



Breast cancer survivorship care during the COVID-19 pandemic within an urban New York Hospital System

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ABSTRACT

Purpose: To examine clinicodemographic determinants associated with breast cancer survivorship follow-up during COVID-19.

Methods: We performed a retrospective, population-based cohort study including early stage (Stage I-II) breast cancer patients who underwent resection between 2006 and 2018 in a New York City hospital system. The primary outcome was oncologic follow-up prior to and during the COVID-19 pandemic. Secondary analyses compared differences in follow-up by COVID-19 case rates stratified by ZIP code.

Results: A total of 2942 patients with early-stage breast cancer were available for analysis. 1588 (54%) of patients had attended follow-up in the year prior to the COVID-19 period but failed to continue to follow-up during the pandemic, either in-person or via telemedicine. 1242 (42%) patients attended a follow-up appointment during the COVID-19 pandemic.

Compared with patients who did not present for follow-up during COVID-19, patients who continued their oncologic follow-up during the pandemic were younger ($p = 0.049$) more likely to have received adjuvant radiation therapy ($p = 0.025$), and have lower household income ($p = 0.031$) on multivariate modeling. When patients who live in Bronx, New York, were stratified by ZIP code, there was a modest negative association ($r = -0.56$) between COVID-19 cases and proportion of patients who continued to follow-up during the COVID-19 period.

Conclusion: We observed a dramatic disruption in routine breast cancer follow-up during the COVID-19 pandemic. Providers and health systems should emphasize reintegrating patients who missed appointments during COVID-19 back into regular surveillance programs to avoid significant morbidity and mortality from missed breast cancer recurrences.

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1. Introduction

In 2019, the 17 million American cancer survivors constituted approximately 5 % of the population. This number is expected to exceed 22 million by 2030, even with declining cancer incidence [1]. Among women, breast cancer remains the most prevalent cancer, accounting for over 3.8 million survivors in 2019 [2].

Improved survival rates with modern cancer therapies has led to

an emphasis on managing long-term complications, such as from radiation and chemotherapy [3–5]. Current guidelines for follow-up care of breast cancer patients by the American Cancer Society (ACS) and American Society of Clinical Oncology (ASCO) recommend at-least annual lifelong clinical follow-up and mammography to manage complications and assess for recurrent or new breast cancer [6]. Despite such guidelines, mounting evidence suggests recent substantial and increasing rates of inadequate long-term follow-up among breast cancer survivors [7].

The novel Coronavirus Disease 2019 (COVID-19) has affected all aspects of healthcare [8]. Cancer treatment during COVID-19 has been triaged [9] with modifications to systematic therapy scheduling [10] and radiation delivery [11]. A recent single institutional

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study demonstrated that over 40 % of breast cancer patients undergoing treatment experienced a delay or change in therapy during the early COVID-19 pandemic [12]. Cancer patients also experience increased case fatality rate from COVID-19 infection [13–16], with evidence suggesting that this may also apply to cancer survivors [17].

This study aimed to estimate disruption of long-term follow-up (beyond 2 years after resection) among early-stage breast cancer survivors during the COVID-19 pandemic at Montefiore Medical Center (MMC), an urban, academic, tertiary-care hospital system in Bronx, New York, which was an early epicenter of the pandemic in the United States. We hypothesized that patients would be less likely to attend follow-up appointments during the pandemic. We also examined associations between follow-up attendance and clinical and demographic risk factors during and prior to the pandemic period.

2. Patients and methods

2.1. Patient selection

Eligible patients had a new diagnosis of stage I or II breast cancer, defined by American Joint Committee on Cancer (AJCC) 7th edition staging guidelines, and underwent surgical resection between January 1, 2006, and June 4, 2018, within the MMC system. Data were obtained from the Montefiore Medical Center, Albert Einstein Cancer Center Cancer Registry (“Cancer Registry”). These dates were chosen so that at least 2 years have passed from initial resection to allow us to evaluate the effect of COVID-19 on long-term follow-up (rather than shorter term follow-up within 2 years after resection).

For patients who underwent adjuvant chemotherapy and/or radiation therapy, the patient’s medical and radiation oncologists were also required to be part of the MMC system (e.g. if resection was performed at MMC but chemotherapy was given outside MMC, this patient was excluded from analysis). This study was approved by the Institutional Review Board at Montefiore Medical Center/Albert Einstein College of Medicine (2020–11141) and conducted in accordance with STROBE guidelines.

Included patients were categorized into three groups:

- 1) “Continued follow-up” denotes patients who had a last documented follow-up appointment with any MMC oncologist during a nine-month period accounting for the initial wave of COVID-19, March 1, 2020, to December 1, 2020.
- 2) “Pending follow-up” denotes patients who had a documented last follow-up appointment with any MMC oncologist between March 1, 2019, and March 1, 2020 (i.e. during the year immediately preceding the COVID-19 pandemic) but did not follow-up during the COVID-19 period. These are patients who are most at risk of having their follow-up disrupted by COVID-19.
- 3) “Lost to follow-up” denotes patients whose last known follow-up appointment was prior to March 1, 2019. These are patients who had gone at least 1 year without MMC oncology follow-up at the beginning of the COVID-19 pandemic.

Both in-person and telehealth visits with any MMC oncology clinic (surgical, medical, or radiation oncology) were counted as follow-up appointments. Appointments with both physicians and nurse practitioners were counted, based on the standard practices of each clinic. Information regarding patients’ follow-up, MMC appointment dates, clinical course, and death were obtained via several sources: MMC electronic medical record (EMR) (EPIC Systems), Bronx RHIO (Regional Health Information Organization), CLG (Clinical Looking Glass, a computerized decision support tool),

death certificates, and letters from outside facilities and physicians. Date of last contact complied with rules from the Commission on Cancer data standards manual [18]. Data in the Cancer Registry (including date of last contact) is updated monthly. Clinical and demographic information were extracted from the patient’s EMR.

Both clinical stage and pathologic stage were evaluated with the higher stage used for analysis for a conservative estimate of stage. The date of collection for this data was December 4, 2020. Patient income was estimated by ZIP code at time of diagnosis.

2.2. COVID-19 case rate estimation

Data for COVID-19 case rates were extracted from the New York City Department of Health for the week of highest COVID-19 rates in New York City (April 5, 2020, to April 11, 2020). For case rates outside of New York City, rates were estimated by county using the New York State Forward County Dashboard. Percentage of COVID-19 positive cases were calculated for all available ZIP codes over the course of the week, and then recoded as quartiles.

2.3. Median income by ZIP code

Median household income data was estimated for each patient using ZIP code at time of diagnosis and compared with 2010 US Census data. Annual household income was grouped into five ranges (<\$25,000, \$25,001–50,000, \$50,001–75,000, \$75,001–100,000, \$100,001+).

2.4. Covariates

The following covariates were evaluated: age (18–34, 34–44, 45–54, 55–64, 65–74, 75+), sex (male, female), race/ethnicity (Asian, Black, Hispanic, non-Hispanic (NH)-White, NH-other), smoking history (Never, Former, Current, Unknown), household income, stage (I, II), type of breast surgery (lumpectomy or mastectomy), year of diagnosis, and COVID-19 case rate quartile (based on patient ZIP code of residence). Receipt of adjuvant radiation therapy, chemotherapy, and/or endocrine therapy was also recorded.

2.5. Statistical analysis

Descriptive statistics are displayed as percentages of all patients unless otherwise labelled and include a margin of error at the 95 % confidence intervals (CI) among all adults. χ^2 [2] tests were used for bivariate comparisons, unless Fisher’s exact test was more appropriate in situations where expected frequencies were less than 5. To estimate determinants of follow-up, we calculated univariate comparisons. A criterion of p value < 0.05 was used as a cutoff to include in the multivariate logistic regression model. A global F test was used to assess significant of all predicts in multivariate regression. Collinearity was assessed to ensure no strong linear relationship among independent variables included in the model was present. For correlation analysis, coefficient of determination, R [2], was used to assess linear association. In addition, p < 0.05 was used as the level of significance. Due to the exploratory nature of this analysis, we did not make adjustments for multiple comparisons. All statistical analyses were conducted using SPSS (IBM Version 24).

3. Results

2942 patients who underwent resection at MMC for early-stage breast cancer at MMC between 2006 and 2018 were included in the analysis. Table 1 summarizes the descriptive baseline

characteristics of patients who continued to attend to follow-up during COVID-19 compared to those that had a last known follow-up within the year prior to March 1, 2020. 1242 (42 %) of patients had a follow-up during the COVID-19 period. 1588 patients (54 %) were categorized as having pending follow-up, meaning they attended a follow-up appointment in the year prior to COVID-19 (March 2019–March 2020) but did not follow-up during the COVID-19 period.

Patients who continued to follow-up with their oncology providers during COVID-19 tended to be younger ($p = 0.022$), non-white in racial identification ($p = 0.003$), have a lower median household income ($p = 0.041$), and have undergone adjuvant therapy with either radiation ($p = 0.009$) or chemotherapy ($p = 0.050$). When patient ZIP codes were grouped into quartiles based on local COVID-19 case rate at the height of the NYC pandemic in April 2020, local case rate was not a predictor of continued follow-up.

On multivariable modelling, the difference in groups observed by age, income and radiation remained significant, while chemotherapy ($p=0.392$) and race/ethnic identification were no longer

significant ($p = 0.128$). Results of the multivariable analysis are shown in Table 2.

There is also an observed decline in the number of last follow-up visits in the months immediately after the start of the COVID-19 period (March and April 2020) compared with the months immediately prior to the pandemic start. Fig. 1 shows the number of patients with last known follow-up by month leading up to and during the COVID-19 period.

3.1. Geographic distribution within The Bronx

Fig. 2 depicts the geographical distribution of COVID-19 case percentages within each ZIP code in The Bronx (Fig. 2A), along with the proportion of Bronx resident patients with pending follow-up prior to COVID-19 as a percentage of the total number of breast cancer patients (including those who continued follow-up during COVID-19), grouped by ZIP code (Fig. 2B). There was a modest negative association ($r = -0.56$) between COVID-19 case percentage within ZIP code and proportion of patients who continued to follow-up during the COVID-19 period.

Table 1
– Baseline characteristics of COVID-19 follow-up cohort.

Baseline Characteristics	Continued Follow-up (n = 1242)	Pending Follow-up (n = 1588)	Total (n = 2830)	P value
Age, y				0.022
18–34	17 (1.4)	22 (1.4)	39 (1.4)	
35–44	97 (7.8)	92 (5.8)	189 (6.7)	
45–54	276 (22.2)	92 (22.8)	638 (22.5)	
55–64	389 (31.3)	452 (28.5)	841 (29.7)	
65–74	313 (25.2)	409 (25.8)	722 (25.5)	
75+	150 (12.1)	251 (15.8)	401 (14.2)	
Gender				0.600
Female	1233 (99.3)	1579 (99.4)	2812 (99.4)	
Male	9 (0.7)	9 (0.6)	18 (0.6)	
Race/ethnicity				0.003
White	221 (17.8)	362 (22.8)	583 (20.6)	
Asian	30 (2.4)	37 (2.3)	67 (2.4)	
Black	504 (40.6)	608 (38.3)	1112 (39.3)	
Hispanic	443 (35.7)	502 (31.6)	250 (33.4)	
Other	44 (3.5)	79 (5.0)	32 (4.3)	
Smoking				0.130
Never	783 (63.0)	1053 (66.3)	1836 (64.9)	
Former	275 (22.1)	313 (19.7)	588 (20.8)	
Current	157 (12.6)	177 (11.1)	334 (11.8)	
Unknown	27 (2.2)	45 (2.8)	72 (2.5)	
Household Income				0.041
<25,000	164 (13.2)	179 (11.3)	343 (12.1)	
25,001–50,000	789 (63.5)	962 (60.6)	1751 (61.9)	
50,001–75,000	229 (18.4)	347 (21.9)	576 (20.4)	
75,001–100,000	27 (2.2)	49 (3.1)	76 (2.7)	
100,001+	33 (2.7)	51 (3.2)	84 (3.0)	
Stage				0.925
I	910 (73.3)	1166 (73.4)	2076 (73.4)	
II	332 (26.7)	422 (26.6)	754 (26.6)	
Surgery				0.672
Lumpectomy	870 (70.0)	1124 (70.8)	1994 (70.5)	
Mastectomy	372 (30.0)	464 (29.2)	836 (29.5)	
Radiation				0.009
No	412 (33.2)	602 (37.9)	1014 (35.8)	
Yes	830 (66.8)	986 (62.1)	1816 (64.2)	
Chemotherapy				0.050
No	798 (64.3)	1076 (67.8)	1874 (66.2)	
Yes	444 (35.7)	512 (32.2)	956 (33.8)	
Endocrine Therapy				0.066
No	410 (33.0)	577 (36.3)	987 (34.9)	
Yes	832 (67.0)	1011 (63.7)	1843 (65.1)	
Community COVID-19 Case rate by ZIP code				0.072
21.8–48 %	198 (15.9)	294 (18.5)	492 (17.4)	
48–57 %	214 (17.2)	305 (19.2)	519 (18.3)	
57.1–61.9 %	647 (52.1)	786 (49.5)	1433 (50.6)	
62–77.8 %	183 (14.7)	203 (12.8)	386 (13.6)	

Table 2
– Multivariate modeling of determinants of follow-up during COVID-19.

Variable	Adjusted Odds Ratio	95 % CI	P value
Age, y			0.049
18–34	ref		
35–44	1.4	0.7–2.8	
45–54	1.0	0.5–2.0	
55–64	1.1	0.6–2.2	
65–74	1.0	0.5–2.0	
75+	0.9	0.4–1.7	
Race/ethnicity			0.128
White	ref		
Asian	1.2	0.7–2.1	
Black	1.3	1.0–1.6	
Hispanic	1.3	1.1–1.7	
Other	0.9	0.6–1.3	
Household Income			0.031
<25,000	ref		
25,001–50,000	0.9	0.7–1.2	
50,001–75,000	0.8	0.6–1.0	
75,001–100,000	0.6	0.4–1.1	
100,001+	0.8	0.5–1.3	
Radiation			0.025
No	ref		
Yes	1.2	1.0–1.4	
Chemotherapy			0.392
No	ref		
Yes	1.1	0.9–1.3	

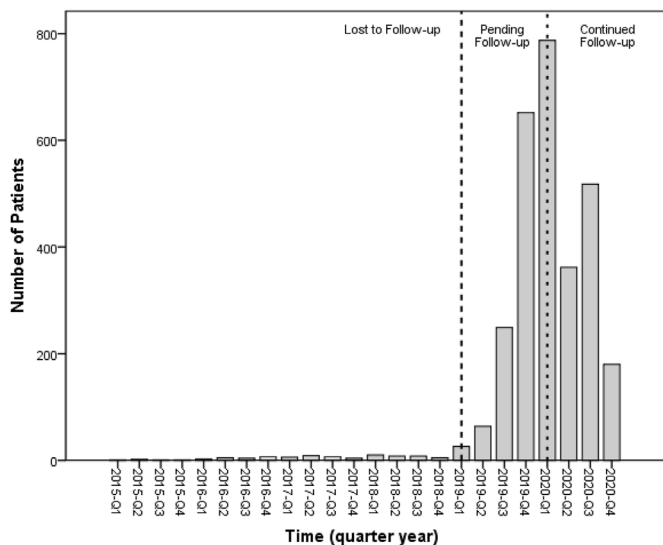


Fig. 1. Number of patients with last follow-up in each quarter year, 2015 to present. Data prior to 2015 not shown.

3.2. Pre-COVID-19 follow-up cohort

Among the 2942 patients initially evaluated, 112 (4 %) had their last follow-up prior to March 2019 and were deemed lost to follow-up. Characteristics of these patients are shown in Table S1. Therefore, we observed an approximately 14-fold increase in patients not attending follow-up during COVID-19 compared with the annual rate of patients lost to follow-up (112 patients over the past 10 years).

An analysis was then performed to compare those patients who historically were lost to follow-up in the pre-COVID era (i.e. had last follow-up prior to March 2019) and individuals who had pending follow-up during the COVID-19 pandemic.

Compared with patients who had pending follow-up, patients who were lost to follow-up were more likely to be older ($p = 0.030$),

White in racial identification ($p = 0.009$), former smokers ($p = 0.031$), have a higher median house hold income ($p < 0.001$) and tended to not have received adjuvant therapy including RT ($p = 0.048$), or endocrine therapy ($p < 0.001$). On multivariable modelling, the difference in groups observed by age, smoking, income, and adjuvant hormonal therapy remained significant, while racial identification ($p = 0.758$) and radiation therapy ($p = 0.962$) were no longer significant. Results of the multivariable analysis are shown in Table S2.

4. Discussion

Cancer survivors have been an understudied population [19]. Post-treatment follow-up and survivorship care seeks to reduce adverse effects associated with cancer and its treatment and includes multi-disciplinary domains that improve physiologic, psychosocial, and functional outcomes for cancer survivors and their families. However, in order to implement strategies to enhance health after cancer treatment, optimal follow-up care and surveillance strategies must be achieved.

In this study, we observed a disruption in guideline-recommended, annual, long-term clinical follow-up during the COVID-19 pandemic period among survivors of early-stage breast cancer living in Bronx, New York, the initial North American epicenter of the COVID-19 pandemic. Prior to the pandemic period, approximately 4 % of patients treated since 2006 were lost to follow-up, suggesting that this represents a baseline rate of attrition in the absence of novel factors such as the COVID-19 pandemic. Over half of patients who had continued follow-up prior to COVID did not present for an appointment during the pandemic period (these patients were classified as “pending follow-up”). These patients may be at elevated risk of being lost to follow-up if efforts are not made by providers and institutions to re-establish follow-up care for them after the pandemic.

Approximately forty percent of patients continued to follow-up with MMC oncology services during the COVID-19 pandemic. Some patients who did not may have perceived breast cancer survivorship care as non-essential and opted to defer these visits per recommendations by the organizations such as the Centers for Disease Control and Prevention (CDC) [20] or European Society for Medical Oncology, which often recommended risk-adapted follow-up programs [21,22]. A recent survey study found that more than three-quarters of cancer survivors were worried about both potential COVID-19 risks associated with in-person appointments and the potential of recurrence due to delays in routine care [23]. Patients’ lack of awareness of government or other guidelines regarding the relative risks of missing follow-up appointments compared with COVID-19 exposure risks also may have contributed to the observed decline in follow-up appointments.

Continued follow-up during COVID-19 was more likely among younger patients, those who had received adjuvant radiotherapy and those with lower socioeconomic status. We also observed a modest negative association between local COVID-19 prevalence and the proportion of patients who continued to follow-up. To our knowledge, this is the first study to assess the potential effect of COVID-19 on follow-up care of cancer survivors within the United States and includes a large cohort of patients from New York City, the early North American epicenter of the COVID-19 pandemic.

To facilitate ongoing care during the pandemic, guidelines issued by several medical societies [24–26] recommend transitioning to telemedicine visits to minimize the risk of COVID-19 exposure among patients and providers [27,28]. Montefiore’s operational response throughout the pandemic was guided by recommendations from the New York State Department of Health and CDC. During the initial two-month peak of the COVID-19 period

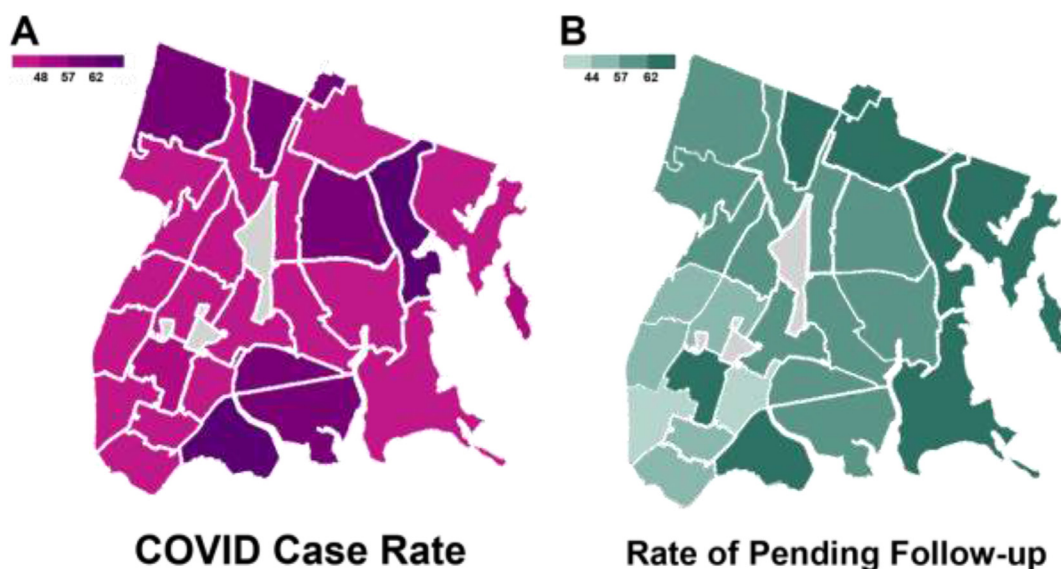


Fig. 2. **A**, Case rate of COVID-19 in Bronx, New York, by ZIP code during April 5–11, 2020; **B**, Proportion of Bronx resident patients with last follow-up prior to COVID-19 as a percentage of the total number of breast cancer patients (including those who continued follow-up during COVID-19), grouped by ZIP code of residence.

(approximately March and April 2020), non-emergent outpatient visits were canceled at MMC, and a large subset of medical staff were redistributed to help with inpatient non-cancer care. After this initial phase, patients were encouraged to transition to telemedicine in order to avoid risks of COVID exposure among patients and providers from in-person visits. Although our data did not contain patient-level data regarding type of insurance, approximately 80% of patients at MMC are covered by public insurance (i.e. Medicare and/or Medicaid). All insurance providers, public and private, allowed (and reimbursed for) telemedicine visits during the pandemic period.

However, the significant decrease in follow-up that we observed during the COVID-19 period occurred despite our center allowing telemedicine visits in lieu of in-person visits. This finding may suggest that telemedicine is not sufficient to maintain proper follow-up for all patients and that re-establishing in-person visits once the COVID-19 pandemic abates is paramount. As well, our result showing that younger patients were more likely to continue follow-up during the pandemic may reflect greater facility with technology among younger patients, allowing them to better access telemedicine services for follow-up appointments. Expanded telemedicine use may continue to increase in the future as providers and patients become more familiar with the technology, allowing telemedicine to become an important tool for long-term follow-up of cancer patients. Future work should assess facility with telemedicine among patients and providers in order to determine best practices for telemedicine and in-person visits to re-integrate patients of all ages and demographics into follow-up care.

There has also been increasing availability of COVID-19 vaccines and testing for the general public, with over 50 % of New York City residents fully vaccinated by the end of July 2021 (although the proportion of Bronx residents is lower than city-wide, at approximately 45 %). Given the low single-digit rate of COVID-19 positivity in New York in summer 2021, routine testing for COVID-19 among outpatient cancer patients is currently not recommended within our institution, but all patients are screened for symptoms and possible exposure prior to entering the hospital. Among our cancer patient population, vaccination is highly encouraged, with demonstrated similar efficacy of IgG production compared to non-cancer healthy individuals [29]. However, there may be slight

variations in efficacy especially among patients on endocrine therapy or individuals undergoing cytotoxic chemotherapy or monoclonal antibody directed treatment [30,31].

Whether long term follow-up returns to pre-COVID levels after the pandemic subsides remains to be seen. If patients with pending follow-up due to COVID-19 are not reintegrated into regular follow-up, we estimate that the effect on breast cancer outcomes could be substantial, even in the context of low-risk breast cancer survivors. There were approximately 3.9 million breast cancer survivors in the United States in 2019, of which 52 % (approximately 2 million) were within the first 10 years since diagnosis [32]. In our cohort, approximately 1600 patients had pending follow-up due to the COVID-19 pandemic. Estimating a recurrence risk of 3 % over 5 years for these patients suggests that not re-integrating these patients into follow-up could result in up to 10 missed breast cancer recurrences among these patients alone. If our observed trends were to hold country-wide in the approximately 4 million current breast cancer survivors, up to 2 million patients may have missed follow-up during COVID which could result in 12000 or more missed recurrences (even without accounting for higher recurrence risk among patients with later-stage disease). Although further work will elucidate the extent to which our findings are generalizable and how many patients with delayed follow-up during COVID return to their recommended follow-up patterns, these estimates demonstrate the potential risks to patient and public health if these patients are not sought out and reestablished to follow-up. We propose that providers and health systems specifically emphasize efforts to re-establish proper follow-up care with patients as the COVID-19 situation improves.

To date, few studies have assessed the direct effect of COVID-19 on cancer survivor follow-up [33,34]. Jammu et al., performed a literature review of COVID-19 on cancer survivors and found limited definitive evidence assessing impacts, although preliminary indications predicted detrimental effects on physical, psychosocial, and economic wellbeing. One report from Italy identified a significant increase in lymph node positive and stage III breast cancer after a two-month interruption in routine breast cancer screening [35]. Even prior to the COVID-19 pandemic, previous work on breast cancer survivorship care had also suggested an increasing rate of inadequate follow-up in the United States among breast

cancer survivors over the past decade [7,36]. Ruddy et al. reported that non-adherence was associated with older age, no radiation, chemotherapy, endocrine, and increasing time after surgery [7]. In our historic long-term follow-up analysis, we observed that increasing age, prior smoking history, higher median house hold income, and lack of adjuvant hormonal therapy were associated with patients who were lost to follow-up. This latter observation is similar to increased rates of continued follow-up among patients who received adjuvant radiation. The association of adjuvant therapies with follow-up can likely be explained by having more oncologists involved in their care and, thus, more providers ensuring that follow-up guidelines are adhered to.

We observed a moderate negative association between ZIP code case rate and patients who continued to follow-up during COVID-19. This finding could reflect the high overall COVID-19 numbers throughout The Bronx borough with pervasive awareness and concern throughout all geographical regions of risks of contracting the disease, with a small contribution of concern related to local disease rates. In addition, the lack of difference in follow-up between patients belonging to different ethnic groups was similar to previously reported clinical outcomes at our institution [37,38]. In these prior studies, which evaluated risk factors for missed daily radiotherapy treatments, low socioeconomic status was an independent predictor for missed appointments while racial/ethnic identification was not. We observed similar results on multivariate analysis in our study.

Our institution serves a large catchment area within the New York City metropolitan area with a diverse population including many patients with low socioeconomic status and/or belonging to potentially marginalized groups such as ethnic or linguistic minorities. Montefiore is the largest hospital network serving the borough of The Bronx, the poorest urban county in the United States with a poverty rate of 31 % (compared with 19 % in the rest of New York City). 54 % of Bronx residents identify as Hispanic and 33 % identify as Black or African American. Patients from such populations are historically underrepresented in medical research and our ability to analyze behavioral patterns from a large cohort of these patients represents a major strength. While we acknowledge that, given the demographics of The Bronx, our findings may not be generalizable to other populations, we believe that our findings likely hold for other potentially marginalized communities within the United States and beyond. Another strength is our ability to make temporal assessments of determinants of follow-up in a large population of cancer survivors.

Limitations of the study include our inability to directly assess the role of other chronic conditions, including prior cancer diagnoses, and co-morbid conditions on long-term cancer follow-up. We were also not able to extract certain tumor characteristics such as grade and receptor status. Patients with receptor positive disease would likely be prescribed adjuvant hormonal therapy (e.g. Tamoxifen or an aromatase-inhibitor) and be followed by a medical oncologist while on this treatment. Thus, patients receiving endocrine therapy may be more likely to have continued follow-up during the pandemic as they would be on active therapy and have more physicians monitoring their condition. However, patients who received adjuvant chemotherapy were not more likely to continue follow-up. Future work may better elucidate the effect of tumor biology on follow-up patterns. Finally, some element of survivorship bias may be present where lack of follow-up may be the result of increased mortality during the COVID period, although we did attempt to verify vital status using death certificates and letters to primary care providers as per Commission on Cancer standards.

In conclusion, COVID-19 has introduced new stressors on our healthcare providers and systems and our study is the first to

document a dramatic disruption in follow-up among early-stage breast cancer survivors during the pandemic [39]. If the patients who are pending follow-up during COVID-19 are not reintegrated into evidence-based follow-up patterns after the COVID-19 period, it has the potential to dramatically affect cancer survival outcomes.

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Author contributions

Conception and design: Allen Mo, Jonathan Klein.
Collection and assembly of data: Julie Chung, Allen Mo, Jeremy Eichler, Sarah Yukelis.

All authors assisted in providing critical feedback, discussed the results, and contributed to the final manuscript.

Declaration of competing interest

NO is a consultant for Merck and AstraZeneca. There are no additional conflicts of interests to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.breast.2021.07.018>.

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