Cancer-related Posttraumatic growth and Posttraumatic stress: Different Correlates and Different
Network Structure in Patients with Cancer and Cancer Survivors

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**Please note this manuscript has not yet been peer reviewed and is therefore subject
to further changes.**

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Data availability statement: The data that support the findings of this study are openly available in osf repository at <https://osf.io/xs5fd/>

Acknowledgements: This study was supported by the Research Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Science [VEGA 1/0305/18] as well as the Slovak Research and Development Agency [APVV-17-0418].

Conflict of interest: The authors declare no conflict of interest.

Supplementary materials: The data, analytical script, additional tables and descriptions can be found at: <https://osf.io/xs5fd/>

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Abstract

A cancer diagnosis is a stressful life event that could lead to higher levels of psychological distress. As a result of its traumatic nature, cancer could trigger certain posttraumatic reactions. The most examined posttraumatic reactions in cancer are posttraumatic stress disorder (PTSD) as the negative changes and posttraumatic growth (PTG) as the positive changes. PTSD and PTG can coexist with each other and have some shared and different correlates. PTSD, PTG, their relationships and their correlates have mostly been studied in mixed samples of patients having cancer treatment and as well as cancer survivors. The present study explored PTSD, PTG, their correlates and their interconnection in separate samples of patients in active treatment (N = 181) and cancer survivors (N = 419). It examined various types of correlates such as sociodemographic (e.g., gender, age), cancer-related (e.g., relapse, late treatment impact), coping (e.g., anxious preoccupation, fighting spirit), emotional (e.g., pain, depression), personality factors (e.g., neuroticism, resilience), eudaimonic (e.g., meaningfulness), social (e.g., regular attendance of cancer support group) and spiritual (e.g., the practice of spirituality). In addition, network models of PTSD, PTG and PTSD-PTG were estimated and compared in both samples. There were different correlates of PTSD and PTG found in patients and survivors. From the network perspective, PTG and PTSD were linked in different patterns in both groups. These results highlight which correlates of posttraumatic reactions are important for patients in treatment and for cancer survivors. The results also depict which PTSD symptoms and PTG indicators are most important in the PTG-PTSD interconnection amongst patients and survivors.

Keywords: cancer, patients, survivors, posttraumatic growth, posttraumatic stress, correlates, network

Word count: 6537 (excluding tables and references)

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Trauma is a serious, unpredictable and stressful life event (APA, 2013) of which being diagnosed with cancer undoubtedly belongs (Cordova et al., 2007; Threader & McCormack, 2015). A cancer diagnosis is accompanied by the treatment process and a worsened quality of physical health, both of which may have a significant impact on mental health (Cordova et al., 2017). This experience of distress can eventuate in posttraumatic stress disorder (PTSD; Swartzman et al., 2017). PTSD is characterized by intrusive thoughts, nightmares, flashbacks, avoidance symptoms, negative affectivity, heightened arousal, changes in behavior and sleep disturbances (APA, 2013). However, traumatic events can stimulate positive changes as well. These positive changes are conceptualized as posttraumatic growth (PTG; Tedeschi & Calhoun, 1996). Posttraumatic growth represents positive changes in spirituality, life meaning, relationships with other people, core beliefs, life priorities and personal strength (Tedeschi et al., 2018). Both PTG and PTSD have been studied a lot in the context of cancer over the last few of decades (see in Koutrouli et al., 2012; Parikh et al., 2015; Salsman et al., 2009; Esser et al., 2019; Wu et al., 2019).

In particular, considerable attention has been paid to looking at the PTSD and PTG correlates in the context of cancer. The most common correlates of PTSD are sociodemographic variables (e.g., age, gender), variables specific to the cancer diagnosis (e.g., pain, somatic health), depression, anxiety, distress, low social support and physical quality of life. The most commonly found correlates of PTG in respect to cancer are sociodemographic variables (e.g., age, gender), variables specific to the cancer diagnosis (e.g., time since diagnosis or treatment completion),

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spirituality, religiosity, social support, optimism, positive reappraisal, low distress and depression (Chen et al., 2019; Dahl et al., 2016; Shand et al., 2015; Turner et al., 2017).

Indeed, there is considerable research evidence regarding cancer and PTSD and PTG. However, a research gap remains in distinguishing between cancer patients and cancer survivors. In other words, studies do not often distinguish between patients in the current stage of treatment and patients who have already overcome cancer (Marziliano et al., 2020). According to the National Cancer Institute, cancer survivorship starts with the diagnosis of cancer and lasts the lifespan (Shapiro, 2018). Yet, current research is predominantly based on mixed samples where clarifying the length of survivorship has not been done. It is undeniable that being diagnosed with cancer has a serious impact on the whole lifespan. However, differentiating between cancer patients and cancer survivors may be of use and interest. While knowledge about how different variables are associated with PTSD and PTG in different ways is important to understanding what interventions are appropriate (Shand et al., 2015), distinguishing between patients and survivors could bring new insight into securing effective care at specific stages (Marziliano et al., 2020).

While there is huge research interest in cancer-related PTSD and PTG, some questions remain open. Besides the discussed issues, there is also considerable heterogeneity in the findings examining the association between PTSD and PTG in terms of the relationship (Marziliano et al., 2020), latent profile (Liu et al., 2020; Zhou et al., 2020) and even network structure (Peters et al., 2021; Yuan et al., 2021). PTSD and PTG as common posttraumatic reactions can exist at the same time (Dekel et al., 2012). One commonly discussed research theme is whether this is a linear or curvilinear relationship (Maia et al., 2021) with most research suggesting this

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relationship to be of a curvilinear nature (Shakespeare-Finch & Lurie-Beck, 2014). A network approach looking at the variable as a network of symptoms (Borsboom & Cramer, 2013) can bring new insight into the study of these phenomena. Rather than examining a latent variable as a construct of symptoms that are independent of each other, the network approach makes it possible to identify indicators (symptoms) crucial for the development, maintenance and extinction of phenomena (McNally, 2016; McNally et al., 2015). In this sense, it offers a new possibility of how to examine PTSD, PTG and the interconnection (Peters et al., 2021; Yuan et al., 2021; Bellet et al., 2018).

The current study aimed to focus on the gaps resulting from the discussed evidence heterogeneity. The first aim is to investigate the correlates of PTSD and PTG across two groups – cancer patients having treatment and cancer survivors. The second aim is to examine the structure of PTSD, PTG and its relationship within the network approach, distinguishing between patients with cancer and cancer survivors.

Methods

Sample and procedure

The questionnaires were administered between July 2019 and July 2020 to cancer survivors in 4 hospitals and 5 different cancer support groups in different parts of Slovakia. This study is a part of the project “Cognitive-existential profile and specifics of posttraumatic growth in cancer survivors” (osf.io/4maz9/). Ethical approval was granted in June 2018 by the Ethical Committee at Trnava University (resolution No. 1/2018), the National Cancer Institute, and the management of hospitals. The research was carried out according to the Declaration of Helsinki.

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Participation in the study was voluntary and patients could leave the research at any stage without any consequences. Patients confirmed their participation in the study by providing informed consent. There were no questions in the questionnaire which were forced, and patients could leave a response blank in the case that they did not wish to answer. The questionnaires were administered individually or in groups. In most cases, the data collection was carried out in person while around 100 patients took part online. There were three different versions of the questionnaire with the three questionnaire parts (measures) in a different order. This aimed to reduce the bias which can occur due to the effect order of questionnaires can have on participant responses (e.g., Chan (1991); Krosnick and Alwin (1987)). After completing the questionnaires, the participants were given a short debriefing. The inclusion criteria were being 18 or older, having been diagnosed with cancer, not having severe mental health or physical condition, and not being terminally ill – the data collection was not carried out in a palliative care unit.

Measures

The **PTGI** (Posttraumatic Growth Inventory; Tedeschi & Calhoun, 1996) consists of 21-items which measure whether a traumatic event can also cause a positive change in the sense of positive growth. The PTGI consists of 5 subscales (relating to others; new possibilities; personal strength; spiritual change; appreciation of life) although it is possible to work with it as with a unidimensional measurement ($\Omega_{\text{patients}} = .78$; $\Omega_{\text{survivors}} = .81$). The items are formulated as statements (e.g., „I changed my priorities about what is important in life.“) where participants use a 6-point scale (from 0-5) to evaluate the extent to which they had experienced change due to this traumatic event. A higher score indicates a higher level of growth.

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The **ITQ** (International Trauma Questionnaire; Cloitre et al., 2018) measures 6 core PTSD symptoms following the diagnostic manual ICD-11 (e.g., re-experiencing avoidance, sense of current threat). The items are formulated as problems and the respondent evaluates how much the problem has bothered them during the last month on a 5-point Likert scale from 0-4 (0-Not at all; 1-A little bit; 2-Moderately; 3-Quite a bit; 4-Extremely). The construct can be divided into three clusters (avoidance; re-experiencing; a sense of threat) that represent the ICD-11 based probable PTSD ($\Omega_{\text{patients}} = .77$; $\Omega_{\text{survivors}} = .73$).

MiniMAC (Mini-Mental Adjustment on Cancer; Watson et al., 1994) is a self-report measure that consists of 29 items that reflect coping styles used by a cancer patient. In other words, this tool is created specifically for measuring adjustment behavior for cancer patients. The questionnaire is comprised of 5 subscales which are aimed to measure different behavioral and emotional states relating to cancer: Helplessness-hopelessness ($\Omega_{\text{patients}} = .88$; $\Omega_{\text{survivors}} = .74$); Cognitive avoidance ($\Omega_{\text{patients}} = .68$; $\Omega_{\text{survivors}} = .70$); Fatalism ($\alpha_{\text{patients}} = .55$; $\alpha_{\text{survivors}} = .55$); Anxious preoccupation ($\Omega_{\text{patients}} = .77$; $\Omega_{\text{survivors}} = .84$); Fighting spirit ($\Omega_{\text{patients}} = .82$; $\Omega_{\text{survivors}} = .68$). The items are formulated as statements that can be related to the respondent's life. The respondent evaluates the extent of how these statements describe him/her. Statements are evaluated by/using a 4-point Likert scale from 1-4 (1-strongly disagree; 2 – disagree; 3 – agree; 4 – strongly agree).

LOT-R (Life Orientation Test; Scheier et al., 1994) consists of 10 items measuring dispositional optimism, but in this research were used 6 items to assess variables: optimism and pessimism. Measuring these two variables as distinct constructs better reflect the point that optimism and pessimism do not create one/single bipolar trait. Therefore, in this case, three items reflect pessimism and three measure optimism. The items are formulated as statements that are

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evaluated with a 5-point Likert scale from 1-5 (from strongly agree to strongly disagree). A high score indicates lower pessimism and vice versa. In the context of optimism, a high score level indicates lower optimism. The items can be counted together, taking into account their opposite scoring, or they can be recoded. The resulting score for each subscale represents the level of the variable – optimism ($\alpha_{\text{patients}} = .84$; $\alpha_{\text{survivors}} = .76$), pessimism ($\alpha_{\text{patients}} = .80$; $\alpha_{\text{survivors}} = .72$).

BFI-2-S (Big Five Inventory-2-Short form; Soto & John, 2017) consists of 30 items reflecting 5 domains of personality - extraversion, friendliness, conscientiousness, negative emotionality, and openness - in other words, big five. The abbreviated version is based on the original 60-item version of the BFI-2. BFI-2 has good psychometric properties. The abbreviated version retains adequate reliability and validity. Due to the 5 domains of personality, it has 5 subscales, each consisting of 6 items. Items are formulated as statements that may or may not describe a person's characteristics. Respondents evaluate the level of agreement with these statements by 5-point Likert scale from 1-5 (1-strongly disagree; 2-strongly disagree; 3-neutral, I have no opinion; 4-slightly agree; 5-strongly agree). For this research, only one subscale was used, namely, a subscale aimed at measuring negative emotionality (neuroticism; $\Omega_{\text{patients}} = .61$; $\Omega_{\text{survivors}} = .66$).

GSE (General Self-Efficacy Scale; Schwarzer & Jerusalem; 1995) consists of 10 items that report a level of self-efficacy as an ability to have control of life course. Self-efficacy has an impact on feelings, thinking, and behavior (Schwarzer & Scholz, 2000). It is a self-report measure that shows good reliability and validity. Items are formulated as affirmations and respondents evaluate them on a 4-point Likert scale from 1-4 (1 – Not at all true; 2 – Hardly true;

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3 - Moderate true; 4 – Exactly true). The sum of items can range between 10-40 and a high score indicates a higher self-efficacy ($\Omega_{\text{patients}} = .79$; $\Omega_{\text{survivors}} = .84$).

SWLS (Satisfaction with life scale; Diener et al., 1985) is a short measurement, it consists of 5 items. SWLS items measure global satisfaction with life separately from other components of subjective well-being. The items are formulated as statements about satisfaction with life and the respondent evaluates the level of agreement on a 7-point Likert scale from 1-7 (from 1-Strongly disagree to 7-strongly agree). SWLS ($\Omega_{\text{patients}} = .86$; $\Omega_{\text{survivors}} = .85$) has good psychometric properties such as high internal consistency, construct validity, and reliability. In addition, this measurement is often used because it requires a short time.

MSPSS (Multidimensional scale of perceived social support; Zimet et al., 1988) is a measure that consists of 12 items addressing the perceived social support from family, friends, and significant others. Therefore, this measure consists of 3 subscales. The respondent evaluates the individual statements by a 7-point Likert scale in which 1 means strong disagreement and 7 means strong agreement. The higher score indicates a higher level of perceived social support ($\Omega_{\text{patients}} = .84$; $\Omega_{\text{survivors}} = .81$).

Life meaningfulness (Halama, 2002) consists of 18 items. These items reflect a life meaning in terms of cognitive dimension, motivation dimension, and affective dimension. This scale is based on a 3-component model of life meaning so it is divided into three subscales that reflect the components of life meaning. The first, cognitive component ($\Omega_{\text{patients}} = .67$; $\Omega_{\text{survivors}} = .74$) measures beliefs, cognitive schemes, and interpretation. The second component – motivational ($\Omega_{\text{patients}} = .69$; $\Omega_{\text{survivors}} = .73$) – reflects values and goals. The third is an affective component ($\Omega_{\text{patients}} = .71$; $\Omega_{\text{survivors}} = .75$) which reflects happiness, fulfillment, and satisfaction.

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The meaning of life scale has good psychometric properties. The respondent evaluates individual items on a 5-point Liker scale from 1 (strongly disagree) to 5 (strongly agree).

BRS (Brief resilience scale; Smith et al., 2008) is a short 6 items tool to measure unitary resilience. It is useful to assess the ability to recover from stress. Items are formulated as statements. The respondent evaluates these statements with a 5-point Likert scale from 1-5 (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; 5-strongly agree). The total score can vary from 6-30. A higher total score indicates higher resilience ($\Omega_{\text{patients}} = .65$; $\Omega_{\text{survivors}} = .72$). BRS has adequate psychometric properties such as reliability and validity.

HADS (Hospital Anxiety and Depression Scale; Zigmond & Snaith, 1983) is a 14 items self-report questionnaire aimed to measure anxiety and depression. It is a widely used screening tool due to its ability to assess the severity of the symptoms not only in patients but it has good results also in the general population. Half of the items of HAD measure anxiety ($\Omega_{\text{patients}} = .77$; $\Omega_{\text{survivors}} = .84$) and the other half measure depression ($\Omega_{\text{patients}} = .77$; $\Omega_{\text{survivors}} = .71$). The sum of the score is calculated separately from impair questions for anxiety and as the sum of paired questions for depression. Both anxiety and depression subscales have good psychometric properties such as reliability and validity. Each item reflects the symptom of anxiety or depression and answers are formulated as statements. The respondent chooses the statement that best describes how he or she has felt lately.

Pain, medical social support, spirituality importance, and the importance of spirituality practice were measured by single items. The pain was measured by asking how often the pain has recently influenced their life from 1 (never) to 9 (always). Perceived medical social support was measured by the question of how the patients perceive psychosocial support

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from medical staff (e.g., physicians, nurses, etc.), using a scale from 1 (excellent) to 10 (very poor). Spirituality was measured by two simple items: 1) Spirituality is important in my life; 2) The practicing of spirituality is important in my life, with a 7 point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Data analysis

From the total $N = 756$ patients, 60 patients were excluded due to missing data higher than 80%. The participants in the effective sample ($N = 696$ patients) were then divided into two groups based on the variable being in active cancer treatment. One group included participants in active cancer treatment and was named patients with cancer ($N = 181$). The other group included participants who had finished cancer treatment and was called cancer survivors ($N = 419$). As 14% (96 cases) had not provided information about ongoing or finished cancer treatment, these participants were excluded from the analysis. Given the lack of a clear definition of cancer survivors (see e.g., Surbone et al., 2013; Mayer et al., 2017), active cancer treatment was chosen as the division criterion for persons in cancer remission and persons undergoing cancer treatment even after cancer relapse.

In the group of patients with cancer, there was a 1.6% overall average missingness of measured items. The highest missingness found was 9.4% in the satisfaction with life item 5. In the cancer survivors, the overall missingness was 0.5% with the highest missingness 5.3% found in items 3 and 4 from the multidimensional social support scale. The missing data were imputed by multiple imputations (Van Buren & Groothuis-Oudshoorn, 2011) by the MICE package. The missing sociodemographic variables, variables related to cancer and cancer treatment, and other categorical variables were not imputed. For the multiple imputations, 9 imputations with 10 iterations were chosen and the PMM (Predictive Mean Matching) method was used. The data

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imputations were carried out separately for the group of patients with cancer and the group of cancer survivors. The descriptive analysis, reliability analysis, correlations and analysis of differences were computed on the multiple imputed objects. For Figures, 1 and 2, the package *effectsize* (Ben-Shachar et al., 2020) was used for the transformation of Cohen's d to Pearson's r in the categorical variables (gender, partnership, remission, relapse and metastasis). For the Bayesian correlation, the package *BayesFactor* package (Morey & Rouder, 2018) was used.

A network approach was used to analyze the structure of PTG, PTSD and their interconnections (Epskamp et al., 2018). Through this approach, the relationships (edges) between individual symptoms and/or indicators (nodes) are computed. The undirected weighted networks were estimated. The strength of the relationship is represented by the thickness of the line and the direction of the relationship given by the color (e.g., red represents a negative relationship while blue represents a positive relationship).

Centrality indices (Constantini et al., 2015) were used to evaluate the importance and status of individual symptoms (indicators), namely: a) strength, which quantifies the extent to which a node is directly connected to other nodes; b) closeness, which quantifies the extent to which a node is indirectly connected to other nodes; c) betweenness, which quantifies the average degree of importance of a node in relation to any other two nodes; d) expected influence is the summed weight of edges that it shares with the remaining nodes in the network, takes negative associations into account, and represents the relative importance of the node in the network (Robinaugh et al., 2016).

The EBICglasso estimator method was used for the estimation of the networks. By using the bootstrapping method ($nBoots = 2500$), the stability of edges in the network structures,

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stability of indices of centrality, and by simulation, the stability and replicability of the estimated networks were checked. The stability of the correlations was examined by the correlation stability (CS) coefficient that indicates which proportion of persons could be eliminated from the analyses while retaining a correlation of at least 0.70. A CS-coefficient should not be below 0.25 and is preferably above 0.50 (Epskamp et al., 2018). A bridge nodes analysis was used for the analysis of the bridging nodes that represent the interconnection between PTSD and PTG (Jones, 2021). For the bridge nodes, the same centrality indices were examined. The bridge nodes were chosen by the 80 percentile or higher on bridge strength. The brief version of the PTG (10 items; Cann et al., 2010) was used for better readability and interpretability of the PTG and PTSD network structure. The network analysis was carried out using these packages: qgraph (Epskamp et al., 2012), bootnet (Epskamp et al., 2018) and networktools (Jones, 2021) for identifying the bridge nodes (79% of total bridge strength indices were chosen for selecting the bridge nodes) and the NetworkComparisonTest package (van Borkulo et al., 2019) for looking at the differences between the PTSD, PTG, and PTSD-PTG networks in patients with cancer and in cancer survivors. All the analyses were computed using R statistical software (R Core Team, 2021).

Results

Sample

In the group of patients with cancer ($N = 181$), 109 were female. Most of the patients were married (62%) with secondary school education (50.6%). The mean age of the patients was 54 ($SD = 15.26$) years old (range = 18-86). From the patients, approximately 66.5% had cancer in their family history. The sample was heterogeneous from the perspective of the type of cancer (19 different types of cancer). The most prevalent diagnosis was breast cancer (47 cases),

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followed by colon cancer (17 cases), ovarian cancer (16 cases) and prostate cancer (14 cases).

About 4% (7 cases) had two or/and more types of cancer. The average time since being diagnosed with cancer was 3.3 years ($SD = 5.5$). About 21% of patients had had one or more cancer relapses. Most of the patients (155 cases) had not had experience with a cancer support group. About one-third of patients have late treatment impact.

In the group of cancer survivors ($N = 419$), 300 were female. Most of the cancer survivors were married (56%) with secondary school education (52.6%). The mean age of the cancer survivors was 52 ($SD = 15.64$) years old (range = 18-87). From these patients, about 61.5% of the patients had cancer in their family history. The sample was heterogeneous from the perspective of the type of cancer (21 different types of cancer). The most prevalent diagnosis was breast cancer (140 cases), followed by leukemia (42 cases), colon cancer (36 cases) and lymphoma (30 cases). About 4% (15 cases) had two or/and more types of cancer. The average time since being diagnosed with cancer was 8.2 years ($SD = 7.23$). About 19.5% of the cancer survivors had had one or more cancer relapses. Most of the cancer survivors (318 cases) had not had experience with a cancer support group. About 43% of cancer survivors have late treatment impact.

Further details can be found in the sample characteristics tables in the supplementary materials.

Descriptive analysis

Table 1 shows the descriptive statistics of the measured variables in patients with cancer and cancer survivors.

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Table 1

Descriptive statistic of PTG, PTSD and its correlates in patients with cancer and cancer survivors

variable	Patients with cancer					Cancer survivors				
	M	SD	S.E.	min	max	M	SD	S.E.	min	max
PTG	59.62	24.27	1.80	0	105	63.75	23.62	1.15	0	105
PTSD	7.50	6.04	0.45	0	23	8.52	5.79	0.28	0	24
helplessness-hopelessness	20.11	8.20	0.61	9	36	11.90	2.78	0.14	4	16
fighting spirit	14.20	4.44	0.33	5	20	15.40	3.24	0.16	5	20
fatalism	10.87	0.21	0.21	4	16	11.85	2.53	0.12	4	16
cognitive avoidance	11.06	3.14	0.23	4	16	11.90	2.78	0.14	4	16
anxious preoccupation	14.62	4.41	0.33	6	24	13.62	4.61	0.23	6	24
pain	2.90	2.31	0.17	0	10	2.87	2.48	0.12	0	10
depression	8.92	2.01	0.15	4	16	8.92	1.99	0.10	4	15
anxiety	8.98	2.38	0.18	4	15	9.11	2.54	0.12	4	17
satisfaction with life	22.95	7.12	0.53	5	35	22.08	6.64	0.32	5	35
motivational meaningfulness	22.59	4.65	0.35	9	30	22.48	4.78	0.23	7	30
cognitive meaningfulness	23.47	4.06	0.30	12	30	23.74	4.68	0.23	6	30
affective meaningfulness	21.88	3.25	0.24	11	28	21.68	3.41	0.17	10	30
self-efficacy	28.44	6.07	0.45	10	40	28.10	6.18	0.30	10	40
resilience	19.08	4.39	0.33	9	29	18.76	4.93	0.24	5	29
pessimism	8.82	3.16	0.24	3	15	8.39	2.84	0.14	3	15
optimism	9.90	3.37	0.25	3	15	10.43	2.92	0.14	3	15
neuroticism	16.22	4.88	0.36	6	30	17.15	4.81	0.24	6	30
social support	71.08	14.78	1.10	12	84	70.86	13.77	0.67	12	84
medical social support	2.76	2.56	0.19	1	10	4.09	2.74	0.13	1	10
spirituality practice	3.67	2.23	0.17	1	7	4.41	2.33	0.11	1	7
spirituality importance	4.57	2.18	0.16	1	7	5	2.09	0.10	1	7

PTG and PTSD correlates

Figure 1 shows the selected correlates of PTSD and PTG in cancer patients who were in active cancer treatment during the data collection (N = 181).

PTG was found to be significantly negatively correlated at the level of weak effect size with the age of the patients and the level of depressive symptoms. PTG was also significantly positively correlated at the level of weak effect size with all components of meaningfulness of life (most strongly with the motivational component).

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In PTSD, a number of significant correlates were found. Most of these significant correlates were at the level of moderate effect size. The strongest positive correlates of PTSD were neuroticism, anxious preoccupation and pain. The strong negative correlates of PTSD were resilience, the motivational and affective component of meaningfulness in life and satisfaction with life.

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Figure 1 Cancer-related, coping, emotional, eudaimonic, personality, social support, sociodemographic and spiritual correlates of posttraumatic growth and PTSD. (Note. categorical variables were coded as: gender - male = 0, female = 1; partnership - without partner = 0, with partner = 1; cancer relapse – without relapse = 0, with relapse = 1; treatment late impact – without late impact = 0, with late impact = 1; cancer family anamnesis – without cancer in family anamnesis = 0, with cancer in family anamnesis = 1; cancer support group – without regular attendance = 0; with regular attendance = 1)

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Figure 2 shows the selected correlates of PTSD and PTG in cancer survivors who were after cancer treatment during the data collection (N = 419).

The strongest positive correlates of PTG were fighting spirit, fatalism, the cognitive and motivational component of the meaning of life, the perception of importance and the practice of spirituality. The strongest negative correlates of PTG were helplessness-hopelessness and anxious preoccupation.

The strongest positive correlates of PTSD were neuroticism, anxious preoccupation and pain. The strongest negative correlates of PTSD were resilience, self-efficacy and the motivational and affective components of the meaning of life.

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Figure 2 Cancer-related, coping, emotional, eudaimonic, personality, social support, sociodemographic and spiritual correlates of posttraumatic growth and PTSD. (Note. categorical variables were coded as: gender - male = 0, female = 1; partnership - without partner = 0, with partner = 1; cancer relapse – without relapse = 0, with relapse = 1; treatment late impact – without late impact = 0, with late impact = 1; cancer family anamnesis – without cancer in family anamnesis = 0, with cancer in family anamnesis = 1; cancer support group – without regular attendance = 0; with regular attendance = 1)

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The most significant differences between the PTSD and PTG correlates compared to the group of patients in treatment and patients who were after treatment were in the PTG correlates. There were fewer significant PTG correlates found in the group of patients undergoing treatment (5 significant PTG correlates were found in the patients' group while 15 significant PTG correlates were found in the cancer survivors' group). In the group of cancer survivors, there was a significantly stronger positive relationship found between PTG and the regular attendance of cancer support groups, compared to the group of patients. Another observed difference was in the level of correlates regarding spirituality. The level of effect of the PTG relationships with the perceived importance of spirituality and with the practice of spirituality increased almost 3-fold to the level of moderately strong positive relationships in group of cancer survivors.

In PTSD, most of the relationships with the analyzed correlates were slightly stronger in the group of patients although most of the significant correlates were at the level of moderate effects even in the cancer survivors. In the group of patients, the negative relationship between PTSD and life satisfaction was also almost 2 times stronger. The biggest difference can be seen in the individual components of the meaning of life, which showed a stronger negative relationship with PTSD in the group of patients. Similarly, fighting spirit was also a significant negative correlate of PTSD in the group of patients. On the other hand, PTSD correlated moderately positively with pessimism and moderately negatively with optimism in the group of cancer survivors, whereas a significant relationship between these two variables and PTSD was not observed in the group of patients. In the group of patients undergoing treatment, there was a significant negative relationship between PTSD and social support from the medical staff. In the group of cancer survivors, this relationship was no longer significant and was more than 2 times weaker.

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At the same time, there was no significant relationship between PTSD and PTG in the treatment group. However, a weak positive relationship was observed between PTSD and PTG in the group of cancer survivors.

The specific values of the correlation coefficients with a 95% confidence interval and Bayesian factor are provided in Table 2 in the supplementary materials.

PTG and PTSD networks

The PTSD networks were stable as indicated by the CS coefficients for edge weights $CS_{patients}(cor = .7) = .67$, $CS_{survivors}(cor = .7) = .75$ and EI values, $CS_{patients}(cor = .7) = .204$, $CS_{survivors}(cor = .7) = .55$. The PTSD networks did not differ in the network structure or even in the global strength of centrality indicators in either group. *Startle response, hypervigilance and cancer-related flashbacks* were the most central symptoms in the PTSD network.

The PTG networks were stable as indicated by the CS coefficients for edge weights, $CS_{patients}(cor = .7) = .55$, $CS_{survivors}(cor = .7) = .75$ and EI values, $CS_{patients}(cor = .7) = .45$, $CS_{survivors}(cor = .7) = .66$. The PTG networks did not differ in the network structure for either group but differed in the global strength of the indicators. For both groups, *putting more effort into relationships* as well as *the ability to do better things with one's own life* were the most central indicators in the PTG network.

The combined PTSD-PTG networks were stable as indicated by CS coefficients for the edge weights, $CS_{patients}(cor = .7) = .56$, $CS_{survivors}(cor = .7) = .75$ and EI values, $CS_{patients}(cor = .7) = .22$, $CS_{survivors}(cor = .7) = .64$, for Strength, $CS_{patients}(cor = .7) = .27$, $CS_{survivors}(cor = .7) = .64$, for BEI, $CS_{patients}(cor = .7) = .29$, $CS_{survivors}(cor = .7) = .54$. The PTSD-PTG networks differed in the network structure. PTSD and PTG were linked through different bridge nodes. PTSD-PTG in the patients

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with cancer was linked through *cancer-related nightmares* and *avoidance of internal reminders of cancer* (as PTSD symptoms) and *changing life priorities* and *ability to do better things with one's own life* (as PTG indicators). *Avoidance of internal reminders* was directly connected with two other PTG bridge nodes, positively with *changing life priorities* and negatively with the *ability to do better things with life*. In cancer survivors, PTSD-PTG was connected through *cancer-related nightmares*, *startle response* and *hypervigilance* (as PTSD symptoms) and *changing life priorities* (as the PTG indicator). *Hypervigilance* was directly positively connected with *changing life priorities* (see Figure 3).

The figures and results for the PTSD and PTG networks as well as the results for the comparison of networks can be found in the supplementary materials.

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PTSD and PTG with bridge symptoms in patients with cancer

PTSD and PTG with bridge symptoms in cancer survivors

Figure 3 Network structure of PTSD-PTG with bridge nodes and their centrality indices in patients with cancer and cancer survivors

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Discussion

The study aimed to explore the differences in posttraumatic growth and posttraumatic stress in patients with cancer in active treatment and cancer survivors, considering the different correlates, networks structure and interconnection between them.

Correlates of PTG and PTSD

The most significant differences between the patients with cancer in active treatment and cancer survivors were in the correlates of PTG. In the patients having cancer treatment, just 5 correlates of PTG were significant compared to 15 significant PTG correlates in the group of cancer survivors. Previous studies (e.g., Cormio et al., 2017, Danhauer et al., 2015) have found that the time since being diagnosed with cancer is positively related to PTG. The present study also found that cancer survivors with longer survival times had slightly higher levels of PTG than patients with cancer although this difference was not significant. On the other hand, the current findings have shown that more factors are part of the positive changes in cancer survivors than in patients with cancer. In the cancer group of survivors, a significantly stronger positive relationship was found between PTG and the regular attendance of cancer support groups, compared to patients in treatment. Psychosocial support is another important factor in facilitating PTG (Zhang et al., 2021; Cormio et al., 2017; Prati & Pietrantonio, 2009). Based on the present findings, it seems that for PTG it is useful to be in touch with other cancer survivors, even a long time after being diagnosed. Another observed difference in the study was at the level of correlates related to spirituality. The effect size of the relationships between PTG and the perceived importance of spirituality and practice of spirituality increased almost 3-fold to the level of moderately strong positive relationships. Various studies (e.g., Paredes & Pereira, 2018; Seo &

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Kwon, 2018; Schultz et al., 2010) have shown that spirituality is an important factor related to PTG. Surviving cancer treatment may lead to the development or increasing spiritual **matters**. Spirituality-related matters were especially important for PTG in cancer survivors. In cancer survivors, talking about spiritual issues should also have space during psychological interventions focused on the facilitation of PTG. The other strong positive correlates of PTG in cancer survivors were fighting spirit and fatalism. This is in line with other studies (Tu et al., 2020; Romeo et al., 2019; Ho et al., 2004). In the current study, PTG was also found to positively correlate with all domains of life meaningfulness in cancer survivors. Triplett et al. (2012) and Casellas-Grau et al. (2017) also found that PTG is directly positively related to meaning in life. In the group of patients, meaning in life, especially motivational meaningfulness, was the strongest positive correlate of PTG. Motivational meaningfulness is related to life goals, plans and the degree of involvement in them. One of the other strongest correlates of PTG in patients with cancer was age. In this group, PTG was higher in younger patients. A combination of younger age and higher motivational meaningfulness could be a strong factor in the facilitation of PTG in this group.

Posttraumatic stress was higher in patients with cancer than cancer survivors but as with PTG, the observed difference was not significant. Most PTSD correlates were slightly stronger in the group of patients in active cancer treatment. The clearest difference was in the correlation of PTSD and life satisfaction where this negative correlation was almost 2 times stronger in the patients than the cancer survivors. Ongoing cancer treatment could have a significant impact on the relationship between posttraumatic stress and life satisfaction. The biggest difference in the PTSD correlates can be seen in the individual components of the meaning of life which showed a stronger negative relationship with PTSD in the group of patients. A negative relationship

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between PTSD and the meaning of life has been consistently found in other studies (Fischer et al., 2020). It seems that the process of meaning-making is important in both posttraumatic reactions and could be crucial in the process of the stress-growth balance (Ochoa-Arnedo et al., 2019). Another difference was that fighting spirit was a significant negative correlate of PTSD in just the group of patients. It may be important not to give up during the early stages of cancer and in particular, the period when undergoing treatment. Other factors that were observed as moderately strong correlates of PTSD in the group of patients were pessimism and optimism. Having a less pessimistic and more optimistic approach seems to also be important during treatment. **Being more optimistic and less pessimistic** could be important in having a fighting spirit (Olason & Roger, 2001). In both groups, resilience and self-efficacy were strong negative correlates of PTSD. In addition, neuroticism, hope-helplessness, anxious preoccupation and pain were strong positive correlates of PTSD. Self-efficacy (Kohn et al., 2010; Wu et al., 2021), resilience (Seiler & Jenewein, 2019; Duan et al., 2015), neuroticism (Dahl, 2010; Baník et al., 2019; Brandão et al., 2017) and coping strategies (Richardson et al., 2016; Pérez et al., 2014) are important factors in the psychological adjustment in cancer.

PTSD and PTG can have shared, as well as distinct, various correlates (David et al., 2021). It is important to understand the correlates of PTSD and PTG not only to have a better theoretical understanding of the posttraumatic reactions in people diagnosed with cancer but also in choosing an appropriate psychosocial intervention. As in previous studies (see Shand et al., 2015; Casellas-Grau et al., 2017), the current study found that various psychological variables are more strongly related to posttraumatic reactions than clinical or socio-demographic variables. In addition, this study highlights that despite the level of posttraumatic stress and/or posttraumatic growth being significantly different in patients in active treatment and cancer survivors, these two

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posttraumatic reactions have different magnitudes related to different correlates. It seems that being in active cancer treatment could be a moderator that affects the strength of the relationships between the various correlates of PTSD and PTG.

The network structure of PTG, PTSD and PTSD-PTG

Additionally, the study looked at the network structure of the posttraumatic reactions and their interconnection in cancer patients in treatment and cancer survivors.

The network structure of PTSD did not differ between the patients and survivors. In both groups, the most central symptoms in the PTSD network were *startle response*, *hypervigilance* and *cancer-related flashbacks*. This finding is in line with other studies that have focused on the network structure of PTSD (see Birkeland et al., 2020). In various trauma samples, being startled and hypervigilance have been identified as the two strongest symptoms (Isvoranu et al., 2020). Indeed, PTSD seems to be an underestimated issue in patients with cancer (Leano et al., 2019) and thus network analysis could bring new insight into this problem. Interventions focused on the most central symptoms could also help reduce other PTSD symptoms (see e.g., Hoffart et al., 2019).

While the network structure of PTG in patients and survivors did not differ in the interconnections between the PTG indicators, they differed in the global strength of the centrality indicators. The clearest difference between their strength was in the *discovery of more strength*, *ability to accept how things are going better* and *better appreciation of each day*. These indicators were less central in the PTG network of the cancer survivors. For both groups, *putting more effort into relationships* and the *ability to do better things with one's own life* were the most central indicators in the PTG network. Despite patients and survivors sharing the strongest PTG

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indicators, it seems that for patients and survivors, different PTG indicators could influence PTG development.

Finally, the patients and survivors differed in the combined PTG-PTSD network. PTSD and PTG were linked through different bridge nodes. The PTSD-PTG network in the patients with cancer was bridged through *cancer-related nightmares*, *internal avoidance*, *changing life priorities* and the *ability to do better things with one's own life*. Internal avoidance was directly connected with two other PTG bridge nodes, positively with *changing life priorities* and negatively with the *ability to do better things with one's own life*. In cancer survivors, the PTSD-PTG was connected through *cancer-related nightmares*, *startle response*, *hypervigilance* and *changing life priorities*. Hypervigilance was directly positively connected with *changing life priorities*. In cancer survivors, it seems that more PTSD symptoms are involved in connection to PTG. Indeed, anxious arousal symptoms may be more important for PTG development in cancer survivors compared to the intrusive and avoidant symptoms in patients undergoing treatment. PTG and PTSD can coexist with each other (Dekel et al., 2012; Cordova & Andrykowski, 2003) and a certain amount of distress is even necessary for the development of PTG (Tedeschi & Calhoun, 2004). In the context of cancer, it seems that cancer-related posttraumatic stress could trigger posttraumatic growth through the direct impact on changing life priorities in particular. This cancer-related posttraumatic stress-growth process happens through different posttraumatic stress symptoms in patients undergoing treatment compared to cancer survivors.

Limitations and Implications for practice

The current study also has limitations that should be mentioned. Firstly, cross-sectional studies offer limited information about possible causal inferences. Posttraumatic reactions are

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phenomena that develop over time and thus longitudinal research would be useful in further studies. The sample was heterogeneous from the point of view of the different types of cancer. For this reason, it is not possible to generalize the results to certain types of cancer. In future research, it could be of interest to focus on specific groups based on the same or similar types of cancer. It is possible that there will be different types of correlates of PTSD and PTG for specific cancer types and that these two posttraumatic reactions could be linked through different patterns. It would also be of interest to focus on the specific type of treatment and objective and subjective measures of how received treatment has an impact on a person. The dividing criterion for the compared groups (patients vs survivors) was being in active treatment although having more detailed information about received cancer treatment could be useful. Another limitation is that self-reported measures were used. For mental health variables (such as PTSD, depression, anxiety) it would be useful to also have some more objective measures, e.g., clinical interviews carried out by clinical psychologists or psychiatrists. Finally, in the network analysis, some indices of centrality were less stable in the group of patients and thus the results should be taken with a pinch of salt. A replication of network studies in this context is needed. Despite these limitations, the study provides useful findings with practical implications. In terms of psychosocial interventions aimed at reducing PTSD and facilitating PTG, different interventions focusing on different correlates should be used for patients undergoing treatment and cancer survivors. The network analysis revealed that PTG could be linked to PTSD through different patterns. This knowledge about how PTSD and PTG are differently related to the same correlates and knowing how they are differently connected and interconnected from the network perspective could be useful in stress-growth balance interventions (Ochoa-Arnedo et al., 2019) or other growth-focused psychosocial interventions (Li et al., 2020; Ochoa-Arnedo et al., 2020). The

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findings depict what is important in the context of posttraumatic reactions separately for patients in treatment as well as cancer survivors.

Conclusion

Posttraumatic growth is a phenomenon that has mostly been studied in the context of cancer (Kou et al., 2021). On the other hand, posttraumatic stress has been an underestimated issue in cancer (Leano et al., 2019). These two posttraumatic reactions are interconnected in patients with cancer and cancer survivors (Jim & Jacobsen, 2008; Marziliano et al., 2020). The results about the correlates of PTSD and PTG and their interconnection have mostly been reported from mixed samples of patients and survivors (see e.g., Shand et al., 2015). In the present study, it was found that PTSD and PTG have both shared and differed correlates and that these relationships also depend on if they are measured in patients in active cancer treatment or survivors. In addition, it was found that PTG is linked with PTSD in a different pattern from the network perspective. The present findings extend current knowledge about posttraumatic reactions in cancer and are also useful for clinical practice as well as patients and survivors.

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