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ORIGINAL LABORATORY INVESTIGATION

Treatments for breast cancer in men: late effects and impact on quality of life

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Abstract

Purpose Male breast cancer accounts for approximately 1% of all breast cancer diagnoses. Unfortunately, a lack of information exists regarding late effects of breast cancer treatment in men.

Methods An online survey directed towards male breast cancer patients was distributed via social medial and emails from June to July 2022. Participants were asked about their disease characteristics, treatments and side effects from the disease or treatment. Patients and treatment variables were reported via descriptive statistics. Univariate logistic regression was performed to evaluate associations between different treatment variables and outcomes expressed by odds ratio.

Results A total of 127 responses were analyzed. Median age of the participants was 64 years (range 56–71 years). A total of 91 participants (71.7%) revealed they experienced late effects secondary to their cancer or cancer treatment. The most concerning physical and psychological symptoms reported were fatigue and fear of recurrence respectively. Axillary lymph node dissection was associated with swollen arm and with difficulty in arm or shoulder movement. Systemic chemotherapy was related to bothersome hair loss and changes on interest in sex; and endocrine therapy was associated with feeling less masculine.

Conclusion Our study showed that men suffer several late effects from treatments for breast cancer. Lymphedema, difficulty with arm and shoulder movement, sexual dysfunction and hair loss should be discussed with males as it can be distressing for some patients and decrease their quality of life.

Keywords Male breast cancer · Late effects · Side effects · Cancer treatment

Introduction

Breast cancer (BC) in men accounts for approximately 1% of all BC diagnoses [1]. In 2023 an estimated of 2800 men will be diagnosed with BC and it is estimated that about 530 men will die from this disease in the United States [2]. For men in the US, the lifetime risk of getting breast cancer is about 1 in 833 [3]. However, there is a global variation in the incidence of this disease. For example, data suggest that worldwide the highest overall age-adjusted rates for male BC occur in Israel (1.08 per 100,000 man-years), followed closely by the Philippines (0.99), Italy (0.8) and then France (0.75). Meanwhile the lowest rates have been recorded in Thailand (0.14), Japan (0.17), Singapore (0.19) and Colombia (0.24) [4]. The incidence of BC in men appears to be rising as data suggest incidence has increased by 7.2% to 10.3% in the last 10 years [5].

As with BC in women, the presence of inherited pathogenic variants is associated with an increased probability of

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disease. The risk for male BC seems to be higher in patients with inherited BRCA2 rather than BRCA1 mutations, as men who inherit germline BRCA2 mutations have an estimated 6.8% cumulative risk of breast cancer vs 1.2% for BRCA1 [6].

Treatment for male BC is often extrapolated from studies conducted in women. The lack of data in men is reflected by the fact that of 131 BC randomized clinical trials, male patients represented 0.087% of the total study population and only 27 trials included male patients [7].

Previous studies have shown that BC in men is more often hormone receptor (HR) positive when compared to female BC, and its prevalence is similar to that in postmenopausal women, suggesting that male BC is usually sensitive to anti-hormonal therapies like tamoxifen [8]. One study showed that among approximately 1500 male BC patients, 99% were estrogen receptor (ER) positive, 81% were progesterone receptor (PR) positive, and 97% were androgen receptor positive [9].

Few studies have specifically evaluated differences in treatment-related side effects between male and female BC. Side effects of tamoxifen that have been reported in men include weight gain, sexual dysfunction, thromboembolic events, mood changes, hot flashes, leg cramps, among others [10]. In terms of secondary lymphedema, data suggest similar rates exist in men and women after surgical treatment for BC [11].

Given the lack of data in men, there is an urgent need to evaluate the presence of cancer-related symptoms and treatment side-effects from the perspective of male BC individuals. Therefore, we decided to survey this particular group of patients about their experience with BC.

Methods

Survey development and administration

With the assistance of patient advocates, we developed an online survey using Qualtrics®, a secure web based software that allows users to create questionnaires and generate reports for data analysis, and we directed it to male BC patients. The survey was provided in English and was composed of 30 multiple choice questions; 4 of these allowed the participant to choose more than one answer, and 8 were taken from the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire for Brest Cancer (EORTC QLQ-BR45). The survey concluded with the opportunity for an open-ended comment. Late effects were defined on the survey as "a health problem that occurs months or years after a disease is diagnosed or after treatment has ended and may be caused by the cancer or by cancer treatment".

A link to the survey was posted on available author's twitter accounts and was distributed via e-mail and social media from the accounts of male breast cancer advocacy organizations including: Male Breast Cancer Global Alliance, Male Breast Cancer Happens, and Asociación Invi. The survey was open from June 14 to July 8, 2022.

The Institutional Review Board of St Elizabeth's Medical Center granted approval for this work.

Statistical analysis

Characteristics and responses were described using mean (± standard deviation), median (interquartile range [IQR]) and percentage according to the data distribution and type. Comparisons between variables were conducted using t test, and chi-square tests for p values. We used logistic regression to evaluate associations between individual independent variables and outcomes as expressed by odds ratios (OR) with 95% confidence intervals (95% CI). For the purpose of logistic regression analysis, we unified the answers from the questions that mentioned severity of side effects into two categories: "yes" or "no", based on the presence or absence of side effects respectively. All statistical analyses were done via SPSS version 25. P values of < 0.05 were considered statistically significant.

Results

Demographics and disease characteristics

We received a total of 164 survey responses; among these, 2 were excluded as they were completed through the same internet protocol address, and an additional 35 were excluded due to incomplete responses. The final cohort included 127 complete surveys.

Participant's age ranged from 33 to 88 years (median 64, IQR 56–71); age at diagnosis ranged from 29 to 74 years (median 55, IQR 49–61). In terms of time since BC diagnosis, 31.5% of the participants ($n = 40$) received their diagnosis 1 to 5 years prior to their entry in the study; 39.4% ($n = 50$) in the previous 6 to 10 years, and 24.4% ($n = 33$) more than 10 years before their participation in the survey.

Our data involved participants from 9 different countries including United States of America, United Kingdom of Great Britain and Northern Ireland, Spain, Australia, Canada, Italy, South Africa, Switzerland, and Netherlands.

Most respondents (48%, $n = 61$) presented with stage II disease and 8 respondents (6.3%) presented with metastatic disease/stage IV. One-third of respondents ($n = 40$, 31.5%) reported currently living with metastatic breast cancer. A total of 108 participants (85%) stated they had undergone genetic testing for BRCA or other

cancer-related genes and among these, 30 (23.6%) had an abnormal gene mutation and 7 (5.5%) had a variant of uncertain significance.

The complete demographic and disease characteristics are shown in Table 1.

Treatment characteristics

The survey allowed respondents to select all relevant treatments. Most participants ($n=114$, 89.8%) underwent mastectomy; 83 (65.4%) received systemic chemotherapy; and 94 (74%) were treated with endocrine therapy (ET). Human Epidermal Growth Factor Receptor 2 (HER 2)-targeted therapy was reported by 19 (15%). Half of respondents ($n=66$,

Table 1 Participants demographics and disease characteristics

Variable	Categories	*n*	%
Age	< 65	64	50.4
	≥ 65	63	49.6
Country of residence	USA	86	67.7
	UK	13	10.2
	Australia	8	6.3
	Canada	4	3.1
	Spain	10	7.9
	Other	6	4.8
Marital status	Single/divorced/ separated	12	9.5
	Married, partner or long-term relationship	110	86.6
	Widowed	5	3.9
Social support during diagnosis and treatment	Family/Spouse/Partner	124	97.6
	Friend(s)	94	74
	Co-worker(s)	50	39.4
	Members of church or religious/spiritual organization	31	24.4
	Other men with BC	53	41.7
	Women with BC	36	28.3
Education	High school degree or less	25	19.7
	Some college but no degree	30	23.6
	Associate or bachelor's degree	38	29.9
	Graduate degree	34	26.8
Race	White	108	85.7
	Hispanic, Latino or Spanish Origin	14	11.1
	Other	7	5.6
Time since breast cancer diagnosis	Less than one year ago	6	4.7
	1 to 5 years ago	40	31.5
	6 to 10 years ago	50	39.4
	> 10 years ago	33	24.4
Cancer stage at time of diagnosis	Stage 0–I	36	28.3
	Stage II	61	48
	Stage III	18	14.2
	Stage IV	8	6.3
	Do not know/Do not remember	4	3.1
Genetic testing for BRCA or other cancer-related genes	Yes	108	85
	No	19	15
Genetic testing results	Abnormal gene mutation	30	23.6
	Variant of uncertain significance	7	5.5
	No abnormal genes	66	52
	Do not know/Do not remember	4	3.1

n number; *USA* United States of America; *UK* United Kingdom; *BC* breast cancer; *BRCA* breast cancer gene

52%) received radiation therapy (RT), and 2 (1.6%) stated they were treated with alpelisib. A total of 85 responders (66.9%) were receiving treatment for their cancer at the time of the survey. The complete description of treatment characteristics is shown in Table 2

Side effects and late effects from the cancer or cancer treatment

Nearly three-fourths ($n=91$, 71.7%) of respondents reported that they experienced late effects of their cancer or treatment. Among them, 71 men (78%) experienced physical symptoms, and the majority (33%) chose fatigue as the most concerning one. 51 respondents (56%) experienced psychological effects, and the majority of them (28.1%) selected fear of recurrence as the most concerning one. Details about the late effects identified in our survey are shown in Table 3.

A total of 63 participants (49.6%) experienced hot flashes related to their treatment; 69 (54.3%) reported feeling less masculine as a result of their illness or treatment; 100 (78.7%) expressed their treatment had impacted their interest in sex; 75 (61%) experienced some level of bothersome hair loss related to their treatment; 70 (55.6%) presented pain in the scar area lasting longer than usual surgery recovery; 42 (33.1%) stated they had presented some degree of swollen arm or hand; 66 (52.8%) had some level of difficulty with arm or shoulder movement as a result of their surgery; and 20 (15.7%) stated they did not feel their medical team had experience in treating men with BC.

We found that certain treatments were significantly associated with the presence of specific side effects (Table 4). Axillary lymph node dissection was associated with the presence of swollen arm or hand ($p<0.001$; OR 5.35, 95% CI 2.4–11.96), as well as with difficulty in arm or shoulder movement ($p=0.047$; OR 2.07, 95% CI 1.01–4.27). Systemic chemotherapy ($p<0.001$; OR 10.61, 95% CI 4.44–25.36), and RT ($p<0.001$; OR 5.16, 95% CI 2.34–11.36), were significantly associated with bothersome hair loss. ET was significantly associated with feeling less masculine as a result of their disease or treatment ($p=0.045$; OR 2.27, 95% CI 1.01–5.1). There were significant associations between HER2-targeted treatment ($p=0.01$; OR 1.33, 95% CI 1.2–1.49), as well as systemic chemotherapy with changes on interest in sex ($p=0.01$; OR 3.06, 95% CI 1.28–7.33). The only treatment associated with the presence of hot flashes was targeted therapy which could have included palbociclib, ribociclib, abemaciclib and/or other ($p=0.01$; OR 4.64, 95% CI 1.46–15.05). There was no significant association between any treatment variable and feeling physically less attractive, or longer-lasting pain in the scar of the breast.

Half of respondents ($n=63$, 49.6%) experienced some level of financial hardship related to their treatments, which could include reduced job hours, loss of job or health insurance, insufficient disability insurance and other financial stress; however, 108 (85%) stated they did not need to make changes in their recommended treatment due to financial hardship.

The last part of the survey included an open comments section. The majority of these responses were suggestions regarding educating people about male breast cancer. Answers included "Need to educate more that men can have breast cancer too and not only females although it's rare", and recommendations about asking "were you aware men could get breast cancer?".

Other comments included "I feel studies should be done in order to give men with breast cancer the most current treatment not…one size fits all" and "More research on men with breast cancer is needed".

Many other comments from this section expressed gratitude to the different male BC associations that support patients with this disease.

Table 2 Treatment characteristics

	Type of treatment	*n*	%
Current or past breast cancer treatment	Mastectomy	114	89.8
	Lumpectomy	12	9.4
	Sentinel LN biopsy/dissection	59	46.5
	Axillary LN dissection	54	42.5
	Systemic Chemotherapy: adriamycin, paclitaxel, capecitabine, and others	83	65.4
	HER2-targeted therapy: trastuzumab, pertuzumab, T-DM1, and others	19	15
	RT	66	52
	ET: Tamoxifen, Anastrozole, Letrozole, Fulvestrant, and others	94	74
	Targeted Therapy: palbociclib, ribociclib, abemaciclib, and others	19	15
	Other	5	3.9

LN lymph node; *HER2* human epidermal growth factor 2; *T-DM1* trastuzumab emtansine; *RT* radiotherapy; *ET* estrogen therapy

Table 3 Side effects and late effects from the cancer or cancer treatment

Variable	Categories	*n*	%
Presence of late effects, side effects or other issues related to cancer or cancer treatment	Yes	91	71.7
	No	36	28.3
Type of late effect experienced*	Physical	71	78
	Psychological	51	56
	Financial	24	26.4
	Interpersonal	47	51.6
	Other	21	23.1
Most concerning physical symptom	Sexual dysfunction	22	24.2
	Peripheral neuropathy	16	17.6
	Musculoskeletal pain	11	12.1
	Fatigue	30	33
	Vision problems	2	2.2
	Other	10	11
Most concerning psychological symptom	Stress	2	2.2
	Anxiety	18	20.2
	Fear of recurrence	25	28.1
	Sleep disturbance	4	4.5
	Post-traumatic stress disorder	7	7.9
	Changes in mood	3	3.4
	Problems with concentration	13	14.6
	Self-consciousness about appearance	10	11.2
	Other	7	7.9
Experienced Financial Hardship	Yes	63	49.6
	No	64	50.4
Change in recommended treatment due to economic difficulties	Yes	19	15
	No	108	85
Hot Flashes	Yes	63	49.6
	No	64	50.4
Feeling Less masculine	Yes	69	54.3
	No	58	45.7
Impact on sex interest	Yes	100	78.7
	No	27	21.3
Bothersome hair loss	Yes	75	61
	No	48	39
Swollen arm	Yes	42	33.1
	No	85	66.9
Difficulty moving the arm or shoulder	Yes	66	52.8
	No	59	47.2
Pain in scar lasting longer than usual surgical recovery	Yes	70	55.6
	No	56	44.4

*Given that patients could have selected more than one option, percentages in this variable do not add up to 100%

Discussion

The motivation for this study came from conversations among male BC advocates participating in support groups and online communities.

Similar to previous studies, our results indicate that most male BC patients are HR positive [9], and most of the patients received treatment directed to these receptors.

The prevalence of genetic mutations was higher (23.6%) in our population compared with prior studies (18.1%) [12];

Table 4 Univariable associations between breast cancer treatments and side effects

		Feeling less Masculine		*p*	OR (95% CI)	Impact on sex interest		*p*	OR (95% CI)	Bothersome Hair Loss		*p*	OR (95% CI)	Swollen Arm or Hand		p	OR (95% CI)	Difficulty in Arm or Shoulder Movement		p	OR (95% CI)	Hot Flashes		p	OR (95% CI)
		Yes	No			Yes	No			Yes	No			Yes	No			Yes	No			Yes	No		
Mastectomy	Yes	64	50	0.23	2.05 (0.63–6.65)	89	25	0.59	0.65 (0.14–3.11)	68	43	0.84	1.13 (0.34–3.79)	39	75	0.42	1.73 (0.45–6.67)	62	51	0.16	2.43 (0.69–8.54)	55	59	0.36	0.58 (0.18–1.89)
	No	5	8			11	2			7	5			3	10			4	8			8	5		
Lumpectomy	Yes	7	5	0.77	1.19 (0.36–3.99)	10	2	0.68	1.39 (0.29–6.75)	7	4	0.85	1.13 (0.31–4.1)	5	7	0.51	1.51 (0.45–5.06)	7	5	0.69	1.28 (0.38–4.28)	7	5	0.53	1.48 (0.44–4.92)
	No	62	53			90	25			68	44			37	78			59	54			56	59		
Sentinel LN biopsy/ Dissection	Yes	39	20	0.01	2.47 (1.2–5.08)	50	9	0.12	2 (0.82–4.88)	38	19	0.23	1.57 (0.75–3.27)	16	43	0.18	0.6 (0.28–1.28)	34	25	0.31	1.45 (0.71–2.93)	31	28	0.54	1.25 (0.62–2.5)
	No	30	38			50	18			37	29			26	42			32	34			32	36		
Axillary LN dissection	Yes	29	25	0.9	0.96 (0.47–1.94)	43	11	0.83	1.1 (0.46–2.6)	41	12	0.001	3.62 (1.63–8.02)	29	25	<0.001	5.35 (2.4–11.96)	34	20	0.047	2.07 (1.01–4.27)	26	28	0.78	0.9 (0.45–1.83)
	No	40	33			57	16			34	36			13	60			32	39			37	36		
Intravenous Chemotherapy	Yes	49	34	0.14	1.73 (0.83–3.62)	71	12	0.01	3.06 (1.28–7.33)	64	17	<0.001	10.61 (4.44–25.36)	32	51	0.07	2.13 (0.93–4.9)	46	36	0.31	1.47 (0.7–3.08)	45	38	0.15	1.71 (0.82–3.56)
	No	20	24			29	15			11	31			10	34			20	23			18	26		
Her2-Targeted	Yes	11	8	0.74	1.19 (0.44–3.18)	19	0	0.01	1.33 (1.2–1.49)	14	4	0.11	2.53 (0.78–8.19)	5	14	0.5	0.69 (0.23–2.05)	7	12	0.13	0.47 (0.17–1.27)	11	8	0.43	1.48 (0.55–3.97)
	No	58	50			81	27			61	44			37	71			59	47			52	56		
RT	Yes	36	30	0.96	1.02 (0.51–2.05)	56	10	0.8	2.16 (0.9–5.19)	51	14	<0.001	5.16 (2.34–11.36)	26	40	0.12	1.83 (0.86–3.89)	41	25	0.03	2.23 (1.1–4.57)	37	29	0.13	1.72 (0.85–3.47)
	No	33	28			44	17			24	34			16	45			25	34			26	35		
ET	Yes	56	38	0.05	2.27 (1.01–5.1)	76	18	0.33	1.58 (0.63–3.98)	59	32	0.14	1.84 (0.82–4.17)	33	61	0.41	1.44 (0.6–3.46)	52	41	0.23	1.63 (0.73–3.66)	51	43	0.08	2.08 (0.92–4.7)
	No	13	20			24	9			16	16			9	24			14	18			12	21		

Table 4 (continued)

		Feeling less Masculine		p	OR (95% CI)	Impact on sex interest		p	OR (95% CI)	Bothersome Hair Loss		p	OR (95% CI)	Swollen Arm or Hand		p	OR (95% CI)	Difficulty in Arm or Shoulder Movement		p	OR (95% CI)	Hot Flashes		p	OR (95% CI)
		Yes	No			Yes	No			Yes	No			Yes	No			Yes	No			Yes	No		
Targeted therapy*	Yes	12	7	0.4	1.53 (0.56–4.19)	19	0	0.01	1.33 (1.2–1.49)	14	5	0.22	1.97 (0.66–5.89)	6	13	0.88	0.92 (0.32–2.63)	8	11	0.31	0.6 (0.22–1.62)	15	4	0.006	4.69 (1.46–15.05)
	No	57	51			81	27			61	43			36	72			58	48			48	60		

LN lymph node; *HER2* human epidermal growth factor receptor; *RT* radiation therapy; *ET* estrogen therapy; *OR* odds ratio

*Targeted therapy could have included palbociclib, ribociclib, abemaciclib and/or other

meanwhile, our data suggest that variants of uncertain significance may be lower in men than in women (5.5% in men in our study vs 9.8% in women as reported by Liu et al.) [13].

Among breast cancer patients, inadequate social support is associated with significant increase in cancer-related mortality and reduction of quality of life [14, 15]. Similar to prior reports [16], the most common support for our population was the family, partner or spouse. We also found that a higher percentage of participants received support from men with BC than from women with BC. This could indicate that men feel more comfortable talking with peers of their same sex, and that certain areas of the support experience may not be extrapolated from women. This highlights the importance of the work conducted by male breast cancer advocacy and support groups. In fact, many of the open responses in our survey were suggestions about educating people about male breast cancer and raising male breast cancer awareness.

Although there was no statistical difference in the presence or absence of late effects related to specific treatments, we did find certain associations with individual side effects.

ET has historically been associated with hormone-related side effects such as changes in erectile function, orgasmic function, and sexual desire [17]. Our data showed that 78.7% felt their treatment had impacted their interest in sex. In addition, 54.3% of the participants stated they felt less masculine. These side effects are critical because they have been associated to discontinuation of tamoxifen in approximately 20% of male BC patients within 1 to 2 years of treatment [18]. Other data suggest that when compared to women, men are less likely to report side effects, but more likely to discontinue treatment early [19]. Chemotherapy can also affect sexual function. Usta et al. reported that approximately 50% of women with breast cancer receiving chemotherapy presented sexual dysfunction [20]. Our data suggest that the percentage may be higher in men (78.7%) and appears to be associated with the use of both systemic chemotherapy and HER2-targeted therapy. Given that sexual dysfunction can affect treatment adherence [18], it is important to discuss these side effects with men when they undergo chemotherapy and ET, and efforts should be made to educate men about these symptoms and discuss measures to minimize their impact on quality of life.

Our study showed that one-third of respondents experienced difficulty moving the arm or shoulder as a result of surgery and longer-lasting pain in their surgical scar. These results are in line with prior studies [21] and suggest that late surgical side effects seem to be similar in males and females. In fact, prior work reaffirmed that lymphedema is a common complication affecting both sexes, and that appropriate treatment and rehabilitation strategies need to be implemented for both [11].

Our study showed that two-thirds of respondents experienced bothersome hair loss and most of respondents who

received taxanes suffered from this side effect (79%). Moreover, 78.4% of respondents who received RT reported bothersome hair loss. A similar finding was discovered in patients who underwent axillary lymph node dissection; most likely related to the fact that patients who undergo this procedure also receive chemotherapy or RT.

This is a side effect of particular interest in men, given that men can have hair loss in the chest as a result of RT. Trusson et al. described that, when compared to women, hair loss in men is discussed and coped with differently, and these distinctions may impact the experience of men during cancer treatment [22].

Fatigue following BC is a well-known and common problem [23]; approximately one in four BC survivors suffer from severe fatigue, and receiving the combination of surgery, radiotherapy, and chemotherapy with or without hormone therapy has been associated with higher prevalence of severe fatigue [24]. Our data suggest that fatigue is an important problem in men, given that the majority of participants selected fatigue as the most concerning physical late effect. Different strategies and treatments have been evaluated to treat fatigue resulting from BC treatment, however, most of these have been explored in female patients only. Invernizzi et al. created a pilot study on the impact of rehabilitation on BC related fatigue and found that after 4 weeks of treatment, there was a significant reduction on BC related fatigue ($p = 0.004$) [25]. Evaluating strategies to improve fatigue in men are warranted.

Peripheral neuropathy (PN) is one the most frequent toxicities associated with taxane use for the treatment of BC. Bandos et al. reported the development of PN two years after initiation of treatment in 41.9% of patients and its presence was significantly associated with worse quality of life ($p < 0.001$) [26]. However, no men were included in this study, and we are not aware of any data on the prevalence of this side effect from chemotherapy in men with BC. From our study, 17.6% of participants reported PN was the most concerning late effect, which suggests a need to study this specific population and provide tools for individualized assessment and treatment.

Clinical levels of anxiety and depressive symptoms have been previously reported in male BC patients, and their prevalence was 6% and 1%, respectively [27]. Meanwhile, the presence of anxiety has been reported to be much higher in women, with prevalence as high as 73.3% and 68.6%, respectively [28]. Our data showed that 20.2% of patients perceived anxiety as the most concerning psychological symptom, and 28.1% of responders mentioned fear of recurrence as the most concerning psychological late effect. This highlights the need to address the aforementioned concerns in men with a history of BC.

Many respondents expressed preoccupation that the general public may still not be aware of this disease, emphasizing the importance of including men and male BC during national breast cancer awareness month campaigns in October. Men with breast cancer feel underrepresented in research, and have historically been excluded from clinical trials of BC drugs; however the U.S. Food and Drug Administration has encouraged sponsors to discuss the inclusion of male patients in BC clinical trials, as well as developing specific programs for this population [29]. Lastly, respondents expressed immense gratitude both to advocacy and support groups as well as to investigators conducting research in male breast cancer.

There have been other studies surveying male breast cancer patients [19, 30, 31]. Berkowitz et al. performed an online survey to evaluate the effects of ET in BC patients, including 54 men. Our study is different from Berkowitz et al. as it focuses on all types of treatments including ET, chemotherapy and surgery. In addition, we focused exclusively on male patients, providing unique and specific information about this population. Kipling et al. also performed a survey that evaluated the experience of male BC patients on the clinic appointments. Our study is different from Kipling et al. as it focuses on treatment side effects rather than the experience with clinic appointments. Additionally, our sample is larger (127 vs 78). Halbach et. al studied the perspective of the health care situation in 100 male patients with BC in Germany. While that study reports on the initial experience with the diagnosis of breast cancer in men, our study adds important information about treatments and side effects in this population. In addition, our study includes patients from 9 different countries from all over the world.

Our study had some limitations. The sample size was small, which may limit the interpretation of some of the results. Moreover, because of this we cannot conduct multivariable analyses to confirm independent associations. Specifically, the lack of multivariable analysis prevents us from evaluating the role of potential confounders such as chemotherapy and radiation therapy with hair loss. The finding of sentinel lymph node biopsy associated with feeling less masculine, may be confounded by ET or RT. Our study is susceptible to ascertainment bias, as the participants we included are mostly members of male cancer advocacy and support groups and the experiences reported here may not be the same for other men with BC in the general population. Responses regarding disease stage and treatment could not be verified with chart review and may also be subject to recall bias. We cannot exclude unidentified confounders that may influence the presence or absence of certain late effects in the studied population.

However, despite these limitations, our survey provides very important insights on the experiences and treatment-related effects that men experience when receiving treatment for BC, many of which can inform the development

of dedicated interventions to improve or prevent these side effects and complications.

Unique features of this project include the use of a survey designed with patient input and distribution using social media platforms, as well as the aims of evaluation self-reported side effects, financial hardship, and the patient's perception about the experience of their medical team treating men with BC.

To our knowledge, this is the largest survey evaluating late effects from BC treatment in male patients. We demonstrated that social media can be effective in rapidly obtaining a large number of international responses, which allows for a more diverse pool of participants.

Conclusions

Our study showed that several late effects are common in men who undergo treatment for BC. The need to include men in more studies assessing surgical and medical treatments for BC is imperative. Symptoms such as lymphedema, difficulty with arm and shoulder movement, sexual dysfunction and hair loss should be discussed with males as they can be bothersome and reduce their quality of life.

Our study provides critical information on several side effects and late effects that are experienced by male patients with breast cancer. Further research is necessary to mitigate the impact of these effects and improve quality of life in men.

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Data Availability Additional data can be obtained by emailing the corresponding author.

Declarations

Conflict of interest JPL has research funding from Kazia therapeutics and consulting from Minerva Therapeutics. All other authors declare no conflict of interest.

Ethical approval This study received approval from the Institutional Review Board of St. Elizabeth's Medical Center.

Research involving human participants and/or animals This study received approval from the Institutional Review Board of St. Elizabeth's Medical Center.

Informed consent Informed consent was obtained by the participants. The introductory page of the survey indicated that "By completing this survey, you are consenting to participate in this study and attesting that you are 18 or older."

Consent to publish Publish to consent was obtained from the participants. The introductory page of the survey indicated that "the final results will be presented in scientific research meetings or published in a medical journal."

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