DOI:
10.1136/oemed-2018-105166

Document Version
Peer reviewed version

Citation for published version (APA):
Mark, K., Stevelink, S., Choi, J., & Fear, N. T. (2018). Post-traumatic growth in the military: a systematic review. *Occupational and Environmental Medicine*, *75*(12), 904-915. Advance online publication. https://doi.org/10.1136/oemed-2018-105166

Post-Traumatic Growth in the Military: A Systematic Review

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Word Count: 4,500 (excluding title page, abstract, key messages, references, figures and tables).

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ABSTRACT

Background: Post-traumatic growth is defined as positive psychological, social, or spiritual growth after a trauma. *Objectives:* This systematic review aimed to identify studies that quantitatively measured post-traumatic growth among (ex-) military personnel, to determine whether there is evidence of growth in this context, and whether such growth is associated with any sociodemographic, military, trauma, or mental health factors. *Data sources:* The electronic databases PsycInfo, OVIDmedline, and Embase were searched for studies published between 2001 and 2017. *Study eligibility criteria and participants:* Papers were retained if they involved military or ex-military personnel, where some had deployed to Iraq or Afghanistan. *Study appraisal:* Quality assessment was conducted on all studies. *Results:* 21 studies were retained. The Post-Traumatic Growth Inventory was employed by 14 studies – means ranged from 32.60 (standard deviation = 14.88) to 59.07 (23.48). The Post-Traumatic Growth Inventory Short Form was used by five studies - means ranged from 17.11 (14.88) to 20.40 (11.88). These values suggest moderate growth. Higher levels of social support, spirituality, and rumination, and minority ethnicity, were most frequently associated with more post-traumatic growth. *Limitations:* The involved studies may lack generalisability and methodological quality. *Conclusions:* Overall, this paper confirms that negative reactions to trauma, particularly post-traumatic stress disorder, are not the only possible outcomes for service personnel, as moderate post-traumatic growth can also be observed. *Implications of key findings:* Interventions aimed at helping current and former armed forces personnel to identify and promote post-traumatic growth post-conflict may be beneficial for their well-being.

KEY WORDS

Afghanistan; Iraq; military personnel; post-traumatic growth; veterans; systematic review.

KEY MESSAGES

1. What is already known about this subject?

Post-traumatic growth has been shown to occur following a range of traumatic experiences. It is related to an individual's affect and values prior to the distressing event, as well as to external details such as social, financial, mental health, and demographic factors. For example, such growth has been linked with higher levels of social support, and lower levels of depression. In terms of military-related post-traumatic growth specifically, existing studies have focused on various past conflicts and service subgroups. However, there has not been a systematic review conducted into the presence of post-traumatic growth, or the factors associated with the phenomenon, in military and ex-military personnel.

2. What are the new findings?

For the first time, we investigated post-traumatic growth in the military using a systematic review design. Moderate levels of growth were found across the 21 included studies, indicating positive change in military and former military personnel following trauma. There was a fairly large range in post-traumatic growth scores across the papers. In terms of factors associated with post-traumatic growth, we found the most frequently reported association was between minority group ethnicity and higher levels of growth, and the strongest reported association was between time since the traumatic event and higher levels of growth. Post-traumatic growth was also associated with social support and rumination, across a number of studies.

3. How might this impact on policy or clinical practice in the foreseeable future?

As well as focusing on the negative consequences of trauma in a military context, this systematic review suggests that treatment provisions for armed forces members, post-deployment, can usefully encourage more positive outcomes. Our findings indicate that interventions aimed at helping current and former military personnel to identify and promote post-traumatic growth may be beneficial for their psychological well-being. In line with the associated factors identified here, clinicians should be advised to provide additional social support to those returning from conflict zones who identify as Caucasian, and who report low levels of spirituality and rumination.

INTRODUCTION

Background

Historically, research has focused on post-traumatic stress disorder (PTSD), to understand the negative implications of trauma on behaviour, cognition, and emotions [1]. However, evidence of positive reactions to distressing events has been observed - termed post-traumatic growth (PTG) [2]. The phrase is defined as positive psychological, social, or spiritual growth after a traumatic incident. Its individual elements are broadly classified as: personal improvement, altered priorities, improved relationships, and finding meaning in life [3]. PTG has been reported following cancer [4], natural disasters [5], abuse [6], and military deployment [7].

The degree of positive change experienced is known to be linked to both internal and external factors. The former are an individual's 'personal system', which refers to one's affect and values prior to the traumatic event. The latter may be the network of support available, certain social, financial, and demographic backgrounds, and factors related to the event itself [8]. For example, the internal factors of searching for answers [9], personality traits [10], and depression [11]; and the external factors of age [12] and social support [13], have all been linked to PTG. Focusing on two of the most strongly endorsed of these specific factors, the literature documents a negative association between PTG and depression [14] – with higher levels of PTG occurring for individual's with lower levels of depression; and a positive association between PTG and social support [15] – with higher levels of PTG occurring for individual's with higher levels of social support.

When considering military-related PTG specifically, the literature spans from past battles, such as the World Wars [16] and the Vietnam War [17], to the most recent conflicts in Iraq

and Afghanistan [18]. Studies have sometimes limited their focus to a subsample of the military – for example, infantry [19], chaplains [20], or medical personnel [21]; or to a specific type of service-related trauma – for example, amputation [22] or brain injury [23]. Although psychological difficulties are present for a number of returning service personnel [24], there is an increased interest in PTG as a positive consequence of deployment. Investigating such positive outcomes in a military context is important considering the substantial risk of trauma exposure and potential for psychological difficulties within this population [24]. A more thorough understanding of PTG in military personnel may also have implications for clinical practice, by confirming whether or not PTG should be incorporated into psychological treatments for service members and veterans [25]. Indeed programs and training, such as 'Comprehensive Soldier Fitness' [26], 'Higher Ground' [27], and 'Battlemind' [28], which help facilitate well-being, resilience, and decompression in post-deployment military personnel, are starting to acknowledge PTG.

Objectives

While there have been systematic reviews of PTSD within military and ex-military personnel [29], there have, to the best of our knowledge, been no comparable reviews focusing solely on PTG in these populations. To address this gap in the literature, the current paper systematically reviewed studies, published between 2001 and 2017, that quantitatively measure PTG in previously deployed (ex-) military personnel. It aimed to identify whether PTG was present, as well as the factors associated with the phenomenon, within this specific group.

METHOD

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (see Supplementary File 1).

Search strategy

The literature search was carried out in December 2017. The electronic databases PsycInfo, OVIDmedline, and Embase identified studies published between January 2001 and December 2017. Search terms used were: 'Post traumatic growth'; 'PTG'; 'Trauma'; 'Growth'; 'Stress related growth'; 'Perceived benefit'; 'Benefit finding'; 'Military'; 'Veteran'; 'Deployment'; 'Combat'; 'War'; 'Army'; and 'Armed forces' (see Supplementary File 2).The reference lists of included studies were checked for further relevant papers. Authors were contacted to obtain additional information when needed.

Selection strategy

A total of 449 articles were retrieved from the above bibliographic searches. 285 papers were removed as duplicates. A further 122 were rejected after reviewing paper titles and abstracts. The final 42 papers were read in full, of which 21 were deemed to be relevant to the search criteria and appropriate for assessing our research objective (see Supplementary File 3).

Inclusion criteria

Inclusion criteria for the systematic review were: (1) studies measuring PTG using any quantitative tool; (2) studies focusing on military samples where at least some included personnel had been deployed to Iraq and/or Afghanistan; (3) studies published between 2001 and 2017 – to cover the entirety of the conflicts in Iraq and Afghanistan, and any papers published subsequently; and (4) studies published in English.

Exclusion criteria

Exclusion criteria were: (1) reviews, PhD dissertations, conference proceedings, abstracts, unpublished studies, and books; (2) randomised controlled trials, and pilot, case, and intervention study designs; and (3) studies of the families of service personnel.

Data extraction

The following data were extracted, and then checked and verified, by the research team: title; author(s); publication year; study location; study design; sample type – defined here as either: (1) representative – a general military sample, from the specific population being studied; (2) medical – individuals enrolled with a medical centre, such as the United States (US) Department of Veterans Affairs (VA), for physical, and not psychological/emotional, care; or (3) clinical – individuals referred to a behavioural health clinic for psychological/emotional care, or those diagnosed with PTSD; number of participants; gender distribution; service status – either (1) active duty; (2) National Guard/reservist; or (3) veteran; deployment location; response rate; PTG measure (and the traumatic event referred to in its wording); and means and standard deviations of PTG scores (the core summary measures). Data relating to factors associated with PTG were extracted.

Quality assessment

The ‘Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies’ was adapted [30], to assess the quality of, and risk of bias within, each study. This quality appraisal tool is based on quality assessment methods, concepts, and scales developed by various stakeholders in the field [30]. It has been used to assess study quality across multiple systematic reviews [31, 32]. Two raters (KMM and SAMS) separately graded each study, according to 13 criteria (no = 0, yes = 1). There was a maximum quality score of 13, and

these scores were used to create quality ratings of 'poor', 'fair', or 'good'. In order to make this rating system as simple as possible, it was decided amongst the authors that four criteria would be considered key when scoring cohort/longitudinal articles, and three criteria would be considered key when scoring cross-sectional articles. A study that met one or none of these items received a quality rating of 'poor', a study that met two items received a quality rating of 'fair', and a study that met three (or three or four for longitudinal studies) items received a quality rating of 'good' (see Supplementary File 4).

RESULTS

Study demographics

Table 1 shows demographic information for each of the 21 included studies. All but one [33] of the studies were conducted in the US. Thirteen [18, 19, 21, 22, 34-42] out of the 21 studies were cross-sectional in nature, and 18 [18, 19, 20, 22, 33-36, 39-48] had mixed gender samples. The average number of respondents was 1,143 (and the range was 56 [22] to 5,302 [43]). Eleven [18, 19, 20, 22, 34, 36-38, 42-44] of the studies recruited military personnel who served in Iraq and/or Afghanistan, and 14 [22, 33, 34, 36, 38-42, 45-49] included veterans (defined here, in line with the US definition, as individuals who had previously been deployed in combat, who were not currently deployed, but who were still employed by the services; or as individuals who had been deployed in the military, and had subsequently left). As well as including personnel who had been deployed during their time in the military, three [35, 45, 47] studies included personnel who had not been deployed, with the prevalence of this non-deployed group ranging from 8% of the sample [35] to 66% of the sample [47]. Finally, 13 [19, 21, 34, 35, 37, 39-42, 44, 47-49] studies recruited what we term representative military samples – that is, a general military sample, from the specific population being studied.

Table 1. Demographic Information and Quality Rating for Each Included Study

Reference	Country	Study Design	Number of Respondents	Gender	Response Rate	Deployment Location	Service Status	Sample Type	Quality Rating
Benetato, 2011 [22]	US	Cross-sectional	56	53 male 3 female	27%	Iraq & Afghanistan	Veterans	Medical	Poor
Bush et al., 2011 [43]	US	Retrospective analysis of electronic records	5302	4742 male 560 female	N/A	Iraq & Afghanistan	Active duty & National Guard/ reservists	Clinical	Fair
Currier et al., 2013 [36]	US	Cross-sectional	110	88 male 22 female	60%	Iraq & Afghanistan	Veterans	Medical	Fair
Gallaway et al., 2011 [19]	US	Cross-sectional	1834	1680 male 116 female 38 undisclosed	89%	Iraq	Active duty	Representative	Good
Kaler et al., 2011 [44]	US	Longitudinal	327	288 male 39 female	81%	Iraq	National Guard/ reservists	Representative	Poor
Lee et al., 2010 [18]	US	Cross-sectional	3537	3259 male 277 female 1 undisclosed	NR	Iraq & Afghanistan	Active duty	Clinical	Fair

Marotta-Walters et al., 2015 [38]	US	Cross-sectional	107	107 male 0 female	14%	Iraq & Afghanistan	Veterans	Medical	Good
McLean et al., 2013 [21]	US	Cross-sectional	253	103 male 95 female 55 undisclosed	NR	Iraq	Active duty (Air Force)	Representative	Poor
Mitchell et al., 2013 [37]	US	Cross-sectional	1663	1663 male 0 female	99.2%	Iraq	Active duty	Representative	Fair
Morgan & Desmarais, 2017 [40]	US	Cross-sectional	197	137 male 60 female	NR	Iraq, Afghanistan, & elsewhere	Veterans	Representative	Fair
Morgan et al., 2017 [41]	US	Cross-sectional	197	137 male 60 female	NR	Iraq, Afghanistan, & elsewhere	Veterans	Representative	Good
Murphy et al., 2017 [33]	UK	Longitudinal	149	148 male 1 female	66%	Iraq, Afghanistan, & elsewhere	Veterans	Clinical	Good
Palmer et al., 2012 [44]	US	Retrospective observational survey	221	208 male 13 female	NR	Iraq, Afghanistan, & elsewhere. 19% not deployed	Veterans	Clinical	Fair
Palmer et al., 2016 [46]	US	Retrospective analysis of	269	252 male 17 female	N/A	Iraq, Afghanistan, & elsewhere	Veterans	Clinical	Poor

		electronic records							
Park et al., 2017 [42]	US	Cross-sectional	630	392 male 238 female	NR	Iraq & Afghanistan	Veterans	Representative	Fair
Pietrzak et al., 2010 [34]	US	Cross-sectional	272	243 male 29 female	25.9%	Iraq & Afghanistan	Veterans	Representative	Fair
Scott et al., 2011 [35]	US	Cross-sectional	557	493 male 64 female	NR	Iraq, Afghanistan, & elsewhere. 8% not deployed	National Guard/ reservists	Representative	Fair
Tsai et al., 2015 [39]	US	Cross-sectional	2719	2571 male 148 female	66.5%	Iraq, Afghanistan, & elsewhere	Veterans	Representative	Good
Tsai et al., 2016 (1) [47]	US	Longitudinal	1838	1665 male 173 female	NR	Iraq, Afghanistan, & elsewhere. 66% not deployed	Veterans	Representative	Fair
Tsai et al., 2016 (2) [48]	US	Longitudinal	1057	987 male 70 female	48.8%	Iraq, Afghanistan, & elsewhere	Veterans	Representative	Fair
Tsai & Pietrzak, 2017 [49]	US	Longitudinal	2718	NR	66.5%	Iraq, Afghanistan, & elsewhere	Veterans	Representative	Fair

Note. US = United States; UK = United Kingdom; N/A = not applicable; NR = not reported. In terms of service status – veteran is defined here, in line with the US definition, as individuals who had previously been deployed in combat, who were not currently deployed, but who were still employed by the services, or as individuals who had been deployed in the military, and had subsequently left; active duty is defined here as individuals whose full-time occupation was to serve in the military at the time of data collection; National Guard/reservist is defined here as individuals who were in the reserve military at the time of data collection, and who had civilian jobs alongside their service role. In terms of sample type – medical is defined here as individuals enrolled with a VA medical centre, for physical, and not psychological/emotional, care; clinical is defined here as individuals referred to a behavioural health clinic for psychological/emotional care, or as those diagnosed with PTSD; representative is defined here as a general military sample, from the specific population being studied. Four of the studies (Tsai et al., 2015 [39]; Tsai et al., 2016 (1) [47]; Tsai et al., 2016 (2) [48]; and Tsai & Pietrzak, 2017 [49]) had overlapping samples. All recruited from The National Health and Resilience in Veterans Study (NHRVS), a three-wave nationally representative survey of US veterans. Tsai et al. (2015) [39] and Tsai and Pietrzak (2017) [49] included participants from the first wave of the study, conducted between October and December 2011; Tsai et al. (2016; 1) [47] included participants who had completed both the first wave and the second wave, conducted between September and October 2013; and Tsai et al. (2016; 2) [48] included participants who had experienced new traumatic events between the first wave and the second wave. All of these papers were included in the review, and treated separately.

Quality assessment

Five [19, 33, 38, 39, 41] of the 21 included studies received a rating of 'good'; 12 [18, 34-37, 40, 42, 43, 45, 47-49] received a rating of 'fair'; and four [21, 22, 44, 46] received a rating of 'poor'(see Table 1 and Supplementary File 5).

Across all included studies, number one of the quality assessment measure - was the research question clearly stated? - was the highest scoring item, with all 21 studies fulfilling this criterion. Numbers five - was a sample size justification, power description, or variance and effect estimate provided?; six - were the independent variables measured prior to the outcome being measured?; and 10 - were the independent variables assessed more than once over time?, were least often endorsed. Three [20, 36, 38] out of a possible 21 studies, three [31, 46, 47] out of a possible 21 studies, and two [31, 46] out of a possible 20 studies (this criterion was not applicable for one study), fulfilled these criteria, respectively.

Across the four studies that received a quality rating of 'poor' [21, 22, 44, 46], numbers one; two - was the study population clearly defined?; eight - for independent variables that can vary in amount or level, did the study examine different levels as related to the outcome?; and nine of the quality assessment measure - were the independent measures clearly defined, valid, reliable, and implemented consistently?, were the most fulfilled criteria, with all four studies endorsing these items. Numbers six; seven - was the timeframe sufficient to see an association between independent variable(s) and outcome?; and 10, were least often endorsed, with none of the four studies fulfilling these criteria.

Measures

Table 2 shows information on the outcome of PTG for each included study, and these details are also shown in a Forest plot in Figure 1. As shown, 14 [18, 19, 21, 22, 33, 36-38, 40-43,

45, 46] studies used the Post-Traumatic Growth Inventory (PTGI [2]; see Supplementary File 6). This questionnaire consists of 21 items, and yields a score ranging from 0 to 105. A higher score indicates greater PTG. Factorial stability [50], internal consistency [51], test-retest reliability [2], and convergent and discriminant validity [52] are high for both the total scale and the five individual subscales of the PTGI. Confirmatory factor analysis has further validated use of the PTGI with a recently deployed population [18].

The mean score found across the 14 studies employing the PTGI was 45.48 (standard deviation (*SD*) = 23.25). There was a fairly large range in PTG scores across these papers, with a 26.47 point difference between the lowest PTGI value (mean (*M*) = 32.60; *SD* = 14.88) [33] and the highest PTGI value (*M* = 59.07; *SD* = 23.48) [22]. All but three [19, 33, 46] of these papers reported Cronbach's alphas for their samples on the PTGI, in order to assess the internal reliability of the scale. All values were excellent, with ranges between 0.90 [42] and 0.96 [21, 37]. None of the studies employing the PTGI reported on the validity or reliability of the scale within their sample.

Insert Figure 1 here

Table 2. Post-Traumatic Growth Information for Each Included Study

Reference	Measure	Traumatic Event(s)*	PTG Score	
			M	*SD*
Benetato, 2011 [22]	PTGI	Combat-related amputation	59.07	23.48
Bush et al., 2011 [43]	PTGI	Deployment/combat experience	49.53	23.25
Currier et al., 2013 [36]	PTGI	Self-reported 'worst' traumatic event suffered	47.83	25.95
Gallaway et al., 2011 [19]	PTGI	Deployment	41.10	25.80
Kaler et al., 2011 [44]	PTGI-SF	Deployment to Iraq	20.40	11.88
Lee et al., 2010 [18]	PTGI	Deployment/combat experience	52.04	22.98
Marotta-Walters et al., 2015 [38]	PTGI	Deployment/combat experience	47.11	22.98
McLean et al., 2013 [21]	PTGI	Any crisis/disaster (original PTGI wording)	38.56	25.64
Mitchell et al., 2013 [37]	PTGI	Deployment	37.98	22.34
Morgan & Desmarais, 2017 [40]	PTGI	Self-reported 'worst' traumatic event suffered in the last 3 years	46.14	24.98
Morgan et al., 2017 [41]	PTGI	Self-reported 'worst' traumatic event suffered in the last 3 years	45.91	24.68

Murphy et al., 2017 [33]	PTGI	Any crisis/disaster (original PTGI wording)	32.60	14.88
Palmer et al., 2012 [45]	PTGI	Any crisis/disaster (original PTGI wording)	39.59	27.43
Palmer et al., 2016 [46]	PTGI	Any crisis/disaster (original PTGI wording)	52.21	22.46
Park et al., 2017 [42]	PTGI	Deployment/combat experience	47.07	18.59
Pietrzak et al., 2010 [34]	PTGI 6-item version	Any crisis/disaster (original PTGI wording)	17.10	0.75
Scott et al., 2011 [35]	4-item Positive Benefits of Deployment Scale	Deployment	3.10	0.92
Tsai et al., 2015 [39]	PTGI-SF	Self-reported 'worst' traumatic event suffered	17.11	14.18
Tsai et al., 2016 (1) [47]	PTGI-SF	Self-reported 'worst' traumatic event suffered	17.59	5.95
Tsai et al., 2016 (2) [48]	PTGI-SF	Self-reported 'worst' traumatic event suffered	17.92	14.02
Tsai & Pietrzak, 2017 [49]	PTGI-SF	Self-reported 'worst' traumatic event suffered	19.50	NR

Note. * Refers to the wording used in the PTG measure. PTGI = Post-Traumatic Growth Inventory; PTGI-SF = Post-Traumatic Growth Inventory Short Form; PTG = post-traumatic growth; *M* = mean; *SD* = standard deviation; NR = not reported. For studies using the PTGI, the maximum PTG score was 105. For studies using the PTGI-SF, the maximum PTG score was 50. The PTGI six-item version had a maximum PTG score of 30. The Positive Benefits of Deployment Scale had a maximum mean PTG score of 4.

Six studies used a shortened version of the PTGI. Five of these [39, 44, 47-49] used a 10-item version – the PTGI short version (PTGI-SF) [50]. This mirrors the strong psychometric qualities of the PTGI. For example, previous confirmatory factor analyses on the items of the PTGI-SF replicated the five factor structure supported by the PTGI [46]; the short form reproduced relationships between PTG and variables of interest among various trauma-afflicted samples [49]; and it produced a total scale internal consistency coefficient of 0.89 [49]. Excellent reliability, factor structure, and concurrent validity for the PTGI-SF have also been shown in a previously deployed military sample [44].

Of the five studies that employed the PTGI-SF, one [49] did not report a SD value for the mean score on this measure. The five studies that reported a PTGI-SF score had a mean of 18.50 (out of 50; *SD* = 11.51 for the four studies that reported this statistic). All five of these papers reported Cronbach's alphas for their samples on the PTGI-SF, in order to assess the internal reliability of the scale. All values were excellent, with ranges between 0.90 [44] and 0.95 [39, 47-49].

One [34] study used a shorter six-item version of the PTGI, specifically designed by the authors. While the researchers reported a high internal consistency score, it is worth nothing that this new scale has yet to be used by others. The study reported a mean PTG score of 17.10 (out of 30; *SD* = 0.75), and the Cronbach's alpha was 0.86.

Finally, one [35] study used a self-designed, and unvalidated, four-item study questionnaire for measuring PTG and the benefits of deployment, and found a mean PTG score of 3.10 (out of 4; *SD* = 0.92). Questions put forward two statements about pride: (1) 'A feeling of pride for having served our country', and (2) 'A sense of accomplishment for a job well done'; as well as two about money: (1) 'I earned more while deployed', and (2) 'I had more health care/retirement benefits'.

Of the 14 studies that used the PTGI, six [18, 19, 37, 38, 42, 43] asked subjects to focus on their deployment/combat experience. The mean of these 14 studies was 45.81 (*SD* = 22.66). Of the five studies that employed the PTGI-SF, four [39, 47-49] asked subjects to focus on the worst traumatic event suffered in their lifetime. The mean of these four studies was 18.03 (*SD* = 11.38 for the three studies that reported this statistic). See Supplementary File 7 and Supplementary File 8 for graphs showing mean levels of PTG on the PTGI and PTGI-SF, respectively, as a function of their wording.

Out of the 14 studies that used the PTGI, six [19, 21, 37, 40-42] recruited representative samples. These six studies had a mean of 42.79 (*SD* = 23.67). When medical samples were recruited, the mean PTG score was 51.34 (*SD* = 24.14). When clinical samples were recruited, the mean PTG score was 45.19 (*SD* = 22.20).

Associated factors

As shown in Table 3, the most commonly reported, in six [19, 37, 39, 42, 44, 47] (out of a possible seven) studies, statistically significant association was between ethnicity and PTG, with less PTG occurring in Caucasians than in ethnic minority groups. Three (out of a possible three) studies each also reported that higher levels of social support [22, 36, 49] and rumination [22, 40, 41] were associated with higher levels of growth (see Supplementary File 9).

Table 3. Factors Associated with Post-Traumatic Growth for Each Included Study, Along with their Direction of Association

Associated Factors	Significant Positive Associations	Significant Negative Associations	Non-Significant Associations
Social Demographics			
Male gender	Tsai & Pietrzak, 2017		Gallaway et al., 2011 Kaler et al., 2011 Morgan & Desmarais, 2017 Morgan et al., 2017 Park et al., 2017 Tsai et al., 2015 Tsai et al., 2016 (1)
Minority ethnicity	Gallaway et al., 2011 Kaler et al., 2011 Mitchell et al., 2013 Park et al., 2017 Tsai et al., 2015 Tsai et al., 2016 (1)		Tsai & Pietrzak, 2017
Married status	Mitchell et al., 2013		Gallaway et al., 2011 Kaler et al., 2011 Park et al., 2017
Education level			Gallaway et al., 2011 Park et al., 2017 Tsai et al., 2016 (1) Tsai & Pietrzak, 2017

Age		Morgan & Desmarais, 2017 Pietrzak et al., 2010 Tsai et al., 2016 (1)	Kaler et al., 2011 Morgan et al., 2017 Park et al., 2017 Tsai & Pietrzak, 2017
Household income		Tsai et al., 2015	Park et al., 2017 Tsai & Pietrzak, 2017
Active lifestyle		Tsai et al., 2015	Tsai & Pietrzak, 2017
Positive spirituality	Park et al., 2017 Tsai et al., 2016 (1)		Tsai et al., 2015 Tsai & Pietrzak, 2017
Negative spirituality		Park et al., 2017	
Military- or Trauma-Related			
Months since amputation			Benetato, 2011
Time since event	Morgan & Desmarais, 2017 (curvilinear)		Morgan et al., 2017 Tsai & Pietrzak, 2017
Combat exposure	Bush et al., 2011 Gallaway et al., 2011 Mitchell et al., 2013 Park et al., 2017	McLean et al., 2013 (quadratic)	Currier et al., 2013 Kaler et al., 2011 Marotta-Walters et al., 2015 Pietrzak et al., 2010 Tsai et al., 2015
Trauma exposure			Currier et al., 2013

Higher rank		Gallaway et al., 2011 Mitchell et al., 2013	
Number of deployments			Gallaway et al., 2013
Perceived threat	Kaler et al., 2011 Marotta-Walters et al., 2015		
Healthcare stress exposure		McLean et al., 2013 (quadratic)	
Unit cohesion	Mitchell et al., 2013		
Impact of military on life			Tsai et al., 2015
Type of trauma	Tsai et al., 2015 – life threatening illness/injury	Tsai et al., 2015 – natural disaster	Tsai & Pietrzak, 2017 – life threatening illness/injury
Deployment location	Tsai et al., 2015 - Vietnam		
Years served in military			Tsai & Pietrzak, 2017
Number of traumas suffered			Tsai et al., 2016 (1) Tsai & Pietrzak, 2017
Mental Health			
Rumination	Benetato, 2011 Morgan & Desmarais, 2017 Morgan et al., 2017		
Depression		Bush et al., 2011 Palmer et al., 2016	Currier et al., 2013 Gallaway et al., 2011

			Kaler et al., 2011 Murphy et al., 2017
Substance abuse		Bush et al., 2011	Tsai et al., 2015 Tsai & Pietrzak, 2017
Alcohol abuse			Gallaway et al., 2011
PTSD symptoms	Pietrzak et al., 2010 Marotta-Walters et al., 2015 – avoidance & hyperarousal Morgan & Desmarais, 2017 Morgan et al., 2017 Tsai et al., 2015 Tsai & Pietrzak, 2017	Bush et al., 2011 Park et al., 2017 Tsai et al., 2016 (2)	Currier et al., 2013 Gallaway et al., 2011 Kaler et al., 2011 Marotta-Walters et al., 2015 – re-experiencing Murphy et al., 2017
Suicidal ideation		Bush et al., 2011 Gallaway et al., 2011	
Global well-being	Kaler et al., 2011		
Satisfaction with life	Morgan et al., 2017		Morgan & Desmarais, 2017
Anxiety			Murphy et al., 2017
Anger			Murphy et al., 2017
Psychosocial difficulties			Pietrzak et al., 2010
Positive psychosocial traits	Tsai et al., 2015		Marotta-Walters et al., 2015 Tsai et al., 2016 (1) Tsai & Pietrzak, 2017

Negative psychosocial traits	Marotta-Walters et al., 2015		
Psychological resilience	Pietrzak et al., 2010		
Common mental health issues			Tsai et al., 2015 Tsai & Pietrzak, 2017
Emotion Regulation			
Emotional lability		Bush et al., 2011	
Challenges to core beliefs	Morgan & Desmarais, 2017 Morgan et al., 2017		
Maladaptive processing			Currier et al., 2013
Adaptive processing			Currier et al., 2013
Reluctance to talk			Currier et al., 2013
Urge to talk	Currier et al., 2013		
Emotional reactions			Currier et al., 2013
Adjustment reactions			Gallaway et al., 2011
Positive personality traits			Tsai et al., 2015 Tsai et al., 2016 (1) Tsai & Pietrzak, 2017
Relationships			

Social support	Benetato, 2011 Currier et al., 2013 Tsai & Pietrzak, 2017		
Unit social support	Pietrzak et al., 2010		Kaler et al., 2011
Post-deployment social support	Kaler et al., 2011		Pietrzak et al., 2010
Social connectedness	Tsai et al., 2015		Tsai et al., 2016 (1)
Relationship difficulties		Bush et al., 2011	
Altruism			Tsai et al., 2015 Tsai & Pietrzak, 2017
Number of friends/relatives	Tsai & Pietrzak, 2017		
Secure attachment style			Tsai & Pietrzak, 2017
Other			
Physical health			Tsai et al., 2015 Tsai et al., 2016 (1) Tsai & Pietrzak, 2017

Note. PTSD = post-traumatic stress disorder. Various tests of association were used throughout the 14 studies (see Supplementary File 9).

Other factors significantly associated with growth were: perceived threat (positive relationship found in two [38, 44] out of a possible two studies); challenges to core beliefs (positive relationship found in two [39, 41] out of a possible two studies); military rank (negative relationship found in two [19, 37] out of a possible two studies); and suicidal ideation (negative relationship found in two [19, 43] out of a possible two studies).

One paper [40] (out of a possible three) showed a positive relationship between PTG and the time since the traumatic event. However, this association was the strongest statistically significant association of all those tested - with the largest effect size, an *F*-test statistic of 49.60 (see Supplementary File 9).

Two factors showed mixed associations with PTG – combat exposure and PTSD. Five (out of a possible 10) studies reported a significant association between combat exposure and PTG, with higher levels of combat exposure being associated with higher levels of growth in four [19, 37, 42, 43] studies, and a curvilinear relationship being reported in one [21] study. However, the other five [34, 36, 38, 39, 44] studies found a non-significant association. Of the 14 studies that investigated the association between PTSD and PTG, five [19, 33, 36, 38, 45] reported a non-significant relationship. However, six [34, 38-41, 49] studies reported a positive association – with higher levels of PTSD being associated with higher levels of growth, and three [42, 43, 48] reported a negative association – with higher levels of PTSD being associated with lower levels of growth.

DISCUSSION

Key findings

This systematic review found moderate levels of PTG across the 21 included studies, indicative of positive change in military (or former military) personnel. There was a fairly

large range in PTG scores across the included papers. For the 14 studies that employed the PTGI, there was a 26.47 point difference between the lowest value [33] and the highest value [22]. Perhaps this difference is attributable to the mental health statuses of the veterans in these two studies. Specifically, the participants from the former study [33] had been diagnosed with, and were being treated for, service-related PTSD symptoms at a military charity within the United Kingdom (UK); while the latter group were a non-clinical, and randomly picked, US veteran sample [22].

A range of factors were shown to be associated with PTG across the 21 studies. The most frequently reported association was between minority group ethnicity and higher levels of PTG, and the strongest reported association between time since traumatic event and PTG. PTG was also associated with social support and rumination across a number of studies.

Comparisons to previous research

PTG scores, measured using the PTGI, of populations involved in historical conflicts have reported growth values close to the range of those in this review (32.60 (*SD* = 14.88) to 59.07 (*SD* = 23.48)). For example, World War II veterans reported an average PTG score of 63.27 (*SD* = 20.69) [16]; and Yugoslavia war veterans of 35.82 (*SD* = 18.09) [11]. When considering traumatic experiences within the civilian population, higher growth scores than those reported in military-based studies have been documented. For example, bereaved individuals have reported an average PTG score of 79.72 (*SD* = 19.50) [51]; and cancer survivors of 73.00 (*SD* = 21.00) [52].

Perhaps there are distinctive factors at play for the differing populations of military and non-military groups. For example, searching for answers [9], personality traits [10], and age [12] have all been associated with PTG. Studies of armed forces members tell us that these

individuals are likely to: (1) actively search for meaning following the traumatic event – due to the, often, large scale devastation of war [16]; (2) embody characteristics such as emotional instability – the majority of those in the forces come from a relatively deprived background, and instability goes hand-in-hand with low income and socioeconomic status [53]; and (3) be young in age – particularly in comparison to those suffering from ill-health related traumas, which increase with age [54]. All of these factors are related to lower levels of growth, which could explain the higher PTG scores reported by non-military, compared to military, trauma victims. Moreover, perhaps the experienced traumas themselves are qualitatively different depending on military status, which in turn may elicit varying responses in armed forces personnel versus civilians. These concepts will be explored more in the section below.

Associated factors

The consistent associations found between ethnicity and PTG [19, 37, 39, 42, 44, 47] are in line with past research [55]. Minority groups may be more likely to be socioeconomically disadvantaged, and to, subsequently, experience multiple additional stressors in their daily lives. The prior confrontation with differing worries may enable them to develop the skill of growing from hardships [56], including armed forces deployments. Alternatively, the greater significance of spirituality among ethnic minorities may increase growth. An emerging body of evidence supports the fact that religion and spirituality may provide beneficial ways for trauma survivors to understand their traumatic experiences [13] – for example, by increasing personal strength and appreciation of life. Indeed, there was some support for the association between spirituality and PTG within this review (in two [42, 47] out of a possible four studies). Although the observed associations between both ethnicity and spirituality and

growth were expected, it is interesting to note that all of the studies endorsing such links employed representative military samples, as opposed to medical or clinical groups.

A positive association was found between social support and PTG [22, 36, 49]. Being cared for by others fosters an environment in which an individual can create meaning from their experience, and can, subsequently, improve their ability to cope [3]. However, findings linking growth with more specific operationalisations of social support in this review were mixed. Three papers included found no association between PTG and unit social support [44], post-deployment social support [34], and social connectedness [47], respectively. Two [44, 47] out of these three [34, 44, 47] opposing papers, showing no association between these specific forms of social support and PTG, employed a longitudinal research design, and recruited samples accessing health care services for medical problems. In contrast, two [22, 36] out of the three [22, 36, 49] papers that endorsed the link between greater social support and greater PTG were cross-sectional in nature, and focused on representative military samples. Firstly, these methodological differences show that the two [44, 47] studies reporting a non-significant link between the target variables were more robust and empirically valid. Secondly, the results suggest that the relationship between PTG and social support is weaker for individuals with less severe and complex military-related needs. Overall, these inconsistent conclusions highlight the need for both high quality studies and qualitative research into these specific relationships.

The finding linking rumination [22, 40, 41] with PTG was predictable, because this relationship is already well-established within the literature [57]. Indeed, rumination is listed as a key element of the PTG model, originally proposed by Tedeschi and Calhoun [3]. According to these authors [3], PTG does not emerge as a direct result of trauma; rather, growth is a consequence of an individual's struggle with, and development of, a new reality

following a distressing event. In line with this definition, the closely related construct of challenges to core beliefs was found to correlate positively with growth here [40, 41]. Importantly, all three of the studies [22, 40, 41] reporting significant associations between rumination, challenges to core beliefs, and growth focused on veterans, and were cross-sectional in nature. Such a relationship needs clarifying in longitudinal studies of active duty and reservist personnel, because it may be that study design and military role impact on the link between these constructs.

In keeping with previous studies [54], combat exposure and PTG were positively associated [19, 37, 42, 43]. Three [19, 37, 43] (of the possible four [19, 37, 42, 43]) papers that endorsed this association included active duty service members. It has been suggested that individuals may gradually build up a tolerance to stress and trauma, upon repeated exposure, and, consequently, may develop coping skills to deal with such situations [58]. In the context of combat then, active military personnel, who are repeatedly exposed to conflict, may be better equipped to handle the effects of traumatic ordeals. Thus, these individuals may be more likely to experience positive growth from these distressing experiences. Contrastingly, when veterans, and, in one paper, reservists, were studied, this review found that combat experience was non-significantly associated with PTG [34, 36, 38, 39, 44]. This seems logical, and in line with Schnurr and colleagues' [59] proposal, as ex-serving personnel are less likely to have been subjected to recent recurring traumas than active duty individuals. Alternatively, perhaps it is simply the passing of time since the trauma that results in less PTG for veterans and reservists, who, we could argue, are more distanced from the immediate impact of the military than those on active duty.

The current review highlights mixed results for the association between PTG and PTSD [19, 33, 34, 36, 38-44, 48, 49]. This corresponds with past literature, showing that the relationship

between these outcomes is unclear, and potentially complex. The inconsistent associations reported may be accounted for by a third mediating variable – such as resilience or cognitive appraisal post-deployment. While there has been controversy regarding the role of resilience, some research has suggested that those who develop negative post-deployment outcomes, like PTSD, may have both more resilient personality characteristics [60] and a more positive appraisal of their distressing experience [61], which could make them more likely to experience growth following a potentially traumatic event.

Alternatively, two previous studies investigating distress, following both a terrorist attack [62] and severe breast cancer [63], have demonstrated a curvilinear association between PTSD and PTG, whereby the relationship follows an inverted 'U'-shaped curve. Similar outcomes have been drawn in military samples [64], and may be at play here. Such non-linearity would indicate that both high and low levels of PTSD symptoms are linked to low levels of growth, and that mid-levels are linked to higher levels of growth. It is also worth noting that low levels of growth and low levels of PTSD occurring together, in tandem, may simply be indicative of the fact that the traumatic event in question was not as traumatic to the participant as would be expected.

Strengths and limitations

This comprehensive, multi-database systematic search and review into quantitatively measured PTG in the military used robust and well-established methodology and quality guidelines. However, taking into account the variability in PTG scores across studies, our use of means as summary statistics is an important limitation. Considering the individual studies included in the systematic review, only one was conducted outside of the US, and four recruited fewer than four women participants. Furthermore, all studies made use of self-report questionnaires. While the full PTGI scale, employed by the majority of papers here, has

demonstrated reliability and validity in multiple populations [45], rater-bias is considered a risk for surveys that require completion by participants themselves [65]. This is likely to be an especially prominent problem for poorly validated measures, such as the six-item PTGI (used here by Pietrzak et al. [34]), and the Positive Benefits of Deployment Scale (used here by Scott et al. [35]). Perhaps reflecting the weaknesses addressed here, only five out of the 21 target papers were rated as 'good' quality. Employing qualitative, researcher-led interviews may help to discern differential reasons for growth, while simultaneously reducing rater-bias.

Implications

The evidence available to date indicates that military populations experience moderate PTG following deployment, and that this growth is not necessarily related to symptoms of PTSD. As well as focusing on the negative outcomes of trauma in this context, care provisions for armed forces members, post-deployment, can usefully encourage more positive consequences. Indeed, this paper's findings indicate that interventions aimed at helping current and former armed forces personnel to identify and promote PTG may be beneficial for their psychological well-being. In line with the salient associated factors identified here, clinicians should be advised to encourage and provide additional social support to those returning from Iraq and Afghanistan, and other conflict zones, who identify as Caucasian, and who report low levels of spirituality and rumination.

Conclusions

This systematic review adds to the evidence base on PTG, indicating that growth exists in military personnel, and that negative reactions to trauma are not the only consequence following deployment. Therefore, interventions aimed at helping past and present military members to identify and promote more positive outcomes, particularly post-conflict, may be beneficial.

Author contributions:

Study concept and design: Sharon A.M. Stevelink, Jeesoo Choi, Nicola T. Fear.

Acquisition, analysis, or interpretation of data: Katharine M. Mark, Jeesoo Choi.

Drafting of the manuscript: Katharine M. Mark, Jeesoo Choi.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Katharine M. Mark.

Administrative, technical, or material support: Sharon A.M. Stevelink.

Study supervision: Sharon A.M. Stevelink, Nicola T. Fear.

Competing interests: Nicola T. Fear is a trustee of a veterans' charity.

Funding: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

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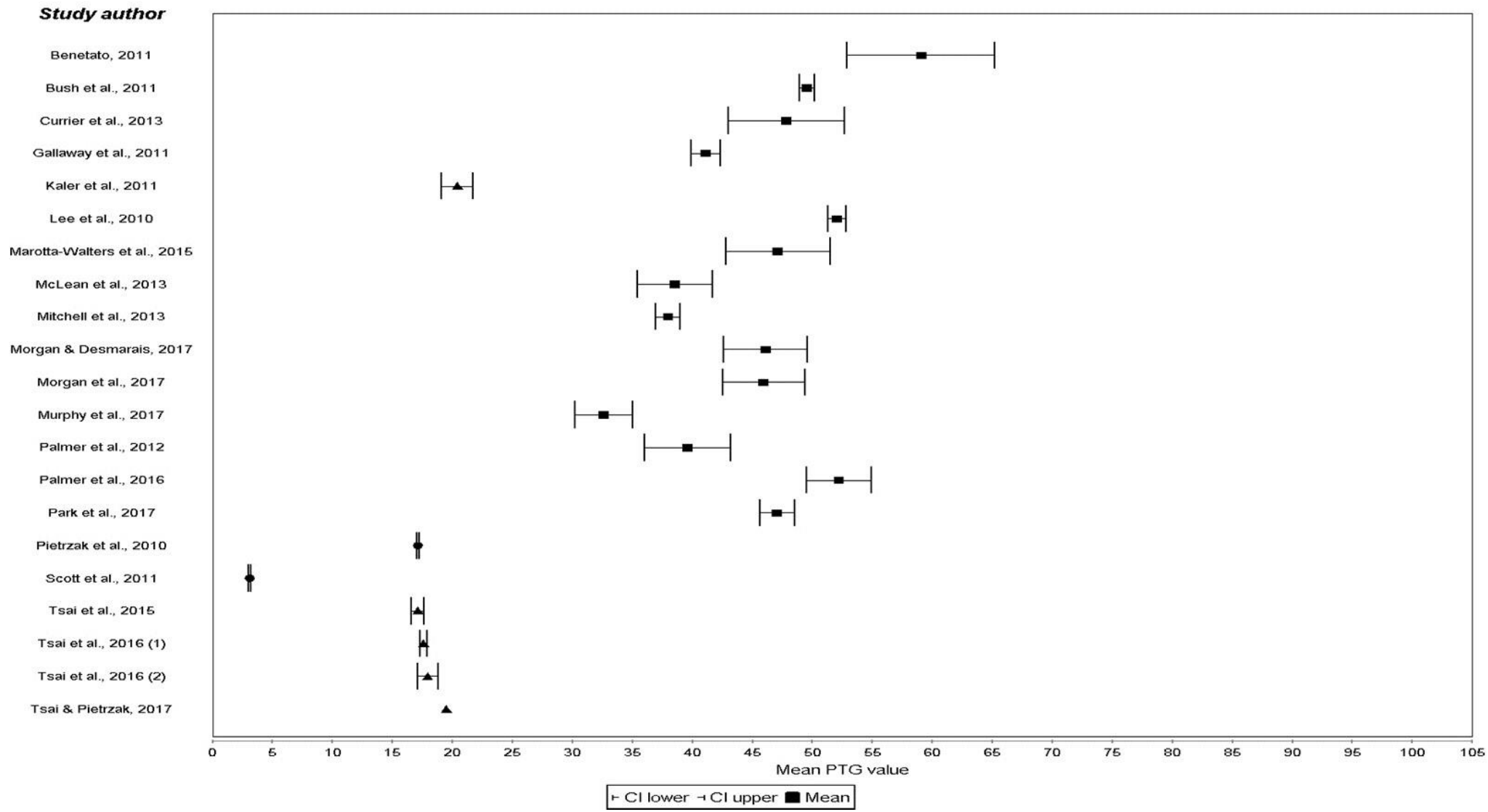
Figure 1. A Forest Plot Graph to Show Mean Post-Traumatic Growth Scores and Associated 95% Confidence Intervals for Each Included Study. *Note.* CI = confidence intervals. Errors bars show confidence intervals: lower cap = difference between mean value and lower confidence interval; upper cap = difference between upper confidence interval and mean value. All studies are shown. Square data points = studies using the full PTGI (with a maximum score of 105); triangle data points = studies using the PTGI-SF (with a maximum score of 50); circle data points = studies using neither the PTGI or the PTGI-SF. The study by Tsai and Pietrzak (2017) [49] does not have CIs shown here. These could not be calculated, because the study was lacking a SD value.


Study author
Benetato, 2011
Bush et al., 2011
Currier et al., 2013
Gallaway et al., 2011
Kaler et al., 2011
Lee et al., 2010
Marotta-Walters et al., 2015
McLean et al., 2013
Mitchell et al., 2013
Morgan & Desmarais, 2017
Morgan et al., 2017
Murphy et al., 2017
Palmer et al., 2012
Palmer et al., 2016
Park et al., 2017
Pietrzak et al., 2010
Scott et al., 2011
Tsai et al., 2015
Tsai et al., 2016 (1)
Tsai et al., 2016 (2)
Tsai & Pietrzak, 2017
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
Mean PTG value
CI lower CI upper Mean

SUPPLEMENTARY FILES

Supplementary File 1 – The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2 – 3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	5 – 6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7 - 8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7 - 8
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary File, page 4

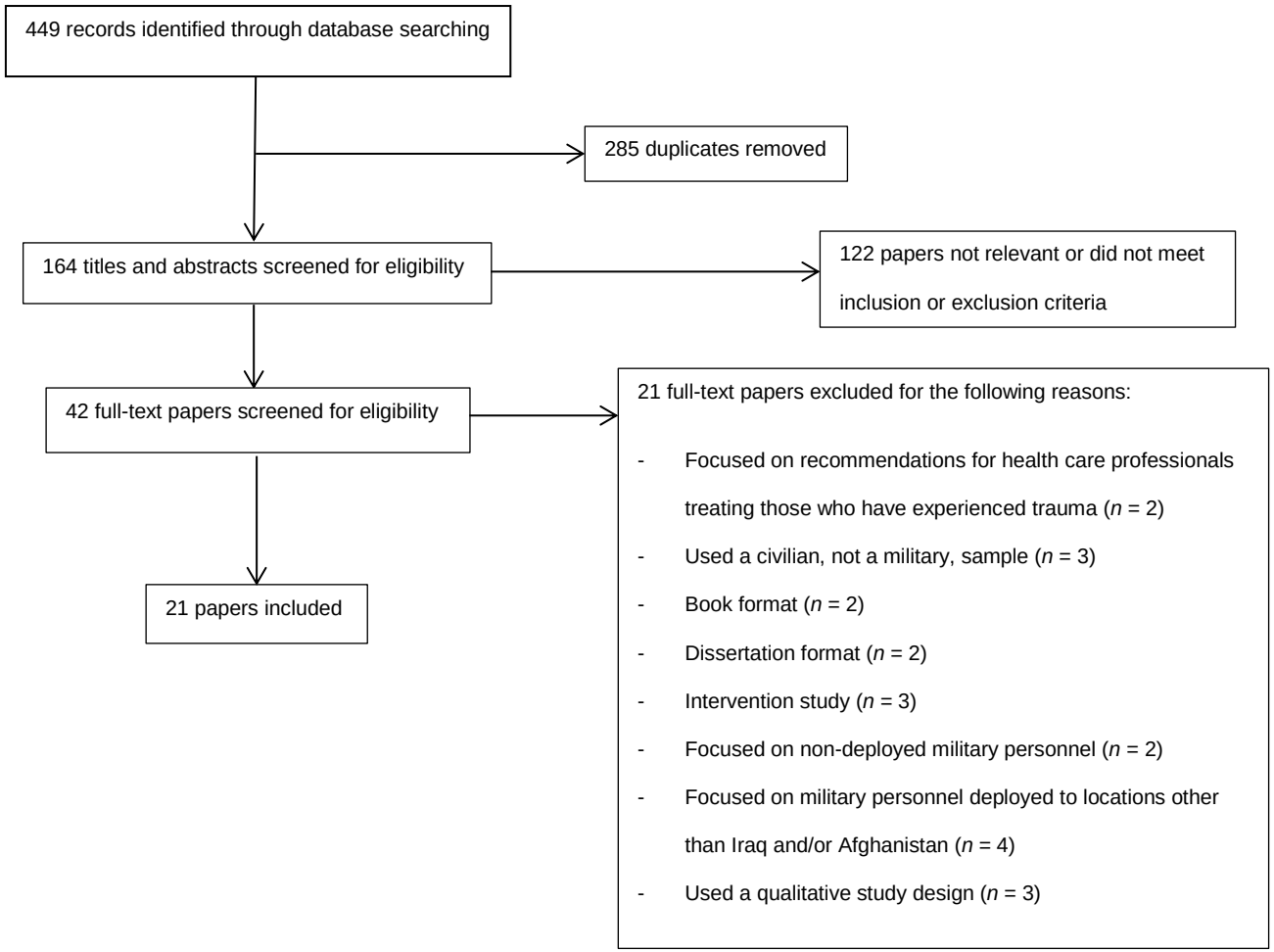
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8 – 9 (and Supplementary File, pages 6 – 8)
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8; 16 - 17
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A
Section/topic	**#**	**Checklist item**	**Reported on page #**
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8 – 9 (and Supplementary File, pages 6 – 8)
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7 (and Supplementary File, page 5)
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	9 – 26

Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14 – 26, 28 – 32 (and Supplementary File, pages 9 – 12)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9 – 26 (and Supplementary File, pages 16 and 17)
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14 – 26, 28 - 32 (and Supplementary File, pages 9 – 12)
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	26 – 31
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	31 – 32
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	32
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	33

Supplementary File 2 – The literature search terms used

1. “post traumatic growth”.ti
2. “posttraumatic growth”.ti
3. “post-traumatic growth”.ti
4. PTG.ti
5. trauma.ti
6. growth.ti
7. “stress related growth”.ti
8. “stress-related growth”.ti
9. “perceived benefit”.ti
10. military.ti
11. veteran.ti
12. veterans.ti
13. deployment.ti
14. combat.ti
15. war.ti
16. army.ti
17. “armed forces”.ti
18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
19. 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
20. 18 and 19
21. limit 20 to English language
22. limit 21 to yr=”2001-2017”
23. remove duplicates from 22

Supplementary File 3 – The article selection strategy used



Supplementary File 4 – The quality assessment tool used, adapted from 'The Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies'

The 13 question-based criteria:

1) Was the research question or objective in this paper clearly stated?
2) Was the study population clearly specified and defined?
3) Was the participation rate of eligible persons at least 50%?
4) Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study pre-specified, and applied uniformly to all participants?
5) Was a sample size justification, power description, or variance and effect estimate provided?
6) For the analyses in this paper, were the independent variables measured prior to the outcome being measured?
7) Was the timeframe sufficient so that one could reasonably expect to see an association between independent variable(s) and outcome, if it existed?
8) For independent variables that can vary in amount or level, did the study examine different levels as related to the outcome (for example, categories of independent variables, or independent variables measured in a continuous way)?
9) Were the independent measures clearly defined, valid, reliable, and implemented consistently across all study participants?
10) Were the independent variables assessed more than once over time?
11) Was the outcome measure clearly defined, valid, reliable, and implemented consistently across all study participants?
12) Were the outcome assessors blinded to the exposure status of participants?

13) Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between independent variable(s) and outcome?

A ‘yes’ response to each question received a score of one; and a ‘no’ or ‘not reported’ response received a score of zero. If a particular criterion was ‘not applicable’ to a study, the total possible score was reduced. Any discrepancies in scores were discussed, and a consensus was reached for each criterion and each study.

In order to make this rating system as simple as possible, it was decided amongst the authors that a number of criteria would be considered key when scoring the articles.

The key criteria for grading:

- For cohort studies, the 4 essential criteria were:

5) Was a sample size justification, power description, or variance and effect estimate provided?
7) Was the timeframe sufficient so that one could reasonably expect to see an association between independent variable(s) and outcome, if it existed?
8) For independent variables that can vary in amount or level, did the study examine different levels as related to the outcome (for example, categories of independent variables, or independent variables measured in a continuous way)?
13) Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between independent variable(s) and outcome?

When scoring on these four criteria, the following categories were used:

- 0-1/4 = poor rating

- 2/4 = fair rating
- 3-4/4 = good rating

- For cross-sectional studies, the 3 essential criteria were:

3) Was the participation rate of eligible persons at least 50%?

11) Was the outcome measure clearly defined, valid, reliable, and implemented consistently across all study participants?

13) Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between independent variable(s) and outcome?

When scoring on these three criteria, the following categories were used:

- 0-1/3 = poor rating
- 2/3 = fair rating
- 3/3 = good rating

Supplementary File 5 – The full quality assessment for each included study

Reference	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)	13)	Score
Benetato, 2011	Y	Y	N	Y	Y	N	N	Y	Y	N	Y	N/A	N	7/12
Bush et al., 2011	Y	Y	NR	N	N	N	N	Y	Y	N	Y	N/A	Y	5/12
Currier et al., 2013	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N/A	N	7/12
Gallaway et al., 2011	Y	Y	Y	Y	N	N	N	Y	N	N	Y	N/A	Y	7/12
Kaler et al., 2011	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	NR	N/A	7/12
Lee et al., 2010	Y	Y	NR	Y	N	N	N	N/A	N/A	N	Y	N/A	N/A	4/9
Marotta-Walters et al., 2015	Y	Y	N	Y	Y	N	Y	Y	Y	N	Y	N/A	N	8/12

McLean et al., 2013	Y	Y	NR	N	N	N	N	Y	Y	N	Y	N/A	N	5/12
Mitchell et al., 2013	Y	Y	NR	Y	N	N	N	Y	Y	N	Y	N/A	Y	7/12
Morgan & Desmarais, 2017	Y	Y	NR	Y	N	N	N	Y	Y	N	Y	N/A	Y	7/12
Morgan et al., 2017	Y	Y	NR	Y	Y	N	N	Y	Y	N	Y	N/A	Y	8/12
Murphy et al., 2017	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	NR	Y	11/13
Palmer et al., 2012	Y	Y	NR	N	N	N	N	N/A	N/A	N/A	Y	N/A	N/A	3/8
Palmer et al., 2016	Y	Y	N/A	Y	N	N	N	Y	Y	N	Y	N/A	N	6/11
Park et al., 2017	Y	Y	NR	Y	N	N	N	Y	N	N	Y	N/A	Y	6/12

Pietrzak et al., 2010	Y	Y	N	Y	N	N	N	Y	Y	N	Y	N/A	Y	7/12
Scott et al., 2011	Y	N	NR	N	N	N	N	N	N	N	Y	N/A	N	2/12
Tsai et al., 2015	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N/A	Y	8/12
Tsai et al., 2016 (1)	Y	Y	Y	Y	N	N	N	Y	Y	N	Y	N/A	Y	8/12
Tsai et al., 2016 (2)	Y	Y	N	N	N	Y	Y	Y	Y	Y	N	N/A	N	7/12
Tsai & Pietrzak, 2017	Y	N	Y	Y	N	Y	Y	Y	Y	N	Y	N/A	N	8/12

Note. Y = yes; N = no; N/A = not applicable; NR = not reported. Numbered column headings represent each of 13 quality assessment criteria (see Supplementary File 4). The 'Score' column represents how many criteria were fulfilled by each study, out of a possible 13 (unless indicated otherwise).

Supplementary File 6 - The Post-Traumatic Growth Inventory

Listed below are 21 areas that are sometimes reported to have changed after traumatic events. Please mark the appropriate box beside each description indicating how much you feel you have experienced change in the area described. The 0 to 5 scale is as follows:

0 = I did not experience this change as a result of my crisis

1 = I experienced this change to a very small degree

2 = a small degree

3 = a moderate degree

4 = a great degree

5 = a very great degree as a result of my crisis

Possible areas of growth and change	0	1	2	3	4	5
1. My priorities about what is important in life						
2. An appreciation for the value of my own life						
3. I developed new interests						
4. A feeling of self-reliance						
5. A better understanding of spiritual matters						

6. Knowing that I can count on people in times of trouble

7. I established a new path for my life

8. A sense of closeness with others

9. A willingness to express my emotions

10. Knowing I can handle difficulties

11. I’m able to do better things with my life

12. Being able to accept the way things work out

13. Appreciating each day

14. New opportunities are available which wouldn’t have been otherwise

15. Having compassion for others

16. Putting effort into my relationships

17. I’m more likely to try to change things which need changing

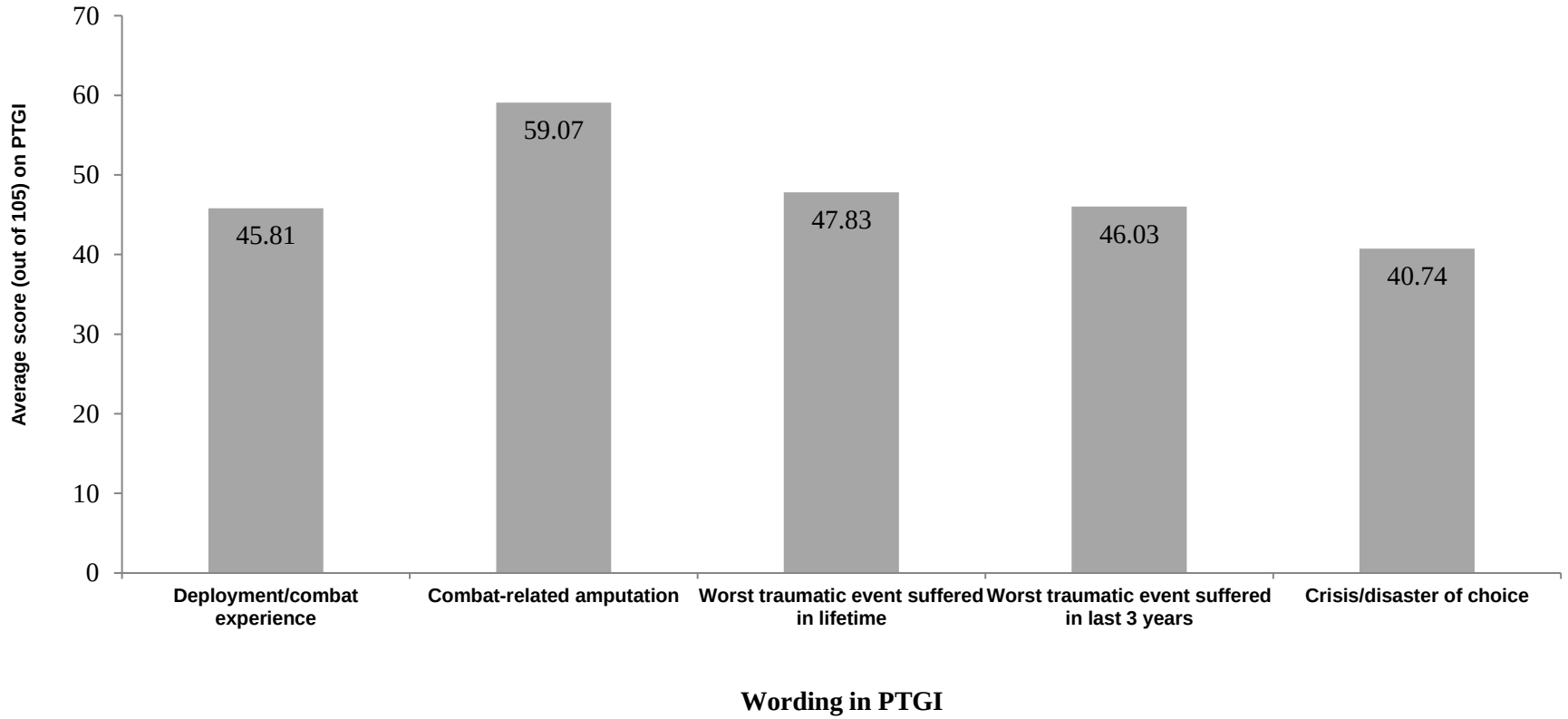
18. I have a stronger religious faith

19. I discovered that I am stronger than I thought I was

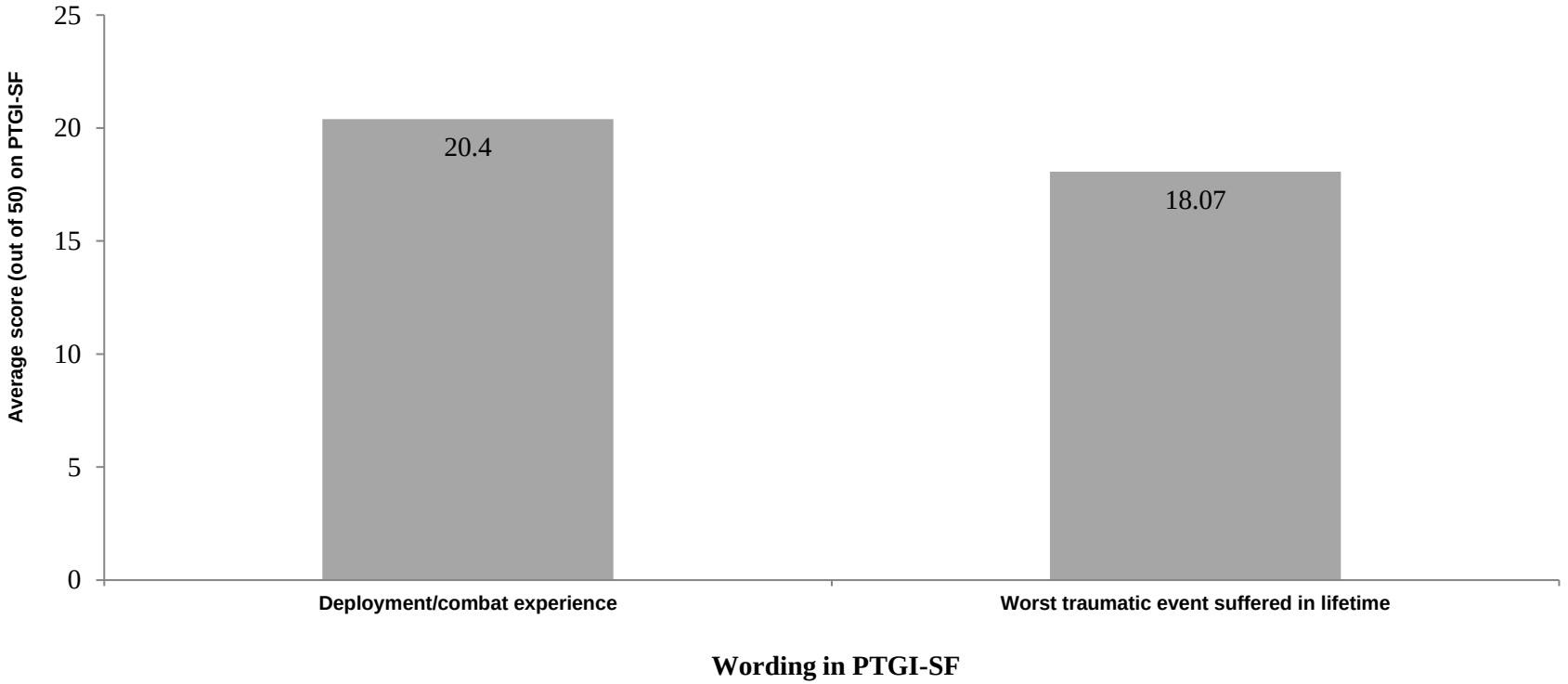
20. I learned a great deal about how wonderful people are

21. I accept needing others

Supplementary File 7 - Graph to show average PTGI scores (out of 105), as a function of the wording used in the measure. **Note. PTGI = Post-Traumatic Growth Inventory**.



Supplementary File 8 – Graph to show average PTGI-SF scores (out of 50), as a function of the wording used in the measure. ***Note.*** **PTGI-SF = Post-Traumatic Growth Inventory – Short Form.**



Supplementary File 9 – Factors associated with post-traumatic growth, along with their test statistics, and references

Associated Factors	Test Statistics	Reference
Social Demographics		
Male gender	*B* = -1.9	Gallaway et al., 2011
	t = 1.85	Kaler et al., 2011
	F = NS	Morgan & Desmarais, 2017
	r = -0.10	Morgan et al., 2017
	B = 0.00	Park et al., 2017
	OR = 1.04	Tsai et al., 2015
	OR = 0.54 – 1.91	Tsai et al., 2016 (1)
	OR = 0.54 – 3.29	Tsai & Pietrzak, 2017
Minority ethnicity	***B* = 5.7 * – 13.7 *****	**Gallaway et al., 2011**

	t* = 2.89 *	**Kaler et al., 2011**
	OR* = 0.84 **	**Mitchell et al., 2013**
	***B* = 0.32 ***	**Park et al., 2017**
	OR* = 0.93 **	**Tsai et al., 2015**
	***OR* = 0.39 – 0.62 ***	**Tsai et al., 2016 (1)**
	OR = 0.96 – 1.19	Tsai & Pietrzak, 2017
Marital status	*B* = -.04 – -1.3	Gallaway et al., 2011
	t = NS	Kaler et al., 2011
	***OR* = 1.03 ***	**Mitchell et al., 2013**
	B = 0.01	Park et al., 2017
Education level	*B* = -3.8 – 0.8	Gallaway et al., 2011
	B = 0.01	Park et al., 2017
	OR = 1.04 – 1.60	Tsai et al., 2016 (1)
	OR = 1.04 – 1.57	Tsai & Pietrzak, 2017

Age	*r* = -0.08	Kaler et al., 2011
	***F* = 5.36 *** **	**Morgan & Desmarais, 2017**
	r = -0.08	Morgan et al., 2017
	B = 0.06	Park et al., 2017
	***B* = -0.16 ** **	**Pietrzak et al., 2010**
	***OR* = 0.95 – 0.98 *** **	**Tsai et al., 2016 (1)**
	OR = 1.00 – 1.01	Tsai & Pietrzak, 2017
Household income	*B* = 0.01	Park et al., 2017
	***OR* = 0.94 ** **	**Tsai et al., 2015**
	OR = 1.16 – 1.38	Tsai & Pietrzak, 2017
Active lifestyle	***OR* = 1.28 *** **	**Tsai et al., 2015**
	OR = 0.81 -1.35	Tsai & Pietrzak, 2017

Positive spirituality	***B* = 0.29 ***	**Park et al., 2017**
	OR = 1.00	Tsai et al., 2015
	OR* = 1.39 – 2.86 **	**Tsai et al., 2016 (1)**
	OR = 0.35 – 3.46	Tsai & Pietrzak, 2017
Negative spirituality	***B* = -0.23 ***	**Park et al., 2017**
Military- or Trauma-Related		
Months since amputation	*r* = 0.13	Benetato, 2011
Time since event	***F* = 49.60 *****	**Morgan & Desmarais, 2017**
	r = 0.10	Morgan et al., 2017
	OR = 0.99 – 1.00	Tsai & Pietrzak, 2017
Combat exposure	***r* = 0.11 ****	**Bush et al., 2011**

	OR = 1.17	Currier et al., 2013
	***B* = 6.0 *** – 7.8 *** **	**Gallaway et al., 2011**
	r = 0.06	Kaler et al., 2011
	r = 0.14	Marotta-Walters et al., 2015
	***B* = -0.08 ** (quadratic)**	**McLean et al., 2013**
	***OR* = 1.26 *** **	**Mitchell et al., 2013**
	***B* = 0.30 ** **	**Park et al., 2017**
	B = -0.10	Pietrzak et al., 2010
	OR = 1.00	Tsai et al., 2015
Trauma exposure	*OR* = 0.85	Currier et al., 2013
Higher rank	***B* = -1.8 – -10.3 *** **	**Gallaway et al., 2011**
	OR* = 1.06 * (lower rank)	**Mitchell et al., 2013**
Number of deployments	*B* = 0.8	Gallaway et al., 2011

Perceived threat	***r* = 0.11 ***	**Kaler et al., 2011**
	***r* = 0.22 ***	**Marotta-Walters et al., 2015**
Healthcare stress exposure	***B* = -0.01 * (quadratic)**	**McLean et al., 2013**
Unit cohesion	***OR* = 1.12 *****	**Mitchell et al., 2013**
Impact of military on life	*OR* = 0.97	Tsai et al., 2015
Type of trauma	***r* = -0.09 ***** – 0.13 *****	**Tsai et al., 2015**
	OR = 0.61 – 1.48	Tsai & Pietrzak, 2017
Deployment location	***r* = -0.03 – 0.06 ** **	**Tsai et al., 2015**
Years served in military	*OR* = 0.99 - 1.00	Tsai & Pietrzak, 2017

Number of traumas suffered	*OR* = 1.07 – 1.23	Tsai et al., 2016 (1)
	OR = 1.01 - 1.17	Tsai & Pietrzak, 2017
Mental Health		
Rumination	***r* = 0.43 ***	**Benetato, 2011**
	F* = 14.95 *	**Morgan & Desmarais, 2017**
	r* = 0.43 **	**Morgan et al., 2017**
Depression	***r* = -0.24 ****	**Bush et al., 2011**
	r = -0.18	Currier et al., 2013
	B = -1.3	Gallaway et al., 2011
	r = -0.01	Kaler et al., 2011
	OR = 9.14	Murphy et al., 2017
	***B* = -0.44 ***	**Palmer et al., 2016**

Substance abuse	***r* = -0.12 ****	**Bush et al., 2011**
	OR = 1.04	Tsai et al., 2015
	OR = 0.96 - 1.18	Tsai & Pietrzak, 2017
Alcohol abuse	*B* = 0.9	Gallaway et al., 2011
PTSD symptoms	***r* = -0.15 ****	**Bush et al., 2011**
	r = 0.02	Currier et al., 2013
	B = 1.1	Gallaway et al., 2011
	r = 0.08	Kaler et al., 2011
	r* = 0.18 – 0.33 *	**Marotta-Walters et al., 2015**
	F* = 7.82 **	**Morgan & Desmarais, 2017**
	r* = 0.30 *	**Morgan et al., 2017**
	OR = 8.05	Murphy et al., 2017
	***r* = -0.15 ***	**Park et al., 2017**

	B* = 0.27 *	**Pietrzak et al., 2010**
	OR* = 1.80 **	**Tsai et al., 2015**
	***OR* = 0.95 ***	**Tsai et al., 2016 (2)**
	OR* = 0.47 - 3.31 **	**Tsai & Pietrzak, 2017**
		Bush et al., 2011
Suicidal ideation	***OR* = 0.90 *****	**Gallaway et al., 2011**
	B* = -7.7 *	
Global well-being	***r* = 0.21 *****	**Kaler et al., 2011**
Satisfaction with life	*F* = NS	Morgan & Desmarais, 2017
	***r* = 0.16 ***	**Morgan et al., 2017**
Anxiety	*OR* = 8.17	Murphy et al., 2017
Anger	*OR* = 14.30	Murphy et al., 2017

Psychosocial difficulties	*B* = 0.12	Pietrzak et al., 2010
Positive psychosocial traits	*r* = -0.19 – 0.12	Marotta-Walters et al., 2015
	***OR* = 1.22 *** **	**Tsai et al., 2015**
	OR = 1.17 – 1.92	Tsai et al., 2016 (1)
	OR = 0.32 – 3.46	Tsai & Pietrzak, 2017
Negative psychosocial traits	***r* = 0.14 – 0.27 ** **	**Marotta-Walters et al., 2015**
Psychological resilience	***B* = 0.18 ** **	**Pietrzak et al., 2010**
Common mental health issues	*OR* = 0.98	Tsai et al., 2015
	OR = 0.73 – 1.05	Tsai & Pietrzak, 2017
Emotion Regulation		

Emotional lability	***r* = -0.18 ****	**Bush et al., 2011**
Challenges to core beliefs	***F* = 38.18 *****	**Morgan & Desmarais, 2017**
	r* = 0.66 **	**Morgan et al., 2017**
Maladaptive processing	*OR* = 1.09	Currier et al., 2013
Adaptive processing	*OR* = 1.20	Currier et al., 2013
Reluctance to talk	*OR* = 1.09	Currier et al, 2013
Urge to talk	***OR* = 1.70 *****	**Currier et al., 2013**
Emotional reactions	*OR* = 1.01	Currier et al., 2013
Adjustment reactions	*B* = -2.0	Gallaway et al., 2011

Positive personality traits	*OR* = 1.02	Tsai et al., 2015
	OR = 0.86 – 1.25	Tsai et al., 2016 (1)
	OR = 0.74 - 1.43	Tsai & Pietrzak, 2017
Relationships		
Social support	***r* = 0.24 ***	**Benetato, 2011**
	***OR* = 1.20 ***	**Currier et al., 2013**
	***OR* = 1.03 ***	**Tsai & Pietrzak, 2017**
Unit social support	*r* = 0.09	Kaler et al., 2011
	B* = 0.19 *	**Pietrzak et al., 2010**
Post-deployment social support	***r* = 0.22 *****	**Kaler et al., 2011**
	B = 0.09	Pietrzak et al., 2010

Social connectedness	***OR* = 1.14 *** **	**Tsai et al., 2015**
	OR = 0.93 – 1.24	Tsai et al., 2016 (1)
Relationship difficulties	***r* = -0.31 ** **	**Bush et al., 2011**
Altruism	*OR* = 1.02	Tsai et al., 2015
	OR = 0.80 - 1.09	Tsai & Pietrzak, 2017
Number of friends/relatives	***OR* = 1.03 * **	**Tsai & Pietrzak, 2017**
Secure attachment style	*OR* = 0.59	Tsai & Pietrzak, 2017
Other		
Physical health	*OR* = 1.03	Tsai et al., 2015

	OR = 1.02 – 1.42	Tsai et al., 2016 (1)
	OR = 0.91 – 1.21	Tsai & Pietrzak, 2017

Note. PTSD = post-traumatic stress disorder; NS = non-significant. All associations with PTG are reported, whether significant or not, but significant factors (and their associated references) are bolded. Various tests of association are reported: *B* = unstandardised regression coefficient; *t* = *t*-test statistic; *OR* = adjusted odds ratio (values < 1 reflect a negative relationship with the outcome; values >1 reflect a positive relationship); *r* = correlation coefficient. Standardised (beta) regression coefficients were converted to odds ratios using exponentiation. An odds ratio range is presented for two studies: Tsai et al. (2016; 1) [47] and Tsai & Pietrzak (2017) [49]. This is because these studies are based on trajectories of PTG – for Tsai et al. (2016; 1) [47], five different courses of PTG were identified, and for Tsai & Pietrzak (2017) [49], three different courses were identified.