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The Impact of Social Determinants on Healthcare Transition Readiness and Posttraumatic Growth Among Adolescent and Young Adult Childhood Cancer Survivors

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Abstract

The Impact of Social Determinants on Healthcare Transition Readiness and Posttraumatic Growth Among Adolescent and Young Adult Childhood Cancer Survivors

By Gayeong Kim

Adolescent and young adult childhood cancer survivors (AYA CCS) experience various types of post-cancer resilience, including behavioral and emotional resilience. Social determinants of health (SDoH) (e.g., neighborhood deprivation) may influence post-cancer behavioral resilience (i.e., healthcare transition readiness) and emotional resilience (i.e., posttraumatic growth) in AYA CCS.

Manuscript I was a mixed-methods systematic review examining the impact of SDoH on healthcare transition readiness among AYA CCS. The review identified factors such as primary caregiver and AYA education levels, relationships with healthcare providers, access to health insurance and services, economic stability, neighborhood income, and parental/peer support as key contributors to healthcare transition readiness.

Manuscript II was a secondary data analysis investigating the impact of neighborhood-level SDoH on healthcare transition readiness among AYA CCS. Potential mediating and moderating effects of neuropsychological factors (e.g., posttraumatic stress and neurocognitive function) on the association between SDoH and healthcare transition readiness were also explored. The Readiness for Transition Questionnaire was used to assess the readiness with three domains: “adolescent responsibility”, “parent involvement”, and “overall readiness.” Neighborhood-level SDoH were measured by the Area Deprivation Index (ADI) and Environmental Justice Index (EJI). More deprived neighborhoods (higher ADI and EJI) were associated with greater “adolescent responsibility” and increased “parent involvement.” Posttraumatic stress mediated the relationship between ADI and adolescent responsibility, with neurocognitive function moderating the effect of ADI on posttraumatic stress.

Manuscript III was a secondary data analysis assessing the impact of neighborhood-level SDoH on posttraumatic growth in AYA CCS. Potential mediating effects of posttraumatic stress on the relationship between SDoH and growth were also explored. Higher neighborhood deprivation was associated with increased growth. A curvilinear relationship between posttraumatic stress and growth was identified, where moderate stress is linked to increased growth, but excessive stress was associated with diminished growth. Posttraumatic stress curvilinearly mediated the relationship between neighborhood deprivation and growth, with the mediation effect varying by posttraumatic stress levels in AYA CCS.

These findings uncovered the significant impact of neighborhood-level SDoH on post-cancer resilience outcomes in AYA CCS, along with the complex influence of neuropsychological factors during the process.

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INTRODUCTION

Problem Statement

Adolescent and young adult childhood cancer survivors (AYA CCS) develop unique post-cancer resilience as they transition into adulthood, influenced by their experiences with cancer diagnosis and treatment. Resilience is defined as a process leading to an outcome by successfully adapting to difficult or challenging life experiences – such as cancer experiences – through emotional and behavioral adjustment to external and internal demands.[1] This resilience has two dimensions in this study: behavioral and psychological/emotional. Behavioral resilience, particularly in terms of ***healthcare transition***, is vital for AYA CCS to manage their health independently as they move from pediatric to adult-centered care.[2,3] This process requires them to take responsibility for ongoing medical care, manage potential late effects of cancer treatments, and communicate independently with healthcare providers.[4–6] On the psychological/emotional aspect, ***posttraumatic growth*** represents emotional resilience. Survivors not only cope with the trauma of their cancer experiences but also experience personal growth, develop a strengthened sense of self and life purpose, and improve their relationships with others. [7] Both behavioral and emotional resilience are influenced by **social determinants of health (SDoH),** such as socioeconomic status (SES), access to healthcare services, and neighborhood environments.[8,9] These SDoH may either support or hinder survivors' ability to transition successfully into adult healthcare and promote emotional recovery. For example, AYA CCS in deprived neighborhoods may face barriers such as limited access to specialized care or increased environmental stress,[10,11] which may delay their healthcare transitions and limit opportunities for emotional growth. Therefore, understanding the role of SDoH on both behavioral and psychosocial resilience is essential for promoting long-term recovery and well-being in AYA CCS. This dissertation aimed to understand the impact of social determinants on healthcare transition and posttraumatic growth among AYA CCS.

Aims of Study

1. **PAPER 1 (Aim 1):** To systematically review the literature regarding the impact of SDoH on healthcare transition readiness among AYA CCS.
    1) ***Specific Aim 1.1.*** To characterize and summarize the evidence about the impact of SDoH on healthcare transition readiness among AYA CCS.
2. **PAPER 2 (Aim 2):** To examine the impact of neighborhood-level social determinants and neuropsychological factors on healthcare transition readiness among AYA CCS.
    1) ***Specific Aim 2.1.*** To assess the influence of neighborhood-level social determinants, using the Area Deprivation Index (ADI) and the Environmental Justice Index (EJI), on healthcare transition readiness among AYA CCS.
    2) ***Specific Aim 2.2.*** To explore the potential mediating effect of posttraumatic stress and the moderating effect of neurocognitive function on the relationship between neighborhood-level social determinants and healthcare transition readiness.
3. **PAPER 3 (Aim 3):** To examine the impact of neighborhood-level social determinants on posttraumatic stress and growth among AYA CCS.
    1) ***Specific Aim 3.1.*** To assess the influence of neighborhood-level social determinants on posttraumatic growth among AYA CCS.
    2) ***Specific Aim 3.2.*** To examine whether posttraumatic stress mediates the association between neighborhood-level social determinants and posttraumatic growth.

Background and Significance

Adolescent and Young Adult Childhood Cancer Survivors

Approximately 15,000 children younger than 20 years are diagnosed with cancer each year in the United States.[12] With the advanced medical treatment, the overall 5-year survival rate for childhood cancer has been improved up to 85%.[13] However, due to cancer and the toxicity of its related treatments, 80% of CCS with treatment-related risks experience at least one severe, disabling, or life-threatening health complication by age 45.[14] Consequently, AYA CCS require ongoing follow-up care to optimize long-term outcomes by screening for and treating complications that may occur at any time during their lifetime.

Post-Cancer Resilience

Post-cancer resilience is defined as a process leading to an outcome by successfully adapting to difficult or challenging life experiences – such as cancer experiences – through behavioral and emotional adjustment to external and internal demands.[1]

Behavioral Resilience: Healthcare Transition among Adolescent and Young Adult Childhood Cancer Survivors. ***Healthcare Transition*****.** Healthcare transition is defined as the purposeful and planned movement of AYA with chronic diseases from pediatric to adult care settings.[2] Particularly for the population of AYA CCS, it may also indicate the movement from acute cancer care setting to long-term survivorship care setting, which also occurs at the age of adolescence and young adulthood.[3] Critical to the healthcare transition process is improving the knowledge and skills of AYA CCS for self-management, including medication knowledge and healthcare system navigation skills,[4–6] which may contribute to optimizing their health care and health outcomes in adulthood. However, only 30% of AYA CCS successfully transition to adult care[15,16], leading to poor detection of late effects, increased hospitalization, and higher mortality.[17,18] A greater understanding of the factors affecting the healthcare transition of AYA CCS is needed.

Healthcare Transition Readiness. Healthcare transition readiness refers to the level of preparedness among AYA to engage in the process of healthcare transition from pediatric to adult care settings.[19] In 2002 and 2011, the American Academy of Pediatrics, American Association of Family Physicians and American College of Physicians recommended that healthcare providers regularly assess the healthcare transition readiness of AYAs to determine the appropriate timing for this transition.[20–22] Healthcare transition readiness encompasses various competencies, including self-management of health in knowledge and skills, self-advocacy, and decision-making.[23]

Neuropsychological Factors Influencing Transition Readiness*: *Posttraumatic Stress Factors Influencing Healthcare Transition Readiness. AYA CCS are at a higher risk for posttraumatic stress compared to AYA with other mild chronic diseases, as the diagnosis and treatment of cancer represent particularly stressful and life-threatening experiences.[23] The experience of cancer involves chronic and multiple stressors that impair both physical and psychosocial functioning.[24] Even after completing curative treatment, AYA CCS continue to face cancer-related stressors, including late effects, diminished autonomy in their relationship with their parents, social isolation, and concerns about infertility.[25-27] These repeated cancer-related traumatic experiences increase the likelihood of developing posttraumatic stress in AYA CCS. The posttraumatic stress symptoms manifest as avoidance of thoughts and feelings, intrusive memories, and persistent arousal, such as insomnia. Previous studies have reported that posttraumatic stress prevalence in AYA CCS ranges from 21 to 40%.[28-30] In addition, AYA CCS are four times more likely to experience posttraumatic stress than their control groups.[9] Furthermore, prolonged posttraumatic stress lasting over one month may lead to a diagnosis of posttraumatic stress disorder (PTSD). This PTSD can heighten the risk of physical and psychological issues such as chronic pain, eating disorders, depression, anxiety, and social isolation.[31] Moreover, excessive and prolonged posttraumatic stress may impair AYA CCS' behavior outcomes such as adherence to follow-up care and treatment protocols, thereby hindering successful transition processes in this population.[32]

Neurocognitive Function Factors Influencing Healthcare Transition Readiness.

According to the Socio-Ecological Model of Adolescent and Young Adult Readiness to Transition (SMART)[9] and extensive studies on AYA with chronic diseases,[24–26] neurocognitive function is considered a key factor influencing healthcare transition readiness. The transition process involves complex neurocognitive tasks, such as managing medications, scheduling appointments, understanding medical history, and communicating with healthcare providers.[27,28] In addition, decision-making regarding treatment options and insurance coverage requires various neurocognitive abilities,[4,29] including memory, attention, executive functioning, and expressive and language skills. Evidence suggests that better neurocognitive performance is associated with improved transition readiness and higher retention rate in adult care after transition, as evidenced in AYA populations with sickle cell disease,[30] Turner syndrome,[31] congenital heart disease,[32] kidney transplantation,[33] and HIV.[34] Particularly, AYA CCS are at higher risk of neurocognitive problems as a result of their cancer treatments, such as chemotherapy, cranial radiation, and neurosurgery,[18] which may further impact their healthcare transition readiness. Therefore, it is important to consider neurocognitive function as a factor affecting transition readiness in AYA CCS.

Emotional Resilience: Posttraumatic Growth of AYA CCS

As a result of struggling with highly challenging and stressful life events, such as cancer diagnosis and treatment, AYA CCS may also experience posttraumatic growth. Posttraumatic growth is defined as a positive psychological change, such as a greater appreciation of life, closer social relationships, a sense of personal strength, spiritual development, and awareness of new possibilities.[7] These attributes of posttraumatic growth may ultimately help AYA CCS adapt to post-cancer life in survivorship. According to Tedeschi and Calhoun, the experience of posttraumatic growth does not necessarily indicate the absence of distress. Psychological distress, such as posttraumatic stress, is rather necessary for the development of growth. Given that a significant amount of stress may develop posttraumatic growth and still may coexist, posttraumatic stress and growth may have complex associations in AYA CCS. To address this knowledge gap, the purpose of this dissertation was to assess the influence of social determinants on healthcare transition readiness and posttraumatic growth among AYA CCS.

Social Determinants of Post-Cancer Resilience. ***Social Determinants of Healthcare Transition Readiness.*** According to the SMART,[9] transition readiness is influenced by various social determinants. Previous studies have primarily focused on intra- or inter-personal factors as barriers to transition, including male gender, Black[36,37] or Latinx,[35] race/ethnicity, lack of self-management skills,[38–40] personal negative feelings/emotions toward transition (e.g., fear, anxiety of transition),[41,42] long-term attachment to pediatric providers,[43] and lack of understanding about late effects of CCS among adult-centered oncology providers.[44,45] Some studies identified the lack of insurance coverage as a societal-level barrier to transition among AYA CCS.[46–48] These barriers contribute to disparities in access to healthcare during transition,[49] highlighting the importance of identifying and addressing these challenges. The SMART suggests that neighborhood-level factors, such as neighborhood deprivation, may also influence transition readiness in this population[9]; however, empirical evidence on neighborhood-level impacts remains limited.

Social Determinants of Posttraumatic Growth. Robust evidence supports that an individual's positive coping skills (e.g., positive reappraisal) and social support from family and peers facilitate individuals to develop posttraumatic growth through deliberate rumination following highly stressful and traumatic events.[50–52] In addition, evidence is emerging regarding the association of posttraumatic growth with neighborhood supportive resources (e.g., accessible care) and neighborhood socioeconomic status among those with trauma experiences of natural disasters such as tsunamis. A study conducted on adult Tsunami survivors highlighted that the social capital available in the neighborhood (e.g., accessibility to social services) can facilitate individuals in developing post-disaster recovery.[8] However, there is no study to date examining whether neighborhood environment is associated with posttraumatic growth among AYA CCS populations. Considering that the cancer diagnosis and cancer treatment are highly stressful and traumatic events for AYA CCS, many of them may experience the development of posttraumatic growth over time depending on their accessible resources from their neighborhood, family, and themselves. Therefore, it is important to consider social determinants in the context of posttraumatic growth, as these factors – such as neighborhood deprivation – can influence the ability of AYA CCS to recover and grow after cancer experiences.

Theoretical Framework

The research framework for this study outlines the hypothesized relationship between social determinants and post-cancer resilience (i.e., healthcare transition readiness and posttraumatic growth) and the role of neuropsychological Factors (e.g., neurocognitive function and posttraumatic stress) in AYA CCS (**Figure 1 and 2**). This theoretical framework is developed by synthesizing the SDoH framework of Healthy People 2030,[53] SMART,[9] and Post-traumatic Growth Theory.[7]

Healthy People 2030. Healthy People 2030 defines SDoH as "the conditions in which people are born, grow, live, work, and age that can affect their health outcomes."[53] Healthy People 2030 identifies key SDoH at both the individual and population level, including economic stability, education access and quality, health care access and quality, neighborhood/built environment, and social/community context. The hypothesized association of social determinants with healthcare transition and other related factors among AYA CCS was derived from the SDoH framework of Healthy People 2030 with a focus on population level (i.e., neighborhood?).

The SMART. The SMART applies a social-ecological framework to the healthcare transition of AYA.[9] Transition readiness indicates that AYA can begin, continue, and complete their transition process from child-centered to adult-oriented health care. The SMART consists of "preexisting factors" (sociodemographic/culture, access/insurance, medical status/risk, and neurocognitive functioning/IQ) that may influence processes of transition, "modifiable factors" (knowledge, skills/self-efficacy, beliefs/expectations, goals/motivations, relationships/communication, and emotions) and one additional factor specific to the individual AYA, developmental maturity. The hypothesized associations among neurocognitive function, emotions, such as posttraumatic stress, and transition readiness were theoretically derived from SMART.

Posttraumatic Growth Theory. *Posttraumatic Growth Theory* defines PTG as positive psychological change experienced as a result of struggling with a life crisis or traumatic event.[7] Posttraumatic Growth Theory comprises nine components: the person pre-trauma, seismic traumatic event, challenges, automatic rumination, coping success, deliberate rumination, social support, posttraumatic growth, and some enduring distress from trauma. According to PTG theory, posttraumatic growth occurs after cognitive processing with rumination over time, and social support enhances the development of posttraumatic growth. Furthermore, a person with posttraumatic growth becomes more resilient with expanded coping skills, such as healthcare transition readiness. The hypothesized relationship between posttraumatic growth and transition readiness theoretically stemmed from Posttraumatic Growth Theory.

The proposed theoretical framework of the dissertation synthesized these three frameworks, assuming that AYA CCS is in the social-ecological system of society and influenced by the system. This framework postulates that neighborhood-level social determinants may lead to changes in healthcare transition readiness and posttraumatic growth, which may be further modified by psychosocial factors, such as stress and neurocognitive function, among AYA CCS.

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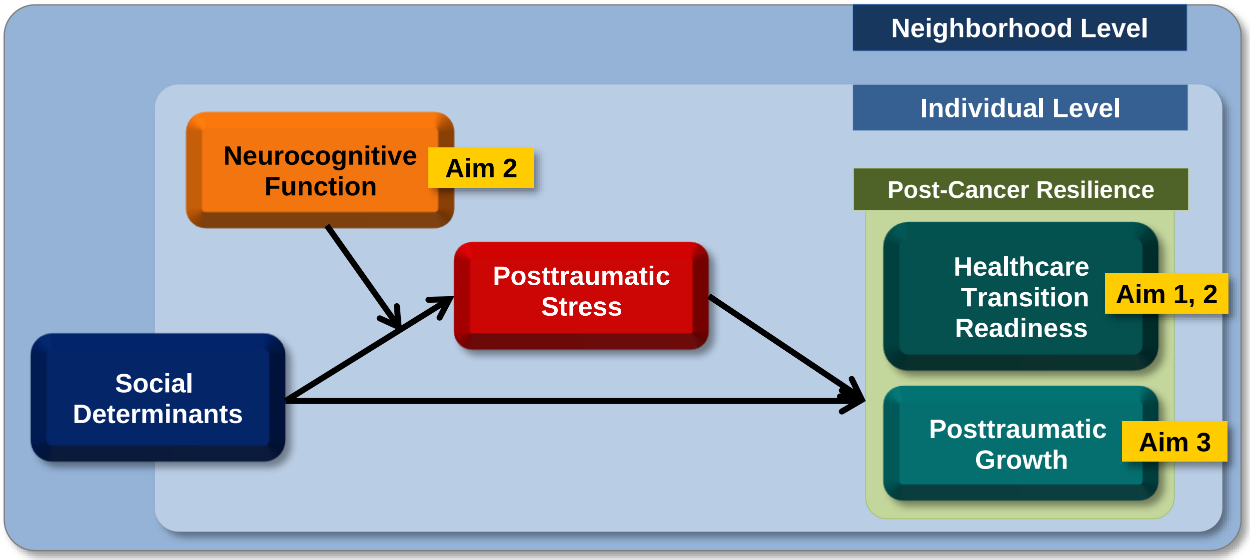

Figure 1. Overall Research Framework.

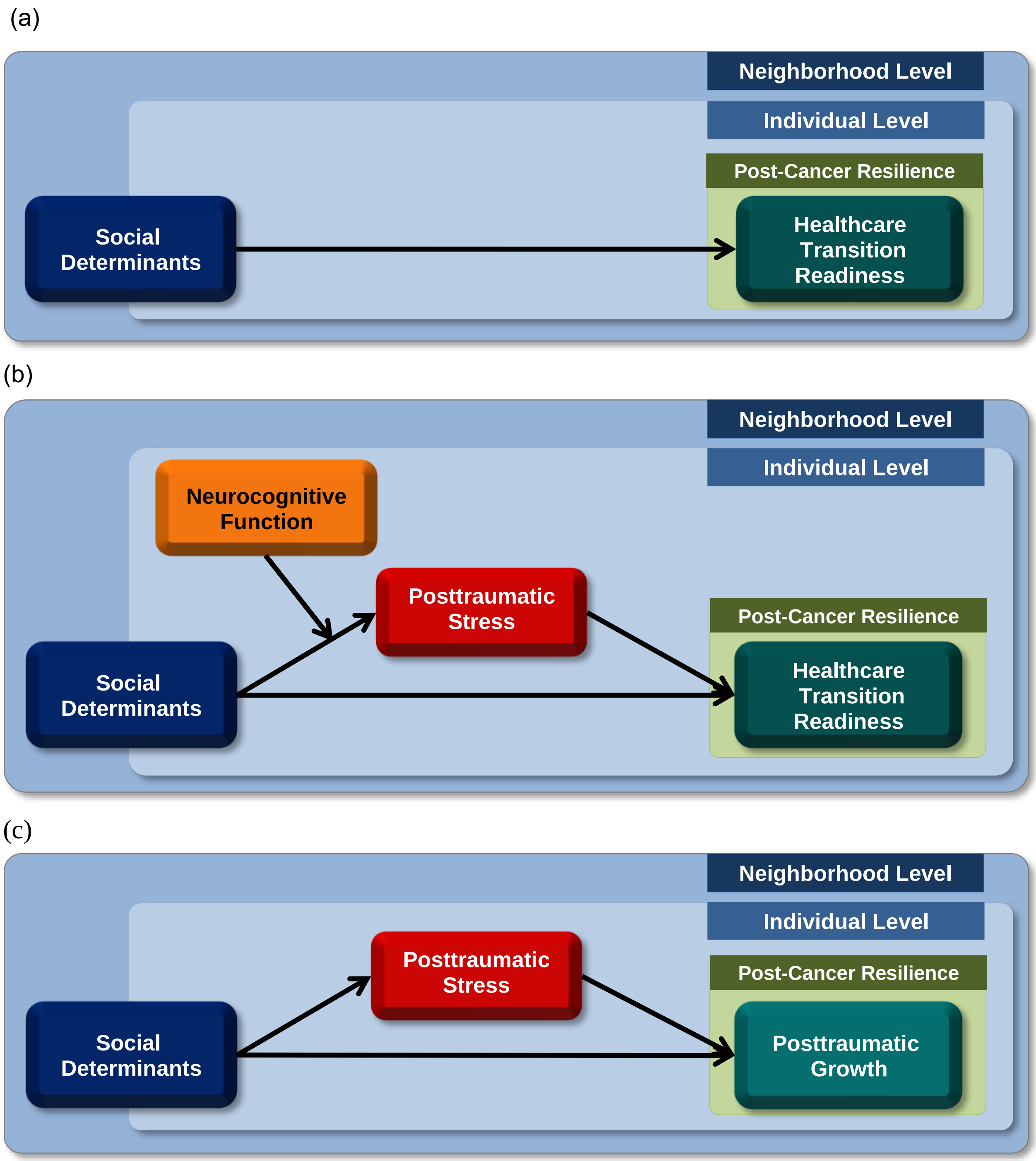

Figure 2. Research Framework.

(a) Framework of Paper 1 (Aim 1): a mixed methods systematic review about the impact of social determinants on healthcare transition readiness among AYA CCS; **(b) Framework of Paper 2 (Aim 2)**: a secondary data analysis study about the impact of social determinants on healthcare transition readiness among AYA CCS; and **(c) Framework of Paper 3 (Aim 3)**: a secondary data analysis study about the impact of social determinants on posttraumatic growth among AYA CCS.

PAPER 1

The Impact of Social Determinants on Healthcare Transition Readiness Among Adolescent and Young Adult Childhood Cancer Survivors: A Mixed Methods Systematic Review

Abstract

Background: Healthcare transition readiness is crucial for adolescent and young adult childhood cancer survivors (AYA CCS) to ensure continuity of care as they move from pediatric to adult healthcare services. A systematic review of the evidence linking social determinants of health (SDoH) and healthcare transition readiness is needed to provide valuable insights into the impact of disparities on transition.

Methods: A Mixed-Methods Systematic Review (MMSR) was conducted on studies published through April 2024, across five databases: PubMed, CINAHL, PsycINFO, EMBASE, and MEDLINE. A search strategy was developed using keywords in the following groups: (1) cancer, (2) survivor, (3) adolescent and young adult, (4) SDoH, and (5) healthcare transition readiness. Quantitative data were extracted to assess measurable outcomes related to healthcare transition readiness and SDoH, while qualitative studies exploring the perceptions and experiences of AYA CCS, their families, and healthcare providers on transition readiness were analyzed using thematic synthesis. The final synthesis followed a convergent integrated approach, guided by the Healthy People 2030 SDoH framework.

Results: The review included five quantitative cross-sectional studies and ten qualitative studies. The included studies revealed that primary caregivers’ and AYA CCS’ education level, relationships with healthcare providers, access to health insurance and healthcare services, economic stability, neighborhood income level, and parental and peer support were associated with healthcare transition readiness levels among AYA CCS.

Conclusion: This MMSR provides a comprehensive understanding of how SDoH impacts healthcare transition readiness among AYA CCS. The findings highlight the need for future research to address gaps in the current literature aiming at improving transition outcomes and reducing disparities during the transition process in this population.

Keywords: Healthcare transition, social determinants of health, adolescent, young adult, childhood cancer survivor, systematic review.

Introduction

Healthcare transition readiness refers to the level of preparedness of adolescents and young adults (AYA) to engage in the process of healthcare transition from pediatric to adult care settings.[1] This healthcare transition is critical for AYA childhood cancer survivors (CCS) to ensure their continuity of survivor care throughout adulthood,[2] as they are at risk of late effects – such as cardiovascular disease,[3,4] infertility,[5,6] subsequent malignancies,[7] cognitive impairment,[8,9] and psychological distress[10,11] – due to the toxic exposure from cancer treatment.[12] To prevent, early detect and manage these late effects, a successful healthcare transition is essential for AYA CCS to maintain adherence to long-term follow-up care.[13]

Despite the importance of healthcare transition, disparities in healthcare transition readiness have been observed in literature among AYAs with chronic conditions, including AYA CCS. Research indicates that individual-level factors such as uninsured health status and lower levels of education and income have been associated with reduced healthcare transition readiness and poorer health outcomes following the transfer to an adult care setting.[14,15] In addition, since the healthcare transition process involves multiple stakeholders – including healthcare providers (e.g., pediatric and adult oncologists, nurses) and their families – healthcare system-level[16–19] and family-level[20] factors affecting transition readiness have also been reported. However, a comprehensive understanding of how these social factors influence healthcare transition readiness in AYA CCS has not yet been systematically reviewed.

Social determinants of health (SDoH) are defined as "the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks."[21] According to the Healthy People 2030 framework, SDoH are categorized into five domains: education access and quality, health care access and quality, economic stability, neighborhood and built environment, and social and community context. Understanding how these social determinants impact transition readiness is essential, as the healthcare transition process involves a complex interplay of various social factors.[22]

Utilizing the Healthy People 2030 SDoH framework,[21] the goal of this review is to systematically evaluate and synthesize contemporary evidence on the influence of SDoH on healthcare transition readiness among AYA CCS to provide valuable insights into addressing health disparities in transition readiness in this population. A Mixed-Methods Systematic Review (MMSR) approach[23] was employed to review current literature by integrating quantitative data, which assessed measurable outcomes of transition readiness, with qualitative evidence that explored the perceptions and experiences of AYA CCS, their families, and HCP in the context of healthcare transition. This approach is essential for providing a comprehensive understanding of how SDoH influences healthcare transition readiness, identifying gaps in literature and informing future research in this area.

Methods

Design

The present MMSR was conducted to integrate quantitative and qualitative evidence to gain a deeper understanding of the impact of social determinants on healthcare transition readiness among AYA CCS. This review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)[24] guideline for quantitative studies and the Enhancing Transparency in Reporting the synthesis of Qualitative (ENTREQ)[25] Research Guidance for qualitative studies. The review protocol was registered in PROSPERO (ID: CRD42024585546).[26]

Search Strategy

A search strategy was developed using keywords in the following groups: (1) cancer, (2) survivor, (3) adolescent and young adult, (4) SDoH, and (5) healthcare transition readiness. The search was performed on literature published in English until April 1, 2024, across five databases: PubMed, CINAHL, PsycINFO, EMBASE, and MEDLINE. Detailed search terms used are listed in **Supplementary Table 1**.

Study Selection

Articles identified from the search strategy were imported to Covidence,[27] a screening and data extraction tool. Covidence automatically identified and removed duplicates. Two reviewers (G.K. and H.K.) independently performed the initial title and abstract screening in Covidence. Discrepancies in the title and abstract screening were resolved through discussion. All eligible literature from the initial screening were screened for full-text eligibility by two reviewers (G.K. and H.K.) based on the inclusion criteria as follows: (1) full-text and peer-reviewed journal articles written in English; (2) population: adolescent and young adult childhood cancer survivors. The National Cancer Institute (NCI) defines the AYA population as individuals between the ages of 15 and 39, while the World Health Organization (WHO) defines adolescence as between the ages 10 and 19 and young adulthood as between the ages of 20 and 24. This study defined the AYA CCS with a broad age range of 10 to 39 years at the time of the study enrollment. In addition, AYA CCS who were 21 years or younger at the time of cancer diagnosis were included in the eligibility criteria; (3) outcome(s): healthcare transition readiness or related outcomes such as self-management or healthcare self-efficacy; and (4) SDoH factors based on the framework of SDoH in Healthy People 2030 (e.g., education access and quality, health care access and quality, economic stability, neighborhood and built environment, and social and community context).[21] Abstracts only, editorials, case reports, conference proceedings, and other review studies were excluded from this review.

Quality Assessment

The Mixed Methods Appraisal Tool (MMAT) was used to assess the quality of the included studies.[28] The MMAT is designed to evaluate the methodological quality of different types of studies including quantitative and qualitative studies. Each study was assessed with two screening questions and five core quality criteria for each study design. Each item was rated “yes”, “no,” or “can’t tell.” For the core quality criteria, the MMAT scores were calculated from 0 % (none of the criteria are met) to 100% (all criteria are met). Two reviewers (G.K. and H.K.) independently appraised the included studies using the MMAT, and discrepancies were resolved by consensus.

Data Extraction

After the final studies from the full-text review were selected, quantitative and qualitative data were extracted by two reviewers (G.K. and H.K.). The data extracted included the first author and publication year, study design, study setting, sample size, and average age of AYA CCS participants (**Table 1**). Quantitative data extracted included the measured SDoH and healthcare transition readiness (**Table 2**). In addition, qualitative data comprised integrative themes (**Table 3**) and subthemes with corresponding quotes, which were assigned a level of credibility (**Table 4**). Any discrepancies that arose between the reviewers were resolved through discussion and consensus.

Data Synthesis and Analysis

A convergent integrated approach, according to the Joanna Briggs Institute (JBI) methodology for MMSR, was used in this review.[23] The quantitative findings were converted into ‘qualitized data’ by transforming the quantitative data into narrative interpretation. Qualitative data was synthesized using content analysis, including data coding and the development of integrated themes and subthemes. Two reviewers (G.K. and H.K.) reviewed the verbatim transcripts of interviews from the included published studies and identified similarities in data. The narrative synthesis of quantitative data and integrative thematic synthesis of the qualitative data were then assembled and categorized into themes based on similarity to create a set of integrated findings. The integrated themes were then coded and categorized into the five domains of SDoH in Healthy People 2030.[21] The five domains include (1) *education access and quality*; (2) *health care and quality*; (3) *economic stability*; (4) *neighborhood and built environment*; and (5) *social and community context*.[21]

Results

Study Inclusion

The search identified 359 articles from the five databases and 2 articles were additionally identified by citation searching. After removing 157 duplicates, we screened 204 for title and abstract eligibility and 29 were selected for full-text review. The full text of 29 articles were assessed and 14 were excluded, due to wrong study design (*n* = 2) such as intervention studies, SDoH not measured (*n* = 4), healthcare transition readiness not measured as an outcome variable (*n* = 6) and abstract only (*n* = 2). In total, 15 articles met the inclusion criteria: 10 qualitative studies and 5 quantitative studies. The study screening process is summarized in the PRISMA flow diagram **(Figure 1).**

Quality Appraisal

A quality score, calculated as the percentage of criteria met, was assigned to each study (**Table 1**). The overall quality scores for the five quantitative cross-sectional studies ranged from 60 % to 80 %, with three studies failing to achieve sample representation of the target population (e.g., reasons why certain eligible samples chose not to participate), and three studies not accounting for covariates in the statistical analysis. All qualitative studies achieved a quality score of 100 % (**Supplementary Tables 2 and 3**).

Characteristics of Included Studies and Participants

The included 15 studies were conducted mostly in Western countries (*n* = 13, 86.7%), including the USA and Canada with one study including Latin American countries. Only two studies (13.3 %) were conducted in Asia (both in China). Twelve studies collected data from AYA CCS, while four studies focused on healthcare providers (HCP), of which two qualitative studies included both AYA CCS and HCP. The sample sizes of AYA CCS participants ranged from 93 to 217 (median, 193) in quantitative studies, and from 5 to 30 (median, 19) in qualitative studies. The mean ages of the AYA CCS participants at the study enrollment, as reported in six studies, ranged from 12.98 to 27.6 years. The sample sizes of HCP participants ranged from 9 to 29 in qualitative studies. **Table 1** provides details of the characteristics of the studies included in this review.

Social Determinants of Health

The frequencies of SDoH identified in the studies are shown in **Figure 2**. Among the five quantitative studies, none comprehensively examined SDoH as a composite SDoH index incorporating all five domains of SDoH. One study measured the cumulative SDoH within three domains, including *education access and quality* (‘primary caregiver education’), *health care and quality* (‘insurance type’), *and neighborhood and built environment* (‘neighborhood income’). Approximately 3 SDoH domains (mean, 2.6; standard deviation (SD), 0.49) were examined as an independent factor in quantitative studies (**Table 2**), while 2 SDoH domains (mean, 1.6; SD 0.66) were identified in qualitative studies (**Table 3**).

Education access and quality was examined as an independent factor in 20 % (n = 3) of the studies, all of which were quantitative.[29–31] Two of these studies measured the primary caregiver's education level,[29,31] while one study measured the AYA CCS' education level,[30] using categories ranging from less than high school or above high school graduate. None of the qualitative studies reported the themes related to education access and quality.

Healthcare access and quality was assessed as an independent factor in four quantitative[30–33] and eight qualitative studies[16–18,20,34–37] (*n* = 12, 86.7 %). In quantitative studies, health insurance coverage,[30–33] healthcare provider (HCP)'s support,[32] access to a regular cancer provider,[33] and access to a survivorship clinic[33] were used as a measure of healthcare access. In qualitative studies, several themes related to healthcare access were derived, including the collaborative relationship between AYA CCS and HCP,[16,17,34–37] communication issues with HCP during the transition,[16–18,34] access to health insurance,[16,20,35] and geographic accessibility to healthcare services.[16,18]

Economic stability was examined as an independent variable in two quantitative[29,30] and one qualitative studies[20] (*n* = 3, 20 %). Specifically, the parent's work status[29] and the AYA's income level[30] were measured in quantitative studies, while economic stability to afford health care[20] emerged as a theme in a qualitative study.

Neighborhood and built environment was examined in only one quantitative study (6.7 %),[31] of which measured the neighborhood income level as part of a composite SDoH index. This composite SDoH index was calculated by summing scores across five domains, including race/ethnicity (minority or non-Hispanic white), number of caregivers (single or partnered), caregiver education level (≤ high school degree or > high school degree), insurance (public/Medicaid or private), and neighborhood income level (low or average/high).

Social and community context was investigated in three quantitative[29,32,33] and six qualitative[20,34–38] studies (n = 8, 60 %). In quantitative studies, peer support,[29,32] family support,[32] involvement in health care,[33] and overall social support[33] were measured. In qualitative studies, key themes identified within social and community contexts included parental support in healthcare transition[20,34–37] and supportive relationships with peer survivors.[35,38]

Healthcare Transition Readiness

Among the five included quantitative studies, healthcare transition readiness was assessed as an outcome using various measurements. Three of these studies[29,31,32] utilized instruments specifically designed to measure healthcare transition readiness, such as the Chinese TRANSITION-Q scale,[39,40] the Chinese Self-Management and Transition to Adulthood with Rx=Treatment Questionnaire (STARx),[41,42] and the Transition Readiness Inventory (TRI).[43] The other two quantitative studies[30,33] assessed specific aspects of the healthcare transition readiness construct among AYA CCS, such as knowledge of disease and treatment[44] and disease self-efficacy.[45] In the ten included qualitative studies, participants were interviewed about their experiences and perceptions of healthcare transition or healthcare transition readiness.[16–20,34–38]

Association Between Social Determinants of Health and Healthcare Transition Readiness

Education Assess and Quality

Overall, no significant impact of education access and quality on healthcare transition readiness was identified among AYA CCS.[29–31] For example, Prussien et al.[31] reported that no statistical difference in healthcare transition readiness was found between AYA CCS whose caregiver had an education level above high school (mean = 49.46, *SD* = 9.08) and those whose caregiver had high school education or less (mean = 51.91, *SD* = 10.81).

Health Care Access and Quality

The effect of healthcare access and quality on healthcare transition readiness were examined using access to healthcare insurance, [16,20,30,32,33,35] geographic accessibility to healthcare services,[16,18,33] and relationship with HCP[16–18,32,34–37] among AYA CCS. Regarding the impact of health insurance, mixed findings were observed in the included quantitative studies.[30–33] For instance, Ganju et al.[30] reported that having health insurance was not associated with knowledge of disease diagnosis and treatment. In contrast, Ma et al.,[32] Miller et al.,[33] and Prussien et al.[31] found that AYA CCS with health insurance tended to report greater healthcare transition readiness. Specifically, in the study of Prussien et al.[31], having private insurance was significantly associated with higher transition readiness compared to having public or Medicaid. In qualitative studies, AYA CCS participants expressed concerns about changes in health insurance during their transition period, particularly as a result of leaving their parents' insurance.[16,20,35] For example, in a study by Sadak et al.[35], an AYA CCS participant mentioned, *"I was going through a time where I would be leaving my parents' insurance, and so I was concerned about getting health insurance and if I would even qualify for health insurance as someone who [had] cancer."* Another participant said, *"The more specialized visits; I know I will need to get a referral from my provider that's listed on my insurance to get an orthopedic visit scheduled, so it's a lot of back and forth, mainly because* *of the insurance issues and what they accept and what they don't accept,"* indicating the challenges of navigating insurance issues during the transition.

The impact of geographic accessibility to healthcare services was positively associated with health-related self-efficacy among AYA CCS in a study by Miller et al.,[33] measured by access to a survivorship clinic ($\beta = 0.61$, SE = 0.22, $p < 0.01$) and a regular cancer provider ($\beta = 0.90$, SE = 0.19, $p < 0.001$). In one qualitative study conducted in Canada,[18] a pediatric oncologist highlighted the difficulties in finding accessible healthcare services for AYA CCS during the transition period, stating that "*I find that on the west coast [of Newfoundland and Labrador], or outside of St. John's, with the patients that we see in our traveling clinics ... the family physicians are so in flux in rural communities that most of these patients don't have a family physician and often we're [the pediatric medical team] the only people that they see,"* indicating the challenges in accessing primary care providers (PCP) in communities during transition and the potential negative impact on the healthcare transition process.

Regarding the relationship with HCP, Ma et al.[32] found that HCP support was positively associated with health care engagement, which is a subscale of the healthcare transition readiness measurement, mediated by patient activation. Integrative themes regarding the impact of the relationship with HCP on healthcare transition readiness emerged strongly in qualitative studies.[16–18,32,34–37] In a qualitative study conducted in New England,[34] AYA CCS participants emphasized the importance of a collaborative relationship with HCP during the transition process, highlighting the crucial role of providers' thorough understanding of childhood cancer history and potential late effects. Conversely, the same study[34] found that some AYA CSS participants underscored the negative impact of ineffective communication with HCP, particularly when their PCP or adult providers lacked comprehensive knowledge of survivorship and appropriate cancer history-based surveillance.

Economic Stability

A quantitative study examining the association between income and healthcare transition readiness found that lower income levels among AYA CCS were more likely to report poor healthcare transition readiness. This finding was also reflected in a qualitative study among parents of AYA CCS, who perceived financial stability as a critical factor in maintaining self-management skills such as adherence to medications during the transition process.[20] In addition, parental work status was assessed in one quantitative study,[29] which found that AYA CCS with both parents employed were more likely to exhibit lower healthcare transition readiness, compared to those with one or neither parent employed ($p < 0.05$).

Neighborhood and Built Environment

In a quantitative study by Prussien et al.,[31] AYA CCS residing in neighborhoods with average or high-income levels reported higher transition readiness, compared to those in low-income neighborhoods ($p > 0.05$). No qualitative findings regarding the impact of neighborhood and built environment were reported in the included studies.

Social and Community Context

Overall, the impact of social and community context on healthcare transition readiness was assessed through the associations between family and peer support and transition readiness among AYA CCS in the included quantitative studies.[29,32,33] In a study by Ma et al.,[32] family support was positively associated with healthcare engagement, a subscale of healthcare transition readiness. Peer support also showed a positive association with healthcare transition readiness, particularly in subscales such as healthcare engagement, provider communication, and disease knowledge. In qualitative studies, parental support was identified as a key theme in half of the qualitative studies. [20,34–37] AYA CCS participants highlighted that parental involvement is crucial for facilitating a smooth transition to adult care settings, especially in navigating changes in health insurance and enhancing communication with healthcare providers. Supportive relationships with peer survivors[35,38] were also found as an integrative theme that explains the role of peer survivors in healthcare transition among AYA CCS. One AYA CCS participant from a study by Rossell et al.[38] emphasized that interactions with other peer survivors offered an opportunity to learn from others' similar experiences regarding late effects during the transition periods: "… *the other day talking with some of my friends who are also survivors I noticed that I was not the only one [with tachycardia], which was strange because it is something that the doctors never talked about, for example, I feel that my bones got damaged because I get tired more easily, my knees crack, or little things like that… I notice that since I finished chemotherapy, I get mouth blisters more often… sometimes talking among my friends who are also survivors, they also tell me what is going on with them, and sometimes they ask their doctors, but it is them who ask, not the doctors themselves who tell them, and the doctors would confirm that yes, those were sequelae.*[38]

Discussion

This MMSR investigated and synthesized evidence from fifteen papers across seven countries regarding the impact of SDoH on healthcare transition readiness among AYA CCS, using the SDoH framework of the Healthy People 2030. Synthesized evidence from qualitative and quantitative data revealed that collaborative relationships with HCP, geographic accessibility to healthcare services, economic stability to afford healthcare costs, residence in neighborhoods with higher average income levels, and parental and peer support are positively associated with greater healthcare transition readiness in this population. However, findings related to the impact of education access and quality and access to health insurance remain inconclusive, with mixed findings reported across studies. In addition, each SDoH domain was assessed using a limited set of factors, which may not fully account for the complexity of SDoH influencing healthcare transition readiness. For example, education access and quality were only measured by the education levels of AYA CCS or their parents, neglecting other potentially influential factors that may be related to education aspects, such as health literacy and accessible educational or training opportunities. In the neighborhood and built environment domain, only one quantitative study was identified, limiting the generalizability of the evidence. Our review addresses these substantial gaps in understanding how SDoH impact healthcare transition readiness, offering a comprehensive assessment of the current state of scientific evidence on this topic and identifying the areas needing further research.

Education access and quality was examined using the education levels of AYA CCS and caregivers, including their parents, in three quantitative studies. However, no significant impact of education levels on healthcare transition readiness was found in the included studies. This finding aligns with the results of a recent scoping review,[46] published in the journal of the American Academy of Pediatrics (AAP), which identified the associations between social and structural SDoH and outcomes for transitioning to adult care among AYA with chronic health conditions including CCS. This scoping review reported that education level was examined as an SDoH factor in 15 out of 101 studies (15 %), and no significant association was found between education level and transition outcomes such as self-management skills and health-related self-efficacy. While education level may not have a direct influence on healthcare transition readiness, health literacy has been found to be associated with transition readiness, particularly in areas such as communication skills with healthcare providers as observed in studies among AYA with chronic kidney disease and spina bifida.[47–49] Health literacy level may influence developing transition readiness, as it can help AYA navigate adult-centered healthcare services and make informed healthcare decisions during the transition period.[49] Furthermore, this health literacy has been found to be highly correlated with the education level of AYA CCS,[50] which may further affect healthcare transition readiness. To better understand the complex dynamics of *education access and quality* within the context of healthcare transition, future research is needed to assess a broader range of factors beyond educational levels, such as health literacy and access to educational resources that may also influence healthcare navigation skills.

The impact of *healthcare access and quality* on healthcare transition readiness was examined mostly using the quality of relationships with HCP. A collaborative relationship with HCPs during the transition process consistently emerged as a key factor across the included studies. Specifically, HCP's knowledge of late effects was identified as a critical factor influencing the quality of the relationship between AYA CCS and HCP, which in turn may affect healthcare transition readiness among AYA CCS. To improve the knowledge and skills of HCPs, particularly PCP in community settings, in managing long-term care for AYA CCS, the Children's Oncology Group (COG) has developed comprehensive Long-Term Follow-Up Guidelines. These guidelines recommend that PCPs implement evidence-based surveillance and health care for survivors[51] and collaborate with oncology specialists to facilitate a successful transfer to adult-oriented survivorship care.[2] Despite the existence of the

COG guidelines to assist PCPs in caring for survivors, studies have shown that many PCPs are unfamiliar with these surveillance guidelines and feel uncomfortable managing care for CCS.[52,53] Therefore, to further promote the use of COG guidelines in clinical settings, it is necessary to evaluate the actual utilization rate of the COG guidelines among PCPs and to explore their experiences in implementing the guidelines when caring for AYA CCS in community settings.

Access to health insurance was another key factor influencing healthcare transition readiness within the *healthcare access and quality* domain, and it may be closely linked to the *economic stability* domain, including employment and income level of AYA CCS and their parents. Although none of the included studies examined the interaction between health insurance and the economic status of AYA CCS, both health insurance and economic stability have been highlighted as critical factors in affording long-term healthcare costs, particularly as AYA CCS are at risk for late effects throughout adulthood. However, many AYA lose their health insurance during the transition period, causing multiple challenges for this vulnerable population such as increased financial burdens due to medical costs and delays in preventive care or early detection of health issues.[54] These problems can lead to a series of negative consequences, including higher hospitalization rates, further financial strain, and poorer long-term survivorship outcomes.[55,56] Since 2010, the implementation of the Patient Protection and Affordable Care Act (ACA) has significantly improved access to health insurance in AYA CCS as they transition into adulthood by expanding employer-sponsored parental coverage for dependents up to age 26 years.[57] However, while the uninsurance rate among AYA CCS has declined since ACA was enacted, disparities remain in some states that have not adopted Medicaid expansion or have only partially expanded coverage.[58,59] For example, Georgia implemented a partial Medicaid expansion in 2023, which limits access to comprehensive health coverage for AYA CCS by requiring them to engage in 80 hours of work per month to qualify for and maintain Medicaid coverage.[60] For AYA CCS who may be struggling with multiple late effects and health issues, fulfilling these work requirements can be challenging. This inconsistency and disparities in insurance availability across the nation can cause significant risks for AYA CCS, particularly during their transition periods. Specifically, the lack of health insurance may hinder access to healthcare providers who are knowledgeable and skillful for managing late effects and supporting AYA CCS.[59] Future studies are needed to examine how insurance instability impacts healthcare access and transition readiness among AYA CCS, with comparisons of transition outcomes across states based on their Medicaid expansion policies. Insights from these studies may provide valuable evidence on how varying insurance policies influence healthcare transition readiness and long-term health outcomes in this vulnerable population.

This review revealed that the association between *neighborhood and built environment* and healthcare transition readiness among AYA CCS has been studied to a limited extent. Prussien et al.[31] conducted the only study investigating neighborhood factors, specifically, examining the impact of neighborhood income levels on healthcare transition in AYA CCS. Prussien et al.[31] reported that higher-income neighborhoods were associated with greater healthcare transition readiness in this population. The paucity of literature on this topic is also highlighted in a recent scoping review, identifying only one other study[61] that examined neighborhood poverty and its association with age at transfer to adult-focused PCP visits among 60,233 AYA both with and without chronic conditions. This study found that AYA living in low-income neighborhoods transferred at older ages and had longer transfer gaps than AYA in higher-income neighborhoods.[61] This finding suggests that low-income neighborhoods have potential adverse impact on proactive and preventive healthy behaviors of AYA, such as healthcare transition readiness or regular PCP visits during transition periods. Although the underlying mechanisms between neighborhood income levels and transition outcomes were not explored in either study, we hypothesize that neighborhood poverty may serve as an indicator of barriers to accessing healthcare services, educational opportunities, transportation, and social cohesion and support. While these factors could influence healthcare transition readiness and health outcomes of AYA CCS, there was limited evidence available on the effect of *neighborhood and built environment* on healthcare transition readiness. Therefore, more research is needed to investigate these relationships in future studies.

In the *social and community context* domain, parental support was positively associated with healthcare transition readiness among AYA CCS. Qualitative studies involving AYA CCS,[17,18,34–38] parents,[20] and HCP[16–19] highlighted the importance of maintaining a balanced parental role during the transition process. Both an abrupt transfer of healthcare responsibility from parents to AYA CCS and prolonged dependence on parental involvement in healthcare management were identified as barriers to achieving healthcare transition readiness in this population. Parental support is influenced by multiple factors, including parental characteristics (e.g., parental health literacy,[62] psychosocial status[63]), AYA-specific factors (e.g., health conditions, complexity of care required for AYA CCS),[64] family dynamics (e.g., family structure, socioeconomic status, cultural beliefs regarding family roles),[65] and health system factors (e.g., relationships with HCP, availability of transition programs).[66] Given the complex and dynamic nature of parental support in healthcare among AYA CCS, future studies are needed to thoroughly explore the role of parental support in the context of healthcare transition. Understanding the underlying mechanisms of parental support in healthcare transition is needed to develop family-centered transition interventions tailored to the needs of AYA CCS and their families during the transition process.

This MMSR has a few limitations. Due to the significant heterogeneity in the data, particularly the variation in outcome measurements across quantitative studies, conducting a meta-analysis of effect sizes was not practical. Consequently, a narrative synthesis approach was employed to analyze the quantitative data. In addition, only English language articles were reviewed and included in this review, which results in the exclusion of relevant studies published in other languages and possibly causes language bias. Lastly, despite an extensive search, this review yielded five quantitative studies, highlighting the limited quantitative research conducted on this topic and emphasizing the need for further empirical investigation.

Conclusion

Our MMSR found evidence that SDoH is associated with healthcare transition readiness among AYA CCS. Overall, the findings of this review highlight the importance of addressing SDoH to reduce disparities in healthcare transition readiness within this population. Notably, of the five SDoH domains outlined in Healthy People 2030, 80% of the included studies focused on *healthcare access and quality* (e.g., access to/availability of transition care, the role of HCP in transition), while 60% explored *social and community context* (e.g., parental and peer support) in relation to healthcare transition readiness. However, certain domains – such as *neighborhood and built environment, education access and quality, and economic stability* – have been understudied within the context of healthcare transition readiness in this population. Future studies should explore and prioritize the five domains of SDoH and their impact on healthcare transition readiness in order to address existing disparities and inform the development of targeted transition programs. In addition, longitudinal studies are recommended to examine the long-term effects of SDoH on healthcare transition readiness in this population. Furthermore, using composite SDoH indices, such as the Area Deprivation Index (ADI) or Environmental Justice Index (EJI), to provide a more comprehensive understanding of the impact of SDoH on healthcare transition readiness in AYA CCS would be helpful.

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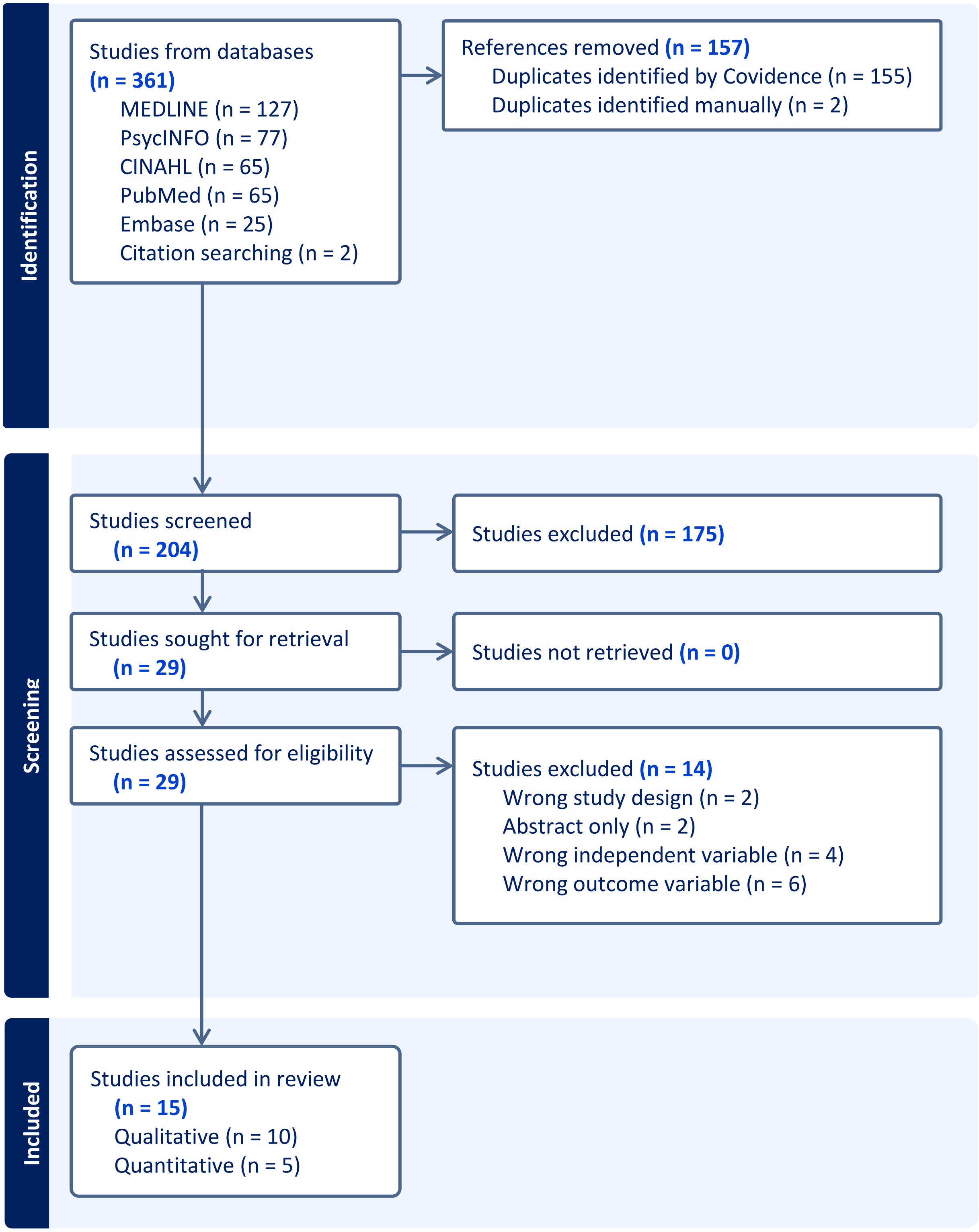
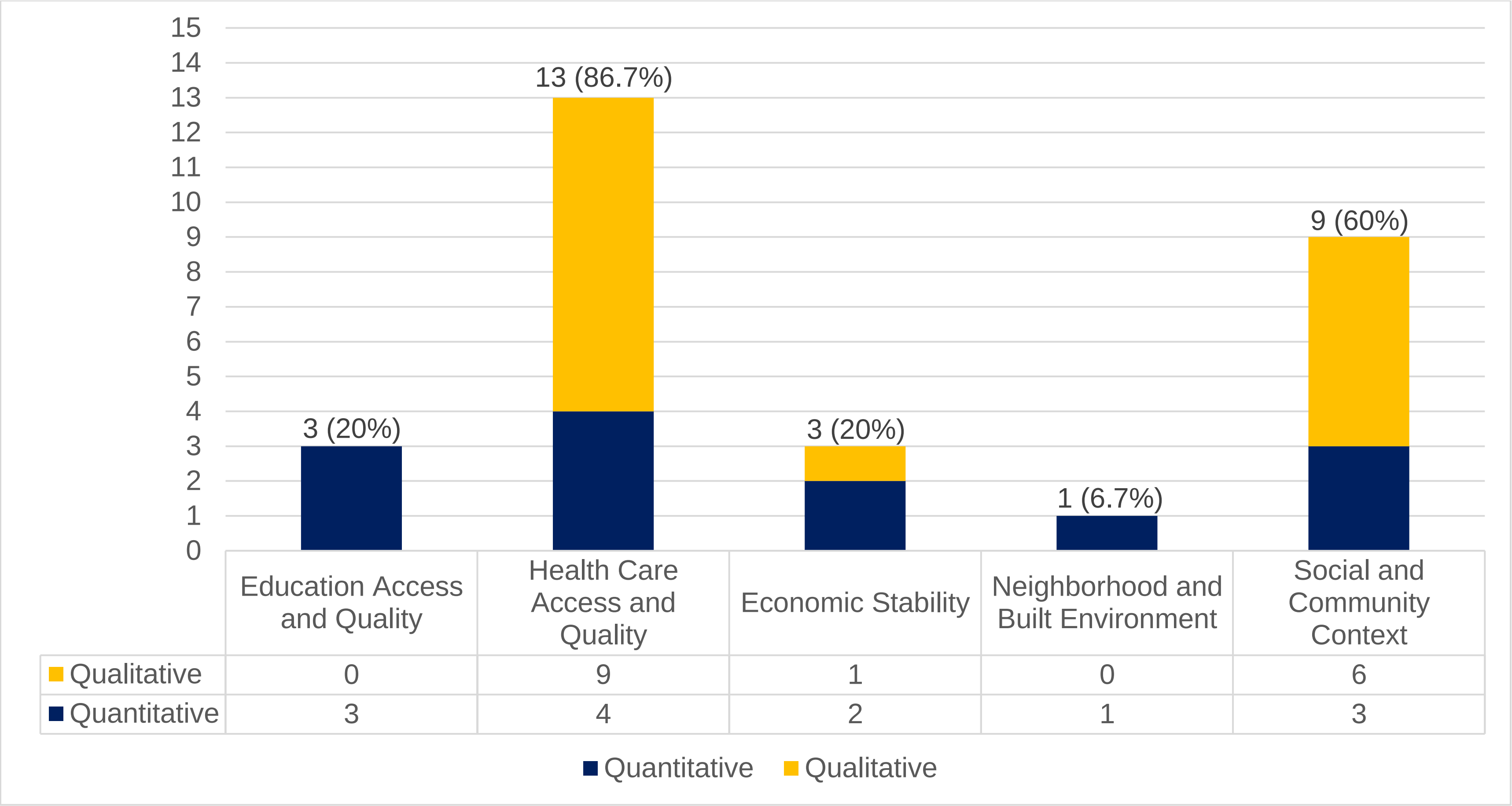


Figure 1. PRISMA flow diagram of the screening and study inclusion process.



	Education Access and Quality	Health Care Access and Quality	Economic Stability	Neighborhood and Built Environment	Social and Community Context
■ Qualitative	0	9	1	0	6
■ Quantitative	3	4	2	1	3

Figure 2. The frequency of social determinants identified in qualitative and quantitative studies.

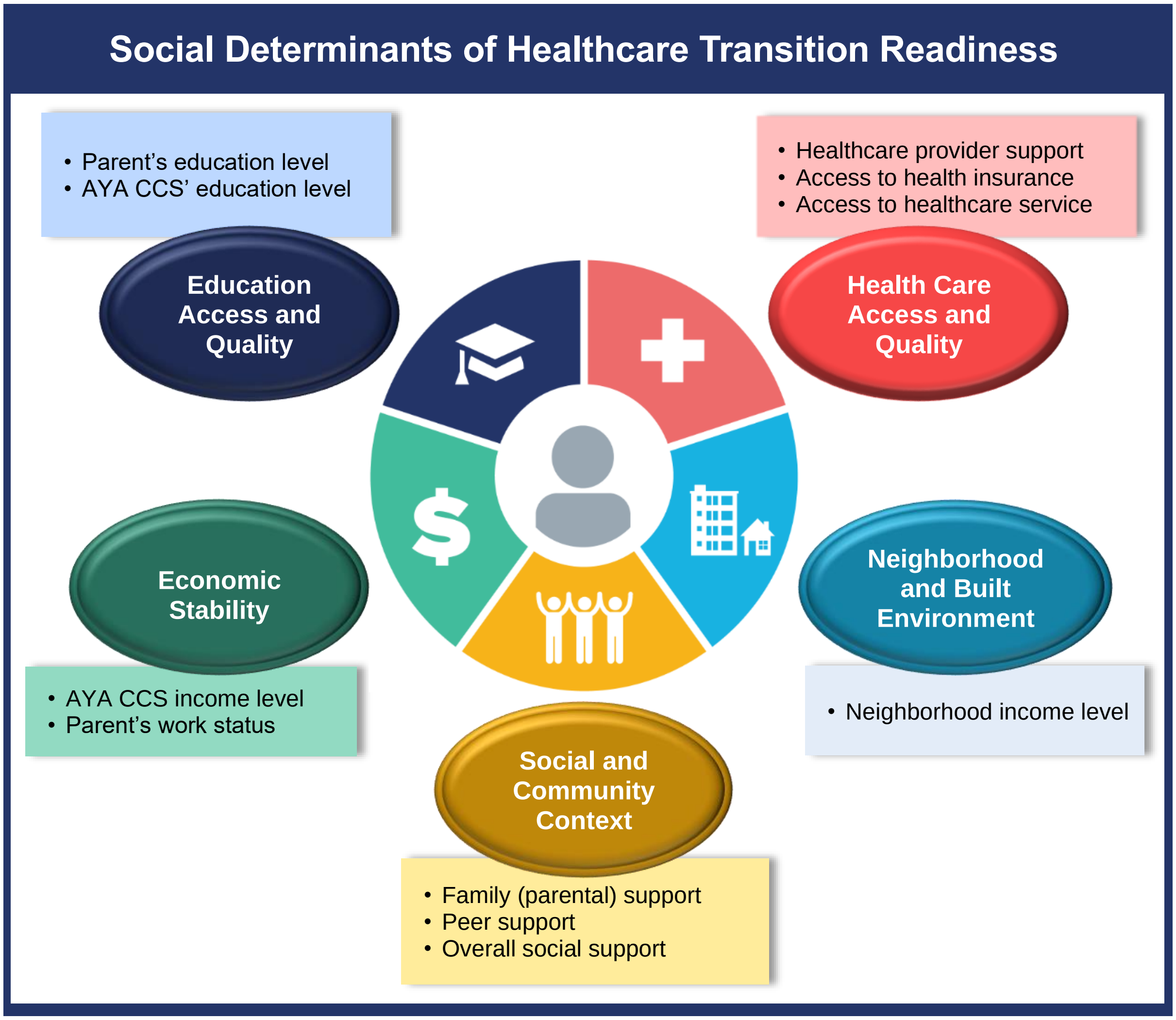


Figure 3. Social determinants of healthcare transition readiness in literature.

Note. Centered figure from Healthy People 2030, U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Retrieved [September 13, 2024], from https://health.gov/healthypeople/objectives-and-data/social-determinants-health

Table 1. Characteristics of Included Studies (*N* = 15).

First Athor	**Year**	**Study Design**	**Country**	**Study population**	**Sample size**	**Mean age (*SD*) or range or *n* (%) at the study enrollment**	**Study Quality**
Cheng[29]	2023	Quantitative Cross-sectional	China	AYA CCS	139	mean age: 14.11 years range: 12-18 years	80 %
Ganju[30]	2016	Quantitative Cross-sectional	USA	AYA CCS	93	23.63 years (*SD* 2.75)	60 %
Ma[32]	2024	Quantitative Cross-sectional	China	AYA CCS	217	12.98 years (*SD* 2.55)	80 %
Miller[33]	2017	Quantitative Cross-sectional	USA	AYA CCS	193	mean age: NR 15-20 years: *n* = 114 (59.10 %) 21-25 years: *n* = 79 (40.93 %)	80 %
Prussien[31]	2022	Quantitative Cross-sectional	USA	AYA CCS	195	19.67 years (*SD* 2.79)	80 %
Frederick[34]	2017	Qualitative	USA	AYA CCS	16	27.6 years (*SD* 4.7)	100 %
Howard[17]	2018	Qualitative	Canada	AYA CCS	30	mean age: NR 20-29 years: *n* = 13 (43 %) ≥ 30 years: *n* = 17 (57 %)	100 %
				HCP	13	NR	100 %
Mouw[16]	2017	Qualitative	USA	HCP	20	NR	100 %
Rossell[38]	2021	Qualitative	El Salvador, Mexico, Peru	AYA CCS	30	mean age: NR range: 13-31 years	100 %
Ryan[18]	2021	Qualitative	Canada	AYA CCS	5	NR	100 %
				HCP	9	NR	100 %
Sadak[19]	2017	Qualitative	USA	HCP	29	NR	100 %
Sadak[35]	2020	Qualitative	USA	AYA CCS	29	mean age: NR 18-24 years: *n* = 16 (55.17 %) ≥ 25 years: *n* = 13 (44.83 %)	100 %
Sadak[20]	2021	Qualitative	USA	Parents	26	NR	100 %
Viola[36]	2022	Qualitative	USA	AYA CCS	19	22.8 years (*SD* 1.6)	100 %
Walsh[37]	2019	Qualitative	USA	AYA CCS	13	mean age: NR range: 19-27 years	100 %

Note. SD, Standard deviation; AYA CCS, adolescent and young adult childhood cancer survivors; HCP, healthcare professionals; NR, not reported.

Table 2. Impact of Social Determinants on Healthcare Transition Readiness in Quantitative Studies (*N* =5).

	Social Determinants of Health					**Healthcare Transition Readiness**	
First Author (year)	**Education access and quality**	**Health care and quality**	**Economic stability**	**Neighborhood and built environment**	**Social and community context**	**Measurement**	**Results (Qualitized data)**
Cheng (2023)[29]	• Primary caregiver education level	NR	• Parent work status	NR	• Peer relationship	• Chinese TRANSITION-Q scale • Higher score indicates higher transition readiness	• AYA CCS whose primary caregiver's education level was less than high school were more likely to have low transition readiness ($p > 0.05$). • AYA CCS with both parents employed were more likely to have low or medium transition readiness, compared to those with only one parent or neither parents employed ($p < 0.05$). • The level of functioning in peer relationships were similar in transition readiness profiles (low vs. medium vs. high transition readiness) ($p > 0.05$).
Ganju (2016)[30]	• AYA education level	• Insurance type	• AYA income level	NR	NR	• Patient Knowledge Survey • Higher score indicates higher knowledge of disease, treatment, health risks, and history of survivor-focused health care visit	• AYA CCS with incomes between \$10,000 and \$24,999 had decreased knowledge of diagnosis, compared to those with incomes between \$25,000 and \$49,999 and above >\$50,000 (OR = 0.17, p = 0.03). • AYA CCS' education level and insurance type were

First Author (year)	Social Determinants of Health: Education access and quality	Health care and quality	Economic stability	Neighborhood and built environment	Social and community context	Healthcare Transition Readiness: Measurement	Results (Qualitized data)
							not associated with their knowledge of diagnosis.
Ma (2024)[32]	NR	- Insurance type - Healthcare provider support	NR	NR	- Peer support - Family support	- Self-Management and Transition to Adulthood with Rx = Treatment Questionnaire (STARx) - Higher score indicates higher transition readiness - Four dimensions: medication management, health care engagement, provider communication, and disease knowledge	- In AYA CCS, urban medical insurance was positively associated with transition readiness ($t = 2.15$, $p = 0.03$). - Student, rural, and commercial medical insurance were not associated with transition readiness. ($p > 0.05$). - Social support was not directly associated with transition readiness but indirectly associated through the mediating effect of patient activation ($\beta = 0.1701$, 95% CIs 0.0770, 0.2640). - Family support was positively associated with health care engagement, mediated by patient activation. - Peer support was positively associated with health care engagement, provider communication, and disease knowledge, mediated by patient activation. - Healthcare provider support was positively

	Social Determinants of Health					Healthcare Transition Readiness	
First Author (year)	**Education access and quality**	**Health care and quality**	**Economic stability**	**Neighborhood and built environment**	**Social and community context**	**Measurement**	**Results (Qualitized data)**
							associated with health care engagement mediated by patient activation.
Miller (2017)[33]	NR	• Health insurance • Access to regular cancer provider • Access to survivor-ship clinic	NR	NR	• Family involvement with health care • Overall social support	• Stanford Patient Education Research Center Chronic Disease Self-Efficacy scales • Higher score indicates higher perceived confidence in healthcare	• In univariate analyses, higher healthcare self-efficacy was associated with: 1) having any type of health insurance ($\beta = 0.57$, SE = 0.25, $p < 0.05$) 2) higher social support ($\beta = 0.32$, SE = 0.16, $p < 0.10$) 3) higher family involvement with healthcare ($\beta = 0.30$, SE = 0.31, $p > 0.05$) 4) access to survivorship clinic ($\beta = 0.61$, SE = 0.22, $p < 0.01$) 5) access to regular cancer provider ($\beta = 0.90$, SE = 0.19, $p < 0.001$) • In multivariate analyses, higher healthcare self-efficacy was associated with: 1) access to survivorship clinic ($\beta = 0.45$, SE = 0.22, $p < 0.01$)

	Social Determinants of Health					Healthcare Transition Readiness	
First Author (year)	**Education access and quality**	**Health care and quality**	**Economic stability**	**Neighborhood and built environment**	**Social and community context**	**Measurement**	**Results (Qualitized data)**
							2) access to regular cancer provider ($\beta = 0.64$, SE = 0.24, $p < 0.01$)
Prussien (2022)[31]	• Primary caregiver education	• Insurance type	NR	• Neighborhood income level	NR	• Transition Readiness Inventory (TRI) • Higher score indicates higher transition readiness	• AYA CCS whose caregiver education level was high school graduate or below reported higher transition readiness, compared to those with caregivers whose education level was above high school ($p > 0.05$). • AYA CCS with private insurance reported significantly higher transition readiness, compared to those with public/Medicaid insurance ($p < 0.05$). • AYA CCS living in a neighborhood with average or high-income levels reported higher transition readiness, compared to those in a neighborhood with low-income levels ($p > 0.05$).

Note. NR, not reported; AYA, adolescents and young adults; CCS, childhood cancer survivors; HTR, healthcare transition readiness; OR, odds ratio; SE, standard error.

Table 3. Thematic synthesis of qualitative themes on adolescent and young adult childhood cancer survivors' perceived impact of social determinants on healthcare transition readiness (N =10).

Social determinants	Integrative themes	Subthemes	Illustrative quote	Contributing studies
Health care and quality	Collaborative relationship among AYA and HCP	Support from HCP who knows about cancer survivorship	• *Yeah, I would have to say with me and my PCP it's definitely a collaborative relationship. It's—we work together to figure it out [AYA CCS].*[34] • *I get very anxious when I do go to any doctor, so I like kind of freeze up and I don't want to ask those questions. But I do have a good relationship with my doctor and she knows that about me so she knows if she tells me like—okay, these are things that may come up [AYA CCS].*[34] • *Ideally it would be nice if you could find someone that understands everything you've been through. Because I've had some effects already happen and they just look at me like oh, that shouldn't happen to someone your age, but they don't see what I've been through [AYA CCS].*[36]	[17,34–37]
		Proactive and effective communication with HCP	• *Dr. [oncologist] was talking and sharing test results and reports back with my PCP and I think she [primary care provider] finally understood what my needs were. So now she's a little bit more on the ball with… Now we've got to get this now and I think she's a little bit more aware that it may be different than say any other patient [AYA CCS].*[17]	[16,17,19]
	Communication issues with HCP during transition	Ineffective communication between AYA CCS and HCP	• *I'd say the biggest struggle with communication with doctors is sometimes things come up that the doctors don't have an explanation for and it's very discomforting to see a doctor not be able to explain something. So I think just like having doctors also be aware that they won't be able to explain everything, making that part of the conversation too, that some of these effects we don't know, but we're going to try to do our best [AYA CCS].*[34] • *We never get back anything from the primary care provider. I mean I'm sure they're incredibly busy with droves of patients. So, that makes this kind of thing hard because we don't have any follow-up. So, we don't know when we send a kid out what's going on the other side [HCP, Pediatric oncologist].*[16]	[16–18,34]

Social determinants	Integrative themes	Subthemes	Illustrative quote	Contributing studies
			• *I still had a family doctor at that point but there wasn't really any contact between them. ... the whole leukemia thing was kinda dealt with in the Janeway [cancer center] and then like, anything outside of that was just kind of taken care of by my family doctor and he didn't really know anything about the cancer, and they didn't know anything about what was going on with my family [AYA CCS].*[18]	
		Insufficient communication about late effects	• *The issue that has caused me most concern because I don't think I was as aware of it and didn't feel like it was as monitored would have been the fertility issues. And I think maybe because I was a teenager at the time those long-term effects weren't necessarily discussed with me. ... And I think that, that has caused me more concern because I felt like I wasn't as aware of it [AYA CCS].*[17] • *They're [CCS] not aware of the problem, the fact that they may develop a problem and it's not going to be for ten years or fifteen years down the line. ... They don't come back, no appointment is made and so then it's not until they actually get very sick that somebody recognizes oh, they maybe should have been followed [HCP].*[17] • *[Be]cause I feel like it was more of a miscommunication in care where maybe one person thought it was being taken care of ... or they thought it was somebody else's job, but I wasn't ever followed up. I was told I would have been and have something in place to transition children from the Janeway to the Health Sciences [Centre], or whatever the hospital that they're seen at [AYA CCS].*[18]	[17,18]
	Access to health insurance	Changes in health insurance during transition	• *I was going through a time where I would be leaving my parents' insurance, and so I was concerned about getting health insurance and if I would even qualify for health insurance as someone who [had] cancer [AYA CCS].*[35] • *The more specialized visits; I know I will need to get a referral from my provider that's listed on my insurance to get an orthopedic visit scheduled, so it's a lot of back and forth, mainly because of the insurance issues and what they accept and what*	[16,20,35]

Social determinants	Integrative themes	Subthemes	Illustrative quote	Contributing studies
			they don't accept. But I think everyone I see at the university are doing what they can [to help]. [AYA CCS].[35] • *We have an individual who's in their 20's and I ask over the phone, "What's your health insurance?" And they sort of say, "Hold on a second." You can hear them say, "Mom!?" [HCP, Social worker].*[16]	
	Geographic accessibility to health care services	Access to health care services in rural areas during transition period	• *It's a big difference [being in a rural community] because it's a 12-hour drive [to the Janeway], so to come in here every year to get the check-up, it was a big deal [AYA CCS].*[18] • *I have got a list of people whom I trust. I've got my hypertension go-to person. I've got my heart failure go-to person and I've got my skin cancer go-to person, etc. etc. But for somebody who lives 150 miles away, that's more challenging [HCP, Pediatric oncologist].*[16] • *I find that on the west coast [of Newfoundland and Labrador], or outside of St. John's, with the patients that we see in our travelling clinics ... the family physicians are so in flux in rural communities that most of these patients don't have a family physician and often we're [the pediatric medical team] the only people that they see [HCP].*[18]	[16,18]
Economic stability	Economic stability to afford health care costs	Economic status and expensive health care costs during transition	• *It's huge; it's huge, because she has so many doctor appointments, and she's on a lot of different medications. Her insurance is really expensive, and she can't afford all of her medications. So, to go to her psychiatrists it's like 250 dollars copay just for one appointment, and that's not the drugs. So she can't afford all that; she's lucky to make it work, then when she does have to go to the doctor, it's very expensive for her [Parent].*[20] • *[Child] works full-time, but it's just under the hours, and it's a small business, so he does not get health insurance. So he pays for that privately. He was under UCare, and that was a pretty good plan, but this plan now doesn't cover his prescriptions or anything, and his deductible is like 2000. ...'I don't want to go to the doctor. It's just going to be another bill for me.' And I'm sure you've seen that [Parent].*[20]	[20]

Social determinants	Integrative themes	Subthemes	Illustrative quote	Contributing studies
Social and community context	Parental support in healthcare transition	Dependence on parental support during transition	• *Oh, [my mom's] totally on top of it. 'Cause when I got sick, I couldn't handle all the medical stuff. So she did all of it...no matter how much time passes I think that she's always gonna want to be there. And I don't mind her being there [AYA CCS].*[36] • *I don't even know what insurance is anymore because my parents just deal with all of that, which is really nice. If I didn't have my parents dealing with it, I would probably be lost [AYA CCS].*[36] • *It definitely makes it easier with them, a normal teenager just having to go see a doctor once a year for their physical versus us having to go see a doctor and then a neurologist or—all different, you may have two or five, or whatever. And having someone coordinating that while you're transitioning from high school to either a job or high school to college, and not wanting to focus on that because it would possibly take away from excelling at your job or your classes or anything. So definitely having that help with scheduling all those appointments is awesome [AYA CCS].*[34]	[34–37]
		Role change for AYA CCS and parents during transition	• *So now I'm just like thinking—where is my mom? And then I'm like—oh, wait, I have to do this by myself?*[34] • *Maybe teaching parents when to back off and teaching the child that they need to be independent…they need to learn how to do this on their own [AYA CCS].*[34] • *I think then, maybe part of that treatment, when you transition, would be requiring that student, "Okay, [Child], you tell me what happened, and what you do know, and what are you supposed to do." Test them on it. Make them responsible. I just think sometimes, we don't say, "Okay, no, this is up to you [now]. It's not up to your mom, and it's not up to me." Maybe they just need a little more reinforcement of that [Parent].*[20] • *I think in general, having specifically [Mom] with [Child] as she goes through some of these things now, allows [Mom] to hand off some of the thoughts that she had at the time, that [Child] was too young to understand, that now she can take ownership of in herself [Parent].*[20]	[20,34]

Social determinants	Integrative themes	Subthemes	Illustrative quote	Contributing studies
	Supportive relationship with peer survivors	Support from peer survivors during transition	• *… the other day talking with some of my friends who are also survivors I noticed that I was not the only one [with tachycardia], which was strange because it is something that the doctors never talked about, for example, I feel that my bones got damaged because I get tired more easily, my knees crack, or little things like that… I notice that since I finished chemotherapy, I get mouth blisters more often… sometimes talking among my friends who are also survivors, they also tell me what is going on with them, and sometimes they ask their doctors, but it is them who ask, not the doctors themselves who tell them, and the doctors would confirm that yes, those were sequelae... [AYA CCS].*[38] • *I know another thing that really helped is to have the survivor conference, the annual conference. That's something that I've gone to for the last few years, and I've brought my family too. So, just feeling that all these other people that are receiving care through the same place for all different kinds of situations. So that was very helpful because it feels more like a community than an individual case, so I think that's something that's really helpful and I really look forward to going and experiencing that every year [AYA CCS].*[35]	[35,38]

Note. AYA CCS, adolescent and young adult childhood cancer survivors; HCP, healthcare provider; PCP, primary care provider.

Table 4. Summary of convergent integrated themes.

SDoH	Integrated themes	Definition of the themes	Contributing studies
Education access and quality	- Primary caregiver's education level	The relationship between the education level of AYA CCS' primary caregiver and healthcare transition readiness remains inconclusive.	[29,31]
	- AYA CCS' education level	The relationship between the education level of AYA CCS and healthcare transition readiness remains inconclusive.	[30]
Health care and quality	- Collaborative relationship between AYA CCS and HCP	Collaborative relationships among AYA CCS and HCP is built based on the shared understanding of cancer history, the need of surveillance in survivorship, and trajectory of cancer survivorship.	[16,17,32–37]
	- Communication issues with HCP during transition	Ineffective and insufficient communication between AYA CCS and HCP during transition includes the conversation with the lack of understanding of cancer history and cancer survivorship.	[16–18,34]
	- Access to health insurance	Health insurance issues include accessibility to insurance with changes in insurance during transition.	[16,20,30–33,35]
	- Geographic accessibility to health care services	Geographic accessibility to health care services for AYA CCS encompasses the access to all types of HCP including PCP, specialists, and oncologists.	[16,18,33]
Economic stability	- Economic stability to afford health care costs	Economic stability, of both parent and AYA CCS, refers to the ability to access the resources needed for health care services.	[20,29,30]
Neighborhood and built environment	- Neighborhood income level	Neighborhoods with higher income levels may be associated with higher transition readiness.	[31]
Social and community context	- Parental support in healthcare transition	Parental support in transition involves both parental involvement and role changes in health care.	[20,33–37]
	- Supportive relationship with peer survivors	Support from peer survivors refers to supportive interactions with other AYA CCS who share similar experience during transition.	[35,38]
	- Peer support from non-CCS peers	Peer support refers to supportive relationships with non-CCS peers during transition.	[29,32]

Note. AYA CCS, adolescent and young adult childhood cancer survivors; SDoH, social determinants of health; HCP, healthcare providers; PCP, primary care providers.

Supplementary Table 1. Literature Search Strategy.

Database	**Group of keywords**	**Search terms**
PubMED	Cancer	"Neoplasms"[MeSH] OR "neoplasm*" OR "cancer" OR "carcinoma" OR "adenocarcinoma" OR "sarcoma" OR "tumor"
	Survivor	"Survivors"[MeSH] OR “survivor*”
	AYA	"Pediatrics"[MeSH] OR "paediatric*" OR "pediatric*" OR "Child"[MeSH] OR "child*" OR "Young Adult"[MeSH] OR "young adult*" OR "Adolescent"[MeSH] OR "adolescent*"
	SDoH	“Social Determinants of Health”[MeSH] OR “social determinants of health” OR “Socioeconomic Factors”[MeSH] OR “economic status”[MeSH] OR “Socioeconomic*” OR “employment”[MeSH] OR “employment” OR “occupations”[MeSH] OR “occupation*” OR “Income”[MeSH] OR “income” OR"Health Literacy"[MeSH] OR “health literacy” OR"Food Insecurity"[MeSH] OR “food insecurity” OR "Poverty"[MeSH] OR “poverty” OR “housing instability”[MeSH] OR “Home Environment”[MeSH] OR “housing insecurity” OR “Educational Status”[MeSH] OR “education*” OR "Child Development"[MeSH] OR “child development” OR “child education” OR "Social Cohesion"[MeSH] OR “social cohesion” OR "Social Discrimination"[MeSH] OR “discrimination” OR "Access to Healthy Foods"[MeSH] OR “access to food*” OR “access to healthy foods” OR “Healthy Food Availability” OR "Food Deserts" [MeSH] OR “food deserts” OR “Neighborhood Characteristics”[MeSH] OR “neighborhood*” OR “neighborhood deprivation” OR “neighborhood disadvantage” OR “Social Deprivation”[MeSH] OR “Housing Quality”[MeSH] OR “housing quality” OR “Residence Characteristics”[MeSH] OR “zip code*” OR “Environmental Exposure”[MeSH] OR “environmental exposure*” OR "Crime"[MeSH] OR “crime” OR "Violence"[MeSH] OR “violence” OR “Rural Population”[MeSH] OR “Rural Health Services”[MeSH] OR “rural area” OR “rural*” OR “Health Services Accessibility”[MeSH] OR “healthcare access” OR “access to care” OR “Insurance, Health”[MeSH] OR “health insurance*” OR “health coverage”
	HTR	“Health transition”[MeSH] OR “healthcare transition” OR “transition to” OR “transfer to” OR “transition readiness”
EMBASE/ MEDLINE	Cancer	‘malignant neoplasm’/exp OR ‘neoplasm*’ OR ‘cancer’ OR ‘carcinoma’/exp OR ‘carcinoma’ OR ‘adenocarcinoma’ OR ‘sarcoma’ OR ‘tumor’
	Survivor	‘survivor’/exp OR ‘survivor*’
	AYA	‘Pediatrics’/exp OR ‘paediatric*’ OR ‘pediatric*’ OR ‘Child’/exp OR ‘child*’ OR ‘Young Adult’/exp OR ‘young adult*’ OR ‘Adolescent’/exp OR ‘adolescent*’

Database	Group of keywords	Search terms
	SDoH	‘Social Determinants of Health’/exp OR ‘social determinants of health’ OR ‘Socioeconomics’/exp OR ‘economic status’/exp OR ‘Socioeconomic*’ OR ‘employment’/exp OR ‘employment’ OR ‘occupation’/exp OR ‘occupation*’ OR ‘Income’/exp OR ‘income’ OR ‘Health Literacy’/exp OR ‘health literacy’ OR ‘Food Insecurity’/exp OR ‘food insecurity’ OR ‘Poverty’/exp OR ‘poverty’ OR ‘housing instability’/exp OR ‘Home Environment’/exp OR ‘housing insecurity’ OR ‘Educational Status’/exp OR ‘education’/exp OR ‘education*’ OR ‘Child Development’/exp OR ‘child development’ OR ‘child education’ OR ‘Social Cohesion’/exp OR ‘social cohesion’ OR ‘Social Discrimination’/exp OR ‘discrimination’ OR ‘Healthy food access’/exp OR ‘access to food*’ OR ‘access to healthy foods’ OR ‘Healthy Food Availability’ OR ‘Food Desert’/exp OR ‘food desert*’ OR ‘Neighborhood Characteristic’/exp OR ‘neighborhood*’ OR ‘neighborhood deprivation’ OR ‘neighborhood disadvantage’ OR ‘Housing Quality’/exp OR ‘housing quality’ OR ‘Residence Characteristics’/exp OR ‘zip code*’ OR ’Environmental Exposure’/exp OR ‘environmental exposure*’ OR ‘Crime’/exp OR ‘crime’ OR ‘Violence’/exp OR ‘violence’ OR ‘Rural Population’/exp OR ‘Rural Health Service’/exp OR ‘rural area’/exp OR ‘rural*’ OR ‘Health care access’/exp OR ‘healthcare access’ OR ‘access to care’ OR ‘health insurance’/exp OR ‘health insurance*’ OR ‘health coverage’)
	HTR	'transition'/exp OR ‘healthcare transition readiness’ OR ‘healthcare transition’ OR ‘transition to’ OR ‘transfer to’ OR ‘transition readiness’
PsycINFO/ CINAHL	Cancer	MA ‘Neoplasms’ OR ‘neoplasm*’ OR ‘cancer’ OR ‘carcinoma’ OR ‘adenocarcinoma’ OR ‘sarcoma’ OR ‘tumor’
	Survivor	MA ‘survivor' OR 'survivor*'
	AYA	MA ‘Pediatrics’ OR ‘paediatric*’ OR ‘pediatric*’ OR MA ‘Child’ OR ‘child*’ OR MA ‘Young Adult’ OR ‘young adult*’ OR MA ‘Adolescent’ OR ‘adolescent*’
	SDoH	MA ‘Social Determinants of Health’ OR ‘social determinants of health’ OR MA ‘Socioeconomic Factors’ OR MA ‘economic status’ OR ‘Socioeconomic*’ OR MA ‘employment’ OR ‘employment’ OR MA ‘occupations’ OR ‘occupation*’ OR MA ‘Income’ OR ‘income’ OR MA ‘Health Literacy’ OR ‘health literacy’ OR MA ‘Food Insecurity’ OR ‘food insecurity’ OR MA ‘Poverty’ OR ‘poverty’ OR MA ‘housing instability’ OR MA ‘Home Environment’ OR ‘housing insecurity’ OR MA ‘Educational Status’ OR ‘education*’ OR MA ‘Child Development’ OR ‘child development’ OR ‘child education’ OR MA ‘Social Cohesion’ OR ‘social cohesion’ OR MA ‘Social Discrimination’ OR ‘discrimination’ OR MA ‘Access to Healthy Foods’ OR ‘access to food*’ OR ‘access to healthy foods’ OR ‘Healthy Food

Database	Group of keywords	Search terms
		Availability’ OR MA ‘Food Deserts’ OR ‘food deserts’ OR MA ‘Neighborhood Characteristics’ OR ‘neighborhood*’ OR ‘neighborhood deprivation’ OR ‘neighborhood disadvantage’ OR MA ‘Social Deprivation’ OR MA ‘Housing Quality’ OR ‘housing quality’ OR MA ‘Residence Characteristics’ OR ‘zip code*’ OR MA ’Environmental Exposure’ OR ‘environmental exposure*’ OR MA ‘Crime’ OR ‘crime’ OR MA ‘Violence’ OR ‘violence’ OR MA ‘Rural Population’ OR MA ‘Rural Health Services’ OR ‘rural area’ OR ‘rural*’ OR MA ‘Health Services Accessibility’ OR ‘healthcare access’ OR ‘access to care’ OR MA ‘Insurance, Health’ OR ‘health insurance*’ OR ‘health coverage’
	HTR	MA 'transition' OR ‘healthcare transition readiness’ OR ‘healthcare transition’ OR ‘transition to’ OR ‘transfer to’ OR ‘transition readiness’

Note. AYA, adolescent and young adult; SDoH, social determinants of health; HTR, healthcare transition readiness.

Supplementary Table 2. Mixed Method Appraisal Tool (MMAT) in selected quantitative studies (*N* = 5).

Design	Methodological quality criteria	Ganju (2016)	Miller (2017)	Cheng (2023)	Prussien (2022)	Ma (2024)
Screening questions (for all types)	S1. Are there clear research questions?	Yes	Yes	Yes	Yes	Yes
	S2. Do the collected data address the research questions?	Yes	Yes	Yes	Yes	Yes
	Further appraisal may not be feasible or appropriate when the answer is ‘No’ or ‘Can’t tell’ to one or both screening questions.					
Quantitative	4.1. Is the sampling strategy relevant to address the research question?	Yes	Yes	Yes	Yes	Yes
	4.2. Is the sample representative of the target population?	No (Single institution)	No (Low enrollment rate; 50%)	Yes	No (Single institution)	Yes
	4.3. Are the measurements appropriate?	Yes	Yes	Yes	Yes	Yes
	4.4. Is the risk of nonresponse bias low?	Yes	Yes	Yes	Yes	Yes
	4.5. Is the statistical analysis appropriate to answer the research question?	No (No covariates)	Yes	No (No covariates)	Yes	No (No covariates)

Supplementary Table 3. Mixed Method Appraisal Tool (MMAT) in selected qualitative studies (*N* = 10).

Design	Methodological quality criteria	Frederick (2017)	Howard (2018)	Mouw (2017)	Rossell (2021)	Ryan (2021)	Sadak (2017)	Sadak (2020)	Sadak (2021)	Viola (2022)	Walsh (2019)
Screening questions (for all types)	S1. Are there clear research questions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	S2. Do the collected data address the research questions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Further appraisal may not be feasible or appropriate when the answer is ‘No’ or ‘Can’t tell’ to one or both screening questions.										
Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1.2. Are the qualitative data collection methods adequate to address the research question?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1.3. Are the findings adequately derived from the data?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1.4. Is the interpretation of results sufficiently substantiated by data?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

PAPER 2

The Impact of Social Determinants and Neuropsychological Factors on Healthcare Transition Readiness Among Childhood Cancer Survivors

Abstract

Objective: This study aimed to examine the impact of neighborhood-level social determinants on healthcare transition readiness among adolescent and young adult childhood cancer survivors (AYA CCS). Additionally, the potential modifying effects of neuropsychological factors (i.e., posttraumatic stress and neurocognitive function) on the association between neighborhood-level social determinants and transition readiness were assessed.

Methods: This study used secondary data collected cross-sectionally from AYA CCS (*N* = 136; age = 18 to 25 years) in a university-affiliated hospital-based survivorship program. Data was collected using the Readiness for Transition Questionnaire with subscales of ‘adolescent responsibility,’ ‘parent involvement,’ and ‘overall readiness,’ the Impact of Event Scale-Revised for posttraumatic stress, and the Childhood Cancer Survivor Study Neurocognitive Questionnaire, as well as sociodemographic/clinical characteristics (age, sex, race/ethnicity, education, income, insurance, diagnosis, and treatment history and intensity). Neighborhood-level social determinants were measured using the Area Deprivation Index (ADI) and the Environmental Justice Index (EJI).

Results: More deprived neighborhoods, indicated by higher ADI scores, were associated with greater ‘adolescent responsibility’ (β = 0.257, B = 0.006, 95% CI of B [0.002, 0.010]). The ADI showed no significant effects on ‘parent involvement’ and ‘overall transition readiness.’ The increased total EJI, indicating more deprived neighborhoods, was associated with greater ‘adolescent responsibility’ (β = 0.198, B = 0.413, 95% CI of B [0.054, 0.773]) and ‘parent involvement' (β = 0.183, B = 0.434, 95% CI of B [0.023, 0.845]), but not with 'overall healthcare transition readiness.' The 'social vulnerability' subscale of the EJI was positively associated with 'adolescent responsibility' (β = 0.183, B = 0.368, 95% CI of B [0.017, 0.720]) and 'parent involvement' (β = 0.207, B = 473, 95% CI of B [0.074, 0.872]) but showed no significant relationship with 'overall transition readiness.' A partial mediation effect of posttraumatic stress on the association between ADI and 'adolescent responsibility' was observed with a significant indirect effect (β = 0.2205, B = 0.0050, 95% CI of B [0.0012, 0.0089]). No significant mediating effect of posttraumatic stress was found on the association between EJI and each healthcare transition readiness subscale. Additionally, neurocognitive function moderated the relationship between ADI and posttraumatic stress within the mediation model (moderated mediation), suggesting that AYA CCS living in more deprived neighborhoods with low neurocognitive function was more likely to have posttraumatic stress.

Conclusion: Our study suggests that AYA CCS in more deprived neighborhoods may take on greater responsibilities in healthcare, which remained significant when AYA CCS experienced increased posttraumatic stress and had neurocognitive dysfunction. More evidence is still needed on the effects of neighborhood-level social determinants on overall transition readiness. Routine assessments of neighborhood-level social determinants and neuropsychological factors are necessary for transition planning for AYA CCS, particularly in deprived areas. Future longitudinal studies are recommended to explore the long-term effects of social determinants and neuropsychological factors on transition outcomes.

Keywords: Healthcare transition, adolescent, young adult, childhood cancer survivor, neighborhood deprivation, posttraumatic stress, neurocognitive function

Introduction

Approximately 15,000 children younger than 20 years are diagnosed with cancer each year in the United States.[1] The overall 5-year survival rate for childhood cancer has been improved up to 85%.[2] However, due to cancer and the toxicity of its related treatments, 80% of childhood cancer survivors (CCS) with treatment-related risks experience at least one severe, disabling, or life-threatening health complication by age 45.[3] Consequently, adolescent and young adult (AYA) CCS require ongoing follow-up care to optimize long-term outcomes by screening for and treating complications that may occur at any time during their lifetime. To continue follow-up care into their adulthood, healthcare transition – from pediatric cancer care to adult survivorship care[4] – is critical. This transition involves enhancing the disease knowledge and independent healthcare skills of AYA CCS to address health complications and improve survival and quality of life.[5–7] Unfortunately, studies have reported that only about 30% of AYA CCS have discussed this transition.[8,9] Poor transition in AYA CCS is associated with increased loss to follow-up and a higher risk of experiencing uncontrolled late complications.[10,11] Thus, there is a critical need to investigate factors affecting healthcare transition among AYA CCS.

Transition readiness refers to the level of preparedness of AYAs to engage in the process of healthcare transition.[12] According to the Social-Ecological Model of AYA Readiness for Transition (SMART), transition readiness is influenced by various social determinants at multiple levels, including individual (e.g., age, gender), family (e.g., family income), neighborhood (e.g., community resources), and societal factors (e.g., policy).[13] Previous studies have found that individual-level social determinants, such as Black or Latinx race/ethnicity, uninsured health status, and lower levels of education and income, were associated with lower healthcare transition readiness and poor health outcomes following transfer to an adult care setting in AYA with various chronic diseases.[14,15] These barriers contribute to disparities in healthcare transition and long-term health outcomes in AYA CCS.[16] The SMART suggests that the healthcare transition of AYA CCS may also be affected by broader social factors. For example, neighborhood deprivation, including poor access to medical care[17,18] unhealthy lifestyle features such as lower quality food and exercise, and increased exposure to risky environmental factors (e.g., alcohol consumption, smoking, pollution) may negatively influence the overall healthcare transition process. However, there is limited empirical evidence regarding the impact of neighborhood deprivation on healthcare transition readiness among AYA CCS.

In the SMART, neuropsychological factors such as psychological symptoms (e.g., posttraumatic stress) and neurocognitive function (e.g., memory, task efficiency, emotional regulation, organization) are theoretically associated with healthcare transition readiness.[13] Specifically, higher levels of stress and neurocognitive dysfunction may hinder the healthcare transition process by adversely affecting decision-making, communication with healthcare providers, or daily self-care tasks.[19–21] In addition, a growing body of literature reports that both posttraumatic stress and neurocognitive function are influenced by neighborhood-level social determinants. Evidence supports that those living in deprived neighborhoods are more likely to experience stress and neurocognitive dysfunction due to exposure to chronic stressors and poor access to protective resources such as quality food, green spaces, and healthcare services.[22,23] Taken together, evidence has suggested that neighborhood-level social determinants affect posttraumatic stress and neurocognitive function in AYA CCS, potentially influencing healthcare transition readiness. However, whether and how neuropsychological factors, such as posttraumatic stress and neurocognitive function factors, modify the association between neighborhood-level social determinants and healthcare transition readiness has not yet been studied in this population.

To address this knowledge gap, this study assessed the influence of neighborhood-level social determinants, using both the Area Deprivation Index (ADI)[24] and the Environmental Justice Index (EJI),[25] on healthcare transition readiness among AYA CCS. Furthermore, the study explored the potential mediating effect of posttraumatic stress and the moderating effect of neurocognitive function on the relationship between neighborhood-level social determinants and healthcare transition readiness.

Research Design and Methods

Study Design and Study Sample

The present study was a secondary analysis using data from the parent study (P.I.: J. G. Marchak), a cross-sectional cohort study of AYA CCS of the Aflac Cancer Survivor Program. The parent study was approved by the Children's Hospital of Atlanta (CHOA) Institutional Review Board (IRB); consents were obtained from all study participants. The inclusion criteria of the parent study were AYA CCS who were 18-25 years of age at the time of enrollment, diagnosed with cancer at ≤ 18 years of age, ≥ 2 years since the last cancer treatment, and seen at least once in the Aflac Cancer Survivor Program of Children's Hospital of Atlanta (CHOA) in the past 2 years. Those who were non-English speakers, cognitively impaired, diagnosed with CNS tumor, or unable to complete the questionnaire were excluded. A total of 286 participants were recruited for the parent study, but we only included the 136 participants who completed all questionnaires for our identified variables of interest for the analysis.

Data Collection

The original data was collected from February 2017 to July 2018 in the parent study. Eligible participants were identified from the Aflac Cancer Survivor Program institutional database and screened by research staff using information from medical records. The recruitment email was sent to eligible participants containing a link to a secure electronic consent and survey battery via the secure, web-based Research Electronic Capture (REDCap) platform[26] hosted by CHOA.

ADI and EJI ranks were calculated using participants' permanent residential addresses at the time of the survey. Utilizing the ArcGIS software program on a designated Woodruff Health Science library computer, the ADI and the EJI ranks were assigned to the participants' addresses based on the residential census block and census tract. Census tracts are subdivisions of counties for which the U.S. Census Bureau collects statistical data and are commonly used as a proxy for neighborhoods in many place-based epidemiological research.

Variables and Measures

Neighborhood-level Social determinants: The ADI[24] and the EJI[25] were coded using the participant's address and 9-digit ZIP codes. ***The ADI*** is a factor-based index that uses 17 items with U.S. census income, education, employment, and housing indicators to characterize census-based regions.[24] The ADI measure was scored from 0 to 100, with higher scores indicating a more disadvantaged neighborhood. We used the 2021 ADI version 4.0.1. that was constructed using the 2017-2021 American Community Survey 5-year estimates. Additionally, to examine interested outcome differences by ADI, ADI scores were divided into four groups with the lowest 25th representing the least deprived neighborhoods and the highest 25th percentile representing the most deprived neighborhoods. ***The EJI*** is a place-based tool designed to measure the cumulative impacts of environmental burden based on the census tract.[25]The EJI comprises

36 social, environmental, and health factors, which then are grouped into three modules. The EJI score is calculated by summing the ranked scores of three modules: Social Vulnerability (14 factors), Environmental Burden (17 factors), and Health Vulnerability (5 factors).[25] Each module was calculated with a scale from 0 to 1.[27] Overall EJI scores ranged from 0-3 by summing the scores of each module and then, the final EJI ranking was calculated into a range from 0-1. All scores were based on percentile ranks, with zero representing the lowest relative burden or vulnerability and 1 representing the highest relative burden or vulnerability. We used the EJI data released in 2022. While both ADI and EJI assess neighborhood-level social determinants, the ADI measures socioeconomic disadvantage at the census block group level and the EJI measures the cumulative impacts of environmental hazards and social vulnerabilities at the census tract group level. In addition, while most of the factors comprising ADI and the "Social Vulnerability" module of EJI are overlapped, the latter includes additional factors that ADI does not, such as minority population, linguistic isolation, and populations of children and older adults. Thus, EJI reflects broader aspects of vulnerabilities in the region compared to ADI, while ADI captures the deprivation levels more sensitively.

Healthcare transition readiness: Healthcare transition readiness was measured by the Readiness for Transition Questionnaire (RTQ).[28] The RTQ is a 22-item questionnaire to assess levels of transition readiness, health management behavior, and family involvement in health care. The measure consists of three subscales: "adolescent responsibility (RTQ-AR)" (10 items), "parent involvement (RTQ-PI)" (10 items), and "overall transition readiness (RTQ-Overall Readiness)" (2 items). Scores of the RTQ-AR and the RTQ-PI scales were each averaged to calculate subscale scores ranging from 1 ("not at all responsible/involved") to 4 ("completely responsible/involved") where higher scores indicate higher responsibility/involvement. The

RTQ-Overall Readiness was obtained by summing scores of two items ranging from 1 (“not at all ready”) to 4 (“completely ready”) and adding the results with an overall ranging from 2 to 8. Reported Cronbach’s alpha for RTQ-Overall Readiness was 0.79, for RTQ-AR was 0.86, and for RTQ-PI was 0.94.[28]

Posttraumatic stress: Posttraumatic stress was measured by the Impact of Event Scale-Revised (IES-R)[29], a 22-item questionnaire to assess traumatic distress in three subscales for “avoidance,” “intrusive thoughts,” and “hyperarousal.” The answers were based on a 5-point Likert scale, scored from 0 to 4 (0= “never” to 4= “extremely”) with a range from 0 to 88. Higher total scores indicate higher post-traumatic stress symptoms.

Neurocognitive function: Neurocognitive function was measured by the Childhood Cancer Survivor Study Neurocognitive Questionnaire (CCSS-NCQ).[30] The CCSS-NCQ was developed to determine neurocognitive outcomes in CCS and consists of 32 questions divided into four domains: task efficiency, emotional regulation, organization, and memory. A 3-point Likert scale was used with three possible responses: “Never a problem,” “Sometimes a problem,” and “Often a problem.” T-scores above the 90th percentile ($T \geq 63$) were used to define having severe problems in neurocognitive performance.[30]

Sociodemographic and clinical characteristics: Sociodemographic characteristics included self-reported gender, race/ethnicity (non-Hispanic (NH) White, NH Black, Hispanic, NH other), age at assessment, age at diagnosis, education level (high school graduate or below/some college or tech school graduate or above), employment status (yes/no), number of household, personal income (less than $9,999/$10,000-49,999/Don’t know or decline to answer), health insurance type (no insurance/private/Medicaid or other public/Don’t know) and primary care setting (pediatricians/adult physicians/family practices/college university health center/other) of AYA

CCS. For parents' characteristics, education level (high school graduate or below/some college or tech school graduate or above), and family income (less than $49,999/$50,000-99,999/more than $100,000/Don't know or decline to answer) were included. Clinical characteristics included diagnosis (leukemia and lymphoma/solid tumors and other), treatment type (chemotherapy/radiotherapy/bone marrow transplant/surgery), patient-reported treatment intensity (range 1-4), and history of relapse (yes/no) and secondary malignancy (yes/no).

Sample Size

This study used moderated mediation analyses based on regression methods. With our sample size of 136, when considering testing for a mediation effect, we can detect moderate-to-large standardized coefficients, as supported by existing literature.[31] A sample size of 136 is also reasonable for achieving a small-to-moderate moderation effect size of $F^2=0.059$ in a moderation model, using G*Power[32], at 80% power and a 5% significance level.

Data Analysis

Descriptive statistics were utilized to characterize sociodemographic and clinical variables, with means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Additionally, to describe differences in healthcare transition readiness and neuropsychological factors across the ADI quartiles, ANOVA (analysis of variance) was used.

Generalized linear regression models were used to assess the impact of neighborhood-level social determinants on healthcare transition readiness. We constructed separate regression models, each using one independent variable from SDOH (i.e., ADI total score, total EJI score, three EJI subscales – Environmental Burden, Social Vulnerability, and Health Vulnerability) as well as one outcome variable from the healthcare transition readiness subscales (i.e., Adolescent

Responsibility, Parent Involvement, and Overall Readiness). Covariates that demonstrated a univariate association with healthcare transition readiness at a significant level at < 0.1 were included in the regression models. Additional covariates were selected a priori based on the literature.[33–35] Furthermore, bivariate correlations among covariates and predictors were examined for multicollinearity.

To examine the potential mediating effect of posttraumatic stress on the relationship between neighborhood-level social determinants (ADI, EJI) and healthcare transition readiness, Hayes' bootstrap-based PROCESS macro was employed.[36] Posttraumatic stress was selected as a potential mediator based on the robust evidence regarding its mediating effect on the association between socioeconomic disadvantages – including neighborhood deprivation – and health behaviors.[37–39] Mediation models were tested with posttraumatic stress as a mediator, with each model using one independent variable and one outcome variable, consistent with the approach used in the prior regression modeling. Hayes' bootstrapping methods were chosen because this approach does not assume that the data are normally distributed and is more suitable for small sample sizes than Baron and Kenny's method.[40] Bootstrapping methods provide a more robust estimation by resampling the data and directly estimating the indirect effect distribution with the confidence intervals (CIs). This study utilized a bootstrapping approach with 10,000 bootstraps sampled to assess the significance of the total and indirect mediating effects, with 95% CIs. A significant mediation effect was confirmed through two steps: (1) evaluating the significance of the indirect effects, and (2) determining a type of mediation (full or partial mediation). Direct effect refers to the effect of the independent variable (social determinants) on the dependent variable (healthcare transition readiness), controlling for the mediator (posttraumatic stress). Indirect effect refers to the effect of the independent variable on the dependent variable through the mediator. An indirect effect was considered statistically significant if the 95% CIs did not contain zero. In addition, when only the indirect effect was significant while the direct effect was not, the mediation was considered as a full mediation. In contrast, when both the indirect and direct effects were significant, the mediation was regarded as partial mediation. Covariates selected for previous regression models were controlled.

Following testing a mediation model, a moderated mediation model – with posttraumatic stress as the mediator and neurocognitive function as the moderator – was also assessed using the PROCESS macro. Neurocognitive function was selected as a potential moderator based on the evidence regarding its moderating effect on the association between socioeconomic disadvantages and stress.[41,42] To examine the nature of the interaction, simple slopes were plotted to test the association between social determinants and posttraumatic stress at different levels of neurocognitive function. All analyses were conducted using IBM SPSS 29.0.

Results

Sociodemographic and Clinical Characteristics

Participants' characteristics are presented in **Table 1** (*n* = 136). Approximately 50% were female, 72.8% were White, and the mean age of the participants was 19.49 years old. At the time of the survey, most participants were current students (*n* = 112, 82.4%), and half of the students were also employed (*n* = 74, 54.4%) (**Supplementary Table 1**). Over half of the participants reported a yearly personal income level of less than $9,999 (*n* = 83, 61.0%), and twenty-eight participants reported their annual family income level was less than $49,999 (20.6%). Most had private health insurance (*n* = 102, 75.0%) and 43.4% of participants' primary care setting was pediatrics. Leukemia was the most common cancer diagnosis (41.9%). The differences in sociodemographic and clinical characteristics by the ADI quartiles were tested using ANOVA and are presented in **Supplementary Table 2**. The mean scores of ADI, EJI, and healthcare transition readiness subscales across ADI quartiles are presented in **Table 2.**

Effects of neighborhood-level social determinants on healthcare transition readiness

Results from the generalized linear regression models show that more deprived neighborhoods, as indicated by higher ADI scores, were associated with greater 'adolescent responsibility' (β = 0.257, B = 0.006, 95% CI of B [0.002, 0.010]), adjusting for race/ethnicity (NH White/others), age at assessment, and years since diagnosis. However, the effects of the ADI on other subscales of transition readiness, such as 'parent involvement' and 'overall transition readiness' were not statistically significant (*p* = .18, *p* = .19, respectively) (**Table 3**).

The total EJI was positively associated with 'adolescent responsibility' (β = 0.198, B = 0.413, 95% CI of B [0.054, 0.773]) and 'parent involvement' (β = 0.183, B = 0.434, 95% CI of B [0.023, 0.845]) but was not statistically associated with 'overall healthcare transition readiness' (*p* = .39). The 'social vulnerability' subscale of the EJI demonstrated a positive association with 'adolescent responsibility' (β = 0.183, B = 0.368, 95% CI of B [0.017, 0.720]) and 'parent involvement' (β = 0.207, B = 473, 95% CI of B [0.074, 0.872]), while showing no significant relationship with 'overall transition readiness' (*p* = .28). Other EJI subscales, including 'environmental burden' and 'health vulnerability' were not associated with any subscales of transition readiness.

Mediation effects of posttraumatic stress on the association between neighborhood-level social determinants and healthcare transition readiness

The results from mediation analysis showed a significant partial mediation effect of posttraumatic stress on the association between ADI and 'adolescent responsibility,' after adjusting for participant's age, race, diagnosis, and treatment intensity level (**Table 4** and **Figure**

1a). The indirect effects of the ADI on 'adolescent responsibility' through posttraumatic stress were statistically significant (β = 0.0364, B = 0.0008, 95% CI of B [0.0001, 0.0019]. The direct effect of the ADI on 'adolescent responsibility' was also statistically significant without considering posttraumatic stress in the model (β = 0.2205, B = 0.0050, 95% CI of B [0.0012, 0.0089]), suggesting partial mediation. In other words, the effect of the ADI on 'adolescent responsibility' was reduced but still significant when posttraumatic stress was introduced to the model. However, the mediating effect of posttraumatic stress was not observed on the association between ADI and other subscales of healthcare transition readiness, including 'parent involvement' and 'overall transition readiness.'

For the total score and the three subscales of the EJI, no significant mediating effect of posttraumatic stress was found on the association between EJI and each healthcare transition readiness subscale (**Table 4**).

Moderated (neurocognitive dysfunction) mediation relationships between neighborhood-level social determinants and healthcare transition readiness

Figure 1b shows the results from moderated mediation analyses with neurocognitive function as a moderator between the ADI and posttraumatic stress (mediator). The interaction term between ADI and neurocognitive function was significantly associated with posttraumatic stress (β = 0.65, B = 0.66, 95% CI [0.36, 0.97], $p < .001$), indicating that neurocognitive function moderates the relationship between the ADI and posttraumatic stress. **Figure 2** shows that participants with neurocognitive dysfunction and residing in more deprived areas had much higher posttraumatic stress levels (with a significantly larger positive slope compared to the flat slope for those without neurocognitive dysfunction). The bootstrapping conditional indirect analysis showed that the indirect effect of posttraumatic stress was significant only for the participants with neurocognitive dysfunction (B = 0.01, 95% CI [0.0003, 0.01]), while the indirect effect of posttraumatic stress was insignificant for those without neurocognitive dysfunction (B = 0.0004, 95% CI [-0.0002, 0.001].

Discussion

This study presents several important findings regarding the impact of neighborhood-level social determinants on healthcare transition readiness in AYA CCS: (1) survivors residing in more deprived neighborhoods reported greater ‘adolescent responsibility,’ and increased perceived ‘parent involvement’ in healthcare. However, no significant association was found between neighborhood deprivation and ‘overall transition readiness,’ (2) posttraumatic stress mediated the relationship between neighborhood deprivation and ‘adolescent responsibility’, with significance observed only when using the ADI, and (3) neurocognitive dysfunction moderated the relationship between neighborhood deprivation and posttraumatic stress within the mediation model. These findings demonstrate that ‘adolescent responsibility’ in healthcare during transition is influenced by multiple layers of complex factors, including both the neighborhood-level social determinants and the individual’s neuropsychological factors, aligning with the socio-ecological foundation of SMART. In addition, the potential mediator and moderator identified in this study suggest specific practical implications and directions for future research.

This study presents a novel finding that AYA survivors residing in more deprived neighborhoods reported greater ‘adolescent responsibility’ or increased ‘parent involvement.’ In contrast, neighborhood deprivation did not influence their ‘overall transition readiness.’ In other words, AYA CCS living in more deprived neighborhoods may take more responsibility for managing their healthcare than those living in less deprived neighborhoods. However, this increased responsibility may not necessarily enhance their perceived overall readiness for independent health management or their transition from pediatric to adult-centered care settings. Our findings suggest that the lack of these external resources in deprived neighborhoods may limit access to necessary support during transition, such as healthcare services and family or community assistance,[43,44] thereby placing additional pressure/stress on AYA CCS to take on greater responsibility in managing their healthcare. In our study, AYA survivors in the most deprived neighborhoods with higher ‘adolescent responsibility’ were more likely to have Medicaid, lower family income, and lower parental educational levels. These factors may further limit access to resources needed for a successful transition[45] and hinder their ability to improve overall healthcare transition readiness. These findings suggest that transition interventions should not only aim to increase AYA's healthcare responsibility but also address the unique challenges AYA CCS may encounter within their environments, including their neighborhoods. Future studies are needed to investigate the specific barriers AYA CCS face in deprived neighborhoods, such as access to healthcare services and transportation to inform the development of targeted interventions that help mitigate the negative impacts of neighborhood deprivation and improve transition outcomes of AYA CCS.

One plausible explanation of the significant impact of neighborhood deprivation on ‘adolescent responsibility,’ but not on ‘overall transition readiness,’ could be the influence of the social roles of AYA survivors. In this study, AYA survivors residing in the least deprived neighborhoods were all students, with 60.6% being full-time students and not employed. In contrast, in the most deprived neighborhoods, only 38.2% reported students, with a higher proportion engaged in full-time employment. Considering our results regarding the income levels of both families and patients across the ADI quartiles, AYA survivors in more deprived neighborhoods may bear greater household financial responsibilities. Maintaining optimal health is critical for stable job performance and for avoiding absenteeism due to health issues, which in turn helps secure their job.[46] Consequently, AYA CCS with full-time jobs may be more focused on their healthcare, potentially developing their 'adolescent responsibility' in healthcare. This increased responsibility may strengthen specific healthcare management skills. However, it may not be enough to prepare AYA CCS for a successful transition to adult care. Furthermore, the compounded burdens of additional healthcare responsibilities with full-time employment may contribute to an unequal healthcare transition experience for AYA CCS in more deprived neighborhoods. Therefore, future research is recommended to investigate the unique challenges AYA CCS face in deprived neighborhoods during their transition, focusing on how their social roles and functioning may influence this process.

Interestingly, a higher proportion (47.1%) of AYA CCS in more deprived neighborhoods reported receiving primary care from adult physicians or family practice providers, compared to only 24.3% in the least deprived neighborhoods. In other words, despite a more significant number of AYA CCS having already transitioned to adult-centered care settings in more deprived neighborhoods, their perceived overall transition readiness was not higher than that of AYA CCS from less deprived neighborhoods. This highlights that the transfer to adult-centered care settings does not necessarily indicate a greater sense of transition readiness, particularly for those in deprived neighborhoods who may encounter additional burdens and obstacles in managing healthcare. Considering the geographic distribution of pediatricians in the United States,[47] AYA survivors in deprived neighborhoods may face limited access to pediatricians for follow-up care, prompting earlier transitions to adult care settings that are not accompanied by sufficient preparation for adult-centered care. Furthermore, AYA CCS in deprived neighborhoods are more likely to have less access to affordable, high-quality adult-centered specialty care.[48,49] This limited access may impede their ability to properly manage long-term late effects, potentially causing more morbidities during adulthood in AYA CCS in deprived neighborhoods.[50] Therefore, future studies are needed to investigate factors contributing to the lack of perceived transition readiness among AYA CCS in more deprived neighborhoods, particularly for those transitioning to adult-centered care earlier. In addition, it is necessary to assess the availability and quality of adult-centered care, including specialty care, in deprived neighborhoods to identify potential barriers to overall transition readiness among AYA CCS in these areas.

We identified that increased levels of posttraumatic stress mediated the association between living in more deprived neighborhoods and greater ‘adolescent responsibility.’ The potential mediating effect of posttraumatic stress, defined in our study as distress specifically related to their cancer experience, highlights the psychological burden faced by AYA CCS in more deprived neighborhoods. These individuals may experience more significant stress due to economic hardship from medical costs,[56] lack of community support,[57] limited access to quality healthcare services,[58] and environmental factors such as unsafe neighborhoods,[59] which may exacerbate the emotional distress related to their cancer experience. In this context, posttraumatic stress can lead AYA CCS to develop a heightened sense of self-reliance and take control of their healthcare to avoid additional health issues,[60] particularly when they perceive external support as insufficient. As a result, AYA CCS in more deprived neighborhoods might feel compelled to take on more responsibility. However, managing complex healthcare needs without sufficient support can hinder developing overall transition readiness. Therefore, healthcare providers are encouraged to consider both psychological factors and social determinants, such as limited access to healthcare and financial insecurity, when involved in the healthcare transition process of AYA CCS, particularly in deprived neighborhoods. Addressing these challenges may lead to identifying social barriers to healthcare responsibility and alleviating the psychological burdens among AYA CCS living in deprived neighborhoods. This approach can be critical in reducing disparities in healthcare transition readiness across neighborhoods in this population.

Our findings indicate that AYA survivors from more deprived neighborhoods who reported higher posttraumatic stress with neurocognitive dysfunction demonstrated greater ‘adolescent responsibility’ in healthcare. However, these results should be interpreted within the context of neighborhood deprivation and cancer survivorship. Approximately 40% of AYA childhood cancer survivors are at risk of neurocognitive impairment as a late effect of cancer or its treatments.[61,62] The complex interplay among a history of cancer, neurocognitive function, and neighborhood deprivation can escalate perceived stress levels. Moreover, the co-occurrence of neurocognitive impairment and posttraumatic stress can significantly hinder an AYA’s ability to manage and retain health-related tasks essential for the transition process, such as remembering to make and attend appointments, communicating effectively with providers, or managing prescription refills. Therefore, while their ‘adolescent responsibility’ may appear higher, the underlying challenges related to posttraumatic stress and neurocognitive problems should not be overlooked. It is crucial for healthcare providers to assess stress and neurocognitive function levels during routine follow-up appointments to address the challenges that may impede their healthcare transition to adult care settings. This is particularly important for AYA survivors from deprived neighborhoods, where such factors may compound health risks and hinder long-term health outcomes despite initial healthcare transition readiness levels.

This study has several limitations. First, this study used cross-sectional data, which limits our interpretation of causal relationships within mediation analysis. Future longitudinal studies are necessary to explore the timing and sequence of how the interplay of individual neuropsychological factors and multi-level social determinants (e.g., individual socioeconomic status and neighborhood deprivation) affects healthcare transition readiness. Second, the data collection for the parent study was conducted at a single institution, which may limit the generalizability of the findings. Future research is recommended to collect data from multiple institutions or diverse healthcare settings to gain a more comprehensive understanding of healthcare transition readiness and its association with various social determinants. Third, participants of this study were recruited from a survivorship program. AYA survivors who are lost to follow-up from a survivorship program were not included, which could bias the results. Lastly, other confounding variables that may influence healthcare transition readiness, such as currently experiencing late effects or comorbidities and health literacy, were not available in this study.

Conclusion

Despite these limitations, our findings add to the growing body of literature on the impact of neighborhood-level social determinants on adolescent responsibility in healthcare among AYA CCS. Despite taking on more responsibility, AYA CCS’ overall healthcare transition readiness for those living in more deprived neighborhoods was not significantly higher than those from less deprived neighborhoods. The results suggest that providers should not solely focus on assessing healthcare transition readiness but should comprehensively evaluate social determinants of transition readiness at multiple levels, including individual and neighborhood factors, particularly those in deprived neighborhoods. Furthermore, assessing overall readiness and its subdomains, such as adolescent responsibility and parent involvement, is also critical to understanding the healthcare transition process for better management. In addition, our findings on the mediating role of posttraumatic stress and the moderating role of neurocognitive dysfunction provide the insights that AYA CCS in more deprived neighborhoods may face a neuropsychological burden, taking on more responsibility in health care with a lack of sufficient family and community resources to support their overall transition readiness fully. Therefore, routine individualized assessments are recommended for AYA CCS to evaluate the neuropsychological functions – including posttraumatic stress and neurocognitive function – and evaluate the resources available and accessible within their family and community context to enhance their transition process. Future studies are needed to longitudinally assess healthcare transition readiness among AYA CCS across multiple institutions, incorporating a broader range of potential covariates and confounding social determinants to thoroughly understand the underlying factors influencing this phenomenon.

Ethical Considerations

This study was approved by the institutional review board of the hospital where the participants were recruited from (IRB No: IRB00091839).

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Table 1. Sociodemographic and Clinical Characteristics (*N*=136).

Characteristics	***n* (%) or mean±SD**	**Adolescent responsibility**		**Parent involvement**		**Overall readiness**	
		Mean±SD	***p***	***Mean±SD***	***p***	***Mean±SD***	***p***
Race and Ethnicity							
Non-Hispanic White	95 (69.9)	3.21±0.60	.21	3.27±0.67	.12	5.44±1.43	.98
Non-Hispanic Black	25 (18.4)	3.08±0.62		3.35±0.70		5.32±1.57	
Hispanic	10 (7.4)	3.48±0.55		3.53±0.54		5.50±0.97	
Non-Hispanic other	6 (4.4)	2.93±0.42		2.72±0.68		5.50±1.38	
Sex							
Male	63 (46.3)	3.15±0.59	.40	3.31±0.64	.63	5.48±1.42	.70
Female	73 (53.7)	3.23±0.60		3.25±0.70		5.38±1.41	
Age at diagnosis							
Total, years (mean±SD)	7.92±5.29	-		-		-	
0-4 years	54 (39.7)	3.15±0.59	.36	3.30±0.69	.79	5.26±1.39	.58
5-9 years	28 (20.6)	3.07±0.54		3.19±0.66		5.36±1.45	
10-14 years	38 (27.9)	3.29±0.63		3.34±0.63		5.61±1.24	
15-19 years	16 (11.8)	3.31±0.61		3.21±0.76		5.69±1.82	
Age at assessment							
Total, years (mean±SD)	19.49±10.2	-		-		-	
18 years	50 (36.8)	3.13±0.57	.28	3.33±0.56	.11	5.10±1.37	.12
19 years	42 (30.9)	3.14±0.61		3.40±0.60		5.57±1.27	
≥ 20 years	44 (32.4)	3.31±0.61		3.11±0.83		5.66±1.54	
Student							
No	24 (17.6)	3.25±0.68	.57	3.37±0.70	.48	5.46±1.28	.90
Yes	112 (82.4)	3.18±0.58		3.26±0.67		5.42±1.44	
Current school level							
High school	14 (12.5)	3.30±0.45	.14	3.30±0.46	.14	5.36±1.60	.66
Technical school/2-year college	16 (14.3)	3.09±0.68		3.52±0.49		5.06±1.65	
4-year college/University	79 (70.5)	3.15±0.57		3.18±0.72		5.48±1.39	
Other	3 (2.7)	3.87±0.23		3.80±0.35		6.00±1.00	
Employment							
No	62 (45.6)	3.13±0.54	.29	3.37±0.55	.14	5.23±1.42	.13
Yes	74 (54.4)	3.24±0.63		3.20±0.76		5.59±1.39	
Workload							

Characteristics	***n* (%) or mean±SD**	**Adolescent responsibility**		**Parent involvement**		**Overall readiness**	
		Mean±SD	***p***	***Mean±SD***	***p***	***Mean±SD***	***p***
Part time (less than 40 hours/week)	54 (73.0)	3.22±0.61	.68	3.01±0.76	.06	5.57±1.45	.84
Full time (40 or more hours/week)	20 (27.0)	3.29±0.71		3.48±0.70		5.66±1.27	
Highest education level							
Patient							
≤ High school graduate	78 (57.4)	3.22±0.59	.55	3.26±0.70	.70	5.42±1.39	.97
≥ Partial college/college graduate	58 (42.6)	3.16±0.60		3.30±0.64		5.43±1.45	
Mother							
≤ High school graduate	29 (21.3)	3.14±0.61	.79	3.26±0.60	.99	5.17±1.34	.39
≥ Partial college/college graduate	98 (72.1)	3.26±0.60		3.28±0.69		5.53±1.44	
Don’t know/decline to answer	9 (6.6)	3.11±0.83		3.28±0.75		5.11±1.36	
Father							
≤ High school graduate	41 (30.1)	3.26±0.64	.62	3.50±0.60	.03	5.51±1.31	.89
≥ Partial college/college graduate	78 (57.4)	3.18±0.56		3.21±0.70		5.40±1.47	
Don’t know/decline to answer	17 (12.5)	3.10±0.68		3.07±0.65		5.35±1.46	
Yearly income level							
Patient							
Less than $9,999	83 (61.0)	3.15±0.56	.63	3.20±0.69	.19	5.42±1.48	.18
$10,000-49,999	22 (16.2)	3.23±0.68		3.47±0.62		5.86±1.25	
Don’t know/decline to answer	31 (22.8)	3.27±0.60		3.35±0.66		5.13±1.28	
Family							
Less than $49,999	28 (20.6)	3.26±0.67	.22	3.33±0.64	.61	5.82±1.16	.41
$50,000-99,999	28 (20.6)	3.00±0.50		3.19±0.77		5.36±1.73	
More than $100,000	31 (22.8)	3.17±0.59		3.19±0.68		5.39±1.48	
Don’t know/decline to answer	49 (36.0)	3.28±0.59		3.36±0.64		5.27±1.30	
Person living with*							
Parents							
Yes	117 (86.0)	3.14±0.59	.02	3.30±0.65	.31	5.37±1.41	.23
No	19 (14.0)	3.48±0.53		3.13±0.82		5.79±1.40	
Siblings							
Yes	88 (64.7)	3.11±0.61	.02	3.22±0.71	.18	5.32±1.43	.23
No	48 (35.3)	3.35±0.53		3.38±0.59		5.63±1.38	
Other relatives							
Yes	10 (7.4)	3.46±0.70	.14	3.69±0.64	.05	6.10±1.45	.12

Characteristics	***n* (%) or mean±SD**	**Adolescent responsibility**		**Parent involvement**		**Overall readiness**	
		Mean±SD	***p***	***Mean±SD***	***p***	***Mean±SD***	***p***
No	126 (92.6)	3.17±0.58		3.25±0.67		5.37±1.40	
Friends/roommates							
Yes	10 (7.4)	3.36±0.47	.35	2.63±0.86	.001	5.50±1.51	.87
No	126 (92.6)	3.18±0.60		3.33±0.63		5.42±1.41	
Spouse/partner							
Yes	2 (1.5)	3.47±0.46	.51	3.55±0.64	.57	7.50±0.71	.04
No	134 (98.5)	3.19±0.60		3.27±0.68		5.40±1.40	
Girlfriend/boyfriend							
Yes	2 (1.5)	3.40±0.85	.62	3.00±1.41	.56	5.50±0.71	.94
No	134 (98.5)	3.19±0.59		3.28±0.67		5.43±1.42	
Living alone							
Yes	5 (3.7)	3.90±0.17	.006	3.50±0.72	.46	6.20±1.30	.21
No	131 (96.3)	3.16±0.59		3.27±0.67		5.40±1.41	
Health insurance							
No insurance	5 (3.7)	3.10±0.73	.22	2.98±1.00	.07	5.20±1.30	.53
Private	102 (75.0)	3.14±0.58		3.21±0.68		5.35±1.46	
Medicaid/other public	27 (19.9)	3.40±0.61		3.55±0.54		5.78±1.28	
Don’t know	2 (1.5)	3.40±0.14		3.75±0.35		5.00±0.00	
Primary care setting							
Pediatricians	59 (43.4)	3.14±0.54	.38	3.30±0.60	.80	5.08±1.33	.06
Adult physicians	21 (15.4)	3.42±0.72		3.39±0.79		6.10±1.37	
Family practices	40 (29.4)	3.13±0.61		3.25±0.70		5.60±1.48	
College university health center	11 (8.1)	3.28±0.34		3.13±0.77		5.27±1.19	
Other	5 (3.7)	3.15±0.62		3.09±0.73		5.60±1.67	
Primary malignancy diagnosis							
Leukemia/Lymphoma	81 (59.6)	3.21±0.61	.61	3.24±0.64	.47	5.48±1.34	.58
Solid tumor/other	55 (40.4)	3.16±0.58		3.33±0.72		5.35±1.52	
Treatment type*							
Chemotherapy	135(99.3)	3.19±0.59	-	3.28±0.68	-	5.41±1.41	-
Radiotherapy	46 (33.8)	3.31±0.54		3.38±0.66		5.26±1.37	
BMT	27 (19.9)	3.12±0.72		3.15±0.86		5.19±1.57	
Surgery	47 (34.6)	3.16±0.59		3.40±0.63		5.28±1.44	
Treatment intensity							

Characteristics	***n* (%) or mean±SD**	**Adolescent responsibility**		**Parent involvement**		**Overall readiness**	
		Mean±SD	***p***	***Mean±SD***	***p***	***Mean±SD***	***p***
1~2	46 (31.6)	3.12±0.57	.61	3.16±0.65	.22	5.11±1.23	.17
3	51 (37.5)	3.24±0.56		3.40±0.56		5.59±1.39	
4	39 (28.7)	3.21±0.67		3.26±0.82		5.59±1.60	
Relapse							
No	118 (86.8)	3.17±0.61	.33	3.31±0.66	.23	5.33±1.41	.04
Yes	18 (13.2)	3.32±0.50		3.10±0.76		6.06±1.26	
Secondary malignancy							
No	134 (98.5)	3.20±0.60	.57	3.29±0.68	.49	5.43±1.42	.67
Yes	2 (1.5)	2.95±0.49		2.95±0.64		5.00±0.00	

Note. ^{a} multiple response questionnaire. SD, standard deviation.

Table 2. Differences in ADI, EJI, Healthcare transition readiness, posttraumatic stress, neurocognitive function by ADI Quartiles (*N*=136).

Categories (possible score range)	**Total (*N*=136)**		**ADI Quartiles**				***P***
			Q1 (*n*=33)	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	
	Mean±SD or n (%)	**Range**	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	
Area Deprivation Index							
Total (0~100)	44.81±25.66	2-99	14.61±5.17	32.22±6.04	54.97±6.70	80.34±11.84	<.001
Environmental Justice Index							
Total (0~1)	0.41±0.28	0.01-0.98	0.16±0.17	0.29±0.20	0.47±0.19	0.74±0.17	<.001
Environmental (0~1)	0.53±0.23	0.09-0.99	0.45±0.24	0.49±0.22	0.58±0.22	0.62±0.22	.01
Social Vulnerability (0~1)	0.42±0.29	0.0007-0.97	0.11±0.14	0.31±0.20	0.55±0.18	0.75±0.16	<.001
Health Vulnerability (0~1)	0.16±0.25	0.00-0.80	0.03±0.07	0.06±0.14	0.11±0.16	0.46±0.29	<.001
Healthcare transition readiness							
Adolescent responsibility (1~4)	3.18±0.60	1.60-4.00	3.06±0.56	3.05±0.57	3.20±0.66	3.44±0.53	.03
Parent involvement (1~4)	3.28±0.67	1.30-4.00	3.08±0.64	3.33±0.59	3.33±0.67	3.37±0.77	.29
Overall readiness (2~8)	5.42±1.42	3.00-8.00	5.33±1.34	5.08±1.44	5.78±1.45	5.53±1.39	.21
Posttraumatic stress							
Total (0~88)	10.84±16.83	0.00-73.00	6.39±8.98	8.95±12.19	11.16±20.72	17.31±21.48	.06
Intrusion (0~4)	0.49±0.76	0.00-3.50	0.30±0.42	0.37±0.54	0.50±0.99	0.81±0.99	.03
Avoidance (0~4)	0.57±0.84	0.00-3.50	0.37±0.55	0.54±0.78	0.55±0.95	0.84±0.98	.15
Hyperarousal (0~4)	0.39±0.82	0.00-3.33	0.18±0.44	0.27±0.55	0.45±1.01	0.69±1.06	.06
Neurocognitive function							
Total (*n*, %)	15 (11.0)	-	3 (9.1%)	5 (13.5%)	3 (9.4%)	4 (11.8%)	.93
Memory (*n*, %)	14 (10.3)	-	3 (9.1%)	3 (8.1%)	4 (12.5%)	4 (11.8%)	.92
Task efficiency (*n*, %)	19 (14.0)	-	4 (12.1%)	7 (18.9%)	4 (12.5%)	4 (11.8%)	.79
Organization (*n*, %)	17 (12.5)	-	4 (12.1%)	4 (10.8%)	5 (15.6%)	4 (11.8%)	.92
Emotional regulation (*n*, %)	17 (12.5)	-	3 (9.1%)	6 (16.2%)	3 (9.4%)	5 (14.7%)	.76

Note. ADI, Area Deprivation Index. SD, Standard Deviation, AYA, Adolescent and Young Adults.

Table 3. Effects of neighborhood-level social determinants on healthcare transition readiness using generalized linear regression models (*N*=136).

	Healthcare Transition Readiness								
	Adolescent Responsibility			**Parent Involvement**			**Overall Transition Readiness**		
Predictors	***β***	**B**	**95% CI of B**	***β***	**B**	**95% CI of B**	***β***	**B**	**95% CI of B**
ADI	**0.257**	**0.006**	**0.002, 0.010***	0.120	0.003	-0.001, 0.008	0.113	0.006	-0.003, 0.015
EJI total	**0.198**	**0.413**	**0.054, 0.773***	**0.183**	**0.434**	**0.023, 0.845***	0.076	0.378	-0.481, 1.236
EJI Environmental Burden	0.157	0.402	-0.036, 0.840	0.081	0.237	-0.268, 0.741	0.029	0.179	-0.863, 1.220
EJI Social Vulnerability	**0.183**	**0.368**	**0.017, 0.720***	**0.207**	**0.473**	**0.074, 0.872***	0.095	0.457	-0.378, 1.292
EJI Health Vulnerability	0.102	0.234	-0.160, 0.628	0.078	0.204	-0.246, 0.653	0.038	0.205	-0.723, 1.134

Note. Adjusted race/ethnicity (Non-Hispanic White/Others), age at assessment and years since diagnosis. ***β***, standardized coefficients. B, unstandardized coefficients. SE, Standard error. CI, Confidence intervals. ADI, Area deprivation index. EJI, Environmental Justice Index. *Statistically significant results.

Table 4. Mediating effects of posttraumatic stress on relationship between neighborhood-level social determinants and healthcare transition readiness using PROCESS macro (*N*=136).

	Adolescent Responsibility *(DV)*					
	Direct effect (*IV* → *DV*)		**Indirect effect (*IV* → *DV* via *M*)**		**Total effect (*IV* → *DV*)**	
Predictors *(IV)*	***β***	**B [95% CI]**	***β***	**B [95% CI]**	***β***	**B [95% CI]**
ADI	**0.2205**	**0.0050 [0.0012, 0.0089] ***	**0.0364**	**0.0008 [0.0001, 0.0019] ***	**0.2569**	**0.0059 [0.0020, 0.0097] ***
EJI Total	**0.1707**	**0.3571 [0.0012, 0.7129] ***	0.0270	0.0564 [-0.0072, 0.1434]	**0.1977**	**0.4134 [0.0538, 0.7730] ***
EJI EB	0.1524	0.3905 [-0.0379, 0.8189]	0.0045	0.0115 [-0.0859, 0.0965]	0.1568	0.4020 [-0.0363, 0.8403]
EJI SV	0.1533	0.3093 [-0.0389, 0.6576]	0.0293	0.0591 [-0.0028, 0.1581]	**0.1825**	**0.3684 [0.0169, 0.7199] ***
EJI HV	0.0823	0.1897 [-0.1971, 0.5765]	0.0192	0.0442 [-0.0352, 0.1461]	0.1015	0.2339 [-0.1598, 0.6276]
	Parent Involvement *(DV)*					
	Direct effect (*IV* → *DV*)		**Indirect effect (*IV* → *DV* via *M*)**		**Total effect (*IV* → *DV*)**	
Predictors *(IV)*	***β***	**B [95% CI]**	***β***	**B [95% CI]**	***β***	**B [95% CI]**
ADI	0.1073	0.0028 [-0.0018, 0.0074]	0.0125	0.0003 [-0.0005, 0.0012]	0.1197	0.0031 [-0.0014, 0.0076]
EJI Total	0.1750	0.4147 [-0.0007, 0.8301]	0.0081	0.0193 [-0.0420, 0.0766]	**0.1831**	**0.4340 [0.0228, 0.8453] ***
EJI EB	0.0798	0.2317 [-0.2729, 0.7364]	0.0017	0.0048 [-0.0542, 0.0481]	0.0814	0.2365 [-0.2678, 0.7408]
EJI SV	**0.1985**	**0.4541 [0.0504, 0.8577] ***	0.0082	0.0187 [-0.0392, 0.0763]	**0.2067**	**0.4728 [0.0738, 0.8718] ***
EJI HV	0.0712	0.1859 [-0.2661, 0.6378]	0.0068	0.0177 [-0.0300, 0.0783]	0.0779	0.2036 [-0.2462, 0.6534]
	Overall Transition Readiness *(DV)*					
	Direct effect (*IV* → *DV*)		**Indirect effect (*IV* → *DV* via *M*)**		**Total effect (*IV* → *DV*)**	
Predictors *(IV)*	***β***	**B [95% CI]**	***β***	**B [95% CI]**	***β***	**B [95% CI]**
ADI	0.1148	0.0062 [-0.0033, 00157]	-0.0020	-0.0001 [-0.0021, 0.0016]	0.1128	0.0061 [-0.0031, 0.0154]
EJI Total	0.0758	0.3763 [-0.4926, 1.2452]	0.0003	0.0014 [-0.1352, 0.1230]	0.0761	0.3778 [-0.4807, 1.2362]
EJI EB	0.0291	0.1773 [-0.8686, 1.2231]	0.0002	0.0014 [-0.0864, 0.0879]	0.0294	0.1786 [-0.8630, 1.2203]
EJI SV	0.0956	0.4579 [-0.3884, 1.3042]	-0.0001	-0.0007 [-0.1336, 0.1293]	0.0955	0.4572 [-0.3778, 1.2923]
EJI HV	0.0368	0.2011 [-0.7346, 1.1368]	0.0007	0.0040 [-0.1217, 0.1181]	0.0375	0.2051 [-0.7235, 1.1337]

Note. IV, independent variable. DV, dependent variable. M, mediator (posttraumatic stress). Adjusted race/ethnicity (Non-Hispanic White/Others), age at assessment and years since diagnosis. ***β***, standardized coefficients. B, unstandardized coefficients. SE, standard error. CI, confidence intervals. ADI, Area Deprivation Index. EJI, Environmental Justice Index. EB, Environmental Burden. SV, Social Vulnerability. HV, Health Vulnerability. *Statistically significant results.

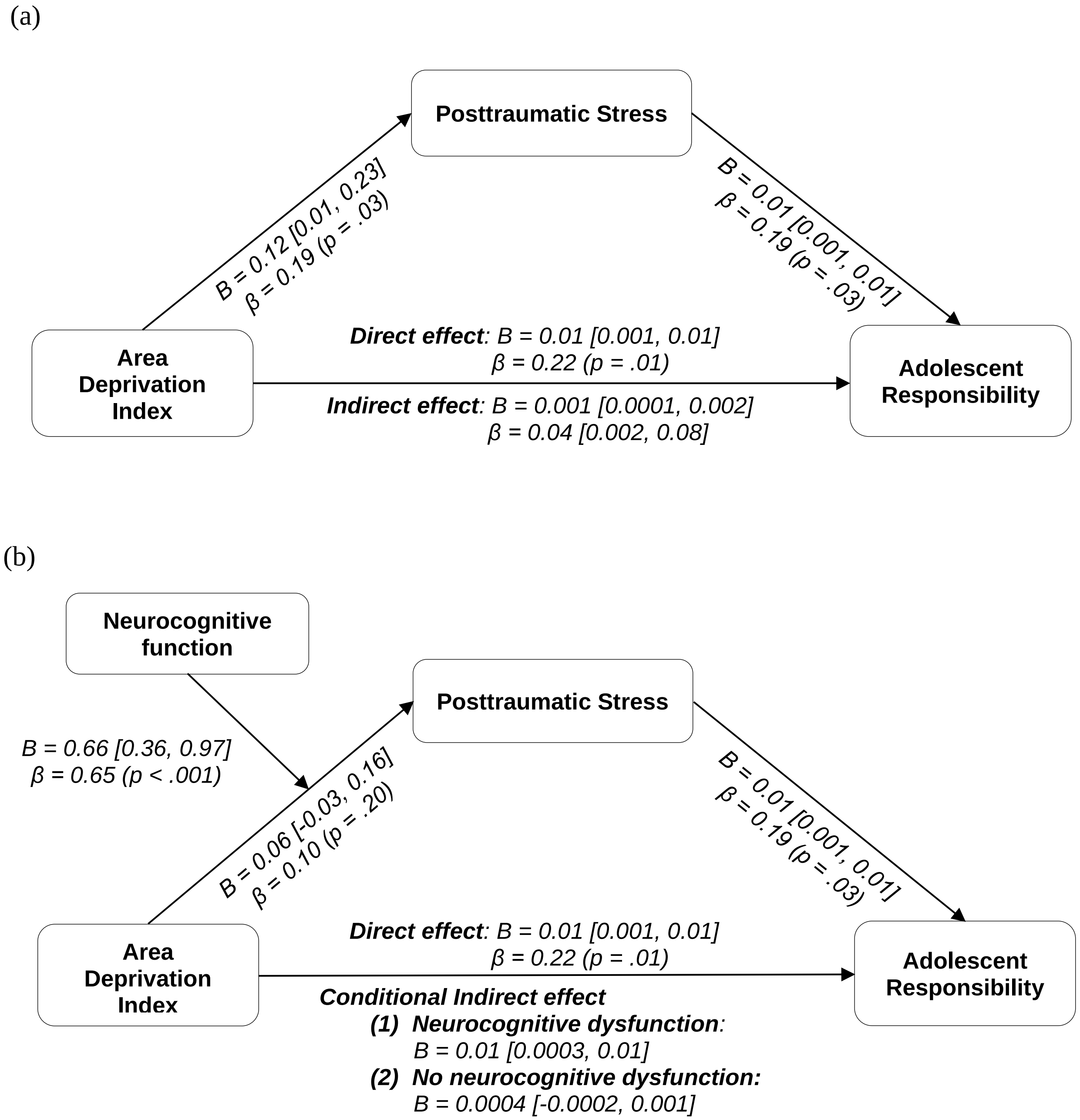

Figure 1. Mediation and moderated mediation models.

Note. Adjusted race/ethnicity (Non-Hispanic White/Others), age at assessment and years since diagnosis. *β*, standardized coefficients. B, unstandardized coefficients.

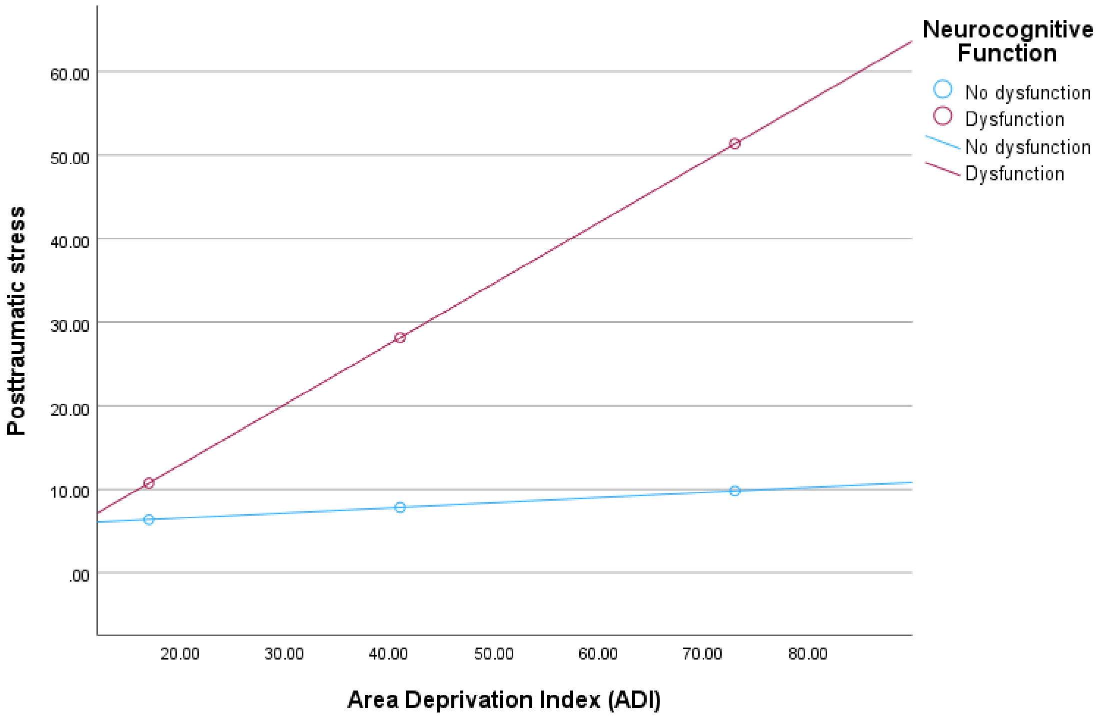

Figure 2. The moderating effect of neurocognitive function on the relationship between ADI and posttraumatic stress.

Supplementary Table 1. Descriptive analyses of healthcare transition readiness scores by being student and/or employed (*N*=136).

(a) Number of participants	**ADI Quartiles**				**Total (*N*=136)**	***p***
	Q1 (*n*=33)	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**		
1. No student/Not employed	0 (0.0)	2 (5.4)	2 (6.3)	2 (5.9)	6 (4.4)	<.001
2. Only employed/No student	0 (0.0)	1 (2.7)	10 (31.3)	7 (20.6)	18 (13.2)	
3. Only student/Not employed	20 (60.6)	16 (43.2)	7 (21.9)	13 (38.2)	56 (41.2)	
4. Both being student and employed	13 (39.4)	18 (48.6)	13 (40.6)	12 (35.3)	56 (41.2)	

(b) Adolescent Responsibility	**Q1 (*n*=33)**	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	**Total (*N*=136)**	***p***
1. No student/Not employed (*n*=6)	0.00±0.00	2.35±0.35	3.36±0.35	3.25±0.92	2.99±0.68	.53
2. Only employed/No student (*n*=18)	0.00±0.00	4.00±0.00	3.42±0.72	3.14±0.62	3.34±0.68	
3. Only student/Not employed (*n*=56)	3.00±0.52	3.02±0.51	3.27±0.31	3.47±0.56	3.15±0.53	
4. Both being student and employed (*n*=56)	3.16±0.62	3.12±0.58	2.97±0.76	3.66±0.25	3.21±0.62	

(c) Parent Involvement	**Q1 (*n*=33)**	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	**Total (*N*=136)**	***p***
1. No student/Not employed (*n*=6)	0.00±0.00	4.00±0.00	3.13±0.75	3.10±0.57	3.41±0.62	.33
2. Only employed/No student (*n*=18)	0.00±0.00	4.00±0.00	3.13±0.88	3.58±0.44	3.35±0.74	
3. Only student/Not employed (*n*=56)	3.22±0.50	3.28±0.59	3.57±0.38	3.58±0.59	3.37±0.55	
4. Both being student and employed (*n*=56)	2.87±0.79	3.26±0.59	3.38±0.62	3.03±1.04	3.15±0.76	

(d) Overall Readiness	**Q1 (*n*=33)**	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	**Total (*N*=136)**	***p***
1. No student/Not employed (*n*=6)	0.00±0.00	3.50±0.71	6.50±2.12	6.50±0.71	5.50±1.87	.42
2. Only employed/No student (*n*=18)	0.00±0.00	7.00±0.00	5.70±0.95	4.86±1.07	5.44±1.10	
3. Only student/Not employed (*n*=56)	5.45±1.28	4.81±1.22	5.29±1.98	5.23±1.42	5.20±1.38	
4. Both being student and employed (*n*=56)	5.15±1.46	5.39±1.54	6.00±1.47	6.17±1.34	5.64±1.48	

Supplementary Table 2. Sociodemographic and Clinical Characteristics by ADI Quartiles (*N*=136).

Characteristics	**Total (*N*=136)**	**ADI Quartile**				
		Q1 (*n*=33)	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	
	Mean±SD or n (%)	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***p***
Race and Ethnicity						
Non-Hispanic White	95 (69.9)	28 (84.8)	25 (67.6)	21 (65.6)	21 (61.8)	.02
Non-Hispanic Black	25 (18.4)	1 (3.0)	6 (16.2)	8 (25.0)	10 (29.4)	
Hispanic	10 (7.4)	0 (0.0)	5 (13.5)	2 (6.3)	3 (8.8)	
Non-Hispanic other	6 (4.4)	4 (12.1)	1 ()2.7	1 (3.1)	0 (0.0)	
Sex						
Male	63 (46.3)	11 (33.3)	18 (48.6)	16 (50.0)	18 (52.9)	.38
Female	73 (53.7)	22 (66.7)	19 (51.4)	16 (50.0)	16 (47.1)	
Age at diagnosis						
Total, years (mean±SD)	7.92±5.29	8.80±5.45	8.30±5.10	7.00±5.12	7.54±5.53	.53 [a]
0-4 years	54 (39.7)	12 (36.4)	11 (29.7)	14 (43.8)	17 (50.0)	.47
5-9 years	28 (20.6)	4 (12.1)	12 (32.4)	7 (21.9)	5 (14.7)	
10-14 years	38 (27.9)	13 (39.4)	9 (24.3)	8 (25.0)	8 (23.5)	
15-19 years	16 (11.8)	4 (12.1)	5 (13.5)	3 (9.4)	4 (11.8)	
Age at assessment						
Total, years (mean±SD)	19.49±10.2	19.52±1.11	19.31±0.88	19.49±1.02	19.64±1.10	.60 [a]
18 years	50 (36.8)	12 (36.4)	14 (37.8)	11 (34.4)	13 (38.2)	.36
19 years	42 (30.9)	9 (27.3)	14 (37.8)	13 (40.6)	6 (17.6)	
≥ 20 years	44 (32.4)	12 (36.4)	9 (24.3)	8 (25.0)	15 (44.1)	
Student						
No	24 (17.6)	0 (0.0)	3 (8.1)	12 (37.5)	9 (26.5)	<.001
Yes	112 (82.4)	33 (100.0)	34 (91.9)	20 (62.5)	25 (73.5)	
Current school level						
High school	14 (12.5)	1 (3.0)	3 (8.8)	4 (20.0)	6 (24.0)	[c]
Technical school/2-year college	16 (14.3)	1 (3.0)	3 (8.8)	8 (40.0)	4 (16.0)	
4-year college/University	79 (70.5)	31 (93.9)	27 (79.4)	8 (40.0)	13 (52.0)	
Other	3 (2.7)	0 (0.0)	1 (2.9)	0 (0.0)	2 (8.0)	
Employment						
No	62 (45.6)	20 (60.6)	18 (48.6)	9 (28.1)	15 (44.1)	.07
Yes	74 (54.4)	13 (39.4)	19 (51.4)	23 (71.9)	19 (55.9)	

Characteristics	Total (*N*=136)	ADI Quartile				
		Q1 (*n*=33)	Q2 (*n*=37)	Q3 (*n*=32)	Q4 (*n*=34)	*p*
	Mean±SD or n (%)	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	
Workload						
Part time (less than 40 hours/week)	54 (73.0)	12 (92.3)	15 (78.9)	15 (65.2)	12 (63.2)	.22
Full time (40 or more hours/week)	20 (27.0)	1 (7.7)	4 (21.1)	8 (34.8)	7 (36.8)	
Highest education level						
Patient						
≤ High school graduate	78 (57.4)	17 (51.5)	22 (59.5)	20 (62.5)	19 (55.9)	.83
≥ Partial college/college graduate	58 (42.6)	16 (48.5)	15 (40.5)	12 (37.5)	15 (44.1)	
Mother [b]						
≤ High school graduate	29 (22.8)	2 (6.3)	8 (22.9)	11 (37.9)	8 (25.8)	.03
≥ Partial college/college graduate	98 (77.2)	30 (93.8)	27 (77.1)	18 (62.1)	23 (74.2)	
Father [b]						
≤ High school graduate	41 (34.5)	1 (3.3)	9 (26.5)	15 (57.7)	16 (55.2)	<.001
≥ Partial college/college graduate	78 (65.5)	29 (96.7)	25 (73.5)	11 (42.3)	13 (44.8)	
Yearly Income level						
Patient [b]						
Less than $9,999	83 (61.0)	26 (100.0)	25 (86.2)	14 (53.8)	18 (75.0)	<.001
$10,000-49,999	22 (16.2)	0 (0.0)	4 (13.8)	12 (46.2)	6 (25.0)	
Family [b]						
Less than $49,999	28 (32.2)	2 (9.5)	7 (29.2)	9 (45.0)	10 (45.5)	.003
$50,000-99,999	28 (32.2)	5 (23.8)	8 (33.3)	10 (50.0)	5 (22.7)	
Above $100,000	31 (35.6)	14 (66.7)	9 (37.5)	1 (22.7)	7 (31.8)	
Person living with [c]						
Parents	117 (86.0)	26 (78.8)	35 (94.6)	25 (78.1)	31 (91.2)	.10 [d]
Siblings	88 (64.7)	23 (69.7)	27 (73.0)	18 (56.3)	20 (58.8)	.39
Other relatives	10 (7.4)	0 (0.0)	2 (5.4)	3 (9.4)	5 (14.7)	.11 [d]
Friends/roommates	10 (7.4)	5 (15.2)	1 (2.7)	1 (3.1)	3 (8.8)	.21 [d]
Spouse/partner	2 (1.5)	0 (0.0)	0 (0.0)	2 (6.3)	0 (0.0)	.05 [d]
Girlfriend/boyfriend	2 (1.5)	1 (3.0)	0 (0.0)	1 (3.1)	0 (0.0)	.36 [d]
Living alone	5 (3.7)	2 (6.1)	1 (2.7)	2 (6.3)	0 (0.0)	.50 [d]
Health insurance						
No insurance	5 (3.7)	0 (0.0)	2 (5.4)	3 (9.4)	0 (0.0)	.07
Private	102 (75.0)	30 (90.9)	26 (70.3)	23 (71.9)	23 (67.6)	

Characteristics	**Total (*N*=136)**	**ADI Quartile**				***p***
		Q1 (*n*=33)	**Q2 (*n*=37)**	**Q3 (*n*=32)**	**Q4 (*n*=34)**	
	Mean±SD or n (%)	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	***Mean±SD or n (%)***	
Medicaid/other public	27 (19.9)	2 (6.1)	9 (24.3)	5 (15.6)	11 (32.4)	
Don't know	2 (1.5)	1 (3.0)	0 (0.0)	1 (3.1)	0 (0.0)	
Primary care setting						
Pediatricians	59 (43.4)	20 (60.6)	18 (48.6)	5 (15.6)	16 (47.1)	<.001 [d]
Adult physicians	21 (15.4)	2 (6.1)	2 (5.4)	10 (31.3)	7 (20.6)	
Family practices	40 (29.4)	6 (18.2)	10 (27.0)	15 (46.9)	9 (26.5)	
College university health center	11 (8.1)	3 (9.1)	7 (18.9)	1 (3.1)	0 (0.0)	
Other	5 (3.7)	2 (6.1)	0 (0.0)	1 (3.1)	2 (5.9)	
Primary malignancy diagnosis						
Leukemia/Lymphoma	81 (59.6)	21 (63.6)	24 (64.9)	19 (59.4)	17 (50.0)	.58
Solid tumor/other	55 (40.4)	12 (36.4)	13 (35.1)	13 (40.6)	17 (50.0)	
Treatment type [c]						
Chemotherapy	135(99.3)	33 (100.0)	37(100.0)	31(96.9)	34 (100.0)	.24 [d]
Radiotherapy	46 (33.8)	10 (30.3)	11 (29.7)	12 (37.5)	13 (38.2)	.81
BMT	27 (19.9)	3 (9.1)	9 (24.3)	7 (21.9)	8 (23.5)	.36
Surgery	47 (34.6)	9 (27.3)	10 (27.0)	13 (40.6)	15 (44.1)	.31
Treatment intensity						
1~2	46 (31.6)	14 (42.4)	14 (37.8)	10 (31.3)	8 (23.5)	.38
3	51 (37.5)	14 (42.4)	12 (32.4)	10 (31.3)	15 (44.1)	
4	39 (28.7)	5 (15.2)	11 (29.7)	12 (37.5)	11 (32.4)	
Relapse						
No	118 (86.8)	31 (93.9)	34 (91.9)	25 (78.1)	28 (82.4)	.19 [d]
Yes	18 (13.2)	2 (6.1)	3 (8.1)	7 (21.9)	6 (17.6)	
Secondary malignancy						
No	134 (98.5)	33 (100.0)	37 (100.0)	30 (93.8)	34 (100.0)	.05 [d]
Yes	2 (1.5)	0 (0.0)	0 (0.0)	2 (6.3)	0 (0.0)	

Note. [a] Independent t-test; [b] Excluded the responses of "Don't know/decline to answer"; [c] multiple response questionnaire; [d] Fisher's Exact test. SD, Standard deviation. ADI, Area deprivation index.

PAPER 3

The Impact of Social Determinants and Posttraumatic Growth Among Adolescent and Young Adult Childhood Cancer Survivors

Abstract

Background: Posttraumatic growth refers to positive psychological changes that arise from overcoming the adversity of cancer and is critical for the psychological well-being of adolescent and young adult childhood cancer survivors (AYA CCS). Social determinants, such as neighborhood deprivation or healthcare access, could influence posttraumatic stress and, subsequently, posttraumatic growth of AYA CCS. However, limited evidence exists regarding the impact of neighborhood-level social determinants on posttraumatic growth in this population. In addition, the potential mediating effect of stress on the relationship between neighborhood-level social determinants and posttraumatic growth remains unknown.

Methods: This secondary data analysis used cross-sectional data collected from 121 AYA CCS. Neighborhood deprivation was measured using the Area Deprivation Index and the Environmental Justice Index. The Posttraumatic Growth Inventory and the Impact of Event Scale-Revised were used to assess posttraumatic growth and stress, respectively. A series of linear regression analyses were performed to assess the impact of neighborhood deprivation on posttraumatic growth. After exploring a potential curvilinear relationship between posttraumatic stress and growth, the curvilinear mediating effect of stress on the association between neighborhood deprivation and posttraumatic growth was assessed using the MEDCURVE macro in SPSS.

Results: Higher neighborhood deprivation was significantly associated with higher posttraumatic growth ($p < .001$) in AYA CCS. Additionally, a curvilinear relationship between posttraumatic stress and growth was identified ($R^2 = 0.06$, $F = 3.40$, $p = .037$), with moderate levels of stress associated with increased growth, while excessive stress was related to diminished growth. Posttraumatic stress was also found to curvilinearly mediate the relationship between neighborhood deprivation (ADI and Social Vulnerability subscale of EJI, respectively) and posttraumatic growth, with the mediation effect varying depending on the level of stress in AYA CCS. Specifically, in neighborhoods one standard deviation below the mean of ADI (less deprived neighborhoods), the indirect effect of posttraumatic stress was 0.109 (95% CIs, 0.019–0.297). In the neighborhood one standard deviation above the mean of ADI (more deprived neighborhoods), the indirect effect of posttraumatic stress decreased to 0.077 (95% CIs, 0.019–0.173). A partial curvilinear mediation effect of posttraumatic stress was identified, indicating that both social determinants and stress have significant impact on posttraumatic growth.

Conclusion: This study highlights the critical role of neighborhood-level social determinants, particularly neighborhood deprivation, in affecting psychological outcomes for AYA CCS. The curvilinear relationship between posttraumatic stress and growth underscores the complexity of stress and growth dynamics, suggesting the consideration of both psychological and environmental factors comprehensively in this vulnerable population.

Keywords: Posttraumatic growth, posttraumatic stress, neighborhood deprivation, adolescent, young adult, childhood cancer survivor.

Introduction

Surviving childhood cancer is an intensely stressful and traumatic experience, but it can also catalyze the development of posttraumatic growth.[1] This growth is characterized by positive psychological changes, such as enhanced personal strength, improved interpersonal relationships, a greater appreciation for life, and spiritual development. According to Tedeschi and Calhoun, growth is developed by cognitive reappraisal and reconstruction of an individual's fundamental beliefs.[1] Adolescent and young adulthood (AYA) childhood cancer survivors (CCS) are in particularly critical periods to experience posttraumatic growth since this developmental stage is distinguished by self-discovery and identity formation, which can help them integrate their cancer experiences into an emerging sense of self.[2] Studies have reported that AYA CCS with greater posttraumatic growth were more likely to experience higher self-efficacy in survivorship[1] and better mental health-related quality of life.[3] Therefore, understanding the factors contributing to posttraumatic growth can provide valuable insights to support the overall psychological health of AYA CCS.

Social determinants – defined as the conditions in which people are born, grow, live, work, and age – may play a critical role in posttraumatic growth among AYA CCS. For example, individual-level social determinants, including lower education attainment,[4,5] lower income levels,[4] and unemployment,[4–7] may impede the development of posttraumatic growth.[8] Beyond the individual level, growing evidence suggests that access to essential resources at neighborhood levels, such as mental health services[9–11] and community support,[12–14] also influences posttraumatic growth across various populations, including CCS, parents of children with developmental disorders, and veterans. However, there remains limited evidence in the literature regarding the impact of neighborhood-level social determinants, particularly neighborhood deprivation, on posttraumatic growth in the AYA CCS population.

Another important factor for posttraumatic growth is posttraumatic stress. Research suggests that the process of posttraumatic growth may be initiated by the experiences of posttraumatic stress as individuals process and adapt to the challenges arising from traumatic events, such as a cancer diagnosis and treatments.[1] Studies reported that up to 56.5% of AYA CCS experience posttraumatic stress symptoms,[15] including intrusive memories of their diagnosis and treatment, efforts to avoid trauma-related reminders (e.g., medical situations, discussions about cancer, etc.), and hyperarousal about general health or the potential for cancer recurrence.[16,17] Given that coping with posttraumatic stress can foster posttraumatic growth, it is essential to explore the mechanisms through which stress facilitates or influences growth in AYA CCS. Moreover, no studies have examined the potential mediating role of posttraumatic stress on the relationship between neighborhood-level social determinants, such as neighborhood deprivation, and posttraumatic growth among AYA CCS.

To address these gaps in literature, this study aimed to investigate the impact of neighborhood deprivation on posttraumatic growth among AYA CCS. Additionally, the study examined whether posttraumatic stress mediated the association between neighborhood deprivation and posttraumatic growth.

Research Design and Methods

Study Design

This study was a secondary data analysis study. The parent study (PI: J. G. Marchak) was a cross-sectional cohort study determining predictors associated with healthcare transition readiness and adherence to adult survivor-oriented healthcare in AYA CCS. Eligible participants for the parent study included AYA CCS who were 18-25 years of age at data collection, diagnosed with cancer at ≤ 18 years of age, more than two years since the completion of cancer treatment, and seen at least once in the Aflac Cancer Survivor Program of Children's Hospital of Atlanta (CHOA) in the past 2 years. For this current study, participants who completed all questionnaires – including sociodemographic and clinical characteristics, and posttraumatic stress and growth – and provided their permanent address for geocoding neighborhood-level social determinants were included in the sample.

Data Collection

The parent study initially identified each AYA CCS family from the Aflac Cancer Survivor Program institutional database and screened for eligibility by research staff using information from the medical record. All eligible participants were emailed by research staff and/or received a printed recruitment letter through postal mail before being contacted by phone. The initial recruitment email was sent to eligible participants containing a link to a secure electronic consent and survey battery via the secure, web-based Research Electronic Capture (REDCap) platform[18,19] hosted by CHOA. E-mails and phone recruitment attempts were made at alternating two-week intervals. Recruitment was discontinued after three unsuccessful email and phone attempts to recruit participants. The online consent form was provided on the initial page of the REDCap survey prior to any study questionnaires. Participants who agreed to participate were linked to the study survey battery following their typed signature.

The proposed study obtained approval from the Institutional Review Board of CHOA. Participants' permanent residential addresses at the time of the survey were linked to 9-digit zip codes, which were used to assign the ADI ranks and EJI scores using designated Woodruff Health Science library computers. Re-consent and additional compensation of participants, beyond what was offered in the parent study, were unnecessary since this study did not involve face-to-face engagement with the participants.

Variables and Measures

Social determinants: Social determinants were coded with the ADI[20] and the EJI[21] using the participants' addresses and 9-digit ZIP codes. *The ADI* comprises 17 U.S. Census indicators in four domains: poverty, education, housing, and employment.[20] The ADI measure was calculated by combining these indicators at the Census Block Group level, in a percentile ranging from 0 to 100. The ADI percentile indicates a socioeconomic status (SES) of a neighborhood to the nation with greater disadvantage ranked higher. *The EJI* is a national, place-based tool designed to quantify the cumulative environmental burden based on the Census tract.[21] The EJI includes three modules: Social Vulnerability (14 factors), Environmental Burden (17 factors), and Health Vulnerability (5 factors).[21] Each module was calculated with a scale from 0 to 1,[22] and the final EJI ranking was calculated with percentile ranks by averaging the scores of three modules. A higher percentile score indicates a neighborhood experiencing more environmental justice concerns.

Posttraumatic growth: Posttraumatic growth was measured by the Posttraumatic Growth Inventory (PTGI) which consists of 21 items to assess positive psychological outcomes in individuals who have experienced trauma in 5 domains of "relating to others," "new possibilities," "personal strength," "spiritual change," and "appreciation of life."[23] Each item was scored using a 6-point Likert scale ranging from 0 ("never experienced it as a result of my cancer") to 5 ("experienced it to a great degree as a result of cancer"). Total scale scores are calculated by adding the item scores, ranging from 0 to 105. Higher scores indicate higher posttraumatic growth, indicating a higher level of positive psychological change experienced following a traumatic event, specifically a cancer experience in this study.

Posttraumatic stress: Posttraumatic stress symptoms with respect to participants' cancer experience were measured using the Impact of Event Scale-Revised (IES-R)[24], which consists of a 22-item questionnaire rated on a 5-point Likert scale (0= "never" to 4= "extremely"). The IES-R includes three subscales: "avoidance," "intrusive thoughts," and "hyperarousal." The total score was calculated by summing all item scores, ranging from 0 to 88. Each subscale score was calculated in the same manner. Higher total scores suggest more severe post-traumatic stress symptoms. A cutoff score of 33 on the posttraumatic stress score was used to identify a clinically probable diagnosis of posttraumatic stress disorder (PTSD).[25]

Sociodemographic and clinical characteristics: Sociodemographic characteristics included self-reported gender, race/ethnicity (non-Hispanic (NH) White, NH Black, Hispanic, NH other), age at survey, education level (high school graduate or below/some college or tech school graduate or above), employment status (yes/no), number of people living with, patient's income (less than $9,999/$10,000-49,999/Don't know or decline to answer), health insurance type (no insurance/private/Medicaid or other public/Don't know r) and primary care setting (pediatricians/adult physicians/family practices/college university health center/other). For participant's parents' characteristics, education level (high school graduate or below/some college or tech school graduate or above), and family income (less than $49,999/$50,000-99,999/more than $100,000/Don't know or decline to answer) were included. Clinical characteristics included age at diagnosis, years since completion of treatment, diagnosis (leukemia and lymphoma/solid tumors and other), treatment type (chemotherapy/radiotherapy/bone marrow transplant/surgery), patient-reported treatment intensity (range 1-4), and history of relapse (yes/no) and secondary malignancy (yes/no).

Sample Size

A statistical power analysis was performed using G*Power 3.1[26] to determine the sample size for the regression analysis. Given our sample size of 121 for multi-linear regression, we were powered at 80% and 5% level of significance to be able to detect a small-to-moderate effect size f^2=0.119 for a model with six predictors. A sample size of 121 is also reasonable for moderate-to-large standardized coefficients in a mediation model, as noted in the literature.[27]

Data Analysis

Descriptive statistics were performed for sociodemographic and clinical characteristics, ADI, EJI, posttraumatic stress, and posttraumatic growth, using means and standard deviations for continuous variables, and frequencies and percentages for categorical variables. The differences in posttraumatic stress and growth by sociodemographic and clinical characteristics were examined by independent t-tests or ANOVA. Additionally, the differences in posttraumatic stress and growth across the ADI quartiles were assessed using an Analysis of Variance (ANOVA).

To examine the impact of neighborhood social determinants on posttraumatic growth, generalized linear regression models were employed. For each linear regression model, one independent variable of neighborhood social determinants – including ADI, total EJI, and three subscales of EJI –was entered with posttraumatic growth as the outcome variable. Covariates were selected based on bivariate correlation analyses among covariates and then between covariates and predictors to identify potential multicollinearity. Variables with variance Inflation Factor (VIF) higher than 10 or tolerance below 0.1 were excluded, indicating high multicollinearity. Covariates that showed a univariate relationship with the outcome variable at a significance level of < 0.1 were considered in regression models. Additionally, covariates were selected a priori based on the literature.[12,13,28–30]

To examine the mediating effect of posttraumatic stress on the association between neighborhood deprivation and posttraumatic growth, the MEDCURVE macro was used. Before proposing the mediation analysis, the nature of the relationship between posttraumatic stress and growth was examined. A curved linear relationship between posttraumatic stress and growth was identified by a statistically significant R^2 among different types of models (linear, quadratic, or cubic). Based on the finding of the curvilinear relationship, we used the MEDCURVE macro, proposed by Hayes and Preacher.[31] The MEDCURVE macro procedure uses ordinary least squares regression to estimate nonlinear mediation models and calculate the *total*, *direct*, and *indirect effects*. The *total effect* refers to the effect of the independent variable (X, neighborhood social determinants) on the outcome variable (Y, posttraumatic growth), without considering the mediator (M, posttraumatic stress). The *direct effect* indicates the effect of X on Y that is ***not*** explained by M, while the indirect effect represents the effect of X on Y through M. In nonlinear mediation analysis, the *indirect effect* varies with the values of X or M, depending on the nonlinear relationship pathway. This *indirect effect* in nonlinear models is termed an *instantaneous indirect effect* (θ, theta).[31] The significance of θ is tested by bias-corrected bootstrap confidence intervals (CIs) generated by the MEDCURVE macro, with 5000 bootstrap samples used to obtain 95% CIs. CIs that do not include zero indicate significant effects at the $p < .05$ level. The same covariates used in the previous steps were consistently controlled for in the mediation analyses.

Results

Sociodemographic and Clinical Characteristics

A total of 121 AYA CCS were included in the final analysis (**Table 1**). Approximately 71% were non-Hispanic (NH) White, 46% were female, 82% were students, and 52% were employed. The participants' average age at diagnosis was 8.13±5.34 years, the average age at the time of the survey was 19.42±1.02 years, and the average time since the completion of treatment was 9.23±5.23 years. For primary malignancy diagnosis, 56% of participants were diagnosed with leukemia or lymphoma. Additionally, 10.7% of participants experienced a relapse, and 1.7% experienced a secondary malignancy. Most participants (n = 89, 73.6%) had private health insurance, approximately 20% had Medicaid or public insurance, and 3.3% had no insurance. Nearly half of the participants (n = 55, 45.5%) reported that their primary care setting was pediatric care, while the rest visited adult physicians, family practices, or college/university health centers. Survivors who reported higher levels of posttraumatic growth were more likely to be non-students ($p < .05$) and working full-time ($p = .02$), compared to those who were students and working part-time. **Table 2** describes the differences in EJI, posttraumatic stress, and growth by ADI quartiles. Fourteen participants (11.6%) exhibited significant posttraumatic stress, which could indicate a clinically probable diagnosis of posttraumatic stress disorder (PTSD), based on a cutoff score of 33 on the IESR[32] (**Supplementary Figure 1**). **Supplementary Table 1** presents the correlation analyses among ADI, EJI, the subscales of EJI, and posttraumatic stress and growth.

Effects of neighborhood-level social determinants (ADI, EJI) on posttraumatic growth

In regression models, positive predictive effects of ADI on posttraumatic growth (β = 0.32, B = 0.36, 95% CIs, 0.17–0.55) with small-to-moderate effect sizes (β between 0.1 and 0.3) were observed (**Table 3; Figure 1**). Additionally, the total EJI was positively associated with posttraumatic growth (β = 0.23, B = 24.10, 95% CIs, 5.78–42.42). Among subscales of EJI, “Social Vulnerability” and “Health Vulnerability” showed statistically significant associations with posttraumatic growth (β = 0.26, B = 26.80, 95% CIs, 9.14–44.45; β = 0.24, B = 27.12, 95% CIs, 7.46–46.78). “Environmental burden” subscale was not associated with posttraumatic growth (p > .05). All regression models were adjusted for covariates of years since completion of treatment, diagnosis (leukemia and lymphoma/solid tumor and other), relapse (yes/no), and participant’s education level (≤ high school graduate/≥ college graduate) (**Table 3**).

Curvilinear mediation relationship

Figure 2 shows the results of the Curve Estimation on the relationship between posttraumatic stress and growth. Among linear, quadratic, and cubic relationships, the model fit of the quadratic relationship was better than others and only statistically significant ($R^2 = 0.06$, $F = 3.40$, $p = .037$).

Figure 3 shows the results of statistically significant curvilinear mediation models. **Figure 3-(a)** illustrates the curvilinear mediating effects of posttraumatic stress on the relationship between ADI and posttraumatic growth. The instantaneous indirect effect (θ) of posttraumatic stress on the relationship between ADI and posttraumatic growth was significantly stronger in the less deprived neighborhoods but became weaker in more deprived neighborhoods. Specifically, in neighborhoods one standard deviation below the mean of ADI (less deprived neighborhoods), the indirect effect of posttraumatic stress was B = 0.11 (95% CIs, 0.02–0.30). In the neighborhood one standard deviation above the mean of ADI (more deprived neighborhoods), the indirect effect of posttraumatic stress decreased to 0.07 (95% CIs, 0.02–0.17).

Among total EJI and its subscales, the curvilinear mediating effect of posttraumatic stress was statistically significant only on the relationship between “Social Vulnerability” and posttraumatic growth (**Figure 3-(b)**). The instantaneous indirect effect (*θ*) of posttraumatic stress on the association between Social Vulnerability and posttraumatic growth showed similar trends with weakening indirect effects of stress as the Social Vulnerability score increases. However, total EJI and other subscales, including Environmental Burden and Health Vulnerability, posttraumatic stress did not have statistically significant curvilinear mediating effects (**Supplementary Figure 2**).

Discussion

Our key finding is that neighborhood-level social determinants significantly influence posttraumatic growth among AYA CCS. Specifically, AYA CCS living in more deprived neighborhoods were more likely to report higher posttraumatic growth. Additionally, we identified a curvilinear relationship between posttraumatic stress and posttraumatic growth. As posttraumatic stress rises to a moderate level, posttraumatic growth increases and reaches a peak. However, further increases in posttraumatic stress are associated with a decline in posttraumatic growth. Lastly, the curvilinear mediating effect of posttraumatic stress on the relationship between neighborhood-level social determinants and posttraumatic growth was supported, indicating that mediating effects of posttraumatic stress vary across neighborhood deprivation levels. The mediating effect of posttraumatic stress on posttraumatic growth weakened in more deprived neighborhoods, suggesting a more critical role of social determinants on posttraumatic growth in those more deprived areas. In addition, our study found that posttraumatic stress partially mediated the relationship between neighborhood-level social determinants and posttraumatic growth, highlighting the critical role of neighborhood deprivation on growth.

AYA childhood cancer survivors living in more deprived neighborhoods reported higher posttraumatic growth, adjusting for years since completion of treatment, diagnosis, relapse, and participant education level. Although empirical evidence on the impact of neighborhood deprivation on posttraumatic growth among AYA CCS is limited, our findings align with the "shift-and-persist" psychological model developed by Chen and colleagues.[33] This framework suggests that disadvantaged individuals in stressful environments often develop greater adaptive coping strategies, such as posttraumatic growth. The model emphasizes two key processes: *Shifting,* which involves reappraising a stressful situation and accepting stressors, and *persisting,* which focuses on enduring adversity with strength, finding meaning, and maintaining optimism.[33] These cognitive strategies, including reappraisal and meaning-making, are consistent with the mechanisms underlying posttraumatic growth.[1] According to Chen and colleagues,[33,34] the shift-and-persist approach is particularly beneficial for disadvantaged environments with limited resources and greater stressors. In deprived neighborhoods, where uncontrollable external challenges with limited resources are common, the shift-and-persist strategy could be particularly valuable for helping individuals accept and adjust to these difficulties. Furthermore, previous study has shown that individuals with low SES who used the shift-and-persist strategy experienced lower levels of anxiety, depression, and fatigue, along with greater engagement in social roles.[35] In contrast, individuals in less deprived neighborhoods with higher SES tend to use proactive strategies to eliminate stressors and engage in preventive behaviors, which are more effective because of their access to greater resources.[34] Applying this framework to our findings, it is plausible that AYA CCS in deprived neighborhoods exhibited greater posttraumatic growth as an adaptative response to traumatic cancer experiences. Neighborhood-level social determinants might significantly influence the development of this growth in our study.

Therefore, fostering posttraumatic growth can be particularly beneficial for AYA CCS in deprived neighborhoods. Additionally, it is essential to consider that not all AYA CCS may experience posttraumatic growth,[36] particularly those in less deprived neighborhoods. Future studies are needed to explore different coping strategies that are beneficial and valued by AYA CCS, considering individual's social determinants and contexts such as SES and neighborhood deprivation.

Our study supports the existence of a curvilinear relationship between posttraumatic stress and posttraumatic growth, consistent with previous research among AYA CCS.[37,38] This result highlights several key aspects of the nature of the relationship between posttraumatic stress and posttraumatic growth. First, low posttraumatic stress is associated with minimal posttraumatic growth, suggesting insufficient stress may not be enough to trigger the development of posttraumatic growth.[8] Second, moderate levels of posttraumatic stress are associated with maximal growth, indicating that a significant amount of stress is necessary to shake an individual's core beliefs and prompt cognitive processes such as deliberate rumination and schema change.[39] According to Tedeschi and Calhoun's posttraumatic growth theory, these cognitive processes are essential for making sense of the trauma and facilitating personal growth.[1] Third, excessive posttraumatic stress may overwhelm an individual's cognitive abilities, possibly leading to poor posttraumatic growth. There seems to be a threshold beyond which stress becomes detrimental, suggesting that a moderate level of stress may be optimal for fostering posttraumatic growth. However, there is also evidence suggesting the absence of a relationship,[40,41] as well as evidence of a linear relationship – both positive[36,42,43] and negative[16,28,43–45] – between posttraumatic stress and posttraumatic growth among AYA CCS, parents of CCS, and general undergraduate students. These conflicting results may be due to the timing of the assessment and the complex nature of posttraumatic stress and posttraumatic growth. Therefore, future studies are needed to replicate these findings using a larger sample and a longitudinal study design to identify the changes in posttraumatic stress and growth over time throughout the cancer trajectory among AYA CCS.

We identified a curvilinear mediating effect of posttraumatic stress on the relationship between neighborhood deprivation and posttraumatic growth among AYA CCS. Due to the quadratic relationship between posttraumatic stress and posttraumatic growth, the mediating effect of stress varies based on the level of posttraumatic stress, referred to as the *instantaneous indirect effect*.[31] Our findings reveal that while this *instantaneous indirect effect* of posttraumatic stress was statistically significant across different levels of neighborhood deprivation, it diminishes as deprivation increases. Interestingly, in less deprived neighborhoods, posttraumatic stress appears to have a stronger influence on posttraumatic growth, indicating the important role of stress in fostering growth. Conversely, in more deprived neighborhoods, the effect of changes in posttraumatic stress on posttraumatic growth is less significant, potentially because the persistently high levels of stress in these neighborhoods diminish the relative effect of additional stress. Considering that deprived neighborhoods are frequently characterized by poverty,[46] limited access to affordable services,[47] lack of green spaces,[48] and higher rates of crime and violence,[49] AYA CCS living in these areas may experience not only posttraumatic stress specifically related to cancer experiences but also more generalized environmental stress at the community levels. As a result, AYA CCS may face elevated levels of daily stress, which can either promote or hinder posttraumatic growth. These results highlight the complex relationship between posttraumatic stress and growth within the context of neighborhood deprivation. Therefore, it is essential for clinicians to regularly evaluate both cancer-related stress and the cumulative daily stressors experienced by AYA CCS. Additionally, as neighborhood deprivation increases, addressing both environmental factors and individual stressors becomes increasingly critical, as focusing only on reducing stress may not be enough to foster posttraumatic growth among AYA CCS in more deprived areas.

When interpreting the findings of this study, several limitations should be acknowledged. First, the cross-sectional design of this study limited the ability to establish definitive causal relationships among neighborhood-level social determinants, posttraumatic stress, and growth. Therefore, the results should be interpreted cautiously; however, the mediation effects observed in this study can provide valuable preliminary insights and inform the need for longitudinal research in the future. Second, the dataset used in this study was collected from a single institution, with all participants recruited from a childhood cancer survivorship program. The sample of this study may not fully represent individuals who do not engage in follow-up survivorship care. Future research is recommended to include data from multiple institutions and diverse settings to provide a more comprehensive understanding of these phenomena. Finally, the study did not consider all potential confounding variables. While key sociodemographic and clinical variables were controlled, other relevant variables, such as social support, parent-child relationships, and access to mental health services, were not included. Future research is recommended to control a broader range of confounding factors to account for the complexity of this phenomenon.

Conclusion

This study highlights the critical role of the neighborhood environment on the psychological growth of AYA CCS. In addition, our findings demonstrate that posttraumatic stress plays a significant mediating role in the relationship between neighborhood deprivation and posttraumatic growth, with the nature of this mediation varying depending on the level of neighborhood deprivation. Specifically, we observed that the impact of posttraumatic stress on growth diminishes as neighborhood deprivation increases, potentially due to the overwhelming stress leading to less growth as indicated by our data. This finding also shows that SDOH could be more important for posttraumatic growth among AYA CCS who experience more stress from both environments and cancer experiences than those who experience less stress. Therefore, it is recommended that healthcare providers comprehensively assess posttraumatic stress with neighborhood-level social determinants in AYA CCS. Particularly for those in deprived neighborhoods, integrating psychological support with improving neighborhood environments may be necessary to effectively promote posttraumatic growth, ultimately contributing to the long-term psychological well-being of this vulnerable population.

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Table 1. Sociodemographic and Clinical Characteristics (*N*=121).

Characteristics	***N* (%) or mean±SD**	**Posttraumatic Growth mean±SD**	***p***
Race and Ethnicity			
Non-Hispanic White	86 (71.1)	65.26±29.50	.69
Non-Hispanic Black	23 (19.0)	67.48±34.03	
Hispanic	9 (7.4)	77.78±27.27	
Non-Hispanic other	3 (2.5)	63.37±7.37	
Sex			
Male	56 (46.3)	66.84±29.51	.93
Female	65 (53.7)	66.34±30.35	
Age at diagnosis			
Total, years (mean±SD)	8.13±5.34	-	-
0-4 years	46 (38.0)	59.54±31.71	.17
5-9 years	25 (20.7)	73.48±26.04	
10-14 years	35 (28.9)	67.37±30.20	
15-19 years	15 (12.4)	74.73±26.52	
Age at assessment			
Total, years (mean±SD)	19.42±1.02	-	-
18 years	48 (39.7)	60.31±29.83	.06
19 years	39 (39.2)	75.33±26.59	
≥ 20 years	34 (28.1)	65.35±31.74	
Student			
No	22 (18.2)	78.05±19.22	<.05
Yes	99 (81.8)	64.02±31.23	
Current school level			
High school	13 (10.7)	70.92±18.22	.37
Technical school/2-year college	14 (11.6)	70.07±33.89	
4-year college/University	69 (57.0)	60.64±32.69	
Other	3 (2.5)	83.67±21.03	
Employment			
No	58 (47.9)	63.34±28.98	.26
Yes	63 (52.1)	69.54±30.54	
Workload			
Part time	46 (38.0)	64.00±32.67	.02
Full time	17 (14.0)	84.53±16.85	
Highest education level			
Patient			
≤ High school graduate	72 (59.5)	65.97±29.49	.79
≥ Partial college/college graduate	49 (40.5)	67.45±30.63	
Mother			
≤ High school graduate	29 (24.0)	72.21±24.68	.36
≥ Partial college/college graduate	85 (70.2)	64.06±31.75	
Don’t know	7 (5.8)	73.71±23.41	
Father			
≤ High school graduate	41 (33.9)	73.15±26.98	.22
≥ Partial college/college graduate	65 (53.7)	62.75±31.89	
Don’t know	15 (12.4)	65.13±26.61	
Yearly Income level			
Patient			

Characteristics	*N* (%) or mean±SD	Posttraumatic Growth mean±SD	*p*
Less than $9,999	74 (61.2)	62.97±31.71	.12
$10,000-49,999	20 (16.5)	78.30±21.97	
Don't know/decline to answer	27 (22.3)	67.74±28.11	
Family			
Less than $49,999	25 (20.7)	74.84±22.63	.24
$50,000-99,999	23 (19.0)	67.48±32.91	
More than $100,000	27 (22.3)	57.93±33.05	
Don't know/decline to answer	46 (38.0)	66.70±29.28	
Person living with*			
Parents			
Yes	105 (86.8)	66.77±29.03	.85
No	16 (13.2)	65.25±35.76	
Siblings			
Yes	80 (66.1)	64.38±28.56	.26
No	41 (33.9)	70.85±32.12	
Other relatives			
Yes	10 (8.3)	73.40±30.36	.45
No	111 (91.7)	65.96±29.86	
Friends/roommates			
Yes	9 (7.4)	57.89±45.46	.37
No	112 (92.6)	67.27±28.41	
Spouse/partner			
Yes	2 (1.7)	92.00±18.38	.23
No	119 (98.3)	66.14±29.86	
Girlfriend/boyfriend			
Yes	1 (0.8)	86.00±0.00	.52
No	120 (99.2)	66.41±29.91	
Living alone			
Yes	4 (3.3)	73.00±17.45	.66
No	117 (96.7)	66.35±30.20	
Health insurance			
No insurance	4 (3.3)	85.75±20.48	.59
Private	89 (73.6)	65.36±30.70	
Medicaid/other public	26 (21.5)	68.23±28.93	
Don't know	2 (1.7)	60.50±3.54	
Primary care setting			
Pediatricians	55 (45.5)	60.75±32.27	.18
Adult physicians	17 (14.0)	72.82±25.42	
Family practices	36 (29.8)	73.33±25.88	
College university health center	9 (7.4)	57.56±36.07	
Other	4 (3.3)	79.50±16.90	
Primary malignancy diagnosis			
Leukemia/Lymphoma	68 (56.2)	72.26±26.57	.02
Solid tumor/other	53 (43.8)	59.26±32.38	
Treatment type *			
Chemotherapy	120 (99.2)	66.47±29.94	-
Radiotherapy	41 (33.9)	64.27±29.55	-
BMT	22 (18.2)	64.91±25.06	-

Characteristics	***N* (%) or mean±SD**	**Posttraumatic Growth**	
		mean±SD	***p***
Surgery	45 (37.2)	60.44±33.18	-
Treatment intensity			
1~2	41 (33.9)	66.34±31.35	.75
3	47 (38.8)	64.53±31.84	
4	33 (27.3)	69.76±25.23	
Years since completion of treatment			
Total, years (mean±SD)	9.23±5.23	-	-
<5 years	37 (30.6)	72.35±26.51	.17
5~9 years	33 (27.3)	69.00±28.10	
≥10 years	51 (42.1)	60.80±32.61	
Relapse			
No	108 (89.3)	77.15±26.33	.18
Yes	13 (10.7)	65.30±30.09	
Secondary malignancy			
No	119 (98.3)	72.00±15.56	.80
Yes	2 (1.7)	66.48±30.05	

Note. SD, Standard deviation.

Table 2. Total Scores and Scores for Area Deprivation Index Quartiles (*N*=121).

Categories (possible score range)	**Total (*N*=121)**		**ADI Quartiles**				
	Q1 (*N*=29)		**Q1 (*N*=29)**	**Q2 (*N*=33)**	**Q3 (*N*=28)**	**Q4 (*N*=31)**	
	Mean±SD or N (%)	**Range**	***Mean±SD or N (%)***	***Mean±SD or N (%)***	***Mean±SD or N (%)***	***Mean±SD or N (%)***	***p***
Area Deprivation Index							
Total (0~100)	45.81±26.66	2-99	14.14±5.25	32.33±5.98	54.18±6.56	82.23±11.61	<.001
Environmental Justice Index							
Total (0~1)	0.41±0.29	0.01-0.98	0.16±0.16	0.28±0.20	0.46±0.19	0.75±0.17	<.001
Environmental Burden (0~1)	0.53±0.23	0.13-0.99	0.46±0.24	0.49±0.22	0.60±0.20	0.60±0.23	<.05
Social Vulnerability (0~1)	0.42±0.29	0.0007-0.97	0.09±0.10	0.31±0.20	0.53±0.18	0.75±0.15	<.001
Health Vulnerability (0~1)	0.18±0.26	0.00-0.80	0.03±0.08	0.05±0.11	0.11±0.16	0.51±0.29	<.001
Posttraumatic growth							
Total (0~105)	66.57±29.84	0-105	47.17±31.45	70.39±27.38	67.79±26.96	79.55±25.09	<.001
Relating to Others (0~35)	22.36±10.72	0-35	14.90±11.14	24.03±9.39	23.32±10.07	26.71±9.02	<.001
New Possibilities (0~25)	15.56±7.46	0-25	11.07±7.67	16.58±7.13	16.07±6.53	18.23±6.83	.001
Personal Strength (0~20)	13.27±6.03	0-20	9.66±6.53	13.88±6.07	13.36±5.33	15.94±4.55	<.001
Spiritual Change (0~10)	5.51±3.65	0-10	3.72±3.50	5.36±3.55	5.64±3.57	7.23±3.27	.002
Appreciation of Life (0~15)	9.86±4.36	0-15	7.83±4.83	10.55±3.87	9.39±4.26	11.45±3.82	.008
Posttraumatic stress							
Total (0~88)	11.48±17.48	0.00-73.00	6.69±9.42	9.12±12.56	12.68±21.76	17.39±21.89	.09
Intrusion (0~4)	0.51±0.79	0.00-3.50	0.30±0.44	0.38±0.55	0.58±0.96	0.80±1.01	.06
Avoidance (0~4)	0.60±0.87	0.00-3.50	0.39±0.58	0.54±0.81	0.63±1.00	0.85±1.00	.22
Hyperarousal (0~4)	0.43±0.85	0.00-3.33	0.20±0.46	0.30±0.58	0.51±1.07	0.71±1.08	.09

Note. ADI, Area Deprivation Index. ADI Quartile 1 = the least deprived neighborhoods. ADI Quartile 4 = the most deprived neighborhoods. SD, Standard deviation.

Table 3. Effects of social determinants on posttraumatic growth (*N*=121).

Predictors	**Outcome: Posttraumatic Growth**				
	β	**B**	**SE**	**LLCI of B**	**ULCI of B**
ADI	**0.32**	**0.36**	**0.10**	**0.17**	**0.55 ***
EJI Total	**0.23**	**24.10**	**9.25**	**5.78**	**42.42 ***
EJI Environmental Burden	-0.02	-2.87	11.93	-26.50	20.76
EJI Social Vulnerability	**0.26**	**26.80**	**8.91**	**9.14**	**44.45 ***
EJI Health Vulnerability	**0.24**	**27.12**	**9.93**	**7.46**	**46.78 ***

Note. All regression models adjusted for years since completion of treatment, diagnosis (leukemia and lymphoma/solid tumor and other), relapse (yes/no), and participant's education level (≤ high school graduate/≥ college graduate). ADI, Area Deprivation Index. EJI, Environmental Justice Index. ***β***, standardized coefficient. B, Unstandardized coefficient. SE, Standard error. LLCI, Lower limit confidence interval. ULCI, Upper limit confidence interval. * Statistically significant findings.

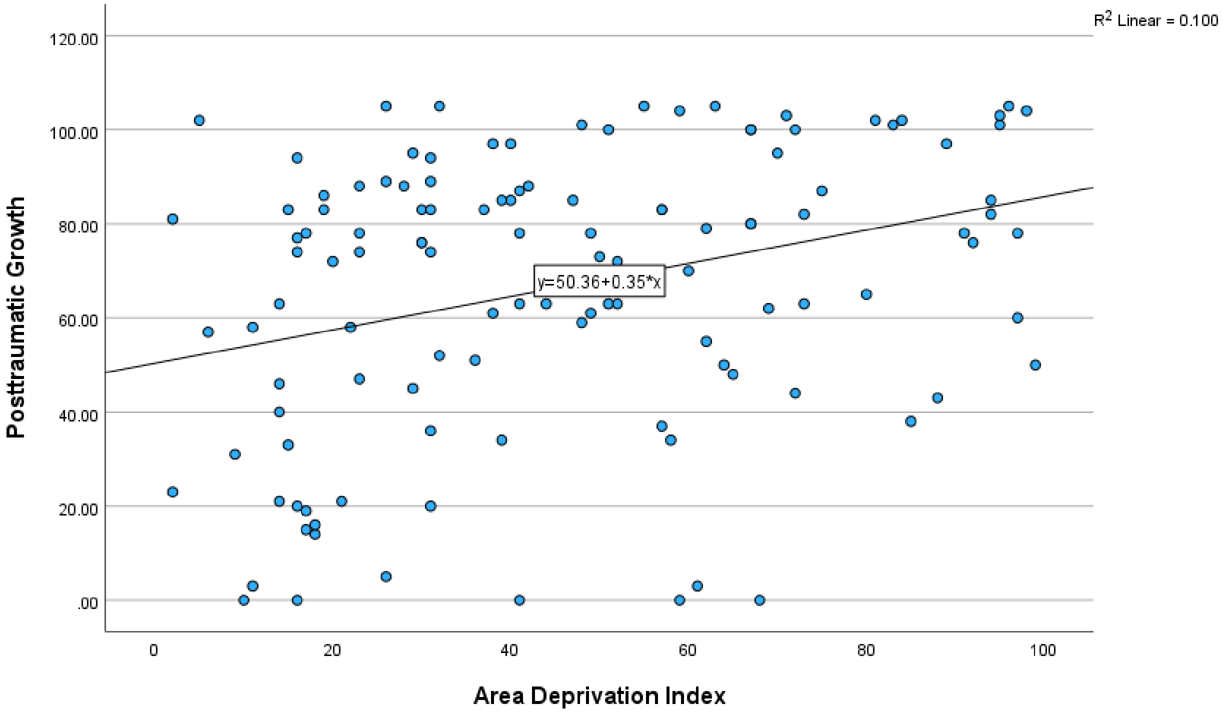


Figure 1. Scatter plots between area deprivation index (ADI) and posttraumatic growth.

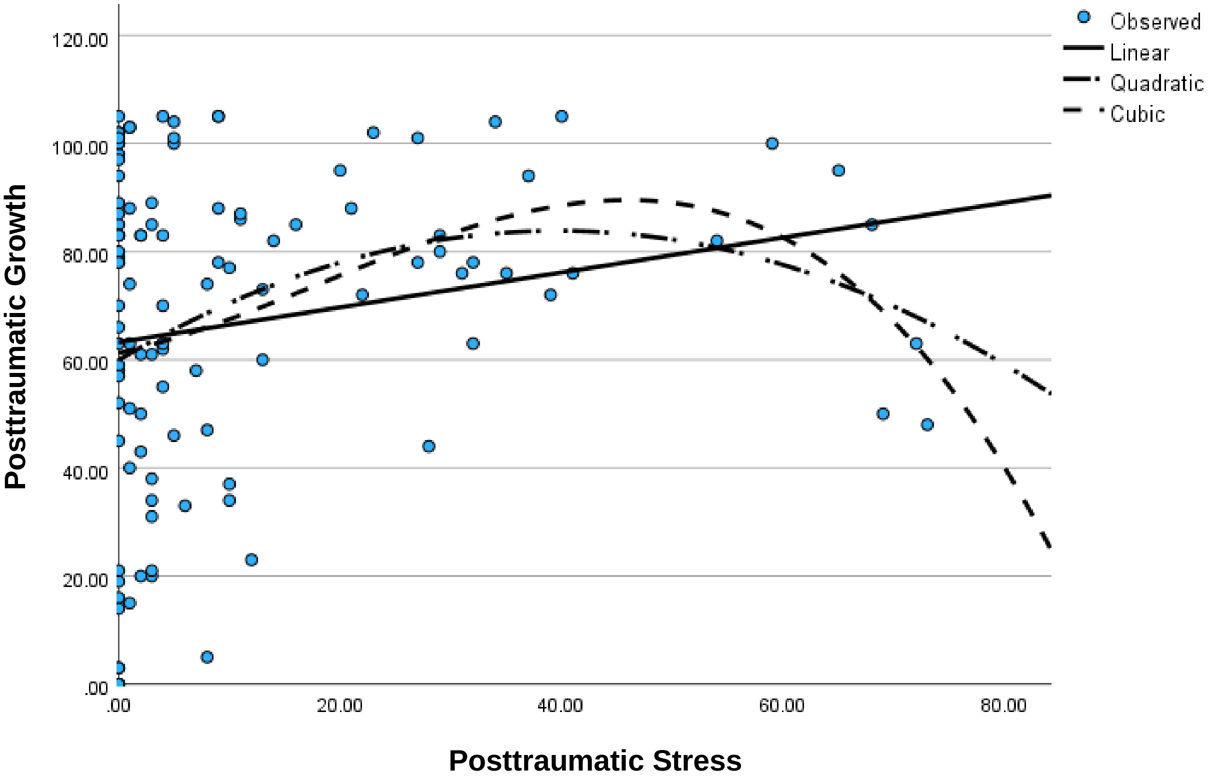


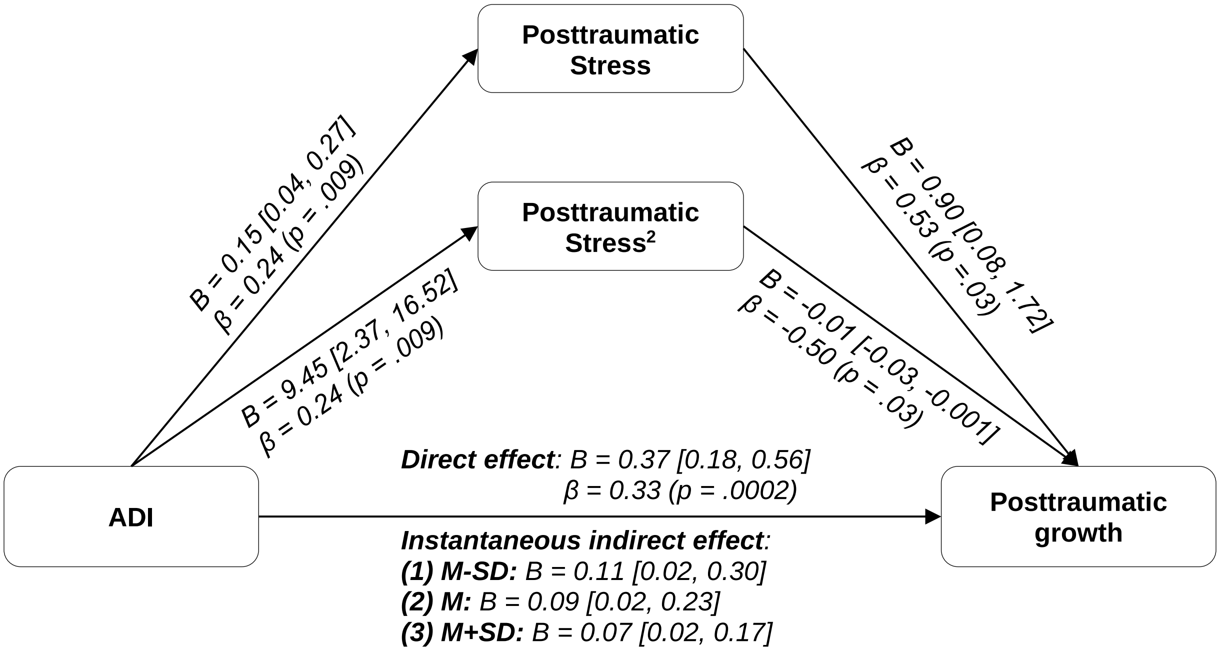
Figure 2. Curve Estimation on the relationship between posttraumatic stress and posttraumatic growth.

Note 1. Independent variable = posttraumatic stress. Dependent variable = posttraumatic growth.

Note 2.

Linear relationship: $R^2 = 0.03$, $F = 3.80$ ($p = .054$).
Quadratic relationship: $R^2 = 0.06$, $F = 3.40$ ($p = .037$).
Cubic relationship: $R^2 = 0.06$, $F = 2.51$ ($p = .062$).

(a) Area Deprivation Index (ADI)



(b) Social Vulnerability Module (SVM)

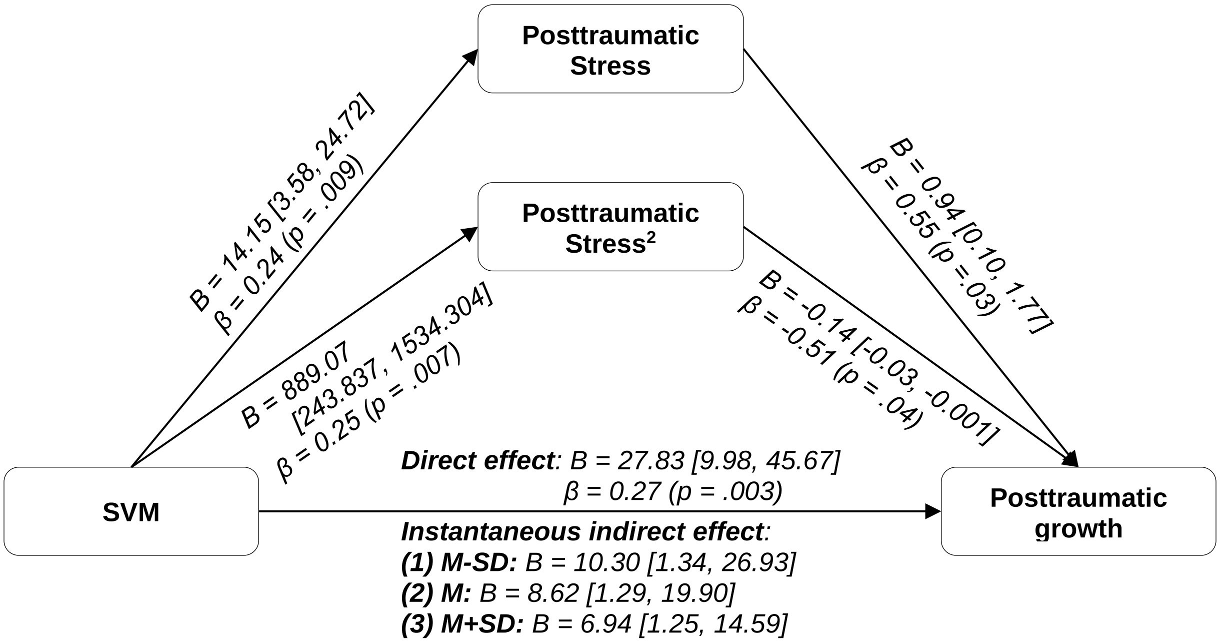


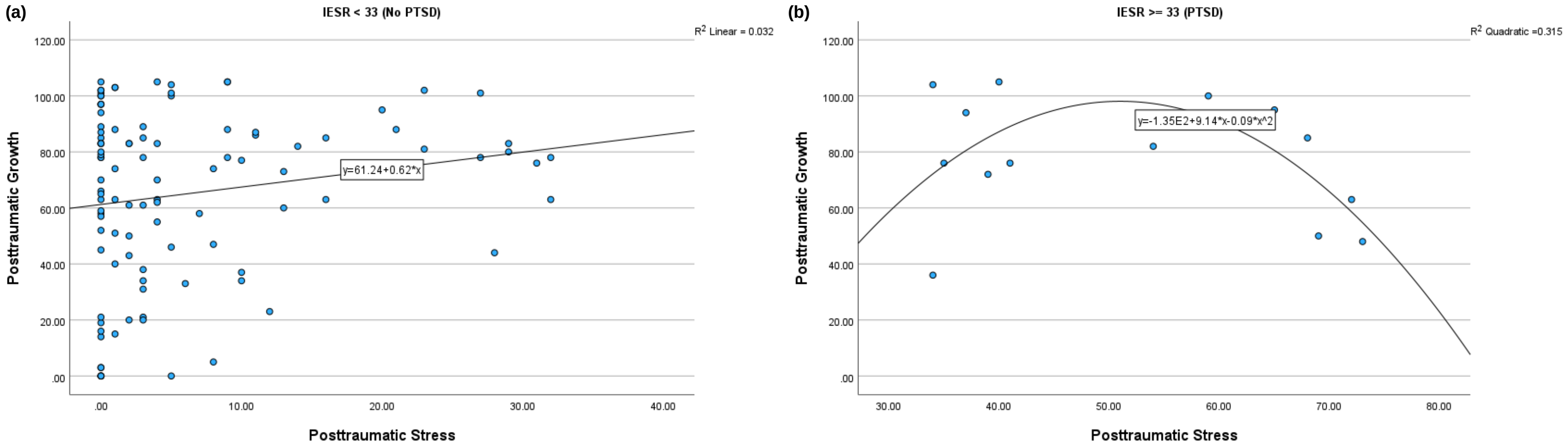
Figure 3. Curvilinear mediation model.

Note. Adjusted for years since completion of treatment, diagnosis (leukemia and lymphoma/solid tumor and other), relapse (yes/no), and participant's education level (≤ high school graduate/≥ college graduate). ADI, Area Deprivation Index. EJI, Environmental Justice Index. M, mean; SD, standard deviation. ***β***, standardized coefficient. B, Unstandardized coefficient.

Supplementary Table 1. Correlations analysis results of social determinants, posttraumatic stress, and posttraumatic growth.

Variable	**1: ADI**	**2: Total EJI**	**3: EJI SVM**	**4: EJI EBM**	**5: EJI HVM**	**6: Stress**	**7: Growth**
1: ADI	1	-	-	-	-	-	-
2: Total EJI	0.77 (<.001)	1	-	-	-	-	-
3: EJI - SVM	0.85 (<.001)	0.90 (<.001)	1	-	-	-	-
4: EJI - EBM	0.21 (.023)	0.62 (<.001)	0.36 (<.001)	1	-	-	-
5: EJI - HVM	0.69 (<.001)	0.78 (<.001)	0.67 (<.001)	0.16 (.073)	1	-	-
6: Posttraumatic stress	0.21 (.019)	0.17 (.057)	0.21 (.023)	0.04 (.691)	0.09 (.306)	1	-
7: PTG	0.32 (<.001)	0.21 (.019)	0.25 (.005)	-0.03 (.762)	0.23 (.011)	0.18 (.054)	1

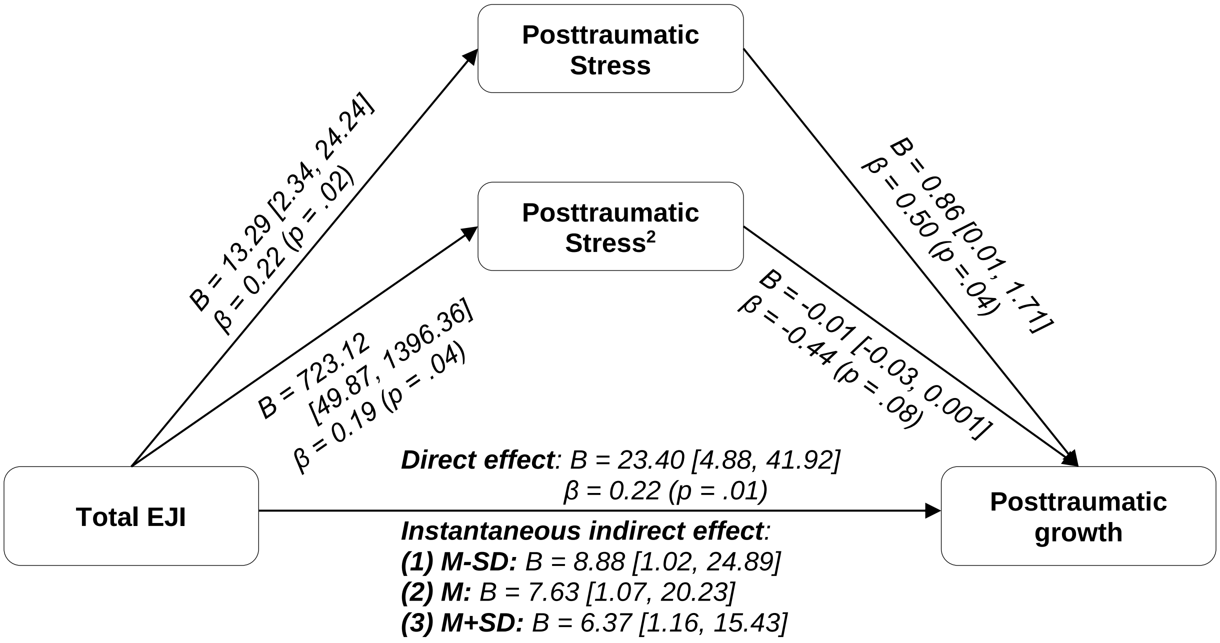
Note. ADI, Area Deprivation Index. EJI, Environmental Justice Index. SVM, Social Vulnerability Module. EBM, Environmental Burden Module. HVM, Health Vulnerability Module. PTG, Posttraumatic growth. SD, Standard Deviation.



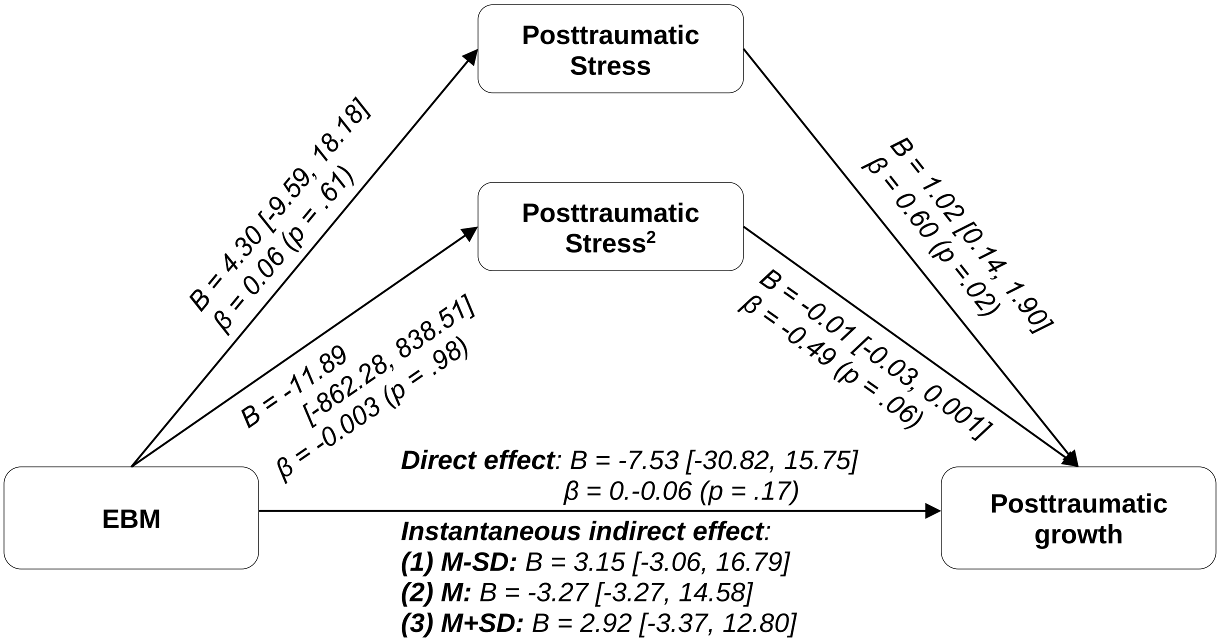
Supplementary Figure 1. Relationship between posttraumatic stress and posttraumatic growth by PTSD cutoff score. (a) Non-PTSD group with posttraumatic stress score below 33 on IESR (*n* = 107, 88.4 %), (b) PTSD group with posttraumatic stress score of 33 or higher on IESR (*n* = 14, 11.6 %).

Note. IESR, Impact of Events Scale-Revised. PTSD, Posttraumatic stress disorder.

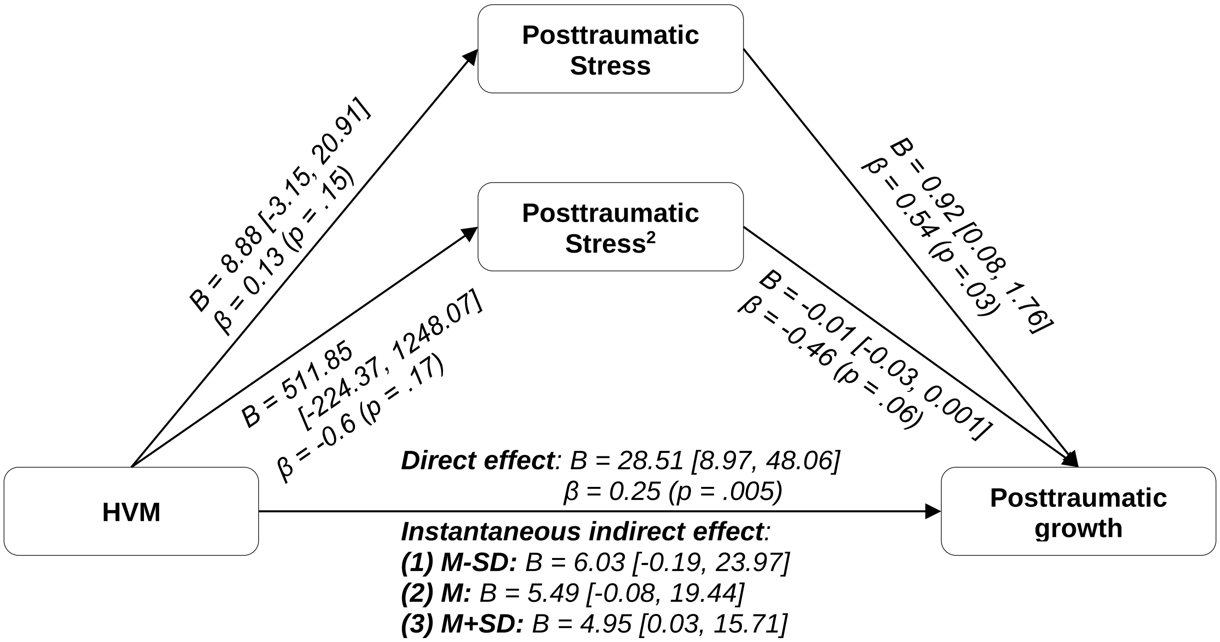
(a) Total EJI



(b) Environmental Burden Module (EBM)



(c) Health Vulnerability Module (HVM)



Supplementary Figure 2. Curvilinear mediation models.
Note. Adjusted for years since completion of treatment, diagnosis (leukemia and lymphoma/solid tumor and other), relapse (yes/no), and participant's education level (≤ high school graduate/≥ college graduate). ADI, Area Deprivation Index. EJI, Environmental Justice Index. M, mean; SD, standard deviation. ***β***, standardized coefficient. B, Unstandardized coefficient.

CONCLUSION

Clinical Implications

Healthcare providers are recommended to comprehensively assess the neighborhood-level social determinants to promote post-cancer resilience outcomes of AYA CCS. First, to mitigate potential disparities in the healthcare transition readiness of AYA CCS across different neighborhoods, healthcare providers are encouraged to comprehensively assess the SDoH, including neighborhood deprivation. As this dissertation study found, since AYA CCS in deprived neighborhoods may take on more responsibility in their healthcare, clinicians are recommended to offer tailored support to alleviate the potential burden of self-management. This includes assessing an individual's specific needs to identify barriers to reaching the optimal level of overall healthcare transition readiness. For example, a need assessment can identify barriers such as limited access to healthcare services in the community, financial difficulties, or neuropsychological problems (e.g., posttraumatic stress, neurocognitive dysfunction) that may complicate the transition process. Second, to promote the posttraumatic growth of AYA CCS, healthcare providers are recommended to consider its complex relationship with posttraumatic stress within the context of environmental factors, such as neighborhood deprivation.

Research Implications

First, future longitudinal research is needed to further explore the long-term impact of neighborhood-level SDoH on resilience, including healthcare transition readiness and posttraumatic growth, in AYA CCS. Second, using a composite set of SDoH assessment tools, such as ADI and EJI, is recommended. These tools provide a comprehensive perspective on the multiple dimensions of SDoH and how various SDoH collectively influences healthcare transition readiness and posttraumatic growth among AYA CCS. Lastly, it is important to develop community-based interventions that address SDoH. For example, partnerships with community organizations to improve access to healthcare services, provide transportation services, and organize educational programs or peer support groups are vital at the community level. Such interventions may particularly be beneficial in deprived neighborhoods, where social and environmental barriers hinder AYA CCS from fully developing the skills and having access to resources necessary for healthcare transition and posttraumatic growth. These community-based effects can contribute to helping AYA CCS promote their post-cancer resilience outcomes both behaviorally and emotionally.

Limitations

The cross-sectional design of this study limits the ability to establish causal relationships between neighborhood deprivation and outcomes including healthcare transition readiness and posttraumatic growth. Additionally, the relatively small sample size restricts the generalizability of these findings to broader populations of AYA CCS. Lastly, a secondary data analysis limited the range of variables available for study.

Conclusion

This dissertation underscores the critical role of the neighborhood-level SDoH that influences post-cancer resilience, as represented by healthcare transition readiness and posttraumatic growth, among AYA CCS. Furthermore, the findings highlight the importance of addressing these environmental and social factors when clinically assessing AYA CCS and designing interventions and research to provide comprehensive and equitable support across communities in this vulnerable population.