Supportive Care in Cancer (2019) 27:829–838
https://doi.org/10.1007/s00520-018-4359-y

ORIGINAL ARTICLE

The role of post-traumatic growth in promoting healthy behavior for couples coping with cancer

Jung-won Lim[1]

Received: 15 January 2018 / Accepted: 17 July 2018 / Published online: 3 August 2018
© Springer-Verlag GmbH Germany, part of Springer Nature 2018

Abstract

Objective Post-traumatic growth (PTG) could be beneficial to cancer survivors who translate growth cognitions or emotional processes into positive behavior changes. The current study aimed to determine how post-traumatic growth (PTG) is associated with health behaviors in couples coping with cancer. Specifically, five hypothetical models based on PTG domains were created to better understand the dyadic relationship between PTG domain and health behaviors.

Methods A total of 91 breast, colorectal, and prostate cancer survivor-spouse dyads were collected from the University Hospital Registry in Cleveland, Ohio. Standardized questions regarding PTG and health behaviors including eating and exercise were used. The actor-partner interdependence model with the use of structural equation modeling was utilized to analyze dyadic data.

Results Findings indicated that survivor actor effects of PTG on health behaviors were observed for survivors only. In the spiritual change and appreciation of life PTG models, the survivor or the spouse partner effects were observed, respectively. The spiritual change model produced the best fit of all of the other models, indicating both a survivor actor effect and survivor partner effect of spiritual change PTG on health behaviors. Thus, the relationships between PTG and health behavior at the dyadic level differed by five domains of PTG.

Conclusions The findings reveal valuable insight into the nature of relationships between PTG and health behaviors at the individual and dyadic levels. The changed philosophies of life for cancer survivor-spouse dyads can specifically encourage healthy behaviors of couples coping with cancer.

Keywords Cancer survivor · Dyadic relationships · Health behavior · Post-traumatic growth

Introduction

Cancer survivors need to stay entrenched in survivorship care, including scheduling follow-up appointments, checking for recurrence, and maintaining healthy behaviors, given the higher risks of medical/physiological and psychosocial sequelae [1–3]. A diagnosis of cancer imposes physical and psychological challenges not only on cancer patients but also their spouses [4]. Couples coping with cancer respond to cancer as an integrated system because cancer patients tend to share their concerns with their spouses [5]. The couples influence each other's resilience, psychological well-being, and health-related quality of life (HRQOL) [6–8]. For example, a spouse's psychological distress is not only associated with their own resilience but also to the survivor's resilience [8]. Thus, dyadic relationships for couples dealing with cancer should be addressed to further understand the lives of cancer survivors.

Post-traumatic growth (PTG) refers to "positive psychological changes and growth beyond previous levels of functioning and thereby implies both an outcome and a process." [9, 10]. Theoretically, PTG emerges after a severe adverse life event or traumatic experience such as cancer diagnosis. Next, cognitive techniques such as effortful rumination are engaged to attribute a sense of comprehension and meaning around the adverse event [11]. Evidence suggests that as much as 40–70% of individuals who experience a traumatic event report benefits from their experience [12]. For example, cancer survivors showed closer intimate relationships, positive changes in spirituality, and an increased appreciation of life as a consequence of the struggle from the cancer diagnosis

✉ Jung-won Lim
jungwonlim@kangnam.ac.kr

[1] College of Social Welfare, Kangnam University, 40 Gangnam-ro, Giheung-gu, Yongin-si, Gyeonggi-do, South Korea

and treatment [13, 14]. Cancer survivors also expressed appreciation for the smaller things in life, which indicates the discovery of new possibilities in daily life [15]. Additionally, several studies reported that the spouse's PTG is positively associated with the survivor's PTG [16], suggesting that cancer dyads share not only their psychological distress but also the potential for gain from their adverse events.

A growing body of literature suggests that positive changes in cancer experiences are associated with enhanced HRQOL [17]. Meanwhile, Deci and Ryan [18] argue that PTG must be translated into behavior to restore the sense of control and ability to deal effectively with the challenges of everyday life for cancer survivors. Authentic growth may occur when it is accompanied by behavior changes and PTG could be beneficial to cancer survivors who translate growth cognitions or emotional processes into positive behavior changes [19]. Indeed, previous studies have shown that PTG is tied to behavior changes, indicating that PTG is strongly associated with health-related behavior changes, such as improved diet and physical fitness, and cessation of risky behaviors [20, 21]. In this sense, health behavior changes, which are influenced by PTG, can be viewed as taking responsibility for cancer survivors' health and placing a heightened importance on the body which, in turn, positively influences cancer survivors' HRQOL [21].

According to Ryan [22], the Integrated Theory of Health Behavior Change (ITHBC) describes that health behavior can be changed by fostering knowledge and beliefs, increasing self-regulation skills, and heightening social facilitation. More specifically, health behavior change is an outcome that can be obtained in the short term and in turn leads to improvement in health status over time. Of diverse conceptualizations of PTG, Taylor [10] regarded PTG as a form of self-enhancing appraisal that helps to cope with threat. Based on Taylor's conceptualization, PTG may be a predictor which enhances health behavior change. Furthermore, given that the ITHBC emphasizes the role of social facilitation such as social influence and support, the interdependence of health behavior and PTG in cancer survivor-spouse dyads may be considered, although the ITHBC did not address the dyadic model beyond the individual model. The ITHBC at the dyadic level may be essential to understand how beliefs or appraisals such as PTG can make health behavior change, interacting between couples coping with cancer.

The current study aimed to determine how PTG is associated with health behaviors in couples coping with cancer. Given that exercise and diet are important to health management for cancer survivors, two health behavior factors were simultaneously included as outcome variables. Additionally, five hypothetical models were created to better understand the dyadic relationship between PTG and health behaviors, considering five domains of PTG which may have different characteristics [23]. Based on the actor-partner interdependence model (APIM) [24] for dyadic data, the following research hypotheses were tested:

- H1. Own PTG scores are significantly related to one's positive change in exercise and diet.
- H2. The partner's PTG scores are significantly related to one's positive change in exercise and diet.
- H3. The relationships between PTG and health behavior at the dyadic level will be different by five domains of PTG.

Methods

Data source and participants

Data were obtained from the parent study, the Family Resilience Dyadic Study (FRDS), which aimed to investigate ways to promote family resilience among cancer survivor couples in Cleveland, Ohio [8]. The FRDS was approved by the Institutional Review Board. Participants were enrolled in the University Hospital Cancer Registry in Cleveland. Eligibility criteria for cancer survivors were as follows: (a) 18 years of age or older at diagnosis; (b) within 1–5 years of a breast, colorectal, or prostate cancer diagnosis (stage I–III); (c) completion of active treatment (i.e., surgery, chemotherapy, or radiation); (d) not having other cancer diagnoses; (e) not having major disabling medical or psychiatric conditions; and (f) self-identification as European- or African-American. Spouses were included if they had been living with a survivor at the time of diagnosis of cancer.

Data collection procedures

Methodological details such as sampling, recruitment procedure, and instrument development have been reported in detail elsewhere [8]. Briefly, participants were identified from the registry and potential participants whose contact information was obtained from the registry received an invitation letter. The research assistant then made a telephone call to confirm their interest and eligibility and subsequently conducted screening using the telephone. Afterwards, the research assistant mailed both a questionnaire and consent form to eligible participants.

Survivors who agreed to invite her/his spouse in the screening process were asked to answer a researcher's contact preference with his/her spouse (i.e. direct contact to his/her spouse or delivering messages). In cases when the survivor did not want for her/his spouse to participate, the survivor was not eligible for the study anymore. The survey administration procedures for the spouse were identical to those used for the

survivors. The survivor and spouse received a $20 gift card in compensation after the survey was returned.

Instruments

Post-traumatic growth inventory—short form

PTG was assessed using the post-traumatic growth inventory—short form (PTGI-SF), a ten-item self-report measure indicating the degree to which the change occurred in the life as a result of one's own or a spouse's cancer diagnosis [25]. The PTGI-SF consists of five subscales: relating to others, new possibilities, personal strengths, spiritual change, and appreciation of life. Each subscale comprising two items was rated on a 6-point Likert scale. The values for the subscale items were averaged, with higher scores indicating greater levels of PTG. The PTGI-SF was validated by the authors, showing an internal consistency ($\alpha = 0.94$), a high correlation with the total PTGI scale ($r = 0.98$). In the current study, the reliability coefficients ranged from 0.738 to 0.907 for survivors and from 0.731 to 0.929 for spouses.

Health behavior

A self-report instrument that assesses health behavior changes was used to measure health behaviors including eating and exercise. Participants were first asked whether they had made any positive lifestyle or health behavior changes since one's own (survivor) or a family member's (spouse) cancer diagnosis. If yes, additional questions were asked whether positive changes in eating and exercise had been made by checking each item including "eat healthier" and "more exercise." For people who check "eat healthier," specific questions were also asked to know more details regarding "eat healthier" such as less meat, less fats, and eat more fruits and vegetables. Specific questions regarding "more exercise" were created based on frequency options such as less than once a week, or 2–3 times a week. In the current study, only questions that check whether positive changes in eating and exercise had been made ("Yes" or "No") were included as a dichotomous variable. Thus, people who checked to "eat healthier" and/or "more exercise" were considered as those who show a positive change. Meanwhile, those who checked "no" in a broad question (positive health behavior change question) and who did not check to each item regarding eating and/or exercise were considered as those who did not show a positive change.

Demographic and medical characteristics

Demographic and medical characteristics were obtained using a self-administered questionnaire. Demographic (i.e., age, gender, income) and medical characteristics (i.e., cancer type and stage, comorbidities, and years since diagnosis) were considered control variables.

Data analysis

The description of participants' characteristics was made using exploratory data analyses. As preliminary analyses, paired-sample *t* tests and the Pearson correlation analyses were conducted to investigate dyadic characteristics of the PTG variables. For health behavior dichotomous variables, point-biserial correlation and McNemar's test were used to conduct such analyses. SPSS 20.0 was used to analyze data.

The Actor-Partner Interdependence Model (APIM) was used to address the research questions for survivor-spouse couples. The APIM was deemed adequate to analyze the dyadic data, because the APIM considers solving methodological problems related to dyadic data [24, 26]. The APIM simultaneously estimates the effect of a person's own variable (i.e., *actor effect*) and the effect of the same variable but from the partner (i.e., *partner effect*) on an outcome variable [27]. In this study, five dyadic models that differ only in the independent variable (five PTG subscales) were made to further explore how each PTG domain is associated with health behavior changes for cancer survivor-spouse couples.

Structural equation modeling was used to examine the associations between PTG and health behaviors in survivor-spouse couples using AMOS 20.0. In our dataset, full information maximum likelihood estimate was used to address missing data [28]. In this study, survivor and spouse PTG scores were exogenous variables and eating and exercise were endogenous variables. Survivor comorbidities and age served as covariates since they are related to survivors' health behavior patterns [29]. The corresponding variables between survivors and spouses were allowed to correlate with each other. Correlations between eating and exercise were also allowed due to their significant associations [30].

To evaluate the hypothesized model, four model fit indices were reported: the chi-square statistics or discrepancy function, the ratio of the discrepancy function to the number of degrees of freedom ($X^2/\mathrm{df} < 3$), the root mean square error of approximation (RMSEA; acceptable fit ≤ 0.08) [31], and the comparative fit index (CFI; acceptable model fit ≥ 0.9) [32].

Results

Sample characteristics

Data from a total of 91 survivor and spouse couples were used in the analysis. As shown in Table 1, the mean age of

Table 1 Demographic and medical characteristics of participants (91 dyads)

Variables		Survivors *N* (%)	Partners
Gender	Male	58 (63.7)	32 (35.2)
	Female	33 (36.3)	59 (64.8)
Ethnicity	European-American	74 (81.3)	74 (82.2)
	African-American	17 (18.7)	15 (16.7)
	Other	0	1 (1.1)
Household income	< 25K	10 (11.6)	10 (11.6)
	25–75K	41 (45.1)	41 (45.1)
	Over 75K	40 (44.0)	40 (44.0)
Education	≤ Some high school	5 (5.5)	4 (4.4)
	High school graduate-associate degree	43 (47.3)	49 (54.4)
	≥ College graduate	43 (47.3)	37 (41.1)
Employment status	Unemployed	11 (12.10)	24 (26.7)
	Employed	80 (87.90)	66 (73.3)
Religion	Yes	79 (86.8)	79 (86.8)
	No	11 (12.1)	11 (12.1)
Cancer type	Breast	28 (30.8)	–
	Colorectal	18 (19.8)	–
	Prostate	45 (49.5)	–
Stage of diagnosis	I	23 (25.6)	–
	II	63 (70.0)	–
	III	4 (4.4)	–
Types of cancer treatment (yes)	Surgery	70 (79.6)	–
	Radiotherapy	53 (58.2)	–
	Chemotherapy	27 (30.0)	–
		Mean (SD)	
Age		64.2 (10.5)	63.8 (11.1)
Years since diagnosis		3.7 (1.9)	–
Current comorbidities		3.1 (3.2)	4.1 (2.4)

participants was approximately 64 years old (SD = 11). Approximately 50% of survivors were diagnosed with prostate cancer and 70% were diagnosed with stage II cancer. The mean number of years since cancer diagnosis was 3.7 (SD = 1.9). The couples were predominantly European-American, employed, relatively educated, and affluent. The mean number of comorbidities of survivors and spouses was 3.1 (SD = 3.2) and 4.1 (SD = 2.4), respectively.

As indicated in Table 2, for between-dyad correlations, the relationships between variables for survivors and spouses were moderate, except for relating to others ($r = 0.19$, $p > .05$), personal strengths ($r = 0.19$, $p > .05$), and physical exercise ($r = 0.18$, $p > .05$). Within-dyad correlations for survivors were statistically significant ($0.21 \leq r \leq 0.83$), except for correlation coefficients between personal strengths and physical exercise ($r = 0.12$, $p > .05$). For spouses, eating and exercise were not significantly associated with any subscale of PTG. A paired-sample *t* test showed that PTG and health behaviors did not differ between couples.

Post-traumatic growth and health behaviors for cancer survivors and spouses

The mean PTG of survivors and spouses was 2.8 (SD = 1.2) and 2.6 (SD = 1.4), respectively, indicating that survivors and spouses felt slightly positive changes in their life as a result of a cancer diagnosis. Mean differences in PTG between dyads did not exist. Appreciation of life received the highest mean score for both survivors and spouses, indicating that both survivors and spouses felt that a changed philosophy of life, such as an appreciation of life, occurred as a result of a cancer diagnosis. This was followed by the subscales of relating to others and personal strengths.

In terms of health behaviors, approximately 62.8% of survivors ($n = 54$) responded that they made positive health behavior changes. Of survivors who made positive changes, 49 were engaged in eating healthy and 47 were in exercise more frequently. For spouses, about 52.9% ($n = 45$) responded that they made positive health behavior changes. Of them, 42 were

Table 2 Inter-correlations of study characteristics between survivors and spouses

Variables	1	2	3	4	5	6	7
1. Relating to others	**0.19**	0.84***	0.84***	0.78***	0.86***	0.07	0.13
2. New possibilities	0.69***	**0.23***	0.74***	0.77***	0.78***	0.16	0.20
3. Personal strengths	0.76***	0.63***	**0.19**	0.71***	0.78***	0.05	0.09
4. Spiritual change	0.71***	0.63***	0.59***	**0.38***	0.71***	0.08	0.16
5. Appreciation of life	0.54***	0.68***	0.55***	0.53***	**0.30****	0.11	0.17
6. Healthy eating	0.31**	0.39***	0.21*	0.33**	0.31**	**0.24***	0.76***
7. Physical exercise	0.22*	0.31**	0.12	0.25*	0.22*	0.83***	**0.18**
	Mean(SD)					*Yes (%)*	
Survivors	3.1(1.2)	2.3(1.4)	2.8(1.3)	2.6(1.8)	3.2(1.5)	53.8	51.6
Spouses	2.8(1.4)	2.3(1.5)	2.6(1.4)	2.4(1.8)	3.1(1.6)	46.2	38.5
Survivor -Spouse	*Paired t -test (p-value)*					*McNemar 's test (p-value)*	
	0.07	0.76	0.34	0.36	0.69	0.31	0.07

Correlation coefficients above each diagonal correspond to spouses and coefficients below each diagonal correspond to survivors; the diagonal correlations (italics) represent correlation coefficients between survivors and spouses in each variable; relationships between binary variables (i.e., healthy eating, physical exercise) and continuous variables were conducted by point-biserial correlation

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

engaged in eating healthy and 35 were in exercise more frequently.

Hypothesis testing

The hypothetical model was evaluated to investigate the associations between PTG and health behaviors in dyads (Fig. 1). A total of five analyses were conducted to explore similarities/differences in the associations among variables according to five domains of PTG, including (1) relating to others, (2) new possibilities, (3) personal strengths, (4) spiritual change, and (5) appreciation of life. Overall, the "relating to others" and "new possibilities" subscales showed similar findings, while the other PTG subscales differed. Hypothetical models, except for the personal strengths PTG subscale, produced excellent fit (Table 3).

First, in terms of the domains "relating to others" and "new possibilities," the survivor actor effects of PTG on eating and exercise were observed, indicating that survivors' changed their sense of relationship with others as well as interests and paths, as new possibilities were associated with their own healthy eating and more exercise. However, actor effects between the PTG domains "relating to others" and "new possibilities" and health behaviors were not observed for spouses. Moreover, neither survivor nor spouse partner effects were observed.

Second, the "personal strengths" domain did not demonstrate appropriateness of the hypothesized model. In the "personal strengths" domain, only the survivor actor effect of PTG on eating was observed.

Third, the "spiritual change" model produced the best fit of all other models. In this model, survivor actor effects of the spiritual change PTG domain on both eating and exercise were observed, indicating that a survivor's positive spiritual change was associated with their own healthy eating and more exercise. Meanwhile, the spouses' spiritual changes were negatively associated with the survivors' health behaviors. That is, the spouses' development of a stronger religious faith did not make the survivor engage in healthy behaviors. Spouse actor effects of PTG domains on health behaviors were not observed.

Finally, survivor actor effects of PTG on health behaviors were observed in the "appreciation of life" PTG domain. Unlike the other models, the survivors' changed philosophies of life were positively associated with their spouses' healthier eating. Neither a spouse actor effect nor a survivor partner effect in the relationships between appreciation of life and health behaviors was observed.

In summary, the hypothesis 1 that own PTG scores are significantly related to one's positive change in exercise and diet was true for cancer survivors only. The hypothesis 2 regarding the partner effects was partially supported by spiritual change and appreciation of life PTG models. As a result, the current study supported the hypothesis 3 that the relationships between PTG and health behavior at the dyadic level differ by five domains of PTG.

Discussion

The present study intended to determine how PTG is associated with health behaviors in couples coping with cancer. How to cope with traumatic experiences such as a cancer diagnosis and treatment can influence a cancer survivor's HRQOL. Cancer survivors often expressed appreciation to someone in their life and showed how their personal strengths have grown and their spirituality has changed after a cancer diagnosis; we call this "post-traumatic growth." A growing

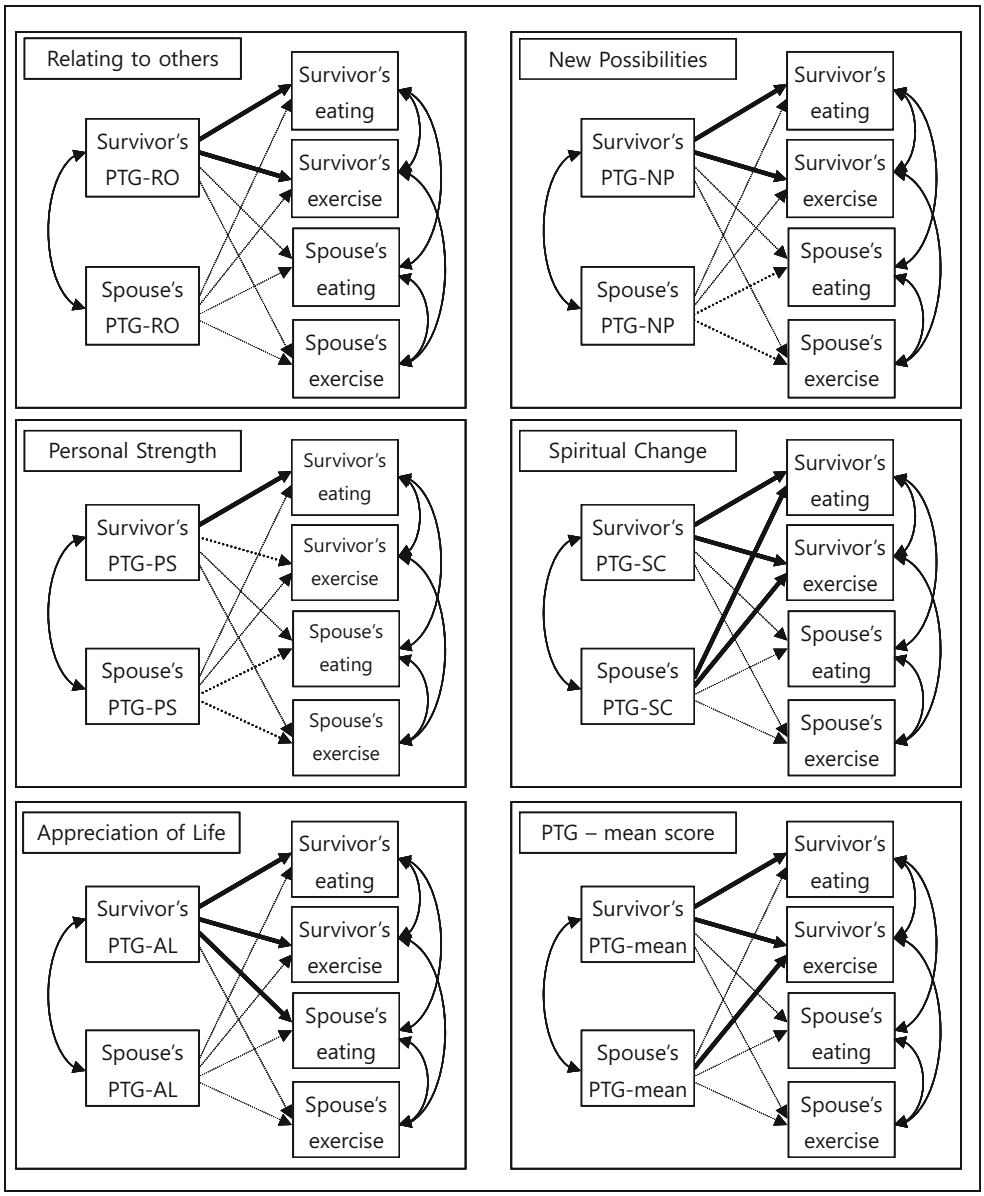

Fig. 1 Dyadic models in the relationship between PTG and health behaviors by five domains of PTG. Solid lines refer to significant paths at $p < 0.05$; dotted lines refer to non-significant paths at $p < 0.05$, the spouse partner effect. Survivor comorbidities and age were controlled in each model

body of literature suggests that PTG can be beneficial to improving a cancer survivor's HRQOL when PTG is accompanied by behavior changes. Nevertheless, no previous studies of relationships between PTG domains and health behaviors at the dyadic level have been conducted. To our knowledge, the current study is the first to investigate the dyadic relationships between PTG and health behaviors in couples coping with cancer.

First, the current study tested five models considering the five domains of PTG. Most previous studies considered the composite scores of PTG subscales rather than the five domains of PTG in separate. Given that the five domains have different meanings within PTG [33], the current study intended to further explore the five domains of PTG in detail to provide information that may be clinically and conceptually informative. Our findings demonstrated that each domain of PTG provided different results. For example, paths between the "relating to others" and "new possibilities" domains and health behaviors were similar at the dyadic level, while those between other PTG domains and health behaviors differed. Such findings suggest that it is necessary to examine the influences of PTG by each domain and to consider the meaning of each domain and its relationship with health behaviors.

Indeed, the "relating to others" and "new possibilities" domains appear to be closer to an external coping mechanism such as seeking social support than other domains given that the external environment is involved in PTG. Such finding is consistent with previous studies [33, 34]. They indicate that the perception of positive changes may create the opportunity for closest relationships, more compassionate behaviors, and new contacts and friendships, suggesting the positive

Table 3 Dyadic effects of PTG domains in predicting health behaviors

Paths		Standardized beta coefficients
PTG 1: relating to others: $X^2 = 12.247$, df = 9, CFI = 0.984, RMSEA = 0.063		
Relating to others → eating	Survivor AE	0.295**
	Spouse AE	0.079
	Survivor PE	− 0.091
	Spouse PE	− 0.035
Relating to others → exercise	Survivor AE	0.219*
	Spouse AE	0.137
	Survivor PE	− 0.117
	Spouse PE	− 0.020
Covariates	Survivors' comorbidities → survivors' eating	− 0.144
	Survivors' comorbidities → survivors' exercise	− 0.123
	Survivors' age → survivors' eating	− 0.192*
	Survivors' age → survivors' exercise	− 0.117
PTG 2: new possibilities: $X^2 = 10.625$, df = 9, CFI = 0.993, RMSEA = 0.045		
New possibilities → eating	Survivor AE	0.344***
	Spouse AE	0.115
	Survivor PE	− 0.046
	Spouse PE	0.199+
New possibilities → exercise	Survivor AE	0.326**
	Spouse AE	0.182+
	Survivor PE	− 0.134
	Spouse PE	0.066
Covariates	Survivors' comorbidities → survivors' eating	− 0.159+
	Survivors' comorbidities → survivors' exercise	− 0.124
	Survivors' age → survivors' eating	− 0.119
	Survivors' age → survivors' exercise	− 0.010
PTG 3: personal strengths: $X^2 = 19.573$, df = 9, CFI = 0.948, RMSEA = 0.114		
Personal strengths → eating	Survivor AE	0.201*
	Spouse AE	0.047
	Survivor PE	− 0.160
	Spouse PE	0.000
Personal strengths → exercise	Survivor AE	0.129
	Spouse AE	0.097
	Survivor PE	− 0.154
	Spouse PE	− 0.017
Covariates	Survivors' comorbidities → survivors' eating	− 0.120
	Survivors' comorbidities → survivors' exercise	− 0.102
	Survivors' age → survivors' eating	− 0.192
	Survivors' age → survivors' exercise	− 0.076
PTG 4: spiritual change: $X^2 = 10.530$, df = 9, CFI = 0.993, RMSEA = 0.043		
Spiritual change → eating	Survivor AE	0.394***
	Spouse AE	0.069
	Survivor PE	− 0.227*
	Spouse PE	0.036
Spiritual change → exercise	Survivor AE	0.345**
	Spouse AE	0.165
	Survivor PE	− 0.261*
	Spouse PE	− 0.007
Covariates	Survivors' comorbidities → survivors' eating	− 0.171+

Table 3 (continued)

Paths		Standardized beta coefficients
	Survivors' comorbidities → survivors' exercise	− 0.140
	Survivors' age → survivors' eating	−0.183^{+}
	Survivors' age → survivors' exercise	−0.067
PTG 5: appreciation of life: $X^2 = 10.847$, df = 9, CFI = 0.992, RMSEA = 0.048		
Appreciation of life → eating	Survivor AE	0.317**
	Spouse AE	0.041
	Survivor PE	− 0.165^{+}
	Spouse PE	0.219*
Appreciation of life → exercise	Survivor AE	0.274*
	Spouse AE	0.131
	Survivor PE	− 0.184^{+}
	Spouse PE	0.115
Covariates	Survivors' comorbidities → survivors' eating	− 0.189*
	Survivors' comorbidities → survivors' exercise	− 0.161
	Survivors' age → survivors' eating	− 0.114
	Survivors' age → survivors' exercise	− 0.005

AE actor effect, *PE* partner effect, *MHRQOL* mental health-related quality of life

$^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

relationships between "relating to others" and "new possibilities" PTG domains and social support.

Second, consistent with previous studies [20, 21], this study demonstrated actor effects of most PTG domains on health behaviors in cancer survivors, which indicates that PTG may lead to health behaviors during the adjustment to cancer. This finding suggests that the ability to effectively and positively cope with traumatic events affects promoting healthy behaviors of cancer survivors. This explanation may aid in the understanding of why some individuals are engaged in healthy behaviors regardless of their exposure to similar adversity.

Meanwhile, this study did not find an actor effect of PTG on health behaviors in spouses. These findings indicate that it is not always the case that PTG will promote healthy behaviors for spouses. Rather, these findings imply that cancer survivors' spouses may not be directly aware of the importance of health behaviors or the risk of the cancer. Indeed, spouses may be more concerned about a healthy lifestyle of cancer survivors rather than their own health. However, spouses often experience greater burden, strain, or distress compared to other family caregivers, which may increase their risk of adverse health outcomes [35]. Given that family interconnectedness can have synergistic effects on motivating a healthier lifestyle together, this suggests that the enhancement of dyadic relationships could result in the promotion of health behaviors in survivor-spouse dyads.

Third, findings demonstrated that the spiritual change model produced the best fit of all other models, suggesting that spirituality may be associated with health behaviors at the dyadic level. Indeed, a survivor's positive spiritual change was associated with their own healthy eating and more exercise. This result implies that a cancer survivor's positive spiritual change after a cancer diagnosis may be a key to creating healthy habits.

Nevertheless, survivors' spouses tell a different story, indicating that the spouses' development of a stronger religious faith did not make the survivor engage in healthy behaviors. Generally, if a person is sick, he/she is likely to be dependent on his/her spouse and tends to be withdrawn and passive [36]. Given that family is an important support system whereby members provide motivation and companionship, a spouse specifically can be an important motivator in promoting healthy behaviors. However, conversely, if a cancer survivor's spouse develops a stronger religious faith, the spouse may go to church to pray as a passive coping strategy. Previous studies have reported that passive coping strategies such as religious coping are negatively associated with promoting health behaviors [37, 38]. Rabinowitz and colleagues [39] also found a negative relationship between religiosity and exercise, explaining that religiosity and exercise may serve as competing coping mechanisms. That is, spouses who rely heavily on religious coping to handle stressful situations may feel a diminished need for utilizing health behaviors, if they derive stress-reducing benefits from religion. Although this explanation was not addressed at the dyadic level, it may justify why the spouse's development of a stronger religious faith is negatively correlated with their health behaviors, which in turn is

associated with the survivor's health behaviors based on coping mechanisms. The effect of the previous religion aptitude of both survivors and spouses also needs to be considered to further examine the influences of religious faiths on health behaviors.

Finally, in terms of the "appreciation of life" PTG model, survivors' changed philosophies of life were positively associated with their spouses' healthier eating. The fact that only the "appreciation of life" model showed a spouse partner effect indicates that the five domains of PTG may have different influences on outcomes at the dyadic level. Future studies will be required to further investigate the uniqueness of PTG by domain at the dyadic level.

Meanwhile, an investigation regarding spouse partner effects of "appreciation of life" on health behavior implies that active dyadic relationships between survivors and spouses may emerge when the survivors approach life with a sense of gratitude. Indeed, a sense of appreciation of life may be similar with a positive attitude toward life. Survivors who express their appreciation of life are likely to be positive, actively communicate with their spouses, and manage their health status. Additionally, survivors may encourage their spouses to be engaged in healthy behaviors with himself/herself. Such findings suggest the importance of a survivor's attitudes toward life, as well as their influence on their spouse's engagement in health behaviors.

Several limitations should be noted. First, these results may not reflect the objective level because our data were collected through a self-report. Second, these findings may not be generalizable to all cancer survivors and their spouses because the response rates were low and the sample size was small. A larger and representative sample of cancer survivors and their spouses is required. Third, this study simply measured exercise and diet, although they are multidimensional concepts which should take into account of frequency, duration, and intensity/amount; it is required to consider multiple aspects of health behaviors. Fourth, the current study may have a potential self-selection bias because most participants agreed to participate in volunteer activities in this study. Fifths, the current study is based on a cross-sectional design. Given that the mean number of years since cancer diagnosis is 3.7, time may mediate the effect of PTG on the adoption of healthier behavior. Finally, levels of PTG for both survivors and spouses were relatively low compared to other studies [25, 40]. Thus, interpretations of the findings should be cautious.

Nevertheless, important information for clinical approaches is provided. Our findings suggest the importance of PTG in promoting healthy behaviors at the dyadic level. Thus, psychosocial interventions that are designed to enhance personal growths and development after a cancer diagnosis are needed to motivate healthy behaviors at the dyadic level. It will be helpful to ultimately improve HRQOL and adjustment for survivors that address the effects of cancer on their lives. Yet, it would be important to further identify how health behaviors of spouses can be improved beyond the PTG. Couple-based interventions may be also necessary to enable successful preparation for cancer survivorship care, given that both cancer survivors and their spouses can encourage healthy behaviors together. Future studies are required to further investigate how the relationship between PTG and health behaviors influences HRQOL at the dyadic level.

Funding This work was supported by Kangnam University Research Grant.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Control of the Data The authors have full control of all primary data and agree to allow the journal to review our data if requested.

References

1. Jones (2014) Survivorship care plans: where are we now? Oncology Exchange 13:14–17
2. Faul et al (2012) Survivorship care planning in colorectal cancer: feedback from survivors & providers. J Psychosoc Oncol 30:198–216
3. Institute of Medicine (2006) From cancer patient to cancer survivor: lost in transition. The National Academies Press, Washington DC
4. Stanton, Bower, Low (2006) Posttraumatic growth after cancer. In: Calhoun LG, Tedschi RG (eds) Handbook of posttraumatic growth: research & practice. Lawrence Erlbaum associates publishers, Mahwah, pp 138–175
5. Kim, Carver, Cannady (2015) Caregiving motivation predicts long-term spirituality and quality of life of the caregivers. Ann Behav Med 49:500–509
6. Kim, Given (2008) Quality of life of family caregivers of cancer survivors. Cancer 112(S11):2556–2568
7. Hagedoorn, Sanderman, Bolks, Tuinstra, Coyne (2008) Distress in couples coping with cancer: a meta-analysis and critical review of role and gender effects. Psychol Bull 134:1–30
8. Lim, Shon, Paek, Daly (2014) The dyadic effects of coping and reslience on psychological distress for cancer survivor couples. Support Care Cancer 22(12):3209–3217
9. Rajandram, Jenewein, McGrath, Zwahlen (2011) Coping processes relevant to posttraumatic growth: an evidence-based review. Support Care Cancer 19:583–589
10. Taylor (1983) Adjustment to threatening events: a theory of cognitive adaptation. Am Psychol 38:1161–1173
11. Tedeschi & Calhoun, eds. A surprise attack, a surprise result: posttraumatic growth through expert companionship. In: G.W. Burns ed. Happiness, healing, enhancement: your casebook collection for applying positive psychology in therapy. 2010, Wiley: Hoboken 226–236
12. Svetina, Nastran (2012) Family relationships and post-traumatic growth in breast cancer patients. Psychiatr Danub 24(3):298–306
13. Rinaldis, Pakenham, Lynch (2010) Relationships between quality of life and finding benefits in a diagnosis of colorectal cancer. Br J Psychol 101:259–275

14. Jansen, Hoffmeister, Chang-Claude, Brenner, Arndt (2011) Benefit finding and post-traumatic growth in long-term colorectal cancer survivors: prevalence, determinants, and associations with quality of life. Br J Cancer 105:1158–1165
15. Thornton (2002) Perceiving benefits in the cancer experience. J Clin Psychol Med Settings 9:153–165
16. Zwahlen, Hagenbuch, Carley, Jenewein, Buchi (2010) Posttraumatic growth in cancer patients and partners–effects of role, gender and the dyad on couples' posttraumatic growth experience. Psychooncology 19(1):12–20
17. Silva, Crespo, Canavarro (2012) Pathways for psychological adjustment in breast cancer: a longitudinal study on coping strategies and posttraumatic growth. Psychol Health 27(11):1323–1341
18. Deci, Ryan (2000) The 'what' and 'why' of goal pursuits: human needs and the self-determination of behavior. Psychol Inq 11(4): 227–268
19. Shakespeare-Finch, Barrington (2012) Behavioural changes add validity to the construct of posttraumatic growth. J Trauma Stress 25(4):433–439
20. Morris, Shakespeare-Finch, Scott (2012) Posttraumatic growth after cancer: the importance of health-related benefits and newfound compassion for others. Support Care Cancer 20(4):749–756
21. Hefferon, Grealy, Mutrie (2009) Post-traumatic growth and life threatening physical illness: a systematic review of the qualitative literature. Br J Health Psychol 14(Pt 2):343–378
22. Ryan (2009) Integrated theory of health behavior change: background and intervention development. Clin Nurse Spec 23(3): 161–172
23. Tedeschi, Calhoun (1996) The Posttraumatic Growth Inventory: measuring the positive legacy of trauma. J Trauma Stress 9:455–471
24. Kenny, Kashy, Cook (2006) Dyadic data analysis. Guilford Press, New York
25. Cann et al (2010) A short form of the posttraumatic growth inventory. Anxiety Stress Coping 23(2):127–137
26. Tambling, Johnson, Johnson (2011) Analyzing dyadic data from small samples: a pooled regression actor-partner interdependence model approach. CORE 2(2):101–114
27. Ledermann, Macho, Kenny (2011) Assessing mediation in dyadic data using the actor-partner interdependence model. Struct Equ Model 18:595–612
28. Enders, Bandalos (2001) The relative performance of full information maximum likelihood estimation for missing data in structural equation models. Struct Equ Model 8(3):430–457
29. Sarfati, Koczwara, Jackson (2016) The impact of comorbidity on cancer and its treatment. CA Cancer J Clin 66(4):337–350
30. Manne et al (2014) Unsupportive partner behaviors, social-cognitive processing, and psychological outcomes in couples coping with early stage breast cancer. J Fam Psychol 28(2):214–224
31. Steiger (1990) Structural model evaluation and modification: an interval estimation approach. Multivar Behav Res 25:173–180
32. Bentler (1990) Comparative fix indexes in structural models. Psychol Bull 107(2):238–246
33. Ramos, Leal (2013) Posttraumatic growth in the aftermath of trauma: a literature review about related factors and application contexts. PCH 2(1):43–54
34. Prati, Pietrantoni (2009) Optimism, social support, and coping strategies as factors contributing to posttraumatic growth: a meta-analysis. J Loss Trauma 14(5):5364–5388
35. Litzelman, Green, Yabroff (2016) Cancer and quality of life in spousal dyads: spillover in couples with and without cancer-related health problems. Support Care Cancer 24(2):763–771
36. Girgis, Lambert, Johnson, Waller, Currow (2013) Physical, psychosocial, relationship, and economic burden of caring for people with cancer: a review. J Oncol Pract 9(4):197–202
37. Maleknia, Kahrazei (2015) The relationship between stress coping styles and quality of life among patient with breast cancer. JMRH 3(4):472–478
38. Krause (2005) God-mediated control and psychological well-being in late life. Psychol Aging 13:553–562
39. Rabinowitz, Mausbach, Atkinson, Gallagher-Thompson (2009) The relationship between religiosity and health behaviors in female caregivers of older adults with dementia. Aging Ment Health 13(6): 788–798
40. Cadell, Suarez, Hemsworth (2015) Reliability and validity of a french version of the posttraumatic growth inventory. OJMP 4: 53–65