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Samah Hayek, Kimberly A. Miller, Michael E. Roth, Michelle A. T. Hildebrandt, David R. Freyer & Joel Milam

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Social Roles and Emotional Distress Are Associated With Successful Aging in Adult Childhood Cancer Survivors

Authors: Samah Hayek [1,2,3*] Kimberly A. Miller[4], Michael E. Roth[5], Michelle A.T. Hildebrandt[6], David R. Freyer[7,8,9], Joel Milam[3,10]

Affiliations:

[1]Department of Epidemiology and Preventive Medicine, School of Public Health, Gray Faculty of Medical and Health Sciences, Tel-Aviv University, Tel-Aviv, Israel

[2]Clalit Research Institute, Clalit Health Services, Tel-Aviv, Israel

[3]Department of Epidemiology and Biostatistics, Joe C. Wen School of Population & Public Health, University of California, Irvine, California, USA.

[4] Department of Population and Public Health Sciences, Keck School of Medicine of the University of Southern California, Los Angeles, California, USA

[5]Division of Pediatrics, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA.

[6]Department of Lymphoma and Myeloma, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA

[7]Cancer and Blood Institute Children's Hospital Los Angeles, Los Angeles, CA, USA

[8]USC Norris Comprehensive Cancer Center, Los Angeles, California, USA

[9]Departments of Pediatrics, Medicine, and Population & Public Health Sciences, Keck School of Medicine, University of Southern California, Los Angeles, California, USA

[10]Cancer Control Program, UCI Chao Family Comprehensive Cancer Center, Orange County, California, USA

***Corresponding author**

Samah Hayek, DrPH

Department of Epidemiology and Preventive Medicine,

School of Public Health,

Gray Faculty of Medical and Health Sciences

Tel Aviv University, Israel

Telephone 972-53-714-1494

E-mail address: samahhayek@tauex.tau.ac.il

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Abstract:

Purpose: Childhood cancer survivors (CCS) face complex long-term health consequences resulting from intensive treatments that may impact their aging trajectory. This study assessed the associations between social role attainment, emotional distress, and indicators of successful aging (SA) among adult CCS, considering treatment intensity. SA, is a multidimensional concept encompassing physical, cognitive, and psychosocial well-being, provides a framework for understanding and optimizing outcomes in this population.

Methods: This cross-sectional study utilized data from Project Forward, a cohort, of 1,248 adult CCS diagnosed between 1996 and 2010. Participants were identified through the Los Angeles County Cancer Surveillance Program and completed a comprehensive self-report survey assessing demographics, physical and clinical conditions, mental health, and social well-being. SA was defined as having no more than one of the following: chronic disease, low physical activity, cognitive impairment, or poor well-being. Emotional distress was measured using the CES-D 7-item negative scale. Social role attainment was evaluated based on educational attainment, marital status, and employment. Multiple logistic regression was used and odds ratio (ORs) with 95% Confidence Intervals (CIs) were reported.

Results: Many survivors reported aging-related deficits, including at least one chronic condition (26.2%), low physical activity (69.6%), cognitive impairment (13.1%), and suboptimal well-being (42.0%). Despite these challenges, two- thirds met the criteria for SA. Higher social role attainment was associated with increased odds of SA (OR: 3.56; 95% CI: 2.06-6.15), while higher emotional distress was associated with a lower odd of SA (OR: 0.66; 95% CI: 0.61-0.71).

Conclusions: Attainment of social roles and emotional distress are significantly associated with SA in adult CCS, highlighting the need for targeted, supportive interventions.

Key words: Childhood cancer survivors, successful aging, social roles, emotional distress

Introduction

Five-year survival after treatment for childhood cancer now exceeds 85% [1, 2]. However, this success is accompanied by significant challenges. Childhood cancer survivors (CCS) often develop a myriad of physical and psychosocial late effects [3, 4], including organ dysfunction [5], functional impairment [6], neurocognitive deficits [7], and chronic disability [8, 6].

As CCS transition into adulthood and beyond, they face unique challenges related to their aging. Studies have shown that CCS are at risk for premature or accelerated aging, characterized by the early onset of chronic health conditions and a higher risk of early mortality compared with the general population [9]. Furthermore, CCS have a higher prevalence of frailty compared to healthy controls, with some 30 year old CCS exhibiting aging-related deficits similar to those in their 60s without a history of cancer [6, 10, 11]. Several studies have examined premature aging among CCS [11, 12], few have explored the converse: successful aging (SA).

In contrast, the concept of successful aging (SA) has been largely overlooked in this population. Traditionally, SA is defined as a multidimensional concept involving the maintenance of physical health, cognitive function, and active engagement in life [13]. Here, we introduce SA as a useful framework for focusing on the positive aspects of aging among CCS. When applied to CCS, SA takes on additional dimensions due to the distinct challenges this population encounters. For CCS, SA might also include overcoming the long-term effects of cancer treatment and achieving personal goals despite these challenges.

Premature aging and SA are not mutually exclusive concepts. While premature aging represents early onset morbidity [14], SA includes indicators of positive functioning and quality of life, which is more than the absence of disease [15]. This broader perspective underscores the need to shift the focus from deficit-based models to a more comprehensive understanding of SA in this population that includes a broader insight of aging that encompasses various aspects of life, rather than focusing on the absence of disease and decline. This approach recognizes the potential of SA in this population, despite even the presence of chronic conditions or any disabilities [15], offers a more holistic understanding of their aging experience.

The current study applies a comprehensive definition of SA that includes four domains: (1) absence of chronic conditions, (2) adequate physical functioning, (3) good cognitive functioning, and (4) good mental health [16].

Engaging in social roles and effectively managing emotional distress can potentially mitigate many of the long-term impacts of early exposure to cancer therapy [17]. Different studies suggest that supportive social relationships positively influence health by meeting fundamental needs for social connection and offering a buffer during stressful periods. Conversely, disruptions in these social relationships can significantly increase levels of distress [18, 19].

Physical, mental, and neurocognitive deficits can significantly affect the education and career development of survivors [20,21]. Adverse psychosocial outcomes are prevalent among adolescent survivors [20], and several studies report physical and mental health limitations in adulthood [22,23]. Poor physical health is associated with an almost eightfold higher risk of health-related unemployment compared to survivors with normal physical health [21]. Adult CCS are often employed in lower-skill jobs compared to their siblings [24], and data from the Childhood Cancer Survivor Study (CCSS) have shown significant declines in employment and increases in health-related unemployment over 10 years of follow-up compared with the general population [25]. Emotional distress is also prevalent among adult CCS [26, 27], often exacerbated by chronic conditions [28], such as cardiac, pulmonary conditions and/or endocrine conditions that develop decades after cancer treatment [29].

While the ability to maintain social roles and manage emotional distress is crucial for SA, little is known about this relationship among childhood cancer survivors. In this secondary analysis of Project Forward, we aim to evaluate the associations between social roles, emotional distress, and indicators of successful aging among adult CCS, taking into account treatment intensity and sociodemographic characteristics. We apply a comprehensive definition of successful aging that includes mental health, cognitive and physical functioning, and the absence of disability and chronic disease [16]. By emphasizing positive indicators of aging rather focusing solely on deficits, this study offers a more holistic perspective on aging in CCS. Identifying modifiable factors can inform survivorship care plans and ultimately enhance the quality of life for this vulnerable population.

Materials and Methods:

Participants were from the Project Forward cohort, a cross-sectional study that focused on follow-up care and health among CCS. Eligible participants were identified through the Los Angeles Cancer Surveillance Program, part of the Surveillance, Epidemiology, and End Results (SEER) cancer registry for Los Angeles County. Inclusion criteria were CCS diagnosed at age 18 or younger, between 1996-2010. Recruitment was based on self-report survey mailings in English and Spanish with the option to complete the survey online, over the phone, or in person in either language. Full details of study methods and procedures have been published [30]. Out of 2,592 eligible individuals approached, 1,248 participated in the study, resulting in a response rate of 48.1%. The study collected data on demographic characteristics, clinical factors, health-care engagement, and psychosocial aspects related to cancer-related follow-up care through a self-report survey assessing variables such as late effects of cancer treatment and health-care self-efficacy. Participants received $20 cash and entry into a lottery into a $300 prize for participation. All procedures were approved by the California Committee for the Protection of Human Subjects, California Cancer Registry, and the Institutional Review Board (IRB) at the University of Southern California [30].

Definition of successful aging indicators

This study examines indicators of successful aging (SA) among CCS, recognizing that SA is a multidimensional concept comprising four major components: cognitive functioning, chronic disease, physical functioning, and psychological well-being, as reported by Sabia et al. (2012) [16] and Cosco et al. (2014) [31]. This definition aligns with the holistic approach of Rowe and Kahn, moving beyond purely biomedical markers towards a more subjective process [13]. Because CCS experience unique health profiles, including elevated rates of chronic conditions and treatment-related late effects at comparatively young ages, we employed a modified operational definition of SA tailored to this population. As clinic-based assessments and biomarkers data were not available, SA domains were operationalized based on self-report items that conceptually mapped onto the original frameworks [16,31]. Prior survivorship literature documents that many CCS experience at least one chronic condition while maintaining strong functioning across other domains [32]. To avoid misclassifying resilient survivors as aging “unsuccessfully,” participants were categorized as meeting the criteria for SA if they exhibited no more than one of the deficit across four domains described below, resulting in a binary outcome (SA=Yes vs. SA=No).

1. Indication of Chronic Disease. Participants meet this criterion if they have more than one of the following conditions: heart problems, second cancer (any cancer diagnosis following the initial childhood cancer), liver disease, hearing problems, vision problems, and bone problems. The threshold of one chronic condition reflects the cancer experience (including treatment exposures) of the study sample, acknowledging that CCS are at elevated risk for chronic conditions at a younger age compared to the general population [32].

2. Indication of Physical Activity (i.e., low physical active): Physical activity was assessed through self-reported measures of overall health and ability to perform physical activities. Participants were asked, "Considering a 7-day period (a week), how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?" with response options being: Never (0 days), Rarely (1 day), Sometimes (2-3 days), Often (4-5 days), and Very often (6-7 days). Participants who reported engaging in physical activity on 0 days or 1 day were considered not physically active (i.e., never or rarely active), and more than 2 days are physical active (medium and high frequency) [33]. High physical activity is a key indicator of physical functioning, helping to maintain mobility, independence and overall quality of life.

3. Indication of Poor Cognitive Functioning: Cognitive functioning was assessed using a self-reported item measuring perceived difficulties with learning and memory (“Difficulties with learning and memory”). Participants who responded “quite likely,” “very likely,” or “I already have this problem” were classified as having cognitive impairment. Those who did not endorse these responses were considered to meet the criterion for successful cognitive functioning. For CCS, cognitive impairment is a known late effect of cancer treatment, potentially resulting from chemotherapy, radiation, or other therapies [34]. Maintaining cognitive function is essential for independence and quality of life in older age, affecting one's ability to engage in daily activities and social interactions.

4. Indication of Psychological Well-being (i.e., not-flourishing): Participants rated their frequency of experiencing 11 positive psychological states during the past month: belonging to a community, contributing to society, living in a positive society, perceiving people as inherently good, understanding societal

functioning, liking their personality, managing daily responsibilities effectively, having warm and trusting relationships, experiencing personal growth, expressing thoughts and opinions confidently, and having a sense of life purpose or direction. Participants rated how often they experienced each state using a 6-point Likert scale: never, once or twice, about once a week, about 2–3 times a week, almost every day, and every day. Consistent with established scoring criteria, respondents were classified as flourishing if they endorsed "almost every day" or "every day" for at least six of the 11 items; those with fewer than six were classified as not flourishing [35]. Internal consistency for these items in our sample was high (Cronbach’s Alpha =0.88, indicating strong reliability).

This operational definition acknowledges that CCS are at elevated risk for at least one of these health challenges due to cancer treatment [36], often manifesting as short-term, long-term, or late effects contributing to premature aging [37]. Allowing one deficit balances the ideal of no deficits (which might exclude many CCS) with a more lenient definition (more than one deficit). Literature suggests CCS frequently experience multiple health challenges concurrently [32]. Therefore, a stricter criterion (absence of all deficits) might exclude many resilient CCS demonstrating positive adaptation despite some challenges.

Exposure variables:

Attainment of Social Roles: Social roles were evaluated by marital status (married or living with a partner versus single or widowed), employment status (employed (full time or part time employment) versus unemployed), and education level (less than high school or high school versus more than high school). This definition is consistent with previous literature [17]. Participants who reported higher high-school education, being employed, and being married or living with a partner were categorized as having higher social roles attainment. Although social role attainment reflects engagement in key roles, it does not directly assess social support (e.g., perceived support, relationship quality, or network strength).

Emotional Distress: Emotional distress was assessed using the 7-item negative affect subscale of the Center for Epidemiologic Studies Depression Scale (CES-D) [38]. Items assessed prior week reports of: feeling sad, experiencing crying spells, feeling fearful, feeling blue, feeling depressed, feeling lonely, and feeling like life is a failure. A higher summary score indicates greater emotional distress (Cronbach's alpha=0.83).

Covariates:

Demographic characteristics include sex, race/ethnicity (Hispanic, non-Hispanic White, Asian, and other), socioeconomic status (SES). SES was categorized into quintiles (very lo.w to highest) based on neighborhood SES (nSES) at diagnosis, derived from census data. The nSES composite score reflects seven indicators, including education, poverty level, employment, housing, and income [39].

Clinical data include age at cancer diagnosis and treatment intensity. Treatment intensity was estimated using a combination of cancer registry data and data collected from medical charts to categorize cancer cases into four levels of treatment intensity, where 1=least intensive (i.e., surgery only), 2= moderately intensive (i.e., chemotherapy or radiation), 3=very intensive (.e., 2+ treatment modalities), and 4=most intensive (i.e., relapse protocols) [40].

Health behavior factors include smoking status and alcohol use. Smoking behavior is assessed based on any cigarette use in the past 30 days. Alcohol use is measured as binge drinking, defined as consuming 5 or more drinks (for men) or 4 or more drinks (for women) within a couple of hours on at least one day during the past 30 days [41].

Statistical analysis:

Descriptive statistics were used to characterize the study population. The primary outcome of this study was successful aging, operationalized as a composite measure including chronic disease, physical activity, cognition, and psychological well-being. Social roles and emotional distress were compared between patients with successful aging and those without successful aging. Multiple logistic regression models were used to evaluate associations between social roles, emotional distress, and successful aging among childhood cancer survivors, accounting for treatment intensity.

Separate models examined treatment intensity, social roles, emotional distress, and combined social roles and emotional distress. Unadjusted and adjusted odds ratios (OR) with 95% Confidence Interval (CI) were reported. Three models were performed: (1) an unadjusted model; (2) a model adjusted for age at diagnosis, time from diagnosis to survey completion, sex, race/ethnicity, smoking status, and alcohol use; and (3) a fully adjusted model that additionally included treatment intensity.

Two-sided P values <.05 were considered significant. All analyses were conducted using SAS, version 9.4 (SAS Institute Inc).

RESULTS

Our study includes 1,248 CCS with a diverse demographic characteristic (Table 1). Nearly half of the participants were Hispanic/Latino (49.2%), and about a third (29.3%) were from the lowest socioeconomic status. Participants were on average 26.7 years old (SD: 5.17) at the time of the survey, and 14.27 years (SD: 4.36) post-diagnosis. Additionally, 45.9% underwent very intense treatment (treatment intensity =4).

The prevalence of social roles includes 77.2% with at least high school education, 54% employed (full-time/part time), and 31.10% married or living with a partner (Table 1).

Table 1 shows the prevalence of emotional distress components, with depression being most prevalent (20.1%), followed by loneliness (19.3%) and sadness (17.6%).

Successful Aging Indicators

Among the study sample, 26.2% had at least one chronic health condition, 69.6% were not physically active, 13.1% had cognitive impairment, and 42.0% reported well-being scores below the threshold for flourishing (Table 2). Despite these deficits, two-thirds of participants met the criteria for SA. Among those who were not aging successfully, 42.3% had at least one chronic condition compared to 15.2% of those who are aging successfully. Additionally, 28.9% of those who were not aging successfully reported cognitive impairment compared to 2.3% of those who are aging successfully. Moreover, 95.2% of those who are not aging successfully are not physically active compared to 53.2% of those who are aging successfully. Among those who are not aging successfully, 83.9% had poor psychological well-being (i.e., not flourishing) compared to 15.0% of those who were aging successfully (Table 2).

Associations between SA and social roles and emotional distress

Table 3 indicates that the unadjusted model for treatment intensity is associated with decreased likelihood of successful aging among childhood cancer survivors. For most intense treatment compared to low intense (OR: 0.43;95%CI:0.26-0.61). However, this association disappeared after adjusting for demographic and lifestyle factors (OR:0.78;95%CI:0.42-1.45).

Fulfilling all three social roles compared to no social roles was significantly associated with a greater likelihood of successful aging. In a model adjusted for age at survey, time since diagnosis to survey completion, sex, ethnicity, SES, treatment intensity, smoking, and binge-drinking, those who fulfilled three social roles were greater than three times more likely to meet indicators of successful aging compared to those who did not fulfill any social roles (OR: 3.56, 95% CI: 2.06-6.15) (Table 3).

Conversely, higher score of emotional distress was associated with a lower likelihood of successful aging, with a one-unit increase in emotional distress linked to a 34% decrease in the odds of successful aging (OR: 0.66, 95% CI: 0.61-0.71). This association persisted when social roles and emotional distress were combined in the same model, adjusted for age at survey, time since diagnosis to survey completion, sex, ethnicity, SES, treatment intensity, smoking, and binge-drinking (Table 3).

DISCUSSION

This study of a large, well-characterized cohort of adult childhood cancer survivors, we found that a significant proportion, approximately two-thirds, met the criteria of SA. The most prevalent unmet indicator of SA was flourishing. Unlike existing literature, which primarily focuses on deficits related to accelerated aging in CCS [8,32], our study extends this knowledge by evaluating positive indicators of SA, offering a more comprehensive understanding of long-term health outcomes and aligning with the growing emphasis on promoting overall well-being, rather than solely addressing late effects.

The observed prevalence of unsuccessful aging (33%) in this relatively young adult population (average age 26.7) appears higher than rates in older adult populations (around 18%, aged 65-90) [42]. However, direct comparison is limited by variations in how SA is operationalized across studies. Our definition utilized four components (Indication of Chronic Disease, Indication of Physical Activity, Indication of poor cognitive functioning, Indication of Psychological Well-being), whereas other studies assessed successful aging based on five components, (intrapsychic and functional performance, coping mechanisms, existential being, introspective gerotranscendence, and retrospective gerotranscendence) emphasizing psychological, spiritual and existential aspects more than purely physical or biomedical factors [42] .This highlights the ongoing need for a standardized definition of SA, particularly in younger populations, to ensure accurate assessment of SA and comparison across studies, better address their unique experiences and challenges, and guide tailored interventions aimed at promoting well-being and resilience.

A key finding of our study is the association between higher social role engagement and reduced emotional distress with SA, after accounting for high treatment intensity, underscores the importance of addressing modifiable psychosocial and behavioral factors in addition to direct mitigation of treatment-related effects as part of long-term survivorship care. While prior research has established that anticancer therapy can accelerate aging [11], the underlying mechanisms are not yet fully understood and the absence of a single, comprehensive marker for biological or functional age [37, 43] necessitates a multi-level, integrative approach to addressing the aging-related consequences of anticancer therapy.

Childhood cancer survivors represent a highly heterogeneous population with respect to diagnosis, treatment exposures, and long-term health consequences. Although such heterogeneity is clinically important, the Project Forward dataset did not capture detailed treatment information such as cranial radiation dose, intrathecal methotrexate exposure, cumulative chemotherapy dosing, or clinical assessments of endocrine, cardiac, pulmonary, or musculoskeletal late effects. These factors may influence both cognitive and physical functioning and therefore may contribute to successful aging outcomes. To account for variability in treatment exposures, we used the validated Intensity of Treatment Rating Scale (ITR-3.0), which enables comparison across diverse diagnostic groups when detailed treatment parameters are unavailable [40]. Nevertheless, the absence of granular treatment data limits our ability to examine specific treatment-related pathways, reinforcing the need for future studies integrating comprehensive clinical treatment information and long-term physiologic assessments.

Our findings align with previous research demonstrating the positive influence of   social roles, emotional distress on SA in non-cancer populations. For example, studies have linked family roles to less negative views on aging [44], and social participation to increased SA [45]. Furthermore, Jeste et al.,

(2013) conducted a study on a community-dwelling adults in San-Diego county, ages 50-99 years, and found that resilience and depression were significantly associated with self-rated SA, with effects comparable in magnitude to those of physical health [46]. Our study extends these findings to a younger cancer-affected population, highlighting the early impact of social roles and emotional distress on the aging process and providing an opportunity for early interventions to improve long-term outcomes for CCS.

Several limitations should be considered when interpreting our findings. First, our participants were drawn from Los Angeles County, and not all eligible survivors agreed to participate. This may limit the generalizability of our results and introduce selection bias. In a previous cohort analysis, differences between responder and non-responder were addressed showing that significant differences were based on sex, Race/ethnicity, and SES [30]. However, this cohort is uniquely including a large Hispanic population, which is more substantial than in other Northern American studies[36]. Second, the cross-sectional design precludes the ability to determine temporal associations between social roles, emotional distress, and successful aging. In addition, baseline post-treatment functional status was not collected, limiting our ability to compare early post-treatment functioning with current functioning. Functional trajectories in CCS may improve, remain stable, or decline over time. However, Project Forward is a re-contactable cohort, and future longitudinal assessments will enable examination of within-person changes and provide a clearer understanding of aging trajectories over time. Third, our reliance on self-reported information may introduce recall bias. However, the survey’s focus on overall CCS health, rather than specific biomarkers, allows for a more nuanced understanding of SA in this population. Additionally, the definition of SA, particularly in young adult CCS, lacks consistence in the literature, representing a significant gap. Our definition, based on frameworks by Sabia et al. (2012) and Cosco et al. (2014), adapted for our self-report questionnaire, may capture initial treatment effects rather than chronic aging processes. The questionnaire’s non-specific design for assessing aging could also impact the precision of our measures. The chosen cut-off points for SA components, like the “no more than one chronic condition” criterion, acknowledge the increased risk of chronic conditions at younger ages in CCS, reflecting their unique health challenges. We acknowledge that other valid constructs of aging, such as premature frailty [47] or deficit accumulation index [48], were not employed. Fourth, although the

Project Forward survey included measures of health-care engagement, it did not capture detailed or longitudinal information on continuity of survivorship care, sustained connections with oncology providers, or participation in formal survivorship programs. This limited our ability to assess whether long-term access to supportive services influenced successful aging outcomes.

Additionally, exposure measures were not fully comprehensive. Social role attainment reflected whether participants had achieved key adult roles, but did not capture qualitative aspects such as job satisfaction, relationship quality, or strength of social support networks. Emotional distress was assessed using the CES-D negative affect subscale; while the absence of negative emotions results in a score of zero, this measure does not capture broader resilience-oriented constructs such as optimism, coping, or self-efficacy, which may further characterize adaptive functioning among survivors. Although psychological well-being was incorporated as an indicator of SA, future studies may benefit from more nuanced measurement of these complementary psychosocial dimensions. Lastly, although treatment intensity was included as an adjustment variable, the dataset did not include detailed treatment information (e.g., specific agents, doses, or modality-specific exposures). The absence of granular treatment data may result in residual confounding. Future survivorship studies incorporating comprehensive treatment variables and clinical assessments will be essential to more precisely quantify treatment-related contributors to successful aging.

Despite these limitations, this study lays a foundation for exploring SA in CCS and emphasizes the importance of considering multiple health and well-being domains. To our knowledge, this is the first study to demonstrate the association of social roles and emotional distress with SA in a young CCS population. These finding suggest that psychosocial and behavioral factors may play an important role in shaping aging-related outcomes among survivors. Interventions focused on promoting physical activity, improving psychological well-being, and fostering social role engagement may represent promising targets for future survivorship research and care, particularly when evaluated longitudinally.

Author contributions: S.H., K.M, M.R., M.A.T.H, D.R.-F and J.M were involved in the conceptualization of this study. S.H and J.M were involved in the formal data analysis. S.H led the data analysis. S.H. and J.M were involved in the methods development. All the coauthors have contributed to the manuscript writing.

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Ethics approval and consent to participate:
The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) at the University of Southern California. All participants provided informed consent.

Data Availability: The data underlying this article cannot be shared publicly due to privacy restrictions of individuals that participated in the study. Aggregated, deidentified data may be shared on reasonable request to the corresponding author.

Declaration of interests: The authors have no conflicts of interest to declare.

Table 1: Sociodemographic and clinical characteristics of study population

	Cancer data
Age at cancer diagnosis (mean, std, min-max), years	
Age at survey (mean, (std), [min-max], years)	26.71(std:5.17) [18-41]
Time since cancer diagnosis (mean, (std), [min-max], years)	14.27(std:4.36) [5-22]
Cancer type	
Leukemia	407(32.6%)
Lymphoma	244(19.6%)
Brain	183(14.7%)
Endocrine	68(5.5%)
Skin	127(10.2%)
Other	219(17.8%)
Treatment intensity	
Least intense	146(11.70%)
Moderate intense	355(28.45%)
Very intense	574(**45.9 %**)
Most intense	173(13.9%)
Sociodemographic characteristics	
Race/ethnicity	
Non-Hispanic white	409(32. 8%)
Hispanic	615(49. 3%)
Asians	114(9.1%)
Others	110(8.8%)
Sex	
Males	601(48.2%)
Females	647(51.8%)
Socioeconomic status	
Lowest	366(29.3%)
Low	265(21.2%)
Medium	199(15.9 %)
High	207(16. 6%)

Highest	211(16.9%)
	Risky behavior
Binge drinking alcohol (Yes)	354(32. 7%)
Smoking cigarette (Yes)	126(11.6%)
Social roles components	
Education	
Less -equal high school	280(22.8%)
More than high school	950(77.2%)
Employment	
Unemployed	564(46.0%)
Employed	662(54.0%)
Marital status	
Single or widow	847(68.9%)
Married or living with a partner	382(31.1%)
Emotional distress components	
Crying spells (yes)	123 (10.1%)
Life is failure (yes)	149 (12.2%)
Felt fearful (yes)	183 (15.0%)
Blues(yes)	206 (16.9%)
Felt sad(yes)	215 (17.6%)
Lonely(yes)	236 (19.3%)
Felt depressed(yes)	244 (20.1%)

Table 2: Prevalence of Successful Aging Overall and by each indicator

			Successful aging	
		Frequency (n, %)	No (n=414,33.2%)	Yes (n=831(66.8%)
Sum of chronic condition				
	0	817(73.8%)	258 (57.7%)	559(84.8%)
	1	182(16.5%)	88(19.7%)	94(14.3%)
	2	71(6.4%)	65(14.5%)	6(0.91%)
	3	24(2.2%)	24(5.4%)	0(0.0%)
	4	9(0.81%)	9(2.0%)	0 (0%)
	5	2(0.18%)	2(0.45%)	0(0%)
	6	1(0.09%)	1(0.22%)	0 (0%)
	Missing	142		
Absence of physical activity				
	Yes	854(69.60%)	457(95.2%)	397(53.2%)
	No	373 (30.4%)	23(4.8%)	350(46.8%)
	Missing	21		
Cognitive impairment				
	Yes	144(13.1%)	129(28.9%)	15 (2.3%)
	No	962(86.9%)	318(71.1%)	644(97.7%)
	Missing	142		
Not flourishing (low well-being)				
	Yes	514(42.0%)	402(83.9%)	112(15.0%)
	No	711(58.0%)	77(16.1%)	634(85.0%)
	Missing	23		

Table 3: Associations of Social Roles, and Emotional Distress with Successful Aging among Childhood Cancer Survivors

		Unadjusted OR (1)	Adjusted OR (95%CI) (2)	Adjusted OR (95%CI) (3)
Treatment intensity				
	Moderate intense treatment versus low intense	0.52(0.33-0.80)	0.97(0.54-1.72)	
	Very intense treatment versus low intense	0.45(0.30-0.68)	0.83(0.48-1.45)	
	Most intense treatment versus low intense	0.43(0.26-0.61)	0.78(0.42-1.45)	
Social roles				
	None	Ref	Ref	Ref
	One role vs. none	1.50(1.01-2.24)	1.54(1.02-2.32)	1.53(1.02-2.32)
	Two roles vs. none	1.65(1.10-2.46)	1.85(1.19-2.86)	1.81(1.17-2.81)
	Three roles vs. none	3.04(1.90-4.68)	3.63(2.10-6.25)	3.56(2.06-6.15)
Emotional distress	Continuous	0.65(0.60-0.71)	0.66(0.61-0.71)	0.66(0.61-0.71)
Combined model				
	None	Ref	Ref	Ref
	One role vs. none	1.45(0.95-2.23)	1.48(0.95-2.30)	1.47(0.94-2.28)
	Two roles vs. none	1.55(1.01-2.40)	1.72(1.08-2.75)	1.68(1.05-2.69)
	Three roles vs. none	2.45(1.49-4.04)	2.90(1.63-5.18)	2.84(1.59-5.09)
Emotional distress	Continuous	0.66(0.61-0.72)	0.66(0.61-0.72)	0.66(0.61-0.72)

Notes: Logistic regression was used to determine the association between each exposure and the outcome.

Outcome is successful aging (Binary outcome): If you have more than one of these conditions then you do not meet the criteria of successful aging: Any chronic conditions (i.e., heart problems, second cancer, liver problems, hearing problems, lung problems, vision problems, bone problems), not being physically active, having a cognitive or memory problems, absence of wellbeing.
1. Unadjusted OR: Unadjusted model that includes only the exposure variable as independent variable
2. Adjusted model: Adjusted for age at survey, time since diagnosis to survey completion, sex, ethnicity and, smoking and alcohol abuse
3. Adjusted model: Adjusted for age at survey, time since diagnosis to survey completion, sex, ethnicity and, smoking and alcohol abuse and treatment intensity

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