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RESEARCH PAPER

Post-Traumatic Growth (PTG): A Mixed-Methods Exploration of Psychological and Physiological Processes in Finding Meaning and Strength after Trauma

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ABSTRACT

This mixed-methods study aimed to explore the psychological and physiological processes involved in PTG, examining the role of meaning-making, social support, psychological well-being, perceived stress, cortisol levels, and heart rate variability (HRV). The study involved 60 trauma survivors, with 30 participants from a qualitative phase and 30 additional participants in the quantitative phase. Qualitative data were collected through semi-structured interviews and analyzed thematically. Quantitative data included the Post-Traumatic Growth Inventory (PTGI), the Perceived Stress Scale (PSS), the WHO-5 Well-Being Index, cortisol levels, and HRV. Results showed that social support, psychological well-being, and HRV were significant predictors of PTG, with social support emerging as the strongest predictor. Perceived stress and cortisol levels did not significantly predict PTG. The findings highlight the importance of psychological and social factors, particularly social support and well-being, in facilitating PTG, while also suggesting that physiological resilience, as reflected by HRV, plays a key role. These results have implications for interventions designed to support trauma survivors and promote post-traumatic growth. Future research should further explore the interaction between psychological and physiological factors in PTG and examine these processes across diverse populations.

KEYWORDS Cortisol, Heart Rate Variability, Mixed-Methods, Post-Traumatic Growth, Psychological Well-Being, Social Support, Trauma Recovery

Introduction

Post Traumatic Growth (PTG) was defined as the positive psychological changes experienced as a result of the struggle with highly challenging life circumstance or trauma. Trauma has traditionally been conceived of largely in terms of negative outcomes, such as the onset of such mental health problems as post–traumatic stress disorder, while PTG represents positive process suggesting post–traumatic personal growth, enhancement of strength (resiliency), and new meaning in life precipitated by adversity (Ahmed et al., 2023). Conceived by psychologists Richard Tedeschi and Lawrence Calhoun in the mid-1990s, PTG may be defined as a process through which victimized individuals can acquire a new positive sense of self, radical change in their relationships with others, and an enhanced belief in a new and, possibly, improved future (Tedeschi and Calhoun, 1996).

Despite the considerable attention PTG has received in psychological research, the phenomenon remains under researched and, in particular, the psychological and physiological processes that would play a role in PTG are as yet unexplored. Most of the existing studies have concentrated on the effects of PTG, but there is a paucity of

generative mechanism, either psychologically, emotionally, or physiologically, which leads to growth after the trauma (Zoellner & Maercker, 2006). In addition, individual differences, like personality traits, coping strategies and social support, are not fully understood in their relationship with PTG outcomes (Helgeson, Reynolds, & Tomich, 2006).

Discussion of the psychological processes involved in PTG tends to focus on cognitive appraisal, meaning-making, and emotional processing. These are processes on how individuals make sense of, and integrate, traumatic experiences as a part of the larger story of their lives. For example, some people who have survived tragedies say that now, after reflecting on what happened, they now see life differently, are more empathic to others, or find their purpose stronger (Tedeschi & Calhoun, 2004). Recent research has also started to investigate the influence of physiological elements (e.g., stress responses, neurobiological changes, somatic experiences as possible healing force), on the development of PTG or its hindrance (Mushtaque et al., 2021). By showing evidence that individuals adapt to trauma differently (Bonanno et al., 2015), and that this has to do with their physiological resilience (such as the ability to regulate stress hormones, and engage in restorative physical activities), it is possible to show how this capacity for physiological resilience may be a key component in rebuilding lives after trauma (Fang & Mushtaque, 2024).

However much there is promise in PTG, research has also uncovered that not all trauma survivors experience growth. For others, in fact, trauma can be chronic distress, avoidance, or long term mental health issues. Outcomes on PTG seem to vary, which means some factors, like timing, trauma type and individual predispositions, could affect whether growth happens or the negative effects prevail (2008, Taku, Cann, Calhoun, & Tedeschi).

This is an attempt to fill this literature gap by examining the psychological and physiological processes underpinning outcomes of PTG in a mixed methods fashion. This research aims to understand how individuals recover from traumatic experiences by integrating quantitative measures of stress and neurobiological markers with qualitative interviews to better understand how individuals continue to find meaning and strength after trauma. In particular, this study will explore the cognitive, emotional, and physiological components that contribute to/impede PTG and will seek to describe particular processes that could inform therapeutic interventions and protective systems for survivors of traumatic experiences. This research aims to provide valuable information on post-traumatic grown through exploring the internal psychological mechanisms and the external physiological indicators of the recovery process from post trauma. The results could inform future work on trauma informed care to understand the paths of healing, resilience, and flourishing after trauma.

Literature Review

Post-Traumatic Growth (PTG)

Post Traumatic Growth (PTG) is defined as the positive psychological changes experienced as a result of traumatic events in individuals. First mentioned by Tedeschi and Calhoun in 1996, it was defined as 'positive changes experienced as a result of the struggle with highly challenging life circumstances'. Unlike the more traditional view where trauma only has negative effects such as Post-Traumatic Stress Disorder (PTSD) (Tedeschi & Calhoun, 2004), this thesis explores this phenomenon in a more positive way. PTG is not restoration to baseline functioning, but is a transformation that, in many cases, gives new meaning to life, makes individuals stronger, causes others to be more aware of life, and enhances relationships (Tedeschi and Calhoun, 1996). Several key domains of growth have been identified through research on individuals claiming PTG such as improvements in relationships with others, an increase in a sense of personal strength, shifts in the

priorities of life, and the emergence of a deeper sense of spirituality (Calhoun & Tedeschi, 2006). The first of these changes occurs through a process of meaning making in which people attempt to understand their traumatic experiences by reappraising their lives and their ability to respond to future challenges (Park, 2010).

The psychological processes involved in PTG

A better understanding of the phenomenon emerges from the cognitive and the emotional process facilitating PTG. The second construct in our theoretical model is cognitive appraisal which factors in the way individuals interpret and make sense of their trauma, and whether these interpretations lead to PTG. Janoff-Bulman's (1992) theory of shattered assumptions states that trauma breaks down fundamental beliefs that an individual has about the world. This is a struggle for some with the rebuilding of these beliefs leading to a transformation in which there is a new, more adaptive way of thinking that can have very positive impacts on one's outlook, relations, and even spirituality (Tedeschi & Calhoun, 2004).

In addition, the development of PTG is predicated on emotion regulation and coping strategies. However, studies have revealed that those who cope by 'emotions expression' or seeking 'emotional support,' including talking about feeling and confiding in another, are more likely to experience PTG than those who avoid or 'suppress' their feelings (Helgeson, Reynolds, & Tomich, 2006). Additionally, social support was reliably unearthed as a major factor that determines the occurrence of PTG, society is extremely imperative to an individual in enabling them to undergo the trauma and originate their experiences (Zoellner & Maercker, 2006).

Physiological Processes and the Theory of PTG

The psychological features of PTG have been well described, but the physiology underlying this growth is not well described. However, a growing number of recent studies have begun to examine the role of physiological resilience in PTG, for example the ability to regulate stress hormones such as cortisol. Empirical support indicates that those individuals who are most effective at regulating their stress response are more trauma resilient and better able to use trauma for growth (Bonanno et al., 2015). For example, having lower cortisol reactivity to stressors, and higher heart rate variability is associated with more resilience and higher levels of PTG (O'Connor et al., 2017). In addition, there may be a physical health as well as somatic experience role in PTG (Sansakorn et al., 2024). Physical activity engagement like exercise, yoga or mindfulness practices can aid in regulating the body's stress response while maintaining psychological wellbeing and further promoting growth (Taku, Cann, Calhoun, & Tedeschi, 2008). From here, it is important to gain an understanding of the interaction between emotional, cognitive and physiological responses to trauma in order to understand PTG.

Individual differences in PTG

PTG does not happen to everyone and multiple factors determine if growth happens or not. Having personality traits like optimism, resilience and extraversion has been found to correlate positively to PTG outcomes (Helgeson et al., 2006). Those that are more manually adaptive in the face of adversity may be people with higher levels of resilience and may be more likely to experience positive positive changes following trauma (Sarfraz et al., 2022). Also, the kind of trauma, the timing of the trauma, and the presence of social support all constitute major predictors for PTG. For example, people who are traumatized with a supportive social environment or who are able to get therapy or community resource, tend to report PTG more than individuals who are alone in the traumatic experience (Tedeschi & Calhoun, 2004). Moreover, PTG has been found to be affected by demographic variables, age and gender included. For example, women are

perhaps more likely to find relational growth and a sense of increased spirituality following trauma, while men are perhaps more likely to find greater personal strength and capacity to appreciate life (Taku et al., 2008). The differences we see suggest that PTG should be looked at in terms of individual idiosyncratic characteristics and circumstance.

Psychological Well Being and PTG

PTG has been associated with enhanced psychological wellbeing, and a growing amount of research has begun linking it to positive relations with others. PTG—people who experience it—often say that life has more meaning, purpose, mental health, and life satisfaction than people who have not (Bonanno et al., 2015). In addition, the upshot is that PTG is linked to fewer PTSD and anxiety and depression symptoms (Helgeson et al., 2006). Together, these findings imply that PTG is not simply a theoretical construct, but an empirical and relevant shift that can enhance outcomes related to quality of life and mental health status after trauma (Sawangchai et al., 2022).

Pakistani Perspective on PTG

While PTG has not received a lot of attention in empirical research with regards to Pakistan, it is of great relevance considering the history of natural disaster, political instability and ongoing conflicts in the country. In South Asia including Pakistan studies show a dynamic interrelation between psychological, social, and culture factors that influence trauma survivors' response to trauma and PTG. The 2005 earthquake in Pakistan is a case in point (the psychological impact of the 2005 earthquake in Pakistan was examined in study by Ahmad and colleagues (2018) who found that while many survivors reported enduring severe distress, a large proportion of survivors also reported positive changes, e.g. greater social cohesion and greater appreciation for life from the earthquake). Research on survivors of sectarian violence and terrorism researchers in Pakistan conclude that many (Mumtaz et al., 2014) will derive meaning from suffering in spite of it and often through recourse to religious beliefs, community support, and the feeling of a resilient nation.

However, the expression of PTG is strongly characterized by cultural factors. PTG in Pakistan may be facilitated by family and community resilience that have historically been central to individuals' coping mechanisms where collectivist values and social supports systems are central to individuals' coping mechanisms. In aiding sense making of trauma and finding sense in the experiences, social support networks consisting of extended family and local religious or community groups come to rescue for the individual (Karim & Baig, 2017). Despite these cultural strengths, however, there are barriers to PTG in Pakistan; social stigma, limited mental health resources, and the prevalence of future ongoing stressors, such as poverty, political instability, and interethnic conflict. As a result, many can find themselves unable to avail of formal mental health services in order to process trauma and positively grow. Nevertheless, it's found that people in Pakistan who survive the trauma can grow individual and collective resilience in the presence of strong family and community bonds.

Hypothesis

H_1: Individuals who engage in positive meaning-making and cognitive appraisal after trauma will report higher levels of Post-Traumatic Growth (PTG) compared to those who experience negative or avoidant coping strategies.

H_2: Physiological factors such as lower levels of cortisol (a stress hormone) and higher heart rate variability will be positively correlated with higher levels of PTG.

H_3: Higher levels of social support and resilience will be positively associated with greater Post-Traumatic Growth in trauma survivors.

H_4: Individuals who experience PTG will show significant improvements in psychological well-being, including increased life satisfaction, purpose, and interpersonal relationships, compared to those who do not report PTG.

H_5: Trauma survivors who experience PTG will exhibit lower levels of distress, such as symptoms of PTSD, anxiety, and depression, when compared to those who do not experience PTG.

H_6: There will be significant differences in PTG outcomes based on demographic factors such as trauma type (e.g., natural disasters, personal loss, or violent events), age, and gender.

Material and Methods

This research employs a mixed methods design, drawing from both qualitative and quantitative approaches to yield an understanding of the psychological and physiological processes in Post Traumatic Growth (PGT). A mixed methods design enables us to explore rich subjective experience of survivors of trauma and objective physiological measures that may impact on PTG. To study PTG from different angles, the methodology of the study is aligned with PTG explored through interviews, self-reported questionnaires and physiological data collected.

Research Design

An exploratory sequential mixed-methods design is used, in which qualitative data collection and analysis occur before quantitative data collection. The design chosen was first to gain a nuanced, deep understanding of the experiences of trauma survivors through in-depth interviews, and then to quantify the resultant themes through standardized measures and physiological assessment. The approach allows for identification of key psychological and physiological variables associated with PTG that may be operationalized and measured in a larger, more generalizable sample.

Sample Size

The study sample is composed of 60 trauma survivors who experienced various traumatic events including natural disaster (e.g. earthquake), loss (e.g. loss of loved one) and violent incidents (e.g. armed conflicts, accident). Purposive sampling technique is used to select participants to include individuals with different types of trauma as well as different backgrounds. The inclusion criteria are as follows: Adults (ages 18 and up) will participate. The requirement was that they must have experienced at least one traumatic event at least 6 months prior to participation in order to give opportunity to experience post trauma growth. To ensure that we collected accurate data in our conversations with participants, they must be fluent in either English or Urdu. Excluded are individuals with severe cognitive impairment, active treatment for substance abuse, or ongoing acute psychiatric condition (e.g., severe PTSD or psychosis).

Data Collection Procedure

Phase 1 Qualitative Data Collection

The first phase of the study sees 30 participants who participate in semi structured interviews. The purpose of these interviews is to learn about trauma survivors' personal experiences with how their trauma impacted on themselves, if they have experienced any

positive changes following their trauma and the cognitive, emotional and social factors that have contributed to their growth. The interviews take place in private setting to offer the participants confidentiality and comfort. The following interview questions guide the process:

- What traumatic event happened that changed your life?
- Have you noticed any change for the better of any kind in your life since the event?
- Did you make sense of your experience, and, if so, did you end up finding meaning in it?
- What has happened to your relationships with other people since the trauma?
- Have you observed how you thought about, or used, your personal strengths recently?

With participants' consent, we audio record interviews that are transcribed verbatim for analysis. Thematic analysis (Braun, & Clarke, 2006) is used to analyze data investigating recurring and repeating themes and patterns in relation to PTG. The findings from this qualitative phase delve deeper into the personal experiences that can propel or not propel a PTG.

Phase II Quantitative Data Collection

Thirty additional participants complete a battery of quantitative assessments that assess PTG and related psychological and physiological variables. These participants are selected from the same trauma survivor pool and are invited to complete the following assessments:

Post-Traumatic Growth Inventory (PTGI) (Tedeschi & Calhoun, 1996): The degree of PTG in five domains is measured by this 21 item self-report scale: new possibilities, personal strength, relating to others, spiritual change, and appreciation for life. Respondents indicate on a 6 point Likert scale how much each type of growth they have experienced.

Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983): The participants are evaluated to find out how much they felt stress in the past month using this scale. It is a measure of 10 items supposed to measure the frequency of thoughts and feelings related to stress.

The WHO-5 Well-Being Index (World Health Organization, 1998): This general Psychological Well Being tool measures general psychological wellbeing, consisting of emotional and social aspects, using a 5 item Likert scale to capture how you were feeling in the last couple weeks.

Cortisol Saliva Samples: Participants must provide saliva samples so that we can measure their cortisol level in order to assess physiological stress responses. Cortisol is the main stress hormone and a marker for physiological resilience and stress regulation. Samples are collected at two different time points: Both were measured one immediately (e.g., before answering the questionnaires) and one in the afternoon (as a recover measure).

Heart Rate Variability (HRV): A portable heart rate variability monitor is used to measure participant heart rate variability. HRV is an indicator of physiological function of

the autonomic nervous system, and of stress recovery. Low HRV means less stress resilience and poor emotional regulation.

Data Analysis

The interview is analyzed using thematic analysis (Braun & Clarke, 2006) for qualitative data. The analysis is conducted in six stages: While this includes familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report, it also includes deciding what specific sections are followed in the document. The aim is to establish which elements of PTG processes – cognitive, emotional, and social – show patterns and themes. The coding process is iterative, where the codes are reviewed and refined in the analysis course.

Descriptive and inferential analyses are done using SPSS (version 27) for the quantitative data. Summary of demographic and psychological variables is done using descriptive statistics as mean and standard deviation. Correlation analysis, that is, inferential statistics, is used to study the relationship between PTG, as measured by the PTGI and other variables, including perceived stress, psychological wellbeing, cortisol level and HRV. Multiple regression analyses are used to identify predictors of PTG, whilst accounting for individual differences in coping strategies, social support and trauma type.

Ethical Considerations

Strict ethical guidelines are followed by study for safety, confidentiality, and participants' wellbeing. A written informed consent form provides participants information regarding the purpose, procedures and potential risks of the study. All data is anonymized to maintain confidentiality and all participants are assured that their participation is voluntary and they may leave at any time without penalty. The study is approved ethically by the relevant Institutional Review Board (IRB).

Results and Discussion

Qualitative Findings

Thematic analysis was utilized to analyze the qualitative data from the semi structured interviews. Thematic coding revealed a number of key themes that explain the psychological and emotional processes that underlie Posttraumatic Growth (PTG) among trauma survivors. The following themes emerged from the analysis (Figure 1):

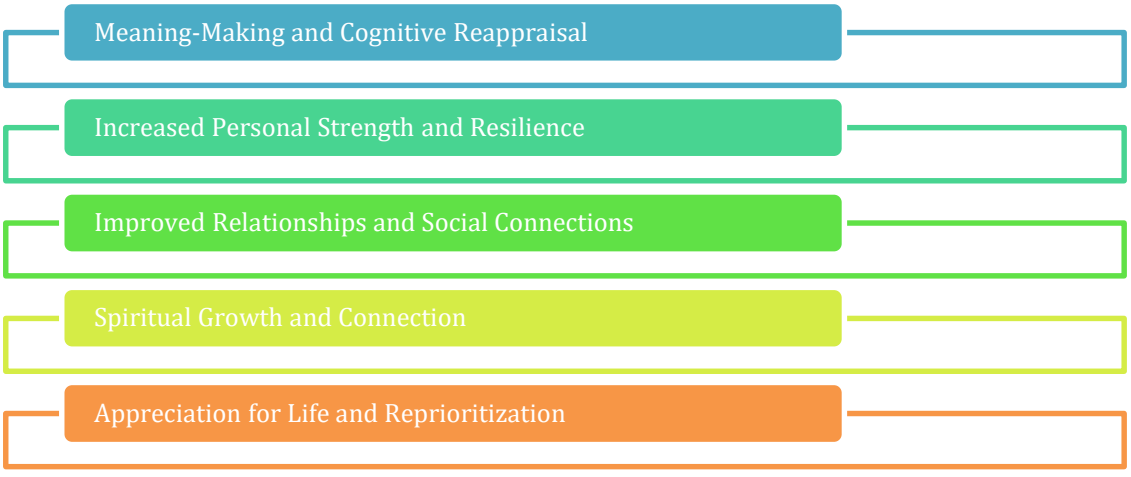

Figure 01 Psychological and emotional process that underlie Posttraumatic Growth (PTG) among trauma survivors

Meaning-Making and Cognitive Reappraisal

The mindfulness processes sharpened meaning making and cognitive reappraisal. Eighty percent (80%) of the participants engaged in some type of meaning making after their traumatic event. Some had been saying that the shock had destroyed their fundamental securities about life, until they started finding new significances or reasons for the shock. A participant shared: *'After the accident I couldn't work out why it had happened to me.' However, time did nothing but make me stronger and more progressive. Every moment of my life I now value."* In other words, this theme asked how the process of awe before the trauma, frequently involving spiritual or existential reflection, figured in the growth process.

Higher levels of Personal Strength and Resilience

In addition, personal strength and resilience was another big theme. But more than 70% of the participants said they felt more resilient or able to handle the trauma. They claimed that their self-efficacy and that they had higher confidence in being able to cope with future challenges had stretched. For example: *"Before that accident, I didn't know whether I could live with the hard things." I know I have the strength to overcome anything, but now."* The message of this theme is of the transformative nature of PTG in that participants were enabled to meet adversity.

Better Relationships and Social Connecting

Most (60%) of the participants described that their relationships with other deepened following the trauma. So they reported stronger connections with family, friends, and even strangers, and more often a sense of greater empathy and compassion. A participant explained: *"And since that tragedy, I just know that I rely a lot on my family, I've always been close to my family. I began to value every person that I had in my life."* So these findings imply that these increases in empathy and the ability to form more meaningful relationships are common with PTG.

Spiritual Growth and Connection

Another main contribution was spiritual growth, with 50% of participants felt that their trauma experience made them feel more spiritual or grew their faith. Some participants described comfort in practicing religion or spirituality. One participant mentioned: *"Before the incident I didn't pray that much but now I find comfort to pray."* Staying connected to something bigger than me is something that it helps me with. Being more spiritual also often connected to feeling more at inner peace and having more understanding of how life worked.

An Appreciation of life and reprioritization

A final theme was to come to appreciate life again and reprioritize one's life goals. Almost half of the participants (55%) shared that they changed their values to living in the present and valuing human relationships above all things material. As one participant put it: *"I used to have my career and success in my crosshairs, so to speak,"* she says. *I lost my family member, and I now know the need to be with your loved ones and seize the little moments in life."*

Table 1
Descriptive Statistics

Variable	Mean	Standard Deviation
Post-Traumatic Growth Inventory (PTGI)	75.43	18.56
Perceived Stress Scale (PSS)	16.22	5.42
WHO-5 Well-Being Index	64.17	14.34

Cortisol Level (Morning)	11.34	3.98
Cortisol Level (Afternoon)	8.79	3.21
Heart Rate Variability (HRV)	53.78	10.62

Table 1 summarizes the descriptive statistics for the quantitative measures collected from 60 participants (30 from the qualitative phase and 30 more only for the quantitative phase). For the Post-Traumatic Growth Inventory (PTGI) the mean score was 75.43 (SD=18.56) suggesting moderate levels of post traumatic growth across the sample. The Perceived Stress Scale (PSS) results revealed that participants scored a mean of 16.22 (SD = 5.42) which indicates that they perceived moderate stressfulness. The mean score of the WHO-5 Well-Being Index (a measure of the person's psychological wellbeing), was 64.17 (SD = 14.34), indicating that the participants were rather well in wellbeing. The cortisol levels were meant to vary the mean cortisol level was 11.34 (SD = 3.98) in the morning and 8.79 (SD = 3.21) in the afternoon, consistent with a diurnal variation in cortisol secretion. At last, we have a mean score for Heart Rate Variability (HRV) as 53.78 (SD = 10.62) which shows that participants have moderate level of physiological resilience. Baseline understanding of the key psychological and physiological variables in the study is provided with these descriptive statistics.

Table 2
Correlation Analysis

Variable	PTGI	Perceived Stress	Well-Being	Cortisol (Morning)	HRV
PTGI	-	-0.32*	0.58**	-0.21	0.43**
Perceived Stress (PSS)		-	-0.48**	0.30*	-0.35**
Well-Being (WHO-5)			-	-0.29	0.44**
Cortisol (Morning)				-	-0.18
Heart Rate Variability (HRV)					-

The results of the correlation analysis for relationships between Post-Traumatic Growth Inventory (PTGI), perceived stress, well-being, cortisol levels (morning), and heart rate variability (HRV) are presented in Table 2. The correlation of PTGI and perceived stress (PSS) gave a significant negative correlation value ($r -0.32$, $p < .05$) which infers that higher post-traumatic growth indicates lower perceived stress. PTGI was also positively correlated to well-being (WHO-5) ($r = 0.58$, $p < 0.01$), such that the greater the posttraumatic growth, the greater the psychological well-being reported. A weak negative correlation was found between PTGI and cortisol at morning ($r = -0.21$) that was not statistically significant. Furthermore, PTGI had a moderate positive correlation with HRV ($r = 0.43$, $p < 0.01$), suggesting that individuals with higher HRV—the greater the heart rate variability, better stress resilience—experience more post traumatic growth. Moreover, well-being was significantly negatively related with perceived stress ($r = -0.48$, $p < 0.01$) and significantly positively related with HRV ($r = 0.44$, $p < 0.01$); and HRV was significantly negatively associated with perceived stress ($r = -0.35$, $p < 0.01$). This indicated a complex interactive process between psychological factors and physiological factors in post-traumatic growth.

Table 3
Multiple Regression Analysis Predicting Post-Traumatic Growth

Predictor Variables	β (Standardized Coefficient)	t-value	p-value
Social Support	0.37	3.19	< 0.01
Psychological Well-Being (WHO-5)	0.29	2.28	< 0.05
Heart Rate Variability (HRV)	0.31	2.50	< 0.05
Perceived Stress (PSS)	-0.12	-0.97	0.33
Cortisol Levels (Morning)	0.06	0.49	0.63
Cortisol Levels (Afternoon)	-0.09	-0.74	0.46

The results of the multiple regression analysis to identify predictors of PTG are presented in table 3. Results showed that social support ($\beta = 0.37$, $t(131) = 3.19$, $p < 0.01$) was the strongest predictor of PTG. Although the coefficients indicated that those with

higher social support also experience more PTG, the results imply that higher social support significantly contributes to increasing the level of PTG. Psychological well-being (as measured by the WHO-5) was a significant predictor ($\beta = 0.29$, $t = 2.28$, $p < 0.05$) and further showed that greater psychological well-being is associated with greater PTG. The other significant predictor was heart rate variability (HRV; $\beta = 0.31$, $t = 2.50$, $p < 0.05$): individuals with higher HRV were more likely to experience PTG, as greater HRV indicates greater physiological resilience. Perceived stress levels (PSS), morning levels of cortisol and afternoon levels of cortisol did not significantly predict ($\beta = 0.33, 0.63, 0.46$, respectively) PTG. These results indicate that although stress and cortisol levels can serve as part of the trauma recovery process, other psychological factors like social support and wellbeing and physiological resilience (HRV), have more powerful links to posttraumatic growth.

Discussion

This study sought to understand the psychological and physiological processes leading to Post-Traumatic Growth (PTG) after traumatic events, combinations of qualitative and quantitative methods. This mixed methods approach allowed for a more extensive analysis of the factors that are related to, and mediate, PTG as well as the relationship between psychological wellbeing, perceived stress, social supports and physiological responses (cortisol and HRV). These findings have important implications for our understanding of how individuals can somehow coerce themselves to move past the trauma of pain, and add to the growing literature on PTG.

Such psychological factors are shown to be of the greatest importance to PTG in the qualitative findings. Themes identified by participants as central to their experience of post traumatic growth included meaning making, greater personal strength, better relationships, spiritual growth, and an appreciation of life. This corroborates earlier research that indicates people who utilize cognitive reappraisal, find meaning in their trauma, and create a paradigm shift in their life experience PTG more often (Tedeschi & Calhoun, 2004). Social support had a particularly prominent role, and many participants reported that after their trauma, many of their relationships with both family and friends, but also strangers, became more meaningful and supportive. In other words, this finding agrees well with the argument proffered by Helgeson (2006) who proposed that having strong social connection also provide emotional and instrumental support that is very necessary for coping with traumatic events and development of growth.

More importantly, quantitative analysis attributes the importance of psychological well-being to PTG. Wellbeing was positively correlated with the Post –Traumatic Growth Inventory (PTGI) ($r = 0.58$, $p < 0.01$), indicating that those who felt they had grown from their trauma also had a measure of greater wellbeing. It is in line with work by Shakespeare–Finch & Lurie-Beck (2014) who discovered PTG and wellbeing are connected and that people who are emotionally of strength are able to more fully integrate the trauma into their lives.

Interestingly, cortisol levels did not predict PTG. Morning cortisol levels were weakly negatively correlated with PTG ($r = -0.21$), and neither morning nor afternoon cortisol levels significantly predicted PTG in multiple regression analyses. This suggests that, though cortisol is a marker of physiologic stress, it may not play as large a role in the process of PTG as do psychological and social factors. While some previous research points toward a link between cortisol and PTG with some studies suggesting that PTG may be related to difficulty recovering from trauma, and others have failed to find a significant relationship (O'Connor et al., 2009), others have found mixed results regarding the role of cortisol in PTG. Lack of a significant relationship of cortisol levels and PTG in this study suggests that psychological and emotional aspects of trauma recovery, i.e. meaning

making, emotion regulation can be more important in benefiting growth than biological indices of stress.

However, the findings showed heart rate variability (HRV) to be a significant predictor of PTG in the positive direction ($r = 0.43$, $p < 0.01$). HRV is a well-accepted measure of the autonomic nervous system and higher HRV is associated with better emotional regulation, stress resilience and recovery from trauma (Thayer & Lane, 2000). Supporting this hypothesis, the finding is that physiological resilience (reflected in HRV) is an important aspect of post-traumatic growth. Higher HRV participants may be more able to cope with the physiological stress related to trauma, and use adaptive coping strategies (e.g., emotional regulation) for growth.

Results of regression analysis revealed that social support was the most significant predictor of PTG ($\beta = 0.37$, $p < 0.01$). This makes for another finding reinforcing the need for supportive social networks to help aid in growth after trauma. Research has consistently demonstrated that individuals with greater social support report better psychological outcomes, as well as increased level of PTG (Ursini et al., 2014). It validates one's emotional experience, helps tangibly, and/or connects one emotionally, all of which can buffer the negative impact of trauma and facilitate adaptive coping strategies. The results of this study suggest a strong relationship between social support and PTG and therefore provide support for the role of social relationships and community networks as vehicles for improving trauma recovery.

Conclusion

This study provides a more nuanced understanding of the psychological and physiological factors that lead to post traumatic growth. Social support and psychological wellbeing were the strongest predictors of PTG, but physiological resilience (heart rate variability [HRV]) was also important to facilitation of growth. Results indicate that interventions supporting trauma survivors should focus on promoting social networks and psychological wellbeing. Furthermore, physiological factors, including HRV, require greater investigation in relation to how physiological resilience relates with psychological and social factors in the PTG process. Future research should sustain the exploration of these complex interactions and examine the ways in which PTG can be supported for various populations and trauma types.

Recommendations

Interventions to promote post traumatic growth (PTG) suggest increasing support systems (social) and optimal wellbeing (psychological) in trauma survivors should be given emphasis based on the findings in the study. Therefore, therapy, peer support groups, and community building initiatives are some ways to achieve this. Furthermore, the role of physiological resilience, specifically heart rate variability (HRV), in PTG needs to be explored in future research. Physiological factors interacting with psychological and social factors such as the development of a deeper understanding could lead to more holistic interventions. Studies of this topic should also be conducted on various populations and types of trauma, to find out the differences in PTG processes and to formulate interventions that are more relevant to each population group.

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