# Post Traumatic Development Five Years After Cancer: Identification Of Associated Actionable Factors

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# Abstract

**Background:** The number of cancer survivors is growing increasingly worldwide and a growing need exists for greater knowledge into cancer survivorship. The long-term negative consequences of the disease are now better known. Cancer may also foster positive outcomes such as post-traumatic growth. Some survivors consider life after cancer as the start of a new life and put in place a coping process called post-traumatic development (PTD) measured by a scale developed by Tedeschi and Calhoun.

**Objective:** The purpose of this article is to determine modifiable factors affecting PTD, particularly those that could integrate clinical interventions, and those that reflects patient behaviors, willing to improve their health.

**Methods:** This study focuses on the 1,982 participants in the VICAN cohort who responded to the survey at two and five years from diagnosis. Our search for characteristics associated with moderate to high PTD was conducted using logistic regressions.

**Results:** Factors positively associated with moderate or high PTD are, a positive perception of time spent on information, increased physical activity and healthier diet, have benefited from psychological support at the beginning of the disease.

**Conclusion:** High PTD is strongly associated with health behavior and information. Our findings suggest that appropriate clinical and educational interventions can help foster growth after the experience of cancer. Even if we do not know what causes what, it is admitted that the interventions leading to the Adapted Physical Activities, for example, are good from all points of view.

# Background

The World Health Organization (WHO, 2020) estimates that 1 in 5 people will develop cancer before the age of 75. At the same time, gains in cancer detection and treatment have led to a marked improvement in patient survival. Consequently, the number of cancer survivors increased in many developed countries. In the United States the number of survivors will grow from more than 15.5 million in 2016 to 20.3 million in 2026 (Miller et al., 2016). In France, according to the National Cancer Institute (INCa), 62% of patients diagnosed with cancer survive beyond five years (3.8 million people surviving in 2018). The concept of "cancer survivor" was introduced in the United States in 1986.The growing interest in this population has made it possible to better understand the consequences of cancer in the years following the diagnosis in terms of health condition, Quality Of Life (QOL), daily life, family, professional and/or social difficulties. Being affected by cancer is considered an ordeal that shakes up temporalities (Derbez & Rollin, 2016) which often marks a biographical disruption (Bury, 1982; Sarradon, 2009). Attention paid to this population of survivors at this particular stage of "living after cancer" (Mayer et al., 2017) must be continued.

Some survivors experience positive mental change in cancer survivorship independent from well-being and personal meaning (Holtmaat et al., 2019). Viewing "post-cancer" as the beginning of a new life that may lead them to change everything in their lives, these survivors implement a coping process called post-traumatic development (PTD) described by Tedeschi and Calhoun (Tedeschi & Calhoun, 1996). From the traumatic event that constitutes a rupture, the individual, thanks to the construction of new goals, takes a new look at the world and at himself, has a feeling of surpassing himself and feels strengthened in front of adversity (Tarquinio & Montel, 2014). This evolutionary process, partly resulting from stress and strong emotion following an aversive event, is not systematic. According to a meta-analyze (Wu et al., 2019), around half the individuals may develop such process following a traumatic event, without erasing its negative impact (Tedeschi & Calhoun, 2004). PTD is commonly measured by the Post Traumatic Growth Inventory (PTGI), a multidimensional scale developed by Tedeschi and Calhoun that includes five fields of development: appreciation of life, richer relationships with others, strength in the face of difficulties, new possibilities and spirituality.

Thus, cancer patients may experience not only negative effects but also positive changes and a growth opportunity. The increase in survival for most cancer types has resulted in a growing interest in PTG among cancer survivors (Menger et al., 2020; Jim & Jacobsen, 2008), mainly focused on breast cancer (Casellas-Grau et al., 2017). According to Mols et al. (Mols et al., 2009), 10 years after a breast cancer diagnosis, there is a strong link between the measurement of high PTD and life satisfaction. After breast cancer, PTD has also been shown to be associated with a higher level of well-being (Lelorain et al., 2010). Focusing on transformation and psychological well-being has been advocated (Pat-Horenczyk et al., 2015) as being equally important as understanding how to alleviate distress among survivors. Casellas-Grau (Casellas-Grau et al., 2017) in a review described the major findings on PTD in cancer, by analyzing its various definitions and assessment tools, and examining its main psychological and clinical correlates. She pointed out the need to better investigate health attitudes, the treatments received and their influence on PTD.

Based on these different findings, we asked ourselves whether some factors could affect the level of PTD, which would eventually allow Health Care Teams (HCT) to offer interventions to promote growth in the aftermath of cancer. The main objective of this study was to determine the factors associated with higher PTD in cancer survivors. Socio-demographic characteristics as well as variables related to health status and health behaviors have been considered; among these, we identified those that were modifiable, in order to propose ways to improve our understanding of the post-cancer experience.

# Methods

# Design

This analysis used data from the French VICAN survey conducted two and five years after cancer diagnosis. The survey aimed to document living conditions and quality of life in cancer survivors. Eligible participants included all adult survivors with primary cancer diagnosed between January 2010 to

December 2011, aged between 18 and 82 years old at diagnosis and affiliated with one of the three main French health insurance schemes (covering together more than 90% of the population). The survey was restricted to 12 cancer sites, accounting for 88% of global cancer incidence in France in 2012: breast, lung, colorectal, prostate, upper aerodigestive tracts (AEDT), bladder, kidney, cervical, endometrial, thyroid, non-Hodgkin lymphoma, and melanoma. The survey also targeted French-speaking patients living in France for at least two years. Data were collected from telephone interviews two and five years after diagnosis. A postal questionnaire was proposed to individuals diagnosed with lung or AEDT cancers, as they could have difficulties in answering orally. The first questionnaire (VICAN 2) was administered in 2012 to 4,347 individuals. The second questionnaire (VICAN 5) was administered in 2015 and 2016 to 4,174 participants; among them, 2,009 individuals had already participated in the VICAN2 survey. A detailed description of the methodology and data collection is available elsewhere (Wu et al., 2019)

# Data Collected

Two data sources were used where used for this study: 1) data from telephone interviews conducted with patients two and five years after cancer diagnosis, 2) data from the SNIIRAM database (Système d'information inter-régimes de l'assurance maladie française), a national administrative database including information on hospital and ambulatory services. Questionnaires dealt with many topics including socio-demographic background and socioeconomic status, daily life, cancer treatment, perceived sequelae and quality of life.

# Ethics

Methodology of the VICAN survey was approved by three national ethics commissions: CCTIRS (Consultative Committee on the Treatment of Health-related data, study No. 11–143), ISP (Institute of Public Health, study No. C11-63) and CNIL (French Commission on Individual Data Protection and Public Liberties, study No. 911290).

# Study Sample

The study sample was 1,982 individuals who participated in both questionnaires (VICAN2 and VICAN5) for whom PTGI was available.

# Variables

# PTD

PTD five years after diagnosis was measured using the French version of the PTGI(Cadell et al., 2015), a 21-item measure that uses a six-point Likert-type response scale (from 0 = not at all to 5 = totally). PTGI

score, obtained by summing up all 21 items, varies between 0 to 105 with higher scores denoting higher PTD. We identified a moderate to high PTD in individuals presenting a PTGI score greater or equal to 63(Wu et al., 2019). Individuals with scores lower than 62 were characterized as having a low PTD.

**Socio-demographic and economic variables** sex, age at time of diagnosis, level of education, couple life, perceived financial precariousness five years after diagnosis.

**Sequelae and psycho-social outcomes measured in VICAN5**

- Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS), a 14-item scale including seven items related to the evaluation of depression and seven to anxiety. An anxiety/depression score above 10 identified participants suffering from symptoms of anxiety/depression (Zigmond & Snaith, 1983)

- Fatigue was measured using the subscale of the EORTC QLQ (European Organization for Research and Treatment of Cancer QoL Questionnaire)(Aaronson et al., 1993). On a scale of 0-100, a score of $\geq 40$ indicated clinically significant fatigue.

- Perceived sequelae: participants were asked about the existence and the severity of cancer sequelae. Answers were merged in a three-level variable: no sequelae/moderate, very moderate sequelae/important, very important sequelae.

- QoL was measured using the SF-12 questionnaire (Burdine et al., 2000) which allow to calculate a mental and a physical score of QoL, with scores ranging from 0 to 100, the higher the score, the better the QoL.

# Medical Variables

They included cancer site, treatments, pejorative evolution of the disease five years after diagnosis. Treatments were collected from the health insurance databases. To estimate pejorative evolution of the disease at time of the survey, an indicator was defined taking into account one of the following events: occurrence of metastasis, second cancer, admission to palliative care, or administration of treatments other than the initial treatment.

**Variables related to health care management, collected in VICAN2**

- Communication with HCT: patients were asked about their satisfaction with the time spent by HCT to answer questions using a three level-variable: unsatisfied, mixed assessment, satisfied.

- Patients were also asked if they received psychological support at diagnosis (yes/no).

**Lifestyle changes, collected in VICAN5**

- Dietary change since diagnosis: participants were asked if they changed their diet since diagnosis. In case of a positive answer, they were asked if they had changed to a healthier diet. Responses were merged into a three-level indicator: no dietary change, change to healthier food, and change for other purpose.

- Increase in Physical Activity (PA): participants were asked if they had changed their PA since diagnosis and if yes, had they increased or decreased it.

# Statistical analysis

Sample weightings ensured that data where representative of the targeted population in terms of age, cancer site, socio-economic condition and cancer evolution at time of the survey.

Descriptive statistics are given for the selected variables and presented as weighted percentages. Simple and multiple weighted logistic regression models were performed to identify the independent factors associated with a moderate/high level of DPT. We first selected variables having a p-value lower than 0.20 by testing one by one in simple weighted logistic regression model. We introduced them simultaneously, into a multiple model, adjusting on gender, level of education and the pejorative evolution of the disease. Only variables remaining significantly associated with the outcome (p < 0.05) were finally kept in the final model.

All analyses were conducted with SAS 9.4 Software (SAS Institute Inc., Cary, NC, USA).

# Results And Discussion

# Population characteristics (Table 1)

Table 1
Factors associated with moderate/high PTG, univariate analyses, VICAN5 study (n = 1982).

| | Total N = 1982 | Low PTG level N = 1247 | Moderate/high PTG level N = 735 | p-value |
|---|---|---|---|---|
| | % | % | % | |
| Socio-demographic variables | | | | |
| Gender | 36.2 | 41.6 | 27.2 | < 0.001 |
| Male | 63.8 | 58.4 | 72.8 | |
| Female | | | | |
| Age classes † | 13.9 | 11.5 | 17.95 | < 0.001 |
| [18;40] | 33.0 | 29.2 | 39.55 | |
| [41;50] | 23.6 | 23.9 | 23.1 | |
| [51;62] | 29.5 | 35.5 | 19.4 | |
| 63 and more | | | | |
| Living as a couple ‡ | 71.8 | 73.0 | 69.8 | 0.169 |
| yes | 28.2 | 27.0 | 30.2 | |
| no | | | | |
| Children | 10.3 | 10.2 | 10.5 | < 0.001 |
| none | 18.0 | 15.0 | 23.0 | |
| at least one dependent child | 71.7 | 74.7 | 66.5 | |
| no dependent child | | | | |
| Level of education | 49.8 | 51.3 | 47.2 | 0.109 |
| no diploma or non-high school graduate | 50.2 | 48.7 | 52.8 | |
| high school graduate | | | | |
| Medical variables | | | | |

| | Total N = 1982 | Low PTG level N = 1247 | Moderate/high PTG level N = 735 | p-value |
|---|---|---|---|---|
| Cancer site | 43.2 | 37.9 | 52.1 | < 0.001 |
| Breast | 3.7 | 4.1 | 3.0 | |
| Lung | 9.1 | 9.2 | 8.85 | |
| Colorectal | 16.6 | 19.4 | 11.9 | |
| Prostate | 3.9 | 4.4 | 3.2 | |
| AEDT | 2.9 | 3.6 | 1.75 | |
| Bladder | 3.7 | 3.35 | 4.2 | |
| Kidney | 5.5 | 5.9 | 5.0 | |
| Thyroid | 3.3 | 3.25 | 3.4 | |
| Lymphoma | 4.8 | 6.0 | 2.7 | |
| Melanoma | 2.3 | 1.7 | 3.4 | |
| Cervical | 1.0 | 1.1 | 0.7 | |
| Uterus | | | | |
| Metastatic cancer † | 1.7 | 1.9 | 1.4 | 0.345 |
| Treated with chemotherapy | 40.1 | 35.6 | 47.6 | < 0.001 |
| Treated with radiotherapy | 54.7 | 51.5 | 60.1 | < 0.001 |
| Pejorative evolution of cancer ‡ | 8.4 | 8.0 | 9.0 | 0.467 |
| Sequelae and behavioral outcomes | | | | |
| Benefitted from psychological support ¶ | 20.1 | 16.1 | 26.9 | < 0.001 |
| yes | 79.9 | 83.9 | 73.1 | |
| no | | | | |
| Satisfaction with the time spent by health care providers answering questions ¶ | 36.9 | 39.1 | 33.2 | 0.017 |
| no | 63.1 | 60.9 | 66.8 | |
| yes | | | | |

| | Total N = 1982 | Low PTG level N = 1247 | Moderate/high PTG level N = 735 | p-value |
|---|---|---|---|---|
| Report of clinically significant fatigue ‡ | 49.9 | 53.2 | 44.2 | < 0.001 |
| no | 50.1 | 46.8 | 55.8 | |
| yes | | | | |
| Sequelae ‡ | 35.3 | 36.5 | 33.1 | 0.328 |
| no | 42.8 | 41.6 | 44.8 | |
| moderate | 22.0 | 21.9 | 22.1 | |
| significant | | | | |
| Anxiety ‡ | 52.3 | 52.3 | 52.3 | 0.862 |
| no | 23.9 | 23.5 | 24.5 | |
| questionable state | 23.8 | 24.2 | 23.2 | |
| certain | | | | |
| Depressive symptoms ‡ | 82.1 | 76.5 | 91.5 | < 0.001 |
| no | 17.9 | 23.5 | 8.5 | |
| yes | | | | |
| Dietary change since diagnosis ‡ | 65.3 | 71.0 | 55.8 | < 0.001 |
| no dietary change | 28.2 | 21.8 | 39.0 | |
| change to a healthier diet | 6.4 | 7.2 | 5.2 | |
| change for other purpose | | | | |
| Change in physical activity since diagnosis ‡ | 87.2 | 90.3 | 82.0 | < 0.001 |
| no change or decreased physical activity | 12.8 | 9.7 | 18.0 | |
| increased physical activity | | | | |

† at diagnosis

‡ collected five years after diagnosis

¶collected two years after diagnosis

Among the 2,009 individuals who participated in both surveys (VICAN2 and VICAN5), 27 had a missing PTG score and were excluded from the study sample. These 24 individuals were older than the 1,982 respondents (mean age = 65.7 (SD = 11.8) *versus* 54.2 (SD = 12.7), p < 0.001)), were more often men

(56.5% *versus* 36.2%, p = 0.044) and a lower proportion had a high level of education (18.2% *versus* 50.2%, p = 0.003).

Among the 1,982 participants included in our study, 63.8% were female, a majority lived as a couple (71.8%) and had children (89.7%) who were still dependent for 18.0% of participants. Considering the level of education, 50.2% had a higher degree. The most represented cancer locations were breast (43.2%), prostate (16.6%) and colorectal cancer (9.1%). Only 1.7% of participants were diagnosed with a metastatic cancer. Half of them were treated with chemotherapy (54.7%) and 40.1% with radiotherapy. Five years after diagnosis, 8.4% experienced a pejorative evolution of their disease.

Two years after diagnosis, one patient out of five declared having benefited from psychological support at the time of diagnosis. Regarding the time spent by HCT on answering questions, the majority of patients were satisfied (63.1%). Only 15.7% reported being unsatisfied. Five years after diagnosis, 34.7% reported a dietary change since diagnosis, mainly to healthier food (28.2%) and 12.8% had increased their physical activity since diagnosis. In addition, 21.95% reported important cancer sequelae; 50.1% of patients suffered from significant fatigue, 47.7% suffered from anxious symptoms, significant for 23.8%, and 17.9% suffer ed from depressive symptoms.

### Prevalence of a moderate/high PTG and associated factors (Table 1)

Five years after cancer diagnosis, more than 1 in 3 participants had moderate to high PTD (37.2%). They were younger than participants with low PTD and included a higher proportion of women. PTD level was associated with tumor location, with a higher proportion of breast cancers within the participants having moderate to high PTD compared to those with low PDT (52.1% *versus* 37.9%), and lower proportion of prostate cancers (11.9% *versus* 19.4%). High to moderate PTD was also associated with a higher proportion of treatment with chemotherapy and radiotherapy (Table 1). No difference was found on PTD level regarding the presence of metastasis at diagnosis and/or the cancer evolution five years after diagnosis.

Participants with high PTD reported higher levels of satisfaction regarding the time spent by HCT to answer questions and more often benefitted from psychological support at the time of diagnosis compared to those with a low PTD (66.8% *versus* 60.9%, p = 0.011 and 26.9% *versus* 16.1%, p < 0.001 respectively). They also more often reported behavioral changes, as 39.0% of them changed to healthier food and 18.0% increased their physical activity since diagnosis *versus* 21.8% and 9.7% of their counterparts, respectively (p < 0.001 in both cases).

Regarding cancer sequelae five years after diagnosis, they more often reported significant fatigue (55.8% *versus* 46.8, p < 0.001) and a lower proportion of depressive symptoms (8.5% *versus* 23.5%, p < 0.001). In contrast, no differences in quality of life, anxiety and reported sequelae were found between both groups.

Table 2 shows the results of the multivariate analysis. Due to an interaction between depressive symptoms and the report of fatigue, a three-level variable was defined resulting from the joint distribution.

After multiple adjustment on disease evolution, gender and level of education, factors associated with a moderate/high level of PTG were the report of significant fatigue without depressive symptoms at the time of the survey, having benefitted of psychological support at diagnosis, being satisfied with the time spent by HCT answering questions, the report of a dietary change to healthier food, and/or increased physical activity since diagnosis. In contrast, the report of depressive symptoms and older age were associated with a lower likelihood of having a moderate/high level of PTD five years after diagnosis. In addition to these factors, female gender was marginally associated with a moderate/high level of PTG (Table 2).

Table 2
Factors associated with a moderate/high level of DPT (n = 1921)

| | Adjusted OR [95% CI] | p |
|---|---|---|
| Gender | 1 | 0.062 |
| male | 1.27 [0.99;1.64] | |
| female | | |
| Age classes * | 1 | 0.777 |
| [18;40] | 0.95 [0.69;1.31] | 0.088 |
| [41 ;50] | 0.73 [0.51;1.05] | 0.002 |
| [51 ;62] | 0.54 [0.37;0.80] | |
| 63 and over | | |
| Level of education | 1 | 0.079 |
| no diploma or non-high school graduate | 0.81 [0.64 ;1.02] | |
| high-school graduate | | |
| Depressive symptoms and report of clinically significant fatigue ** | 1 | < 0.001 |
| no significant fatigue nor depressive symptoms | 1.62 [1.28;2.06] | |
| significant fatigue and no depressive symptoms | 0.36 [0.25;0.54] | < 0.001 |
| depressive symptoms (whatever the level of fatigue) | | |
| Satisfaction with the time spent by health care providers to answer questions *** | 1 | 0.010 |
| no | 1.35 [1.08;1.70] | |
| yes | | |
| Benefitted from psychological support *** | 1 | 0.002 |
| no | 1.53 [1.16;2.01] | |
| yes | | |
| Dietary change since diagnosis ** | 1 | < 0.001 |
| no dietary change | 1.85 [1.44;2.36] | |
| change to a safer diet | 0.85 [0.54;1.32] | 0.462 |
| change for other purpose | | |

|  | Adjusted OR [95% CI] | p |
|---|---|---|
| **Increased physical activity since diagnosis \*\*** | 1 | 0.030 |
| no | 1.42 [1.04;1.95] | |
| yes | | |

\* at diagnosis

\*\* collected five years after diagnosis

\*\*\* collected two years after diagnosis

Note : the model was adjusted on the pejorative evolution variable which is not presented because it was not significant.

## Discussion

PTD benefits cancer survivors by translating an emotional process or cognitive development into change toward positive behaviors (Morris et al., 2012). In our study, 37.2% of participants were identified as reporting moderate to high PTD five years after diagnosis. Older age and the report of depressive symptoms were associated with low PTD. Being satisfied with the time spent by HCT on answering questions, having received psychological support at diagnosis, having increased physical activity and/or adopting healthier diet were associated an increased likelihood of having moderate to high PTD.

Numerous associations have been identified so far between medical conditions, socio-demographic factors and PTD experience, such as gender (Teixeira & Pereira, 2013), young age (Cormio et al., 2015), time since diagnosis, and advanced disease stage (Koutrouli et al., 2012;(Moreno & Stanton, 2013). As previously described, our results found an association between PTD and younger age. Female gender was also associated with higher levels of PTD in the univariate analysis, but only remained marginally associated after multiple adjustments. Cancer site was not associated with PTD after multiple adjustments, probably because it was closely linked to age and gender. Moreover, we did not find an association between PTD and cancer evolution five years after diagnosis. In contrast, participants who reported significant fatigue without depressive symptoms also reported higher levels of PTD. Fatigue and its repercussions on daily life is one of the major sequelae of cancer (Berger et al., 2015), and may play a role in the recall of the disease; the report of general sequelae may recover various problems which may explain the absence of a relationship with PTD.

Our attention was focused on modifiable factors, as was a previous study (Connerty & Knott, 2013) that explored and identified factors that facilitate growth. Interestingly, the study highlighted the value of modifiable factors such as physical activity and searching for information as promoting the level of PTD. However, this study only included expert patients. Our study conducted upon a representative sample of the cancer survivor population confirmed the impact of increased physical activity on PTD, and the importance for patients that HCT spent sufficient time answering questions. It also highlighted the

association between PTD and the adoption of a healthy diet, as well as the benefit of psychological support.

PA and healthy diet are part of the foundation for improved health and wellness, especially for cancer survivors (Shapiro, 2018; Zhai et al., 2019; Mourouti et al., 2017). This suggests that, after cancer, advice regarding lifestyle habits should have their place, particularly in the need for individuals to optimize their diet. Adopting behaviors that contribute to health benefits could be associated with certain areas of development. This result is consistent with a previous study showing that functional well-being was associated with high PTD in elderly survivors (Yang & Ha, 2019). In our study, of those who reported a diet change, only 37.5% had access to a dietitian, so it seems therefore relevant to reinforce this access. Increased PA could also be a catalyst for PTG, as outlined in a previous study (Sabiston et al., 2007) in breast cancer patients included in a dragon boat program. The researcher suggests that, as part of a team sport challenge, support from others sharing the same experiences is helpful in facilitating PTG. This would be consistent with the concept of physical PTG explored in prostate cancer patients (Walsh et al., 2018). In the same way, a systematic review (Zhai et al., 2019) showed a relationship between growth and challenging activities for breast cancer survivors. Furthermore, there is a positive association between PA and a reduction of the risk of recurrence and overall mortality in patients with non-metastatic breast, colon and prostate cancer (Duclos, 2021). Another systematic review (Mishra et al., 2012) showed that exercise interventions may have beneficial effects on HRQoL. For all these reasons, adapted PA should be advocated more systematically for cancer survivors.

We observed an association between the access to psychological support at diagnosis and a high/moderate level of PTD, while long-term depressive symptoms were associated with a lower level of PTD. These results are consistent with a previous study showing that access to psychological support (Üzar-Özçetin & Hiçdurmaz, 2019) incorporating empowerment programs offered to cancer survivors improved PTD and resilience levels. These results are also confirmed in a review (Tomita et al., 2017) of previous studies reporting that PTG is associated with lower psychological distress, less depression, greater well-being and higher quality of life. The benefits of psychological support seem to be unanimous, but show considerable inter-individual variability (Porro et al., 2019) depending on certain areas of development such as relationships with others and the perception of new opportunities. Moreover, psychological group interventions are related to greater PTG (Lechner & Antoni, 2004);(Ramos et al., 2018)

Satisfaction with the time spent by HCT answering questions was associated with higher levels of PTD. Cancer survivors who are satisfied with the information they received have a better QOL, and are less anxious and depressive (Blödt et al., 2018). Information plays a role in cancer survivors that is clearly associated with regaining control in the face of a seemingly uncontrollable situation, becoming confident in their own decisions, understanding the impact of the disease on their lives, overcoming fear, etc. (Blödt et al., 2018). Despite this finding, numerous studies (Kent et al., 2012; Faller et al., 2016) have shown that the level of information still needs to be improved. According to Miller's study (Miller et al., 2018), information seeking in people who had cancer in childhood is associated with higher levels of PTD.

Sufficient information could allow many individuals to use self-management (Coffey et al., 2016) and to better adapt to post-cancer conditions. Moreover, responding to patients' need for information encourage them to play an active role in their own care (Blödt et al., 2018). Information is one of the tools of adaptation that is closely linked to the individual's trajectory and interactions with HCT. We assume that meeting patients' need for information by devoting the necessary time to it would make it possible to improve their survivorship.

We did not find an association between PTD and QOL. We noted in a previous meta-analysis (Liu et al., 2020) that most studies found a positive relationship between QOL and PTG, suggesting that PTG may play a role in successful coping following cancer. This association is still unclear and the different measurements of overall HRQoL may also account for this heterogeneity. However, it appears to be an outcome of quality of life and encourages an understanding of the way to promote PTD. To understand this, longitudinal data are needed; adaptation process is complex and dynamic and response shift approaches are needed to highlight the link.

## Study Limitations

In our study, we chose to focus on PTD as a whole and not by sub-dimension. Some authors wishing to highlight the multidimensional nature of PTD (Morris et al., 2012) have noted the predominance of some areas of development, such as life satisfaction and relationships to others. Further analyses should be conducted to better characterize each sub-dimension of this scale.

One of the strengths of this study is its original approach that highlights modifiable factors on which HCT could act to improve PTD. It used a large representative sample of cancer survivors and combined several sources of data (Bouhnik et al., 2015). Inclusion of variables measured at two years after diagnosis, to study their association with PTD five years after diagnosis, may limit memorization bias.

**Clinical Implications** Understanding the positive consequences of cancer, such as PTD, is fundamental to oncology HCT. Our study provides useful information to enhance positive psychological outcomes and findings may guide the development of post-cancer tailored supportive interventions such as exercise prescription, and/or education toward healthier lifestyles that may facilitate PTD among cancer survivors.

Statements and Declarations

## Statements And Declarations

Conflicts of interest: The authors declare that they have no conflict of interest.

Availability of data: on request Data availability statement: data that support the findings of this study are available from the corresponding author upon reasonable request.

Code availability: not applicable

Authors' contributions: CE, ADB and BSS designed the study. ADB and MKBD collected the data. BSS performed data analysis. CE, ADB, MKBD and BSS interpreted the data. CE and ADB drafted the manuscript. All authors discussed, revised, and finally approved the manuscript.

Ethical approval: All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/or national research committee (the CCTIRS: Comité Consultatif sur le Traitement de l'Information en Matière de Recherche dans le Domaine de la Santé, study registered under no 11-143, the ISP: Institute of Public Health, study registered under no C11–63 and the CNIL: French Commission on Individual Data Protection and Public Liberties, study registered under no 911290) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate: Informed consent was obtained from all individual

participants included in the VICAN study

Consent for publication: not applicable

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