

Examining COVID-19 Preventive Behaviors among Cancer Survivors in the United States: An Analysis of the COVID-19 Impact Survey

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ABSTRACT

Background: The COVID-19 pandemic has impacted adults with chronic diseases, and their health care delivery. Patterns of COVID-19–related preventive behaviors practiced by cancer survivors are unknown, including practices related to canceling doctor's appointments. We evaluated COVID-19–related preventive behaviors among cancer survivors in the United States.

Methods: We used nationally representative data of 10,760 U.S. adults from the COVID-19 Impact Survey. We defined cancer survivors as those with a self-reported diagnosis of cancer ($n = 854$, 7.6%). We present frequencies and χ^2 tests to evaluate COVID-19–related preventive behaviors among cancer survivors. We estimated determinants of canceling doctor's appointments among cancer survivors using Poisson regression models.

Results: Cancer survivors were more likely to practice preventive behaviors, including social distancing (93%, $\chi^2 P < 0.001$), wearing a face mask (93%, $\chi^2 P < 0.001$), and avoiding crowded areas (84%, χ^2

$P < 0.001$) compared with adults without cancer. Cancer survivors were more likely to cancel doctor's appointments (41%, $\chi^2 P < 0.001$), whereas they were less likely to cancel other social activities such as work (19%, $\chi^2 P < 0.001$) and school-related (13%, $\chi^2 P < 0.001$) activities. After adjustment for covariates, while non-Hispanic (NH)-Black cancer survivors were less likely to cancel a doctor's appointment compared with NH-White cancer survivors, cancer survivors aged 18 to 29, who were female, and who had least one comorbid condition were more likely.

Conclusions: Cancer survivors are adhering to recommended preventive behaviors. Cancer survivor's continuity of care may be impacted by COVID-19, specifically young adults, females, and those with existing comorbid conditions.

Impact: Insights into cancer survivors whose care may be most impacted by COVID-19 will be valuable toward surveillance and survivorship of U.S. cancer survivors.

Introduction

The World Health Organization (WHO) declared COVID-19 as a Public Health Emergency of International Concern in January 2020 (1). In the United States, the first confirmed case of COVID-19 was reported on January 20, 2020, in the state of Washington (2). Since the onset of the pandemic, preventive behaviors against COVID-19 have been promoted through the mainstream media based on recommendations from prominent public health agencies, such as the WHO and the Centers for Disease Control and Prevention (CDC; Atlanta, GA; ref. 3). Behaviors such as hand washing, maintaining 6-foot distance from others (i.e., social distancing), and avoiding large crowds have been touted as the population's main preventive strategies in the absence of a vaccine or medication to directly combat severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the infection that leads to COVID-19 (4, 5). In addition, due to the surge of patients with COVID-19 in hospitals and clinics, canceling nonessential visits to the

doctor's office has been recommended by the CDC to mitigate the risk of exposure.

However, the potential implications of the recommendation to cancel nonessential visits to the doctor in the population are unknown, as there is a gap in understanding among the general population between what is elective and what is essential, leading to high uncertainty among patients with a fear of contracting SARS-CoV-2 (6). Among those that may be most impacted by this recommendation are also those at high risk of contracting COVID-19, such as the elderly and those with existing chronic conditions (7–12). The COVID-19 pandemic has highly impacted the delivery of care to those with chronic conditions as providers may often opt for treatment with lower efficacy but lower risk of hospitalization to mitigate the risk of exposure. Since the start of the pandemic, health care providers have had to make critical decisions on prioritization of care among those with chronic conditions (13–15).

Cancer survivors, defined as those living after a diagnosis of cancer (16), may be most impacted by the shift in clinical care due to the potential immediate threat of certain malignancies and the significance of surveillance (17–23). Cancer and cancer-related treatment frequently cause immunosuppression, and adults with cancer have excess mortality risk from SARS-CoV-2. The magnitude of risk among adults with cancer is still unknown; however, early reports suggest a substantial risk of death associated with COVID-19 infection, perhaps highest among those older than 60 years and those with compromised lung function (24, 25). Because of the high risk among cancer survivors, preventive behaviors are critical to reducing the risk of developing COVID-19. However, data on adherence to recommended preventive behaviors among cancer survivors are limited. More specifically, national data on the impact of continuity of care among cancer survivors during the COVID-19 pandemic are also scarce. Our objective was to evaluate COVID-19–related preventive behaviors

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Note: Supplementary data for this article are available at Cancer Epidemiology, Biomarkers & Prevention Online (<http://cebp.aacrjournals.org/>).

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Cancer Epidemiol Biomarkers Prev 2020;29:2583–90

doi: 10.1158/1055-9965.EPI-20-0801

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among cancer survivors using a nationally representative sample of U.S. adults. We further examined behaviors related to canceling or postponing activities, specifically doctor's appointments. Insights into the impact of the COVID-19 pandemic on the continuity of care among cancer survivors will be valuable toward surveillance and survivorship of adults with cancer in the United States.

Materials and Methods

COVID-19 Impact Survey

Data for these analyses were obtained from the publicly available COVID-19 Household Impact Survey, conducted by NORC at the University of Chicago for the Data Foundation. The COVID-19 Household Impact Survey is a philanthropic effort to provide national and regional statistics about physical health, mental health, economic security, and social dynamics in the United States (26). The survey is designed to provide weekly estimates of the U.S. adult (ages 18 and older) household population nationwide and for 18 regional areas including 10 states (CA, CO, FL, LA, MN, MO, MT, NY, OR, and TX) and eight Metropolitan Statistical Areas (Atlanta, Baltimore, Birmingham, Chicago, Cleveland, Columbus, Phoenix, and Pittsburgh). Currently, data from week 1 (April 20–26, 2020), week 2 (May 4–10, 2020), and week 3 (May 30–June 8, 2020) are available, which were merged for this analysis.

AmeriSpeak sample

Funded and operated by NORC at the University of Chicago, AmeriSpeak is a probability-based panel designed to be representative of the U.S. household population. During the initial recruitment phase of the AmeriSpeak panel, randomly selected U.S. households were sampled using area probability and address-based sampling, with a known, nonzero probability of selection from the NORC National Sample Frame. These sampled households were then contacted by U.S. mail, telephone, and field interviewers (face-to-face). The panel provides sample coverage of approximately 97% of the U.S. household population. Those excluded from the sample include people with P.O. Box only addresses, some addresses not listed in the USPS Delivery Sequence File, and some newly constructed dwellings. Although most AmeriSpeak households participate in surveys by web, non-internet households were able to participate in AmeriSpeak surveys by telephone. Households without conventional internet access but having web access via smartphones were allowed to participate in AmeriSpeak surveys by web. AmeriSpeak panelists participate in NORC studies or studies conducted by NORC on behalf of governmental agencies, academic researchers, and media and commercial organizations. Interviews were conducted in English and Spanish. Interviews were conducted with adults age 18 and over representing the 50 states and the District of Columbia. Panel members were randomly drawn from AmeriSpeak. In households with more than one adult panel member, only one was selected at random for the sample. Invited panel members were given the option to complete the survey online or by telephone with a NORC telephone interviewer. The number of participants invited and percentage of interviews completed by week are as follows: 11,133 invited with 19.7% interviews completed during week 1; 8,570 invited with 26.1% interviews completed (week 2); and 10,373 invited with 19.7% interviews completed (week 3). Panelists were offered a \$5 monetary incentive for completing the survey. The analytic sample includes 10,760 adults nationwide. The final analytic sample were weighted to reflect the U.S. population of adults aged 18 years and over. The demographic weighting variables

were obtained from the 2020 Current Population Survey. The count of COVID-19 deaths by county was obtained from USA Facts.

Multimode address-based sample

Data for the regional estimates were collected using a multimode address-based sample (ABS) approach that allowed residents of each area to complete the interview via the web or with a NORC telephone interviewer. In four states (CA, FL, NY, and TX), the AmeriSpeak panel design yields representative state samples. As such, AmeriSpeak panelists who reside in each of these four states are combined with the ABS sample to generate region-level estimates. For each geographic area, an iterative raking process is used to adjust for any survey nonresponse as well as any noncoverage or under and oversampling. Demographic weighting variables were obtained from the 2018 American Community Survey. The weighted data reflect the population of adults age 18 and over in each region.

Primary outcome

The primary outcome for this analysis was participants' response (yes/no) to the following question: "Which of the following measures, if any, are you taking in response to the coronavirus?" Participants were able to select all that applied from a list of 19 options. We focused on the following options: canceled a doctor appointment; visited a doctor or hospital; canceled or postponed work activities; canceled or postponed school activities; canceled or postponed dentist or other appointments; avoided some or all restaurants; worked from home; studied from home; canceled or postponed pleasure social or recreational activities; stockpiled food or water; avoided public or crowded places; prayed; avoided contact with high-risk people; washed or sanitized hands; kept 6-foot distance from those outside my household; stayed home because I felt unwell; and wiped packages entering my home.

Primary predictor

The primary predictor for this analysis was participants' self-report of cancer. Participants were asked to reply "yes, no, or not sure" to the following question: "Has a doctor or other health care provider ever told you that you have any of the following: Diabetes; High blood pressure or hypertension; Heart disease, heart attack or stroke; Asthma; Chronic lung disease or COPD (chronic obstructive pulmonary disease); Bronchitis or emphysema; Allergies; a Mental health condition; Cystic fibrosis; Liver disease or end-stage liver disease; Cancer; a Compromised immune system; or Overweight or obesity." We defined those who selected "Cancer" as a cancer survivor.

Covariates

The following covariates were included in the multivariable analyses: age (18–29, 30–44, 25–59, 60+), sex (male, female), race/ethnicity [non-Hispanic (NH)-White, NH-Black, Hispanic, NH-other], education [no high school (HS) diploma, HS graduate or equivalent, some college, baccalaureate degree or above], employment status (employed/unemployed), household income (<\$50,000, \$50,000–<\$100,000, ≥\$100,000), population density (rural, suburban, urban), insurance status and type, comorbid conditions, and symptoms experienced in the last 7 days. Population density was determined based on the 2010 U.S. Census data.

Statistical analysis

Descriptive statistics are displayed in percentages among all respondents unless otherwise labeled and include a margin of error of ±3.0 percentage points at the 95% confidence intervals (CI) among all adults. χ^2 tests were used for bivariate comparison of physical

symptoms experienced in the last 7 days and preventive behaviors against the COVID-19 pandemic among cancer survivors compared with adults without cancer. To estimate determinants of cancer survivors canceling doctor's appointments, we calculated prevalence ratios with Poisson regression using robust estimation of standard errors (27–29). Potential variables for inclusion in the model were assessed using available sociodemographic variables and age-adjusted Poisson regression analysis. Because of the exploratory nature of this analysis using a predictive framework, an arbitrary *P* value of <0.10 was used as criteria to include the variable in the multivariable Poisson regression model. For multivariable Poisson regression models, adjusted prevalence ratios (aPR), and 95% CIs for each independent variable were calculated. We conducted sensitivity analyses to evaluate the association of canceled school or childcare among female cancer

survivors who canceled their doctor's appointments using Poisson regression. In addition, *P* < 0.05 was used as the level of significance. Collinearity was assessed using the variance inflation factor to ensure a strong linear relationship among independent variables included in the model was not present. On the basis of the exploratory nature of this analysis, we did not include an adjustment for multiple comparisons (30). All statistical analyses were conducted using Stata IC 15.1 (StataCorp LLC, College Station, TX). Sampling weights were applied to provide results that were nationally representative of the U.S. adult population.

Results

Table 1 summarizes the descriptive characteristics of the analytic sample overall and by self-reported cancer diagnosis. Overall, cancer

Table 1. Characteristics of COVID Impact Survey respondents (*n* = 10,760), a nationally representative survey of the United States, stratified by cancer diagnosis (April–June 2020).

	Total		Cancer survivors ^a		Respondents never diagnosed with cancer	
	Col %	95% CI	Col %	95% CI	Col %	95% CI
Age						
18–29	20.5	19.3–21.9	3.0	1.8–4.9	22.0	20.7–23.4
30–44	25.3	24.2–26.4	9.4	6.9–12.6	26.6	25.5–27.8
45–59	24.3	23.2–25.4	23.0	19.4–27.0	24.4	23.2–25.5
60+	29.9	28.8–31.1	64.7	60.3–68.9	27.0	25.8–28.2
Sex						
Male	48.4	47.0–49.7	47.6	43.2–51.9	48.4	47.0–49.8
Female	51.6	50.3–53.0	52.4	48.1–56.8	51.6	50.2–53.0
Marital status						
Married/living with partner	57.3	55.9–58.6	57.0	52.6–61.3	57.3	55.9–58.7
Widowed/divorced/separated	18.5	17.5–19.5	31.2	27.3–35.4	17.4	16.4–18.4
Never married	24.2	23.0–25.5	11.8	9.1–15.3	25.3	24.0–26.6
Race/ethnicity						
White, NH	62.8	61.5–64.2	75.3	71.0–79.1	61.8	60.4–63.2
Black, NH	11.6	10.8–12.5	11.6	8.7–15.4	11.6	10.7–12.5
Hispanic	16.5	15.4–17.7	8.3	6.1–11.3	17.2	16.1–18.4
Other, NH	8.5	7.7–9.3	4.0	2.9–5.7	8.9	8.0–9.8
Employed in the past 7 days	49.9	48.6–51.3	31.9	28.1–36.2	51.5	50.1–52.9
Education						
No HS diploma	9.6	8.7–10.7	6.4	4.4–9.3	9.9	8.9–11.0
HS graduate	28.1	26.8–29.5	30.3	26.0–34.9	28.0	26.6–29.4
Some college	27.7	26.7–28.8	27.9	24.7–31.4	27.7	26.7–28.8
Baccalaureate or above	34.5	33.3–35.7	35.4	31.3–39.7	34.4	33.2–35.7
Household income						
<\$50,000	45.5	44.2–46.9	48.5	44.2–52.9	45.3	43.9–46.7
\$50,000–<\$100,000	32.1	30.9–33.4	26.9	23.4–30.8	32.6	31.3–33.9
≥\$100,000	22.4	21.3–23.5	24.5	20.9–28.5	22.2	21.0–23.4
Population density						
Rural	9.0	8.3–9.8	13.4	10.4–17.0	8.7	8.0–9.4
Suburban	18.7	17.7–19.7	20.0	16.9–23.6	18.6	17.6–19.6
Urban	72.3	71.1–73.4	66.6	62.3–70.7	72.7	71.5–73.9
Insurance type or health coverage plans						
Purchased plan	17.1	16.1–18.2	20.2	17.0–23.8	16.9	15.8–18.0
Employer-sponsored	51.9	50.6–53.3	47.0	42.6–51.4	52.3	50.9–53.7
TRICARE	4.8	4.3–5.4	6.8	4.8–9.5	4.7	4.2–5.2
Medicaid	23.5	22.3–24.6	30.3	26.1–34.8	22.9	21.7–24.1
Medicare	25.4	24.3–26.6	56.1	51.6–60.4	22.8	21.7–24.0
Dually eligible (Medicare and Medicaid)	10.1	8.9–11.3	9.0	7.9–10.3	23.5	17.8–30.2
Veterans affairs (VA)	4.4	4.0–4.9	8.8	6.6–11.6	4.1	3.6–4.6
Indian health service	1.2	0.9–1.6	0.3	0.1–0.8	1.3	0.9–1.7
No insurance	8.8	8.0–9.6	3.0	1.8–4.9	9.2	8.4–10.1

^a2.46% of participants either chose not sure, skipped, or refused when asked about their chronic conditions, including cancer.

Table 2. Symptoms in the last 7 days and preventive behaviors against COVID-19 of COVID Impact Survey respondents ($n = 10,760$), a nationally representative survey of the United States, stratified by cancer diagnosis (April–June 2020).

	Total		Cancer survivors		Respondents never diagnosed with cancer		P^a
	Col %	95% CI	Col %	95% CI	Col %	95% CI	
Physical symptoms experienced in the last 7 days							
Fever	16.2	15.2–17.2	18.4	15.0–22.2	16.0	14.9–17.0	0.19
Muscle or body aches	12.9	12.1–13.9	17.4	14.1–21.2	12.6	11.7–13.5	0.00
Sneezing	13.6	12.7–14.6	17.1	14.1–20.6	13.3	12.4–14.4	0.02
Sore throat	13.5	12.7–14.5	17.2	14.2–20.7	13.2	12.3–14.2	0.01
Nausea or vomiting	12.7	11.8–13.6	16.5	13.5–20.1	12.4	11.5–13.3	0.01
Shortness of breath	12.3	11.5–13.2	16.0	13.1–19.5	12.0	11.2–12.9	0.01
Runny or stuffy nose	14.2	13.3–15.2	15.7	12.8–19.0	14.1	13.1–15.2	0.34
Fatigue or tiredness	13.4	12.5–14.4	15.5	12.6–19.0	13.2	12.3–14.3	0.15
Headaches	14.3	13.4–15.2	15.2	12.3–18.7	14.2	13.3–15.2	0.53
Cough	13.6	12.7–14.6	11.7	9.3–14.7	13.8	12.8–14.8	0.18
Preventive behaviors against COVID-19							
Washed or sanitized hands	90.2	89.4–90.9	93.9	91.5–95.6	89.9	89.0–90.8	0.00
Kept 6-foot distance from those outside my household	84.1	83.1–85.0	92.7	90.2–94.6	83.5	82.4–84.5	<0.001
Worn a face mask	85.0	84.1–85.9	92.1	89.9–93.8	84.3	83.3–85.3	<0.001
Avoided public or crowded places	76.2	75.1–77.3	83.8	80.5–86.7	75.7	74.5–76.9	<0.001
Avoided some or all restaurants	70.6	69.4–71.8	80.4	77.0–83.4	69.9	68.6–71.1	<0.001
Canceled or postponed pleasure, social, or recreational activities	64.8	63.5–66.0	73.8	69.8–77.5	64.4	63.0–65.7	<0.001
Avoided contact with high-risk people	58.6	57.2–59.9	67.6	63.4–71.5	57.9	56.5–59.3	<0.001
Canceled a doctor appointment	30.9	29.7–32.1	41.3	37.0–45.6	29.9	28.7–31.2	<0.001
Canceled or postponed dentist or other appointment	36.1	34.9–37.3	40.7	36.5–45.0	35.7	34.4–37.0	0.03
Worked from home	31.6	30.4–32.8	23.9	20.4–27.8	32.3	31.1–33.6	<0.001
Canceled or postponed work activities	27.9	26.7–29.1	18.7	15.7–22.1	28.6	27.4–29.9	<0.001
Visited a doctor or hospital	9.7	9.0–10.5	14.2	11.4–17.6	9.4	8.6–10.2	<0.001
Canceled or postponed school activities	20.1	19.0–21.2	13.4	10.4–17.1	20.3	19.2–21.5	0.001
Stayed home because I felt unwell	10.7	9.9–11.6	8.6	6.5–11.4	10.8	9.9–11.7	0.15

Note: Bolded values <0.05 .

^a P value based on χ^2 test.

survivors (7.6%) were mostly 60 years and above (65%), female (52%), and NH-White (75%). About one third of cancer survivors were employed, held a Baccalaureate degree or above, and had a household income of \$75,000 and above. Most cancer survivors resided in urban areas (66%). The most common insurance plans among cancer survivors included Medicare (56%), employer-sponsored insurance (47%), and Medicaid (30%). About 9% of cancer survivors were dually eligible for both Medicare and Medicaid.

Table 2 summarizes symptoms experienced in the past 7 days and preventive behaviors practiced by respondents against COVID-19 across categories of prior cancer diagnosis. In the past 7 days, cancer survivors reported most frequently experiencing the following symptoms: fever (18%), muscle or body aches (17%), sneezing (17%), and sore throat (17%). Compared with those without cancer, cancer survivors were more likely to report experiencing the following symptoms in the past 7 days: muscle or body aches ($\chi^2 P < 0.001$), sneezing ($\chi^2 P = 0.02$), sore throat ($\chi^2 P = 0.01$), nausea or vomiting ($\chi^2 P = 0.01$), and shortness of breath ($\chi^2 P = 0.01$).

When comparing cancer survivors with the general study population, we found that cancer survivors were more likely to report washing or sanitizing their hands (94% vs. 90%, $\chi^2 P = 0.00$), maintaining social distance (93% vs. 84%, $\chi^2 P < 0.001$), wearing a face mask (92% vs. 84%, $\chi^2 P < 0.001$), avoiding public or crowded places (84% vs. 76%, $\chi^2 P < 0.001$), avoiding some or all restaurants (80% vs. 70%, $\chi^2 P < 0.001$), avoiding contact with high-risk people (68% vs. 58%, $\chi^2 P < 0.001$), and visiting a doctor or hospital (14% vs. 9%, $\chi^2 P < 0.001$). We observed

that cancer survivors were also more likely to cancel a doctor's appointment (41% vs. 36%, $\chi^2 P < 0.001$), cancel or postpone a dentist or other appointment (41% vs. 36%, $\chi^2 P = 0.03$), and cancel pleasure, social, or recreational activities (74% vs. 64%, $\chi^2 P < 0.001$) compared with those without cancer. Between April and May, the proportion of cancer survivors that canceled a doctor or dentist's appointment increased from 35% to 52% and 36% to 49%, respectively (**Fig. 1**). In early June, the proportion of cancer survivors that canceled a doctor's appointment decreased to 35%; however, a significant difference between cancer survivors and other adults persisted ($\chi^2 P = 0.02$). Between April and early June, cancer survivors were less likely to cancel work activities when compared with the general population (**Fig. 1**). Cancer survivors were less likely to cancel school activities in April compared with other adults (7.6% vs. 21.8%, $\chi^2 P < 0.001$); however, this proportion was no longer significantly different by early June. We observed similar trends when we restricted the analytic sample to adults below the age of 60 years: By early June, cancer survivors below the age of 60 years were less likely to cancel work activities (12% vs. 28%, $P < 0.001$; Supplementary Fig. S1).

We subsequently identified determinants of canceling a doctor's appointment among cancer survivors (**Table 3**). In age-adjusted analyses, we observed that cancer survivors aged 18 to 29 were more likely to cancel a doctor's appointment compared with those aged 60 years and above (PR: 1.83; 95% CI, 1.41–2.37). In addition, females (PR: 1.37; 95% CI, 1.11–1.69), and cancer survivors with at least one comorbid condition (PR: 1.47; 95% CI, 1.11–1.94) were more likely to

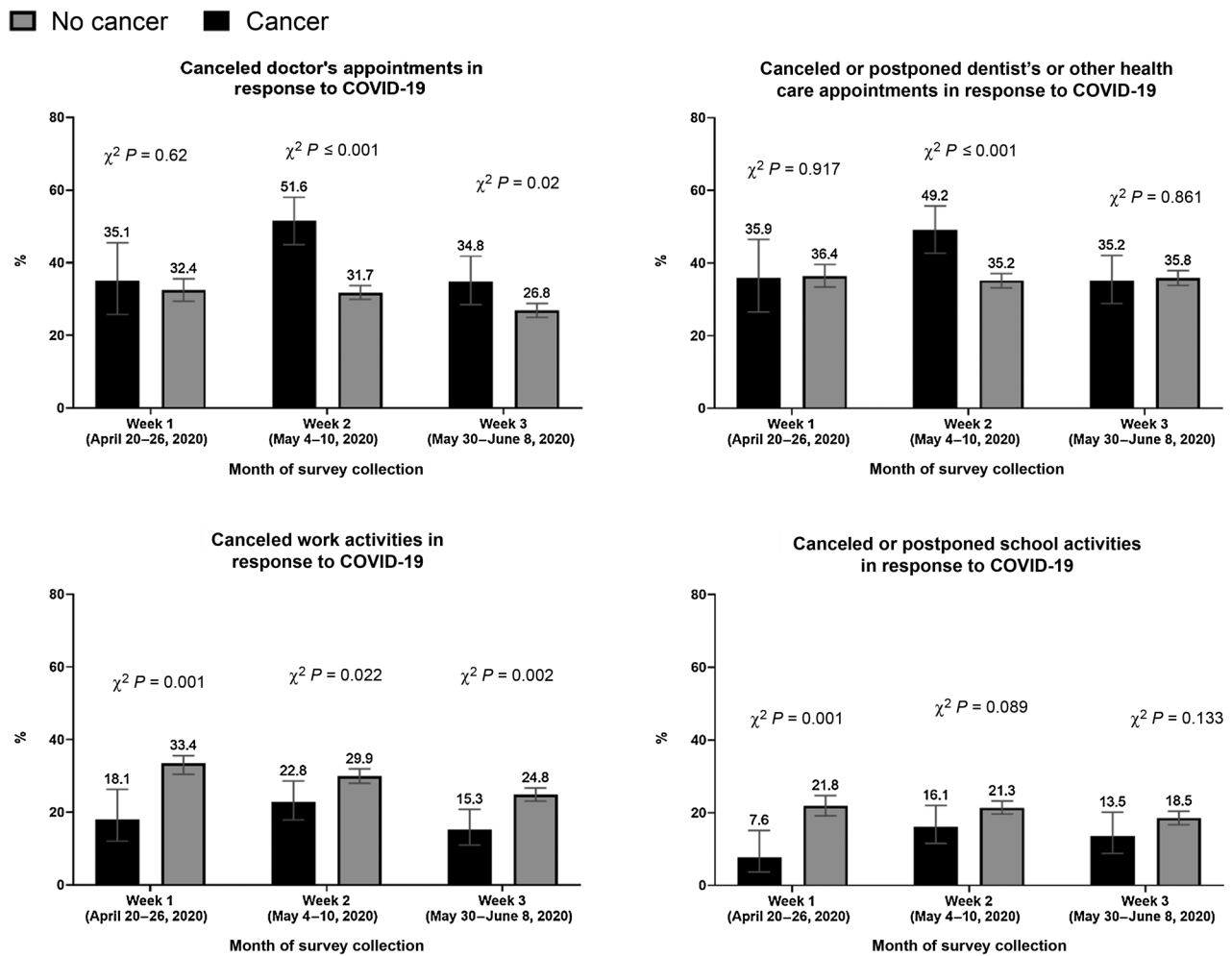


Figure 1. Preventive behaviors related to canceling appointments and activities in response to the COVID-19 pandemic among cancer survivors and the general adult population, COVID Impact Survey (April–June 2020).

cancel a doctor's appointment. Cancer survivors who were widowed/divorced/separated were less likely to cancel doctor's appointments compared with those who were married (PR: 0.77; 95% CI, 0.61–0.98), as well as those who were employed (PR: 0.68; 95% CI, 0.52–0.89). In addition, cancer survivors who resided in the South (age-adjusted PR: 0.75; 95% CI, 0.57–1.00) and the West (PR: 0.64; 95% CI, 0.47–0.87) were less likely to cancel doctor's appointments compared with those in the Northeast.

In the fully adjusted model, those aged 18 to 29 years (aPR: 1.70; 95% CI, 1.31–2.21), females (aPR: 1.39; 95% CI, 1.13–1.72), and those with at least one comorbid condition (aPR: 1.38; 95% CI, 1.06–1.80) continued to be more likely to cancel a doctor's appointment (Table 3). Cancer survivors who were widowed/divorced/separated (aPR: 0.78; 95% CI, 0.61–0.99), resided in the West (aPR: 0.69; 95% CI, 0.51–0.95) and were employed (aPR: 0.72; 95% CI, 0.56–0.93) continued to be less likely to cancel a doctor's appointment. When compared with NH-White cancer survivors, NH-Black cancer survivors were less likely to report canceling a doctor's appointment (aPR: 0.57; 95% CI, 0.34–0.97).

As a sensitivity analysis, we focused on female cancer survivors and evaluated the association of reporting personal plans were affected by

the closure of pre-K through 12th grade or childcare with canceling their doctor's appointments. Women with cancer were more likely to cancel a doctor's appointment if they reported their personal plans were affected by the closure of pre-K through 12th grade or childcare (56.7%) compared with women who did not (40.3%; χ^2 P = 0.011). After adjustment for age and having at least one other comorbid condition, we found that women with cancer who reported their plans were affected by the closure of pre-K through 12th grade or childcare had a 37% higher prevalence of reporting they canceled their doctor's appointments (aPR: 1.37; 95% CI, 1.04–1.80) compared with women who did not.

Discussion

In this analysis, we found that cancer survivors are practicing many of the recommended COVID-19-related preventive behaviors, such as social distancing and staying away from crowded areas. However, cancer survivors reported experiencing symptoms that may be related to the ongoing pandemic or their cancer treatment, such as muscle or body aches, sore throat, and nausea or vomiting. In addition, we found that cancer survivors are more likely to cancel their doctor's

Table 3. Determinants of cancer survivors canceling a doctor's appointment among COVID Impact Survey, a nationally representative survey of the United States ($n = 854$; April–June 2020).

	Unadjusted PR (only adjusted for age)	95% CI	Adjusted PR	95% CI
Age				
18–29	1.83	1.41–2.37	1.70	1.31–2.21
30–44	0.95	0.61–1.47	0.90	0.63–1.29
45–49	0.89	0.68–1.17	0.99	0.76–1.31
60+	Ref.		Ref.	
Sex				
Male	Ref.		Ref.	
Female	1.37	1.11–1.69	1.39	1.13–1.72
Marital status				
Married/living with partner	Ref.		Ref.	
Widowed/divorced/separated	0.77	0.61–0.98	0.78	0.61–0.99
Never married	0.94	0.67–1.31	0.90	0.66–1.21
Race/ethnicity				
White, NH	Ref.		Ref.	
Black, NH	0.68	0.43–1.07	0.57	0.34–0.97
Hispanic	1.02	0.72–1.44	1.13	0.83–1.54
Other, NH	0.89	0.57–1.39	1.02	0.67–1.56
At least one comorbid condition ^a	1.47	1.11–1.94	1.38	1.06–1.80
Region				
Northeast	Ref.		Ref.	
Midwest	0.79	0.58–1.06	0.80	0.61–1.05
South	0.75	0.57–1.00	0.78	0.60–1.02
West	0.64	0.47–0.87	0.69	0.51–0.95
Employment status				
Not employed	Ref.		Ref.	
Employed/self-employed	0.68	0.52–0.89	0.72	0.56–0.93
At least one COVID-19–related symptom ^b	1.18	0.94–1.48	—	
Obese/overweight	1.13	0.91–1.39	—	
Household income				
<\$50,000	0.93	0.72–1.21	—	
\$50,000–<\$100,000	1.11	0.85–1.45	—	
≥\$100,000	Ref.		—	
Population density				
Rural	1.09	0.79–1.52	—	
Suburban	1.06	0.83–1.34	—	
Urban	Ref.		—	

^aComorbid conditions include diabetes, high blood pressure, heart disease/heart attack/stroke, asthma, COPD, bronchitis or emphysema, allergies, a mental health condition, cystic fibrosis, liver disease, and a compromised immune system.

^bSymptoms include fever, chills, runny or stuffy nose, chest congestion, skin rash, cough, sore throat, sneezing, muscle or body aches, headaches, fatigue or tiredness, shortness of breath, abdominal discomfort, nausea or vomiting, diarrhea, changed or loss of sense of taste or smell, and loss of appetite.

appointments, whereas they are less likely to cancel other social activities such as work and school-related activities. The proportion of cancer patients that have canceled doctor's appointments due to COVID-19 rose from April to May, and by early June, the proportion was 34% and continued to be greater among cancer survivors compared with other adults. Younger adults aged 18 to 29 years, females, and cancer survivors with at least one other comorbid condition are more likely to cancel their doctor's appointments, whereas NH-Black cancer survivors are less likely to cancel a doctor's appointment when compared with NH-White cancer survivors. Findings from this analysis may inform strategies regarding treatment decisions among those caring for cancer survivors, specifically those with existing comorbidities.

Preventive behaviors against COVID-19 have been broadly highlighted in the media and recommended by prominent public

health organizations, such as the WHO and CDC (3). A specific focus has been placed on those at high risk of infection, including the elderly and those with chronic conditions, such as cancer survivors (18–23). In the COVID-19 pandemic context, cancer survivors are of particular significance because they are generally older and frequently live with existing comorbidities (24, 31). In our study, we found that cancer survivors were often more likely to practice COVID-19–related preventive behaviors when compared with the general study population. This is not surprising due to their high-risk status. However, an interesting finding was that cancer survivors reported experiencing select COVID-19–related symptoms including shortness of breath, nausea or vomiting, sore throat, and muscle or body aches. We are unable to disentangle if these symptoms may be due to their ongoing cancer treatment, which frequently is associated with various adverse side effects (32). However, it may be concerning that despite these

reported symptoms cancer survivors were more likely to cancel their doctor's appointment, and the proportion increased to 50% by May, when compared with the general adult population.

In our analysis, we identified specific demographic groups of cancer survivors that were either more or less likely to cancel a doctor's appointment. We observed that women with cancer were significantly more likely to cancel a doctor's appointment during the COVID-19 pandemic period, compared with men. This could reflect an increase in caregiver responsibilities (e.g., childcare) within the pandemic period, which poses structural barriers to maintaining appointments (33). Indeed, we observed that female cancer survivors who reported their plans being disrupted due to school or childcare closures were more likely to report canceling a doctor's appointment. Lack of childcare options coupled with an unwillingness to potentially expose children to COVID-19 to maintain the doctor's appointment may have led to this gender disparity. In addition, this gender disparity could also reflect differences in the type or stage of cancer, which may be less aggressive in women compared with men within the sample. NH-Black cancer survivors were significantly less likely to cancel a doctor's appointment during the COVID-19 pandemic period, compared with NH-White cancer survivors. This finding may be due to the advanced cancer stage at diagnosis, which was not measured in the COVID-19 Impact Survey. Previous studies have documented that NH-Black men and women are more likely to be diagnosed at a later stage for the most common forms of cancer, and have more aggressive forms of cancer, compared with NH-White adults (34–36). Willingness to maintain appointments may reflect the clinical characteristics of cancer, which may require more aggressive treatment (37–42). In addition, we know that NH-Black cancer survivors are also more likely to have multiple comorbidities compared with White patients with cancer; the willingness to maintain appointments among NH-Black patients with cancer may be appointments for other chronic conditions (e.g., diabetes, cardiovascular conditions; refs. 43–48).

Our study has notable strengths. We were able to utilize data from a nationally representative survey of U.S. adults and therefore, obtain a representative sample of cancer survivors. However, our results should be interpreted with several limitations in mind. Chronic conditions, including a prior cancer diagnosis, were based on self-report, leading to the potential for measurement error in our definition of cancer survivor. We were unable to measure and account for important covariates such as cancer type, cancer stage, or type of cancer treatment (surgery vs. chemo vs. radiation). Important factors to consider when interpreting our results also include, if the respondent was currently undergoing cancer treatment, and if so, how long they have been undergoing treatment or time since treatment; however, these data were not available. In addition, we were unable to assess whether cancer survivors were canceling cancer-related appointments or appointments related to existing comorbidities. Importantly, data regarding the cancer survivor's symptoms and practices prior to COVID-19 were unavailable, and therefore, we were unable to conclude whether the symptoms are COVID-19 related or

due to another cause. Finally, we were unable to assess whether respondents rescheduled their doctor's appointments as telehealth visits as no follow-up questions were asked regarding their reasons for canceling doctor's visits. As such, we were unable to account for potential reasons for canceled doctor's appointments, or telehealth visits, such as lack of internet access. Future qualitative research into experiences of cancer survivors during the COVID-19 pandemic to elucidate reasons for interrupted cancer care and barriers to medical care is needed.

In conclusion, we provide several insights into COVID-19-related preventive behaviors among cancer survivors. We found that cancer survivors frequently reported practicing recommended behaviors such as wearing a face mask, maintaining social distance, and avoiding crowded areas. In our study, we focused on cancer survivors reported cancellation of doctor's appointments to gain insights into the continuity of care among cancer survivors in the United States during the COVID-19 pandemic. Surveillance of cancer survivors through follow-up appointments and consistent check-ins with their care team is a pivotal aspect of cancer survivorship. However, the COVID-19 pandemic has introduced a new dynamic in clinical care, transitioning to telehealth, and limiting health care appointments to only essential appointments (49–51). Limited understanding in the general population of when appropriate to cancel doctor's appointments and potentially inequitable access to telehealth are factors that providers should consider, specifically among this vulnerable group (21, 52). As the COVID-19 pandemic continues in the coming months, providers will have to continue to prioritize resources and treatment, and surveillance of potential unintended consequences of these decisions should continue.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

J.Y. Islam: Conceptualization, formal analysis, supervision, visualization, methodology, writing—original draft, writing—review and editing. **M. Camacho-Rivera:** Visualization, methodology, writing—review and editing. **D.C. Vido:** Methodology, writing—review and editing.

Acknowledgments

The authors gratefully acknowledge NORC at the University of Chicago for the Data Foundation for data collection and making the data from the COVID Impact Survey publicly available. J.Y. Islam is supported by the University of North Carolina's Cancer Care Quality Training 2T32CA116339-11. M. Camacho-Rivera is supported by the TRANSPORT – The Translational Program of Health Disparities Research Training 5S21MD012474-02.

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Received May 23, 2020; revised July 6, 2020; accepted September 22, 2020; published first September 25, 2020.

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