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Associations of vulnerability to stressful life events with suicide attempts after active duty among high-risk soldiers: results from the Study to Assess Risk and Resilience in Servicemembers-longitudinal study (STARRS-LS)

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Abstract

Background. The transition from military service to civilian life is a high-risk period for suicide attempts (SAs). Although stressful life events (SLEs) faced by transitioning soldiers are thought to be implicated, systematic prospective evidence is lacking.

Methods. Participants in the Army Study to Assess Risk and Resilience in Servicemembers (STARRS) completed baseline self-report surveys while on active duty in 2011–2014. Two self-report follow-up Longitudinal Surveys (LS1: 2016–2018; LS2: 2018–2019) were subsequently administered to probability subsamples of these baseline respondents. As detailed in a previous report, a SA risk index based on survey, administrative, and geospatial data collected before separation/deactivation identified 15% of the LS respondents who had separated/deactivated as being high-risk for self-reported post-separation/deactivation SAs. The current report presents an investigation of the extent to which self-reported SLEs occurring in the 12 months before each LS survey might have mediated/modified the association between this SA risk index and post-separation/deactivation SAs.

Results. The 15% of respondents identified as high-risk had a significantly elevated prevalence of some post-separation/deactivation SLEs. In addition, the associations of some SLEs with SAs were significantly stronger among predicted high-risk than lower-risk respondents. Demographic rate decomposition showed that 59.5% (S.E. = 10.2) of the overall association between the predicted high-risk index and subsequent SAs was linked to these SLEs.

Conclusions. It might be possible to prevent a substantial proportion of post-separation/deactivation SAs by providing high-risk soldiers with targeted preventive interventions for exposure/vulnerability to commonly occurring SLEs.

Introduction

The transition from military service to civilian life is a high-risk period for suicide-related behaviors (Ravindran, Morley, Stephens, Stanley, & Reger, 2020; Shen, Cunha, & Williams, 2016). In recognition of this fact, a 2018 Presidential Order and 2020 Act of Congress called for coordination between the US Departments of Defense (DoD) and Veterans Affairs (VA) to improve suicide prevention strategies during this transition period (116th Congress, 2020; U.S. Department of Veteran Affairs, 2018). Such strategies up to now have focused primarily on identifying demographic and military service-related risk factors for suicide deaths after separating (i.e. leaving) or deactivating (i.e. being released from active duty but remaining in the US Army Reserve or National Guard) using retrospective cohort study designs (Bullman, Hoffmire, Schneiderman, & Bossarte, 2015; Kang et al., 2015; Ravindran et al., 2020; Reger et al., 2015). In the one prospective study that used information available during active duty to predict suicide attempts (SAs) after separating/deactivating in the Study to Assess Risk and Resilience in Servicemembers-Longitudinal Study (STARRS-LS) sample, Stanley et al.

(2022) found that the 15% of soldiers with the highest predicted risk based on information available during active duty accounted for nearly two-thirds of all SAs occurring after separation/deactivation.

This predicted SA risk index might be used by military leaders to identify which individuals are most in need of preventive intervention prior to separation/deactivation. Given that no information was available in the SA risk index about experiences that occurred after separation/deactivation, though, no recommendations could be made about the most useful types of preventive interventions. One plausible focus would be stressful life events (SLEs) that often occur during the transition from military service to civilian life (Morin, 2011; Pease, Billera, & Gerard, 2016), such as housing instability, legal conflicts, employment instability, relationship problems, victimization, and financial strain (Larson & Norman, 2014; Mobbs & Bonanno, 2018; Morin, 2011; Pease et al., 2016). Given that other research has shown that these SLEs are associated with increased suicide risk in the general population (Howarth et al., 2020; McFeeters, Boyda, & O'Neill, 2015; Nock et al., 2013), it is plausible to hypothesize that the SA risk index developed in the STARRS-LS sample predicts SAs at least partly because it predicts which soldiers are either at elevated risk of SLE exposure and/or psychologically vulnerable (e.g. greater emotional distress) to the effects of these SLEs.

Only two empirical studies have investigated the associations of transition-related stressors with suicide risk in military samples. The first, a cross-sectional study of Navy and Marine Corps personnel attending classes in preparation for transitioning to civilian life, found that self-reported stress resilience was significantly associated with reduced severity of psychiatric symptoms and suicidal thinking (Mansfield, Bender, Hourani, & Larson, 2011). The second, a retrospective cohort study of two SLEs occurring during military service (divorce and demotion in rank), found that both were significantly associated with increased suicide risk during and after (the two timepoints were not distinguished) military service (Shen et al., 2016). Neither study collected data on SLEs that occurred after separation/deactivation.

To address this gap, we investigated the extent to which the prospective association found by Stanley et al. (2022) between a SA risk index defined while soldiers were still on active duty and self-reported after separation/deactivation could be explained by self-reported SLEs that occurred after separation/deactivation.

Method

Sample and procedures

STARRS-LS is an epidemiological-neurobiological study designed to evaluate risk-protective factors for suicidal behaviors among Army soldiers (Ursano et al., 2014). As field procedures have been detailed elsewhere (Heeringa et al., 2013; Kessler et al., 2013a, 2013b; Ursano et al., 2014), only a brief overview is presented here. There were three baseline STARRS surveys: (i) the New Soldier Study (NSS) survey, a 2011–2012 cross-sectional survey of $n = 38\,733$ soldiers, including members of the Army Reserve and Army National Guard, administered when new soldiers reported for Basic Combat Training; (ii) the All Army Study (AAS) survey, a 2011–2013 cross-sectional survey of $n = 25\,088$ active-duty soldiers serving throughout the world, including in combat deployments in Afghanistan; and (iii) the Pre-Post Deployment Study (PPDS) survey, a 2012–2014 four-wave panel survey of $n = 8566$ soldiers in three Brigade Combat Teams deployed to Afghanistan, with a baseline survey administered ~2–3 weeks before deployment and subsequent surveys administered 1–9 months after returning from deployment. All study participants provided written informed consent. The recruitment, informed consent, and data collection protocols were approved by the Human Subjects Committees of the University of Michigan and the Uniformed Services University of the Health Sciences. In addition, approval was obtained from the Army Medical Research and Materiel Command for the AAS component carried out among soldiers deployed to Afghanistan. As detailed elsewhere (Kessler et al., 2013b), post-stratification weighting was used to adjust the baseline samples for discrepancies with administrative variables available for all soldiers.

Beginning 2 years after the last baseline Army STARRS survey was completed, two long-term (LS) surveys (LS1: September 2016-April 2018; LS2: April 2018-July 2019) were administered to a probability sample of the baseline STARRS survey respondents who provided informed consent to link survey responses to their Army administrative records. The LS1 sampling frame over-sampled baseline STARRS survey participants who reported a history of psychiatric symptoms in addition to several other segments of the baseline samples. Potential LS1 respondents were mailed a letter inviting them to participate in a new survey with a \$50 incentive and a link to the online questionnaire. Initial nonrespondents were then sent a series of email and text invitations and reminders followed by phone calls. A subsample of nonrespondents after these recruitment phases was then offered an increased incentive of \$100 (Online Supplementary Fig. S1) before ending recruitment. Final LS1 data were weighted to include the nonresponse adjustment weights developed for the baseline Army STARRS surveys, a second weight to adjust for over-sampling some baseline sample segments, and a third weight to adjust for the under-representation of difficult-to-recruit participants in the final LS1 sample. A total of $n = 14508$ respondents completed LS1, with a weighted response rate of 35.6%. This weighted sample was then post-stratified to adjust for differential response related to survey variables available for all baseline Army STARRS survey respondents and all administrative data available for these baseline respondents as of December 31, 2016. All LS1 respondents were eligible to complete LS2. The same field procedures were used in LS2 as in LS1 (Online Supplementary Fig. S2). The conditional LS2 response rate was 83.7% ($n = 12156$). The same post-stratification procedures were used in LS2 as in LS1. Median (inter-quartile range) time between LS1 and LS2 among respondents who participated in both was 18 (16–18) months.

Results reported here combine data from LS1 and LS2 among respondents who were separated/deactivated from active duty at the time of their focal LS survey(s). Some LS respondents were on active duty at LS1 but separated/deactivated as of LS2 ($n = 813$). Others were already separated/deactivated as of LS1 ($n = 5411$), $n = 8$ of whom were subsequently reactivated and then again separated/deactivated as of LS2. Respondents were included in the current analysis only in LS waves in which they had been separated/deactivated for a minimum of 12 months. This restriction was made to make sure none of the SAs or SLEs assessed with the 12-month recall questions occurred while respondents were still on active duty. We also excluded LS2 respondents who were eligible in both surveys and reported a SA in the 12 months before LS1. As discussed in more detail in the Technical Supplement, this exclusion was made to avoid the clustering that would exist if we considered separate SAs for the same respondent in both waves. As a result of this exclusion, none of the $n = 4044$ respondents considered in the current analysis who completed both LS1 and LS2 reported a SA in the 12 months before LS1. The full analysis sample included 8899 observations ($n = 4230$ LS1; $n = 4669$ LS2).

Measures

Stressful life events (SLEs)

Prior research has shown that a wide range of SLEs predict SAs (McFeeters et al., 2015). Based on this evidence, both LS surveys asked about past 12 month exposure to a standard set of 12 SLEs that have been found in previous research to capture the majority of the overall association between larger SLE batteries and common mental disorders (Brugha, Bebbington, Tennant, & Hurry, 1985). Our 13-item battery was somewhat different from the original 12-item battery, though, in that we collapsed several original items (e.g. separate questions about death of a parent, child or spouse and about death of some other close friend or relative were collapsed into one about death of a loved one) and expanded several others (e.g. one question about serious illness, injury or assault was changed to two separate questions, one about serious illness or injury and another about physical or sexual assault). The final battery included questions about serious illness/injury, economic events (job loss, major financial crisis), victimizations (burglary, armed robbery, physical or sexual assault), legal events (trouble with the police, other trouble with the law), interpersonal events that directly affected the respondent (separation/divorce/other breakup, betrayal by a loved one), and SLEs that occurred to loved ones (death, serious illness/injury, other life crises).

Suicide attempts

Self-reported SAs were assessed in both LS surveys using a question adapted from the Columbia-Suicide Severity Rating Scale (Posner et al., 2011): '*Did you ever make a suicide attempt* (*i.e. purposefully hurt yourself with at least some intention to die*) *at any time since your last survey?*' Respondents who responded '*yes*' were then asked about lifetime number of SAs and recency. We focused on SAs reported to have occurred within 12 months of the focal LS survey.

The SA risk index

A dichotomous version of the composite SA risk index developed by Stanley et al. (2022) was used as the independent variable in the current report. This index was developed using the information on risk-protective factors from STARRS baseline surveys collected while LS respondents were still on active duty along with Army/DoD administrative data available while respondents were still on active duty and small area geospatial variables about the respondent's neighborhood, county, and state of residence after separation/deactivation. This geocode information was available prior to separation/deactivation based on soldiers providing forwarding addresses before leaving active duty.

Procedures used to develop the risk index are presented in the original Stanley et al. (2022) report, but, in brief, involved extracting information from the above three information sources to define predictors in nine known SA risk factor domains: sociodemographics, Army career history, personality characteristics, physical health problems, psychiatric disorders, self-injurious thoughts and behaviors, chronic stressors, adverse childhood experiences, and other lifetime traumatic events (Franklin et al., 2017; Holliday et al., 2020; Klonsky, May, & Saffer, 2016; Nock et al., 2013). The model was built using the Super Learner ensemble machine learning method, which allows results to be pooled across multiple algorithms using stacked generalization (Polley, Rose, & van der Laan, 2011). The latter approach generates a weight for each algorithm via cross-validation in a user-specified collection ('ensemble') of algorithms to combine predicted outcome scores across algorithms in a way guaranteed in expectation to perform at least as well as the best component algorithm according to a pre-specified criterion (in our case, minimizing mean-squared prediction error) (LeDell, van der Laan, & Petersen, 2016).

Analysis methods

Analysis was carried out August-October 2021 using conventional demographic rate decomposition methods (Chevan & Sutherland, 2009) to evaluate the role of SLEs in accounting for the association between a dichotomized predicted high-risk SA indicator based on the risk index and subsequent SAs. In this approach, described in more detail in the Technical Supplement, a separate prediction model is estimated for the joint associations of a series of intervening variables (in our case, SLEs) with an outcome (in our case, SAs) within subsamples defined by the dichotomous focal predictor (in our case, the SA risk index). Simulation was then used based on the coefficients in these models to estimate the extent to which the observed difference in SA risk between the two subsamples could be accounted for by between-subsample differences in (i) SLE exposure (the *exposure* component), (ii) strength of the associations between SLEs and SA (the *vulnerability* component), (iii) both combined (the *interaction* component) due to the joint occurrence of higher exposure and higher vulnerability among predicted high-risk than lower-risk respondents, and (iv) the *residual* component of the between-subsample difference in SA risk among respondents who experienced none of the SLEs.

Analysis began by examining differential SLE exposure between predicted high-risk and lower-risk respondents. We then estimated differences in vulnerability using adjusted risk difference (ARD) transformations from modified Poisson regression equations to characterize the vulnerability measures (Long & Mustillo, 2018). This was done using the STATA margins command, a post-regression command that estimates and compares differences in mean predicted probabilities for binary predictors in nonlinear models while adjusting for complex survey design applied to the output of subsample Poisson models with robust variance estimates (STATACorp LLC, 2022). We started with univariable models and then estimated multivariable models to evaluate the possibility of multicollinearity among the SLEs. Subsequent multivariable models collapsed across SLEs within conceptual domains to deal with high intercorrelations among SLEs and low prevalence of others. We also evaluated the possibility that joint associations of multiple SLEs with SA were non-additive. Demographic rate decomposition simulation methods described in the Technical Supplement were then used to decompose the mediating and moderating effects of SLEs based on coefficients in the final multivariable models. Standard errors of ARD estimates were computed using the Taylor linearization method (Dowd, Greene, & Norton, 2014). Standard errors of the component proportions aggregated across all SLEs were estimated using the Jackknife repeated replications simulation method (Ash, 2018).

Results

Sample composition

Samples were combined across all baseline Army STARRS surveys and pooled over LS1 and LS2 to build the prediction models. SA prevalence in the 12-months before the LS survey was 1.0% (s.e. = 0.1) in the pooled analysis sample. Based on this low prevalence, the prediction model was developed using a case-control design to balance prevalence in a 70% training sample and then tested in the full remaining 30% test sample. We reweighted the training sample for the subsequent analyses of SLEs to adjust for the under-sampling of controls and combined this weighted case-control training sample with the full test sample. See the Technical Supplement for a detailed discussion of this design, which resulted in a sample of $n = 3175$ respondents, consisting of all observations with a 12-month SA and a probability sample of remaining observations. The sum of weights was 8997, which is the number of respondents in the full eligible sample.

The great majority of respondents in the analysis sample identified as male (84.3%), Non-Hispanic White (68.7%), and heterosexual (93.2%) (Table 1). Most respondents had a high school education (69.7%) and were either currently (55.4%) or never (38.5%) married at separation/deactivation. Most respondents either had 0 (41.7%) or exactly 1 (32.0%) combat deployment, were of junior-enlisted rank at the time of separation/deactivation (63.4%) and separated (89.0%) rather than deactivated (11.0%). Median (interquartile range) number of years enlisted was 5 (3–9). Median (interquartile range) number of years since separation/deactivation was 3 (2–4). Median (interquartile range) age at separation/deactivation was 27 (23–33).

The association of predicted SA risk with subsequent SA

Prevalence of a 12-month SA in the pooled LS1-LS2 analysis sample was 1.0% (s.e. = 0.1%). The 15% of respondents in the predicted high-risk group accounted for 88.7% (s.e. = 4.8%) of these SAs. 5.9% (s.e. = 0.8%) of predicted high-risk respondents made a 12-month SA compared to 0.1% (s.e. = 0.0%) in the remainder of the sample (Table 2).

SLE Prevalence

Prevalence of any SLE in the 12 months before the LS survey was 55.2% (s.e. = 1.6), with 23.4% (s.e. = 1.5) experiencing exactly 1 SLE and the remaining experiencing either exactly 2 (14.9%, s.e. = 1.1) or 3 + (16.9%, s.e. = 1.3) SLEs. The most prevalent individual SLEs and SLE types were financial crises (20.5%, s.e. = 1.5), death of a loved one (19.3%, s.e. = 1.3), and betrayal by a loved one (17.4%, s.e. = 1.3). Relative-risk [RR, 95% confidence interval (CI) of RR] of SLE exposure among predicted high-risk *v.* lower-risk respondents was RR = 1.4 (CI 1.0–1.8) for exactly 1 SLE, RR = 2.0 (CI 1.4–2.8) for exactly 2, and RR = 2.1 (CI 1.6–2.8) for 3 + (Table 3). Predicted high-risk respondents were significantly more likely than lower-risk respondents to be exposed to trouble with the law (RR = 4.1, CI 1.4–11.4), legal events (RR = 2.4, CI 1.2–4.6), victimizations (RR = 1.9, CI 1.0–3.6), major financial crises (RR = 1.6, CI 1.2–2.2), any economic events (RR = 1.6, CI 1.3–2.1), betrayal by loved one (RR = 2.6, CI 1.9–3.5), and separation/divorce/other breakup (RR = 1.6, CI 1.1–2.3).

Associations of SLE exposure with predicted SA risk

Univariable models documented 4 SLEs with significantly elevated ARD among predicted high-risk respondents (Online Supplementary Table S1): separation/divorce/other breakup (ARD = 13.1%, 95% CI 3.7–22.6), job loss (ARD = 7.5%, 95% CI 0.3–14.8), major financial crisis (ARD = 8.0%, 95% CI 1.5–14.6), and any economic event (ARD = 7.5%, 95% CI 2.1–12.8). None of the univariable ARDs was significant among lower-risk respondents (Online Supplementary Table S2). Sequential multivariable models were then estimated to examine overlap across SLEs and to collapse across rare SLEs within conceptual domains due to either SLE rarity or ARD similarity. In the final model, 3 individual or grouped SLEs had significantly elevated ARD among predicted high-risk respondents (Table 4): separation/divorce/other breakup (ARD = 10.2%, 95% CI 3.2–17.2), economic problems (ARD = 4.8%, 95% CI 1.5–7.8), and victimization (ARD = 7.7%, 95% CI 1.3–14.1). All 3 of these ARDs were significantly higher among predicted high-risk than lower-risk respondents. None of the SLEs had a significant ARD among lower-risk respondents. Non-additivity tests for the joint effects of exposure to multiple SLEs were nonsignificant among both predicted high-risk ($t_1 = 1.6$; $p = 0.11$) (Online Supplementary Table S1) and lower-risk ($t_1 = -0.8$; $p = 0.40$) (Online Supplementary Table S2) respondents.

Relative importance of differential exposure and differential vulnerability

Decomposition showed that 36.9% (s.e. = 8.1%) of the observed difference in SA prevalence between predicted high-risk and lower-risk respondents was associated with increased vulnerability to the associations of SLEs with SA, 1.0% (s.e. = 0.7%) to increased SLE exposure, and 21.7% (s.e. = 9.1) to the interaction of vulnerability with exposure. The residual was 40.5% (s.e. = 10.2), which means that the difference in SA risk within the subsamples of predicted high-risk and lower-risk respondents who were exposed to none of these SLEs was only 40.5% as large as the difference in the total sample. This, in turn, means that SLE exposure and/or vulnerability accounts statistically for 59.5% (s.e. = 10.2) of the observed difference in SA prevalence between the predicted high-risk and lower-risk groups.

Discussion

In this study, we examined the extent to which SLEs associated with adjustment to separation/deactivation account statistically for the observed association between a SA risk model based on information available while soldiers were on active duty and the subsequent occurrence of a SA after separation/deactivation. We found that 59.5% of the observed difference in SA prevalence between predicted high-risk and lower-risk respondents was associated with the SLEs assessed in our survey. Interpersonal (separation/divorce/other breakup), economic (major financial crisis), and victimization events were all involved. Differential vulnerability to SLEs was more important than differential exposure, although both were statistically significant and the interaction between the two was also significant.

To our knowledge, this is the first study to document prospective associations between SLEs experienced during the transition from military to civilian life and SAs among soldiers recently separated/deactivated from the Army, although our results align

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Table 1. Socio-demographic and Army career characteristics in the total analytic sample ($n = 3175$) and in subsamples defined by high and lower predicted 12-month suicide attempt (SA) risk[a]

	Total ($n = 3175$)		High-risk[b] ($n = 775$)		Lower-risk[b] ($n = 2400$)		
	%	(S.E.)	%	(S.E.)	%	(S.E.)	χ^2
							61.5[c]
12-month suicide attempt	1.0	0.1	5.9	0.8	0.1	0.1	
I. Demographics							
Gender							7.0[c]
Female (*v.* Male)	16.6	1.3	24.2	3.1	15.2	1.4	
Race							1.0
Non-Hispanic white	68.7	1.7	72.5	3.2	68.1	1.9	
Non-Hispanic black	15.1	1.2	12.5	2.5	15.5	1.5	
Hispanic	9.9	1.0	8.0	2.0	10.3	1.1	
Other	6.3	0.9	7.0	2.2	6.1	0.9	
Sexual orientation							7.3[c]
Non-heterosexual (*v.* heterosexual)	6.8	0.8	12.7	2.4	5.7	0.9	
Highest educational level at separation/deactivation							5.6[c]
GED or equivalent	9.9	1.0	15.2	3.2	9.0	1.1	
High school diploma	69.7	1.5	72.2	3.9	69.2	1.7	
Some college	4.6	0.8	4.9	1.9	4.5	0.9	
College or more	15.8	1.4	7.7	1.7	17.2	1.7	
Marital status at separation/deactivation							3.5[c]
Currently married	55.4	1.4	45.9	4.1	57.0	2.2	
Previously married	6.2	0.5	12.9	3.5	5.0	1.0	
Never married	38.5	1.5	41.2	3.6	38.0	2.2	
II. Army career characteristics							
Lifetime combat deployment							0.7
None	41.7	2.1	45.1	3.8	41.1	2.3	
Exactly 1	32.0	1.9	32.1	4.1	32.0	2.0	
2+	26.3	1.6	22.7	3.5	27.0	1.8	
Rank at separation/deactivation							11.9[c]
Junior enlisted	63.4	1.8	73.3	3.3	61.6	2.1	
Senior enlisted	29.3	1.7	24.2	3.3	30.2	2.0	
Officer	7.3	0.8	2.5	0.6	8.1	0.9	
Leaving the Army							0.1
Deactivated (*v.* separated)	11.0	1.2	11.6	2.7	10.9	1.3	
Total years of Army enlisted							1.8
1–2	20.1	1.4	23.8	3.7	19.5	1.5	
3–4	29.7	1.5	33.3	3.9	29.1	1.6	
5–6	11.7	1.0	7.3	1.9	12.5	1.2	
7–8	12.6	1.4	11.7	2.8	12.7	1.6	
9+	25.8	1.7	23.9	3.3	26.2	1.9	
Years since separation/deactivation							1.0
1	18.3	1.2	18.5	3.0	18.3	1.3	
2	20.4	1.4	22.4	3.5	20.1	1.5	

(*Continued*)

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Table 1. (*Continued.*)

	Total (n = 3175)		High-risk[b] (n = 775)		Lower-risk[b] (n = 2400)		
	%	(S.E.)	%	(S.E.)	%	(S.E.)	χ^2
3	23.4	1.4	23.3	3.2	23.4	1.5	
4	18.9	1.3	14.6	2.5	19.7	1.4	
5+	18.9	1.4	21.2	2.8	18.5	1.4	
Age at separation/deactivation							1.7
18–21	13.0	1.2	12.9	2.4	13.0	1.3	
22–24	22.3	1.5	25.5	3.5	21.7	1.7	
25–27	18.9	1.4	16.8	2.9	19.3	1.6	
28–33	21.9	1.5	28.1	3.6	20.8	1.6	
34+	23.9	1.6	16.7	3.4	25.2	1.8	

[a]Estimates reflect weighted data to make the n = 3175 respondents considered here representative of the n = 8997 in the full eligible LS1–LS2 pooled sample. The smaller sample is due to our use of a case-control sampling scheme to develop the model. See the Technical Supplement for a discussion of this design.
[b]High-risk was defined as the 15% of respondents with the highest predicted SA risk based on a previously developed machine learning model using information available during active duty. The remaining 85% of respondents were classified as lower-risk.
[c]Significant difference between high-risk and lower-risk subsamples at the 0.05 level, two-sided test.

with prior work suggesting the existence of broadly similar associations during the transition to civilian life (Mansfield et al., 2011; Shen et al., 2016). Strikingly, 55.2% of the total sample and 72.6% of predicted high-risk respondents reported experiencing any 12-month SLE. This is likely to be an underestimate of significant stress exposure, though, given that we focused on commonly occurring acute stressors and did not assess either less-common acute stressors or chronic stressors known to occur to soldiers after leaving active duty (Adams, Meerwijk, Larson, & Harris, 2021; Kline, Ciccone, Falca-Dodson, Black, & Losonczy, 2011; Mansfield et al., 2011; Morin, 2011; Shen et al., 2016) and to be associated with elevated suicide risk (Hooley, Franklin, & Nock, 2014; Howarth et al., 2020; McFeeters et al., 2015; Nock et al., 2013). These results suggest that interventions to limit exposure to major stressors and, more importantly, to reduce vulnerability to these stressors might prevent a substantial proportion of the SAs that occur among high-risk soldiers after separation/deactivation.

The analysis has four important limitations. First, some unknown parts of the associations found here are likely due to SLEs occurring as a result of other risk factors for SAs that would not be adequately modified by decreasing SLE exposure (e.g. non-suicidal self-injury, difficulties regulating emotions, psychiatric disorders; Ewing, Hamza, & Willoughby, 2019; Schmied, Larson, Highfill-McRoy, & Thomsen, 2016), although these unmeasured factors might also be vulnerability factors. Second, some SAs might have occurred prior to SLEs given that SLEs and SAs were both assessed within the same 12-month retrospective timeframe. If so, this would mean that the associations of SLEs in predicting subsequent SAs would be lower than assumed here. It is noteworthy, though, that other research has documented prospective associations of the important SLEs identified in our analysis (i.e. separation/divorce/other breakup, job loss, major financial crisis, victimization) with subsequent suicidal behaviors (Bryan, McNaugton-Cassill, Osman, & Hernandez, 2013; Classen & Dunn, 2012; Næss, Mehlum, & Qin, 2021). Third, sample bias

Table 2. Association of predicted 12-month suicide attempt (SA) risk with subsequent SAs in the 12-months before LS surveys pooled across LS1 and LS2 (n = 3175)[a]

	Sensitivity[b]				Positive predictive value[b]			
	Within-stratum		Cumulative		Within-stratum		Cumulative	
	%	(S.E.)	%	(S.E.)	%	(S.E.)	%	(S.E.)
Predicted SA risk strata								
Top 15%	88.7	(4.8)	88.7	(4.8)	5.9	(0.8)	5.9	(0.8)
16–30	3.0	(1.4)	91.7	(4.8)	0.2	(0.0)	3.1	(0.4)
31–45	1.9	(1.9)	93.6	(4.5)	0.1	(0.0)	2.1	(0.3)
46–60	1.9	(1.3)	95.5	(4.3)	0.1	(0.0)	1.6	(0.2)
Bottom 40%	4.5	(4.3)	100.0	–	0.1	(0.0)	1.0	(0.1)

[a]Estimates reflect weighted data to make the n = 3175 respondents considered here representative of the n = 8997 in the full eligible LS1–LS2 pooled sample. The smaller sample is due to our use of a case-control sampling scheme to develop the model. See the Technical Supplement for a discussion of this design.
[b]Sensitivity is the proportion of all 12-month SAs that occur within a given stratum. Positive predictive value is the proportion of respondents in the stratum who report a 12-month SA. The estimates of sensitivity and positive predictive value differ from those in Table 3 of Stanley et al. (2022) in that the results reported here are for the entire analysis sample, whereas the results reported in the Stanley et al., paper were only for the 30% test sample.

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Table 3. Distribution of 12-month stressful life events (SLEs) in subsamples defined by predicted 12-month suicide attempt (SA) risk and univariate associations of 12-month SA risk with SLEs ($n = 3175$)[a]

	12-month SLE prevalence						
	High-risk[b] ($n = 775$)		Lower-risk[b] ($n = 2400$)		Univariate association of SA risk with SLE exposure		
Stressful life events (SLEs)	%	(s.e.)	%	(s.e.)	RR	(95% CI)	(n)[c]
Physical health							
Serious illness/injury	9.2	(2.0)	6.9	(0.9)	1.3	(0.8–2.3)	(219)
Interpersonal							
Separation/divorce/other breakup	20.6	(2.6)	13.1	(1.3)	1.6[d]	(1.1–2.3)	(483)
Betrayal by loved one	36.5	(3.8)	14.0	(1.3)	2.6[d]	(1.9–3.5)	(542)
Economic							
Job loss	18.0	(3.0)	9.1	(1.1)	2.0[d]	(1.3–3.0)	(395)
Major financial crisis	30.1	(4.0)	18.7	(1.5)	1.6[d]	(1.2–2.2)	(609)
Any economic event[e]	38.3	(4.2)	23.7	(1.7)	1.6[d]	(1.3–2.1)	(815)
Victimization							
Burglary[f]	6.6	(2.0)	3.9	(0.8)	1.7	(0.8–3.6)	(128)
Armed robbery[g]	0.4	(0.2)	0.7	(0.3)	0.6	(0.2–2.2)	(21)
Physical or sexual assault	2.7	(1.1)	0.9	(0.3)	3.2	(1.0–10.6)	(57)
Any victimizations[e]	9.1	(2.2)	4.8	(0.8)	1.9[d]	(1.0–3.6)	(185)
Legal							
Trouble with police[h]	5.5	(2.0)	2.8	(0.6)	1.9	(0.9–4.4)	(103)
Trouble with the law[i]	4.9	(1.5)	1.2	(0.4)	4.1[d]	(1.4–11.4)	(56)
Any legal events[e]	9.0	(2.2)	3.7	(0.8)	2.4[d]	(1.2–4.6)	(142)
Social support network							
Death of a loved one	22.7	(3.1)	18.7	(1.4)	1.2	(0.9–1.7)	(638)
Serious illness/injury of loved one	16.1	(2.9)	11.5	(1.3)	1.4	(0.9–2.1)	(404)
Life crisis of loved one	10.5	(1.9)	8.3	(1.0)	1.2	(0.7–2.1)	(297)
Any social support network events[e]	34.4	(3.9)	28.0	(1.8)	1.2	(0.9–1.6)	(951)
Total							
Any SLE[j]	72.6	(3.5)	52.1	(1.7)	1.4[d]	(1.2–1.6)	(1779)
Exactly 1 SLE	22.6	(3.3)	23.5	(1.6)	1.4[d]	(1.0–1.8)	(753)
Exactly 2 SLEs	21.9	(3.0)	13.7	(1.2)	2.0[d]	(1.4–2.8)	(480)
3+ SLEs	28.2	(3.2)	14.9	(1.4)	2.1[d]	(1.6–2.8)	(546)

CI, confidence interval; RR, relative risk; SA, suicide attempt; s.e., standard error; SLE, stressful life event.
[a]Estimates reflect weighted data to make the $n = 3175$ respondents considered here representative of the $n = 8997$ in the full eligible LS1-LS2 pooled sample. The smaller sample is due to our use of a case-control sampling scheme to develop the model. See the Technical Supplement for a discussion of this design.
[b]High-risk was defined as the 15% of respondents with the highest predicted SA risk based on a previously developed machine learning model using information available during active duty. The remaining 85% of respondents were classified as lower-risk.
[c]Number of respondents exposed to the SLE.
[d]Significant at the 0.05 level, two-sided test.
[e]Any of the individual SLEs within this conceptual domain.
[f]Break-in or burglary of home, car, or workplace.
[g]Victim of a mugging or armed robbery.
[h]For example, getting arrested.
[i]For example, a tax audit or lawsuit.
[j]Any individual SLE across all conceptual domains.

might have influenced results. Fourth, SAs were only assessed using self-report measures, which are known to be downwardly biased (Millner, Lee, & Nock, 2015). Because of these limitations, caution is needed in drawing overly precise conclusions. It is also noteworthy that results may not generalize to other military populations.

Despite these limitations, it is plausible, given the kinds of variables used to build the SA risk model (Stanley et al., 2022), that high-risk soldiers are substantially more likely than others to experience some types of SLEs during the transition back to civilian life and to have a more difficult time coping with these SLEs

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Table 4. Comparison of adjusted risk differences (ARD) in 12-month suicide attempt (SA) risk associated with each stressful life event in a multivariate prediction model separately among respondents classified as high-risk and lower-risk of 12-month suicide attempt (SA)[a]

	High-risk[b]				Lower-risk[b]			
	SLE prevalence				SLE prevalence			
Stressful life events (SLEs)	%	(s.e.)	ARD[c]	(95% CI)	%	(s.e.)	ARD[c]	(95% CI)
Physical health								
Serious illness/injury	9.2	(1.3)	1.4	(−2.4 to 5.2)	6.9	(0.9)	0.0	(−0.1 to 0.1)
Interpersonal								
Separation/divorce/other breakup	20.6	(2.3)	10.2[d,e]	(3.2–17.2)	13.1	(1.3)	0.0[e]	(−0.1 to 0.0)
Betrayal by loved one	36.5	(3.0)	−1.9	(−4.2 to 0.3)	14.0	(1.3)	0.1	(−0.1 to 0.3)
Economic								
Any economic event[f]	38.3	(4.2)	4.8[d,e]	(1.5–7.8)	23.7	(1.7)	0.1[e]	(−0.0 to 0.2)
Victimization								
Any victimizations[f]	9.1	(2.2)	7.7[d,e]	(1.3–14.1)	4.8	(0.8)	0.2[e]	(−0.1 to 0.4)
Legal								
Any legal events[f]	9.0	(2.0)	−0.4	(−3.6 to 2.7)	3.7	(0.7)	0.0	(−0.1 to 0.1)
Social support network								
Any social support network events[f]	34.4	(3.9)	−1.3	(−3.3 to 0.7)	28.0	(1.8)	0.0	(−0.1 to 0.1)

ARD, adjusted risk difference; CI, confidence interval; SA, suicide attempt; s.e., standard error; SLE, stressful life event.
[a]Estimates reflect weighted data to make the $n = 3175$ respondents considered here representative of the $n = 8997$ in the full eligible LS1–LS2 pooled sample. The smaller sample is due to our use of a case-control sampling scheme to develop the model. See the Technical Supplement for a discussion of this design. The predictors reported here are based on the results of earlier univariable and multivariable prediction models presented in Online Supplementary Table S1 and described in the text. Included here was a model to evaluate the possibility of non-additivity in the joint associations of the different SLEs with SA. This test was non-significant both among high-risk respondents ($t_1 = 1.6$; $p = 0.11$) or in a comparison between high-risk and lower-risk respondents ($t_1 = 1.6$; $p = 0.10$).
[b]High-risk was defined as the 15% of respondents with the highest predicted SA risk based on a previously developed machine learning model using information available during active duty. The remaining 85% of respondents were classified as lower-risk.
[c]ARD represents the difference in estimated prevalence of SA between respondents exposed and those not exposed to the SLE. ARD estimated were made based on transformations from modified Poisson regression equations.
[d]Significant ARD at the 0.05 level, two-sided test.
[e]Significant difference between ARD in the high-risk *v.* lower-risk subsamples at the 0.05 level, two-sided test.
[f]Any of the individual SLEs within this conceptual domain.

than lower-risk soldiers. Given this likelihood, our results suggest that efforts to support transitioning soldiers estimated to be at high SA risk through interventions aimed both at reducing SLE exposure and increasing resilience might reduce the number of SAs that occur after separation/deactivation. Consistent with the broader literature on military suicide risk factors (e.g. Bryan & Bryan, 2019; Gradus, Shipherd, Suvak, Giasson, & Miller, 2013; Hyman, Ireland, Frost, & Cottrell, 2012), the SLEs of importance appear to be economic or interpersonal in nature, or experiences of victimization; however, as noted above, a more in-depth analysis that considered a wider range of SLEs and examined chronic stressors might lead to a broader focus.

Existing DoD programs already indirectly target transition-related economic stresses by providing support in obtaining employment and accessing VA education and benefits through the Transition Assistance Program (TAP) (Faurer, Rogers-Brodersen, & Bailie, 2014; Kamarck, 2018; Whitworth, Smet, & Anderson, 2020). However, TAP is a universal program that makes no special outreach efforts to high-risk transitioning DoD members who might have psychological or structural barriers to accessing these services. The VA Solid Start program is another recent initiative that provides information about VA benefits and services to transitioning service members in the first year after separation/deactivation (U.S. Department of Veterans Affairs, 2020). Again, though, this is a universal program (i.e. three calls to each new veteran over the first year after leaving active duty) that does not make more intensive efforts to reach out to high-risk recent veterans. In addition, neither TAP nor the VA Solid Start program focuses on transitioning service members' risk for experiencing a variety of psychosocial stressors after military service or provides tailored support for those individuals known to be at the greatest risk for SAs (U.S. Department of Veterans Affairs, 2020; Whitworth et al., 2020). More recently, the DoD and VA piloted the Victory Wellness Check (VWC) program, which assesses and addresses deficits in resilience during military service (U.S. Department of Defense, 2020), and the Expiration Term of Service Sponsorship (ETSS) Program, which connects transitioning service members with sponsors who are trained to provide transition support (Geraci, 2020; Geraci et al., 2020). However, the VWC program does not specifically address transition stress (U.S. Department of Defense, 2020). Furthermore, the VWC and ETSS are still pilot programs that are not widely implemented or evaluated (Geraci, 2020; Geraci et al., 2020; U.S. Department of Defense, 2020).

Given the challenges of rapidly implementing the universal provision of suicide prevention resources for all transitioning service members and facilitating the continuous mental health care for transitioning service members mandated in Presidential

Executive Order 13822 (Department of Defense Office of Inspector General, 2021), it might be useful to explore the value of staggered implementation that targets high-risk transitioning soldiers. DoD and VA could consider expanding existing coping skills and social support programs (Miller & Kearney, 2020; U.S. Department of Defense, 2020; U.S. Department of Veterans Affairs, 2020) to incorporate a focus on preventing and coping with commonly experienced, transition-related SLEs and to target recent veterans estimated to be at the highest SA risk for these programs. Given that the programs for addressing stress are still being piloted (e.g. VWC, ETSS), the DoD and VA could also consider offering established empirically supported suicide interventions that focus on coping strategies, such as the Safety Planning Intervention (Ghahramanlou-Holloway et al., 2014; Stanley & Brown, 2012) to high-risk service members. Expansion of financial assistance for such individuals might also be cost-effective to the extent that this reduces subsequent costs to the VA (Murdoch et al., 2011). Identifying high-risk DoD personnel and delivering targeted interventions prior to their separation/deactivation would presumably be more cost-effective than delivering the interventions only after separation/deactivation.

In addition, enhanced screening for SLE exposure after separation/deactivation with recent veterans targeted at the time of separation/deactivation to be at high SA risk might be useful to learn in a timely way about SLE exposure and secondary adverse outcomes after SLEs. Such efforts might also consider a modular approach of evaluating and responding to specific SLEs at multiple points throughout the transition period to facilitate cost-effective intervention tailoring. Regular screening for SLEs and education about resources for addressing them could potentially be incorporated into the existing VA Solid Start program or some other periodic monitoring program and tailored resources could be provided based on results. Indeed, an evaluation of a modular measurement-based intervention approach of this sort implemented during the transition period is currently underway (Vogt, 2021). A modular approach could also reveal alternative entry points to VA care that circumvent the stigma of mental health care (Monteith et al., 2020) and facilitate future as-needed connections with VA suicide prevention programs and mental health care.

Conclusions

This study investigated the extent to which differential exposure and vulnerability to SLEs explained the association of a previously developed SA risk index with subsequent SAs occurring after US Army soldiers separated/deactivated. Both differential exposure and differential vulnerability to SLEs were found to be associated with subsequent SAs. This suggests that interventions to reduce SLE exposure and vulnerability targeted to individuals at the highest SA risk might prevent a substantial proportion of the SAs that are known to occur in the early years after separation/deactivation from DoD service. Identification and evaluation of interventions for reducing SLE exposure or vulnerability during this transition period and preventing secondary adverse outcomes after SLE exposure are important areas for further investigation.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0033291722000915.

Conflicts of interest. In the past 3 years, Dr Kessler was a consultant for Datastat, Inc., Holmusk, RallyPoint Networks, Inc., and Sage Therapeutics. He has stock options in Mirah, PYM, and Roga Sciences. Dr Stein in the past 3 years has received consulting income from Actelion, Acadia Pharmaceuticals, Aptinyx, atai Life Sciences, Boehringer Ingelheim, Bionomics, BioXcel Therapeutics, Clexio, EmpowerPharm, Engrail Therapeutics, GW Pharmaceuticals, Janssen, Jazz Pharmaceuticals, and Roche/Genentech. Dr Stein has stock options in Oxeia Biopharmaceuticals and Epivario. He is paid for his editorial work on *Depression and Anxiety* (Editor-in-Chief), *Biological Psychiatry* (Deputy Editor), and *UpToDate* (Co-Editor-in-Chief for Psychiatry). He has also received research support from NIH, Department of Veterans Affairs, and the Department of Defense. He is on the scientific advisory board for the Brain and Behavior Research Foundation and the Anxiety and Depression Association of America. No other disclosures were reported.

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Ethical standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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