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ORIGINAL ARTICLE

# Trajectories of Posttraumatic Growth and Associated Characteristics in Women with Breast Cancer

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**Abstract**
***Background*** Cancer survivors may experience posttraumatic growth (PTG), positive psychological changes resulting from highly stressful events; however, the longitudinal course of PTG is poorly understood.
***Purpose*** The purpose of the present study was to determine trajectories of PTG in breast cancer survivors and associated characteristics.
***Methods*** Women ($N$=653) participating in a longitudinal observational study completed questionnaires within 8 months of breast cancer diagnosis and 6, 12, and 18 months later. Group-based modeling identified PTG trajectories. Chi-square tests and ANOVA detected group differences in demographic, medical, and psychosocial variables.
***Results*** Six trajectory groups emerged. Three were stable at different levels of PTG, two increased modestly, and one increased substantially over time. Trajectory groups differed by age, race, receipt of chemotherapy, illness intrusiveness, depressive symptoms, active-adaptive coping, and social support.
***Conclusions*** This first examination of PTG trajectories in US cancer survivors elucidates heterogeneity in longitudinal patterns of PTG. Future research should determine whether other samples exhibit similar trajectories and whether various PTG trajectories predict mental and physical health outcomes.

**Keywords** Posttraumatic growth · Breast cancer · Longitudinal · Trajectory

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## Introduction

Posttraumatic growth (PTG) is defined as "positive psychological change experienced as a result of the struggle with highly challenging life circumstances." [1, 2] Such circumstances typically involve trauma or major losses that "represent significant challenges to the adaptive resources of the individual, and . . . to individuals' ways of understanding the world and their place in it." [2] The most frequently used measure of PTG, the Posttraumatic Growth Inventory (PTGI), measures positive changes across five domains: relating to others, new possibilities, appreciation of life, personal strength, and spiritual change [3]. It has been used in research focused on cancer patients and post-treatment survivors [4, 5].

Research confirms that cancer creates a "significant adaptive challenge" for most people, particularly after diagnosis and at the end of treatment [4]. Women with breast cancer can have difficulty adjusting to the fact that they have cancer [6]. Further, at the end of treatment, they are often concerned with the ever-present possibility of cancer recurrence [7–9].

Nonetheless, longitudinal studies of women with breast cancer have shown that most women maintain good psychological adjustment during the course of their treatment [10–12].

Among the few longitudinal studies of PTG after breast cancer, most have reported stable mean levels of PTG [13–16]. Of note, each of these studies followed women for only 3–6 months, whereas longer-term research has identified increasing PTG after breast cancer. The earliest such longitudinal analysis reported steadily rising levels of PTG during the 1.5–2 years following breast cancer diagnosis [17]. Data from the sample in this report were previously analyzed [5] using random effects models to assess average changes in PTG over time; those results showed that mean PTGI scores increased during the first 18 months after diagnosis and leveled off thereafter [5].

Each of these longitudinal studies of women with breast cancer described average changes in PTG over time, but none has assessed whether there are subgroups of women who exhibit common patterns of change (e.g., start low and remain stable, start low and increase rapidly). Group-based trajectory analysis can be used to identify subsets of women who exhibit similar longitudinal patterns in PTG, providing a more nuanced view than is available from typical analyses. The first study of PTG trajectories was conducted in a sample of persons living with HIV [18]. In that study, PTG was measured at only two time points (mean time between measurements was 1.6 years), and groups were identified in which PTG was stable (consistently either high or low), increasing, or decreasing. Those who were consistently high and those who increased in PTG had significantly lower depressive symptoms at follow-up than those who were consistently low or decreased in PTG [18]. This study did not examine how individual baseline characteristics were associated with membership in various PTG trajectories.

Since then, only one study has examined PTG trajectories using more than two timepoints in a sample of cancer survivors [19]. Taiwanese women with breast cancer completed measures at four time points over the first year after surgery. This study identified four trajectories of PTG: high stable, high decreasing, low increasing, and low decreasing. The last group showed the sharpest change in PTG, with levels declining to near zero. The four groups did not differ on medical variables or marital status, but the two groups with high PTG were younger and more educated. Depression at time 4 was highest in the low increasing and high decreasing groups, which also had the most similar PTG levels at time 4. Anxiety at time 4 was highest in the low increasing group, while the final measures of positive affect were highest in the groups with high stable and high decreasing PTG.

Better understanding of the temporal course of PTG during and after the cancer experience thus remains a research priority [4, 20]. From the present literature, we are unable to tell whether/how PTG is maintained or changes over time [1, 21]. This work is critical for considering optimal timing and potential target groups for possible interventions.

In short-term studies, PTG was positively associated with worry about breast cancer [13], social support [13–15], and cognitive or problem-focused (planning and active) coping [14, 15]. Similarly, predictors of higher PTG in a prior analysis of data from the current sample included higher baseline level of illness intrusiveness and greater increases in social support and active-adaptive coping, along with higher levels of education and greater increases in mental health and spirituality [5]. Higher PTG among breast cancer survivors has also been associated with younger age at diagnosis, more emotional expressiveness, and more time spent considering reasons for developing cancer [17].

To better understand PTG patterns following a cancer diagnosis, the goals of this analysis were to (1) determine whether there are identifiable patterns (trajectories) of PTG up to 24 months post-breast cancer diagnosis and (2) identify demographic, medical, and psychosocial factors associated with PTG trajectories. We hypothesized that (1) there would be varying patterns (trajectories) of PTG with some stable, increasing, and decreasing, and that (2) greater illness intrusiveness, social support, and active-adaptive coping and younger age would be associated with higher stable and increasing PTG trajectories (based on the literature [13–15, 17] and our prior work [5]). There has been little work that has examined variables associated with trajectories of PTG making it difficult to specify further the expected relationships of baseline variables with PTGI score over time.

## Method

### Sample

Data for these analyses were derived from a larger study designed to examine age differences in adjustment to breast cancer [22, 23].Women were eligible for this observational, longitudinal study if they were aged ≥18 years, had received their first diagnosis of stage I–III breast cancer within 8 months of completing the baseline survey, and were able to read and understand English. A total of 658 women were recruited from 740 mailed surveys (initial response rate 89 %). After determining 5 respondents to be ineligible, the final sample was comprised of 653 women. Retention and data capture were excellent; while no incentive was offered, recruiters maintained excellent rapport with participants and mailed an annual newsletter and birthday card to all participants to preserve their interest in and commitment to the study. All women provided PTGI data at baseline, 94 % at 6 months, 91 % at 12 months, and 86 % at 18 months; 544 (83 %) provided complete PTGI data at all four time points. Overall, 93 % of the possible PTGI was obtained.

Sample characteristics and baseline values for psychosocial variables are shown in Table 1. Women ranged in age from 25 to 96 years with a median of 54 years. Most were non-

Hispanic White (90 %) and married (72 %) and had at least a college education (63 %). Slightly more than half the women had stage I disease, while 40 % had stage II disease. For the medical variables reported in Table 1, cancer stage, receipt of chemotherapy, receipt of radiation therapy, and surgeries were similar between women who remained in the study and those who dropped out.

## Procedure

Women were recruited from Memorial Sloan-Kettering Cancer Center and the University of Texas Southwestern Center for Breast Care through hospital clinics and advertisements, with recruitment occurring between December 2002 and February 2006. Institutional Review Boards at each of the participating institutions approved this study. After being screened for eligibility by chart review or telephone, women provided informed consent. At baseline (within 8 months of diagnosis) and 6, 12, and 18 months after baseline, participants received questionnaires via mail and returned them to the Coordinating Center at the Wake Forest School of Medicine. Other than demographic and medical variables, all measures were obtained at all four time points.

**Table 1** Baseline characteristics of the study sample ($N$=653)

| | *n* (%) | | *M* (*SD*) |
|---|---|---|---|
| Demographic variables | | | |
| Age, median (range) | | | 54 (25–96) |
| Race (White) | 585 | (90) | |
| Marital status (married/partnered) | 468 | (72) | |
| Education | | | |
| ≤High school | 82 | (13) | |
| Some college | 162 | (25) | |
| College degree | 149 | (23) | |
| Post-graduate | 260 | (40) | |
| Ability to pay for basics | | | |
| Very/somewhat hard | 121 | (19) | |
| Not hard | 532 | (81) | |
| Medical variables | | | |
| Months since diagnosis at study entry, median (range) | | | 4.7 (0.1–7.3) |
| Cancer stage | | | |
| I | 338 | (52) | |
| II | 262 | (40) | |
| III | 53 | (8) | |
| Surgery | | | |
| Lumpectomy only | 416 | (64) | |
| Mastectomy/no reconstruction | 106 | (16) | |
| Mastectomy/reconstruction | 131 | (20) | |
| Radiation therapy (yes) | 472 | (72) | |
| Chemotherapy (yes) | 436 | (67) | |
| Psychosocial variables | | | |
| Active-adaptive coping factor | | | 2.6 (0.6) |
| Passive coping factor | | | 1.3 (0.4) |
| Illness intrusiveness | | | 34.6 (16.9) |
| Depressive symptoms | | | 8.5 (6.8) |
| Social support | | | 4.3 (0.7) |

## Measures

*Posttraumatic growth* The Posttraumatic Growth Inventory (PTGI) [3] is a 21-item scale that measures the degree of reported positive changes experienced in the struggle with major life crises. Possible total scores range from 0 to 105, with higher scores indicating more PTG. The mean (standard deviation) and median for each of the time points are as follows: baseline ($n$=653) 54.0 (23.2), 56.0; 6-month follow-up ($n$=613) 56.7 (23.1), 58.0; 12-month follow-up ($n$=593) 57.1 (22.9), 59.0; and 18-month follow-up ($n$=564) 58.4 (22.8), 60.0. Cronbach's alpha was consistently high, .94 at each of the four visits.

The following variables were included in the analysis as factors potentially related to trajectory group membership.

*Demographic variables* Demographic information obtained at baseline included age (continuous), race (White, non-White), marital status (married/partnered, other), educational level (≤high school, some college, college degree, post-graduate), and ability to pay for basics (very/somewhat hard, not hard).

*Medical variables* A comprehensive medical chart review was performed upon completion of primary treatment. Data included date of breast cancer diagnosis, cancer stage (I, II, III), type of surgery (lumpectomy only, mastectomy without reconstruction, and mastectomy with reconstruction), radiation therapy (yes/no), and chemotherapy (yes/no).

*Depressive symptoms* The Beck Depression Inventory (BDI) version IA [24], a 21-item scale, was used to assess depressive symptoms [25]. Item scores were summed to provide the total BDI score, which ranges from 0 to 63; higher scores indicate more depressive symptoms. The BDI has been used with a variety of clinical and non-clinical populations and has been validated as a reliable screening tool for depressive symptoms, with a score of 10 and above considered indicative of depression warranting clinical attention [25]. Internal consistency for the BDI tends to be high ($\alpha$=.89) [24]. In this sample, Cronbach's alpha was .87 for the baseline measurement.

*Coping* Coping was assessed with the 28-item Brief COPE scale [26], which measures 14 conceptually differentiable coping reactions and is based on the longer COPE inventory [27]. Participants rated the extent to which they used each response when trying to deal with cancer-related stresses.

Cronbach's alpha for individual scales ranged from .50 to .90 in the original validation sample [26]. As previously reported [5, 22, 23], a second-order factor analysis was conducted on the current data, according to recommendations from the author of the Brief COPE scale [26]. This factor analysis revealed two domains. The first coping factor, active-adaptive coping, was calculated as the mean of eight subscales: self-distraction, active coping, emotional support, instrumental support, venting, positive reframing, planning, and turning to religion. Cronbach's alpha was .79 at baseline. The second coping factor, passive coping, was calculated as the mean of three subscales: self-blame, denial, and behavioral disengagement. Cronbach's alpha was .51 at baseline.

*Illness intrusiveness* The Illness Intrusiveness Rating Scale [28–30] measured the extent to which participants perceived that breast cancer diagnosis and treatment affected 13 life domains: health, diet, work, active recreation, passive recreation, financial situation, relationship with spouse, sex life, family relations, other social relations, self-expression, religious expression, community and civic involvement. Respondents rate the impact of cancer on each domain from 1 (not very much) to 7 (very much). Total scores can range from 13 to 91, with internal consistency typically greater than .80 [31]. In this study, Cronbach's alpha was .90 at baseline.

*Social support* The RAND Social Support Scale measured respondents' evaluation of the functions and resources provided by their social network [32]. It measures four aspects of support: emotional, tangible, affection, and social interaction [33]. An overall support score is the mean of the 19 items and ranges from 1 to 5, with higher scores indicating greater support. Cronbach's alpha was .91 for the total score in the validation sample [32]. Cronbach's alpha in this sample at baseline was .96 for the overall support score; for the subscales, internal consistency at baseline was .95 (emotional), .87 (tangible), .88 (affection), and .94 (social interaction).

### Plan of analysis

The group-based trajectory model SAS procedure TRAJ [34] was used to identify distinct subgroups of women who followed similar PTGI total score trajectories over time. We modeled PTGI using a censored normal distribution [35]. Trajectories were initially modeled as a quadratic function of time since diagnosis, which served as a more clinically meaningful metric than time since the baseline survey, which varied from 1 to 8 months post-diagnosis. When the quadratic term was non-significant for a trajectory, it was removed, and that trajectory was remodeled as a linear function of time. The linear term was retained even if it was non-significant.

The Bayesian Information Criterion (BIC) and group size were used simultaneously to select the final number of trajectory groups. A higher BIC indicates a better model fit, and the BIC tends to increase as the number of trajectories increase. However, as the BIC includes a penalty for the number of model parameters, over-fitting can result in a decrease in the BIC. A change in the BIC (from a model with $n$ trajectories to one with $n+1$ trajectories) of three or more is considered strong evidence that the more complicated model provides a better fit [36]. Accordingly, in considering models with varying numbers of trajectories, we selected the model with the largest number of trajectories if the BIC was at least 3 units greater than the BIC of the next largest model. Further, we required the membership probability (approximately the proportion of the sample) to be ≥5 % for all but one (at most) of the trajectory groups. It has been suggested that each trajectory should have membership probabilities of 5 % or higher, but because small groups could also be interesting, we allowed the smaller probability [37].

The TRAJ procedure computes posterior probabilities of group membership for all individuals. These probabilities measure each individual's likelihood of belonging to each of the trajectory groups. Individuals were assigned to the trajectory group for which they had the maximum posterior probability. The TRAJ procedure includes all observations with data at any time point under the assumption that the missing data are missing completely at random [38].

Chi-square tests and analysis of variance were used to determine which baseline characteristics were associated with trajectory membership. Predictor variables used in these analyses included demographic (age, race, marital status, education, ability to pay for basics), medical (time since diagnosis, cancer stage, type of surgery, receipt of radiation therapy, receipt of chemotherapy), and psychosocial (active-adaptive coping, passive coping, illness intrusiveness, depressive symptoms, social support) variables. SAS version 9.2 was used for all analyses.

## Results

### Trajectories for PTGI total score

Six PTGI trajectory groups emerged to characterize the patterns that women followed over the first 24 months following diagnosis. The six-trajectory solution was chosen as the best fit because, after six groups, the BIC increased by less than 3 points (see Table 2). The overall mean posterior membership probability was .80, while the mean probabilities for membership in the individual trajectories were .86, .83, .74, .77, .80, and .83 in trajectories 1–6, respectively. Nearly all (98 %) posterior probabilities pertaining to final group assignment were>.50. Sixty-four percent of the sample had posterior probabilities of ≥.75 for membership in the assigned trajectory group; the lowest posterior probabilities pertained to groups 3 and 4, where 54 and 43 % of the women in each group,

respectively, had posterior probabilities <.75 for their group assignment.

Plots of the six trajectories are shown in Fig. 1. The intercepts and linear terms (i.e., slopes) are shown in Table 3. Three of the six trajectories (1, 4, and 6), containing almost half the women, are relatively stable, with non-significant changes over time. Trajectories 2 and 5 had significant, but modest, changes over time. Thus, throughout the first 2 years post-diagnosis, PTG remained relatively low in trajectories 1 and 2, moderate in trajectories 4 and 5, and high in trajectory 6. Conversely, PTG in trajectory 3 changed dramatically over time. In this group, PTG was initially low, rose sharply over the first 12–16 months post-diagnosis, and then plateaued at a relatively moderate level. Across all trajectory groups, the weighted average increase in PTGI was approximately 5.8 units over 2 years.

### Characteristics related to PTGI trajectories

Associations between participant characteristics and membership in the six PTGI trajectory groups are summarized in Table 4. Age ($p$=.0001), race ($p$=.009), chemotherapy status (ever/never; $p$=0.005), use of active-adaptive coping strategies ($p$<.0001), illness intrusiveness ($p$<.0001), depressive symptoms ($p$=0.03), and social support ($p$<.0001) all differed significantly among the groups; ability to pay for basics (very/somewhat hard vs. not hard) did not quite reach statistical significance ($p$=0.053). Marital status, education, cancer stage, and use of passive coping strategies were not significantly associated with differences among trajectory groups.

As shown in Table 4, trajectories 3–6 had a higher proportion of women who were non-White, relatively young, and treated with chemotherapy; they also reported relatively higher baseline levels of illness intrusiveness, depressive symptoms, and active-adaptive coping than women in the other trajectory groups. Differences were most pronounced between trajectory 1 (very low) and trajectories 4–6 (moderately high). Compared to participants reporting relatively high levels of PTG, participants in trajectory 1 (very low) were more likely to be older and White and less likely to have received chemotherapy. In addition, they reported less use of active-adaptive coping strategies, lower illness intrusiveness, and fewer depressive symptoms. Participants with the lowest (trajectory 1) and highest (trajectories 5 and 6) levels of PTG also reported the highest levels of social support.

Participants in trajectory 3, the only group with a significant quadratic term and a steep increase in PTG, reported moderate levels of most predictors; however, these women reported the second-highest depressive symptom scores at baseline and included the second-largest proportion (15 %) of non-White individuals. Pairwise comparisons additionally identified characteristics that distinguished women in this trajectory from women in trajectories 1 and 2 whose PTG remained low. Women who showed a dramatic increase in PTG over time reported greater use of active-adaptive coping ($p$<.01) at baseline than women in both trajectories 1 and 2 and more depressive symptoms and illness intrusiveness (all $p$≤.01) at baseline than women in trajectory 1.

**Table 2** Bayesian Information Criterion (BIC) values and group membership probabilities for determining number of trajectories for PTGI total score ($N$=653)

| Number of trajectories | BIC | Estimated probabilities (estimated % in each group) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | −10944.49 | 100 | | | | | | |
| 2 | −10422.45 | 44 | 56 | | | | | |
| 3 | −10252.44 | 21 | 41 | 38 | | | | |
| 4 | −10220.99 | 14 | 26 | 32 | 28 | | | |
| 5 | −10214.43 | 5 | 19 | 31 | 28 | 17 | | |
| **6** | **−10204.07** | **5** | **19** | **6** | **26** | **28** | **17** | |
| 7 | −10202.31 | 3 | 5 | 14 | 18 | 24 | 27 | 9 |

Bold text indicates the number of groups selected for the current analyses

## Discussion

Individual differences in the longitudinal course of PTG have received scant research attention [1, 18, 19, 21]. This study identified trajectories of PTG during and after cancer treatment in a large longitudinal dataset of women with breast cancer. The best fitting model yielded six trajectories. In three of those groups (one low, one moderate, and one high), PTGI total scores did not change significantly over time, suggesting that for approximately half of the women, PTG was stable over the 2 years post-diagnosis. Two additional trajectories (one low and one moderate) increased significantly, though modestly (approximately 5 units over the 2 years). Only trajectory 3 demonstrated a sizeable increase in PTG. Women in this group started out with low levels of PTG, increased to moderate levels over the first 16 months following diagnosis, and then leveled off. These findings partially supported our hypothesis that there would be varying patterns of PTG with some stable, some increasing, and some decreasing. We observed no decreasing PTG trajectories.

The null to modest increases in PTG seen for most of this sample are consistent with several other longitudinal studies, each of which followed women for approximately 6 months to 1 year after breast cancer diagnosis [13–16, 19]. However, these results contradict previous findings from longer-term research, in which PTG rose steadily during the 1.5–2 years following breast cancer diagnosis [17]. In our earlier analysis of this dataset using random effects models, we found an approximate 10-unit increase in PTGI over time [5]. That

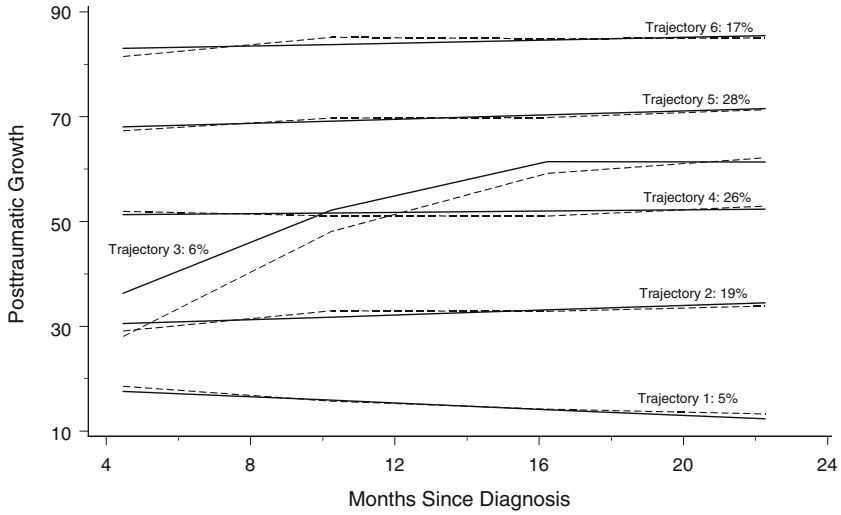


**Fig. 1** PTGI total score trajectories. Percentages shown are the probabilities of group membership. Possible PTGI scores range from 0 to 105. *Dashed lines* reflect observed values, and *solid lines* reflect predicted values

model included time-invariant and time-varying covariates, and the latter covariates were held constant when estimating PTGI changes. In a random effects model without covariates, the estimated change in PTGI overtime was 6.7 units, just slightly greater than the weighted average in the current analysis. Interestingly, this trajectory analysis shows that while, on average, PTG increases over time, such an increase is not found in all women. Half of the women showed no change at all, and the majority of those who did increase reported only a modest increase. A small number of women demonstrated an impressive increase in PTG over time. The current analyses thus provide a more nuanced understanding of how women may experience PTG following a breast cancer diagnosis.

Women who reported moderate to high levels of PTG, either consistently (trajectories 4–6) or gradually over time (trajectory 3), were more likely to be non-White, relatively young, and treated with chemotherapy. They also had relatively higher baseline levels of illness intrusiveness, depressive symptoms, and active-adaptive coping than women reporting low levels of PTG. These findings suggest that the coexistence of greater difficulty *and* effective coping may be important for promoting higher PTG, a finding that is consistent with the PTG theoretical model [39]. Thus, receiving a breast cancer diagnosis at a younger age and having to undergo chemotherapy may be especially disruptive for women, yet still allow them to engage in adaptive processes that also enable them to experience positive changes such as PTG. For most women (i.e., the 71 % in trajectories 4–6), this happened quickly, while a small group of women (trajectory 3) developed PTG only over time. Future analyses could additionally clarify the experiences of this latter unique group by examining time-varying covariates; for example, considering the specific domains of illness intrusiveness over time may be important, as the perceived challenge of breast cancer may affect different areas of women's lives and in different ways throughout the course of diagnosis, treatment, and survivorship [40].

Conversely, women with the lowest reported levels of PTG (trajectory 1) also reported the lowest levels of illness intrusiveness and depressive symptoms. Thus, the diagnosis of cancer was not as disruptive to their lives as it was for women in other trajectories, possibly due to factors such as older age, less financial strain, no chemotherapy treatment, and higher levels of social support. Moreover, they reported the lowest levels of active-adaptive coping, likely because they reported not being as challenged by their cancer experience and therefore required less coping. This is consistent with the PTG

**Table 3** Intercepts and slopes for each trajectory for PTGI total score

| Domain | Trajectory | Intercept | *SE* | Linear term | *SE* | *p* | Quadratic term | *SE* | *p* |
|---|---|---|---|---|---|---|---|---|---|
| PTGI total score | 1 | 19.24 | 3.41 | −0.343 | 0.193 | .075 | – | – | – |
| | 2 | 29.13 | 2.15 | 0.228 | 0.102 | .026 | – | – | – |
| | 3 | 9.036 | 6.05 | 5.224 | 1.030 | <.001 | -0.128 | 0.037 | .001 |
| | 4 | 50.96 | 2.59 | 0.059 | 0.103 | .567 | – | – | – |
| | 5 | 66.86 | 3.07 | 0.200 | 0.085 | .018 | – | – | – |
| | 6 | 82.31 | 2.65 | 0.146 | 0.105 | .166 | – | – | – |

Intercept is the predicted value at diagnosis (0 months)

**Table 4** Characteristics associated with PTGI trajectory membership

| Categorical variables | PTGI trajectory groups (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 (*n*=26) | 2 (*n*=127) | 3 (*n*=26) | 4 (*n*=184) | 5 (*n*=183) | 6 (*n*=107) | *p* |
| Demographic variables | | | | | | | |
| Race | | | | | | | <0.01 |
| White | 96 | 96 | 85 | 90 | 90 | 81 | |
| Other | 4 | 4 | 15 | 10 | 10 | 19 | |
| Marital status | | | | | | | 0.62 |
| Married or partnered | 65 | 72 | 77 | 70 | 75 | 68 | |
| Divorced/widowed/separated | 15 | 22 | 15 | 18 | 15 | 20 | |
| Never married | 19 | 6 | 7 | 11 | 9 | 12 | |
| Education | | | | | | | 0.08 |
| ≤High school | 15 | 13 | 8 | 12 | 11 | 15 | |
| Some college | 27 | 17 | 42 | 26 | 27 | 24 | |
| College degree | 19 | 29 | 27 | 29 | 33 | 41 | |
| Post-graduate | 38 | 41 | 23 | 33 | 29 | 20 | |
| Ability to pay for basics | | | | | | | 0.05 |
| Very/somewhat hard | 8 | 10 | 19 | 20 | 22 | 23 | |
| Medical variables | | | | | | | |
| Cancer stage | | | | | | | 0.18 |
| I | 73 | 56 | 46 | 52 | 47 | 50 | |
| II | 27 | 36 | 38 | 42 | 42 | 42 | |
| III | 0 | 8 | 15 | 5 | 11 | 7 | |
| Surgery | | | | | | | 0.10 |
| Lumpectomy only | 88 | 65 | 62 | 68 | 59 | 57 | |
| Mastectomy/no reconstruction | 4 | 18 | 23 | 15 | 17 | 16 | |
| Mastectomy/reconstruction | 8 | 17 | 15 | 17 | 24 | 27 | |
| Radiation therapy (yes) | 73 | 74 | 77 | 73 | 72 | 67 | 0.86 |
| Chemotherapy (yes) | 50 | 57 | 58 | 66 | 75 | 72 | <0.01 |

| Continuous variables | PTGI trajectory groups [*M* (*SD*)] | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | *p* |
| Demographic variables | | | | | | | |
| Age | 62.4 (11.6) | 58.2 (13.8) | 55.3 (13.8) | 55.9 (12.3) | 53.1 (12.5) | 52.8 (11.5) | 0.0001 |
| Psychosocial variables[a] | | | | | | | |
| Active-adaptive coping | 2.1 (0.7) | 2.3 (0.6) | 2.6 (0.7) | 2.5 (0.5) | 2.7 (0.5) | 2.9 (0.5) | <0.0001 |
| Passive coping | 1.2 (0.4) | 1.3 (0.4) | 1.4 (0.4) | 1.4 (0.4) | 1.3 (0.4) | 1.3 (0.4) | 0.33 |
| Illness intrusiveness | 22.7 (14.2) | 30.0 (15.9) | 34.7 (17.1) | 35.9 (17.2) | 36.2 (16.0) | 38.0 (17.2) | <0.0001 |
| Depressive symptoms | 4.5 (5.2) | 8.3 (7.6) | 9.0 (7.3) | 9.2 (7.3) | 8.5 (6.0) | 8.0 (5.8) | 0.03 |
| Social support | 4.5 (0.6) | 4.1 (0.9) | 4.3 (0.8) | 4.2 (0.7) | 4.4 (0.6) | 4.5 (0.6) | <0.0001 |

[a] Mean and standard deviation for psychosocial variables at baseline

model, which indicates that some individuals who experience a potentially stressful event will not find it disruptive to their personal goals, narrative, or worldview and thus will not engage in processes that ostensibly can lead to PTG; nonetheless, these individuals may experience other positive outcomes such as life satisfaction or well-being [39]. A growing body of evidence indicates that such positive adjustment occurs in approximately one third to one half of women with breast cancer [40–43].

Some of the women in trajectory 2, who also reported low PTG, may have had a similar experience to those in trajectory 1.

However, women in trajectory 2 reported more illness intrusiveness and depressive symptoms than women in trajectory 1, yet similarly low levels of active-adaptive coping and even lower levels of social support. It is therefore likely that women in trajectory 2 were distressed by their cancer diagnosis but did not have the psychosocial resources to manage it very well, leading to their slow development of low PTG over time.

Social support was highest among women reporting more extreme levels of PTG—either very low (trajectory 1) or high (trajectories 5 and 6). Thus, for some women, such as those reporting very little PTG, social support may provide a buffer that prevents breast cancer from being disruptive enough to catalyze PTG. Alternately, for women with higher levels of PTG, social support may serve as an effective means of coping with the stress of cancer and cultivating PTG. The former finding is relatively novel, while the positive association between PTG and social support is consistent with prior research [13–15] and the PTG theoretical model [39]. Given the small, though statistically significant, differences between trajectories' social support scores, these results should be interpreted with caution. However, potential quadratic relationships between social support and PTG may be an important direction for future studies.

There are several limitations to note. First, the sample size of trajectories 1 and 3 is quite small ($n$=26 each). Second, the sample is comprised solely of female breast cancer survivors and has limited diversity (race, education). Although the sample thus limits generalizability, the analyses still add to the understanding of PTG by providing evidence of subgroups of PTG trajectories in response to cancer, along with medical and psychosocial correlates. Nonetheless, given the lack of data beyond 24 months post-diagnosis, the longer-term trajectory of PTG remains unknown. Because cut-points for low versus high PTG and the implications of various PTGI scores have not been established, we have used the term "relatively" in describing low, moderate, and high levels of PTG. Finally, the passive coping factor demonstrated poor internal consistency in this sample. Rather than representing a unitary construct, the separate elements of the Brief COPE that comprised this factor (self-blame, denial, and behavioral disengagement) may be a better reflection of the coping processes.

These limitations notwithstanding, specific strengths of this analysis include a large sample of breast cancer survivors ($N$= 653) and longitudinal data collected from shortly after diagnosis up to 24 months post-diagnosis. Further, these results expand existing knowledge of positive psychological adaptation, specifically PTG, in female breast cancer survivors. Since the PTGI was introduced in 1996, it has been widely used to study PTG and is the most frequently used measure of positive psychological change in cancer survivors [3, 4]. Only one prior study has examined common PTG trajectories in a cancer survivor sample, and it identified only four trajectory groups [19]. In that study, none of the groups demonstrated a sharp increase in PTG over time, and two of the groups showed significant declines in PTG, one modestly and one sharply. This pattern contrasts with the current findings, in which one group demonstrated sharp increases in PTG over time, and none of the six trajectory groups exhibited a significant decrease in PTG. However, the previous trajectory analysis was conducted in Taiwanese women, and while PTG has been validated in many different groups, some aspects may be influenced by culture [39, 44]. Moreover, that study focused on adjustment instead of investigating baseline covariates such as coping and social support that may be important for the development of PTG. The results presented in this manuscript therefore provide a significant initial step to better understand how PTG may develop over time in breast cancer survivors. Important future directions will include replication of PTG trajectory analyses in other samples and determining whether various trajectories demonstrate any differential relationships with mental and physical health outcomes.

Although this study did not expose the women in this sample to specific interventions to facilitate PTG, we do not know what resources might have been present in their social networks that could have contributed to PTG development. Some survivors may achieve PTG without any formal intervention. These data suggest that survivors who were not particularly challenged by their cancer and were resilient to challenges of the cancer experience, or were unable to adapt successfully at all, reported less PTG, whereas those who found the experience of cancer particularly intrusive and distressing *and* reported use of more active coping strategies achieved higher levels of PTG. Relatively few women appear to change their level of PTG over time, with most reporting quite stable levels of PTG across the range of the scale. The relative consistency shown for women with moderate to high levels of PTG might indicate that, for many women, PTG is not a transitory coping mechanism but a more persistent change in life perspective. Based on these data, some survivors may benefit from interventions to enhance PTG, while those who are resilient or finding PTG on their own may not. As knowledge of PTG predictors and outcomes expands, interventions may be developed to facilitate these processes in cancer survivors who find the experience of cancer particularly challenging and do not spontaneously report such positive outcomes. However, such work should be undertaken with caution so as not to imply that all survivors should or will experience PTG following a cancer diagnosis.

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## References


1. Calhoun LG, Tedeschi RG. Posttraumatic growth: The positive lessons of loss. In: Neimeyer RA, ed. *Meaning reconstruction & the experience of loss*. Illustratedth ed. Washington, DC, US: American Psychological Assoication; 2001: 157-172.
2. Tedeschi RG, Calhoun LG. Posttraumatic growth: conceptual foundations and empirical evidence. *Psychol Inq*. 2004; 15(1): 1-18. doi: 10.1207/s15327965pli1501_01.
3. Tedeschi RG, Calhoun LG. The posttraumatic growth inventory: measuring the positive legacy of trauma. *J Trauma Stress*. 1996; 9(3): 455-72.
4. Stanton AL, Bower JE, Low CA. Posttraumatic growth after cancer. In: Calhoun LG, Tedeschi RG, eds. *Handbook of posttraumatic growth: Research and practice*. Mahway, NJ: Lawrence Erlbaum Associates; 2006: 138-175.
5. Danhauer SC, Case LD, Tedeschi R, Russell G, Vishnvesky T, Triplett K. Predictors of posttaumatic growth in women with breast cancer. *Psycho-Oncol*. 2013; 22(12): 2673-83. doi:10.1002/pon.3298.
6. O'Connor M, Christensen S, Jensen AB, Moller S, Zachariae R. How traumatic is breast cancer? Post-traumatic stress symptoms (PTSS) and risk factors for severe PTSS at 3 and 15 months after surgery in a nationwide cohort of Danish women treated for primary breast cancer. *Brit J Cancer*. 2011; 104(3): 419-26. doi:10.1038/sj.bjc.6606073.
7. Costanzo ES, Lutgendorf SK, Mattes ML, et al. Adjusting to life after treatment: distress and quality of life following treatment for breast cancer. *Brit J Cancer*. 2007; 97(12): 1625-31. doi:10.1038/sj.bjc.6604091.
8. Hanson FM, Suman VJ, Rummans TA, et al. Physical, psychological and social well-being of women with breast cancer: the influence of disease phase. *Psycho-Oncol*. 2000; 9(3): 221-31. doi:10.1037/a0028523.
9. Montazeri A, Vahdaninia M, Harirchi I, Ebrahimi M, Khaleghi F, Jarvandi S. Quality of life in patients with breast cancer before and after diagnosis: an eighteen months follow-up study. *BMC Cancer*. 2008; 8: 330. doi:10.1186/1471-2407-8-330.
10. Danhauer SC, Crawford SL, Farmer DF, Avis NE. A longitudinal investigation of coping strategies and quality of life among younger women with breast cancer. *J Behav Med*. 2009; 32(4): 371-9. doi:10.1007/s10865-009-9211-x.
11. Knobf MT. Psychosocial responses in breast cancer survivors. *Semin Oncol Nurs*. 2007; 23(1): 71-83. doi:10.1016/j.soncn.2006.11.009.
12. Rowland JH, Baker F. Introduction: resilience of cancer survivors across the lifespan. *Cancer*. 2005; 104(11 Suppl): 2543-8. doi:10.1002/cncr.21487.
13. McDonough MH, Sabiston CM, Wrosch C. Predicting changes in posttraumatic growth and subjective well-being among breast cancer survivors: the role of social support and stress. *Psycho-Oncol*. 2013; 23(1): 114-20. doi:10.1002/pon.3380.
14. Silva S, Crespo C, Canavarro MC. Pathways for psychological adjustment in breast cancer: a longitudinal study on coping strategies and posttraumatic growth. *Psychol Health*. 2012; 27(11): 1323-41. doi:10.1080/08870446.2012.676644.
15. Scrignaro M, Barni S, Magrin ME. The combined contribution of social support and coping strategies in predicting post-traumatic growth: a longitudinal study on cancer patients. *Psycho-Oncol*. 2011; 20(8): 823-31. doi:10.1002/pon.1782.
16. Tanyi Z, Szluha K, Nemes L, Kovács S, Bugán A. Health-related quality of life, fatigue, and posttraumatic growth of cancer patients undergoing radiation therapy: a longitudinal study. *Appl Res Qual Life*. 2013; 8(31): 1-14. doi:10.1007/s11482-013-9261-7.
17. Manne S, Ostroff J, Winkel G, Fox K, Grana G, Goldstein L. Posttraumatic growth after breast cancer: patient, partner, and couple perspectives. *Psychosom Med*. 2004; 66(3): 442-54. doi:10.1097/?01.psy.0000127689.38525.7d.
18. Milam JE. Posttraumatic growth among HIV/AIDS patients. *J Appl Soc Psychol*. 2004; 34(11): 2353-76. doi:10.1111/j.1559-1816.2004.tb01981.x.
19. Wang AW, Chang CS, Chen ST, Chen DR, Hsu WY. Identification of posttraumatic growth trajectories in the first year after breast cancer surgery. *Psychooncology*. 2014. doi:10.1002/pon.3577.
20. Linley PA, Joseph S. Positive change following trauma and adversity: a review. *J Trauma Stress*. 2004; 17(1): 11-21. doi:10.1023/B:JOTS.0000014671.27856.7e.
21. Aspinwall LG, MacNamara A. Taking positive changes seriously. *Cancer*. 2005; 104(11 Suppl): 2549-56. doi:10.1002/cncr.21244.
22. Avis NE, Levine B, Naughton MJ, Case LD, Naftalis E, Van Zee KJ. Age-related longitudinal changes in depressive symptoms following breast cancer diagnosis and treatment. *Breast Cancer Res Tr*. 2013; 139(1): 199-206. doi:10.1007/s10549-013-2513-2.
23. Avis NE, Levine B, Naughton MJ, Case DL, Naftalis E, Van Zee KJ. Explaining age-related differences in depression following breast cancer diagnosis and treatment. *Breast Cancer Res Tr*. 2012; 136(2): 581-91. doi:10.1007/s10549-012-2277-0.
24. Beck AT, Steer RA, Ball R, Ranieri W. Comparison of beck depression inventories -IA and -II in psychiatric outpatients. *J Pers Assess*. 1996; 67(3): 588-97. doi:10.1207/s15327752jpa6703_13.
25. Beck A. *BDI, Beck Depression Inventory: Manual*. San Antonio, TX: Psychological Corp; 1987.
26. Carver CS. You want to measure coping but your protocol's too long: consider the brief COPE. *Int J Behav Med*. 1997; 4(1): 92-100.
27. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: a theoretically based approach. *J Pers Soc Psychol*. 1989; 56(2): 267-83. doi:10.1037/0022-3514.56.2.267.
28. Devins GM, Edworthy SM, Seland TP, Klein GM. Differences in illness intrusiveness across rheumatoid arthritis, end-stage renal disease, and multiple sclerosis. *J Nerv Ment Dis*. 1993; 181(6): 377-81.
29. Devins GM, Binik YM, Hutchinson TA, Hollomby DJ, Barre PE, Guttmann RD. The emotional impact of end-stage renal disease: Importance of patients' perception of intrusiveness and control. *Int J Psychiatry Med*. 1983; 13(4): 327-43. doi:10.2190/5DCP-25BV-U1G9-9G7C.
30. Devins GM. Illness intrusiveness and the psychosocial impact of lifestyle disruptions in chronic life-threatening disease. *Adv Renal Replace Th*. 1994; 1(3): 251-63.
31. Devins GM. Using the illness intrusiveness ratings scale to understand health-related quality of life in chronic disease. *J Psychosom Res*. 2010; 68(6): 591-602.
32. Sherbourne CD, Stewart AL. The MOS social support survey. *Soc Sci Med*. 1991; 32(6): 705-14.
33. House JS, Kahn RL, McLeod JD, Williams D. Measures and concepts of social support. In: Cohen S, Syme SL, eds. *Social Support and Health*. San Diego, CA, US: Academic Press; 1985:83–108.

34. Jones BL, Nagin DS. Advances in group-based trajectory modeling and an SAS procedure for estimating them. *Sociol Method Res*. 2007; 35(4): 542-71. doi:10.1177/0049124106292364.
35. Nagin DS. *Group-based modeling of development*. Harvard University Press; 2005.
36. Jones BL, Nagin DS, Roeder K. A SAS procedure based on mixture models for estimating developmental trajectories. *Sociol Method Res*. 2001; 29(3): 374-93. doi:10.1177/0049124101029003005.
37. Andruff H, Carraro N, Thompson A, Gaudreau P, Louvet B. Latent class growth modelling: a tutorial. *TQMP*. 2009; 5(1): 11-24.
38. Haviland A, Rosenbaum PR, Nagin DS, Tremblay RE. Combining group-based trajectory modeling and propensity score matching for causal inferences in non-experimental longitudinal data. *Dev Psychol*. 2008; 44(2): 422-36. doi:10.1037/0012-1649.44.2.422.
39. Calhoun LG, Cann A, Tedeschi RG. The posttraumatic growth model: Sociocultural considerations. In: Weiss T, Berger R, eds. *Posttraumatic growth and culturally competent practice: Lessons learned from around the globe*. Hoboken, NJ: John Wiley & Sons, Inc; 2010: 1-14.
40. Sohl SJ, Levine B, Case LD, Danhauer SC, Avis NE. Trajectories of illness intrusiveness domains following a diagnosis of breast cancer. *Health Psychol*. 2014; 33(3): 232-41. doi:10.1037/a0032388.
41. Helgeson VS, Snyder P, Seltman H. Psychological and physical adjustment to breast cancer over 4 years: identifying distinct trajectories of change. *Health Psychol*. 2004; 23(1): 3-15. doi:10.1037/0278-6133.23.1.3.
42. Henselmans I, Helgeson VS, Seltman H, De-Vries J, Sanderman R, Ranchor AV. Identification and prediction of distress trajectories in the first year after a breast cancer diagnosis. *Health Psychol*. 2010; 29(2): 160-8. doi:10.1037/a0017806.
43. Lam WW, Bonanno GA, Mancini AD, et al. Trajectories of psychological distress among Chinese women diagnosed with breast cancer. *Psycho-Oncol*. 2010; 19(10): 1044-51. doi:10.1002/pon.1658.
44. Weiss T, Berger R. Posttraumatic growth around the globe: Research findings and practice implications. In: *Posttraumatic growth and culturally compentent practice: Lessons learned from around the globe*. Hoboken, NJ: US: John Wiley & Sons Inc; 2010: 189-195.