past 30 days) stressors

Supervisors reported cases were more likely to have a spouse or partner leave them (OR = 30.6 [95% CI = 2.6, 361.7] $\chi^2 = 7.35$, $q = 0.0366$); to have experienced perceived failure or humiliation (OR = 24.9 [95% CI = 3.1, 200.3] $\chi^2 = 9.15$, $q = 0.0324$); and any other stressful event (OR = 4.3 [95% CI = 1.5, 12.6] $\chi^2 = 6.94$, $q = 0.0366$) compared to controls.

4.2.4. Ability to handle stress

Cases were perceived by their supervisors as having poor ability to manage stress relative to controls (OR = 13.6 [95% CI = 2.3, 79.2] $\chi^2 = 8.44$, $q = 0.0220$).

4.2.5. Personality traits

Supervisors described cases as more likely to be incautious compared to controls (OR = 7.6 [95% CI = 3.0, 19.7] $\chi^2 = 17.76$, q = 0.0006).

Table 1
Demographic and Army career-related variables: Suicide without warning sample

Characteristic	Cases (n = 40)		Controls (n = 99)			
	N	%	N	%	OR[a]	95% CI
Gender						
Female	2	4.73	9	12.49	0.3	(0.1,1.8)
Male	38	95.27	90	87.51	REF	REF
X^2, p_{fdr}[b]					1.63, 0.5126	
Marital status						
Never Married	18	48.58	24	26.75	**2.7***	**(1.2,6.1)**
Previously Married	3	7.09	6	6.40	1.7	(0.4,7.6)
Currently Married	19	44.33	69	66.85	REF	REF
X^2, p_{fdr}[b]					6.21, 0.5126	
Race/ethnicity						
White	24	62.76	64	56.92	REF	REF
Black	6	13.89	13	22.58	0.6	(0.2,1.6)
Hispanic	4	9.46	13	15.58	0.6	(0.2,1.9)
Asian/Other	6	13.89	9	4.92	2.6	(0.7,9.3)
X^2, p_{fdr}[b]					4.72, 0.5126	
Rank						
E1–E4	21	55.07	40	41.40	1.6	(0.7,3.4)
E5–E9	15	35.47	43	45.12	REF	REF
Officer	4	9.46	16	13.48	1.2	(0.3,4.0)
X^2, p_{fdr}[b]					1.27, 0.5696	
Education						
H.S.- Alternate Education-GED	6	13.89	9	10.33	1.5	(0.5,4.6)
High School diploma	25	61.52	59	66.85	REF	REF
Some College	3	10.40	5	5.66	2.0	(0.5,7.7)
College or higher	6	14.19	26	17.16	0.9	(0.3,2.6)
X^2, p_{fdr}[b]					1.46, 0.7489	
Age at Entry to Army Service						
17–20	23	57.09	49	55.60	REF	REF
21–24	11	26.01	28	29.03	0.9	(0.4,2.1)
25 +	6	16.89	22	15.37	1.1	(0.4,3.0)
X^2, p_{fdr}[b]					0.14, 0.9316	
Deployment						
Never	7	22.26	14	12.40	1.7	(0.7,4.1)
Previous	33	77.74	85	87.6	REF	REF
X^2, p_{fdr}[b]					1.26, 0.5126	
History of any Classic Mental Health Disorder in the Past						
Yes	24	59.76	40	35.66	**3.5***	**(1.5,8.2)**
No	16	40.24	59	64.34	REF	REF
X^2, p_{fdr}[b]					**8.69*, 0.0446**	

Notes:
Variables not listed due to space constraints are available upon request.
[a] OR, odds ratio. CI. Confidence Interval. FDR, false discovery rate.
[b] *p*-values have been corrected using FDR for multiple comparisons.
* Bolded values are statistically significant at *p*-value ≤ 0.05.

4.2.6. Medical record of mental disorder

History of mental health disorder from the military medical record defined as a lifetime history of any of the following 22 diagnoses as indicated by administrative record of ICD-9 codes: ADHD, adjustment disorder, alcohol, anxiety, bipolar, conduct/ODD, minor depression, MDD, eating disorders, non-affective psychosis, organic mental disorders, other disorders, other impulse-control disorders, personality disorders, sex disorders, sleep disorders, somatoform/dissociative disorders, traumatic stress, PTSD, and substance dependence. Cases were three times more likely than controls to have a history of a one of these mental health disorders from the military medical record (OR = 3.5 [95% CI = 1.5, 8.2] $\chi^2 = 8.69$, q = 0.0446).

To address the research question as to whether there was overlap between the supervisors' and next-of-kin's awareness of the mental

Table 2
Univariable logistic regression model for suicide from supervisor reports.

Characteristic	Supervisor					
	Cases (n = 40)		Controls (n = 99)			
	N	Weighted %	N	Weighted %	OR[a]	(95% CI)
Recent Stressful Events						
a. Spouse or Partner Left Them						
Past month vs. Never/ever-lifetime[b]	8	18.32	3	.29	**30.6**	**(2.6, 361.7)**
χ^2, p_{fdr}[c]					**7.35***, **0.0366**	
b. He/she experienced some type of perceived failure or humiliation, such as letting down those around him/her in some way						
Past Month vs. Never/ever-lifetime[b]	9	20.38	2	0.63	**24.9**	**(3.1, 200.3)**
χ^2, p_{fdr}[c]					**9.15***, **0.0324**	
c. Any other very stressful event						
Past month vs. Never/ever-lifetime[b]	9	23.99	3	6.38	**4.3***	**(1.5,12.6)**
χ^2, p_{fdr}[c]					**6.94***, **0.0366**	
Amount of Stress						
a. His/her life overall						
High Stress vs None/some stress	8	18.62	5	2.00	**9.4***	**(2.0,43.3)**
χ^2, p_{fdr}[c]					**8.21***, **0.0459**	
b. Ability to Handle Stress						
Poor vs good/excellent	7	20.03	2	1.22	**13.6***	**(2.3,79.2)**
χ^2, p_{fdr}[c]					**8.44***, **0.0220**	
Social Networks						
a. People he/she (Case: did/Control: can do) things with, like watch TV together, go out for a drink or movie together, or play cards 0-5 vs. 6 or more	10	23.91	49	50.25	**3.1***	**(1.3,7.4)**
χ^2, p_{fdr}[c]					**6.86***, **0.0284**	
b. People who he/she (Case: felt/Control: feels) really close to						
0.5 vs 6 or more	7	43.1	41	42.62	**3.5***	**(1.3, 9.2)**
χ^2, p_{fdr}[c]					**6.41***, **0.0284**	
c. Seek help from spouse or partner						
No vs Yes	16	39.40	75	73.95	**4.1***	**(1.8, 9.4)**
χ^2, p_{fdr}[c]					**11.34***, **0.0038**	
d. Seek help from a mental health counselor						
No vs Yes	12	29.16	64	67.45	**4.8***	**(2.1,11.1)**
χ^2, p_{fdr}[c]					**13.45***, **0.0024**	
Personality Traits						
a. He/She (Case: was/Control: is) a cautious person.						
No vs. Yes	22	57.13	88	90.62	**7.6***	**(3.0, 19.7)**
χ^2, p_{fdr}[c]					**17.76***, **0.0006**	

Notes:
Reference group after vs.
[a] OR, odds ratio. CI, Confidence Interval. FDR, false discovery rate.
[b] Variables coded as Never or Ever in their Lifetime.
[c] *p*-values have been corrected using FDR for multiple comparisons.
* Boldfaced values are statistically significant at p-value < 0.05 cases vs. controls.

health symptoms, we examined those cases with both SUP and NOK reports among this subsample. There were only 15 NOK cases and 54 NOK controls that had both SUP and NOK reports. While SUP reported no survey mental health disorders or suicidal ideation, NOK reported 59.7% (n = 9) cases with the presence of a lifetime mental disorder and 39.4% controls (n = 24).

4.3. Multivariable analyses

As reported above, ten items were statistically significant at $p < 0.05$ after FDR adjustment. The final multivariable model consisted of seven of those items after checking for multicollinearity: 1) perceived humiliation or failure, 2) spouse or partner left them, 3) ability to manage stress, number of people they felt really close to, 4) help seeking from spouse or partner, 5) help seeking from a mental health counselor, and 6) personality traits. We excluded these variables due to multicollinearity: any other recent stressful event; stress in his or her life overall and feeling close to others. The most parsimonious multivariable model controlling for deployment status, as reported by SUP predicting suicide death consisted of four variables: a spouse or partner leave him or her in the past month (OR= 28.5 [95% CI =1.8, 442.7] $\chi^2 = 5.72$, $p = .0168$); a smaller social network (OR = 4.2 [95% CI = 1.0, 17.3] $\chi^2 = 3.97$, $p = .0462$), less likely to seek help from a mental health counselor (OR =3.4 [95% CI = 1.2, 9.7] $\chi^2 = 5.35$, $p = .0207$) and more likely to be described as incautious (OR= 3.8 [95% CI = 1.2, 11.7] $\chi^2 = 5.42$, $p = .0199$). The AUC = .88 [95%CI = 0.82, 0.94] for this regression model suggests strong prediction. **See** Table 3**.**

4.4. Risk scores

The ten items included in the multivariable model were each given one point, and then the scores for cases and controls were compared, with an OR = 2.9; 95% CI (1.95, 4.28); $\chi^2 = 29.0492$; $p < 0.0001$; AUC = 0.8648. See Table 4. and Fig. 1.

5. Discussion

5.1. Key findings

There are four key findings from our study. First, while SUP did not observe evidence of MH disorder or suicidality, in cases where we also had NOK reports, NOK reported 60% of cases had a lifetime mental health diagnosis, and in fact, the majority had a mental health diagnosis based on the administrative database. Thus, typical warning signs that might prompt intervention or mental health referral are not observed by supervisors and this hinders prevention efforts in a military context. Second, cases were more likely to have experienced relationship problems such as a recent break-up, smaller social networks, and greater reluctance in confiding in, and seeking help from others. Third, cases were more likely to be regarded by supervisors as incautious and had difficulty handling stress. Fourth, perceived humiliation and failure predicted suicide death as reported by supervisors after controlling for covariates. These findings suggest some specific prevention strategies, but also suggest that universal prevention interventions that do not rely on self-disclosure, but instead augment resilience in all servicemen and women may be required to reach this subgroup under study.

In this sample, more than one-third of those soldiers who died by suicide did not evidence the most commonly found indicators of suicidal risk, namely, the presence of at least one lifetime psychiatric disorder, and/or lifetime suicidal ideation. Only a small proportion of soldiers had both NOK and SUP informants, but when they did, NOK informants were twice as likely as SUP to report a MH diagnosis or suicidality. The other

Table 3
Multivariable logistic regression model of suicide from supervisor reports.

Characteristics	Final model:	
	OR[a]	95% CI
I. Demographics		
Deployment		
Never vs. Previous	0.7	(0.2, 2.8)
χ^2, *p-value*[b]	0.2810, 0.5962	
II. Stressors		
He/She experienced some type of perceived failure or humiliation, such as letting down those around him/her in some way		
Past Month vs. Never-Ever	7.6	(0.9, 65.8)
χ^2, *p-value*[b]	3.364, 0.0667	
Spouse or partner left him or her		
Past-Month vs. Never-Ever	**28.5***	**(1.8, 442.7)**
χ^2, *p-value*[b]	**5.72*, 0.0168**	
Manage Stress		
Poor vs. Good/Excellent	7.2	(0.8, 63.1)
χ^2, *p-value*[b]	3.16, 0.0753	
III. Social Network Size and Help Seeking		
People who she/he really close to		
0-5 vs 6 or more	**4.2**	**(1.0, 17.3)**
χ^2, *p-value*[b]	**3.97*, 0.0462**	
Sought help from: Spouse/partner		
No vs. Yes	2.4	(0.8, 6.9)
χ^2, *p-value*[b]	2.58, 0.1081	
Sought help from: A mental health counselor		
No vs. Yes	**3.4***	**(1.2, 9.7)**
χ^2, *p-value*[b]	**5.35*, 0.0207**	
IV. Personality		
Cautious person		
No vs. Yes	**3.8***	**(1.2, 11.7)**
χ^2, $p - value$[b]	**5.42*, 0.0199**	

Notes:
CI, Confidence Interval; OR, Odds Ratio. * Bold values are statistically significant at p-value ≤ 0.05.
Multivariable Logistic regression model was constructed using predictors significant at $p \leq 0.05$ after FDR adjustment. The model was corrected with Firth's penalized likelihood method to help address small sample size bias. Reference after the vs.

Table 4
Risk score logistic regression model for suicide.

	Cases n = 40		**Controls n = 99**	
			OR[1]	(95% CI)
Model Estimates				
OR			**2.9**	**(1.95, 4.28)**
χ^2, p-value			**29.0492, < 0.0001**	
AUC			0.8648	
	n's	**%**	**n's**	**%**
Count Statistics				
0	0	0	24	24.02
1	1	2.36	21	21.35
2	6	14.19	23	23.64
3	8	18.92	17	12.53
4	6	14.19	13	17.91
5	11	28.42	0	0
6	7	19.56	0	0
7	0	0	1	0.55
8	1	2.36	0	0
Mean	4.15		1.79	
Median	4		2	
Mode	5		0	
Q1	3		1	
Q3	5		3	
Minimum	1		0	
Maximum	8		7	
Std	1.56		1.45	

Note: Bold values are statistically significant at p-value ≤ 0.05. The model was corrected with Firth's penalized likelihood method to help address small sample size bias. Abbreviations: AUC, Area under the receiver operator characteristic curve; CI, Confidence Interval; OR, Odds Ratio.

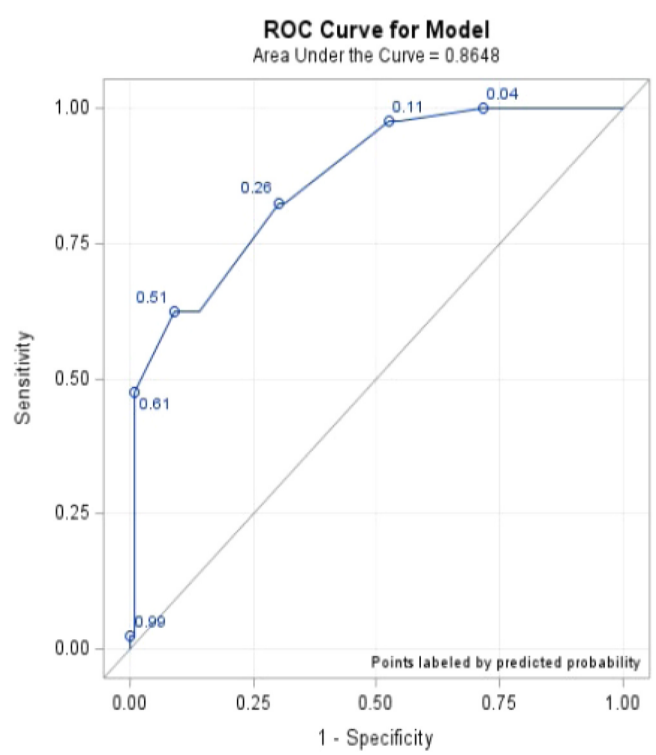

Fig. 1. ROC curve for risk score logistic regression model of suicide.

characteristics of this group of soldiers who died by suicide were those that made detection of a mental disorder less likely: they had fewer close relationships, and more reluctant to confide in others. Despite their reluctance to confide in others, a significant majority of the cases had seen a mental health counselor at least once and had a health diagnosis, although this was not known to the supervisor. Moreover, their supervisors, perhaps through hindsight, viewed them as less able to cope well with stress, and also reported that they were more likely to have experienced a humiliating event. Thus, the combination of being under greater stress, and being less likely to reach out to others in these cases was a lethal combination. An important part of resilience training may include perceived humiliation or failure. Treatment implications from these findings suggest that addressing humiliation may be an important part of resilience training. There may also be an association between relationship problems and perceived humiliation or failure. Unfortunately, we did not have the sample size to check for interactions between relationship problems and perceived humiliation, but this will be an important topic for future research.

Universal prevention approaches, if modest in expense and complexity, could be one way to increase the likelihood that a suicidal soldier would seek treatment. The Air Force Suicide Prevention Program was designed to decrease barriers to seeking mental health treatment by increasing knowledge of mental health and mental health treatment, and decreasing stigma [26]. The rate of suicide in the Air Force, after implementing the program declined by 33%. The program was multifaceted, involving training of leadership and supervisors on facilitating referrals, changes in the way mental health care was delivered, and providing training for supervisors in identification and triage of high risk individuals, such as those facing legal or disciplinary issues, and those exposed to traumatic experiences [27]. More targeted interventions in high school students that teach students about the signs of depression and suicidal risk, how to get help, and how to respond to a friend who shows evidence of depression or suicidal risk have been tested in randomized clinical trials and showed to reduce the rate of suicide attempts by half [28,29]. In the Army, Military OneSource provides peer support 24/7 and includes access to resilience tools, coaching, mood trackers, mindfulness apps, and resources for those in crisis in a manner to reduce stigma and to encourage help-seeking [30]. Therefore, programs designed to reduce stigma should be considered in order to reach soldiers who are both at risk, and reluctant to disclose.

The second universal approach involves increasing a sense of social connection. A meta-analytic review of one of the best-studied theories of suicidal risk, the Interpersonal Theory of Suicide, shows strong support for a relationship between both thwarted belongingness and perceived to be a burden and suicidal risk [31–33]. It is well-known that connections to peers, supervisors, and loved ones is protective against a range of health risk behaviors, including suicidal behavior, and may be more protective against suicide in men [34]. A longitudinal study of physicians found that indices of social integration, including social network size, depth and frequency of engagement with social contacts, and marital status were protective against suicide, cardiovascular deaths, and all-cause mortality [35]. A randomized controlled trial of a program to foster greater connectedness between service members showed that this program, Wingman Connect, increased class connectedness, decreased depression, suicidal ideation, and occupational problems compared to usual care [36,37].

The only weapon items assessed by the supervisor was whether or not the soldier ever aimed a firearm at another person and whether the soldier ever fired a gun at another person – which was not significant, and was consistent with our other study in this sample. In summary, there truly are some individuals for whom the most obvious warning signs (suicidal ideation, mental disorder diagnosis) are not evident to supervisors and unfortunately for this group it appears other warning signs are elusive. Making supervisors aware that barriers and stigma related to help seeking may be their only warning sign and encouraging counseling are reasonable preventative strategies under these difficult circumstances, where predictors are not obvious. Recent recommendations from the Suicide Prevention & Response Independent Review Committee [38] encourages leaders to use non-stigmatizing language when talking about suicide to target stigma-related beliefs about mental health. Preliminary results suggest this approach may be helpful among younger service members [38].

This study had some significant strengths as well as limitations. Strengths included use of the psychological autopsy method, a well-accepted, valid method for learning about the factors that led up to a suicide. Limitations include low rates of response, relatively few cases and controls that had both NOK and SUP data, and for this particular post-hoc analysis, relatively small samples. We have tried to address these limitations of sample size by rigorously controlling for multiple comparisons in order to be conservative in our presentation of the data and subsequent inferences. The response rates were low compared to surveys conducted in the general population, but they were high for multi-informant interviews conducted in a military population [12,39]. The psychological autopsy method has shown that the information obtained is reliable and valid [4]. However, especially if one does not get information from friends or relatives, it is likely, as was the case in this study, to underestimate the prevalence of psychiatric disorder and suicidal behavior to suicidal risk. Finally, these data are more than ten years old and therefore some important stressors such as the pandemic may have yielded different results using the same design. It will be important and timely to examine the effects of the pandemic in future research. As a result, we are planning to conduct analyses of the pre/post effects of the pandemic on the mental health of active-duty soldiers in another component of Army STARRS Longitudinal Survey. It's also important to note that hindsight bias could have influenced supervisor informant perspectives, which is a concern reported with psychological autopsy studies [11]. In terms of methodology, this study meets many of the criteria for a well-designed psychological autopsy study, including having a clear sampling frame, being able to determine response biases, drawing cases and controls from the same population drawn at the same time, assessing psychosocial supports and stressors as well as psychopathology, and obtaining information from multiple sources [11,12].

In conclusion, the service members who died by suicide and did not have the standard warning signs were more socially isolated and less likely to confide in others than controls, which substantially reduces the chance that a supervisor could recognize one of their supervisees as being at increased suicidal risk. Individuals with fewer than average social contacts, are loath to confide, and who have suffered a humiliation or rejection are one sub-group that may merit closer attention by supervisors. Moreover, programs designed to decrease stigma, increase help-seeking, training leadership in suicide prevention best practices, and that increase cohesion and social support may be able to prevent suicide even in those who might otherwise suffer in silence.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Robert Ursano reports financial support was provided by US Department of the Army. Robert Ursano reports financial support was provided by National Institute of Mental Health. Murray B Stein M.D. and Ronald C Kessler PhD. are on the editorial board of the Journal of Mood and Anxiety Disorders and are co-authors on the manuscript entitled "Suicide without Warning: Results from the Army Study to assess Risk and Resilience in Servicemembers. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.xjmad.2024.100064.

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