Journal of Affective Disorders 282 (2021) 732–739

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

Can military trauma promote psychological growth in combat veterans? Results from the national health and resilience in veterans study

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ARTICLE INFO

Keywords:
Combat
Trauma
Posttraumatic stress disorder
Posttraumatic growth
Veterans

ABSTRACT

Background: Military combat trauma is often associated with negative outcomes, including high rates of posttraumatic stress disorder (PTSD). Less is known, however, about whether military combat trauma may foster posttraumatic growth (PTG), which has been observed in relation to other trauma types, in representative samples of veterans.

Methods: We analyzed data from veterans who participated in the National Health and Resilience in veterans Study who reported a military-related trauma (n = 210). Participants completed measures of trauma history, combat exposure, PTSD symptoms, PTG, functioning, and quality of life (QOL). Bivariate correlations, regression analyses, analyses of covariance, and fit of linear and quadratic functions were used to examine relationships between PTSD symptom clusters, PTG and its subdomains, and functioning.

Results: Number of deployments (β=0.23) and lifetime PTSD symptom severity (β=0.19), particularly re-experiencing symptoms (β=0.37), were independently associated with greater PTG. An inverted-U-shaped quadratic function provided the best fit for the relationship between PTSD symptoms and PTG (R^2 =0.22). Greater PTG was associated with greater mental functioning (β=0.15) and QOL (β=0.24).

Limitations: The inability to make casual inferences in this cross-sectional study; possible bias related to self-report measures; and the lengthy time period between index trauma and assessment of PTSD and PTG.

Conclusions: PTG is relatively common among combat veterans, particularly among those with PTSD, and is associated with better mental functioning and QOL. Positive psychology interventions to bolster PTG may help promote functional outcomes in this population.

1. Introduction

The negative mental health impacts of combat exposure among military veterans are well documented. For example, U.S. Vietnam War veterans exposed to combat had much higher rates of posttraumatic stress disorder (PTSD) than both noncombat veterans of the same era and civilians (Jordan et al., 1991). Higher rates of other mental health problems including depression, mania, generalized anxiety, panic disorder, and obsessive compulsive disorder were also seen among U.S. Vietnam combat veterans as compared to noncombat veterans (Jordan et al., 1991). More recently, high rates of both combat exposure and PTSD have been found among U.S. veterans of the wars in Iraq and Afghanistan, with an estimated 65% of Army and Marine veterans returning from deployments in these conflicts reporting exposure to some form of combat, about half reporting having witnessed casualties including death, about half having felt in great danger of being killed, and many having mental health problems thereafter (Hoge et al., 2006). Among United Kingdom military personnel deployed to Afghanistan, frequency of combat exposure and proximity to violent injury and death were significantly associated with higher levels of PTSD (Osório et al., 2018). Additionally, one U.K. study found that different categories of combat experiences (e.g., coming under fire, witnessing injury or death, experiencing explosions) effected PTSD symptom clusters differentially, suggesting implications for treatment (Osório et al., 2018). Notably, the

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https://doi.org/10.1016/j.jad.2020.12.077
Received 2 August 2020; Received in revised form 10 December 2020; Accepted 21 December 2020
Available online 24 December 2020
0165-0327/

negative effects of combat appear to be long-lived. Half of a sample of Australian Vietnam veterans who reported PTSD upon return from duty met diagnostic criteria for current PTSD 22 years later, and half of the latter group also met criteria 36 years after return (O'Toole and Catts, 2017).

The study of risk factors for PTSD has focused on the effects of premilitary, military, and postmilitary factors. Steenkamp et al. studied such factors in a large cohort of Vietnam combat veterans. The authors identified a number of military variables, including combat exposure, exposure to abusive violence, killing, injury during combat, and perceived threat; among them, greater combat exposure was shown to increase the risk of PTSD symptom exacerbations (Steenkamp et al., 2017). Additionally, both longer deployments (Shen et al., 2009) and greater number of deployments (Kline et al., 2010; Maguen et al., 2010) have been associated with higher rates of PTSD. Exposure to combat also increases the risk of suicidal behavior, which is partially mediated by increased rates of PTSD (Dillon et al., 2018).

While combat exposure often has a number of harmful effects, research has also found that many individuals who live through traumatic events, in some cases the majority (Affleck and Tennen, 1996), report experiencing positive psychological changes. This process has been termed posttraumatic growth (PTG). In such cases, the experience of trauma may lead to a higher level of functioning or well-being (Calhoun and Tedeschi, 2014; Tedeschi and Calhoun, 1995, 2004), or enable the individual to respond more adaptively to future stressors (Tsai et al., 2016a). Research on PTG has been conducted in a wide variety of populations, including cancer patients and their partners and children, parents of surgical patients, earthquake and hurricane survivors, survivors of childhood sexual abuse, survivors of motor vehicle collisions, women victims of sexual assault, patients with PTSD, ex-prisoners of war, students, and military veterans (Schubert et al., 2016). These findings suggest that PTG is not uncommon among a broad range of trauma survivors, particularly among those with PTSD.

Tedeschi and Calhoun (1995) described several benefits reported by people who have lived through traumatic experiences, including self-reliance; recognition of vulnerability; changed sense of relationship to others; improved ability to discriminate between positive and negative relationships; and changed philosophy of life. Empirical study has confirmed that, whereas trauma in general is associated with avoidant coping (Stump and Smith, 2008), PTG has been associated with approach coping and problem solving (Stump and Smith, 2008; Widows et al., 2005). Furthermore, it has been shown that levels of PTG were highest in those with the greatest trauma severity (Tedeschi and Calhoun, 1995), providing support to the notion that the trauma, rather than some other undetected phenomenon, is at least partially responsible for the reported growth.

Although the adverse consequences of combat are often the most prevalent, there is evidence that exposure to combat can result in PTG among military veterans. For example, Solomon and Dekel (2007) found substantial levels of PTG among Israeli combat veterans, including ex-prisoners of war. Elder and Clipp (1989) studied positive and negative long-term consequences of combat exposure among men serving in World War II and the Korean War. Along with a variety of negative impacts, substantial numbers of study participants reported positive changes which they attributed to combat experiences, including enhanced coping skills, self-discipline, and appreciation for life's value. Those categorized as having "heavy" combat experience reported higher rates of such changes than those having no or "light" combat exposure. Combat exposure was also related to increased likelihood of ego-resilient behavior and diminished sense of helplessness at mid-life, after controlling for other variables. Aldwin et al. (1994) studied the relationship between combat exposure and positive and negative appraisals of military service, and found that veterans with heavier exposure reported greater perceived positive effects of military service than those with lighter or no exposure. Campbell et al. (2018) found that, in a large Veteran sample spanning multiple conflicts from World War II to the present, desirable effects of military service were more frequently reported than undesirable effects. More combat veterans endorsed the item "value life more" than noncombat veterans. However, despite this difference, and contrary to the finding by Aldwin et al. cited above, combat veterans were more likely than noncombat veterans to report undesirable effects of military service overall.

A number of studies have reported on the estimated prevalence of PTG in different populations. Wu et al. (2019) conducted a meta-analysis of 26 studies of PTG related to various trauma types (e.g., disease, accidents, professions with trauma exposure) and found prevalences of moderate-to-high PTG ranging from 10 to 77% across studies, with a pooled prevalence of 53% across all trauma types. Factors associated moderate-to-high PTG included age younger than 60, shorter duration of time since the indexed trauma, direct exposure to trauma (vs. indirect exposure, such as being the parent of a seriously ill child), and being in a profession with high levels of trauma, which includes military service. There is also evidence of high rates of PTG among military veterans specifically. We previously found that 50.1% of all veterans who participated in the National Health and Resilience in veterans Study (total $n = 3157$), and 72.0% of those participants who screened positive for PTSD, reported at least moderate PTG in relation to their worst traumatic event (Tsai et al., 2015).

Given that PTSD and other conditions stemming from trauma have negative impacts on functioning, an important question is whether PTG entails gains in functioning, quality of life (QOL), or both. Studies have shown a mixture of positive, negative, and null relationships between PTG and QOL (Helgeson et al., 2006; Stanton et al., 2006). Most studies reporting associations between PTG and QOL or functioning have been conducted with individuals diagnosed with cancer and other medical conditions (e.g., Alisic et al., 2008; Gangeri et al., 2018; Li et al., 2019a, 2019b; Martin et al., 2017; Tanyi et al., 2015; Tomich and Helgeson, 2012; Wang et al., 2018). For example, Li et al. (2019b) found a quadratic relationship between PTG and QOL in participants who had significant depressive symptoms but a linear relationship in participants without depressive symptoms, with depression serving as a moderator. Another study found that PTG significantly predicted QOL in low-grade glioma patients, but PTSD symptoms and avoidant coping dampened the positive effect of PTG on QOL (Li et al., 2019a). Tomich and Helgeson found unexpectedly complex and dynamic relationships between PTG and functioning as measured by the 36-Item Short Form Health Survey, SF-36. These included a negative linear association between PTG and mental functioning shortly after cancer diagnosis, a positive linear association between baseline PTG and physical functioning three months later, and cross-sectional but not longitudinal curvilinear relationships Tomich and Helgeson, (2012)

A smaller number of studies have examined relationships between PTG and QOL/functioning in veterans. veterans with PTSD exhibiting at least moderate PTG reported better mental functioning and general health than those without PTG (Tsai et al., 2015). Martz et al. presented evidence for a complex relationship between PTG, PTSD symptoms, and QOL in U.S. veterans who reported a life-threatening illness or injury as their worst traumatic event. PTSD symptoms were related to worse QOL, while greater perceived PTG was associated with positive QOL. PTG moderated the effect of PTSD symptom severity on QOL, an effect which was strongest for those with more severe PTSD. All five PTGI subdomains except appreciation of life contributed to this moderating effect Martz et al. (2018).

An important question for the field has been the relationship between combat exposure, PTSD symptoms, and PTG. One meta-analysis of 42 studies encompassing more than 11,000 participants found a significant linear relationship between PTG and PTSD symptoms for the pooled data, but a significantly stronger curvilinear relationship. The strength and linearity of these relationships differed according to trauma type and age, and combat-related trauma was not specifically examined (Shakespeare-Finch and Lurie-Beck, 2014).

In the current study, we used assessments of PTSD symptoms and

PTG domains indexed specifically to military trauma, which were administered to a nationally representative sample of U.S. military combat veterans. We examined the associations between PTSD symptom clusters, PTG and its subdomains, physical and mental health functioning, and QOL. This study addresses the gap in the literature on PTG and functioning, and provides greater specificity than previous studies on the complex relationship between PTSD and PTG related to military trauma.

2. Methods

2.1. Sample

Data were drawn from the National Health and Resilience in veterans Study (NHRVS), a nationally representative study of U.S. veterans conducted October to December 2011. NHRVS participants completed a 60-minute anonymous web-based survey. The NHRVS sample was drawn from a research panel of more than 50,000 households that was developed and is maintained by GfK Knowledge Networks, Inc., a survey research firm based in Menlo Park, CA. GfK Knowledge Networks, Inc. maintains KnowledgePanel®, a probability-based, online non-volunteer access survey panel of a nationally representative sample of approximately 50,000 U.S. adults that covers about 98% of U.S. households, including cell-phone-only households. Panel members are recruited through national random samples, originally by telephone and now almost entirely by mail. Households are provided with access to the Internet and computer hardware if needed. Unlike Internet convenience panels, also known as "opt-in" panels, that include only individuals with Internet access who volunteer themselves for research, KnowledgePanel® recruitment uses dual sampling frames that includes both listed and unlisted telephone numbers, telephone and non-telephone households, and cell-phone-only households, as well as households with and without Internet access. Only persons sampled through these probability-based techniques are eligible to participate in KnowledgePanel®. To permit generalizability of study results to the broader population of U.S. veterans, post-stratification weights were computed based on the demographic composition of veterans in KnowledgePanel® (i.e., age, gender, race/ethnicity, education, Census region, and metropolitan area) and calibrated against the most contemporaneous (October 2010) Current Population Survey (U.S. Census Bureau, 2010). In the current study, which focused on military-related PTG in combat veterans, we analyzed data from NHRVS participants who reported a military-related trauma as their "worst" stressful event ($n = 210$; see details below). All participants provided informed consent and the Human Subjects Subcommittee of the VA Connecticut Healthcare System approved the study.

2.2. Assessments

Demographic and Military History Questionnaire was administered to assess demographic characteristics and details regarding respondents' military history, including whether they enlisted or drafted into the military; branch of military; war era in which they served; number of times deployed to a combat zone; and number of years spent in the military.

The *Trauma History Screen* (THS) (Carlson et al., 2011) is a self-report measure that assesses the occurrence of 14 traumatic life events. Traumas across the lifespan were assessed, including early life traumas such as physical or sexual assault during childhood; as well as traumas that more commonly occur in adulthood, such as military combat, motor vehicle accident, and unexpected loss of a loved one. An additional potentially traumatic event—life-threatening illness or injury—was added to the THS in the NHRVS. To evaluate predictors of military-related PTG, only respondents who reported a military-related trauma as their "worst" stressful event were included in the current study ($n = 210$): "During military service — saw something horrible or was badly scared."

The *Combat Exposure Scale* (CES) (Keane et al., 1989) is a 7-item measure that assesses the frequency and intensity of combat-related experiences. The items ask about respondents' exposure to various combat situations, such as going on combat patrols, firing rounds at the enemy, and experiencing casualties in one's unit. Higher scores reflect greater intensity of combat exposure. Scores range from 0 to 14, with scores of 0–8 indicative of light combat exposure; 9–16 light-moderate exposure; 17–24 moderate exposure; 25–32 moderate-heavy exposure; and 33–41 heavy exposure. Cronbach's α on the CES in the current sample was 0.84.

The *PTSD Checklist–Specific Stressor Version* (PCL-S) (Weathers et al., 1993) is a 17-item screening instrument based on *Diagnostic and Statistical Manual for Mental Disorders–Fourth Edition* criteria for PTSD (American Psychiatric Association, 2000). We administered the PCL-S, which asks about symptoms related to respondents' worst stressful experience, to assess PTSD symptoms. All symptoms were assessed on a lifetime basis: "Thinking about the WORST stressful experience, please read each item carefully, then enter the number to the right to indicate how much you have been bothered by that problem IN YOUR LIFETIME." Scores on the PCL range from 17 to 85. To evaluate associations between PTSD symptom clusters and PTG, we used a 5-factor model of re-experiencing, avoidance, emotional numbing, dysphoric arousal (i.e., sleep disturbance, concentration difficulties, anger/irritability), and anxious arousal (i.e., hypervigilance, exaggerated startle response), which has received support from confirmatory factor analyses of PTSD symptoms in military veterans (Harpaz-Rotem et al., 2014; Pietrzak et al., 2012). In the current study, a positive screen for PTSD was operationalized as a total PCL score $\geq$ 44 (Blanchart et al., 1996). Cronbach's α on the PCL-S in the current sample was 0.95.

The *Posttraumatic Growth Inventory-Short Form* (PTGI-SF) (Cann et al., 2010) is a 10-item instrument that assesses perceptions of positive psychological changes that one may experience as a result of struggling with highly challenging life circumstances. A total score is derived, which reflects overall perceptions of positive psychological changes related to a particular stressful life event. This total score is comprised of scores reflecting five domains of PTG, including greater appreciation of life; changed sense of priorities for one's life; development of warmer, more intimate relationships; having a greater sense of personal strength; recognizing new possibilities or paths for one's life; and having greater spiritual development. Higher scores indicate greater perceptions of growth. Cronbach's α on the PTGI-SF in the current sample was 0.94.

The *Short Form-8 Health Survey* (SF-8; QualityMetric, 2014) is a validated, abbreviated version of the SF-12 (Ware et al., 2002), one of the most widely used measures of physical and mental health–related functioning. Item responses are used to generate standardized physical component and mental component summary scores. Mental and physical component summary scores range from 0 to 100, with a score of 50 representing the average level of functioning in the general population, and each 10-point interval representing one standard deviation. Higher scores reflect better functioning.

The *Quality of Life Enjoyment and Satisfaction Questionnaire-Short Form* (Q-LES-Q-SF; Endicott et al., 1993) is a 14-item measure that asks respondents about their satisfaction in the past week with various aspects of their lives (e.g., work, family). Respondents are asked to rate their satisfaction in these areas from 1 (Very poor) to 5 (Very good) and scores are summed for a total score.

2.3. Data analysis

Logarithmic base 10 transformations were used to transform non-normally distributed continuous variables (e.g., PCL-S scores). Data analyses proceeded in five steps. First, descriptive statistics were computed to summarize demographic, military, PTSD, and PTGI variables. Second, bivariate correlations between PTGI total and subscale scores, and demographic, military, and PTSD variables were computed

to identify independent variables associated with PTG. Independent variables significantly related to PTGI total scores at the $p<.05$ level in bivariate analyses were entered into a multivariable linear regression analysis (Enter estimation method). If one or more of the independent variables (e.g., CES total score, PCL-S total score) significantly predicted PTGI total scores, we conducted post-hoc multivariable regression analyses to examine which subscales or items that comprised this variable were independently related to PTGI total scores; α was set to 0.01 in these analyses to reduce the likelihood of Type I error. Third, to evaluate whether PTGI-SF scores differed by PTSD status, we conducted two analyses of covariance. PTSD status was entered as an independent variable; demographic, military, and trauma-related variables that differed by PTSD status were entered as fixed factors or covariates; and PTGI-SF total (ANCOVA) and subscale (multivariate ANCOVA) scores were entered as dependent variables in separate analyses. Cohen's d was computed to estimate effect sizes of group differences in PTGI-SF scores (Cohen, 1988). Fourth, to examine the nature of the association between severity of PTSD symptoms and PTG, we fitted linear and quadratic functions. R^2 values were then used to determine which function provided the best fit to these data and explained the most variance in total PTGI scores. Fifth, to evaluate the relation between PTG and functioning, we conducted multivariable linear regression analyses with demographic and military variables associated with SF-8 and Q-LES-SF scores at the $p<.05$ level in bivariate analyses, number of lifetime traumas, and PTSD symptoms entered as covariates; PTGI scores entered as the independent variable; and SF-8 Mental and Physical Functioning summary scores and Q-LES-SF total scores entered as dependent variables in separate analyses. If PTGI total scores predicted SF-8 or Q-LES-SF scores, we conducted post-hoc multivariable regression analyses to examine which PTGI subscales were independently linked to these outcomes; α was set to 0.01 in these analyses to reduce the likelihood of Type I error.

3. Results

Table 1 displays descriptive statistics and results of bivariate correlation analyses of demographic, military, and trauma-related correlates of military-related PTG. The mean age of the sample was 60 and it was comprised entirely of men. The majority of the sample was white, had some college or higher education, was married/living with partner, and retired/not currently working. Regarding military characteristics, the majority of the sample enlisted in the military, served in the Army and Vietnam war, deployed once. On average, respondents spent 9.5 years in the military, had a moderate level of combat exposure (Keane et al., 1989), and reported experiencing 4.7 traumatic events in their lifetimes. One-fifth of the sample met screening criteria for probable military-related PTSD.

Results of bivariate correlation analyses revealed that number of times deployed, severity of combat exposure, and severity of military-related PTSD symptoms were significantly associated with total PTGI scores; none of the other demographic, military, or trauma-related variables were significant. Results of a multivariate linear regression analysis revealed that serving 2 or more deployments (β=0.23, $t = 3.39$, p=.001) and lifetime PTSD symptom severity (β=0.19, $t = 2.84$, p=.005) were independently positively related to total PTGI scores; combat exposure was not significant (β=0.10, $t = 1.25$, p=.21). Post-hoc analyses indicated that re-experiencing symptoms were independently associated with total PTGI scores (β=0.37, $t = 2.70$, p=.008), as well as with scores on the Relating to Others (β=0.51, $t = 3.74$, $p<.001$), Appreciation of Life (β=0.49, $t = 3.67$, $p<.001$); and New Possibilities (β=0.48, $t = 3.49$, p=.001) subscales; none of the other symptom clusters was significant, all p's>0.06.

As shown in Table 2, analyses of covariance revealed that probable PTSD was associated with greater total PTGI-SF scores, as well as with each of the five PTGI-SF subscales, even after adjustment for race/ethnicity, education, marital status, branch of service, and severity of combat exposure. For total PTGI-SF scores, the magnitude of the mean effect size difference was moderate by convention (Cohen, 1988), with the largest magnitude mean effect size difference observed on the Personal Strength subscale.

Fig. 1 illustrates the association between severity of lifetime PTSD symptoms and total scores on the PTGI-SF. A quadratic function provided the best fit to these data, as revealed by R^2. Specifically, R^2 for a quadratic function was 0.22 ($r = 0.47$), while it was 0.03 ($r = 0.17$) for a linear association.

Table 3 shows results of multivariable linear regression analyses evaluating the relationship between PTG and QOL as well as measures of physical and mental functioning. Results of these analyses suggested that, after adjustment for demographic and military covariates, number of lifetime traumas, and PTSD symptoms, greater PTGI total scores were independently associated with greater SF-8 Mental Functioning and Q-LES-SF scores, but not SF-8 Physical Functioning scores. Post-hoc analyses revealed that higher scores on the Personal Strength subscale

Table 1
Descriptive statistics and results of bivariate correlation analyses of correlates of military-related posttraumatic growth in combat veterans.

	Mean (SD) or n (%)	Bivariate correlation with total PTGI scores
Age	60.2 (16.3)	−0.05
18 to 44	38 (18.2%)	
45 to 54	25 (11.8%)	
55 to 64	56 (26.4%)	
65 to 74	54 (25.4%)	
75+	38 (18.2%)	
Male sex	210 (100%)	–
White race/ethnicity	158 (75.0%)	.07
Some college or higher education	148 (70.2%)	.08
Married/living with partner	170 (80.9%)	−0.02
Retired/not currently working	129 (61.4%)	−0.10
Enlisted in military (vs. drafted)	171 (81.3%)	.09
Branch of military		.09[a]
Army	104 (49.7%)	
Air Force	36 (17.0%)	
Marine Corps	35 (16.8%)	
Navy	26 (12.4%)	
National Guard	8 (3.9%)	
Wars/conflicts in which served		.05[b]
Vietnam war	111 (52.8%)	
Iraq/Afghanistan wars	41 (19.3%)	
Korean war	20 (9.5%)	
Persian Gulf	15 (7.3%)	
World War II	12 (5.5%)	
Other	12 (5.5%)	
Number of times deployed to combat/war zone (median, interquartile range)	1.0 (2.0)	.25***
1 deployment	121 (57.5%)	
2+ deployments	89 (42.5%)	
Years in military	9.5 (8.6)	.04
Combat exposure scale total score	20.5 (10.6)	.21**
Light exposure	34 (16.0%)	
Light-Moderate exposure	38 (18.1%)	
Moderate exposure	46 (22.1%)	
Moderate-Heavy exposure	58 (27.5%)	
Heavy exposure	34 (16.3%)	
Number of lifetime traumas	4.7 (2.7)	.12
Lifetime probable PTSD	42 (20.2%)	.23***
Lifetime PTSD symptom severity	34.7 (15.3)	.18**
Total PTGI-SF score	19.1 (14.6)	
Relating to Others	3.4 (3.2)	
New Possibilities	3.5 (3.4)	
Personal Strength	4.5 (3.3)	
Spiritual Change	3.1 (3.4)	
Appreciation of Life	4.6 (3.4)	

Note: Significant association with total PTGI scores: *$p<.05$, **$p<.01$, ***$p<.001$.
[a] Army vs. other branch.
[b] Vietnam/Korea era vs. other era.

Table 2
Posttraumatic Growth Inventory total and subscale scores by PTSD status.

	No PTSD Mean (SD)	Probable PTSD Mean (SD)	Test of difference (F, p)	Cohen's d (95%CI)
Total PTGI-SF score	17.0 (14.1)	26.2 (15.6)	19.26, <0.001	0.64 (0.29–0.98)
Personal Strength	3.9 (3.2)	6.9 (3.7)	32.34, <0.001	0.91 (0.55–1.26)
Appreciation of Life	4.0 (3.3)	5.9 (3.5)	13.61, <0.001	0.57 (0.22–0.91)
New Possibilities	3.1 (3.2)	4.7 (3.8)	15.20, <0.001	0.48 (0.14–0.82)
Relating to Others	3.0 (2.9)	4.4 (3.6)	9.71, 0.002	0.46 (0.11–0.80)
Spiritual Change	2.9 (3.3)	4.2 (3.5)	5.88, 0.016	0.39 (0.05–0.73)

Note: PTSD = posttraumatic stress disorder; PTGI-SF = Posttraumatic Growth Inventory-Short Form; SD = standard deviation.
Means are adjusted for race/ethnicity, education, marital status, branch of service, and severity of combat exposure, which differed between the No PTSD and Probable PTSD groups.

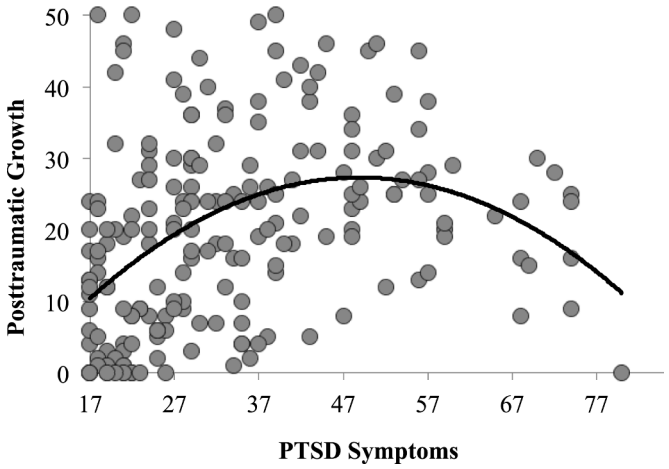

Fig. 1. Association between PTSD symptoms and posttraumatic growth
Note: PTSD Symptoms assessed using the DSM-IV version of the PTSD Checklist–Specific Stressor version (score range = 17–85); posttraumatic growth assessed using the Posttraumatic Growth Inventory–Short Form (score range = 0–50).

(**β**=0.19, t = 3.05, p=.003) were independently associated with higher SF-8 Mental Functioning scores; and that higher scores on the New Possibilities (β=0.20, t = 3.25, p=.001) subscale were independently associated with higher Q-LES-SF scores.

4. Discussion

We examined associations between PTSD symptoms, PTG and its subdomains, and functioning and QOL among a nationally representative sample of U.S. military combat veterans who reported military trauma as their index trauma event. We sought to understand the relationships between PTSD symptom clusters and different components of PTG and their implications for functioning, in order to add greater specificity to what is known about these complex relationships in the context of combat exposure.

Multivariable linear regression showed that serving two or more deployments and severity of PTSD symptoms were independently correlated with PTG. Among PTSD symptom clusters, re-experiencing symptoms were independently associated with greater PTG. This finding, which is consistent with existing theories of PTG as well as

Table 3
Multivariable linear regression analyses evaluating relationship between posttraumatic growth, and measures of physical and mental functioning, and quality of life.

	R^2	β	t	p
SF-8 Mental Health Functioning	.32			
Number of lifetime traumas		−0.05	.76	.45
PTSD symptoms		−0.45	5.89	<0.001
Posttraumatic growth		.15	2.52	.012
Quality of Life	.34			
Number of lifetime traumas		−0.18	2.45	.015
PTSD symptoms		−0.36	4.68	<0.001
Posttraumatic growth		.24	3.92	<0.001
SF-8 Physical Health Functioning	.22			
Number of lifetime traumas		−0.18	2.18	.031
PTSD symptoms		−0.21	2.52	.013
Posttraumatic growth		.09	1.31	.19

Note: Analyses of SF-8 Physical Functioning scores are adjusted for education, working status, drafted vs. enlistment status, Army vs. other branch status, total combat exposure severity, and number of years in the military. Analyses of SF-8 Mental Functioning scores are adjusted for age, marital status, Vietnam/Korea vs. other war era, and number of years of military. Analyses of quality of life scores are adjusted for age, marital status, working status, number of deployments, and number of years in the military.

empirical findings (below), points to a possible mechanism linking PTSD symptoms to PTG. Specifically, Tedeschi and Calhoun (2004) posited that intrusive thoughts are necessary to trigger deliberate attempts to understand the meaning behind a traumatic event. Such symptoms or other persistent reminders of a trauma may provide the necessary substrate for the cognitive processing that is believed to underlie PTG. Also consistent with this theory is the finding by Brooks et al. (2019) that intrusive thoughts mediated the relationship between interpersonal trauma, including military combat, and PTG. Re-experiencing symptoms may be important for sustained mental engagement with the traumatic events or memories, thereby facilitating PTG. However, there is evidence that different forms of re-experiencing may lead to different outcomes. Lafarge et al. (2020) studied the role of rumination—cognitive activity related to a traumatic event—in the development of PTG among women who terminated pregnancy due to fetal abnormality. Both intrusive and deliberate forms of rumination were measured. Intrusive rumination was a negative predictor of PTG, whereas deliberate rumination was a positive predictor, and mediated the relationship between grief and PTG. The authors posited that interventions that encourage reflective thinking and narrative construction may be beneficial in facilitating PTG.

We found a curvilinear, quadratic, inverted-U-shaped association between severity of PTSD symptoms and PTG resulting from military combat, which is consistent with a number of studies that have found such as relationship in a variety of populations (e.g., Shakespeare-Finch and Lurie-Beck, 2014, Leykin et al., 2013). The existence of a positive relationship between PTSD and PTG may seem paradoxical; that is, the notion that distressing and impairing symptoms are associated with positive change or growth appears to be counterintuitive. However, this finding is consistent with foundational conceptual work in PTG showing that positive and negative aspects of adjustment are independent (Park, 1998), that ongoing distress and growth are not mutually exclusive and can coexist within the same individual (Solomon and Dekel, 2007; Tedeschi and Calhoun, 2004), and that, compared to individuals who report only positive changes, persons who report both positive and negative changes experience more PTG (Taylor et al., 1991). More specifically, as shown in Fig. 1, the inverted-U-shaped function indicates that PTG is maximized when posttraumatic symptoms fall within a moderate range as compared to when they are very mild or severe. If symptoms are too severe, they may overwhelm a person's processing ability or other resources that are needed for PTG (Butler et al., 2005). If, on the other hand, a minimum threshold of symptoms is not met, it is

possible that the indexed trauma was either not impactful enough or its effects not persistent enough to drive the mental engagement necessary for PTG described earlier.

Given mixed evidence regarding the relationship between PTG and functioning (Helgeson et al., 2006; Stanton et al., 2006), we sought to determine relationships between PTG and mental and physical functioning as well as QOL in our sample. Greater PTG was independently associated with better mental functioning and QOL, even after adjustment for trauma burden, and severity of combat exposure and PTSD symptoms. To our knowledge, our study is the first to examine the relationships between PTG and both QOL and functioning in a sample of veterans with combat trauma, and our findings support the potential value of fostering PTG for improving functioning and wellness in this population. With regard to dimensions of PTG, personal strength was independently associated with mental functioning, and new possibilities was independently associated with QOL. Similarly, a previous study by (Tsai et al., 2016a) found that greater personal strength was associated with reduced severity and incidence of PTSD at 2-year follow-up. These findings suggest that personal strength as a dimension of PTG may help protect against future PTSD. It also appears to have functional implications: Sekely and Zakzanis (2019) showed that the personal strength and new possibilities subscales of the PTGI were independently associated with return to work following traumatic brain injury, which is highly comorbid with PTSD among military veterans. Additionally, increases in both personal strength and new possibilities as a result of exposure therapy for PTSD were associated with decreases in PTSD symptoms. (Hagenaars and van Minnen, 2010) Given these findings, it is fortunate that for the majority of military veterans, PTG remains stable over time: in one study, 60% of veterans who reported at least moderate PTG maintained that level of PTG two years later (Tsai et al., 2016b). At the same time, although personal strength has been shown to respond to intervention (Hagenaars and van Minnen, 2010), we recognize that in some cases, personal strength may represent an enduring personality trait that existed prior to the trauma. In a related finding, Pietrzak et al. (2010) reported that higher scores on a measure of effort/perseverance, which may reflect more stable character traits, were associated with PTG. Future studies should assess personal strength and other personality traits and take them into account when examining posttraumatic growth.

Our findings suggest that assessment, monitoring, and possible therapeutic enhancement of PTG may help promote mental health functioning and QOL in symptomatic combat veterans. To date, however, studies of interventions to improve PTG remain scarce. A 2010 study of exposure therapy for non-combat-related PTSD found that prolonged exposure led to increases in PTGI scores (Hagenaars and van Minnen, 2010). More recently, a 2015 meta-analysis of psychosocial interventions and PTG found no interventions that were specifically designed to promote PTG as a primary outcome. Nonetheless, the trauma-focused interventions included in the analysis, which included cognitive behavioral therapy, cognitive based stress management, and emotional disclosure, did modestly increase PTG, with a pooled Hedge's *g* of 0.36. The small number of eligible studies (12) limited the interpretability of these findings.(Roepke, 2015) Mindfulness-based interventions such as mindfulness-based stress reduction and mindfulness-based cancer therapy have been shown to enhance both PTG and QOL in cancer patients and survivors, according to a meta-analysis by Xunlin et al. (2020). The pooled effect size for PTG was considered large, with a standardized mean difference of 0.58. As the authors point out, the nonjudgmental awareness of one's traumatic experience(s) involved in mindfulness practice may foster perspective taking and reappraisal processes required for growth. Psychological interventions for partners of cancer patients have also been shown to improve PTG.(Kleine et al., 2019) However, to the best of our knowledge, interventions for promoting PTG among combat veterans have yet to be implemented.

5. Limitations

The use of a brief screening instrument for trauma exposure ("saw something horrible or was badly scared during military service") should not be taken as equivalent to a more comprehensive assessment; future studies should include more extensive assessments and full diagnostic interviews to capture the fuller experience of military service-related trauma and PTSD symptoms. Due to the correlational nature of the findings we cannot draw conclusions about causal relationships. Studies that employ longitudinal designs are needed in order to answer questions related to causality. The self-report nature of the surveys leaves open the possibility of response, social desirability, and recall biases, as well as the influence of transient affectual changes. Nevertheless, we chose the most commonly used instruments for assessing the concepts under study, which facilitates comparison of findings across studies. Levels of PTG and/or PTSD symptoms may vary depending on how much time has passed since the traumatic event or events. The time since index trauma in our study was nearly 40 years on average. It is not known whether results would be similar with shorter periods of elapsed time or whether a longer period of time allows for additional time for processing and growth. Some researchers have proposed that an individual's perception of PTG is an illusory experience which amounts to a psychological defense or denial rather than real growth (Andersen, 1975; Sledge et al., 1980); others have disputed this (e.g., Solomon and Dekel, 2007; Tedeschi and Calhoun, 2004). Our methods did not allow us to address this question. Similarly, we cannot rule out the possibility that having survived combat may be experienced as a relief and enhance certain aspects of PTG (e.g., appreciation of life). The field has yet to establish a gold standard for the objective measurement of PTG (i.e., observable evidence of growth) and, although challenging, this should be undertaken. Silverstein et al. (2018) found poor differentiation among the five PTGI subdomains in terms of their associations with external correlates, which may suggest a need for caution in interpretation of our results related to PTGI subdomains. Finally, the sample analyzed for this study consisted entirely of men, the majority of whom were older and white, so results may not be generalizable to more diverse samples.

6. Conclusion

This study contributes to understanding the complex association between combat exposure, PTSD, and PTG by focusing on the experiences of combat veterans. PTSD symptoms from combat seem to stimulate personal strength and a sense of new possibilities for some veterans. This may be able to be capitalized upon to help veterans cope with the sequelae of combat exposure. However, much remains to be understood regarding PTG among combat veterans in order to maximize clinical relevance. Further research is needed to determine whether combat-related PTG can be promoted via intervention, and whether this leads to gains in functioning and/or QOL. Additionally, research into mechanisms of change in PTG and PTSD among combat veterans is needed in order to ascertain which domains of PTG are most amenable to intervention, which are most likely to improve outcomes, and which individuals are most likely to benefit from PTG-focused treatments.

Contributors

Authors Tsai, Southwick, and Pietrzak designed the study. Author Pietrzak conducted the analysis. Author Greenberg conducted the literature searches and wrote the first draft of the manuscript. All authors contributed to revision of the manuscript and have approved the final manuscript.

Role of funding source

This work was supported by the Neurosciences Division for the

National Center for PTSD and a private donation.

Declarations of Competing Interest

None.

Acknowledgement

None.

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