



## ORIGINAL ARTICLE

# Socioeconomic correlates of health outcomes and mental health disparity in a sample of cancer patients during the COVID-19 pandemic

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## Abstract

**Aims and objectives:** To investigate socioeconomic, behavioural and healthcare delivery factors that are associated with health outcomes of cancer patients during the COVID-19 pandemic, especially among underserved cancer patients.

**Background:** Cancer patients are at a higher risk of adverse physical and mental health outcomes during the pandemic than those without cancer.

**Design:** Cross-sectional online survey. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines in this study.

**Methods:** The sample comprised 322 individuals diagnosed with incident cancer between January 2019 and January 2020. Demographically, 64% were female, 49% had a college degree, 12% were African American, and 88% were White (77% of the Whites were from metropolitan and 23% from nonmetropolitan areas). Descriptive analysis and multivariable regression analyses of global health status, depression and irritability were performed.

**Results:** After adjusting for demographic variables and comorbidity, the feelings of loneliness, crowded living space, lower confidence in taking preventive measures and less satisfaction with telehealth visits were significantly associated with poorer global health, depression and irritability. Daily exercise was associated with better global health, and difficulty in getting medicine was associated with depression and irritability. Moreover, African Americans who felt lonely reported more depression and irritability and those who had less confidence in taking preventive measures reported more irritability than Whites. Respondents having low income and feeling lonely reported more depression than others.

**Conclusions:** In this study, socioeconomic factors (e.g. loneliness or crowded living conditions) were as important to health outcomes during the pandemic as behavioural (e.g. prevention and exercises) and quality-of-care factors (e.g. telehealth, access to medicine). Disparity was more pronounced in the mental health of African Americans and those with low incomes.

**Relevance to clinical practice:** Healthcare providers should promote social support and physical activity for improving health and reducing mental health disparities among cancer patients.

**KEYWORDS**

cancer, COVID-19, health disparity, mental health, socioeconomic determinants

## 1 | INTRODUCTION

Cancer patients are at a higher risk for life-threatening illness caused by COVID-19 because of older age, high comorbidity and compromised immunity (Centers for Disease Control and Prevention (CDC), 2020). They were diagnosed with and died from COVID-19 at a significantly higher rate than people without cancer (Yang et al., 2021). Besides biological factors, socioeconomic circumstances and behavioural factors also precipitate health adversity. Inadequate preventive measures, including failure to wear a mask or practice social distancing, increase the risk of COVID exposure and infection. Acute disruptions in cancer care such as suspending vital diagnostic, therapeutic and surveillance care due to COVID concerns (Greiner, 2020) may result in adverse cancer outcomes. Physical and social isolation, declining social support, and economic hardship can diminish the availability of resources and impede preventive action and healthcare seeking, thus exacerbating a decline in the mental and physical health of patients with cancer.

## 2 | BACKGROUND

The World Health Organization has promoted the idea that socioeconomic determinants of health are as important as the physical environment (including the healthcare system) and individual characteristics or behaviours (e.g. prevention behaviours) in determining health outcomes (World Health Organization, 1998; World Health Organization, 2017). Theories of socioeconomic determinants of health explain that although an individual's behavioural choices are responsible for personal health, they are determined by the individual's material condition of life; it is the economic and social condition that affects one's living condition (Bartley, 2003) and health behaviour (Townsend et al., 1992; Marmot and Wilkinson, 2005), thus increasing vulnerability to poor health. Therefore, to understand health outcomes of cancer patients during the pandemic requires an understanding of the patient's socioeconomic and living conditions. Furthermore, the Centers for Disease Control and Prevention has defined socioeconomic determinants of health as 'resources' to be used to promote health and well-being; for example, food, housing, transportation, health care, employment or income, and social connections. Unequal distribution of resources due to existing political and power structures produces health disparities among populations (Ramirez et al., 2008).

### What does this paper contribute to the wider global clinical community?

- Living condition, whether it is too lonely or too crowded, significantly associates with health outcomes of cancer patients during the COVID-19 pandemic.
- Disparities are pronounced in mental health outcome. African American and low-income cancer patients that felt lonely reported significantly more depression than other patients.

Conceivably, insufficient financial resources to acquire hygiene materials, less physical space for quarantine, a literacy level inadequate to understand the necessity and practice of preventive measures, a lack of social connection or support, and less access to healthcare facilities or high-quality care can heighten vulnerability to COVID-19, stress, and adverse physical and mental health consequences. The lack of these resources among African Americans has been well documented (Beyer, 2019; Hastert et al., 2019; Echeverri et al., 2018) and likely contributes to poorer health outcomes in this population. In fact, African Americans represent 13% of the population, but 34% of the total COVID-19 deaths in the United States (Holmes et al., 2020). As of June 2021, they were hospitalised for COVID-19 at 2.9 times the rate of White Americans and died of the disease twice as often (CDC, 2021). Among cancer patients, another vulnerable subgroup is people who live in nonmetropolitan areas and are mostly White. Rural residents are more likely to have less education, lower income, higher unemployment rates and less health insurance coverage than their urban counterparts (Henley & Jemal, 2018). Data have shown that cancer patients living in nonmetropolitan areas have higher cancer mortality than those residing in urban areas, explained in part by the higher poverty rates and barriers to healthcare access (CDC, 2017; Blake, 2020). Apparently, both African Americans and nonmetropolitan Whites are at a socioeconomic disadvantage compared to White counterparts living in urban and suburban areas (Yabroff et al., 2020; Hunt et al., 2019). The relationship between unequal resource distribution among these three groups and cancer-related health disparities warrants examination.

To understand the reasons for disparities in health outcomes of cancer patients during the COVID-19 pandemic, we conducted a survey study among cancer patients to evaluate socioeconomic

determinants (e.g. unmet socioeconomic needs), health service delivery (e.g. continuity of care), individual behaviours (e.g. prevention practice) and their association with health outcomes, especially among underserved African American and nonmetropolitan White patients. This study focused on two main questions: (a) What socioeconomic, health service and behavioural factors are associated with physical and mental health outcomes of cancer patients during the pandemic? (b) Do these associations differ across racial and urban/nonurban communities? Identifying modifiable variables (structural or behavioural) will help to inform interventions aimed at improving cancer care in underserved subgroups of the population during public health crises.

### 3 | METHODS

#### 3.1 | Study design and subjects

This was a cross-sectional survey study of cancer patients at a major medical cancer centre in Ohio. It was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (see File S1). We surveyed the patients via online questionnaires between late November 2020 and March 2021 during the deadliest third wave of COVID-19 in the United States. Adult patients (age >18 years) that were White or African American and diagnosed with cancer between January 2019 and January 2020 were eligible, regardless of cancer type or stage. Individuals were excluded if they did not speak English or had impaired cognitive ability that would interfere with survey completion due to Alzheimer's, Huntington's or Parkinson's disease, traumatic brain injury or Creutzfeldt-Jakob disease. Patient's eligibility was identified from medical records and the self-reported information provided during the online informed-consent process. This study was approved by a local Institutional Review Board (#STUDY20200582).

We identified 2,171 potentially eligible cancer patients (256 African Americans, 1,915 Whites) in the hospital's tumour registry whose electronic medical records included an email address. An invitation letter that introduced the study and included a link to the survey webpage was emailed to these patients directly from a Research Electronic Data Capture (REDCap) database, a secure web platform for building and managing online surveys and databases. This invitation was followed by three automatic email reminders once every other day over a week. The research assistant on our team monitored patient response. Because our source database had fewer African American patients available for the study and we were striving to obtain an adequate sample of them, our research assistant phoned African American patients to ensure that they had received the email invitation. In the end, a total of 322 patients consented online to participate and responded to the survey with a response rate of 14.8%.

When they opened the survey link, respondents were asked to read a consent form describing the study, followed by the survey questions to be completed using a phone or computer. Responses to any survey questions constituted the consent and were kept

confidential. The responses provided online were entered directly into a secured REDCap database. Certain responses that suggested a risk for depression triggered the display of a hotline telephone number. We estimated that completing the survey required 45 minutes. Participants received a \$15 Walmart gift card after completing the survey.

#### 3.2 | Instruments

We used existing instruments whenever available and incorporated survey questions from the Phenotype and eXposures (PhenX Toolkit, Ver 40.1) when there were no valid measures, especially with regard to COVID-19 (Hamilton et al., 2011). Through a catalog of recommended measurement protocols, PhenX facilitates the use of standard measures and promotes collaborative and translational research. To confirm the feasibility of implementing this online instrument among cancer patients, and to assess the survey's burden on participants, we enrolled two cancer patients (one White, one African American) to pilot test the study questionnaire. The final questionnaire gathered data in the following five areas that are relevant to the above-stated study questions:

*Individual characteristics were assessed in three areas:*

- demographic traits, specifically age, race, gender, religion and number of persons in the household;*
- socioeconomic status, comprising education ( $\leq$ high school, associate degree;  $\geq$ college), annual household income (grouped by four ranges from  $\leq$ \$25,000 to  $\geq$ \$100,000) and employment status; and*
- medical conditions, including cancer diagnosis, stage, treatment status, comorbidity (i.e. number of chronic diseases) and COVID-19 diagnosis (yes/no).*

*Socioeconomic factors and unmet needs* were measured using the Accountable Health Communities Health-Related Social Needs (AHC HRSN) Screening Tool and the PhenX Toolkit (Ver 40.1) measures. The AHC HRSN Screening Tool was developed by the Centers for Medicare & Medicaid and is one of the most commonly used tools for assessing unmet socioeconomic needs, but it has not been standardised (Billieux et al., 2017). It consists of 10 core items in 5 domains (housing, food, transportation, utilities and safety) and 16 items in 8 supplemental domains (financial strain, employment, family and community support, education, physical activity, substance use, mental health and disabilities). To measure domains of interest parsimoniously, we used 6 of the 10 core items to assess housing, food, transportation and safety, and 3 supplementary items to assess financial strain and community and family support. The additional questions from measures of the PhenX Toolkit asked about stockpiling of food, medicine and cleaning products; difficulty in obtaining medicine; the frequency and means of staying in touch with others during the pandemic (e.g. phone, email, postal mail, video or in-person meeting); and the degree of neighbourhood safety for walking or exercise.

*Health behaviours* included preventive behaviours against COVID-19 infection and lifestyle health behaviours. The preventive behaviours were assessed by a number of items taken from the PhenX Toolkit using a 4-point scale (never, rarely, sometimes, most of the time) in three areas: protection of oneself (e.g. wearing a mask, washing hands), household protection (e.g. regular cleaning or disinfecting) and social activities (e.g. social distancing). Additionally, participants were asked to rate their confidence in taking preventive measures daily for self, household protection and social activities, using a scale from 0 ('not confident at all') to 10 ('extremely confident').

To evaluate lifestyle behaviours, we used additional three items of the AHC HRSN Screening Tool in two supplementary domains: physical activity and substance use. Physical activity was determined with a single question: 'How many days per week did you engage in moderate exercise in the past 30 days?' Substance use comprised questions about daily consumption of alcohol and tobacco: 'How many times in the past month have you had 5 or more alcoholic drinks in a day (males) or 4 or more drinks in a day (females)?' and 'How many times in the past month have you used tobacco products?' Possible answers ranged from 'never' to 'daily or almost daily'.

*Cancer and medical care services* were based on access to, and quality of, health care. Participants were asked whether (yes or no) they had health insurance, had cancelled a cancer care appointment or had changed an in-person visit to a telehealth visit. Additionally, they were asked to rate their satisfaction with telehealth for cancer care or general medical care, using a scale from 0 ('not satisfied at all') to 10 ('extremely satisfied').

*Health outcomes* were measured in terms of general health and mental health. The Patient-Reported Outcomes Measurement Information System Global Health (v1.2) measure was used to assess general health. It includes 10 items and assesses 5 core domains: physical function, pain, fatigue, emotional distress and social health. Four items of physical and mental health (2 items each) are used to calculate a score of global health status that represents overall health. This measure of global health status has a satisfactory internal consistency reliability (0.81) and validity ( $r = 0.76$  and  $-0.75$  for correlation with EQ-5D and pain impact scores respectively). A higher score indicates better global health status. (Hays et al., 2009).

Two instruments measured depression, anxiety and irritability as indications of mental health. The Profile of Mood State (POMS) has been used extensively to measure psychological adjustment to cancer (McNair et al., 1992). The shortened version of POMS (SV-POMS) has shown good internal consistency, reliability and responsiveness to change among cancer patients (Dilorenzo et al., 1999). Scores were calculated for its subscales of *depression or dejection* (8 items) and *tension or anxiety* (6 items), rated on a 5-point Likert scale (0–4), with a higher score indicating worsening mood. These subscale scores indicate severity of symptoms without specific cut-offs for a clinical diagnosis.

The Irritability Scale-Initial Version (TISI) was developed with cancer patients and consists of 35 items. It measures irritability in

physical, mood and behavioural domains; the total score reflects the level of irritability with satisfactory psychometric properties (Cronbach's  $\alpha = 0.97$ , test-retest reliability = 0.69 and intraclass correlation coefficient = 0.86) (Zhang & Ganocy, 2020). Irritability has been reported by cancer patients undergoing treatments, and increasing irritability has been associated with depression (Sharpley et al., 2018; Zhang et al., 2021).

### 3.3 | Data analysis

Descriptive analyses (chi-square test and simple ANOVA) were conducted on all study variables except health outcome variables to explore differences among three groups (African Americans, metropolitan Whites and nonmetropolitan Whites). Generalised linear regression analyses were performed in two steps to identify factors associated with health outcomes. Initially, variables in each of the three areas (unmet socioeconomic needs, healthcare services and behaviours) were regressed (stepwise) separately on the dependent variables of global health status, depression, and anxiety and irritability, while controlling for individual characteristics (demographics, socioeconomic status and medical conditions). Next, significant variables with  $p < 0.05$  from each area were identified and pooled together to be included in the final analysis. These selected variables were regressed on each dependent variable, respectively, using a threshold significance level of  $p < 0.05$ . All analyses controlled for age, gender and the number of chronic diseases as covariates.

To examine the effects of racial and nonmetropolitan status, two dummy variables of race and nonmetropolitan status (using metropolitan Whites as the reference group) were created and included in the final regression model. Interaction terms between each dummy variable and most impactful predicting variable(s) were created and added to the final regression model. An interaction term between income and the most impactful predicting variable was also included. In the regression analyses, cases with missing values for dependent variables were excluded, while cases with missing values for independent variables or covariates were retained, and the missing values were treated in a generalised linear model without interfering consequence. For the bivariate analysis, missing data were assigned a value (e.g. 9) and counted as such in the frequency distributions. All data analyses were performed using SAS, version 9.4 (SAS Institute Inc.).

## 4 | RESULTS

The study sample included 322 respondents; 40 were African American and 282 were White, of whom 215 lived in an urban or suburban areas and 67 lived outside urban or suburban areas (i.e. nonmetropolitan) as defined by the rural-urban continuum code (USDA, 2021). The latter two groups are hereafter referred to as Metro Whites and non-Metro Whites respectively.

#### 4.1 | Distribution of demographic and clinical variables

As shown in Table 1, there were marked differences between groups in demographic traits. With regard to age, individuals 65 years of age or older had a higher representation among Metro Whites (46.98%), compared with African Americans (37.50%) or non-Metro Whites (35.82%). We also noted a higher percentage of men (35.92%) in Metro Whites than in African Americans (23.08%) or non-Metro Whites (29.69%). With regard to education and income, we found statistically significant differences across the three groups. The lowest percentage of individuals with a college degree or above was among African Americans (28.21%), followed by non-Metro Whites (45.31%), and the highest percentage being among Metro Whites, at 57.21%. Similarly, while nearly half of African American respondents reported incomes below \$50,000, 31.15% and 25.64% of respondents in non-Metro and Metro White groups, respectively, reported incomes in that range. Conversely, while 42.56% of Metro Whites said their incomes exceeded \$100,000, only 24.59% of non-Metro Whites and 10.26% of African Americans reported incomes in that range. In terms of religious affiliation, approximately two-thirds of each group identified as Christian, while 15.38% of African Americans, 18.93% of Metro Whites and 20.63% of non-Metro Whites responded as 'not religious'.

No statistically significant differences were noted across the three groups in cancer stage at diagnosis, treatment modalities received at the time of survey completion, or number of chronic diseases. With respect to cancer stage, the percentage of respondents diagnosed with metastatic cancers was 11.42% among African Americans, 9.37% for Metro Whites and 7.27% in non-Metro Whites. Relative to treatment modalities, a lower percentage of Metro Whites than African Americans or non-Metro Whites were undergoing chemotherapy (15.35%, 22.50% and 23.88%, respectively), and a higher percentage of Metro Whites than others were receiving other/hormonal therapy (27.44%), compared with 20% of African Americans and 23.88% of non-Metro Whites. The percentage of individuals with greater than 10 chronic diseases was highest among non-Metro Whites (40.62%), followed by Metro Whites (30.62%) and African Americans (28.20%). Lastly, we noted that the percentage of individuals who had been diagnosed with COVID-19 was 10.53% among African Americans, 6.15% among non-Metro Whites and 5.24% among their Metro White counterparts.

#### 4.2 | Distribution of socioeconomic, health services and behavioural variables

Table 2 shows the distribution of variables measuring unmet socioeconomic needs, health services and health behaviours. A higher percentage of the African American group than the other two groups reported storing food, medical supplies and cleaning supplies due to COVID-19. In particular, we noted statistically significant differences in storage of cleaning supplies (67.50%, 49.77% and 37.31% by the African American, Metro White and non-Metro White groups

respectively) and food (60%, 45.58% and 35.82%, respectively). Conversely, a lower percentage of African Americans than Metro and non-Metro Whites said they did not buy more than the usual amount of food (15%, 35.81% and 20.81%, respectively).

Fewer than 3% of each group reported a lack of reliable transportation for their medical needs, with this percentage being highest among African Americans (2.86%), followed by Metro Whites (2.01%). None of the non-Metro Whites reported difficulty with transportation. Similarly, only 3 respondents combined for all three groups reported a lack of social support; however, some 30% of respondents reported feeling lonely sometimes/often/always (37.14%, 29.50% and 43.63%, respectively, for African Americans, Metro Whites and non-Metro Whites), and most respondents stayed in touch with friends and relatives by phone, speaking in person and video calls. Use of email to stay in touch varied significantly among the three groups, with the highest usage being by Metro Whites (61.40%), then African Americans (42.50%) and non-Metro Whites (41.79%). We also noted that some of our respondents felt insulted or talked down to by family members or friends, though the percentage was relatively small (7.54% among Metro Whites, followed by non-Metro Whites [7.27%] and African Americans [5.71%]).

Asked whether they felt safe to exercise in their neighbourhood, 89.45% of Metro Whites and 90.91% of non-Metro Whites reported feeling very safe or safe, compared with only 45.71% of African Americans. Over half of African American respondents reported feeling somewhat safe, not safe or quite unsafe to do so.

With regard to cancer care disruptions, over 80% reported no cancer-related appointment cancellations due to coronavirus. This percentage was lowest among Metro Whites (82.12%), compared with nearly 87% in each of the other groups. However, at least 50% of appointments were changed from in-person to telehealth visits (50.51%, 55.77% and 68.75%, respectively, for Metro Whites, non-Metro Whites and African Americans). Of the 130 participants who responded to the question, 'How satisfied are you with telehealth for cancer care?', no more than 60% of African Americans said, 'very satisfied or satisfied'; the percentages were even lower in the other two groups (40.21% and 26.09%, respectively, for Metro and non-Metro Whites). When asked about telehealth for other (non-cancer) medical care, 77.78% of Metro Whites, 78.29% of non-Metro Whites and 62.5% of African Americans reported being very satisfied or satisfied.

A higher percentage of African Americans (>94%) said that they practiced preventive behaviours (washing hands with soap and water, wearing a mask and keeping physical distance) compared to Metro and non-Metro Whites. The difference between groups was statistically significant for keeping physical distance 'most of the time' (94.74% among African Americans, compared with 82.86% and 70.31% for Metro and non-Metro Whites respectively).

In terms of healthy lifestyle behaviours, exercising 6 to 7 days a week was reported by a significantly lower percentage of African Americans (62.86%) than either Metro or non-Metro Whites (86.5% and 72.73%, respectively). On the contrary, we found little variation among the three groups for alcohol consumption (75%–80% of respondents answered 'never') and smoking (over 90% answered 'never').

TABLE 1 Distribution of sample characteristics by racial and metropolitan status

Variables of interest	N (322)	AA (40) n (%)	Metro Whites (215) n (%)	Non-metro Whites (67) n (%)	p-value
Age, years					0.3613
<45	44	6 (15.00)	30 (13.95)	8 (11.94)	
45 to 64	138	19 (47.50)	84 (39.07)	35 (53.24)	
65 and above	140	15 (37.50)	101 (46.98)	24 (35.82)	
Sex					0.2405
Male	102	9 (23.08)	74 (35.92)	19 (29.69)	
Female	207	30 (76.92)	132 (64.08)	45 (70.31)	
Missing	13				
Education					0.014
<High school or high school	31	5 (12.82)	18 (8.65)	8 (12.50)	
Associate degree	121	23 (58.97)	71 (34.13)	27 (42.19)	
≥College	159	11 (28.21)	119 (57.21)	29 (45.31)	
Missing	11				
Income					0.0008
<\$25,000	26	8 (20.51)	13 (6.67)	5 (8.20)	
\$25,000 to \$49,999	62	11 (28.21)	37 (18.97)	14 (22.95)	
\$50,000 to \$99,999	105	16 (41.03)	62 (31.79)	27 (44.26)	
\$100,000 and above	102	4 (10.26)	83 (42.56)	15 (24.59)	
Missing	27				
Religious affiliation					0.7584
Christian	205	25 (64.10)	137 (66.50)	43 (68.25)	
Not religious	58	6 (15.38)	39 (18.93)	13 (20.63)	
All others	45	8 (20.51)	30 (14.56)	7 (11.11)	
Missing	14				
Stage of cancer					0.5339
0 (not staged/don't know)	86	9 (25.71)	57 (29.68)	20 (36.36)	
1	87	10 (28.57)	63 (32.81)	14 (25.45)	
2	49	10 (28.57)	29 (15.10)	10 (18.18)	
3	34	2 (5.71)	25 (13.02)	7 (12.72)	
4	26	4 (11.42)	18 (9.37)	4 (7.27)	
Missing	40				
Which cancer treatment are you taking now?					
Surgery	61	8 (20.00)	40 (18.60)	13 (19.40)	0.9732
Radiation	29	4 (10.00)	18 (8.37)	7 (10.45)	0.8506
Chemotherapy	58	9 (22.50)	33 (15.35)	16 (23.88)	0.2080
Other/hormonal	83	8 (20.00)	59 (27.44)	16 (23.88)	0.5669
Have you been diagnosed with COVID-19 by a doctor or other healthcare provider?					0.4540
No	294	34 (89.47)	199 (94.76)	61 (93.85)	
Yes	19	4 (10.53)	11 (5.24)	4 (6.15)	
Missing	9				
Number of chronic diseases					0.4838
<10	116	12 (30.76)	84 (40.19)	20 (31.25)	
10	95	16 (41.02)	61 (29.18)	18 (28.12)	
>10	101	11 (28.20)	64 (30.62)	26 (40.62)	
Missing	10				

Note: For all categorical variables, chi-square test was performed.

Abbreviation: AA, African American.



### 4.3 | Results from the multivariable regression analysis

The results from the multivariate regression analyses are presented in Table 3. The three outcomes of interest were global health, depression and irritability. Anxiety as a dependent variable generated similar and even less information than did depression and thus is not presented separately. As noted earlier, we included the independent variables in the models only if they were selected in stepwise regression models.

#### a. Variables associated with global health outcome

The results showed that the outcome of global health was positively associated with more satisfaction about telehealth for medical care (other than cancer care), more confidence in taking preventive measures and more days engaging in exercise. On the contrary, we observed a negative association between global health and greater comorbidity, feeling lonely, and living in a place too crowded to allow social distancing.

#### b. Variables associated with mental health outcomes

The results showed that depression was negatively associated with satisfaction about telehealth for medical (non-cancer) care and confidence in taking preventive measures, and positively associated with feeling lonely (sometimes, often or always), and living in a place too crowded for social distancing. Depression also had a positive association with having Medicaid only (vs. Medicare) or having difficulty obtaining medicine.

Analysing the outcome of irritability, we found that it had a significant negative association with being older, being insured through an employer or through the Affordable Care Act (ACA), being satisfied with telehealth for medical care (other than cancer care) and having confidence in taking preventive measures. Conversely, being African American, having difficulty obtaining medicine, feeling lonely and living in a place too crowded to have social distancing were positively associated with irritability.

#### c. Effects of race and metro/non-metro status

Regarding the outcome of depression, the interaction term of African American race by loneliness was positive and statistically significant, meaning that the association between loneliness and depression was stronger in African Americans than among Metro Whites. An interaction term between feeling lonely and income level (<\$25,000 vs. ≥\$25,000) was negative and statistically significant, indicating that the association between loneliness and depression was lessened with higher income levels.

Regarding the outcome of irritability, the interaction term of African American race by loneliness was positive and statistically significant, meaning that the association between feeling lonely and

irritability was stronger in African Americans than among Metro Whites. Further, the interaction term of African American race by confidence in taking preventive measures was negative and statistically significant, indicating that the association between lower confidence in taking preventive measures and irritability was stronger among African Americans than their White counterparts. We did not identify any statistically significant interaction effects regarding global health.

## 5 | DISCUSSION

Our findings show that living conditions, indicated by the two variables of feeling lonely and crowded living space, were significantly associated with poorer global health status, depression and irritability. Most notably, feeling lonely stands out as the most significant associated factor of poor health outcomes during the pandemic. Studies have shown that loneliness is significantly associated with depression and the risk of all-cause mortality (Erzen & Çikrikci, 2018; O'Suilleabháin, et al., 2019). A possible explanation is that feelings of loneliness correlate significantly with increasing cortisol during the day (Doane & Adam, 2010). Excessive cortisol weakens immunological function that, in our study participants, was already compromised by cancer and its treatment, hence affecting their global health and mental health. Normally, loneliness can be mitigated by social support from various private and social activities (Liu et al., 2016), but such options were limited during the pandemic, especially for those with limited resources or living in remote areas. Similarly, in this study, cancer patients living in a crowded space also indicated poorer global health, more depression and greater irritability. Studies have shown that crowded housing adversely affects health, physically and mentally, because of increased stress, stress hormones and blood pressure (Adegoke, 2014; Gove et al., 1979). Moreover, difficulty in obtaining needed medicine (another living condition) was significantly associated with depression and irritability. These problems can be prolonged and exacerbated under a stay-at-home order. Thus, cancer patients feeling lonely, living in a crowded space or lacking medical supplies appear to be at a higher risk of worsening global and/or mental health status during the COVID-19 pandemic.

Individual health behaviours played a significant role in the health outcomes as expected, but our findings highlighted two important behaviours: daily exercise and confidence in taking preventive measures for personal safety. In this study, cancer patients reporting more days of exercises during the week also reported better global health status, while those feeling more confident in taking preventive actions to protect oneself from COVID-19 infection reported better global health and less depression and irritability. Although those having better health were more capable of exercising or more ready mentally for keeping up with prevention efforts, the alternative explanation can be also true, as sustaining exercises can contribute to better overall health, and preventive actions not only benefit health, but also bring peace of mind. A causal nature of these associations could not be established, given the cross-sectional nature of our data.

TABLE 2 Distribution of socioeconomic, health service and behavioural factors by racial and metropolitan status

Variables of interest	N (322)	AA (40) n (%)	Metro Whites (215) n (%)	Non-metro Whites (67) n (%)	p-value
<i>Unmet socioeconomic needs</i>					
As a result of COVID-19, have you stored (i.e. bought more than usual) any of the following					
Food	146	24 (60.00)	98 (45.58)	24 (35.82)	0.0517
Medical supplies	80	13 (32.50)	55 (25.58)	12 (17.91)	0.2184
Cleaning supplies	159	27 (67.50)	107 (49.77)	25 (37.31)	<b>0.0102</b>
None	113	6 (15.00)	77 (35.81)	30 (20.81)	<b>0.0071</b>
Worried last month about running out of food					
Never true	266	27 (77.14)	186 (93.94)	53 (96.36)	<b>0.0012</b>
Sometimes/often	22	8 (22.86)	12 (6.06)	2 (3.64)	
Missing	34				
Food did not last or had no money to buy more during last month					
Never true	272	28 (80.00)	189 (94.50)	55 (100.00)	<b>0.0005</b>
Sometimes/often	18	7 (20.00)	11 (5.50)	0 (0.00)	
Missing	32				
How much difficulty have you encountered in obtaining needed medicine because of the COVID-19 pandemic or social distancing rules?					
Yes	32	4 (11.43)	22 (11.06)	6 (10.91)	0.9970
No	257	31 (88.57)	177 (88.94)	49 (89.09)	
Missing	33				
In the past month, has lack of reliable transportation kept you from medical needs					
Never true	284	34 (97.14)	195 (97.99)	55 (100.00)	0.5165
Sometimes/often	5	1 (2.86)	4 (2.01)	0 (0.00)	
Missing	33				
I do not have any support, checkbox					
Did check the box	3	0 (0.00)	2 (0.93)	1 (1.49)	0.7391
Did not check the box	319	40 (100.00)	213 (99.07)	66 (98.51)	
Continued staying in touch by					
Speaking in person	166	15 (37.50)	116 (53.95)	35 (52.24)	0.1595
Social media	125	15 (37.50)	86 (40.00)	24 (35.82)	0.8150
Phone calls	268	31 (77.50)	186 (86.51)	51 (76.12)	0.0810
Postal mail	36	3 (7.50)	25 (11.63)	8 (11.94)	0.7305
Video calls	145	19 (47.50)	103 (47.91)	23 (34.03)	0.1410
Email	177	17 (42.50)	132 (61.40)	28 (41.79)	<b>0.0045</b>
Other	35	8 (20.00)	25 (11.63)	2 (2.99)	<b>0.0196</b>
Feel lonely					
Never/rarely	194	22 (62.85)	141 (70.50)	31 (56.36)	<b>0.0251</b>
Sometimes/often/always	96	13 (37.14)	59 (29.50)	24 (43.63)	
Missing	32				
Felt insulted or talked down to by family or friend					
Never/rarely	268	33 (94.29)	184 (92.46)	51 (92.73)	0.9292
Sometimes/often/always	21	2 (5.71)	15 (7.54)	4 (7.27)	
Missing	33				
Safe neighbourhood for exercise					
Very safe/safe	244	16 (45.71)	178 (89.45)	50 (90.91)	<b>&lt;0.0001</b>
Somewhat safe	39	15 (42.86)	20 (10.05)	4 (7.27)	



TABLE 2 (Continued)

Variables of interest	N (322)	AA (40) n (%)	Metro Whites (215) n (%)	Non-metro Whites (67) n (%)	p-value
Not safe/quite unsafe	6	4 (11.43)	1 (0.50)	1 (1.82)	
Missing	33				
<i>Healthcare services</i>					
Have you had any cancer appointments cancelled related to coronavirus?					
Yes	43	4 (13.33)	32 (17.88)	7 (13.46)	0.6656
No	218	26 (86.67)	147 (82.12)	45 (86.54)	
Were any of your cancer appointments changed to telehealth appointments?					
Yes	130	10 (31.25)	97 (49.49)	23 (44.23)	0.1493
No	150	22 (68.75)	99 (50.51)	29 (55.77)	
How satisfied are you with telehealth for cancer care?					
Very satisfied/satisfied	51	6 (60.00)	39 (40.21)	6 (26.09)	0.1725
Less/not at all satisfied	79	4 (40.00)	58 (59.79)	17 (73.91)	
Missing	192				
How satisfied are you with telehealth for medical needs other than cancer care?					
Very satisfied/satisfied	144	15 (62.5)	101 (77.78)	28 (78.29)	0.5035
Less/not at all satisfied/not at all	45	9 (37.50)	28 (21.70)	8 (22.22)	
Missing/not applicable	133				
<i>Health behaviours</i>					
Washed hands with soap and water					
Most of the time	278	36 (94.74)	185 (88.10)	57 (89.06)	0.2422
Some of the time	32	1 (2.63)	24 (11.43)	7 (10.94)	
Rarely/never	2	1 (2.63)	24 (11.43)	7 (10.94)	
Missing	10				
Wearing mask					
Most of the time	291	37 (97.37)	197 (93.81)	57 (89.06)	0.3028
Some of the time	17	0 (0.00)	11 (5.24)	6 (9.38)	
Rarely/never	4	1 (2.63)	2 (0.95)	1 (1.56)	
Missing	10				
6 Feet physical distance					
Most of the time	255	36 (94.74)	174 (82.86)	45 (70.31)	0.0171
Some of the time	46	1 (2.63)	31 (14.76)	14 (21.88)	
Rarely/never	11	1 (2.63)	5 (2.38)	5 (7.81)	
Missing	10				
On a scale of 0–10, how confident are you keeping <sup>a</sup>					
Personal prevention	310	8.65	8.94	8.61	0.3069
Household prevention	310	8.18	8.41	7.96	0.3163
Social/physical distancing	309	9.52	8.80	8.49	0.0223
Days engage in exercise					
≤5 days weekly	55	13 (37.14)	27 (13.50)	15 (27.27)	0.0010
6 to 7 days weekly	235	22 (62.86)	173 (86.50)	40 (72.73)	
Missing	32				
Alcohol consumed					
Daily/almost daily	3	0 (0.00)	3 (1.52)	0 (0.00)	0.7986
Once or more weekly	63	7 (20.59)	45 (22.73)	11 (20.00)	

(Continues)

TABLE 2 (Continued)

Variables of interest	N (322)	AA (40) n (%)	Metro Whites (215) n (%)	Non-metro Whites (67) n (%)	p-value
Never	221	27 (79.41)	150 (75.76)	44 (80.00)	
Missing	35				
Tobacco consumed					
Daily/almost daily	11	1 (2.94)	7 (3.54)	3 (5.45)	0.5381
Once or more weekly	10	1 (2.94)	9 (4.55)	0 (0.00)	
Never	266	32 (94.12)	182 (91.92)	52 (94.55)	
Missing	35				

Abbreviation: AA stands for African American.

<sup>a</sup>Continuous variables for which ANOVA was performed. For all categorical variables, chi-square test was performed.

p-values <0.05 are shown in bold fonts.

Access to, and quality of, healthcare services were significantly associated with the mental health outcomes of study participants. Medicaid recipients reported more depression than Medicare recipients, who in turn reported more irritability than those with health insurance from an employer or the ACA. These significant associations likely reflect the impact of socioeconomic hardship on mental health. Although disruption in cancer care, such as appointment cancellation or alteration, did not significantly associate with health outcomes, those reporting less satisfaction with telehealth visits for general medical needs showed poorer global health and greater depression and irritability. It is possible that those having more depression, irritability or poorer health found telehealth inadequate to meet their needs, but it is also plausible that inadequate care from telehealth visits adversely affected the well-being of these patients. The nature of this relationship requires further investigation.

In addressing the first study question, our findings support the notion that socioeconomic determinants (e.g. living conditions) are as important as individual behaviours (e.g. exercises and preventive action) in physical and mental health outcomes. Moreover, access to health care (e.g. insurance status) and medicine had a primary effect on mental health. Regarding the second study question, our survey identified disparity in mental health outcomes, showing two alarming trends. First, compared with Metro Whites or African Americans who did not feel lonely, African Americans who reported feeling lonely experienced more depression and irritability. Secondly, cancer patients with an annual household income of \$25,000 or less and feeling lonely reported more depression than all others, including those with similar earnings who did not feel so lonely. It is conceivable that mood disorders such as depression are more common in individuals with low incomes and African American communities due to discrimination and other stresses. However, the fact that loneliness, a by-product of the current pandemic, has worsened such mental problems simply demonstrates greater vulnerability and more severe consequences of mental health in these marginalised communities during the pandemic. Moreover, African Americans feeling less confident in taking preventive measures for self-protection also reported significantly more irritability than all

others, suggesting irritability is a psychological correlate of self-efficacy for a health behaviour. Irritability is a mood problem and closely associated with depression (Sharpley et al., 2018; Zhang et al., 2021). Identifying and reducing irritability may contribute to better mental health outcomes and health behaviour. Overall, the impact of the pandemic on the mental health of African American patients and those with low income cannot be dismissed, because deteriorating mental health can lead to diminished physical health, and our findings on mental health disparity may show just the tip of the iceberg, given the small number of African Americans in the study (Ohrnberger et al., 2017).

Our regression models have explained more than half of the variances (50%–54%) in dependent variables, providing important lessons for future responses to public health crises. The feelings of loneliness appear to be most detrimental to our respondents' physical and mental health during the pandemic stay-at-home period, particularly for underserved African Americans and those with low incomes, knowing that they have significant needs for social support during cancer treatments. Engagement in community and/or healthcare systems to enhance social support for these patients would be very beneficial to their well-being. Further, exercise is known to enhance health, and this was evident for our cancer patients. However, compared to other study participants, African American cancer patients reported feeling less safe for walking or exercising in their neighbourhoods. Improving home and neighbourhood environments for exercise purposes or promoting exercise at public parks in African American communities should be important for health enhancement. Our results also indicate that improved healthcare delivery in terms of better access to medicine and higher-quality telehealth visits can lead to better health outcomes.

The study findings have important implications for nurses and other clinicians. When conducting clinical assessments, nurses should pay attention to the patient's living environment in order to identify vulnerable patients at risk for adverse health outcomes. Patients that live alone or report feeling lonely should be evaluated carefully for mental and physical health status. The influence of living conditions on the cancer patient's health should be taken

TABLE 3 Multivariate generalised linear model of health outcome measures

Variables of interest	Global Health			Depression			Irritability		
	Estimates	SE	p-value	Estimates	SE	p-value	Estimates	SE	p-value
Age: ≥65 vs <65, years	0.2265	0.12	0.0643	0.0959	0.14	0.5025	-0.9931	0.30	<b>0.0012</b>
Gender: Female vs Male	0.1156	0.07	0.1316	-0.0392	0.09	0.6657	-0.1225	0.19	0.5144
Race: AA vs Metro-White	-0.1117	0.61	0.8555	0.9223	0.71	0.1953	2.7132	1.35	<b>0.0461</b>
Non-Metro White vs Metro-White	0.1406	0.10	0.1922	-0.0930	0.12	0.4566	-0.1940	0.25	0.4450
Number of chronic diseases									
10 vs <10	0.0379	0.08	0.6305	-0.0983	0.09	0.2911	-0.2094	0.19	0.2803
>10 vs <10	-0.2339	0.08	<b>0.0033</b>	-0.0062	0.09	0.9460	0.1566	0.18	0.3939
Income: ≥ \$25,000 vs < \$25,000	-0.0072	0.16	0.9654	0.2251	0.20	0.2647	0.3510	0.45	0.4425
Insurance: Medicare (referenced)									
Insured through employer	0.1765	0.12	0.1652	0.1437	0.15	0.3307	-0.6414	0.31	<b>0.0416</b>
Insured through spouse, parent	0.1392	0.13	0.2963	0.6703	0.16	0.2585	-0.1810	0.31	0.5638
Insured through Affordable Care Act ('Obamacare')	0.1540	0.19	0.4373	0.0175	0.23	0.9407	-0.9213	0.44	<b>0.0406</b>
Medicaid	-0.0997	0.21	0.6409	0.6151	0.24	<b>0.0128</b>	0.2318	0.55	0.6748
Both Medicaid and Medicare	-0.1265	0.25	0.6222	-0.3232	0.29	0.2750	-0.1011	0.60	0.8669
Uninsured	0.1683	0.39	0.6697	-0.4189	0.45	0.3573	0.5140	0.85	0.5471
More vs less satisfaction with telehealth for medical needs	0.3263	0.09	<b>0.0010</b>	-0.3154	0.11	<b>0.0073</b>	-0.6004	0.24	<b>0.0135</b>
Difficulty vs no difficulty obtaining medicine	-0.1973	0.10	0.0732	0.3607	0.12	<b>0.0053</b>	1.2604	0.26	<b>&lt;0.0001</b>
Confidence in taking personal prevention measures (0=not at all; 10=extremely confident)	0.3571	0.14	<b>0.0114</b>	-0.5024	0.16	<b>0.0022</b>	-0.1948	0.38	<b>0.0183</b>
Feeling lonely vs not	-0.7587	0.27	<b>0.0057</b>	1.3403	0.31	<b>&lt;0.0001</b>	0.9278	0.69	<b>&lt;0.0001</b>
Living place too crowded to maintain social distancing vs not	-0.3753	0.16	<b>0.0203</b>	0.5678	0.18	<b>0.0024</b>	1.3919	0.40	<b>0.0008</b>
>5 days engaged in exercise vs 5 or <5	0.3609	0.08	<b>&lt;0.0001</b>	-0.0579	0.10	0.5665	-0.2862	0.20	0.1592
AA x feeling lonely	-0.1554	0.21	0.4754	0.5266	0.25	<b>0.0373</b>	1.2274	0.53	<b>0.0223</b>
Non-metro Whites x feeling lonely	-0.1063	0.17	0.5355	0.2924	0.20	0.1504	0.6982	0.40	0.0895
AA x confidence in preventive behaviour	0.1213	0.60	0.8418	-1.1758	0.70	0.0960	-2.8220	1.34	<b>0.0375</b>
Low income x feeling lonely	-0.2709	0.89	0.3747	0.7949	0.31	<b>0.0131</b>	0.1515	0.69	0.8261
<b>R-square (df)</b>	<b>0.50 (281/41)</b>			<b>0.53 (272/41)</b>			<b>0.54 (226/40)</b>		

Note: The reference group for categories of insurance is Medicare.

p-values <0.05 are shown in bold fonts.

Abbreviation: AA, African Americans.

into consideration for providing supportive care or appropriate interventions.

This survey study has provided rich information to explain a large part of health outcomes in a sample of newly diagnosed cancer patients, but the findings should be viewed in light of the following limitations. First, only the patients with available email addresses on file were invited to participate. This strategy was intended to circumvent the issue of slow and potentially unsafe postal mail delivery during the pandemic, as privacy and confidentiality concerns prohibited direct recruitment by phone. Since email availability may be associated with a certain socioeconomic status, subject self-selection may be a biasing factor. Second, our response rate remained low

(at 15%), which may affect the accuracy of study findings. Despite this, our sample size was sufficient to yield adequate power to detect statistically significant associations of study variables. Third, the number of African American participants in this study was small (40/322). Although their response rate was similar to that of White participants, fewer African Americans were available in the tumour registry database; we had to reach some African American patients by phone, which might have biased the response. Access to a computer or phone device, required for study participation, may have excluded some African Americans from participation. Further, despite our effort to examine racial effects of feeling lonely and confident in taking preventive measures for self-protection, we were unable to

exhaust the possibility of interaction effects between race and all other significant associates of health outcomes. Finally, this study was cross-sectional, and the findings have enlightened associations between socioeconomic, healthcare, personal, and behavioural variables and health outcomes. However, a directional relationship and a causal nature of the associations require a longitudinal study. We plan to follow-up with the study participants over several months to further investigate these associations. These shortcomings can limit the generalisability of study findings.

In conclusion, this study has shown that socioeconomic determinants of health as manifested in individual living conditions are strongly associated with health outcomes of cancer patients during the COVID-19 pandemic. We have observed remarkable mental health disparities among African American and low-income cancer patients. In particular, loneliness deserves special attention from clinicians and researchers, as it may signal worsening mental and overall health in cancer patients.

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#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### AUTHORS CONTRIBUTIONS

Jennifer Frame and Jinglu Li assisted with project management. Matthew McManus provided editorial assistance.

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