Prospective associations of emotion reactivity and risk behaviors with suicide attempts in US Army soldiers

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Abstract

Background. Emotion reactivity and risk behaviors (ERRB) are transdiagnostic dimensions associated with suicide attempt (SA). ERRB patterns may identify individuals at increased risk of future SAs.

Methods. A representative sample of US Army soldiers entering basic combat training ($n = 21\,772$) was surveyed and followed via administrative records for their first 48 months of service. Latent profile analysis of baseline survey items assessing ERRB dimensions, including emotion reactivity, impulsivity, and risk-taking behaviors, identified distinct response patterns (classes). SAs were identified using administrative medical records. A discrete-time survival framework was used to examine associations of ERRB classes with subsequent SA during the first 48 months of service, adjusting for time in service, socio-demographic and service-related variables, and mental health diagnosis (MH-Dx). We examined whether associations of ERRB classes with SA differed by year of service and for soldiers with and without a MH-Dx.

Results. Of 21 772 respondents (86.2% male, 61.8% White non-Hispanic), 253 made a SA. Four ERRB classes were identified: 'Indirect Harming' (8.9% of soldiers), 'Impulsive' (19.3%), 'Risk-Taking' (16.3%), and 'Low ERRB' (55.6%). Compared to Low ERRB, Impulsive [OR 1.8 (95% CI 1.3–2.4)] and Risk-Taking [OR 1.6 (95% CI 1.1–2.2)] had higher odds of SA after adjusting for covariates. The ERRB class and MH-Dx interaction was non-significant. Within each class, SA risk varied across service time.

Conclusions. SA risk within the four identified ERRB classes varied across service time. Impulsive and Risk-Taking soldiers had increased risk of future SA. MH-Dx did not modify these associations, which may therefore help identify risk in those not yet receiving mental healthcare.

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US Army suicide rates increased sharply during the wars in Iraq and Afghanistan and have remained elevated (Black, Gallaway, Bell, & Ritchie, 2011; Gibson, Corrigan, Kateley, Youmans Watkins, & Pecko, 2017; Pruitt et al., 2018; Tucker, Smolenski, & Kennedy, 2019). There was a similar increase in non-fatal suicide attempts (SAs) during the same period (Ursano et al., 2015b). Identifying those at risk of attempting suicide is a difficult challenge (Franklin et al., 2017). Substantial proportions of soldiers entering service have a pre-enlistment history of mental disorder or suicidal thoughts and behaviors (Rosellini et al., 2015; Ursano et al., 2015a). Knowledge of these histories can help identify soldiers at risk of attempting suicide during service (Naifeh et al., 2022b). Transdiagnostic dimensions, such as emotion reactivity and risk behaviors (ERRB), may also help identify risk for future suicidal behavior.

Emotion reactivity, impulsivity, and risk-taking are three ERRB dimensions that have been conceptualized and measured in a variety of ways (Becerra & Campitelli, 2013; Lynam & Miller, 2004). Emotion reactivity has been defined as the degree to which an individual's emotional responses tend to be intense, prolonged, and elicited by a broad range of stimuli (Nock, Wedig, Holmberg, & Hooley, 2008). Elevated emotion reactivity is associated with increased risk for suicidal thoughts and behaviors (DeCou & Lynch, 2019; Dour, Cha, & Nock, 2011; Najmi, Wegner, & Nock, 2007; Nezu et al., 2017; Nock et al., 2008; Polanco-Roman, Moore, Tsypes, Jacobson, & Miranda, 2018), including among active-duty soldiers (Naifeh et al., 2022a). Impulsivity has played a prominent role in some conceptualizations of suicidal behavior (Baumeister, 1990; Mann, Waternaux, Haas, & Malone, 1999). A meta-analysis

found a significant but modest relationship between trait impulsivity and suicidal behavior (Anestis, Soberay, Gutierrez, Hernandez, & Joiner, 2014). Risk-taking was associated with a history of non-fatal SAs among decedents (Athey et al., 2018). A representative survey of US Army soldiers found that extreme risk-taking predicted the transition from suicide ideation to SA (Nock et al., 2018). While these dimensions are individually associated with risk of SA to varying degrees, far less is known about the patterns of co-occurrence of these dimensions and how those patterns of ERRB may prospectively predict SA risk.

Here, we use data from the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS) New Soldier Study (NSS) (Ursano et al., 2014) to prospectively examine patterns of ERRB as predictors of risk for SA during the first 4 years of service in the US Army. The first 4 years of service is generally equivalent to soldiers' first term of enlistment and is the Army career phase associated with the highest risk of SA (Ursano et al., 2015c). Using a representative survey of soldiers in their first week of Army service, we identify latent subgroups (classes) of soldiers based on ERRB dimensions. We then examine the prospective association of those classes with first medically documented SA during service, before and after adjusting for important socio-demographic and service-related characteristics. Identifying risk factors for SA in those who are unknown to the mental healthcare system is a particularly important challenge for suicide prevention (Britton et al., 2012; Naifeh et al., 2022b; Ursano et al., 2018). Roughly one-third of US Army suicide attempters do not receive a mental health diagnosis prior to their first SA (Naifeh et al., 2022b; Ursano et al., 2018). Therefore, we also examine whether ERRB classes differentially predict SAs among those who do and do not receive a mental health diagnosis prior to their SA.

Method

Sample

The NSS was administered to representative samples of US Army soldiers beginning Basic Combat Training (BCT) at Fort Benning, GA, Fort Jackson, SC, and Fort Leonard Wood, MO between April 2011 and November 2012. Recruitment began by selecting weekly samples of 200–300 new soldiers at each BCT installation. Soldiers attended an informed consent presentation within 48 h of reporting for duty. The presentations explained study purposes, confidentiality, and voluntary participation, then answered all attendee questions before seeking written informed consent to give a computerized self-administered questionnaire (SAQ) and neurocognitive tests, and to link these data prospectively to the soldier's administrative records. Study recruitment and consent procedures were approved by the Human Subjects Committees of Army STARRS collaborating organizations.

The 21 772 NSS respondents considered here represent all Regular Army enlisted soldiers who completed the SAQ and agreed to administrative data linkage (77.1% response rate). Data were doubly-weighted to adjust for differences in survey responses among the respondents who did v. did not agree to administrative record linkage, and differences in administrative data profiles between the latter subsample and the population of all new soldiers. Specifically, we obtained de-identified administrative data for the entire Army and for survey respondents who agreed to administrative data linkage, allowing two weights to be created to adjust for non-response bias (i.e. discrepancies between

the analytic sample and target population). Each weight was constructed based on an iterative process of stepwise logistic regression analysis designed to arrive at a stable weighting solution. Weight 1 (W1) adjusted for discrepancies between survey completers with and without administrative record linkage based on a prediction equation that used SAQ responses as predictors: W1 = $1/p1$, where $p1$ is the probability of consenting to administrative data linkage. Weight 2 (W2) adjusted for discrepancies between weighted (W1) survey completers with record linkage and the target population based on a prediction equation that used a small set of administrative variables as predictors (e.g. age, sex, rank): W2 = $1/p2$, where $p2$ is the probability of survey completion. These doubly-weighted (W1 × W2) data were used in all of the current study's analyses. More details on NSS clustering and weighting are reported elsewhere (Kessler et al., 2013).

Using the survey-linked administrative data, person-month records were created by coding each month of a soldier's career separately for each administrative variable and allowing values to change over time (Singer & Willett, 2003; Willett & Singer, 1993). Respondents were followed via administrative data for up to 48 months, which is commonly the length of the first term of enlistment. The actual number of administrative person-months available for NSS respondents varied because of attrition.

Measures

Outcome variable

Suicide attempt. Non-fatal SAs were identified using administrative records from: the DoD Suicide Event Report (DoDSER) (Gahm et al., 2012), a DoD-wide surveillance mechanism that aggregates information on suicidal behavior via a standardized form completed by medical providers; and codes from ICD-9-CM (E950–E958; indicating self-inflicted poisoning or injury with suicidal intent) (Centers for Disease Control and Prevention, 2013) and ICD-10-CM (X71–X83, indicating intentional self-harm; T36–T65 and T71, where the 5th or 6th character indicates intentional self-harm; and T14.91, indicating SA not otherwise specified) (Centers for Disease Control and Prevention, 2019; Hedegaard et al., 2018) in the Military Health System Data Repository (MDR), Theater Medical Data Store (TMDS), and TRANSCOM (Transportation Command) Regulating and Command and Control Evacuating System (TRAC^{2}ES), which together provide healthcare encounter information from military and civilian treatment facilities, combat operations, and aeromedical evacuations (online Supplementary eTable 1).

Predictor variables

Administrative variables. Administrative personnel records (online Supplementary eTable 1) were used to identify time-varying and time-invariant socio-demographic (gender, current age, race, education, marital status) and service-related [rank, deployment status (never deployed, currently deployed, previously deployed)] characteristics. Administrative medical records were used to create an indicator variable for mental health diagnosis during Army service based on ICD-9-CM and ICD-10-CM mental health diagnostic codes and mental health-related V-codes and Z-codes (e.g. stressors/adversities, marital problems), excluding postconcussion syndrome and tobacco use disorder (online Supplementary eTable 2). Person-months were coded such that once a mental health diagnosis was recorded in an individual's records, that month and all

subsequent months were coded as positive for previous mental health diagnosis.

Self-reported baseline survey variables. SAQ items assessing dimensions of ERRB were used to construct time-invariant baseline predictors. Items were prefaced with: *How well does each of the following statements describe you?* Response options ranged from 0 (*Not at all like me*) to 4 (*Exactly like me*). Emotion reactivity was assessed with two items (*I am a very emotional person*; and *I have very strong emotional reactions to things*) adapted from the Emotion Reactivity Scale (Nock et al., 2008). Impulsivity was assessed using two items adapted from the Negative Urgency subscale (*When I am upset I often act without thinking*; and *It is hard for me to resist acting on my feelings*) and two items adapted from the Sensation Seeking subscale (*I enjoy taking risks*; and *I sometimes like doing things just because they are dangerous*) of the UPPS Impulsive Behavior Scale (Magid & Colder, 2007; Whiteside & Lynam, 2001). Risk-taking that may harm others was assessed with one item (*I sometimes do things that might indirectly harm other people, like driving when I am drunk/high or not using protection when having sex with someone I don't know well*) adapted from the Structured Clinical Interview for DSM-IV-TR Axis II Personality Disorders (First, Gibbon, Spitzer, Williams, & Benjamin, 1997).

Analysis methods

Missing data on a given ERRB item ($\leqslant 7.8\%$) were imputed using the sample-wide median for that item. All seven baseline survey items assessing ERRB were standardized to have a mean of 0 and standard deviation of 1. To characterize the co-occurrence of these dimensions, we conducted a latent profile analysis (LPA) in Mplus 7.3 (Muthén & Muthén, 1998–2012). Competing solutions were compared on model fit and conceptual interpretability of derived classes. Model fit was evaluated based on the log-likelihood, Akaike information criterion, Bayesian information criterion (BIC), entropy, and Lo–Mendell–Rubin (LMR) adjusted likelihood ratio test. Priority was given to BIC and LMR based on evidence that they are the most robust measures of model fit (Nylund, Asparouhov, & Muthén, 2007).

A variable indicating class membership was constructed for use as a predictor of SA in subsequent analyses, all of which were performed in SAS version 9.4 (SAS Institute Inc., 2013). Person-month data were analyzed using discrete-time survival analysis with a logistic link function (Singer & Willett, 2003; Willett & Singer, 1993). Logistic regression analyses examined the association of class membership with first documented SA during the first 4 years of Army service, before and after adjusting for socio-demographic variables, service-related variables, and administrative mental health diagnosis. A two-way interaction examined whether the association of class membership with SA differed for those with *v.* without an administrative mental health diagnosis. All models accounted for changes in SA risk across time in service using splines (piecewise linear functions) that were identified in previous analyses of these data (see online Supplementary eFig. 1) (Naifeh et al., 2022b).

Logistic regression coefficients and their confidence limits were exponentiated to obtain estimated odds ratios (OR) and 95% confidence intervals (95% CI). Standard errors were estimated using the Taylor series method (Wolter, 1985) to adjust for the weighting and clustering of the NSS data. Multivariable significance tests in the logistic regression analyses were made using Wald χ^2 tests based on coefficient variance–covariance matrices that were

adjusted for design effects using the Taylor series method. Statistical significance was evaluated using two-sided design-based tests and the 0.05 level of significance. Within ERRB classes, χ^2 tests were used to examine differences in SA rates by year of service.

Results

Sample characteristics

In the total cohort, weighted person-months were mostly male (87.6%), White Non-Hispanic (60.9%), had at least a high school education (91.0%), not married (61.8%), at least 21-years-old (72.9%), E4 or higher rank (50.2%), and never deployed (74.0%). Person-months in which a SA occurred ($n = 253$) were mostly male (75.4%), White Non-Hispanic (59.9%), at least high school educated (84.4%), not married (60.8%), age 21 years or older (61.6%), E3 or lower rank (71.0%), and never deployed (74.5%) (Table 1).

LPA of the ERRB dimensions

LPA of the seven standardized items assessing dimensions of emotional and behavioral functioning tested 2–6 classes, all of which converged (online Supplementary eTable 3). The four-class solution was selected because it was interpretable and demonstrated improved fit relative to the three-class solution, including a lower BIC (398 409.3 *v.* 401 002.0) and significant LMR ($p < 0.0001$). Although the five-class solution had a lower BIC (384 567.4), LMR was non-significant ($p = 0.99$). We examined the pattern of mean scores within each class in the four-class solution and named the ERRB classes with consideration of their highest scoring dimension(s): 'Indirect Harming' (8.9% of soldiers), 'Impulsive' (19.3%), 'Risk-Taking' (16.3%), and 'Low ERRB' (55.6%) (Fig. 1).

Association of class membership with SA

In a model that adjusted only for time in service, class membership was significantly associated with subsequent SA ($\chi^2_3 = 17.7$, $p = 0.0005$), with soldiers in the Impulsive [OR 1.8 (95% CI 1.3– 2.4)] and Risk-Taking [OR 1.6 (95% CI 1.1–2.2)] classes having significantly higher odds relative to those in the Low ERRB class. These associations persisted after adjusting for socio-demographic and service-related variables, and mental health diagnosis (Table 2). The two-way interaction between class membership and mental health diagnosis was non-significant. Within each of the four classes, SA rates differed across the 4 years of service ($\chi^2_3 = 112.6$–260.0, all p's < 0.0001) (Fig. 2).

Discussion

Using a representative sample soldiers surveyed upon entering the Army and followed for 48 months through administrative records, we identified four classes of ERRB and their association with future SA. Nearly one-fifth of soldiers fell into the Impulsive class, characterized by heightened emotion reactivity and a tendency to act rashly when distressed ('negative urgency'). More than 16% were in the Risk-Taking class, characterized by heightened levels of sensation seeking but low levels on all other dimensions. Approximately 9% fell into the Indirect Harming class, differentiated by the tendency to engage in risky behaviors that may harm others. The remaining soldiers, more than half of

Table 1. Distribution of sample characteristics among a cohort of Regular Army enlisted soldiers over their first 4 years of service[a]

	Suicide attempt cases		Total cohort	
	Unweighted person-months	Weighted percentage	Unweighted person-months	Weighted percentage
	N	%	N	%
Gender				
Female	63	24.6	101 936	12.4
Male	190	75.4	737 990	87.6
Race/ethnicity				
White non-Hispanic	155	59.9	539 990	60.9
Black	63	22.7	169 884	20.6
Other	35	17.4	130 052	18.5
Education				
<High school[b]	38	15.6	70 559	9.0
High school or more	215	84.4	769 367	91.0
Marital status				
Not married	152	60.8	526 622	61.8
Currently married	101	39.3	313 304	38.2
Current age				
≤20 years	93	38.4	218 135	27.1
≥21 years	160	61.6	621 791	72.9
Rank				
E1	30	11.2	50 694	6.1
E2	51	17.3	108 019	13.0
E3	96	42.5	256 985	30.8
E4+	76	29.0	424 228	50.2
Deployment status				
Never deployed	197	74.5	625 276	74.0
Currently deployed	11	5.8	65 777	8.0
Previously deployed	45	19.7	148 873	17.9
Administrative mental health diagnosis				
Yes	173	68.3	171 248	20.8
No	80	31.7	668 678	79.2
Total	**253**	**100**	**839 926**	**100**

[a]The survey respondents considered here were Regular Army enlisted soldiers (*n* = 21 772). Survey-linked administrative person-month records were examined through 48 months of service. The number of available person-month records for a given soldier varied because of attrition from service.
[b]<High School includes: General Educational Development credential (GED), home study diploma, occupational program certificate, correspondence school diploma, high school certificate of attendance, adult education diploma, and other non-traditional high school credentials.

those entering Army service, were in the low overall ERRB class, characterized by low levels on all dimensions. Soldiers who were Impulsive and those who were Risk-Taking were significantly more likely to attempt suicide during service than those in the low ERRB class. These associations persisted even after adjusting for socio-demographic and service-related characteristics and mental health diagnosis. The association of class membership with SA did not differ for those with *v.* without a mental health diagnosis, suggesting that impulsive and risk-taking characteristics may help identify SA risk even in soldiers who are unknown to the mental healthcare system. Overall, the findings indicate that

knowledge of ERRB may assist in detecting future SA risk among soldiers. It would be valuable for future research to specifically determine whether ERRB-related behaviors that are observable by peers and leaders during service are associated with these ERRB classes. This would aid in peers, leaders, and family members identifying soldiers at risk and enable the opportunity for intervention or referral for care.

Soldiers in the Impulsive class, a group at increased risk of attempting suicide, report a tendency to have strong emotional reactions and to act without thinking when upset. These characteristics suggest that those soldiers may be more likely than
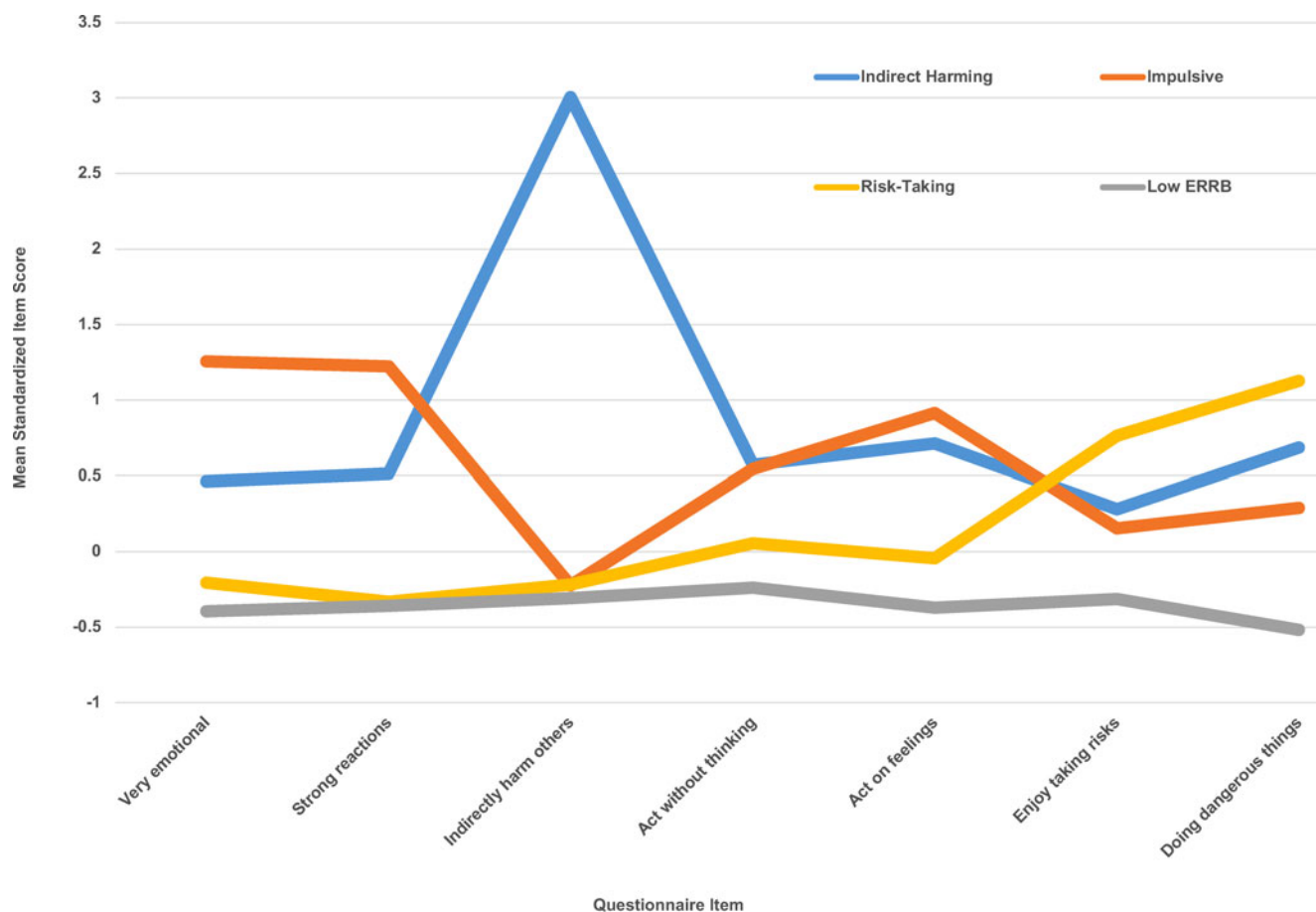
Fig. 1. A latent profile analysis of emotion reactivity and risk behavior (ERRB) items among 21 772 Regular Army enlisted soldiers resulted in the following four-class solution: Indirect Harming = 8.9%; Impulsive = 19.3%; Risk-Taking = 16.3%; Low ERRB = 55.6%.

Table 2. Univariable and multivariable associations of ERRB class membership with documented suicide attempts among a cohort of Regular Army enlisted soldiers over their first 4 years of service[a]

	Univariable[b]		Adjusted for socio-demographics and service-related variables[c]		Adjusted for socio-demographics, service-related variables, and mental health diagnosis[d]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
ERRB class						
Indirect harming	1.5	(0.9–2.3)	1.5	(1.0–2.4)	1.3	(0.8–2.1)
Impulsive	1.8*	(1.3–2.4)	1.6*	(1.2–2.2)	1.4*	(1.1–2.0)
Risk-taking	1.6*	(1.1–2.2)	1.6*	(1.2–2.2)	1.6*	(1.1–2.2)
Low ERRB[e]	1.0	–	1.0	–	1.0	–
χ^2_3	17.7* ($p = 0.0005$)		15.0* ($p = 0.0018$)		10.6* ($p = 0.0140$)	

ERRB, emotion reactivity and risk behaviors.
[a]The survey respondents considered here were Regular Army enlisted soldiers ($n = 21\,772$). Survey-linked administrative person-month records were examined through 48 months of service. The number of available person-month records for a given soldier varied because of attrition from service.
[b]Adjusted only for time in service (spline variables).
[c]Adjusted for time in service (spline variables), socio-demographic variables (gender, race/ethnicity, education, marital status), and service-related variables (rank, deployment status).
[d]Adjusted for time in service (spline variables), socio-demographic variables (gender, race/ethnicity, education, marital status), service-related variables (rank, deployment status), and administratively documented mental health diagnosis.
[e]Low ERRB, low scores on all items assessing dimensions of emotion reactivity and risk behaviors (ERRB).
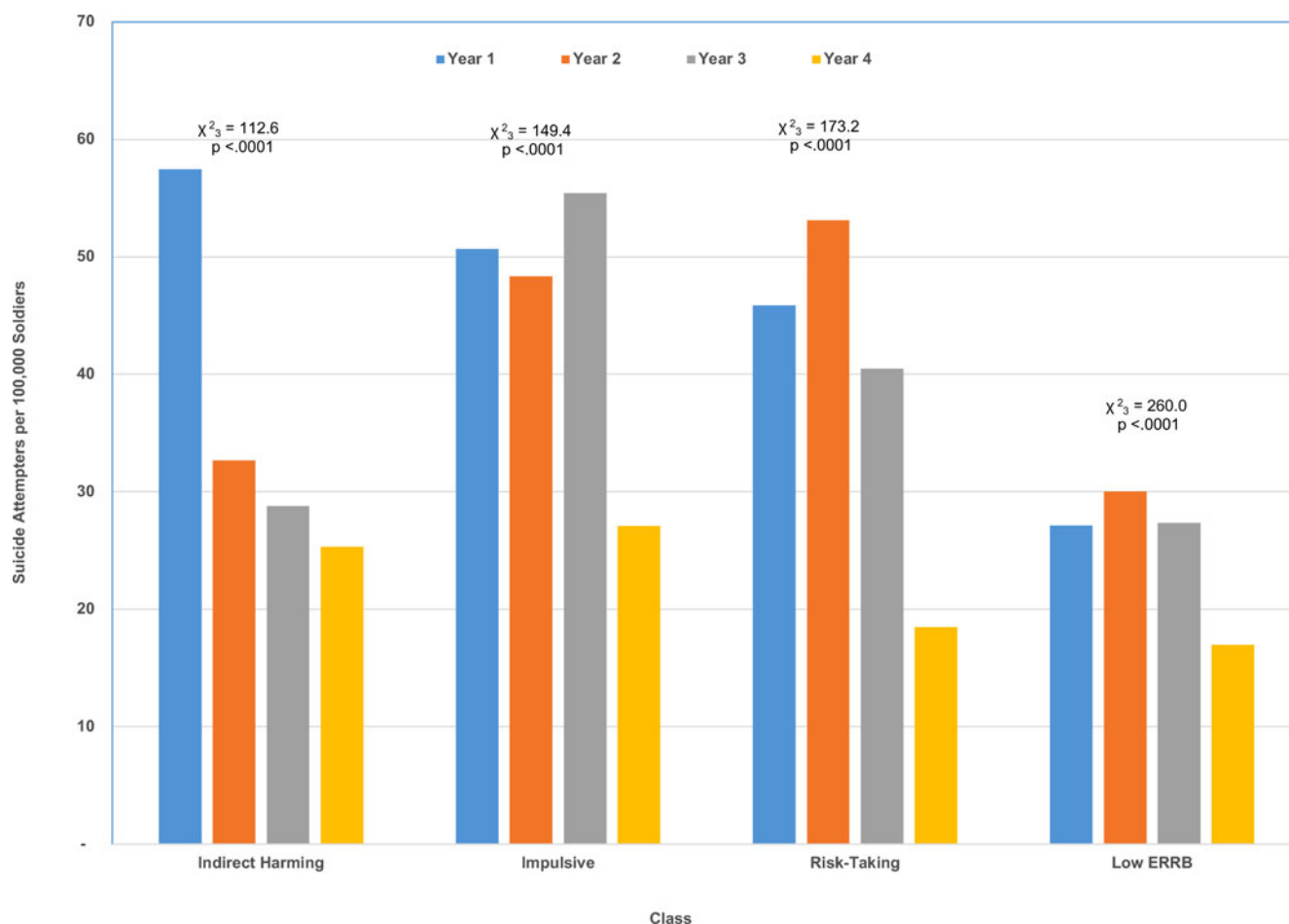*$p < 0.05$.

Fig. 2. Rate of suicide attempt by year of service for each emotion reactivity and risk behavior (ERRB) class.

soldiers in the other classes to rapidly transition from suicide ideation to SA, perhaps making an unplanned attempt (Chaudhury et al., 2016) following exposure to a stressor (Bagge, Glenn, & Lee, 2013). Given the potential challenges of preventing rapid transitions and unplanned SAs, it would be valuable to investigate the prevalence and predictors of unplanned attempts among solders in this Impulsive group.

It is noteworthy that we identified a distinct Risk-Taking group of soldiers at increased risk of SA. These soldiers are characterized by elevations only on the sensation-seeking items. Although some conceptualizations suggest that sensation seeking may be a component of impulsivity (Whiteside & Lynam, 2001), our findings support evidence that these are separate constructs (Harden & Tucker-Drob, 2011; Smith et al., 2007; Steinberg et al., 2008), and therefore may represent distinct pathways to SA.

Although we did not find a significant association between SA risk and the Indirect Harming group, this pattern of ERRB was distinct from the other classes. The Indirect Harming group involves recklessness or disregard for others that is not present in the other classes of soldiers. This is a potentially important distinction that warrants consideration in future research on other negative outcomes associated with risk-taking behavior, particularly those where other people may be injured in addition to the identified soldier, such as motor vehicle accidents.

The risk of SA for both the Impulsive and Risk-Taking classes varied across the first 4 years of service. This suggests that these types of behaviors interact with the stressors and life events occurring within particular Army career phases. Better understanding these specific career and life phase-related stressors can inform the targeting of interventions.

The findings of this study should be interpreted in light of the following limitations: First, administrative data may be incomplete and/or inaccurate. Medical records, which are subject to errors in clinician diagnosis and coding, are unlikely to capture all SAs and mental disorders. Second, we used abbreviated measures of emotion reactivity, negative urgency/impulsivity, and sensation seeking, which may not fully represent the constructs captured in the larger instruments from which they were adapted. Third, our outcome was limited to first documented SA during service. It is unknown if risk for repeated SAs would be similarly associated with these ERRB classes. Fourth, results are specific to enlisted soldiers in their first 4 years of service and to soldiers entering service during the study period. Therefore, the findings may not generalize to other service members or military eras, or to non-military populations.

With those limitations in mind, our findings indicate that certain ERRB patterns, assessed during the first week of Army service, are associated with future SAs. Specifically, soldiers classified as either Impulsive or Risk-Taking upon entering service had elevated risk of subsequently attempting suicide during their first 4 years in the Army, associations that persisted after controlling for socio-demographic, service-related, and mental

health variables. Importantly, class membership was associated with risk in soldiers who had never received a mental health diagnosis, and therefore had not been identified by the Army mental healthcare system prior to their SA. There is a need for research examining whether behaviors related to impulsivity and risk-taking that are observable by peers, family members, and military leaders, can be used in place of self-report data to further aid in identifying soldiers at risk of attempting suicide. To assist clinicians assessing suicide risk, it will be important for future prospective research to examine whether soldiers in the Impulsive or Risk-Taking classes who have suicide ideation are more likely to rapidly transition to SA or have unplanned attempts as suggested in previous cross-sectional research (Naifeh et al., 2022a; Nock et al., 2018).

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