Associations Between Social Determinants of Health and Psychoneurologic Symptom Clusters in Women With Gynecologic Cancers: A Longitudinal Study

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OBJECTIVES: To evaluate the associations between social determinants of health (SDOH) and psychoneurologic symptom (PNS) clusters in women with gynecologic cancers during cancer treatment.

SAMPLE & SETTING: 67 women with gynecologic cancers who received radiation therapy were assessed at baseline, six to eight weeks after treatment, and six months after treatment at oncology clinics in Georgia.

METHODS & VARIABLES: Fatigue, pain, sleep disturbances, cognitive impairment, and depressive symptoms were measured to determine a PNS cluster score. Associations between SDOH and PNS cluster scores were assessed using mixed-effect models.

RESULTS: Larger mean PNS cluster scores were reported in individuals with less education, lower income, and unemployment, as well as in those living in more disadvantaged neighborhoods.

IMPLICATIONS FOR NURSING: Individual- and community-level SDOH and their interactions were associated with more PNS clusters. Studying SDOH at multiple levels depicts how various social disadvantages can exacerbate poor health outcomes.

KEYWORDS social determinants of health; psychoneurologic symptoms; gynecologic cancers
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Advancements in early cancer diagnosis and treatment have dramatically increased the survival rate among patients with cervical and endometrial cancers over the past 20 years in the United States (Ledford & Lockwood, 2019; Sekse et al., 2015). Five-year survival rates have climbed to 81% for patients with endometrial cancer and 66% for patients with cervical cancer, resulting in an estimated one million survivors of gynecologic cancer in the United States (Cancer.net, n.d.; Schlumbrecht et al., 2018). The growing number of survivors of gynecologic cancer experience side effects of treatment and an array of multiple co-occurring symptoms known as psychoneurologic symptom (PNS) clusters (Bai et al., 2020; Deshields et al., 2014; Pozzar et al., 2022). PNS clusters include fatigue, depressive symptoms, pain, sleep disturbance, and cognitive impairment, which can profoundly affect the quality of life, treatment adherence, and functional status of individuals with and survivors of gynecologic cancer (Bai et al., 2020; Chan et al., 2001; Joly et al., 2019; Karawekpanyawong et al., 2021; Poort et al., 2020; Prue et al., 2010; Sekse et al., 2015; Starkweather et al., 2013). Findings from a critical review by Klügel et al. (2017) indicate that women with gynecologic cancers experience a high rate of depressive symptoms. Among individuals with cancer, women with gynecologic cancers report higher levels of sleep disturbance, anxiety, and depressive symptoms after diagnosis (Linden et al., 2012; Palesh et al., 2010). Identifying factors that influence PNS clusters

can help reduce suffering and enhance quality of life among cancer survivors.

It has been well established that disparities in social determinants of health (SDOH) may lead to poor health outcomes (Daniel et al., 2018). The World Health Organization (n.d.) states that SDOH "are the conditions in which people are born, grow, live, work, and age" (para. 1). They include factors at individual and community levels such as personal socioeconomic status (SES), income, education, employment, and neighborhood SES (Karran et al., 2020; Rethorn et al., 2020). SDOH are shaped by distributions of resources, power, and money at the global and community levels (Karran et al., 2020; World Health Organziation, n.d.). Inequities in access to resources may create poor health outcomes and health disparities for individuals with cancer (Karran et al., 2020; Tucker-Seeley, 2021). Studies show that individuals with lower SES have higher cancer incidence and mortality compared with individuals with higher SES (Alberg et al., 2016; Hovanec et al., 2018; Singh & Jemal, 2017; Tetzlaff et al., 2021). However, less is known about how SDOH influence symptoms experienced by individuals with cancer (Fagundes et al., 2014).

To date, few studies have evaluated the influence of individual- and community-level SDOH on cancer- and treatment-related symptoms. For individual-level SDOH, studies show that less education, unemployment, and lower income were associated with more severe pain and depressive symptoms (Broemer et al., 2021; Ilie et al., 2021). Studies show that community-level SDOH, such as neighborhood socioeconomic disadvantages, may also influence the symptom experience of individuals with cancer. For example, living in disadvantaged neighborhoods is associated with a higher symptom burden (Bai et al., 2021; Lloyd-Williams et al., 2021). Findings from previous studies suggest that individual- and community-level SDOH independently influence cancer symptoms. However, SDOH variables are typically interrelated in their effects on health outcomes (Rethorn et al., 2020). What remains elusive is the collective effect of individual- and community-level SDOH on cancer- and treatment-related symptoms.

This study aimed to evaluate the influence of individual- and community-level SDOH on and their associations with PNS clusters in women with gynecologic cancers over time. The findings of this study may provide a better picture of the effects of individual- and community-level SDOH on PNS clusters.

TABLE 1. Demographic and Clinical Characteristics at Baseline (N = 67)

Characteristic	$\bar{X}$	SD
Age (years)	57.9	12.9
Body mass index (kg/m^2)	31.4	8.5
Characteristic		**n**
Race[a]		
Black		32
White		31
Marital status		
Married		34
Single or divorced		33
Cancer type		
Cervical		34
Endometrial		33
Cancer stage[a]		
I		37
II or greater		29
Treatment type[a]		
RT		31
Chemotherapy and RT		30

[a] Some participant data in this category are missing, so values do not add up to the total N.
RT—radiation therapy

Methods

Study Design

This study was a secondary data analysis based on data collected in an ongoing parent study that recruited and assessed participants at baseline before treatment (T0), six to eight weeks after treatment (T1), and six months after treatment (T2). The purpose of the parent study was to evaluate the changes in the vaginal microbiome and associations with patient-reported treatment-related toxicities in women with cervical and endometrial cancers compared with healthy matched controls (Bai et al., 2021). Recruitment of the women with gynecologic cancers took place at two radiation oncology clinics at a large academic medical center in Georgia. The parent study was approved by the Emory University Institutional Review Board (IRB00085823).

Participants

The inclusion criteria for enrollment in the parent study were as follows: (a) being a woman diagnosed with cervical or endometrial cancer and planned curative treatment using radiation therapy alone or

chemotherapy and radiation therapy; (b) being aged 18 years or older; (c) being willing and able to provide informed consent; and (d) being able to read English. The exclusion criteria were as follows: (a) having a history of metastatic cancer or any other primary cancer at study entry; (b) having comorbidities that might cause vaginal toxicities (e.g., hepatitis C, sexually transmitted infections, autoimmune diseases, fungal infection); (c) currently using interferon; or (d) having used antibiotics or corticosteroids within four weeks of the baseline assessment.

Study Procedures

Eligible participants were identified according to the parent study's inclusion and exclusion criteria using electronic health records. A nurse who was a clinical collaborator arranged study visits for the parent study. During outpatient clinic visits, the study was introduced to eligible participants. If participants were interested, personnel requested informed consent to recruit them for the study. After obtaining informed consent, participants were asked to complete required questionnaires at T0, T1, and T2.

TABLE 2. Demographic and Clinical Characteristics by Social Determinant of Health Category at Baseline (N = 67)

	Education[a] (N = 63)				Income[a] (N = 46)				Employment[a] (N = 50)				ADI Quartile (N = 67)			
	Some College or Below		Above College		Less Than $50,000		$50,000 or More		Employed		Unemployed		Quartiles 1–3		Quartile 4	
Characteristic	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Age (years)	56.5	14	60.7	11.3	58.7	15.2	60.5	10.8	61.5	12	50.2	13.6	59.3	12.9	54.2	12.5
BMI (kg/m^2)	32.8	9.3	29.4	7	32.9	9.9	28.4	6.6	29.8	7.6	34.8	12.5	31.3	8.6	31.7	8.4
Characteristic	**n**		**n**		**n**		**n**		**n**		**n**		**n**		**n**	
Race[a]																
Black	21		8		15		16		18		7		19		13	
White	14		16		7		6		21		2		27		4	
Marital status																
Married	16		17		10		15		25		2		25		9	
Single or divorced	21		9		14		7		16		7		24		9	
Cancer site																
Cervical	22		10		15		9		20		6		24		10	
Endo	15		16		9		13		21		3		25		8	
Cancer stage[a]																
I	17		17		13		14		23		8		26		11	
II–IV	20		8		11		7		17		1		22		7	
Treatment type[a]																
RT	16		13		9		11		21		9		24		7	
Chemo and RT	17		11		10		11		14		5		21		9	

[a] Some participant data in this category are missing, so values do not add up to the total N.
ADI—Area Deprivation Index; BMI—body mass index; chemo—chemotherapy; endo—endometrial; RT—radiation therapy
Note. The ADI score includes block group measures of education, employment, income, and housing quality. The ADI ranks block groups from 1 (least disadvantaged) to 100 (most disadvantaged). ADI scores were categorized into quartiles 1–3 (ADI rank 1–75) and quartile 4 (ADI rank 76–100).

Outcome Measures

Fatigue, pain, sleep disturbance, and cognitive impairment: Fatigue, pain, sleep disturbance, and cognitive impairment were measured using different items of the Functional Assessment of Cancer Therapy–General (FACT-G). The FACT-G is a 27-item validated self-report questionnaire measuring quality of life in individuals with cancer (Cella et al., 1993). Each item is scored on a Likert-type scale ranging from 0 (no symptoms) to 4 (severe symptoms) (FACIT Group, 2021). In the present study, an average of the three items (GP1, GP6, and GP7) was used to calculate the total score for fatigue; an average of two items (GF1 and GF2) was used to measure cognitive impairment; one item (GP4) was used to measure pain; and one item (GF5) was used to measure sleep disturbance. A higher total score for each symptom indicated greater severity of that symptom.

Depressive symptoms: Depressive symptoms were measured using the Patient Health Questionnaire–9 (PHQ-9) (Arroll et al., 2010). The PHQ-9 has been validated to measure depressive symptoms in individuals with cancer (Hinz et al., 2016). This nine-item Likert-type scale is scored from 0 (not at all) to 3 (nearly every day), with a total score ranging from 0 to 27. In this study, higher scores indicated more severe depressive symptoms.

PNS clusters: To calculate PNS cluster scores, the raw scores for each symptom (pain, fatigue, depressive symptoms, sleep disturbances, and cognitive impairment) were normalized using a z-score to make them comparable. If the patient reported at least three out of five symptoms, the PNS cluster score was computed as a mean z-score of those symptoms.

Individual-level SDOH: Education, income and employment were defined as individual-level SDOH. Education was measured using a question with seven response categories ranging from "below high school" to "graduate degree." Level of education was categorized into two groups: "some college or below" and "above college." To measure income, annual household income was obtained by asking a question about annual income with answers ranging from "less than $20,000" to "more than $150,000." Income was categorized into two groups: "less than $50,000" and "$50,000 or more." Employment status was measured using a single question. Participants were categorized into "employed" and "unemployed" based on their responses.

Community-level SDOH: Community-level SDOH were assessed using the Area Deprivation Index (ADI), which was developed by the U.S. Department of Health and Human Services' Health Resources and Services Administration and validated and adapted by the University of Wisconsin–Madison (Center for Health Disparities Research, 2021). The ADI is an index of 17 block group–level socioeconomic indicators from the American Community Survey 5-Year Data (Center for Health Disparities Research, 2021). The ADI score includes block group measures of education, employment, income, and housing quality, and it can rank neighborhood socioeconomic disadvantage at the state and national levels (Center for Health Disparities Research, 2021; Glassman, 2020). The national-level ranking was used in this study because the participants lived in different states. The national ADI ranks block groups from 1 (least disadvantaged) to 100 (most disadvantaged) in the United States (Kind & Buckingham, 2018; Rosenzweig et al., 2021). The ADI was derived for each participant by entering the participant's home zip code into a publicly available, interactive website (Center for Health Disparities Research, 2021; Kind & Buckingham, 2018). ADI rankings were grouped into quartiles:

TABLE 3. Participants in Individual-Level SDOH Categories Based on ADI Quartile at Baseline (N = 67)

	Quartiles 1–3	Quartile 4
Variable	**n**	**n**
Education level[a]		
Some college or below	25	12
Above college	22	4
Income ($)[a]		
Less than 50,000	17	7
50,000 or greater	16	6
Employment[a]		
Employed	31	10
Unemployed	5	4

[a] Some participant data in this category are missing, so values do not add to the total N.
ADI—Area Deprivation Index; SDOH—social determinants of health
Note. The ADI score includes block group measures of education, employment, income, and housing quality. The ADI ranks block groups from 1 (least disadvantaged) to 100 (most disadvantaged) in the United States. ADI scores were categorized into quartiles 1–3 (ADI rank 1–75) and quartile 4 (ADI rank 76–100).

first quartile (1–25), second quartile (25–50), third quartile (50–75), and fourth quartile (76–100). Considering the small sample size in this study, the first three ADI quartiles (1–75) were considered the least disadvantaged neighborhoods, and the fourth ADI quartile (76–100) represented the most disadvantaged neighborhoods.

Demographic and clinical variables: Demographic and clinical variables were collected from electronic health records and patient-reported forms. Variables were age, body mass index (BMI), race (Black and White), marital status (married and single or divorced), cancer site (endometrial and cervical), cancer stage (I and II or greater), and treatment type (radiation therapy alone and chemotherapy and radiation therapy).

Statistical Analysis

The demographic and clinical characteristics of the participants were calculated using means and standard deviations (SDs) for continuous variables and frequencies and percentages for categorical variables. To evaluate the associations between each of the five symptoms in the PNS cluster score and individual- and community-level SDOH over time, a linear mixed-effects model was used. Multilevel mixed-effects models were also employed, considering covariates, to test the independent associations among significant individual-level SDOH univariate variables, ADI as the community-level SDOH, and their interactions with PNS cluster scores. Three models were developed for this purpose. Model 1 included level of education, model 2 included ADI, and model 3 included the interaction between level of education and ADI. Statistical significance was set at a two-tailed p value of less than 0.05. This study used R, version 4.1.1, to conduct all statistical analyses.

Results

Demographic and Clinical Characteristics

This study consisted of 67 women with gynecologic cancers at T0, 67 participants at T1, and 55 participants at T2. The mean age of the participants was 57.9 years (SD = 12.9), and the mean BMI was 31.4 (SD = 8.5). Almost half of the participants were Black, were married, had cervical cancer, or had stage I cancer (see Tables 1 and 2). About half of the participants who lived in an area within the first three ADI quartiles had an education level of some college or below, about half had an income of $50,000 or greater, and most of the participants were employed (see Table 3).

TABLE 4. Mean PNS Cluster Scores for SDOH Categories at Each Time Point

	T0	T1	T2
Variable	$\bar{X}$	$\bar{X}$	$\bar{X}$
Education level			
Some college or below	52.79	50.71	51.02
Above college	48.92	46.36	46.49
Income ($)			
Less than 50,000	52.33	50.11	50.96
50,000 or greater	50.74	46.05	45.48
Employment			
Employed	50.51	47.48	47.48
Unemployed	56.97	52.03	55.23
ADI			
ADI quartiles 1–3	50.55	47.62	47.7
ADI quartile 4	54.61	52.03	54.27

ADI—Area Deprivation Index; PNS—psychoneurologic symptom; SDOH—social determinants of health; T0—baseline; T1—6–8 weeks post-treatment; T2—6 months post-treatment
Note. The ADI score includes block group measures of education, employment, income, and housing quality. The ADI ranks block groups from 1 (least disadvantaged) to 100 (most disadvantaged) in the United States. ADI scores were categorized into quartiles 1–3 (ADI rank 1–75) and quartile 4 (ADI rank 76–100).

Mean PNS Cluster Scores for Individual- and Community-Level SDOH Categories

The average PNS cluster scores of participants with an education level of some college or below were 52.79 at T0, 50.71 at T1, and 51.02 at T2, which were higher on average than participants with an education level of above college (48.92 at T0, 46.36 at T1, and 46.49 at T2). The participants with incomes of less than $50,000 had slightly higher mean PNS cluster scores (52.33 at T0, 50.11 at T1, and 50.96 at T2) than individuals with incomes of $50,000 or greater (50.74 at T0, 46.05 at T1, and 45.48 at T2). The same pattern was observed in participants who were unemployed (56.97 at T0, 52.3 at T1, and 55.23 at T2) compared with participants who were employed (50.51 at T0, 47.48 at T1, and 47.48 at T2). In addition, the participants who lived in the fourth ADI quartile had higher mean PNS cluster scores at each time point (54.61 at T0, 52.03 at T1, and 54.27 at T2) than participants who resided in the first three quartiles (50.55 at T0, 47.62 at T1, and 47.70 at T2) (see Table 4).

Associations Between Individual- and Community-Level SDOH Categories and PNS Cluster Symptoms

According to the results, an education level of some college or below was significantly associated with higher total PNS cluster score (estimate = 4.5; p = 0.005), depressive symptoms (estimate = 2.34; p = 0.04), cognitive impairment (estimate = 0.9; p = 0.001), and sleep disturbance (estimate = 4.58; p = 0.034). An income of less than $50,000 was significantly associated with only higher cognitive impairment (estimate = –0.93; p = 0.002). Unemployment was significantly associated with depressive symptoms (estimate = 3.68; p = 0.033), cognitive impairment (estimate = 1.4; p = 0.001), and pain (estimate = 1.13; p = 0.003) after cancer treatment. Individuals who lived in the fourth ADI quartile had higher total PNS cluster scores (estimate = 4.5; p = 0.011), depressive symptoms (estimate = 2.55; p = 0.043), cognitive impairment (estimate = 0.85; p = 0.006), pain (estimate = 0.72; p = 0.021), and sleep disturbance (estimate = 4.68; p = 0.046) than individuals in the first three ADI quartiles (see Table 5). Because race was not significantly associated with total PNS cluster scores or symptom scores in this study, it was not included in Table 5.

Among the individual-level SDOH factors, education level had the most significant associations with PNS cluster symptoms. Three multilevel mixed-effects models were developed to determine the associations among education and ADI and their interactions with PNS cluster scores while considering covariates. Model 1 showed that an education level of some college or below was significantly associated with higher PNS cluster scores over time (estimate = 3.685; p = 0.041) after controlling for age, BMI, race, and type of cancer treatment. Model 2 showed that the individuals who lived in the fourth ADI quartile experienced higher PNS cluster scores over time (estimate = 4.055; p = 0.034) after controlling for the same covariates. Model 3 showed the interaction between education and ADI on PNS cluster scores. This model indicated that less educated participants who lived in

TABLE 5. Associations Between SDOH and PNS Cluster Symptoms Using a Linear Mixed-Effects Model (Unadjusted)

	PNS Cluster Total Score		Fatigue		Depressive Symptoms		Cognitive Impairment		Pain		Sleep Disturbance	
Predictor	est	p	est	p	est	p	est	p	est	p	est	p
T1	–2.56	0.002*	–0.29	0.022*	–0.9	0.123	–0.58	0.001*	–0.22	0.195	–2.53	0.241
T2	–1.76	0.055	–0.19	0.169	–1.21	0.067	–0.58	0.002*	–0.14	0.456	–0.53	0.824
Education	4.5	0.005*	0.29	0.146	2.34	0.04*	0.9	0.001*	0.53	0.06	4.58	0.034*
T1	–3.33	0.001*	–0.33	0.037*	–1.77	0.004*	–0.59	0.005*	–0.3	0.159	–4.05	0.109
T2	–2.54	0.02*	–0.35	0.051	–1.65	0.02*	–0.56	0.022*	–0.35	0.144	–0.59	0.834
Income	–3.3	0.072	–0.1	0.643	–2.24	0.102	–0.93	0.002*	–0.2	0.533	–3.92	0.075
T1	–3.27	0.001*	–0.32	0.031*	–1.6	0.007*	–0.59	0.003*	–0.29	0.179	–4.5	0.075
T2	–2.01	0.057	–0.33	0.046*	–1.54	0.019*	–0.56	0.012*	–0.24	0.322	0.64	0.817
Employment	6.27	0.06	0.36	0.185	3.68	0.033*	1.4	0.001*	1.13	0.003*	2.55	0.367
T1	–2.87	0.001*	–0.34	0.007*	–0.95	0.092	–0.6	0.001*	–0.33	0.054	–2.72	0.196
T2	–1.85	0.041*	–0.23	0.104	–1.3	0.04*	–0.59	0.001*	–0.2	0.305	–0.06	0.978
ADI	4.5	0.011*	0.2	0.366	2.55	0.043*	0.85	0.006*	0.72	0.021*	4.68	0.046*

* $p < 0.05$

ADI—Area Deprivation Index; est—estimate; PNS—psychoneurologic symptom; SDOH—social determinants of health; T1—6–8 weeks post-treatment; T2—6 months post-treatment

Note. Some college or below was considered a reference for education, less than $50,000 was considered a reference for income, unemployed was considered a reference for employment, and ADI quartile 4 was considered a reference for ADI.

more disadvantaged neighborhoods had higher PNS cluster scores (estimate = 12.044; p = 0.002) (see Table 6). Figure 1 illustrates the associations among education level, ADI quartile, and PNS cluster score.

Discussion

This study aimed to evaluate the associations between PNS clusters and individual- and community-level SDOH of women with gynecologic cancer over time from before treatment to six months after treatment. The results of the study revealed that individual- and community-level SDOH were associated with PNS clusters. In particular, the interaction of education level and ADI quartile was a strong predictor of PNS clusters over time.

The results of this study are in line with those of other studies, which show that less education is associated with more overall symptoms and more severe post-treatment symptoms, such as fatigue, depressive symptoms, pain, and sleep disturbance, in individuals with cancer (Akechi et al., 2012; Cleeland et al., 2011; Fagundes et al., 2014). Education is recognized as an important factor of SDOH and can influence health outcomes through different pathways (Braveman & Gottlieb, 2014; Shankar et al., 2013). Higher educational attainment can provide better employment opportunities. It can also improve decision-making skills, facilitate healthier behaviors, and provide capacity to find essential personal and social support resources for physical and mental health (Braveman & Gottlieb, 2014; Shankar et al., 2013). In addition, individuals with less education may have fewer skills and less social support to buffer against cancer symptoms or adverse effects of treatment (Fagundes et al., 2014; Stice et al., 2004). An interesting finding of this study was that participants with higher education levels living in more disadvantaged neighborhoods experienced lower PNS cluster scores on average.

This study showed that low income and unemployment were associated with more depressive symptoms, pain, and cognitive impairment. These findings are consistent with other studies, which showed that cervical cancer survivors who were unemployed had higher depressive symptoms (Bradley et al., 2006; Kim et al., 2010). Other studies also showed that lower income was associated with higher PNS cluster symptom burden in survivors, including depression, anxiety, and pain (Bubis et al., 2018). The associations of low income and unemployment with PNS clusters may highlight the importance of symptom burden in the functional status of individuals with cancer. For instance, people with cancer who have a higher symptom burden may be unable to maintain employment because of impaired physical, psychological, and social functioning (Knight et al., 2016). These challenges may extend beyond financial difficulties and may isolate these individuals from society, which may result in less social support and eventually lead to more symptoms or increased symptom severity (Knight et al., 2016).

KNOWLEDGE TRANSLATION

- Social determinants of health (SDOH) strongly influence health outcomes.
- Poor SDOH can lead to higher symptom burden.
- Nurses can play a pivotal role in reducing symptom burden and improving health outcomes by addressing SDOH at different levels.

Community-level SDOH have been less studied, compared with individual-level SDOH. The results of this study are concordant with several others that found that residency in neighborhoods with lower SES was associated with higher symptom burden in individuals with cancer (Bai et al., 2021; Bubis et al., 2018; Lloyd-Williams et al., 2021). In a longitudinal study, individuals with advanced cancer who lived in socioeconomically disadvantaged areas were more likely to report depressive symptoms, pain, and greater global symptom burden than individuals in less disadvantaged areas (Lloyd-Williams et al., 2021). In a study of newly diagnosed patients with cancer, individuals in low-income quintiles had significantly higher moderate to severe symptoms compared with individuals in the highest income quintile (Bubis et al., 2018). Individuals with prostate cancer from the fourth ADI quartile also reported more pain than individuals from the first three ADI quartiles (Bai et al., 2021). Although little is known about the mechanism of associations between neighborhood SES and cancer- or treatment-related symptoms, potential factors could be greater psychosocial stress and difficulty in social integration in disadvantaged neighborhood areas (Wang et al., 2001). There is evidence that individuals with cancer from more socioeconomically disadvantaged areas receive later diagnoses, which may influence symptoms and health outcomes (Woods et al., 2006).

Evaluation of the interaction between individual- and community-level SDOH and PNS clusters among women treated for gynecologic cancers made this study unique. The findings revealed that low education level and residency in socioeconomically disadvantaged neighborhoods were associated with higher PNS cluster scores in women with endometrial and cervical

cancers. Although little is known about the mechanism of this phenomenon, living in socioeconomically disadvantaged neighborhoods may lead to social isolation, which, combined with poorer education and poorer job opportunities, may exacerbate cancer- and treatment-related symptoms. In addition, lack of adequate housing and food insecurity are likely to influence the psychological factors that could lead to greater PNS cluster burden (Bonathan et al., 2013). Studying the interactions of individual- and community-level SDOH with symptoms is important because it can depict the ways in which difficult individual- and community-level SDOH can aggravate poor health outcomes.

Limitations

This study may have some limitations that need to be considered when interpreting the results. The small sample size with an attrition rate of 18% in six months may limit the generalizability of the results. Specific items of the FACT-G were used to measure fatigue, pain, sleep disturbance, and cognitive impairment. Caution is required when interpreting the results of this study, which should be replicated in a larger sample using standard questionnaires. In addition, symptom measurements were not on the same scale because they were based on different items of the FACT-G and PHQ-9 questionnaires. Missing data on income and employment may have affected the assessment of the associations of these SDOH with PNS clusters. In addition, using self-reported annual household income without considering the number of household members may not reflect the real spending power of the participants in this study. The present study was also limited to Black and White individuals with cancer who could speak English. Future studies with larger sample sizes with more diverse populations from various racial and ethnic backgrounds are required to evaluate the associations of individual- and community-level SDOH with symptoms using standard measures.

Implications for Nursing

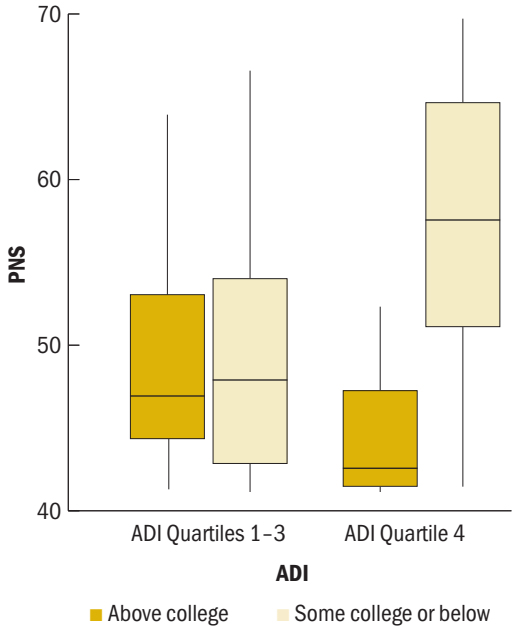
Findings from this study showed that individual- (low education, low income, and unemployment) and community-level (disadvantaged neighborhoods) SDOH were associated with more PNS clusters. As highly trusted healthcare providers, nurses can play a pivotal role in improving health outcomes by addressing SDOH at different levels (Andermann, 2016; Chen et al., 2022). At the individual level, nurses can identify patients' needs through the nursing care process and facilitate connections to available support systems (Grant et al., 2000; Manchanda & Gottlieb, 2015). At the community level, nurses can partner with other sectors (e.g., education, employment) as part of interprofessional teams that include physicians and social workers to develop a common language for addressing issues surrounding SDOH (Andermann, 2016). Nurses have a unique position to reduce symptom

TABLE 6. Multilevel Mixed-Effects Models of the Associations Among Individual-Level (Education) and Community-Level SDOH (ADI), and Their Interactions With PNS Cluster Scores, Adjusted for Covariates

	Model 1		Model 2		Model 3	
Characteristic	**est**	**p**	**est**	**p**	**est**	**p**
SDOH variable	3.685	0.041*	4.055	0.034*	12.044	0.002*
T1	−2.396	0.095	−2.622	0.068	−2.358	0.098
T2	−1.743	0.107	−1.793	0.089	−1.67	0.121
Age	−0.083	0.231	−0.087	0.183	0.038	0.537
BMI	−0.002	0.983	0.05	0.604	0.013	0.884
Race (White)	−2.093	0.864	−0.717	0.672	−0.344	0.836
Radiation therapy	0.182	0.908	−0.226	0.885	0.154	0.921
Chemotherapy and radiation therapy	−1.069	0.466	−0.904	0.54	−1.067	0.461

* $p < 0.05$
ADI—Area Deprivation Index; BMI—body mass index; est—estimate; PNS—psychoneurologic symptom; SDOH—social determinants of health; T1—6–8 weeks post-treatment; T2—6 months post-treatment
Note. Model 1 showed associations between education level as the SDOH variable and PNS cluster scores, model 2 showed associations between ADI as the SDOH variable and PNS cluster scores, and model 3 showed the interaction between education and ADI as the SDOH variable on PNS cluster scores.
Note. Some college or below was considered a reference for education level, and ADI quartile 4 was considered a reference for ADI.

FIGURE 1. PNS Cluster Scores Based on Individual-Level SDOH (Education) and Community-Level SDOH (ADI)



ADI—Area Deprivation Index; PNS—psychoneurologic symptom; SDOH—social determinants of health
Note. The ADI score includes block group measures of education, employment, income, and housing quality. The ADI ranks block groups from 1 (least disadvantaged) to 100 (most disadvantaged) in the United States. ADI scores were categorized into quartiles 1–3 (ADI rank 1–75) and quartile 4 (ADI rank 76–100).

burden by identifying patients' barriers in the context of SDOH for better health outcomes.

Conclusion

Individual- and community-level SDOH were associated with PNS clusters as many as six months post-treatment among women treated for gynecologic cancers. Individuals who received treatment for cancer living in more disadvantaged neighborhoods were typically less educated and experienced higher rates of PNS clusters. Additional studies are necessary to confirm these findings and explore the mechanism of these associations.

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