Exploration of Stress and Inflammatory Biomarkers Among Non-Hispanic Black and Hispanic Cancer Survivors

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OBJECTIVES: To evaluate associations among social determinants of health (SDOH), stress, interleukin-6 (IL-6), and quality of life among non-Hispanic Black and Hispanic cancer survivors.

SAMPLE & SETTING: Individuals who had completed cancer treatment and did not identify as White (N = 46) were recruited through community partnerships in western Massachusetts and a state cancer registry.

METHODS & VARIABLES: This descriptive cross-sectional study used questionnaires and morning salivary samples to collect data between June 2022 and September 2023.

RESULTS: Most participants were breast cancer survivors, were female, identified as African American or Black, and reported moderate levels of stress and low physical activity. Cortisol levels were higher among African American or Black participants, those with lower body mass index, and those with less consumption of fruit and vegetables. Higher symptom experience was associated with higher IL-6 levels. No associations were identified between IL-6 and cortisol or perceived stress and cortisol levels.

IMPLICATIONS FOR NURSING: Incorporating SDOH in self-reported outcomes, including health behaviors and associated biologic indicators, can facilitate early identification and interventions to improve symptom experience and health outcomes of cancer survivors.

KEYWORDS biologic determinants; survivorship; health behaviors: cancer disparities
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Cancer disparities reflect the interplay of many factors that contribute to health outcomes, including cancer risk, survival, and quality of life (QOL) after a cancer diagnosis. These factors include social determinants of health (SDOH) such as race, ethnicity, and education; health behaviors; biology; and genetics (Alcaraz et al., 2020; American Cancer Society, n.d.). SDOH are influential conditions in which individuals are born, live, work, have recreation, and age (Office of Disease Prevention and Health Promotion, n.d.). As nonbiologic factors, various aspects of SDOH, such as poverty, social stress, unsafe neighborhoods, and lack of healthcare access, play a crucial role in predicting health outcomes, including QOL (American Cancer Society, n.d.; Ashing et al., 2022). SDOH can promote dysregulation of biologic factors such as the tumor microenvironment and comorbid diseases (Carlos et al., 2022; Prakash et al., 2020) and increase the risk of cancer mortality and poor QOL (Alcaraz et al., 2020; American Cancer Society, n.d.). Racial and ethnic disparities have been mainly explained by lack of access to care (Zavala et al., 2021). Much of the inequality in SDOH among Hispanic and non-Hispanic Black people stems from historical systemic and structural racism that has contributed to lower education and income as well as limited access to equitable care (American Cancer Society, n.d.; Zavala et al., 2021). In addition, racial segregation and discrimination are reported to increase ambient stress (Smith et al., 2011), health service utilization, poor health status, and poor QOL (Arizpe et al., 2024; Fazeli Dehkordy et al., 2016).

A cancer diagnosis and its treatment often cause chronic psychological stress, with strong evidence showing links between chronic stress and increased

cancer incidence and mortality (Moore et al., 2022; Vignjević Petrinović et al., 2023). Emerging evidence suggests that long-term and constant exposure to psychosocial stressors (e.g., structural inequities, racial discrimination) increases risk-enhancing behaviors and can directly affect well-being and QOL (Arizpe et al., 2024) through stress response (Deshmukh et al., 2017; Knight et al., 2021). One of the major regulators of inflammation and stress is the hypothalamic–pituitary–adrenal axis. Biologic markers that reflect heightened hypothalamic–pituitary–adrenal axis activation and stress-induced inflammatory responses, including interleukin-6 (IL-6) and salivary cortisol, have been investigated to understand the link between stress and cancer outcomes (Minas et al., 2021; Vignjević Petrinović et al., 2023). For example, IL-6 has been associated with heightened cancer-related symptoms, including pain, fatigue, sleep disturbance, and depression (Doong et al., 2015; Wright et al., 2017), and poorer QOL (Alexander et al., 2018; Ji et al., 2017; Sprangers et al., 2014). In addition to cancer diagnosis and treatment, multiple behavioral and psychosocial factors contribute to inflammation-related impaired immune responses associated with adverse health outcomes (Bennett et al., 2018; Deshmukh et al., 2017; Zhang et al., 2019). Exposure to one or more SDOH is associated with a heightened inflammatory response (Deshmukh et al., 2017). For example, one study found that a sample of breast cancer survivors (N = 225) living in disadvantaged neighborhoods (measured by the Area Deprivation Index) reported higher levels of anxiety and exhibited higher levels of serum cortisol (Goel et al., 2023). The disadvantaged neighborhood is reported as a byproduct of economic and racial segregation. It often has less access to green spaces and sidewalks, as well as more noise and chemical pollution, which may affect overall health and cancer outcomes (Goel et al., 2023).

Considering historical structural inequities and the chronic stress of poor SDOH that affect non-Hispanic Black and Hispanic people (Fazeli Dehkordy et al., 2016; Kiely et al., 2022; Smith et al., 2011), it is important to understand the determinants of biologic responses affecting the QOL among these populations. However, limited studies have examined the association between SDOH, stress, immune response, and QOL among predominantly non-Hispanic Black and Hispanic cancer survivors. Therefore, the purpose of this exploratory analysis was to evaluate associations of SDOH, including sociodemographic and self-reported care outcomes (QOL including global health status, functional status, and symptom experience) with indicators of stress (perceived stress, cortisol) and inflammatory response (IL-6), among a sample of predominantly non-Hispanic Black and Hispanic cancer survivors.

Methods

Design and Sample

This exploratory quantitative analysis is based on a subsample of a cross-sectional, mixed-methods study including 74 participants. Study design and sample characteristics were described previously (Seven et al., 2023). Inclusion in the study required that participants were aged 18 years or older, were of any sex or gender identity, had been diagnosed with any stage of cancer, had completed medical treatment (surgery, chemotherapy, radiation therapy, immunotherapy) for cancer within the past five years, and were living in Massachusetts at the time of data collection. This article evaluated associations between perceived stress, salivary cortisol (stress hormone), salivary IL-6, and QOL and associated factors among a sample of non-Hispanic Black and Hispanic cancer survivors (N = 46). Participants who were able to provide saliva samples during in-person visits (N = 46) were included in this analysis. The sample participants identified as Hispanic (n = 17), non-Hispanic African American or Black (n = 27), American Indian or Alaska Native (n = 1), and did not wish to report (n = 1); all participants were affected by cancer (breast, lung, gastrointestinal).

Instruments

Sociodemographic: Using the National Institute on Minority Health and Health Disparities Research Framework (National Institute on Minority Health and Health Disparities, 2017), the following sociodemographic data were included: age, gender, education, employment, health insurance, and insurance type. This part of the survey also included weight, height (to measure body mass index [BMI]), any chronic disease, cancer type, and cancer stage.

European Organisation for Research and Treatment of Cancer Quality-of-Life Questionnaire–Core 30: The European Organisation for Research and Treatment of Cancer Quality-of-Life Questionnaire–Core 30 is the most commonly used valid and reliable patient-reported outcome measure evaluating all dimensions of QOL. The measure includes global health status, functional status (including physical, role, emotional, cognitive, and social functioning), and symptom experience (including fatigue, nausea and vomiting, pain, dyspnea, insomnia, appetite loss,

constipation, diarrhea, and financial difficulties). Items are summed, and scores can range from 0 to 100, with higher scores representing higher (better) levels of functioning and general health status or a higher (worse) level of symptoms (Nolte et al., 2019).

International Physical Activity Questionnaire: The International Physical Activity Questionnaire comprises seven items for use by telephone or self-administered methods. Results can be reported in categories (low, moderate, and high activity levels) or as a continuous variable (estimated resting energy expenditure, metabolic equivalent minutes per week) (International Physical Activity Questionnaire, 2022).

Dietary Screener Questionnaire: The Dietary Screener Questionnaire in the National Health and Nutrition Examination Survey assesses individuals' health and nutritional status in the United States. The 26-item questionnaire assesses the frequency of consumption of selected foods and drinks in the past month, including fruits and vegetables, dairy/calcium, added sugars, whole grains/fiber, red meat, and processed meat. The web-based Dietary Screener Questionnaire has been validated against the paper version (National Cancer Institute, n.d.). In the current study, the authors used number of cups of fruits and vegetables, including legumes and excluding french fries, as a dietary measurement.

Perceived Stress Scale: The Perceived Stress Scale is a classic stress assessment instrument. The scale is a 10-item self-report measure that captures individuals' perceptions of how overwhelmed they have been by life circumstances during the past month. The total score is categorized as low, moderate, or high perceived stress (Crosswell & Lockwood, 2020). In this sample, the Cronbach's alpha was 0.83. This scale was used to explore how perceived stress (stressors) in participants' personal lives affects stress response (measured by salivary cortisol).

Salivary biomarkers: Saliva testing is well suited for determining stress and hypothalamic–pituitary–adrenal axis function (El-Farhan et al., 2017; La Fratta et al., 2018; Nieman, 2024). The authors used a saliva collection kit provided by Salimetrics to assess IL-6 and cortisol levels.

Data Collection

The recruitment and data collection were described in a previously published article (Seven et al., 2023). Briefly, participants were recruited through community partnerships in western Massachusetts and a statewide cancer registry. The principal investigator (PI) and community liaison collaborated with community/healthcare centers. The PI and community liaison described the study purpose and procedures to communities by telephone or during in-person gatherings, formal/informal meetings, and festivals. In addition, the authors used the Massachusetts Cancer Registry to send invitation letters to potentially eligible people. Data were collected at the University of Massachusetts Amherst campus, community organizations' or centers' facilities, or anywhere participants preferred that provided privacy. The PI and/or research assistants used a consent form to inform all participants about the study procedures. Participants were provided

TABLE 1. Participant Demographic Characteristics (N = 46)

Characteristic	$\bar{X}$	SD
Age (years)	60.2	13
Characteristic		**n**
Sex		
Female		44
Male		2
Race and ethnicity		
African American or Black		27
American Indian or Alaska Native		1
Hispanic, Latino, or Spanish origin, including Puerto Rican		17
Did not wish to report		1
Marital status		
Single/divorced		27
Married/living with a partner		19
Education level		
High school or less		13
Some college, technical school, or associate degree		18
College graduate and above		15
Employment status		
Employed		23
Not employed/homemaker/retired		20
Did not answer		3
Health insurance status		
Only state health insurance (i.e., Medicare and Medicaid, with or without MassHealth)		21
Private insurance (with or without state insurance)		24
Other (e.g., senior plan)		1

the opportunity to complete the survey online or in person with a paper-based survey. For the saliva sample collection, the PI and/or research assistant met with participants in person at a location of the participant's preference.

All saliva samples were collected between 8 and 10 am. Cortisol mirrors circadian rhythms and pulsatile patterns, with the highest peak in the early morning and nadir between midnight and 3 am. Cortisol's rhythm is further affected by multiple factors, such as sleep deprivation/shift working, gender, age, and BMI (El-Farhan et al., 2017). Although there are conflicting findings in the literature regarding the peak of IL-6 in the evening or night, the diurnal variation of circulating IL-6 has been established (Nilsonne et al., 2016). The Saliva Collection Aid was used as an ideal collection tool because of its ease of use, reduced burden, and improved adherence for collecting the whole saliva. Saliva was collected using the passive drool method, in which participants were asked to drool into tubes with a capacity of 2 ml. The authors followed the sample collection instructions before, during, and after the collection. For instance, participants were instructed to not eat or drink anything within one hour of sample collection, and the collected saliva sample was transferred with dry ice to the laboratory within two hours. Salivary cortisol analyses were performed in duplicate using a commercially available high-sensitivity salivary cortisol enzyme immunoassay by Salimetrics and stored at the University of Massachusetts Amherst College of Nursing laboratory in a –80°C freezer.

TABLE 2. Cancer Diagnosis and Other Health-Related Characteristics (N = 46)

Characteristic	$\bar{X}$	SD	Range
Time since cancer diagnosis (years)	3.41	1.39	1–5
Characteristic			**n**
Cancer stage at diagnosis			
I or II			32
III			9
Missing data			5
Cancer type			
Breast cancer			37
Gastrointestinal cancer			7
Lung cancer			2
Other chronic health conditions			
No other diagnosed disease			21
At least 1 chronic condition (e.g., diabetes, thyroid, hypertension, heart disease)			25
Body mass index (kg/m^2)			
Healthy weight (18.5–24.9)			5
Overweight (25–29.9)			13
Obese (30 or greater)			15
Missing data			13
Menopausal status (N = 44 female patients)			
Menopausal			33
Not menopausal			8
Missing data			3

Data Analysis

Descriptive statistics, including frequencies and percentages, were used to describe the characteristics of participants. The authors used correlations to examine bivariate relationships between continuous variables. Following the literature using IL-6 and cortisol as outcomes, the natural log of IL-6 and cortisol levels were used for analyses (Feng et al., 2014).

Multivariate linear regression was used to examine the relationship between the independent variables and IL-6 and cortisol levels. Because of the small sample size (N = 46) and the exploratory nature of this analysis, the authors did not include all independent variables in the study models. It is generally recommended that for models to have adequate power, there should be at least about 10 respondents per independent variable in the model (Harrell et al., 1984). Therefore, the authors restricted models to five to six independent variables. For instance, the authors excluded gender because there were very few men (n = 2) in the study, which was not associated with cortisol levels. The authors did not include sleep duration during the night before saliva collection for cortisol because it was not associated with cortisol level in bivariate correlation analyses. Perceived stress was used as a categorical variable in the model for cortisol because the bivariate correlation between cortisol and the continuous measure of perceived stress was very small ($r < 0.02$) and not statistically significant. The multivariate regression model for associated factors with salivary morning cortisol level included age (Lutgendorf et al., 2008; Yiallouris et al., 2019), BMI (Schorr et al., 2015), race (Hajat et al., 2010), physical activity (Hayes et al., 2015), diet (intake of fruits and vegetables) (Pearlmutter et al., 2020), and perceived stress. The regression model for associated factors with salivary morning IL-6 level was built based on the

literature and included symptom experience (Doong et al., 2015; Wright et al., 2017), physical activity (Zhou et al., 2022), dietary pattern (Koelman et al., 2022), cancer stage (Lippitz & Harris 2016), and age (Márton et al., 2019; Parkin et al., 2023).

Results

Table 1 shows demographic characteristics, and Table 2 shows the clinical characteristics of participants. The mean age was 60.2 years (SD = 13 years), and most of the participants were female (n = 44) and African American or Black (n = 27). A majority had breast cancer (n = 37), with a greater representation of stage I or II cancer (n = 32).

As shown in Table 3, global health status (61.59 of 100, SD = 66.66) and functional status (65.84 of 100, SD = 68.88) were moderate, and symptom experience was low (33.5 of 100, SD = 37.17). Most participants were either inactive (n = 20) or minimally active (n = 20). The mean score of perceived stress was 18.82 (SD = 19), and most participants (n = 27) had a moderate level of stress. The mean daily intake of fruits and vegetables, including legumes and excluding french fries, was 2.37 (SD = 2.32) cup equivalents (range = 1.48–3.93).

The mean IL-6 level was 28.37 (SD = 34.735), and the mean cortisol level was 0.29 (SD = 0.155). No association between IL-6 and cortisol (correlation coefficient [r] = 0.016, p = 0.912) was identified. Bivariate correlations showed no statistically significant association between IL-6 and general QOL (r = –0.117, p = 0.969), symptom burden (r = 2.837, p = 0.282), or functional status (r = 0.206, p = 0.943). Perceived stress was not associated with cortisol levels (r = –0.414, p = 0.851). In multiple regression analyses with BMI, race, age, physical activity, diet, perceived stress, and covariates in the model, BMI, race, and diet were significantly associated with cortisol levels (see Table 4). Lower BMI, less fruit and vegetable consumption, and identifying as African American or Black (compared with Hispanic) were associated with higher cortisol levels. For instance, each BMI increase of 1 kg/m² was associated with a 2.3% decrease in cortisol. African American or Black respondents had cortisol levels that were 63% higher than other respondents. As the predicted consumption of fruits and vegetables increased by 1 cup per day, the cortisol level decreased by 46%.

When controlling for variables including cancer stage, age, physical activity, and diet, only symptom burden was significantly associated with IL-6 level. As symptom experience (burden) increased by 1, IL-6 level increased by 1.8% (see Table 5).

TABLE 3. Quality of Life and Health Behaviors of Participants (N = 46)

Characteristic	$\bar{X}$	SD	Range
Quality of life			
Functional status	65.84	68.88	20–100
Symptom experience	33.5	37.17	0–76
Global health status	61.59	66.66	0–100
Perceived stress			
Total	18.82	19	4–39
Diet/nutrition pattern			
Predicted intake of fruits and vegetables, including legumes and excluding french fries (cup equivalents/day)	2.37	2.32	1.48–3.93
Predicted intake of vegetables, including legumes and excluding french fries (cup equivalents/day)	1.42	1.39	0.98–2.41
Predicted intake of fruits (cup equivalents/day)	0.9	0.08	0.45–2.21
Predicted intake of fiber (g/day)	14.94	14.62	10–22.71
Predicted intake of whole grains (oz equivalents/day)	0.67	0.59	0.33–1.83

Characteristic	n
Perceived stress level	
Low stress	13
Moderate stress	27
High stress	6
Physical activity level	
Inactive	20
Minimally active	20
More active	6

Discussion

This study evaluated the stress response (perceived stress, cortisol), inflammatory response (IL-6), and associated factors in a sample of non-Hispanic Black and Hispanic individuals who had completed cancer treatment. Non-Hispanic Black and Hispanic cancer survivors are more likely to experience societal and structural inequities relative to other racial and ethnic groups (Egede et al., 2024; Zavala et al., 2021). Strategies to better understand associations between stress and inflammatory biomarkers and QOL can guide interventions to mitigate health disparities in cancer.

In this study, most participants (n = 33) reported moderate or high stress; however, self-reported

TABLE 4. Factors Associated With the Cortisol Level of Participants (N = 46)[a]

Factor	β	SE	t	p
Body mass index (kg/m^2)	–0.0231018	0.01	–2.3	0.031*
Race (African American or Black versus other)	0.6322735	0.218	2.89	0.008*
Age (years)	–0.0124879	0.007	–1.74	0.096
Physical activity (metabolic equivalents)	–0.0001261	–	–1.56	0.133
Diet (fruit and vegetable consumption)	–0.4586636	0.184	–2.49	0.021*
Perceived stress (categorical)	–0.2891059	0.163	–1.77	0.09
Constant	1.624232	0.914	1.78	0.089

* $p < 0.05$
[a] $R^2 = 0.41$, $F(6, 23) = 2.71$, Prob > F = 0.038
Prob—probability; SE—standard error

stress was not associated with salivary morning cortisol levels. Perceived stress is a dynamic multidimensional concept and can change over time with different factors such as sleeping and environment (Ekuni et al., 2022; Feng et al., 2023). Responses to stress are also variable, ranging from potentially adaptive to maladaptive and affected by the stressor's intensity, duration, and controllability (Vignjević Petrinović et al., 2023). Finding a gold-standard biomarker to measure the body's response to social, emotional, and physical experiences is challenging because of its complex etiology and highly individual manifestations (Mészáros Crow et al., 2023). Although saliva has been proven to be more viable for cortisol determination because of its noninvasive collection method and high correlation values to serum cortisol concentration, it is important to recognize differences between the various bodily cortisol concentration levels (Pearlmutter et al., 2020). There are conflicting findings on associations between stress or different forms of stress measured by various tools and cortisol levels (O'Donovan et al., 2010; Pearlmutter et al., 2020). One study (Pearlmutter et al., 2020) found no association between mood and anxiety symptoms and cortisol levels; however, the study team discussed that psychological distress could directly correlate with saliva cortisol levels. Another study (O'Donovan et al., 2010) reported that compared to nonanxious people, clinically anxious participants exhibited significantly higher levels of morning salivary cortisol. In addition, a systematic review and meta-analysis (Mészáros Crow et al., 2023) reported that certain types of psychosocial interventions (aiming to reduce stress) reduced cortisol in patients with breast cancer.

In addition to associations between cortisol levels and self-reported stress, conflicting findings exist on associations between cortisol and IL-6 levels. Evidence indicates that stress activates inflammatory responses, and chronic stressors overactivate the immune system, leading to the imbalance of inflammation and proinflammation (indicated by IL-6) (Liu et al., 2017). However, like the current study, O'Donovan et al. (2010) reported no significant association between cortisol and inflammatory markers such as IL-6 in clinically anxious and nonanxious adults. Taken together, these findings warrant further investigation with longitudinal studies that comprehensively assess stress, sources of stress, cortisol, and inflammatory biomarkers.

In this study, being African American or Black (compared to Hispanic) and having lower BMI and less fruit and vegetable consumption increased the likelihood of having higher cortisol levels. In a study of patients undergoing cancer treatment (Alvarez et al., 2022), compared to other racial groups, Black patients had significantly higher levels of race-related stress. Incidents of racism increased the likelihood of treatment interruptions, longer time to treatment initiation, and longer treatment interruptions (Alvarez et al., 2022). In a separate study (Allen et al., 2019), findings indicated that racial health disparities were associated with cortisol levels, particularly among Black men. Conversely, other research findings did not identify associations between discrimination and cortisol levels (Lawrence et al., 2022). Of note, a systematic review (Dowd et al., 2009) that included 26 published studies reported that socioeconomic status was not consistently related to cortisol across studies. In addition, self-reported race and ethnicity correlates with socioeconomic status (Williams et al., 2016), and, in turn, low socioeconomic status has been associated with poorer cancer health outcomes (American Cancer Society, n.d.). Health disparities

between racial and ethnic minoritized groups and non-Hispanic White people can be, in part, explained by these associations (Zavala et al., 2021). Future studies with larger sample sizes are needed to assess stress-induced cortisol as a potential factor that explains variability across different racial and ethnic groups with cancer in consideration of the SDOH.

There was a negative association between BMI and cortisol levels. Although conflicting evidence has been reported in the literature (Pearlmutter et al., 2020; Schorr et al., 2015), similar to the current findings, one study of people with anorexia nervosa (Schorr et al., 2015) reported that as BMI decreased, cortisol measures were elevated. Another longitudinal cohort study (Champaneri et al., 2013) found that BMI and waist circumference were negatively correlated with awakening cortisol levels in a diverse sample of people without any clinical cardiovascular disease. In addition, in the current study, low fruit and vegetable consumption was associated with high cortisol levels. Similarly, correlations were reported between fat intake, psychological distress, and salivary cortisol concentrations in females and athletes after exercise (Pearlmutter et al., 2020). In addition, Soltani et al. (2019) reported a strong negative association between dietary carbohydrates and log salivary cortisol; the study suggests that increasing dietary carbohydrates based on the Dietary Guidelines for Americans (www.dietaryguidelines.gov) may reduce circulating cortisol and dampen psychological stress-related cortisol responsiveness (Soltani et al., 2019). These findings demonstrate that stress-induced cortisol might be modifiable through weight control and a healthy diet for improved general well-being and QOL among cancer survivors. Considering the low adherence to dietary guidelines among cancer survivors, it is important for nurses to focus on a healthy diet as a part of cancer survivorship care.

KNOWLEDGE TRANSLATION

- Improved health promotion behaviors and symptom management tailored to non-Hispanic Black and Hispanic cancer survivors may improve quality of life, stress, and inflammatory responses.
- Effective symptom management strategies may moderate inflammatory response (measured by interleukin-6) among cancer survivors.
- Social determinants of health may affect stress response (measured by cortisol level) among cancer survivors.

This study found no statistically significant associations between IL-6 and general health and functional status, age, and cancer stage. IL-6 is a major inflammatory cytokine that is frequently identified and/or assessed when measuring cancer-related outcomes, including QOL (Ji et al., 2017; Lengacher et al., 2019; Orchard et al., 2018). Similar to this study's findings, studies in other populations reported no association between age and IL-6 among people with oral squamous cell carcinoma (Dineshkumar et al., 2016) or healthy adults (Parkin et al., 2023). However, one study reported a significant association between transformed salivary IL-6 mRNA expression levels and the age of people with oral squamous cell carcinoma (Márton et al., 2019). Contrary to these findings, the increased IL-6 serum level is also reported to be correlated with survival in later cancer stages, independent of the cancer type (Lippitz & Harris, 2016). However, in the current study, when controlling for variables including cancer stage, age, physical activity, and diet, symptom experience was significantly associated with IL-6. Compared with nonanxious people, clinically anxious individuals exhibited significantly higher levels of IL-6, independent of age, sex, and

TABLE 5. Factors Associated With the Interleukin-6 Level of Participants (N = 46)[a]

Factor	β	SE	t	p
Symptom experience	0.018	0.009	2.05	0.049*
Cancer stage (locally advanced)	–0.826	0.444	–1.86	0.073
Age (years)	–0.016	0.014	–1.15	0.257
Physical activity (metabolic equivalents)	–	–	1.71	0.098
Diet (fruit and vegetable consumption)	0.552	0.348	1.58	0.124
Constant	1.818	1.353	1.34	0.189

* $p < 0.05$
[a] $R^2 = 0.032$, $F(5, 30) = 2.93$, Prob > F = 0.028
Prob—probability; SE—standard error

depressive symptoms (O'Donovan et al., 2010). In one mindfulness-based stress reduction intervention, significant associations were observed at the baseline assessment between IL-6 and symptoms such as overall problems and fatigue and pain in the exercise intervention and control groups (Lengacher et al., 2019). Mindfulness-based stress reduction interventions aiming to mitigate psychological and somatic symptoms may be helpful for cancer survivors. In addition, the level of cytokines (i.e., IL-6) can be moderated by health behaviors such as stress management (Lengacher et al., 2019; Mészáros Crow et al., 2023) and physical activity (intervention period greater than 12 weeks) (Zhou et al., 2022), resulting in improved QOL. These findings suggest that effective symptom management and health behaviors may moderate inflammatory response to improve QOL among cancer survivors, which warrants further investigation. Self-management interventions led by nurses focusing on health behaviors such as physical activity and healthy diet improve the QOL of cancer survivors (Kim et al., 2017; Paşalak et al., 2024; Reinke et al., 2024). Oncology nurses should use effective strategies to improve self-management through developing and maintaining health behaviors.

Limitations

This study has some limitations. The small sample size limited the authors' ability to consider all potential SDOH in statistical analyses and to make generalizable results; therefore, further investigation with a larger sample size is warranted. Most participants had stage I or II cancers, with different cancer types requiring additional research with consideration of cancer type and stage. In addition, cortisol levels were assessed only in the morning; because of the dynamic nature of cortisol, future studies are needed to evaluate cortisol levels at different times of the day. Stress and sources of stress might affect people differently; valid and reliable measurement tools for comprehensive stress evaluation might be needed for future studies to assess associations between self-reported stress and cortisol levels.

Conclusion

This study provides preliminary explanatory evidence for factors associated with cortisol and IL-6 levels that may affect QOL among non-Hispanic African American or Black and Hispanic cancer survivors. Cancer survivors with lower BMI, those with lower fruit and vegetable consumption, and those who are African American or Black (compared with Hispanic) had higher morning salivary cortisol levels. Increased fresh fruit and vegetable intake and improved weight management may moderate the effect of cortisol. Although further research is needed to investigate cortisol (stress response) and race in the context of SDOH, social and structural inequities that minoritized racial and ethnic groups experience may affect cortisol levels. Oncology nurses are well positioned to integrate effective strategies into practice, facilitating the development and maintenance of health behaviors among cancer survivors. This study's findings showed the need for intersectional approaches that focus on the complex interaction of biopsychosocial determinants that are experienced simultaneously to mitigate health disparities in cancer survivors from minoritized racial and ethnic groups.

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QUESTION GUIDE FOR A JOURNAL CLUB

Journal clubs can help to increase and translate findings to clinical practice, education, administration, and research. Use the following questions to start discussion at your next journal club meeting. Then, take time to recap the discussion and make plans to proceed with suggested strategies.

1. How might biologic factors be influenced by social determinants of health, and how might each of these affect symptom burden?
2. What policy changes might reduce the impact of social determinants of quality of life on people affected by cancer?
3. How does this study underscore the need to recruit diverse research participants to participate in studies of cancer symptoms?

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