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Authors
Clint, Edward K
Fessler, Daniel MT

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Early adversity, adult lifestyle, and posttraumatic stress disorder in a military sample

Edward K. Clint[1] and Daniel M. T. Fessler[2,]

[1]The Neuroscience Program, University of Illinois, Urbana-Champaign, US

Edward K. Clint*
Beckman Institute
405 N. Mathews Ave.
Urbana, IL 61801
Email: clint1@illinois.edu

Daniel M. T. Fessler
Department of Anthropology; Center for Behavior, Evolution and Culture; and UCLA Bedari Kindness Institute
University of California, Los Angeles
Los Angeles, California, USA
dfessler@anthro.ucla.edu

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Early adversity is considered a major risk factor for adult PTSD. Simultaneously, however, early adversity is also known to contribute to psychological resilience, and, indeed, some high-adversity groups do not display elevated PTSD risk. We explored correlates of PTSD in the STARRS military data set to evaluate contrasting accounts of the relationship between early adversity and PTSD. The standard deficit model depicts ontogeny as inherently vulnerable to insult, such that early adversity yields a less robust adult phenotype. A complementary life history theory account holds that adverse early experiences cue a fast life history orientation that reduces investment in maintenance, yielding an adult phenotype less able to recover from trauma. An opposing life history theory account holds that early adversity cues expectations of an adverse adult environment, adaptively reducing reactivity to adverse events. We use principal component analysis to extract a latent variable representing several childhood experiences and multiple lifestyle factors that plausibly proxy life history orientation. After correcting for covariates, we find a strong positive influence of such proxies on PTSD risk, suggesting that early adversity may indeed increase risk for PTSD, and thus that either the standard deficit model, the reduced maintenance account, or a combination are correct.

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Introduction

Anxiety disorders are the most common mental illness in the United States. Over eight million Americans suffer from Posttraumatic Stress Disorder (PTSD); 6.8% of the population will develop PTSD at some time in their lives (Dückers et al., 2016). PTSD can be understood as a disorder of evolved defensive reactions following exposure to trauma (Cantor, 2009). Indeed, consistent with the condition's being rooted in species-typical psychology, despite some variation, it occurs across widely divergent sociocultural and ecological contexts (Zefferman & Mathew, 2021).

While trauma exposure is definitional to PTSD, there is nevertheless substantial inter-individual variation in the extent to which such experiences result in the condition. According to the DSM-5, pre-trauma risk factors include prior mental disorders, lower socioeconomic status, childhood adversity, minority racial status, and reduced social support (American Psychiatric Association, 2013). Risk is higher among females and younger adults. These individual factors predisposing PTSD risk support the deficit model of PTSD wherein one's ability to emotionally process a traumatic experience is debilitated by early adversity, resulting in dysregulated, overactive coping mechanisms persisting beyond their usefulness and long after the initial experience. This construal of adversity as cumulatively damaging or hindering an individual's cognitive and emotional capacity for coping with potentially traumatic experiences is a component of all major existing theories and perspectives on PTSD etiology.

Viewed from an evolutionary perspective, the deficit model can be understood in either of two ways. First, the extent of developmental canalization may have been inherently constrained. All else being equal, a developmental process robust to perturbation would seem optimal. However, all else is not equal, as such robusticity may be prohibitively expensive (coming, for example, at the expense of the pace of development, total number of offspring, etc.). If the average payoff across individuals of robust development exceeds the cost, canalization will be incomplete – in essence, selection will favor a degree of developmental fragility as a price worth paying, the consequence being that adverse early experiences may set the stage for multiple adult pathologies. Alternately, selection may favor developmental plasticity rather than canalization. Insults during development may constitute cues regarding the expected payoffs of enduring investments in maintenance.

Life history theory seeks to understand key aspects of the adult phenotype in terms of inherent tradeoffs between growth, reproduction, and longevity. Of direct relevance here, various versions of life history theory hold that adverse early experiences can indicate that, given corresponding expected high adult mortality, on average fitness will be optimized by devoting resources to rapid maturation and reproduction at the expense of longevity (Ellis et al., 2017; Figueredo et al., 2006; Hill & Kaplan, 1999; Simpson et al., 2012; Wu et al., 2020a). Considerable debate surrounds various applications of life history frameworks to individual variation among contemporary humans (see Frankenhuis & Nettle, 2020; Stearns & Rodrigues, 2020; Wu et al., 2020a). Furthermore, observers (see Frankenhuis & Nettle, 2020; Sear, 2020) have distinguished between the use of the life history framework in the measurement of features

directly associated with the key tradeoffs (such as morphological and physiological attributes; the timing of sexual maturation and reproduction; total fertility; etc.), and the use of this framework in the measurement of psychosocial features that, conceptualized as part of overall strategies, are more distally related to these tradeoffs (such as personality; sociosexual orientation; future discounting; cooperativeness; etc.). Critics (ibid.) argue that, unlike the former corpus, the latter body of work is too far removed from the tradeoffs central to life history theory to be informed by such considerations – and at least one study has found that, when psychometric measures are directly pitted against biodemographic indices more closely linked to the key tradeoffs, the former fail to predict the latter (Međedović, 2020).

While acknowledging the limitations of some translations of life history frameworks to the psychological domain, in an attempt to better illuminate the relationship between early experience and PTSD, here we suggest two applications of the life history approach which apply the construct of a life history strategy while conceptually centering the key principle of tradeoffs between growth, reproduction, and longevity. Deferring for the moment the details of how we operationalize life history strategy, below we outline these two theoretical applications.

First, if a harsh early environment is treated by evolved calibration mechanisms as predictive of high extrinsic mortality in adulthood, investments in rapid maturation and reproduction may be privileged over investments in long-term maintenance and repair, leading to a less resilient adult phenotype. This provides an ultimate explanation for the patterns posited by the conventional deficit model of PTSD etiology. Individuals who experienced adverse early environments will be more vulnerable to a variety of insults to fitness not because building resilience was inherently precluded by deprivation, but rather because the resources necessary for such resilience were instead committed to rapid growth and reproduction. If any potential gains from greater durability would likely be precluded by fatal challenges against which no degree of resilience would suffice, then building resilience yields lower expected payoffs than accelerating reproduction.

The deficit model of PTSD is both intuitive and supported by a considerable corpus of epidemiological findings. For example, for U.S. disaster workers who responded in the aftermath of the 9/11 terrorist attacks, PTSD incidence was higher among those whose lifestyle characteristics were associated with greater early adversity (Giosan & Wyka, 2009). However, not all available evidence supports this model. Despite the description present in the DSM-5, meta-analyses have shown that racial minority status – which, reflecting the consequences of discrimination, is frequently associated with adverse early experiences – is a weak or absent predictor (Bonanno et al., 2007; Roberts et al., 2011). Moreover, research into psychological resilience has demonstrated that, under certain circumstances, adversity is critical to developing resilience (Luthar, 2006). Within the U.S. military, reserve forces – who, being more educated and enjoying higher socioeconomic status, can be presumed to have suffered fewer adverse early experiences – sometimes have similar or higher PTSD rates compared to active-duty troops (Lane et al., 2012; Milliken et al., 2007). Lastly, a recent study of PTSD in 24 nations found that measures of adversity such as malnutrition, income inequality, and access to sanitation were

negatively, not positively, associated with rates of PTSD even controlling for exposure to traumatic experiences (Dückers et al., 2016). Such observations suggest that alternative accounts may be required.

Life history theory can again be a fertile source of possibilities. Emergency responses to imminent threats are costly. The value of extensive responses thus hinges in part on the expected frequency of crises, as frequent high levels of activation throughout adulthood will often not be sustainable. If early experiences provide cues of the expectable adult environment, then, in the service of sustainability, adverse early experiences may tamp down adult emergency reactivity. Such a pattern is particularly adaptive if many of the most significant sources of adult mortality are truly extrinsic, such that marshalling resources to address a source of danger will do little to buffer the individual against the threat. Rather than being wasted in the fruitless pursuit of longevity, such resources are instead better spent in enhancing reproduction. If PTSD constitutes a pathological chronic hyper-activation of emergency responses, then, being less reactive to crises, individuals with a history of adverse early experiences could actually be at lower risk of PTSD – the opposite prediction to that of the deficit model. In this application of life history theory, individuals who experience propitious early environments will deploy extensive resources in the face of fitness insults in order to pursue longevity; ironically, however, this very reactivity will make them vulnerable to pathologically excessive defensive responses that endure long after a momentous threat has passed.

Epidemiological data support the association of early adversity with such physiological and behavioral characteristics as faster development, more offspring, decreased self-investment, higher preference for risk-taking, more selfish and less pro-social attitudes, steeper future discounting and present-orientation, and a preference for shorter-term sexual relationships (Belsky et al., 2015; Brumbach et al., 2009b; Carver et al., 2014; Fisher et al., 2011; McDermott et al., 2021). In short, existing evidence suggests that there is indeed adaptive calibration of life history trajectory early in life. However, it remains an open question whether such traits reflect a phenotype in which the individual is more vulnerable to, or, conversely, better prepared for, potentially traumatic experiences.

To explore the competing possibilities described above, using a large military sample, we examined the extent to which early life adversity influences lifestyle and personality characteristics in adulthood that, in turn, may correlate with PTSD risk. A military sample affords relatively high rates of both exposure to traumatic events and PTSD, increasing statistical power for detecting correlated traits. For much of the past two decades, the U.S. was actively involved in armed conflict. Throughout this period, the U.S. military screened service members for PTSD following deployment. Relative to the general population, U.S. military personnel thus constitute a community both at greater risk of developing PTSD and more likely to have been evaluated for PTSD. The Study to Assess Risk and Resilience in Servicemembers (STARRS) dataset includes detailed records on exposure to potentially traumatic experiences, as well as personal, health, and lifestyle data, allowing for a multiplex assessment of life history orientation and its relationship with PTSD.

Sample

Our data derive from the United States Army STARRS Consolidated All Army Survey (AAS), an epidemiological study that combined data across 3 surveys:

1. The core AAS, a survey administered from 2011 to 2012 in a probability sample of 17,462 active Regular Army, National Guard, and Army Reserve units worldwide, excluding soldiers deployed or in basic training;
2. A 2012 to 2013 AAS expansion that surveyed 3,987 deployed soldiers stationed in Afghanistan while in Kuwait awaiting transit to or from mid-deployment leave; and
3. The baseline STARRS Pre-Post Deployment Survey, which surveyed 8,558 soldiers in 3 Brigade Combat Teams shortly before deploying to Afghanistan in 2012.

Recruitment, informed consent, and data collection procedures, described in more detail elsewhere (Kessler, Colpe, et al., 2013), were approved by the Human Subjects Committees of the Uniformed Services University of the Health Sciences (Bethesda, Maryland) for the Henry M. Jackson Foundation (the primary grantee), the Institute for Social Research at the University of Michigan (Ann Arbor, the organization collecting the data), Harvard Medical School (Boston, Massachusetts), and the University of California, San Diego (La Jolla). All study participants gave written informed consent.

Information on handling bias, including sample weighting, response rate, and sample exclusions, is reported elsewhere (Kessler, Heeringa, et al., 2013). We focus on the 21,449 respondents who completed a survey. We excluded respondents who did not consent to link their administrative records to their survey for analyses that include service component as a covariate. In total, 17,462 soldiers who completed the survey consented to administrative data linkage. 180 respondents were omitted because survey data did not include PTSD symptom and/or age data. 1443 were excluded due to reporting subadult-onset PTSD. A further 3,730 respondents' data did not include one or more set of survey items on which we conducted our life history orientation principal components analysis. This left a sample of n = 16,096; see Supplemental Table 1 for sample characteristics.

Methods

Variables extracted from STARRS

PTSD

A majority of participants answered 9 PTSD checklist (PCL)-based survey questions about PTSD symptoms (Bliese et al., 2008). 4,102 of those did not record age of onset, so a second survey item (see Table 2) and its associated age of onset was used where present (Weissman et al., 2000).

Exposure level

Participants responded to fourteen questions about potentially traumatic experiences (PTEs) during deployment (e.g., combat patrol duty, assault, firing rounds at the enemy or taking fire,

being wounded in combat). Each question asked about the number of times each PTE occurred during any previous deployment.

Early adversity measures

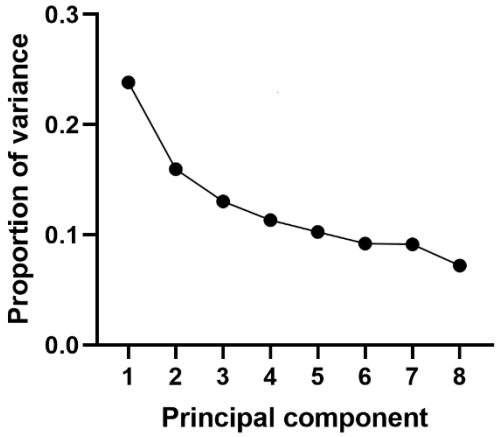
Parent's education. Maximum education level of either parent was used as a proxy for childhood SES. The dataset values ranged from 1 (No education) to 8 (post-graduate, see Supplemental Table 1).

Early head injuries. Childhood head injury sufficient to cause loss of consciousness, eardrum perforation, memory loss, or dazing comprised the second measure of early adversity. These four possible head injury conditions suffered in childhood were added together to form a composite with a range of 0 to 4. The multiple durations of "loss of consciousness" were collapsed into a binary value for the loss of consciousness injury condition prior to compositing with the other early age head injury conditions.

Life history construct

From the wide array of survey items employed in the STARRS, we identified those relevant to psychological traits hypothesized to be associated with differing life history orientations, including self-investment, relationship quality, prosociality, and reproduction (Brumbach et al., 2009a; Figueredo et al., 2006). Multiple survey items were composited for each of the eight categories: relationship quality, education, health, tobacco addiction, substance use and abuse, antisocial attitudes, criminal involvement, and number of children. When items within the same category used different scales, items were normalized by dividing the value by the maximum item value within each category. To facilitate interpretation of results, where necessary, scales were inverted such that a higher numerical value was consistent with the predicted trait associated with early adversity (see supplemental materials, life history category construction). A principal component analysis was performed on the eight category composites. The first principal component (PC1) accounted for a 23.8% plurality of the variance (see Fig. 1). Every category composite loaded positively and, other than the number of children item, quite substantially on PC1, therefore PC1 was selected as the life history orientation construct for subsequent analyses.

A.



B.

Component loading	PC1	PC2
Reproductive index	0.104	<|0.1|
Relationship quality / mating style	0.375	-0.402
Education (self)	0.401	0.457
Tobacco addiction	0.379	0.564
Substance use/abuse	0.379	0.201
Antisocial attitudes	0.404	-0.367
Criminal justice involvement	0.280	-0.250
Health	0.399	-0.270

Figure 1. Principal component analysis (PCA) of the lifestyle latent variables. A. Proportion of variance explained by each of the eight principal components. B. Loadings of PC1 and PC2 on the eight variables. For information on how the variables were constructed from the STARRS dataset, see methods and supplementary materials.

Covariates

Age, race, sex, service component, location of the interview.

Age was a continuous variable. Sex was a binary variable. Race was coded in three ways, white or not white, Black or not Black, or as a categorical variable with 8 levels (white, Black, Native American, Asian, Pacific Islander, Hispanic/Latino, bi-racial, or other). These were exclusive categories, i.e., individuals were placed in one and only one category. Multi-racial refers to individuals who checked yes to at least two of the categories. Service component was a categorical binary of active duty or not, in which "not" meant a member of the National Guard or Reserve who had been activated and deployed. Location of the interview was coded as a categorical variable with 3 levels: United States, overseas base, and overseas theater.

Subjective coping resources.

Subjective coping resources act as buffers against stress and adversity. These can include the degree of direct and indirect social support, as well as pre-trauma well-adjustedness. For deployed soldiers, their professional setting is also their de facto community and base of social support for months or longer. Therefore, their view of the degree of acceptance, respect, support, competence, fairness, and professionalism should be an important factor aiding them in coping with PTEs. The 14 items chosen for this composite included the participant's rated morale, whether they feel discriminated against, the degree to which they can rely on peers and superiors for help, how well leaders treat soldiers, and whether they respect the unit leadership (for a complete list, see Supplemental Table 2). Coding of eight of the variables was inverted so that higher values consistently indicated greater subjective coping resources across all items. The items were normalized and averaged together to produce the coping resources composite variable.

Resilience to stress.

Participants responded to five items by indicating their ability to keep calm in a crisis; manage stress; try new approaches when old ways do not work; get along with people when "you have to"; and keep a sense of humor in tense situations. The encoding was inverted so that higher values indicated increased self-reported resilience. They were summed to produce the resilience composite variable.

Statistical analysis

Data were analyzed using RStudio version 1.4.1106. Principal component analysis was used to extract the main axis of variation (PC1) from the eight compiled measures of life history orientation described above. Probability of PTSD diagnosis was analyzed as a linear function of multiple continuous and categorical predictor variables using logistic regression implemented using the "glm" function and entering family as "binomial". Fisher's exact test was used for pair-wise comparisons of the probability of PTSD diagnosis between two groups without correcting for any covariates (e.g., two sexes, two races). Mediation analysis was conducted using the mediation library in R. Two separate mediation analyses were conducted for each of the early adversity measures: number of head injuries and parent's education level. Specifically, the extent to which each of the early adversity measures influenced PTSD probability via its influence on the life history construct (PC1 from the principal component analysis; see above) was evaluated. Correlations between two continuous variables were evaluated using Pearson's correlation coefficient.

Results

Early adversity increases PTSD risk

Analysis of PTSD risk as a function of early head injuries showed a positive correlation by logistic regression (no covariates, slope = 0.3; $p < 0.0001$). Parent's education was significantly negatively correlated with PTSD risk (no covariates, slope = -0.035, $p = 0.01$). The two measures of early adversity were weakly positively correlated with each other (Pearson's $r = 0.073$; $p < 0.0001$).

Life history metric

The first principal component (PC1) extracted from 44 variables (See Supplemental Table 2) explained 23.8 % of the variation in the data (Fig. 1a). Each of the variables were positively loaded on PC1, indicating that all the variables contributed to PC1 in the expected direction, with weights shown in Figure 1.

Life history strongly predicts PTSD risk

In a logistic regression analysis predicting PTSD risk as a function of exposure, number of head injuries in childhood, parent's education, survey location, service component (active duty versus guard/reserve), sex, coping, resilience, age, race, and PC1, all variables were significant (type III sums of squares) except parent's education (Table 1). Race was marginally insignificant ($p = 0.057$). We analyzed race both as a categorical variable with 8 levels (see

above), and, on the presumption that, although many people of color suffer discrimination in the U.S., on average, Black individuals plausibly suffer the greatest disadvantage, as a binary variable (entered as Black or not Black). In all cases, race remained not significant (all $p > 0.05$).

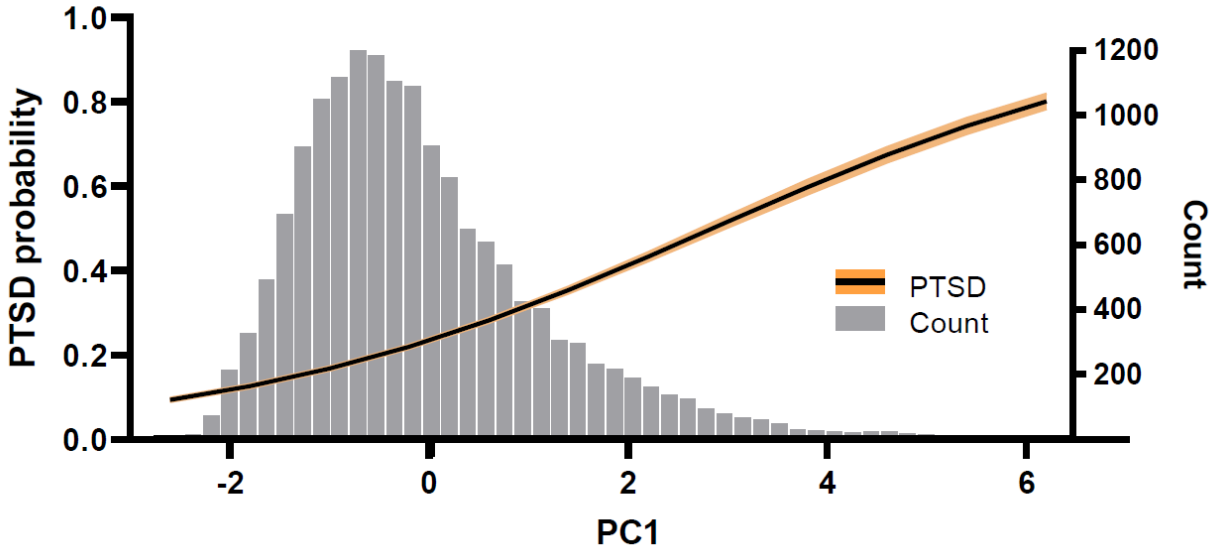


Figure 2. Estimated probability of PTSD (+- SE) as a function of lifestyle orientation (PC1) and PC1 frequency histogram. PTSD probability is estimated from the linear model shown in Table 1, with all the covariates entered as average values from the sample, and in cases where the variables are categorical, we entered the first level as coded which ended up being male, white, active duty, base location. Lifestyle orientation as measured by PC1 is significantly positively associated with PTSD risk after controlling for all covariates in the full model.

Table 1. PTSD risk logistic regression model.

Coefficients:		Estimate	Std Error	z value	Pr(>|z|)	
Intercept		0.0661297	0.190663	0.347	0.728711	
Early age head injury		0.2211061	0.0241605	9.152	< 2e-16	***
Parent's education		0.0035155	0.016437	0.214	0.830643	
Location: base overseas		-0.1353677	0.0615893	-2.198	0.027955	*
Location: US		0.1164747	0.0443292	2.627	0.008602	**
Service component: active duty		0.1229113	0.0449158	2.736	0.00621	**
Service component: Guard/Reserve		-0.2372191	0.0725868	-3.268	0.001083	**
Deployment PTE exposure		0.0282604	0.0009696	29.148	< 2e-16	***
Sex (male)		-0.3920696	0.0323226	-12.13	< 2e-16	***
Age		0.0348802	0.0030193	11.553	< 2e-16	***
Coping		-1.6510042	0.1553754	-10.626	< 2e-16	***
Resilience		-0.0768164	0.005145	-14.93	< 2e-16	***
Race	White	-0.058453	0.0532114	-1.099	0.271984	
	African American	-0.1396394	0.0688697	-2.028	0.042602	*
	Native American	-0.3546507	0.1769375	-2.004	0.045029	*
	Asian	0.0995306	0.1157165	0.86	0.38972	

	Pacific Islander	0.2702698	0.1850988	1.46	0.144252	
	Other	0.0494713	0.1558409	0.317	0.750904	
	Mixed	0.1651128	0.100555	1.642	0.100587	
PC1		0.1848043	0.063825	2.895	0.003786	**
Resilience:PC1		0.0118682	0.0033352	3.558	0.000373	***

ANOVA type-3	DF	Deviance	Pr(>Chi)	
Early age head injury	1	82.95	< 2.2e-16	***
Parent's education	1	0.05	0.8306318	
Location of survey	2	7.6	0.0223668	*
Service component (Guard/reserve)	2	13.13	0.0014102	**
Deployment PTE exposure	1	899.75	< 2.2e-16	***
Sex	1	141.84	< 2.2e-16	***
Age	1	131.68	< 2.2e-16	***
Coping	1	112.81	< 2.2e-16	***
Resilience	1	224.48	< 2.2e-16	***
Race	7	13.67	0.0574666	.
PC1	1	8.59	0.0033826	**
Resilience:PC1	1	12.45	0.0004188	***

Race is not a significant predictor of PTSD risk even without correcting for covariates

We also analyzed PTSD risk as a function of *only* race (Black or not Black) absent other factors. The result was marginally not significant with the trend toward *reduced* PTSD risk for Black soldiers ($p = 0.09381$). When all races were entered as a categorical variable (1-8), race was also marginally not significant ($p = 0.05$).

Sex is a highly significant predictor of PTSD risk

Without correcting for any covariates, women displayed a 1.27-fold increased risk compared to men. This difference was larger (1.71-fold) after correcting for all covariates (Supplemental Figure 1b).

Number of traumatic experiences is also a strong predictor of PTSD risk

Figure 3 shows the probability of suffering PTSD as a function of the number of traumatic experiences (first quartile, mean, third quartile), separately for individuals with a low versus high score for PC1 (first and third quartiles for PC1), illustrating the large effect that life history orientation has on risk independent of the number of traumas experienced.

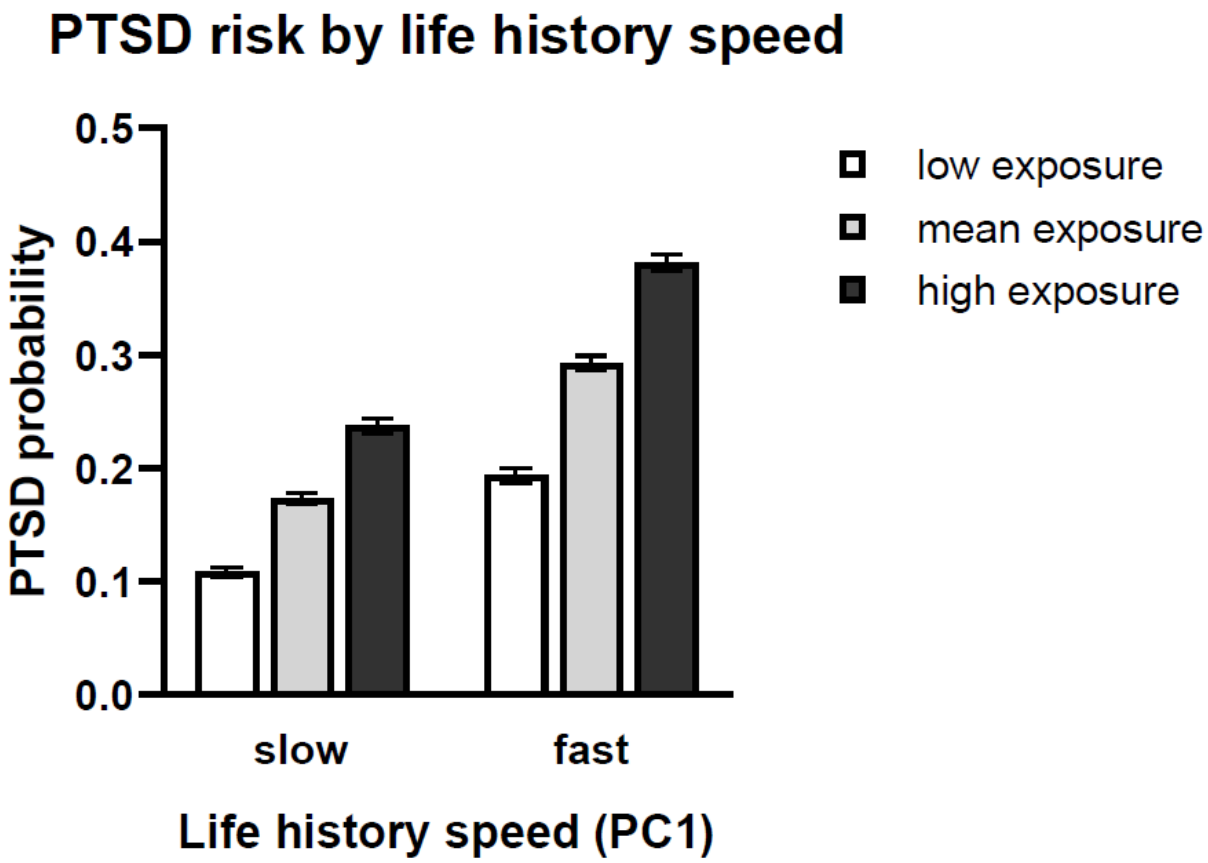


Figure 3. Estimated probability of PTSD (+- SE) shown for three levels of exposure to potentially traumatic experiences during deployment for representative low versus high score for the lifestyle factor (PC1). PTSD risk increases with the lifestyle latent variable independent of degree of exposure to potentially traumatic experiences during deployment. Estimates were from a linear model that included all the covariates entered as average values from the sample, and in cases where the variables are categorical, we entered the first level as coded which ended up being male, white, active duty, base location. Exposure levels were the first, second, and third quartiles in the sample (Exp = 0.0, 19.3, 33.3). First and third quartiles were used for low and high values for the lifestyle construct (PC1 = -0.885, 0.751).

Guard and reserve soldiers had a marginally lower value for life history orientation, and lower PTSD risk

Active duty status was associated with increased PTSD risk after controlling for all covariates ($s = 0.1852$, $p < .001$, n = 1.)

Mediation analysis

Results reveal that both early adversity measures affected PTSD risk via life history characteristics. The number of early head injuries had a significant direct effect and a significant mediation effect (Table 2). Approximately 25% of the total effect was mediated via life history factors. Parent's education did not have a significant direct effect, but there was a significant mediation effect (Table 2). Approximately 84% of the total effect was mediated by life history factors.

Table 2. Mediation analysis

Early-age head injuries		
effect	estimate	p-value
direct effect	0.0368	<0.0001
indirect effect	0.0127	<0.0001
total effect	0.0504	<0.0001
proportion mediated by PC1	0.2515	<0.0001

Parent's education		
effect	estimate	p-value
direct effect	-0.00102	0.694
indirect effect	0.00607	<0.0001
total effect	0.005041	0.076
proportion mediated by PC1	1.128891	0.076

Discussion

The hypothesis that a life history orientation associated with early adversity could buffer against PTSD risk was not supported in our results. To the contrary, a life history orientation characterized by greater risk-taking, anti-social behavior, and fewer long-term investments was a potent positive predictor of PTSD risk. At the lower end of the life history orientation distribution (associated with a nurturing early environment), PTSD risk was about 15%; at the higher end (associated with a harsh early environment), this risk was over 50% (Fig. 2). This relationship held even controlling for exposure, early adversity, sex, age, race, resilience, and subjective coping resources. In our analytic model, a soldier at the low end of the life history construct (PC1 first quartile) would require more than double the number of exposures to potentially traumatic events to equal the PTSD risk for the high end (PC1 third quartile) given mean exposure. Few epidemiological PTSD studies have controlled for both the frequency and degree of exposure to potentially traumatic experiences and pre-existing childhood trauma.

Evolutionary perspectives on PTSD

To our knowledge, we are the first to hypothesize that a fast life history orientation might buffer PTSD risk. Our analysis does not support this hypothesis. Instead, it supports the prevailing deficit model, an account congruent with either constrained developmental canalization, or the dominant view among psychological life history theorists, namely that health, including mental health, is traded off against other demands among “faster” individuals (Del Giudice, 2014; Giosan & Wyka, 2009): the fast life history developmental syndrome sacrifices elements of phenotypic robustness in order to prioritize faster development and earlier reproduction, similar to the way that immune system competence and somatic maintenance are diminished. This appears to extend to the mind as well, with fewer resources dedicated to

managing substantial adversity because superlative (versus adequate) coping with such adversity may principally benefit only those phenotypes betting on a longer life.

We acknowledge that it is difficult to fully adjudicate among the possible explanations described above. While this application of life history theory can be seen as complementing the standard deficit model, providing an account of ultimate causation that interdigitates with the latter's proximate explanation, yet, by virtue of their complementarity, it is difficult to determine whether one, the other, or the combination of these accounts is correct. Nevertheless, some evidentiary space may exist between the stand-alone conventional deficit model and a version thereof that is informed by life history theory. Specifically, in addition to making sensical the relationships between early experience, adult lifestyle factors, and PTSD risk, it is possible that the addition of life history highlights some aspects of developmental experience that underspecified notions of "abuse and neglect" might otherwise overlook. For example, investigators have only recently begun exploring the covariation between (conventionally defined) adverse childhood experiences and childhood food insecurity (e.g., Baiden et al., 2021). However, whereas a deficit approach explains the detrimental developmental effects of the latter in terms of nutritional inadequacy, a life history perspective dictates that, even if nutritional needs are met, the experience of food insecurity may constitute a developmental cue that, being predictive of an adverse adult environment, results in a faster life history strategy (Nettle, 2017), including both associated lifestyle factors and reduced investment in maintenance, with corresponding increased vulnerability to disorders such as PTSD.

Lastly, adjudicating among the potential explanations for results such as ours is further complexified by the possibility that patterns evident among contemporary soldiers in a highly developed nation may reflect evolutionary disequilibrium. The virtues associated with a nurturing environment, e.g., prosociality, conscientiousness, and self-investment in education and skill, are all highly rewarded in the U.S. Conversely, potential virtues theorized to result from a harsher environment, e.g., aggression, risk-taking, and short-term mating preferences, are today punished by law or social censure. In addition, early adversity increases the risk of poverty (Frederick & Goddard, 2007), and, in the U.S., poverty exacerbates and magnifies many hindrances to flourishing that compromise coping resources, such as a lack of access to healthcare, the inability to legally defend oneself from undue insults of the state, poor access to quality education, poorer nutrition, and food insecurity.

Early adversity

Working within the constraints of the STARRS dataset, our lack of rich data on early adversity is a significant limitation of the current study. The direct association between head injuries during childhood and PTSD risk could be mediated by traumatic brain injuries, as traumatic brain injuries have been associated with PTSD risk in previous studies (Hoge et al., 2008; Miller et al., 2015; Schneiderman et al., 2008; Yurgil et al., 2014). The mediated effect suggests physical damage to the brain also interacts with resulting life history orientation that, in turn, increases PTSD risk. The SES proxy of parent's education was a weak but significant

positive predictor of the life history orientation composite variable (without covariates) and PTSD (without covariates, see Figure S1 C), consonant with predictions and previous studies (Bonanno et al., 2007; Breslau et al., 1998; Brewin et al., 2000; Koenen et al., 2007). The mediation analysis suggests that the influence of parent's education on PTSD risk was nearly entirely indirect, through its influence on the life history latent variable. More early adversity measures that do not involve head trauma, such as other SES measures, witnessing violence, losing family members, food insecurity, and harsh and inconsistent parenting, are needed to strengthen the evidence for a positive association between early adversity and the life history construct.

Race

We found a small, marginally non-significant effect of race, such that being Black, arguably the most disadvantaged racial identity in the U.S., trended toward offering protection from PTSD. The deleterious effects of discrimination and racism on mental health have long been a focus in psychopathology research, particularly for Black and Latinx individuals in the U.S. These effects are implicated in elevated rates or severity of depression, anxiety, and substance use disorders among some racial minorities. The deficit model predicts substantially increased PTSD rates for persecuted minority groups, particularly when exposure to potentially traumatic experiences is higher. Although elevated risk for PTSD among minorities has been reported (Breslau et al 2004), controlling for appropriate factors such as SES, life stress, and degree of exposure tends to eliminate effects of race (Brewin et al, 2000; Bonanno et al, 2007; but contra Roberts et al 2011). Accordingly, we conclude that direct measures of adversity and lifestyle are likely more informative than race as regards PTSD risk.

Age

Previous studies generally find PTSD risk to be somewhat higher among younger adults (Bonanno et al., 2007; Brewin et al., 2000). However, results from military samples have been mixed in this regard (Xue et al., 2015). We found a small (slope = 0.035, $p < 0.0001$) positive association between age (older) and PTSD risk when controlling for covariates. Holding aside geopolitical vagaries that increase or decrease U.S. military engagement, among career soldiers, age can be expected to correspond to total exposure to PTEs, hence a positive correlation with PTSD is in keeping with the impaired-resilience account.

Sex

Consonant with numerous other studies, women exhibited higher risk of PTSD (Supplemental Figure 2g). The disparity increased when covariates were controlled for, increasing from 1.27 times to 1.71 times the risk for PTSD among men. Consonant with the notion that, in an effectively polygynous species such as ours, females are characterized by a slower life history orientation than males (Kruger & Nesse, 2006; Tarka et al., 2018), the mean PC1 value was lower among women (-0.1274) than among men (0.1234). Nevertheless, the

benefits of lower values on our life history orientation factor were not enough to offset other factors that magnify PTSD risk among women. In non-military samples, across cultures, women evince greater anxiety, neuroticism, and pain sensitivity than men, and lower sensation seeking, attributes which are consistent with a more cautious, harm-avoidant strategy consonant with lower sex-specific variance in fitness (Benenson et al., 2021; Sparks et al., 2018). These personality correlates themselves constitute risk factors for PTSD (Calegaro et al., 2019; Jakšić et al., 2012). Hence, although a slower life history orientation appears to generally buffer against PTSD, the sex difference in PTSD risk may ironically owe to "slow" personality features which are more common among women. We acknowledge, however, that it is an open question whether results such as ours are explicable in this manner, as highly anxious, harm-avoidant individuals are unlikely to volunteer for military service, and unlikely to be accepted or retained if they do. Lastly, women suffer sexual assault in the military at far higher rates than men, and this crime is likely significantly underreported (Wilson, 2018), hence the sex difference in PTSD risk may partially reflect patterned differences in exposure to unreported potentially traumatic experiences.

Limitations

As some of the above points suggest, a military sample is not representative of the U.S. civilian population. It is demographically distinct, being mostly male and having many more younger versus older adults, with service being restricted to those who meet many qualifications of health and legal good-standing. Likewise, viewed cross-culturally, both the norms within the U.S. military and the beliefs of the larger U.S. society are not representative of the diverse meaning systems within which individuals may situate traumatic experiences, with corresponding implications for some facets of PTSD (Zefferman & Mathew, 2021).

Importantly, as noted above, our measures of early adversity are quite limited, with only a proxy for SES (parent's education) and a few items comprising the head injury measure. Consonant with the logic of the deficit model, head injury is associated with PTSD independent of other factors, potentially confounding our use of this variable. For these reasons, the connection we draw between early adversity measures and the life history orientation latent construct is tenuous, though other studies have provided evidence of such a link (Brumbach et al., 2009a).

Conclusion

Millions of Americans suffer debilitating effects of PTSD, some for many years. Effective pharmaceutical and therapeutic solutions have remained elusive. Prevention is therefore all the more important. In turn, efforts to prevent PTSD hinge on understanding underlying risk factors. Early life adversity as a predisposing risk factor is both intuitive and empirically supported, and appears to act in part through features of adult lifestyle characteristic of a fast life history trajectory. With the caveat that our measures are subject to substantial limitations, our findings bolster the prevailing view of developmental adversity as erosive to psychological capacities to

cope with trauma. Institutions, such as modern armed forces, in which exposure to potentially traumatic events is likely to occur, may therefore better serve both their members and society at large by assessing such risk factors during selection and training, and directing enhanced resources to members at greater risk.

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Author Contributions

Daniel Fessler and Edward Clint conceived and designed the study and wrote the article. Edward Clint performed the statistical analyses and produced the tables and graphs.

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Data availability

The data are available from the Inter-University Consortium for Political and Social Research (ICPSR) at the University of Michigan (http://doi.org/10.3886/ICPSR35197.v2).

Figure Legend

Figure 1. Principal component analysis (PCA) of the lifestyle latent variables. A. Proportion of variance explained by each of the eight principal components. B. Loadings of PC1 and PC2 on the eight variables. For information on how the variables were constructed from the STARRS dataset, see methods and supplementary materials.

Figure 2. Estimated probability of PTSD (+- SE) as a function of lifestyle orientation (PC1) and PC1 frequency histogram. PTSD probability is estimated from the linear model shown in Table 1, with all the covariates entered as average values from the sample, and in cases where the variables are categorical, we entered the first level as coded which ended up being male, white, active duty, base location. Lifestyle orientation as measured by PC1 is significantly positively associated with PTSD risk after controlling for all covariates in the full model.

Figure 3. Estimated probability of PTSD (+- SE) shown for three levels of exposure to potentially traumatic experiences during deployment for representative low versus high score for the lifestyle factor (PC1). PTSD risk increases with the lifestyle latent variable independent of degree of exposure to potentially traumatic experiences during deployment. Estimates were from a linear model that included all the covariates entered as average values from the sample, and in cases where the variables are categorical, we entered the first level as coded which ended up being male, white, active duty, base location. Exposure levels were the first, second, and third quartiles in the sample (Exp = 0.0, 19.3, 33.3). First and third quartiles were used for low and high values for the lifestyle construct (PC1 = -0.885, 0.751).

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Methods

Compositing of variables

Life history category construction

Relationship quality

Eight variables assessed relationship stability, investment, and quality (Supplemental Table S2). Other than the categorical variable for marital status, these survey questions were Likert scales. Values were divided by the item maximum value to normalize them because the range of each item varied. The resulting values of the eight were averaged to create a relationship quality composite variable.

Education quality (self)

Education quality is a composite of discrete numerical variables for maximum attainment and self-reported English reading ability. Attainment was inverted such that a higher value indicated lower education in order to align its polarity with the other constructed variables wherein a higher numerical value is consistent with the theoretical expectations of faster life history speed. All inverted variables were appended with the suffix INV in the R code. Both were normalized before being averaged to produce the composite.

General health

Participants reported experiencing ailments such as headaches, dizziness, fatigue, loss of appetite, body pains and sleep problems in the previous month. In all, 14 variables were used in this composite. Responses were Likert values associated with answers such as “All of the time” or “None of the time”. All 14 were inverted for life history alignment, normalized because of the use of different scales across items, and averaged together.

Tobacco addiction

Participants reported addiction, physical complications of tobacco use, and inability to cease use. Five binary variables and one inverted Likert variable were averaged together to produce the composite.

Substance use and abuse

Participants reported their frequency of consumption of alcohol, marijuana, and other illegal drugs in the past month. Five Likert survey items were inverted and averaged together to produce the composite.

Antisocial attitudes and behavior

Participants indicated the degree to which statements about illicit behavior resembled them. These included assaulting others, driving while intoxicated, lying for personal gain, and feeling justified in doing what others consider wrong. Five Likert items were inverted and averaged together to produce the composite.

Criminal involvement

Participants reported having spent time in correctional custody/jail, had “problems with police”, and receiving punishment under the Uniform Code of Military Justice such as Court Martial or Article 15 punishment. These three binary items were averaged together to produce the composite.

Reproduction index

The residuals of a linear model of number of offspring per year of sexual maturity (age 17 and older) were used as an estimate of each participant's reproduction. The residuals were used instead of the raw total number of offspring to account for the fact that older adults are capable of having more children than younger adults. This was supported by the analysis in which the slope was significantly positive and accounted for 25.6% percent of the variation (slope = 0.08 $p < .0001$).

Early age head injuries

The STARRS AAS dataset includes data on four broad types of head injuries differentiated by symptoms: loss of consciousness, becoming dazed and confused, eardrum perforation, and loss of memory. Frequency within type was not part of the dataset. The EAHI composite is a sum of the types reported, 0-4.

Resilience

Five survey questions asked about the ability to handle stress. The responses were 1-5 Likert scales where 1 = Excellent and 5 =Poor. These values were inverted for clarity during analysis such that higher numbers indicated higher reported resilience. The composite is a simple sum of these values (n=12 records deleted for missing data).

Subjective coping resources

During deployments, a soldier's unit can practically become their friends, quasi-family, and community. Therefore, the subjective sense of support, interpersonal respect and confidence, and experiences of discrimination and favoritism in one's unit bear heavily on one's ability to manage adversity.

14 survey items were used. These Likert-based questions related to social and professional support within their unit ("I can rely on other members of my unit for help if I need it"; "leaders show concern about the safety of soldiers"), morale, and the perception of favoritism and discrimination. Eight of these were inverted for clarity such that higher values indicate better support or less reported discrimination.

Exposure to potentially traumatic experiences during deployment

14 survey items identified stressful experiences during deployment: combat patrols, firing at the enemy or taking fire, getting wounded by the enemy, nearly being injured or killed, having a unit member seriously injured or killed, being responsible for the death of an enemy combatant, being responsible for a non-combat death, being responsible for the death of an ally, saving the life of a soldier or civilian, seeing "homes or villages destroyed or people begging for food", exposure to severely wounded/dying people/dead bodies, witnessing violence within the local population or mistreatment toward non-combatants, being physically assaulted, and being sexually assaulted or raped. For each survey item, participants could indicate 0, 1, 2-4, 5-9, or 10 or more times. These responses were transformed as follows:

0 → 0
1 → 1
2-4 → 3.1
5-9 → 7
10+→10

The value 3.1 was used instead of 3 to avoid potential confusion of the transformed and non-transformed values during variable preparation and analysis in R. These fourteen values were summed to produce the exposure variable.

The fourteen items vary greatly in their traumagenic potency. We performed an analysis comparing the soldiers who experienced at least one of the four most traumagenic events (being wounded, killing the enemy, being assaulted, being sexually assaulted) to those who did not. There was no substantial effect on the primary findings of the correlations between PC1 and PTSD.

Table S1. Sample characteristics. n = 16,096.

Age		
	Range	18-61
	Mean	28.8
	STD	7.41
Sex		%
	Female	11.3
	Male	88.3
Race		%
	White	68.9
	Black	13.8
	Native American / Alaskan Native	1.1
	Spanish/Hispanic/Latinx	5.4
	Asian	3.0
	Pacific islander	0.9
	Mixed	3.9
	Other	1.4
Education		%
	GED or equivalent	5.5
	High school	30.7
	Some college	27.9
	Technical school	6.0
	Associate degree	10.3
	Bachelor's degree	14.5
	Graduate or professional	5.6
Military service component		%
	Active duty	82.3
	National Guard / Reserve	6.0
PTSD		%
	Yes	27.2
	No	72.8

725 **Table S2.** Component items of the PCA category composites

Relationship quality
- Marital status
- Relationship happiness
- Relationship divorce/separation/termination discussion frequency
- How often do you think "things going well" between you, partner
- How often do you confide in your partner?
- Handle disagreement with aggression (insulting, swearing, yelling, violence)
- How often your partner handles disagreement with aggression
- Relationships tend to have a lot of "extreme ups and downs"

Education
- Highest level of education completed
- Ability to read English

Tobacco addiction
- Unable to quit or cut down in spite of efforts to do so.
- Experienced withdrawal symptoms such as fatigue, headaches, constipation, trouble sleeping
- Experienced tobacco-related coughing, difficult breathing, lung trouble, heart or blood pressure problems
- Developed tobacco tolerance negating previous physical effects (e.g. nausea, irritability)
- Continued use in spite of physical problems that it caused.

Substance use/abuse
- Frequency of use of alcohol, tobacco, or drugs in past month
- Frequency of use of alcohol in past month
- Frequency of binge use (5x in one day) of tobacco, alcohol, drugs in past month
- Frequency of use of marijuana or hashish in past month
- Frequency of use of any other illegal drug in past month
- How often you needed an "eye-opener" drink in the morning to relieve shakes?

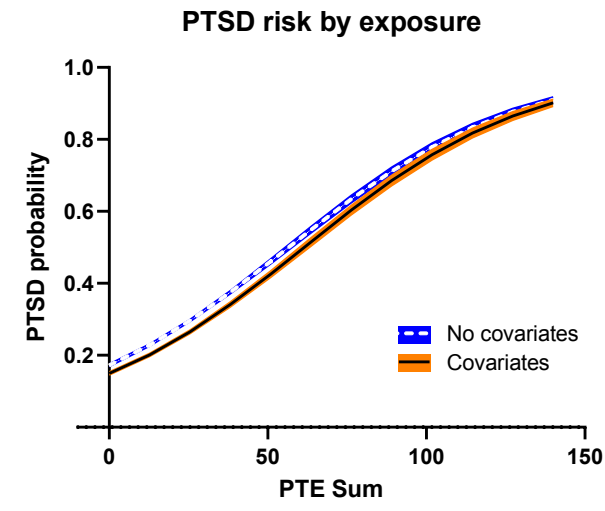
Antisocial attitudes and behavior
- I have done things against the law such as stealing
- I often have to lie to get what I want
- I sometimes hit other people so hard that they get bruises or require medical attention
- I sometimes do things that might indirectly harms others (e.g. impaired driving, not using protection during casual sex)
- I believe that I have been justified in doing some things other people might see as wrong

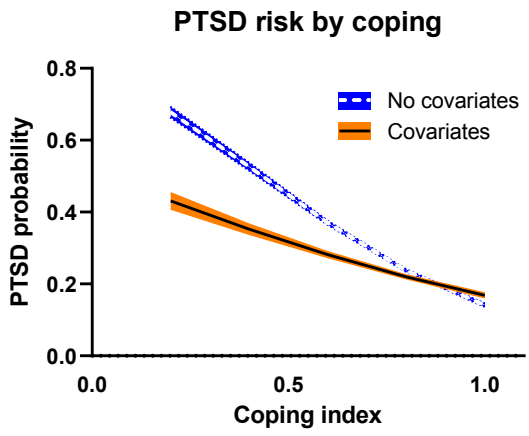
Criminal justice involvement
- Received Uniform Code of Military Justice (UCMJ) punishment in past year (e.g. Court Martial, Article 15, reprimand)
- Had trouble with the police, civilian or military in the past year
- Spent time in jail, the brig, or correctional custody in the past year

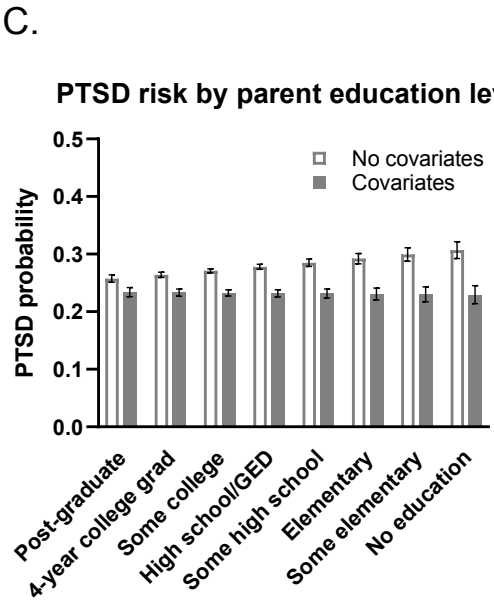
Health
- Poor appetite or overeating in past month
- Headaches in the past month
- Pain in back, neck, arms, legs, or joints in the past month

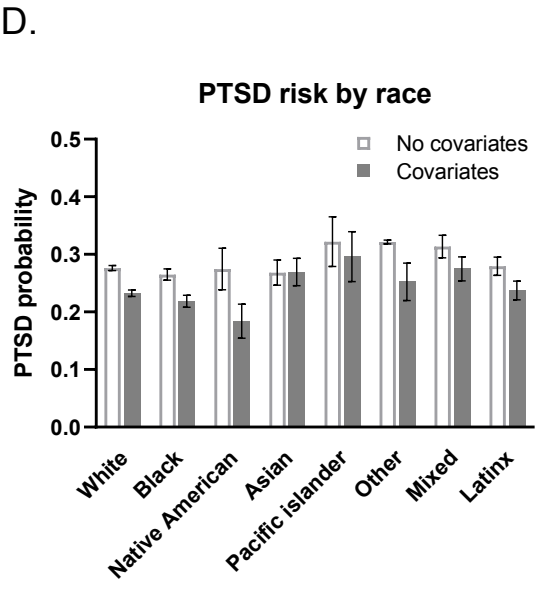
Muscle tension in the past month
Dizziness in the past month
Fainting spells in the past month
Memory problems in the past month
Difficulty concentrating in the past month
Irritability in the past month
Balance problems in the past month
Ringing in ears in the past month
Sleep problems in the past month
Feeling tired / low energy in the past month
Easily fatigued in the past month

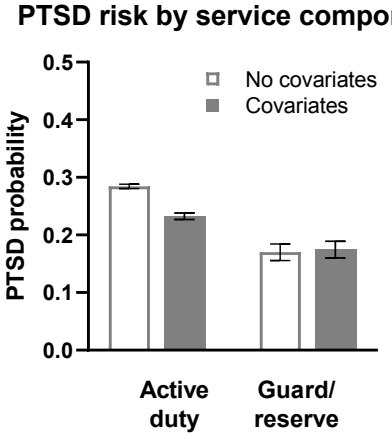
Figure S1

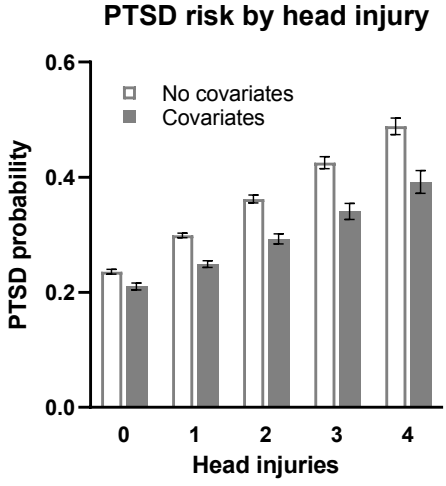

A.
PTSD risk by exposure
PTSD probability
1.0
0.8
0.6
0.4
0.2
No covariates
Covariates
0
50
100
150
PTE Sum


B.
PTSD risk by coping
PTSD probability
0.8
0.6
0.4
0.2
0.0
No covariates
Covariates
0.0
0.5
1.0
Coping index


C.
PTSD risk by parent education level
PTSD probability
0.5
0.4
0.3
0.2
0.1
0.0
No covariates
Covariates
Post-graduate
4-year college grad
Some college
High school/GED
Some high school
Elementary
Some elementary
No education


D.
PTSD risk by race
PTSD probability
0.5
0.4
0.3
0.2
0.1
0.0
No covariates
Covariates
White
Black
Native American
Asian
Pacific islander
Other
Mixed
Latinx


E.
PTSD risk by service component
PTSD probability
0.5
0.4
0.3
0.2
0.1
0.0
No covariates
Covariates
Active duty
Guard/ reserve


F.
PTSD risk by head injury
PTSD probability
0.6
0.4
0.2
0.0
No covariates
Covariates
0
1
2
3
4
Head injuries

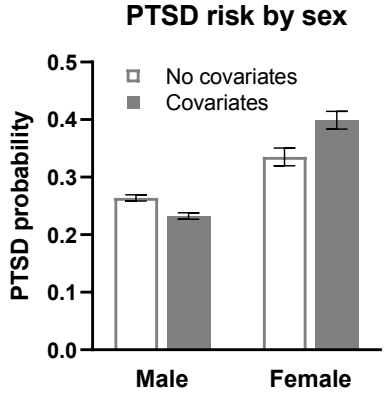

G.
PTSD risk by sex
PTSD probability
0.5
0.4
0.3
0.2
0.1
0.0
No covariates
Covariates
Male
Female

Figure S2

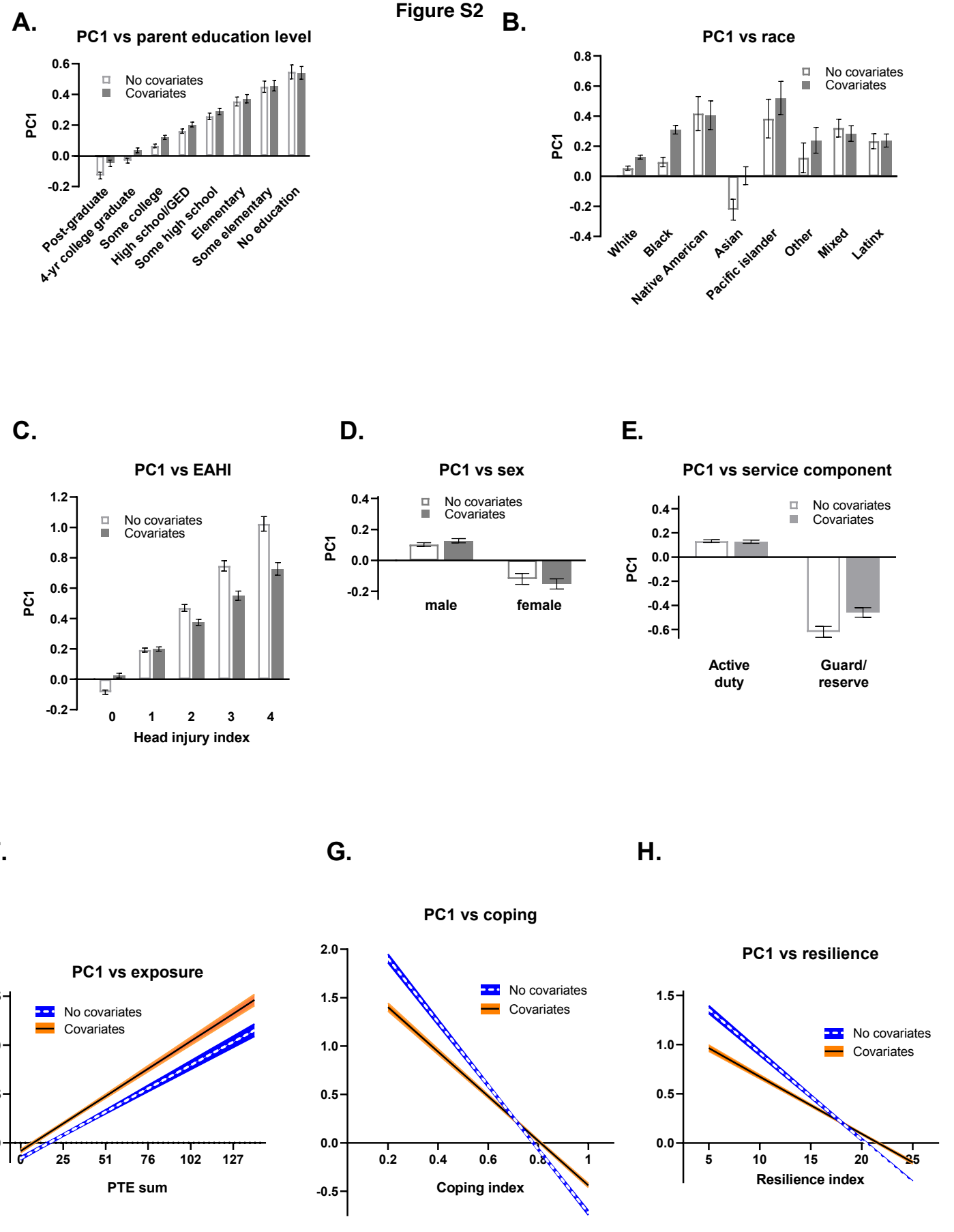
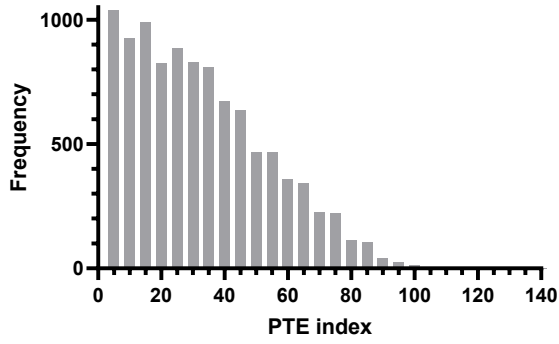
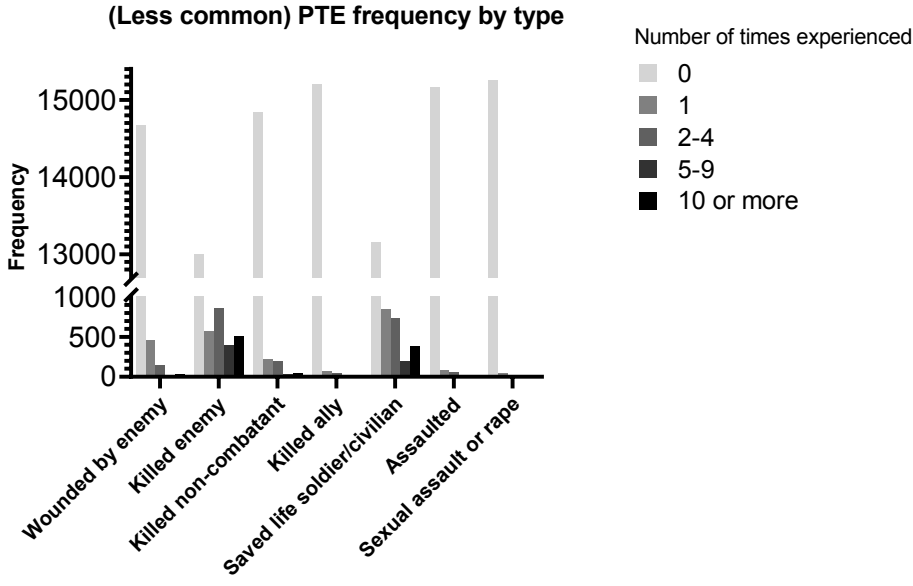

A.
PC1 vs parent education level
No covariates
Covariates
PC1
Post-graduate
4-yr college graduate
Some college
High school/GED
Some high school
Elementary
Some elementary
No education
B.
PC1 vs race
No covariates
Covariates
PC1
White
Black
Native American
Asian
Pacific Islander
Other
Mixed
Latinx
C.
PC1 vs EAHI
No covariates
Covariates
PC1
Head injury index
D.
PC1 vs sex
No covariates
Covariates
PC1
male
female
E.
PC1 vs service component
No covariates
Covariates
PC1
Active duty
Guard/ reserve
F.
PC1 vs exposure
No covariates
Covariates
PC1
PTE sum
G.
PC1 vs coping
No covariates
Covariates
Coping index
H.
PC1 vs resilience
No covariates
Covariates
Resilience index

Figure S3

A.



B.



C.