COVID-19 perceptions, impacts, and experiences: a cross-sectional analysis among New Jersey cancer survivors

Adana A. M. Llanos[1,2] · Angela J. Fong[3,4] · Nabarun Ghosh[5] · Katie A. Devine[4,6] · Denalee O'Malley[4,7] · Lisa E. Paddock[4,8] · Elisa V. Bandera[3,4] · Shawna V. Hudson[4,7] · Andrew M. Evens[3,4] · Sharon L. Manne[3,4]

Abstract

Background Cancer survivors are particularly vulnerable to adverse COVID-19-related outcomes, but limited data exist on perceptions about the pandemic and related experiences in this group.

Methods In a cross-sectional analysis of 494 survivors of genitourinary, breast, gynecologic, colorectal, lung, melanoma, or thyroid cancer, from a larger study of cancer survivors in New Jersey, we assessed perceptions about COVID-19 threat, impacts, and experiences using three validated instruments. Responses were coded on a 7-point Likert scale, and subscales were averaged across included items, with higher scores indicating greater perceptions of COVID-19 threat and greater impacts and experiences because of the pandemic. Multivariable linear regression models were used to determine factors associated with higher scores, with Bonferroni correction for multiple comparisons.

Results In general, cancer survivors reported moderate perceived COVID-19 threat (3 items, mean score = 3.71 ± 1.97), minimal COVID-19-related impacts (6 items, mean score = 2.23 ± 1.34), and COVID-19-related experiences (7 items, mean score = 2.17 ± 1.00). COVID-19 impact subscale scores varied little (mean subscale score range = 2.09 to 2.29), while COVID-19 experiences subscale scores were quite variable (mean subscale score range = 1.52 to 3.39). Asian American/Pacific Islander race, Black race, female sex, and having more cardiovascular and metabolic and other comorbidities were associated with higher scores on the perceived coronavirus threat questionnaire. Having completed the COVID-19 questionnaires earlier in the pandemic, younger age, American/Pacific Islander race, Hispanic ethnicity, and having more comorbidities were associated with higher scores on the COVID-19 impact questionnaire. Younger age, racial minority status, and having more cardiovascular and metabolic comorbidities were associated with higher scores on the COVID-19 experience questionnaire.

Conclusion Among cancer survivors in New Jersey—a state that experienced high rates of COVID-19 infection—sociodemographic and health-related factors (e.g., race and ethnicity, sex, and multimorbidity) correlate with greater perceptions of COVID-19 threat, impacts, and experiences.

Implications for Cancer Survivors Studies are needed to examine the influence of vaccination status on COVID-19 perceptions and identify inequities in clinical outcomes due to pandemic-related disruptions to cancer care.

Keywords COVID-19 perceptions · Cancer · Adults · Cancer survivors

Introduction

The emergence of the novel coronavirus disease 2019 (COVID-19) and the ensuing global pandemic (herein referred to as "the pandemic") have led to a growing concern about its impacts on vulnerable populations, particularly those with preexisting health conditions such as cancer. Current evidence suggests that the pandemic has adverse effects on cancer survival outcomes because individuals with cancer tend to have preexisting comorbidities (e.g., cardiovascular disease, hypertension, diabetes, and obesity) and treatment-related immunosuppression [1–8], making them more vulnerable to COVID-19 infection [1, 9, 10]. Further, studies also indicate that cancer survivors experience a higher risk of severe COVID-19-related hospitalization, complications, and death following infection [1, 4–8, 11–24].

Adana A. M. Llanos and Angela J. Fong contributed equally to this work.

✉ Adana A. M. Llanos
al4248@cumc.columbia.edu

Extended author information available on the last page of the article

Studies among cancer survivors have also noted disproportionate pandemic-related impacts among racial and ethnic minorities [25–27] and among those of lower socioeconomic status (SES) and education [28–30]. Additionally, these same populations also report experiencing disproportionate cancer incidence and mortality rates [31]. The pandemic has negatively impacted many domains of life including employment, availability of and access to necessary resources and healthcare, psychological well-being, and social support [10, 32, 33]. While some studies have examined clinical and psychosocial outcomes among cancer survivors during the pandemic and resulting from COVID-19 infections [25, 34], there is a dearth of knowledge about cancer survivors' perceptions of the threat, impacts, and overall experiences of COVID-19 regardless of infection status. Understanding these perceptions and experiences could be valuable for determining the psychosocial impact of the pandemic beyond a COVID-19 diagnosis among a vulnerable population. The current study aimed to address this gap in knowledge by describing cancer survivors' perceptions of the pandemic and examining associations of sociodemographic and health characteristics with perceived threat, impacts, and overall experiences during the pandemic in a population-based sample of cancer survivors in New Jersey. We hypothesized that cancer survivors belonging to racial and ethnic minority groups and those with lower SES would report greater perceived threat, impacts, and overall experiences during the pandemic.

Materials and methods

Participants

The study received institutional review board approval at Rutgers University. Prospective participants were identified through the New Jersey State Cancer Registry (NJSCR), and eligibility was confirmed by the diagnosing physician and research staff. Eligibility criteria included individuals who were (a) 18–85 years of age; (b) a current resident of New Jersey; (c) diagnosed in 2015 or 2016 with a primary case of genitourinary (i.e., bladder and prostate), female breast, gynecologic (i.e., cervical, endometrial, ovarian), colorectal, lung, melanoma, or thyroid cancer; and (d) able to read and speak English.

Procedures

In this cross-sectional analysis of data from a larger study of cancer survivors in New Jersey, we sought to assess perceptions about COVID-19 threat, impacts, and experiences in a population-based cohort of cancer survivors in New Jersey. Between August 2018 and January 2022, NJSCR

staff mailed a recruitment package, which included a cover letter, study information, questionnaire, and postage-paid return envelope, to prospective participants. One week after the mailing, NJSCR staff called potential participants to confirm receipt of the recruitment package and answer any questions before returning the survey. Participants received up to 8 follow-up phone calls throughout the week and weekend to remind them to complete and return the questionnaire. Individuals who returned the survey were provided with a $25 gift card in appreciation for their time. A total of 3,012 individuals met the eligibility requirements and were contacted for study participation. Among them, 29 were deceased, 175 were deemed ineligible, 116 were categorized as lost, 1,830 refused (484 active and 1,346 passive), and 862 returned the survey (28.6% response rate).

The COVID-19 questionnaire was included from August 2020 onward for the purposes of assessing COVID-19 perceptions among cancer survivors. Among eligible participants who completed the written informed consent, 494 responded to all items in the COVID-19 questionnaires and were included in the analytic sample described herein. Responders to the COVID-19 questionnaires tended to be older ($P < 0.0001$) and less likely to self-identify as Black ($P < 0.0001$) than cohort participants who did not complete the COVID-19 questionnaire (Supplementary Table 1).

Measures

Primary cancer diagnosis Self-reported primary cancer diagnosis included genitourinary (urinary bladder or prostate), female breast, gynecologic (cervical, endometrial, or ovarian), colorectal, lung, melanoma, or thyroid. Data on tumor stage were provided by NJSCR.

Sociodemographic characteristics Self-reported sociodemographic characteristics included age (in years), gender (male or female), self-identified race (White, Black or African American, Asian or Asian American, or others including American Indian or Alaska Native, Native Hawaiian, or other Pacific Islanders, and multiracial), Hispanic ethnicity (yes or no), nativity (US-born [yes or no]), marital status (married or unmarried—divorced, widowed, or single/never married), education (less than high school, high school graduate, or General Education Diploma [GED], some post high school or college training, college graduate and above, or others), employment status (employed outside the home or unemployed outside the home—disabled, homemaker, or retired), annual household income (less than $50,000, $50,000 to $89,999, and greater than $90,000), and health insurance status (private, Medicaid, Medicare, others, or uninsured).

Health characteristics A single item was used to assess the last time cancer-related care was sought, and a checklist of 23 health conditions derived from the Health Information National Trends Survey (HINTS) was used to assess respondents' history with comorbidities. Responses included yes or no [35, 36]. Frequency of yes responses were tallied to score the measure.

Perceived threat, impacts, and experiences of COVID-19 We used psychometrically sound abridged versions of three instruments developed by Conway and colleagues [37] to assess how threatened or worried about COVID-19 threat (1 scale) respondents are (COVID-19 threat) and to gauge their experiences with (3 subscales) and impacts from (3 subscales) COVID-19. These instruments were developed and validated in a series of three studies, where items were first developed in an exploratory study and validated in two confirmatory studies in a sample of 984 adults without a cancer diagnosis [37].

Perceived threat was assessed using 3 items ("Thinking about the coronavirus (COVID-19) makes me feel threatened"; "I am afraid of the coronavirus [COVID-19]"; and "I am stressed around other people because I worry I'll catch the coronavirus [COVID-19]"; Cronbach's $\alpha = 0.91$). Impacts of COVID-19 were assessed using 6 items (Cronbach's $\alpha = 0.80$) with three subscales: financial (two items: "The coronavirus [COVID-19] has impacted me negatively from a financial point of view" and "I have lost job-related income due to the Coronavirus [COVID-19]"; Cronbach's $\alpha = 0.73$), resources (two items: "I have had a hard time getting needed resources (food, toilet paper) due to the Coronavirus [COVID-19]" and "It has been difficult for me to get the things I need due to the Coronavirus [COVID-19]"; Cronbach's $\alpha = 0.92$), and psychological (two items: "I have become depressed because of the Coronavirus [COVID-19]" and "The Coronavirus [COVID-19] outbreak has impacted my psychological health negatively"; Cronbach's $\alpha = 0.87$). Experiences of COVID-19 were assessed using 7 items (Cronbach's $\alpha = 0.59$) with three subscales focused on personal diagnoses and symptoms (three items: "I have been diagnosed with coronavirus [COVID-19]", "I have had coronavirus-like symptoms at some point in the last two months", and "I have been sick with something other than the coronavirus in the last two months"*; Cronbach's $\alpha = 0.45$), proximity to others (two items: "I have been in close proximity with someone who has been diagnosed with coronavirus [COVID-19]" and "I have been in close proximity with someone who has had coronavirus-like symptoms in the last two months"; Cronbach's $\alpha = 0.76$), and news (two items: "I watch a lot of news about the Coronavirus [COVID-19]" and "I spend a huge percentage of my time trying to find updates online or on TV about Coronavirus [COVID-19]"; Cronbach's $\alpha = 0.76$) domains. Responses for all items were recorded on a 7-point Likert scale (1 = *not true of me at all* to 7 = *very true of me*); scales/subscales were scored using means across items included in each, with higher scores indicating greater perceptions of threat, impacts, and experiences.

Data analysis

Descriptive statistics were used to characterize the study sample characteristics and COVID-19 perceptions variables. Based on participants' responses to questions about history of health conditions, we tallied comorbidities into categories as follows: pulmonary comorbidities (history of emphysema, chronic obstructive pulmonary disease [COPD], and/or asthma), cardiovascular and metabolic comorbidities (history of diabetes, hypertension, hypercholesterolemia, heart disease, angina, heart attack, congestive heart failure, myocardial infarction, kidney disease, and/or liver disease), and other comorbidities (history of depression, anxiety disorder, bipolar disorder, post-traumatic stress disorder [PTSD], peripheral vascular disease, cerebrovascular disease, connective tissue disease, hematological or solid tumor, and/or acquired immunodeficiency syndrome [AIDS]). Bivariate (correlations and analysis of variance [ANOVA] for continuous and categorical variables, respectively) and multivariable (linear regression models) analyses were used to describe factors associated with COVID-19 perceived threat, impacts, and experiences subscale scores. We also included the timing of completion of the COVID-19 questionnaires (based on months since the declaration by the World Health Organization of a global pandemic on March 11, 2020) as a covariate in our multivariable analysis. To account for multiple comparisons, we used Bonferroni correction with a criterion of $P < 0.017$ (i.e., 0.05/3) for statistical significance given that there were 3 tests of association. All analyses were conducted using Stata MP (version 17, StataCorp, College Station, TX).

Results

Description of study sample

As shown in Table 1, the study sample included a heterogeneous group of cancer survivors, with breast (29%), genitourinary (bladder and prostate; 28%), and lung cancer (13%) accounting for approximately 70% of diagnoses; the majority were diagnosed with early-stage cancer (79%). A little over half were female (58%), the average age was 64 years, the majority self-identified as White (80%) and non-Hispanic (91%), and more than half were college educated (56%). Employment status was heterogenous, with 44%

Table 1 Descriptive statistics of New Jersey cancer survivor cohort members who responded to the social psychological measurements of COVID-19 questionnaire, $N=494$

Characteristic	n (%)
Age at survey completion (years), mean±SD	63.6 ± 10.7
Time since declaration of pandemic at survey completion (months), mean±SD	13.1 ± 4.3
Primary cancer diagnosis	
Genitourinary[a]	138 (27.9)
Breast	145 (29.3)
Colorectal	55 (11.1)
Gynecologic[b]	36 (7.3)
Lung	63 (12.8)
Melanoma	33 (6.7)
Thyroid	24 (4.9)
Tumor stage[c]	
Early stage	359 (78.6)
Late stage	98 (21.4)
Sex	
Male	207 (42.0)
Female	284 (57.6)
Prefer not to answer	2 (0.4)
Self-identified race	
White	393 (80.2)
Black	40 (8.2)
Asian American/Pacific Islander	36 (7.3)
Others[d]	21 (4.3)
Hispanic ethnicity	
No	443 (91.0)
Yes	39 (8.0)
Prefer not to answer	5 (1.0)
US-born	
No	82 (16.6)
Yes	407 (82.6)
Prefer not to answer	4 (0.8)
Marital status	
Married	345 (70.8)
Unmarried	142 (29.2)
Education	
Less than high school	17 (3.5)
High school graduate or GED	82 (16.9)
Some post high school or college training	104 (21.4)
College graduate and above	273 (56.2)
Others	10 (2.1)
Employment status	
Employed outside the home	206 (43.6)
Not employed outside the home or disabled	70 (14.8)
Retired	196 (41.5)
Household income	
< $50,000	93 (19.1)
$50,000–$89,999	117 (24.1)
≥$90,000	162 (33.3)

Table 1 (continued)

Characteristic	n (%)
Prefer not to answer	114 (23.5)
Health insurance status	
Private	152 (42.3)
Medicaid	12 (3.3)
Medicare	149 (41.5)
Others	45 (12.5)
Uninsured	1 (0.3)
Pulmonary comorbidities[e]	
0	408 (82.6)
≥1	86 (17.4)
Cardiovascular and metabolic comorbidities[f]	
0	154 (31.2)
1	135 (27.3)
≥2	205 (41.5)
Other comorbidities[g]	
0	347 (70.2)
≥1	147 (29.8)

[a]Genitourinary cancers includes the bladder and prostate

[b]Gynecologic cancers includes cervical, endometrial, and ovarian

[c]Early stage includes in situ and localized cases and late stage includes regional and distant

[d]Other race includes those self-identifying as American Indian or Alaska Native and other/multiracial

[e]History of emphysema, chronic obstructive pulmonary disease (COPD), and/or asthma

[f]History of diabetes, hypertension, hypercholesterolemia, heart disease, angina, heart attack, congestive heart failure, myocardial infarction, kidney disease, and/or liver disease

[g]History of depression, anxiety disorder, bipolar disorder, post-traumatic stress disorder (PTSD), peripheral vascular disease, cerebrovascular disease, connective tissue disease, hematological or solid tumor, and/or acquired immunodeficiency syndrome (AIDS)

reporting employment outside the home and 42% in retirement. The distribution of household income was similarly heterogenous. All except one participant had health insurance, with the majority having private insurance (42%) and Medicare (42%). Less than 20% reported having pulmonary comorbidities, 42% reported cardiovascular and metabolic comorbidities, and 30% reported other comorbid conditions such as anxiety, peripheral vascular disease, or connective tissue disease.

Summary of perceived coronavirus threat, impacts, and experiences during the pandemic

The distribution of scores on the COVID-19 questionnaires is shown in Fig. 1, and mean item-specific and subscale scores are shown in Supplementary Table 2. In general, cancer survivors in this study reported a moderate level of perceived COVID-19 threat (subscale score = 3.71±1.97)
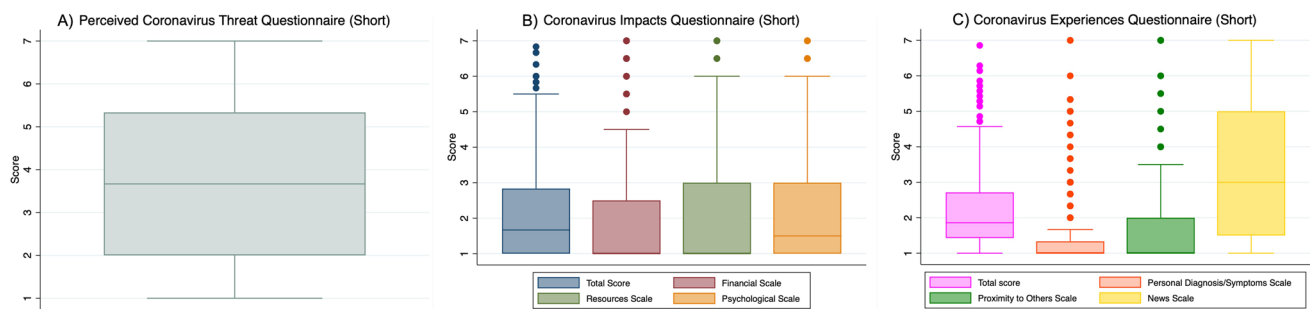
Fig. 1 Distribution of scores on the perceived coronavirus threat questionnaire (short) (**A**); coronavirus impacts questionnaire (short) (**B**); and coronavirus experiences questionnaire (short) (**C**), which comprises the 16-item, short version of the perceived threat, impacts, and experiences of COVID-19 questionnaire. Three questions were included in the perceived coronavirus threat short form (Cronbach's α = 0.91). Six questions were included in the coronavirus impacts short form (Cronbach's α = 0.80) (two in the financial scale [Cronbach's α = 0.73], two in the resource scale [Cronbach's α = 0.92], and two in the psychological scale [Cronbach's α = 0.87]). Seven questions were included in the coronavirus experience short form (Cronbach's α = 0.59) (three in the personal diagnoses/symptoms scale [Cronbach's α=0.45], two in the proximity to others scale [Cronbach's α=0.76], and two in the news scale [Cronbach's α = 0.76])

and a moderate level of fear about the novel coronavirus (4.00 ± 2.18). Overall, minimal impacts due to the COVID-19 pandemic were reported across three domains: finances (subscale score=2.16 ± 1.84), resources (subscale score=2.09 ± 1.60), and psychological well-being (subscale score=2.29±1.67). Similarly, reports of minimal COVID-19 experiences were reported. That is, mean subscale scores on the personal diagnoses/symptoms scale (1.52 ± 1.07) and proximity to other scale (1.94 ± 1.79) were below 2.00, while scores on the news scale was slightly higher (3.39 ± 1.90). The higher news scale score indicated participants tended to watch a considerable amount of news coverage about COVID-19 (item-specific score=4.12 ± 2.27), although it appeared that seeking updates about the coronavirus did not consume a substantial proportion of respondents' time (item-specific score=2.65 ± 1.95).

Correlates of perceived coronavirus threat, impacts, and experiences during the pandemic

In bivariate analysis (Table 2), primary cancer diagnosis, sex, race, and birthplace were significantly associated with perceived coronavirus threat. Age ($r = -0.19$, $P < 0.0001$) and time since the declaration of the pandemic at survey completion ($r = -0.14$, $P = 0.0026$), and race, ethnicity, having cardiovascular and metabolic comorbidities, and having other comorbidities were associated with total score on the coronavirus impacts questionnaire. Age ($r = -0.13$, $P = 0.0038$), cancer diagnosis, race, and ethnicity were associated with total score on the coronavirus experience questionnaire.

In multivariable-adjusted regression models (Table 3), we found that among cancer survivors in this study, female sex (e^{β} 1.61, 95% CI: 1.12, 2.31), Black or Asian American/Pacific Islander race (API) (Black: e^{β} 1.98, 95% CI:

1.05, 3.75 and API: e^{β} 4.74, 95% CI: 2.07, 10.85, relative to White), having more cardiovascular and metabolic comorbidities (1: e^{β} 1.82, 95% CI: 1.16, 2.86; ≥2: 1.43, 95% CI: 1.18, 2.82, relative to none), and having at least one additional comorbid condition (e.g., psychological condition, cerebrovascular disease, another cancer) (e^{β} 1.50, 95% CI: 1.03, 2.18) were associated with higher score on the perceived coronavirus threat subscale. Younger age (e^{β} 0.97, 95% CI: 0.96, 0.99), completing the survey earlier in the pandemic (e^{β} 0.95, 95% CI: 0.92, 0.97), API race (e^{β} 2.38, 95% CI: 1.36, 4.17), Hispanic ethnicity (e^{β} 1.93, 95% CI: 1.16, 3.20), and having ≥1 other comorbid condition (e^{β} 1.44, 95% CI: 1.12, 1.86) were associated with higher score on the coronavirus impact subscale. Younger age (e^{β} 0.99, 95% CI: 0.98, 1.00), other racial minority status (e^{β} 2.18, 95% CI: 1.30, 3.64), and having a cardiovascular or metabolic comorbidity were associated with higher score on the coronavirus experience scale.

Discussion

This study sought to characterize COVID-19 pandemic-related perceptions, impacts, and experiences among cancer survivors using a 16-item scale that was previously validated in a cancer-free sample [37] and to determine factors associated with subscale scores. Generally, participants in this study reported moderate levels of perceived coronavirus threat (e.g., worry about being infected) and minimal COVID-19-related impacts (i.e., financial, resources, and psychological) and experiences (i.e., diagnoses/symptoms, proximity to others, and news). Notably, participants reported consuming large amounts of news about the coronavirus. The observation that cancer survivors in this study had minimal to moderate perceptions

Table 2 Bivariate associations between select characteristics and COVID-19 perceived threat, impacts, and experiences subscale scores among New Jersey cancer survivor cohort members

Characteristic	Perceived coronavirus threat		Coronavirus impacts (total score)		Coronavirus experiences (total score)	
	Mean±SD	P	Mean±SD	P	Mean±SD	P
Primary cancer diagnosis		**0.03**		0.36		**0.02**
Genitourinary[a]	3.39±1.85		1.92±1.17		2.07±0.86	
Breast	3.88±1.95		2.15±1.18		2.08±0.90	
Colorectal	3.84±2.04		2.38±1.51		2.10±0.93	
Gynecologic[b]	3.82±2.08		2.37±1.45		2.27±1.26	
Lung	3.87±2.19		2.34±1.40		2.49±0.95	
Melanoma	3.47±1.82		2.43±1.34		2.23±1.35	
Thyroid	3.43±2.00		2.40±1.63		2.39±1.39	
Tumor stage[c]		0.60		0.16		0.58
Early stage	3.78±1.92		2.20±1.29		2.19±0.98	
Late stage	3.54±2.08		2.22±1.42		2.15±0.98	
Gender		**0.01**		0.72		0.37
Male	3.42±1.92		2.07±1.26		2.14±0.97	
Female	3.91±1.97		2.28±1.33		2.20±1.02	
Self-identified race		**< 0.0001**		**0.04**		**< 0.0001**
White	3.48±1.88		2.15±1.29		2.08±0.96	
Black	4.01±1.82		2.10±1.35		2.38±1.13	
Asian American/Pacific Islander	5.38±1.92		2.70±1.49		2.62±0.80	
Others[d]	4.63±2.17		2.11±1.11		2.90±1.27	
Hispanic ethnicity		0.16		**0.04**		**0.003**
No	3.64±1.94		2.16±1.28		2.13±0.93	
Yes	4.50±1.98		2.60±1.53		2.76±1.47	
US-born		**< 0.0001**		0.43		0.07
No	4.52±2.05		2.41±1.28		2.52±1.21	
Yes	3.53±1.90		2.15±1.31		2.10±0.94	
Marital status		0.47		0.58		0.94
Married	3.76±2.00		2.15±1.26		2.20±1.00	
Unmarried	3.60±1.90		2.23±1.40		2.11±0.99	
Education		0.12		0.64		0.80
Less than high school	3.94±2.43		2.39±1.46		2.24±1.17	
High school graduate or GED	3.58±2.23		2.16±1.35		2.29±1.13	
Some post high school or college training	3.62±1.94		2.12±1.35		2.02±0.83	
College graduate and above	3.76±1.86		2.19±1.27		2.16±0.97	
Others	3.87±2.14		2.17±1.24		2.29±0.98	
Employment status		0.73		0.63		0.83
Employed outside the home	3.67±1.95		2.17±1.25		2.23±1.00	
Not employed outside the home or disabled	4.24±2.11		2.93±1.67		2.47±1.25	
Retired	3.62±1.91		1.93±1.11		1.98±0.83	
Household income		0.35		0.54		0.50
< $50,000	4.20±2.03		2.40±1.43		2.37±1.13	
$50,000–$89,999	3.48±1.99		2.21±1.39		2.10±0.95	
≥$90,000	3.47±1.84		2.03±1.10		2.14±0.93	
Prefer not to answer	3.89±1.98		2.21±1.38		2.15±1.02	
Health insurance status		0.61		0.62		0.70
Private	3.50±1.96		2.05±1.20		2.31±1.02	
Medicaid	4.78±1.86		3.60±1.56		3.21±1.57	
Medicare	3.70±2.01		1.82±1.01		2.04±0.85	

Table 2 (continued)

Characteristic	Perceived coronavirus threat		Coronavirus impacts (total score)		Coronavirus experiences (total score)	
	Mean±SD	P	Mean±SD	P	Mean±SD	P
Others	3.54±2.11		2.44±1.48		2.23±1.06	
Pulmonary comorbidities[e]		0.40		0.57		0.99
0	3.69±1.96		2.16±1.30		2.17±1.01	
≥1	3.84±2.01		2.28±1.35		2.17±0.94	
Cardiovascular and metabolic comorbidities[f]		0.38		**0.05**		0.82
0	3.49±2.04		2.27±1.38		2.16±1.06	
1	3.83±1.89		2.03±1.16		2.32±1.03	
≥2	3.80±1.96		2.22±1.33		2.09±0.91	
Other comorbidities[g]		0.10		**0.002**		0.52
0	3.62±1.96		2.06±1.25		2.15±0.94	
≥1	3.93±1.98		2.46±1.39		2.22±1.12	

There was a significant inverse correlation between coronavirus impact subscale ($r = -0.19$, $P < 0.0001$) and coronavirus experience subscale scores ($r = -0.13$, $P = 0.0038$) and age (years). The correlation was not statistically significant for perceived coronavirus threat subscale score ($r = -0.06$, $P = 0.22$). Coronavirus impact subscale score was inversely correlated with timing of survey completion ($r = -0.14$, $P = 0.0026$). No significant correlation was observed between survey completion and scores on the perceived coronavirus threat subscale or coronavirus experience subscale

[a]Genitourinary cancers includes the bladder and prostate

[b]Gynecologic cancers includes cervical, endometrial, and ovarian

[c]Early stage includes in situ and localized cases and late stage includes regional and distant

[d]Other race includes those self-identifying as American Indian or Alaska Native, and others/multiracial

[e]History of emphysema, chronic obstructive pulmonary disease (COPD), and/or asthma

[f]History of diabetes, hypertension, hypercholesterolemia, heart disease, angina, heart attack, congestive heart failure, myocardial infarction, kidney disease, and/or liver disease

[g]History of depression, anxiety disorder, bipolar disorder, post-traumatic stress disorder (PTSD), peripheral vascular disease, cerebrovascular disease, connective tissue disease, hematological or solid tumor, and/or acquired immunodeficiency syndrome (AIDS)

of threat, impacts, and experiences might be because the COVID-19 questionnaires were completed on average 13 months into the pandemic. It is possible that if respondents had been given the questionnaire at the start of the pandemic (or shortly after the global pandemic declaration), we might have observed greater perceived threat and impact. Respondents with one or more comorbidities reported greater COVID-19 threats and impacts than those with no comorbidities. Given that media reporting has emphasized greater risks of COVID-19 among persons with comorbidities, higher levels of perceived threat in this population are congruent with such messages [38]. On a positive note, we found that cancer survivors in this study experienced relatively little COVID-19-related impacts related to finances/employment and resources. One potential explanation is that our sample—which was disproportionally White (80%), retired (42%), and had relatively high income ($50,000–$89,999 [24%] and ≥$90,000 [33%])—may not have been as greatly affected in terms of finances and resources as the general population. Nonetheless, our findings show that cancer survivors belonging to racial and ethnic minority groups reported greater

impacts and experiences, which might reflect awareness among respondents that throughout the pandemic, at least in the general population, there has been a disproportionate burden of COVID-19 infection, hospitalization, and death among racial and ethnic minority groups relative to non-Hispanic Whites [39–41].

While data on racial and ethnic inequities in COVID-19-related outcomes among cancer survivors are sparse, some evidence indicates that non-Hispanic Black cancer patients may have greater risk of COVID-19-related hospitalization than their non-Hispanic White counterparts [6]. Moreover, non-Hispanic Black and Hispanic cancer survivors are likely to have higher rates of COVID-19 infection (as observed among their counterparts without a cancer diagnosis [29, 30]) and to suffer adverse consequences attributable to impacts on employment, lapses in health insurance coverage, and delayed cancer-related care and reduced access to high-quality care [29, 30]. This may be partly due to the disproportionate burden of comorbidities among non-Hispanic Black and Hispanic cancer survivors [42], which increases the risk of COVID-19 hospitalization and complications [1, 6, 7, 11–15].

Table 3 Multivariable regression analysis[†] of factors associated with perceived coronavirus threat subscale, coronavirus impact subscale, and coronavirus experience subscale scores among New Jersey cancer survivor cohort members

	Perceived coronavirus threat		Coronavirus impacts (total score)		Coronavirus experiences (total score)	
	e^{β} (95% CI)	P	e^{β} (95% CI)	P	e^{β} (95% CI)	P
Age (years)	0.99 (0,97, 1.01)	0.158	**0.97 (0.96, 0.99)**	**< 0.0001***	**0.99 (0.98, 1.00)**	**0.017***
Time since declaration of pandemic at survey completion (months)	0.96 (0.93, 1.00)	0.061	**0.95 (0.92, 0.97)**	**< 0.0001***	1.00 (0.98, 1.02)	0.845
Sex						
Male	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Female	**1.61 (1.12, 2.31)**	**0.009***	1.09 (0.85, 1.39)	0.506	0.98 (0.81, 1.18)	0.822
Self-identified race						
White	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Black	**1.98 (1.05, 3.75)**	**0.036**	1.05 (0.68, 1.62)	0.825	1.28 (0.92, 1.79)	0.142
Asian American/Pacific Islander	**4.74 (2.07, 10.85)**	**< 0.0001***	**2.38 (1.36, 4.17)**	**0.002***	**1.60 (1.04, 2.47)**	**0.033**
Others[a]	2.37 (0.88, 6.37)	0.087	0.86 (0.44, 1.67)	0.651	**2.18 (1.30, 3.64)**	**0.006***
Hispanic ethnicity						
No	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Yes	1.71 (0.81, 3.61)	0.163	**1.93 (1.16, 3.20)**	**0.011***	**1.55 (1.05, 2.30)**	**0.027**
US-born						
No	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Yes	1.43 (0.78, 2.61)	0.243	0.86 (0.58, 1.30)	0.477	1.09 (0.80, 1.49)	0.587
Cardiovascular and metabolic comorbidities[b]						
0	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
1	**1.82 (1.16, 2.86)**	**0.009***	0.96 (0.71, 1.30)	0.793	**1.35 (1.06, 1.70)**	**0.013***
≥2	**1.43 (1.18, 2.82)**	**0.007***	1.32 (0.98, 1.76)	0.068	1.05 (0.84, 1.32)	0.679
Other comorbidities[c]						
0	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
≥1	**1.50 (1.03, 2.18)**	**0.035**	**1.44 (1.12, 1.86)**	**0.005***	1.14 (0.94, 1.39)	0.193

[†]Risk estimates generated using generalized linear models (exponentiated β coefficients reported), $n = 476$

[a]Other race includes those self-identifying as American Indian or Alaska Native and other/multiracial

[b]History of diabetes, hypertension, hypercholesterolemia, heart disease, angina, heart attack, congestive heart failure, myocardial infarction, kidney disease, and/or liver disease

[c]History of depression, anxiety disorder, bipolar disorder, post-traumatic stress disorder (PTSD), peripheral vascular disease, cerebrovascular disease, connective tissue disease, hematological or solid tumor, and/or acquired immunodeficiency syndrome (AIDS)

[*]Statistically significant with correction for multiple comparisons ($P < 0.017$)

Our finding that racial minority status and having a history of multiple comorbid conditions are among the factors consistently associated with greater perceived coronavirus threat might reflect an acute awareness of these issues among cancer survivors in the current study, particularly because they have generated substantial media attention throughout the pandemic [43–45]. The most readily apparent impact of the pandemic on cancer survivors has been the severe care delivery system shock that produced major disruptions and delays in the provision of screening, diagnostics, and treatments for cancer [46]. In New Jersey, there were surge periods in different geographic regions throughout the study period. During these time periods, hospitals and ambulatory settings adopted policies to restrict the number of patients and family members onsite. These care disruptions may

have added to the perceptions of threat among patients with multimorbidity who likely have more care needs. Additionally, one mitigation strategy to address these care disruptions was the hasty implementation of telehealth and virtual healthcare visits [47]. Known issues in disparate access to telehealth modalities among racial and ethnic minorities may have contributed to higher perceptions of COVID-19 threats [48]. Secondly, the requirements of social distancing limited the ability of guaranteed access to high-quality cancer care, which may require numerous oncology visits and availability of caregivers or relatives for support [46]. While not assessed in this study, prior data from qualitative interviews and reports by cancer care providers have highlighted three major care delivery challenges that arose from pandemic conditions [46]. Firstly, cancer care providers were

required to balance the risk of delaying appointments with increasing cancer patients' exposure to COVID-19. This was particularly difficult as early studies indicated higher risk of COVID-19 complications and severity among cancer survivors, but also that the delays to diagnosis and treatment could negatively affect prognosis [46]. In addition, cancer survivors with multimorbidity might have had far greater risks of exposure to COVID-19 due to the necessity of visiting multiple specialists during the ongoing pandemic [49]. Furthermore, such patients were likely to experience more delays to non-urgent appointments as providers recognized their increased risk of COVID-19 complications [50]. Finally, medical facilities throughout the country were forced to allocate limited health resources (e.g., intensive-care unit beds, ventilators, medications, and other supplies) for COVID-19 patients, resulting in reduced availability of such resources for cancer patients and survivors [46].

As we enter the endemic phase of COVID-19, along with availability of vaccination and effective therapies for infected individuals, our findings suggest that two in-clinic measures may be adopted to improve care among cancer survivors, particularly those who belong to racial and ethnic minority groups and those with comorbid conditions conferring greater risk of poorer COVID-19 outcomes. First, clinic sites should consider permitting one masked support person or caregiver to attend follow-up visits or allowing such an individual to participate in virtual clinical visits, which could contribute to improvements in the COVID-19-related impacts and experiences reported by cancer survivors. Secondly, oncology providers should encourage open dialogue about the clinical implications of COVID-19 with their patients and recommend timely follow-up (especially for missed appointments with specialists who provide care for comorbid conditions) to mitigate delays and potential complications among cancer survivors. This might contribute to manageable perceptions of COVID-19-related threat in this group. Future studies incorporating mixed-methods approaches are needed to understand the implications of perceptions of threat and impact among cancer survivors and to develop evidence-based strategies that might prove useful for this patient group during the current and future infectious disease outbreaks.

Strengths of this study included a population-based study sample—representing survivors with an array of cancer diagnoses—in New Jersey, a state in the Northeastern region of the USA that experienced high rates of COVID-19 infection and the use of validated questionnaires. There are also some limitations that should be considered in the interpretation of our findings, including the relatively small and disproportionately White study sample, although the sample included wide socioeconomic variation (e.g., education, income, insurance status) reflective of the Northeast. Relatedly, participation of very few participants of Hispanic

ethnicity was another important limitation, which is attributed at least in part with not being able to provide Spanish translations of the questionnaires. The study relied on self-reported measures which may have induced recall bias. While validated questionnaires were used, they were validated in non-cancer survivor populations. Future research is encouraged to validate the questionnaires among cancer survivor populations. Lastly, a key limitation was that the questionnaire did not assess vaccine status and was fielded over many months after the declaration of the pandemic. The lack of information about vaccination status among survivors in this sample, which plausibly impacted perceived coronavirus threat and experiences, particularly among those responding to the survey after the approved vaccines were widely available.

Despite these limitations, this study highlights the disparate perceptions and experiences of the pandemic among racial and ethnic minority groups in a population-based sample of cancer survivors. Future work is encouraged to examine the influence of vaccination status on such perceptions and experiences and to identify health inequities in clinical outcomes due to disruptions and delays to cancer care, particularly among vulnerable and underserved populations. Additionally, this study's findings should be considered in guideline development for mitigating negative perceptions and experiences of the ongoing pandemic as it shifts into an endemic phase.

Declarations

Conflict of interest The authors declare no competing financial interests.

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Authors and Affiliations

Adana A. M. Llanos[1,2] · Angela J. Fong[3,4] · Nabarun Ghosh[5] · Katie A. Devine[4,6] · Denalee O'Malley[4,7] · Lisa E. Paddock[4,8] · Elisa V. Bandera[3,4] · Shawna V. Hudson[4,7] · Andrew M. Evens[3,4] · Sharon L. Manne[3,4]

1   Department of Epidemiology, Mailman School of Public Health, Columbia University Irving Medical Center, New York, NY, USA

2   Herbert Irving Comprehensive Cancer Center, Columbia University Irving Medical Center, New York, NY, USA

3   Department of Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, USA

4   Rutgers Cancer Institute of New Jersey, New Brunswick, NJ, USA

5   Department of Biostatistics and Epidemiology, Rutgers School of Public Health, Piscataway, NJ, USA

6   Department of Pediatrics, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, USA

7   Department of Family Medicine and Community Health, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, USA

8   New Jersey Department of Health, New Jersey State Cancer Registry, Trenton, NJ, USA