

Health-related quality of life in breast cancer survivors of different sexual orientations

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Abstract

Purpose Sexual minority women, e.g., lesbians and bisexuals, are an underserved population but not much is known about their quality of life (QOL) after a breast cancer diagnosis. For this reason, this study examines the physical and mental QOL and its association with sexual orientation in a cohort of long-term nonrecurring breast cancer survivors.

Methods Survivors were recruited from a cancer registry and additional sexual minority survivors through convenience methods. Data were collected via telephone survey from all 438 survivors, who were disease free and diagnosed with nonmetastatic breast cancer an average of 5 years earlier. Sexual orientation was the primary independent factor, and QOL, measured with the SF-12, was the outcome. Demographic and clinical factors were considered as correlates.

Results Sexual orientation was not significantly associated with survivors' physical or mental QOL. The majority of survivors reported good physical and mental QOL. The demographic and clinical factors explained about one-third of the variation in survivors' physical QOL, but did not account for most of survivors' mental QOL.

Conclusions The lack of an association between sexual orientation and QOL suggests that if there is a link, it does not relate directly to clinical and demographic factors. Future studies need to identify areas of similarity and difference between sexual minority and heterosexual survivors and mechanisms to explain the similarity in QOL.

Keywords Breast neoplasm · Survivorship · Homosexuality, female · Disparities · Quality of life

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Introduction

There are currently more than 2.5 million breast cancer survivors living in the US according to the American Cancer Society (ACS website) [1]. The number of breast cancer survivors is steadily increasing due to earlier detection and improved treatments for breast cancer. With more women surviving breast cancer, an understanding of the sequelae of a breast cancer diagnosis, specifically women's health-related quality of life (QOL), has emerged as an important focus of study. Studies indicate women are distressed due to the diagnosis and treatment for breast cancer, yet gradually recover over the first 2 years after diagnosis [2, 3]. However, for up to 25% of cancer patients, distress persists long after diagnosis [4–6]. The survivorship literature points to clinical, social, and cultural factors, as explanations for poor adjustment. Breast cancer survivors who receive systemic adjuvant therapy (chemotherapy,

tamoxifen, or both together) [6], who are younger [7], African American [8–10] or of lower socioeconomic status [10, 11] have lower health-related QOL compared to those without systemic adjuvant therapy, and survivors, who are older, White, and with more socioeconomic resources.

So far, studies have mostly omitted sexual orientation as a contributing factor to cancer survivors' QOL. The nation's key cancer research and policy organizations, such as the National Cancer Institute, American Cancer Society, Centers for Disease and Prevention, recognize lesbian, gay, and bisexual populations as underserved populations, but cancer-related disparities due to sexual orientation have not been thoroughly evaluated [12–14]. There are multiple reasons for this lack of knowledge, including the systematic exclusion of sexual minorities from clinical trials [15], lack of surveillance of sexual minorities in the context of cancer registries [16], scarce funding of research on sexual minorities [17], and difficulty recruiting sexual minority women with a history of breast cancer [18].

Given these challenges, the existing studies of sexual minorities are mostly limited to small convenience samples [19–23], with results pointing to a myriad of difficulties. In noncancer populations, research consistently demonstrates sexual minorities' exposure to social stresses, including discrimination and violence, which affects their overall health and well-being [24–26]. From this evidence, one can infer, sexual minority women with breast cancer will have a lower QOL compared to heterosexual women with breast cancer. Studies to evaluate this are mostly missing. One exception is a recent population-based study of California cancer survivors, which concluded that lesbian and bisexual women cancer survivors had 2.0 and 2.3 times the odds of reporting fair or poor health compared to heterosexual women cancer survivors [27]. The study presented here focuses on physical and mental QOL and its association with sexual orientation in a cohort of long-term nonrecurring breast cancer survivors.

Methods

All aspects of the study were approved by both the Boston University and the Massachusetts Department of Public Health Institutional Review Board (IRB).

Recruitment

The multistep and complex approach to recruit heterosexual and sexual minority breast cancer survivors, using the Massachusetts Cancer Registry (MCR), is described in detail elsewhere [18]. In brief, recruitment was limited to 146 cities and towns in Massachusetts that had a high density of sexual minority women, which was defined as

0.50% or more of the female population residing in a female same-sex household. The 146 selected areas had 0.81% of women living in female same-sex partnered households compared to the Massachusetts average of 0.56%. Data for the specified 146 cities and towns were obtained from the MCR and limited to cases with a primary diagnosis of breast cancer staged as Ductal Carcinoma In Situ (DCIS) or stages I–III, diagnosed between January 1, 2000 and December 31, 2005. Passive physician consent was sought before a breast cancer survivor was contacted. The Boston University IRB restricted telephone screening for eligibility to a maximum of ten call attempts, including three voice mail messages. During the 5-minute telephone screening, survivors were asked questions about cancer history to exclude cancer recurrences and women who were currently receiving active cancer treatment, defined as surgery, radiation, and chemotherapy. All survivors' sexual orientation was ascertained during the telephone screening. Eligible heterosexual and sexual minority participants completed a 35-minute telephone survey. These surveys comprise this study's registry sample of 257 heterosexual and 69 sexual minority women, recruited between August 2007 and November 2008.

Between January 2009 and October 2009, convenience recruitment methods were employed in order to increase the number of sexual minority women with breast cancer in the study [28]. This latter convenience sample of sexual minority breast cancer survivors fit the same eligibility criteria: primary nonmetastatic breast cancer, diagnosis during the years 2000–2005, without a recurrence, and currently not receiving active cancer treatment. However, the convenience sample was geographically unrestricted, resulting in 112 sexual minorities who were mostly residing outside of Massachusetts.

Measures

For the registry-derived sample, cancer stage, date of diagnosis, and date of birth were obtained directly from the MCR, which are derived from patients' medical records, and age at interview was calculated based on date of birth. All other data, including age, stage, and date of diagnosis for the convenience sample, were collected during the 35-minute telephone survey. Sexual orientation distinguished heterosexual survivors from sexual minority survivors, who were comprised of lesbian, bisexual, and women reporting a preference for women partners. Other demographic data consisted of race (non-Hispanic White vs. Non-White), marital status (never married, married, separated, divorced, or widowed); education (high school, college, or graduate level); employment (full or part-time vs. unemployed); and health insurance status (insured or uninsured). A discrimination measure previously used [29,

30] was modified to ascertain participants' discrimination experiences due to seven characteristics: age, race or ethnicity, gender, sexual orientation, appearance, income level, or cancer diagnosis. To measure socioeconomic status, information was collected on individual income in \$10,000 increments, ranging from less than \$10,000 to \$100,000 and above. Based on participants' addresses, two measures of neighborhood socioeconomic status were derived using census information. First, poverty level was defined as the percentage of the population in a census block living under the Federal poverty level. For Census 2000 data, the Federal poverty level for a family of four was an income of \$17,029 (US Census Bureau, 2007). A second measure assessed the census block's median household income categorized into quintiles.

Time since diagnosis was calculated using the date of diagnosis and the interview date. Women were asked about their receipt of various cancer treatments, to derive self-reported clinical information. Measures of surgery, radiation, chemotherapy, as well as tamoxifen or aromatase inhibitor therapy, were derived from their responses. Participant comorbidities were captured using a comorbidity measure developed by Ganz and previously used with long-term breast cancer survivors [6].

The SF-12, an abbreviated version of the widely used Medical Outcomes Study Short-form Health Survey (SF-36), was used to measure QOL. The SF-12 reproduces the two component summaries, the Physical Component Summary (PCS) and the Mental Component Summary (MCS) [31]. PCS and MCS are computed using the scores of twelve questions and range from 0 to 100, where a zero score indicates the lowest level of health measured by the scales and 100 indicates the highest level of health. A single question of the SF-12, regarding respondents' general health perceptions, was also examined. Its response choices of excellent, very good, good, fair, and poor health were dichotomized as fair or poor vs. better health.

Statistical analysis

Survivors' demographic and clinical characteristics were compared, using *t* tests and chi-square tests, to examine differences by sexual orientation and by sample. To understand how these characteristics relate to QOL, MCS and PCS were separately regressed via least-square regression on each demographic and clinical characteristic, controlling for sexual orientation. Several of the demographic and clinical predictor variables had missing values, though with the exception of four variables, the fraction of missing values was no more than 3%. The four variables with more substantial amount of missing values were the discrimination score (11% missing), percentage of those living below the poverty level (8% missing), median

neighborhood household income (8% missing), and personal income (7% missing). To address the missing values in our analyses, regression imputation was performed by averaging using Markov chain Monte Carlo simulations from a multivariate normal model for the data. The categorical variables income, education, marital status, and cancer stage were treated as quantitative, and means of the simulated values were rounded to the closest whole number. The imputation was performed using SAS PROC MI. This strategy was applied only to predictor variables in the regression models, not to the dependent variables, PCS and MCS.

For multiple regression models of MCS and PCS on demographic and clinical characteristics, an *F* test was first performed for the significance of the inclusion of any variable. Then, a stepwise variable selection criterion was used to exclude and retain variables at each stage when the *P* value was greater or less than 0.1, respectively. This procedure forced sexual orientation into the model and allowed all other variables to be selected by the stepwise procedure. Because of consistent evidence that sexual minority women differ from heterosexual women with respect to income, education [27, 32], and discrimination experiences due to sexual orientation [33–36], four interaction terms (sexual orientation with: (1) education, (2) income, (3) median neighborhood income, (4) discrimination) were also evaluated, via stepwise linear regression, for significant effects on PCS and MCS, using the same variable exclusion and retention criterion. The fit of the final models were summarized with R-squared statistics. To examine the appropriateness of combining the registry and convenience samples as the final sample for model summaries, an additional model was fitted, based on the combined sample, that included a binary indicator of sample membership (registry versus convenience) along with the interaction of this indicator with all the independent variables that resulted from the stepwise procedure. The inclusion of these variables was assessed with a partial *F* test.

Results

Table 1 presents participants' characteristics by sexual orientation and by sample type, first testing for differences between heterosexual and sexual minority survivors in the registry sample, and, subsequently, comparing sexual minority women in the registry sample with sexual minority women in the convenience sample. In the registry sample, there were significant differences in some demographic and clinical characteristics. The sexual minority survivors were younger, more likely of white race, never married, better educated, more likely employed, and with

Table 1 Characteristics of the sample

	Registry heterosexual (n = 257)	Registry SMW (n = 69)	Convenience SMW (n = 112)	P value £	P value ¥
Current age (Mean ± SD)	62.7 ± 11.0	55.9 ± 8.3	55.1 ± 8.7	<0.01	0.54
Missing	0	0	1		
Race					
White	219 (85.2%)	65 (94.2%)	97 (86.6%)	0.048	0.10
Missing	0	0	0		
Current marital status					
Married	161 (62.9%)	37 (54.4%)	24 (21.6%)	<0.01	<0.01
Never married	32 (12.5%)	22 (32.4%)	65 (58.6%)		
Sep/Div/widowed	63 (24.6%)	9 (13.2%)	22 (19.8%)		
Missing	1	1	1		
Education					
High school	47 (18.4%)	0 (0.0%)	1 (0.9%)	<0.01	<0.01
College	127 (49.8%)	23 (33.3%)	64 (57.1%)		
Graduate	81 (31.8%)	46 (66.7%)	47 (42.0%)		
Missing	2	0	0		
Employed					
Yes	139 (54.1%)	50 (72.5%)	73 (65.2%)	<0.01	0.31
No	118 (45.9%)	19 (27.5%)	39 (34.8%)		
Missing	0	0	0		
With health insurance	255 (99.2%)	68 (98.6%)	110 (98.2%)	0.60	0.86
Missing	0	0	0		
Income					
<\$30,000	122 (53.0%)	22 (31.9%)	39 (35.8%)	<0.01	0.84
\$30,000–\$70,000	61 (26.5%)	23 (33.3%)	36 (33.0%)		
\$70,000 +	47 (20.4%)	24 (34.8%)	34 (31.1%)		
Missing	27	0	3		
Percentage of those living below the poverty level					
0–4.9%	114 (45.8%)	22 (33.3%)	38 (43.2%)	0.25	0.59
5–9.9%	73 (29.3%)	27 (40.9%)	33 (37.5%)		
10–19.9%	44 (17.7%)	12 (18.2%)	11 (12.5%)		
20% or more	18 (7.2%)	5 (7.6%)	6 (6.8%)		
Missing	8	3	24		
Median neighborhood household income					
Low (1st quintile < \$43,846)	67 (26.9%)	10 (15.2%)	20 (22.7%)	<0.01	0.29
High (5th quintile > \$74,313)	66 (26.5%)	9 (13.6%)	16 (18.2%)		
Missing	8	3	24		
Discrimination (Mean ± SD)	0.5 ± 0.9	1.4 ± 1.4	1.5 ± 1.6	<0.01	0.72
Missing	22	8	20		
Years since diagnosis	4.7 ± 1.8	5.3 ± 1.5	6.4 ± 1.8	0.01	<0.01
Missing	0	0	1		
Stage					
DCIS	63 (24.7%)	26 (38.2%)	23 (21.3%)	0.05	<0.01
I	107 (42.0%)	28 (41.2%)	35 (32.4%)		
II	73 (28.6%)	10 (14.7%)	39 (36.1%)		
III	12 (4.7%)	4 (5.9%)	11 (10.2%)		
Missing	2	1	4		

Table 1 continued

	Registry heterosexual (n = 257)	Registry SMW (n = 69)	Convenience SMW (n = 112)	<i>P</i> value £	<i>P</i> value ¥
Surgical treatment					
Lumpectomy	181 (70.4%)	53 (76.8%)	48 (42.9%)	0.02	<0.01
Mastectomy only	37 (14.4%)	14 (20.3%)	45 (40.2%)		
Mastectomy w/reconstruction	39 (15.2%)	2 (2.9%)	19 (17.0%)		
Missing	0	0	0		
Radiation	192 (74.7%)	52 (75.4%)	66 (58.9%)	0.91	0.02
Missing	0	0	0		
Chemotherapy	103 (40.1%)	24 (34.8%)	66 (58.9%)	0.42	<0.01
Missing	0	0	0		
Hormone therapy	168 (65.4%)	37 (53.6%)	78 (69.6%)	0.07	0.03
Missing	0	0	0		
Comorbidities					
No	22 (8.8%)	7 (10.4%)	9 (8.3%)	0.35	0.62
One	42 (16.8%)	12 (17.9%)	18 (16.7%)		
Two	46 (18.4%)	18 (26.9%)	22 (20.4%)		
Three or more	140 (56.0%)	30 (44.8%)	59 (54.6%)		
Missing	7	2	4		
PCS (Mean ± SD)	49.3 ± 9.4	51.4 ± 10.2	48.8 ± 10.9	0.10	0.11
Missing	6	1	1		
MCS (Mean ± SD)	50.3 ± 10.4	48.8 ± 10.1	52.4 ± 9.0	0.27	0.01
Missing	6	1	1		
Fair or poor health	27 (10.5%)	6 (8.7%)	11 (9.8%)	0.66	0.80
Missing	0	0	0		

£ *P* value for comparison of registry heterosexual to registry SMW

¥ *P* value for comparison of registry SMW to convenience SMW

higher individual income compared to heterosexual survivors. Sexual minority women resided less often in lowest or highest median household neighborhoods and reported significantly more experiences of discrimination compared to heterosexual women. On average, time since diagnosis was longer for sexual minority women, more were treated with lumpectomy, and almost none of the sexual minority survivors treated with mastectomy opted for breast reconstruction. No significant differences were found with respect to stage of disease, receipt of adjuvant therapies, and the number of comorbidities. Sexual minority women in the convenience sample shared most demographic characteristics of the sexual minority women in the registry sample. Exceptions were that in the convenience sample, fewer were married, fewer had graduate education, more lived in neighborhoods with low median income, and more time elapsed since diagnosis compared to the registry sample. Clinical differences existed in that the convenience sample was diagnosed at a later stage, had less breast-conserving surgery, less radiation, yet more chemotherapy, and more hormonal therapy. In this study, 11% of survivors

reported surgical treatment only, while the majority were followed up with complex combinations of adjuvant therapy, 25% with radiation and hormone therapy, 23% radiation, chemotherapy, and hormone therapy, 12% radiation and chemotherapy, and 8% chemotherapy and hormone therapy. Another 21% of survivors had monotherapy after surgery, in that 11% had radiation, 9% had hormone therapy, and 1% chemotherapy.

When outcomes were compared by sexual orientation and then by sample type, there were no significant differences in PCS and in the proportion of survivors with fair or poor health. Heterosexual survivors did not significantly differ from sexual minority survivors in the registry sample, yet there were significant differences by sample. Sexual minority survivors in the convenience sample reported better mental health compared to sexual minority survivors in the registry sample.

Because discrimination summarizes different experiences, and because discrimination significantly differed by sexual orientation, but not sample, the type of discrimination reported by the 68% of sexual minority and the 35% of

heterosexual women who reported any discrimination was further examined. Sexual minority survivors' discrimination experiences consisted of 53% gender, 43% sexual orientation, 17% appearance, 13% age, 11% cancer, 10% income, and 8% race/ethnicity discrimination. In comparison, heterosexual survivors' discrimination related to: 25% gender, 9% age, 6% race/ethnicity, 5% appearance, 4% income, 4% cancer, and 0% sexual orientation discrimination.

Table 2 relates each demographic and clinical factor to PCS. Sexual orientation was not significantly associated with physical health in the bivariate model and did not reach significance, in any of the models that assessed the association of demographic and clinical characteristics and PCS. When controlling for sexual orientation, women who were younger, White, more educated, employed and had higher income had significantly better physical health. Women who were separated or divorced had significantly worse physical health. With respect to residence, living in a neighborhood with less poverty and neighborhoods with higher median income was associated with significantly better physical health. Of the clinical characteristics, mastectomy rather than lumpectomy, and having two or more comorbidities, was significantly associated with worse physical health.

The last two columns of Table 2 provide the results for the combined sample, after the addition of the convenience sample of sexual minority survivors to the registry sample of heterosexual and sexual minority survivors. Most results were consistent, replicating the previously described significant associations of age, race, marital status, education, employment, income, neighborhood poverty level, median neighborhood income, surgical treatment, and comorbidities with physical health. Again, sexual orientation showed no significant association either alone or in combination with another characteristic. One new association was identified; more experiences of discrimination were associated with worse physical health.

Table 3 presents the association of each clinical and demographic characteristic and survivors' MCS, first for the registry sample alone and then for the combined sample that includes the convenience sample of sexual minority survivors. Sexual orientation was not significantly associated with mental health alone or in combination with any of the demographic or clinical characteristics in both samples. Only one characteristic, age, was significantly associated with MCS in both samples, indicating that older women had significantly better mental health.

Table 4 presents the results of two stepwise regression models of survivors' physical health, one for the registry and one for the combined sample. Prior to performing the stepwise procedure, a linear regression including all the candidate variables was fitted and then an F test was

performed to determine whether any of the variables was significant. For both samples, the tests were significant at the 0.0001 level ($F = 5.21$ on 31, 287 df , $P < 0.0001$ for the registry sample; $F = 6.21$ on 30, 398 df , $P < 0.0001$ for the combined sample). Based on the stepwise results, when focusing on the registry sample, survivors' physical health was significantly associated with cancer stage, the neighborhood poverty level where survivors reside, with hormone therapy, chemotherapy, their comorbidities, and an interaction between sexual orientation and income. Survivors with earlier cancer stage, those living in less impoverished neighborhoods, and those treated with chemotherapy had better physical health, whereas survivors with more comorbidities and with hormone therapy had worse physical health. The interaction effect of income and sexual orientation suggests better physical health in survivors with an income of \$30,000 and above, compared to survivors in the lowest income group, regardless of survivors' sexual orientation. Sexual minority women in the middle and low-income groups had lower physical health on average than heterosexual women.

When physical health was examined using the expanded sample of survivors, a different combination of demographic and clinical characteristics significantly contributed toward explaining breast cancer survivors' physical health than in the registry sample. The interaction term of sexual orientation and income, cancer stage, neighborhood poverty level, and chemotherapy was no longer significant. However, in this expanded sample, an interaction term of discrimination and sexual orientation significantly contributed toward explaining physical health, in that sexual minority women with more experiences of discrimination had significantly worse physical health. Hormone therapy and greater number of comorbidities were related to worse physical health, whereas white race, employment, and greater education were significantly associated with better physical health. In both models, sexual orientation was not significantly related with physical health. The combination of the various demographic and clinical characteristics explained 33 percent of survivors' physical health for the registry and 28 percent for the combined sample.

Table 5 reports factors relevant to breast cancer survivors' mental health. The F tests for the importance of any of the candidate independent variables were not significant at the 0.05 level, for the registry sample ($F = 1.32$ on $df = 29, 289$, $P = 0.13$) and for the combined sample ($F = 1.41$ on $df = 29, 399$, $P = 0.081$). Employed and older breast cancer survivors in the registry sample had significantly better mental health. In the combined sample, better mental health was related to being older and higher income. However, for each sample, the combination of demographic and clinical characteristics explained only a small proportion of survivors' mental health. Similar to the

Table 2 Associations of demographic and clinical characteristics with PCS, after controlling for sexual orientation

Characteristics	Registry sample		Combined Sample	
	Characteristic coefficient \pm SE	Sexual orientation coefficient \pm SE	Characteristic coefficient \pm SE	Sexual orientation coefficient \pm SE
Sexual orientation ^a (SMW)		2.16 \pm 1.31		0.52 \pm 0.97
Current Age	-0.13 \pm 0.05*	1.28 \pm 1.35	-0.10 \pm 0.05*	-0.21 \pm 1.03
Race (White)	4.27 \pm 1.58**	1.77 \pm 1.31	4.69 \pm 1.41**	0.28 \pm 0.97
Current marital status		2.16 \pm 1.33		0.58 \pm 1.05
Married (ref)	-1.70 \pm 1.49		-0.72 \pm 1.22	
Never married	-2.76 \pm 1.34*		-2.74 \pm 1.24*	
Sep/Div/widowed				
Education				
High school (ref)		0.56 \pm 1.35		-0.44 \pm 1.01
College	2.29 \pm 1.60		2.34 \pm 1.64	
Graduate	5.76 \pm 1.70***		5.17 \pm 1.71**	
Employed	4.42 \pm 1.08***	1.34 \pm 1.30	4.95 \pm 0.96***	-0.13 \pm 0.96
With health insurance	3.77 \pm 5.57	2.19 \pm 1.31	-0.65 \pm 4.49	0.52 \pm 0.98
Income		0.94 \pm 1.27		-0.47 \pm 0.96
<\$30,000 (ref)				
\$30,000–\$70,000	4.55 \pm 1.23***		4.20 \pm 1.11***	
\$70,000 +	6.42 \pm 1.31***		5.98 \pm 1.16***	
Percentage of those living below the poverty level		2.47 \pm 1.28		0.80 \pm 0.97
0–4.9%	7.68 \pm 2.11***		4.46 \pm 1.75*	
5–9.9%	4.94 \pm 2.16*		2.63 \pm 1.79	
10–19.9%	5.15 \pm 2.29*		3.35 \pm 1.96	
20% or more (ref)				
Median neighborhood household income		2.47 \pm 1.32		0.81 \pm 0.98
Low (1st quintile < \$43,846)	-1.01 \pm 1.32		-0.66 \pm 1.15	
Middle (\$43,847–\$74,312) (ref)				
High (5th quintile > \$74,313)	3.30 \pm 1.31*		2.65 \pm 1.21*	
Discrimination	-0.28 \pm 0.54	2.43 \pm 1.41	-0.95 \pm 0.40*	1.56 \pm 1.06
Years since diagnosis	-0.08 \pm 0.31	2.21 \pm 1.33	-0.39 \pm 0.27	0.96 \pm 1.03
Stage				
DCIS (ref)		2.09 \pm 1.31		0.70 \pm 0.97
I	2.27 \pm 1.30		0.58 \pm 1.20	
II	-0.68 \pm 1.46		-1.79 \pm 1.29	
III	-2.34 \pm 2.57		-4.21 \pm 2.08*	
Surgical treatment				
Lumpectomy (ref)		2.35 \pm 1.31		1.07 \pm 0.99
Mastectomy only	-3.65 \pm 1.49*		-3.39 \pm 1.20**	
Mastectomy w/reconstruction	0.13 \pm 1.62		-1.67 \pm 1.40	
Radiation	-0.21 \pm 1.24	2.17 \pm 1.31	-0.78 \pm 1.06	0.45 \pm 0.65
Chemotherapy	0.34 \pm 1.10	2.18 \pm 1.32	-1.16 \pm 0.97	0.63 \pm 0.52
Hormone therapy	-1.30 \pm 1.12	2.02 \pm 1.32	-1.83 \pm 1.00	0.50 \pm 0.97
Comorbidities no (ref)		1.18 \pm 1.16		0.13 \pm 0.86
One	-2.41 \pm 1.94		-1.75 \pm 1.77	
Two	-4.25 \pm 1.88*		-3.38 \pm 1.71*	
Three or more	-11.66 \pm 1.69***		-11.26 \pm 1.54***	

Results of separate linear regression models for each characteristic, controlling for sexual orientation

^a This row represents binary associations of sexual orientation with the outcome

* $P < .05$, ** $P < .01$,

*** $P < .001$

Table 3 Associations of demographic and clinical characteristics with MCS, after controlling for sexual orientation

Characteristics	Registry sample		Combined sample	
	Characteristic coefficient ± SE	Sexual orientation coefficient ± SE	Characteristic coefficient ± SE	Sexual orientation coefficient ± SE
Sexual orientation [^] (SMW)		−1.57 ± 1.41		0.70 ± 0.98
Current age	0.16 ± 0.06**	−0.50 ± 1.45	0.15 ± 0.05**	1.78 ± 1.03
Race (White)	−0.80 ± 1.73	−1.50 ± 1.42	−0.40 ± 1.45	0.73 ± 0.99
Current marital status		−1.70 ± 1.44		0.29 ± 1.07
Married (ref)				
Never married	−0.30 ± 1.61		1.05 ± 1.24	
Sep/Div/widowed	−1.50 ± 1.45		−0.52 ± 1.26	
Education				
High school (ref)		−1.83 ± 1.48		0.43 ± 1.03
College	1.76 ± 1.77		1.18 ± 1.68	
Graduate	1.59 ± 1.87		1.55 ± 1.75	
Employed	−0.14 ± 1.19	−1.55 ± 1.43	−0.11 ± 1.00	0.72 ± 0.99
With health insurance	1.38 ± 6.01	−1.56 ± 1.42	7.17 ± 4.52	0.77 ± 0.98
Income		−1.76 ± 1.43		0.39 ± 1.00
<\$30,000 (ref)				
\$30,000–\$70,000	0.002 ± 1.38		0.64 ± 1.16	
\$70,000+	1.23 ± 1.47		2.17 ± 1.21	
Percentage of those living below the poverty level		−1.48 ± 1.41		0.73 ± 0.99
0–4.9%	−0.19 ± 2.31		−1.42 ± 1.77	
5–9.9%	−1.18 ± 2.37		−1.56 ± 1.82	
10–19.9%	1.82 ± 2.51		0.80 ± 1.99	
20% or more (ref)				
Median neighborhood household income		−1.39 ± 1.44		0.77 ± 0.99
Low (1st quintile < \$43,846)	0.43 ± 1.44		0.70 ± 1.17	
Middle (\$43,847–\$74,312) (ref)				
High (5th quintile > \$74,313)	0.95 ± 1.43		0.38 ± 1.23	
Discrimination	−0.61 ± 0.58	−1.00 ± 1.51	−0.62 ± 0.41	1.38 ± 1.08
Years since diagnosis	0.02 ± 0.33	−1.58 ± 1.43	0.15 ± 0.27	0.54 ± 1.05
Stage				
DCIS (ref)		−1.69 ± 1.42		0.77 ± 0.98
I	−2.68 ± 1.41		−1.85 ± 1.22	
II	−1.01 ± 1.58		−0.96 ± 1.31	
III	−1.49 ± 2.78		−4.03 ± 2.11	
Surgical treatment				
Lumpectomy (ref)		−1.94 ± 1.42		0.85 ± 1.00
Mastectomy only	−0.76 ± 1.61		−1.11 ± 1.22	
Mastectomy w/reconstruction	−3.22 ± 1.76		−1.49 ± 1.43	
Radiation	0.56 ± 1.34	−1.58 ± 1.42	−0.35 ± 1.07	0.67 ± 0.99
Chemotherapy	−1.32 ± 1.18	−1.64 ± 1.41	−1.39 ± 0.98	0.83 ± 0.99
Hormone therapy	0.52 ± 1.21	−1.51 ± 1.42	1.14 ± 1.02	0.72 ± 0.98
Comorbidities no (ref)		−1.68 ± 1.41		0.64 ± 0.98
One	1.46 ± 2.37		0.09 ± 2.01	
Two	−0.73 ± 2.29		−1.23 ± 1.94	
Three or more	−1.29 ± 2.06		−2.45 ± 1.75	

Results of separate linear regression models for each characteristic, controlling for sexual orientation

[^] This row represents binary associations of sexual orientation with the outcome

** $P < .01$

Table 4 Modeling PCS, using stepwise regression

Variable	Registry sample		Combined sample	
	Coefficient	SE	Coefficient	SE
Sexual orientation (SMW)	-1.11	1.88	0.85	1.18
Income			-	-
<\$30,000 (ref)				
\$30,000–\$70,000	2.36	1.25		
\$70,000 +	2.16	1.40		
Interaction sexual orientation*Income			-	-
\$30,000–\$70,000*SMW	-0.59	2.77		
\$70,000+*SMW	5.38	2.74		
Stage			-	-
DCIS (ref)				
I	1.27	1.18		
II	-2.30	1.67		
III	-4.34	2.58		
Discrimination score	-	-	0.85	0.63
Interaction sexual orientation*Discrimination score	-	-	-1.64	0.75
Percentage of those living below the poverty level			-	-
0–4.9%	5.76	1.87		
5–9.9%	4.35	1.91		
10–19.9%	4.61	2.03		
20% or more (ref)				
Hormone treatment	-2.25	1.00	-2.12	0.88
Chemotherapy	2.34	1.28	-	-
Comorbidities no (ref)				
One	-2.14	1.88	-1.26	1.73
Two	-4.16	1.82	-3.27	1.67
Three or more	-10.64	1.67	-10.11	1.54
Race: White	-	-	2.82	1.28
Employed	-	-	2.72	0.88
Education				
High school (ref)				
College			0.56	1.47
Graduate			2.41	1.55
<i>R square</i>	<i>0.33</i>		<i>0.28</i>	

Sexual orientation was forced into each model; remaining variables were excluded and retained when P value was >0.1 or <0.1 , respectively. The P values for sexual orientation were 0.5547 in the Registry Sample model and 0.4710 in the Combined Sample model

PCS models, sexual minority status was not significantly predictive of MCS in the registry or the combined sample.

For the PCS and MCS combined sample models in Tables 4 and 5, models were fitted by adding the registry/convenience sample indicator along with the interactions of this binary variable with the entire model terms resulting

from the stepwise model. The P value for the F test for the PCS model was 0.9917 ($F = 0.242$, $df = 10,407$), and for the MCS model was 0.0749 ($F = 2.141$, $df = 4,420$). Thus, for each model, the collection of additional predictors was not significant at the 0.05 level.

Discussion

The expectation that sexual minority survivors have lower QOL compared to heterosexual women was not confirmed. To the contrary, heterosexual and sexual minority survivors presented similarly with respect to their PCS and MCS, with scores close to the US population mean of 50. This is consistent with an earlier study of long-term disease-free breast cancer survivors, which concluded that many years after breast cancer diagnosis and treatment, most breast cancer survivors have a good QOL [6].

In contrast to sexual orientation, clinical and demographic characteristics made a significant contribution toward explaining physical health. Survivors treated with adjuvant hormonal therapy, such as tamoxifen, and those with more comorbidities and later stage of disease had worse physical QOL, consistent with earlier findings [6, 37–39]. Similarly, as others have shown, lower socioeconomic status [10, 11] and being non-White is linked to worse physical health [8–10]. A novel finding of this study is the significant association between neighborhood-level socioeconomic status and physical health, indicating that living in neighborhoods with less poverty is related to better physical health scores. When the registry sample alone was examined, sexual minority women in the highest income group reported better physical health compared to heterosexual survivors of any income and sexual minority women with less income. However, the relationship between income and PCS was not stable; in the combined sample, which includes more sexual minority women, neighborhood poverty level and the interaction term of sexual orientation and income were no longer significantly associated with physical health. It is possible that some of the sample differences in the characteristics associated with PCS may be due to confounding. For example, in the combined sample, education and employment had significant associations, whereas income was not significant. Similarly, confounding is also a likely explanation for the significant positive association between chemotherapy and PCS in the registry sample. A novel finding of these analyses is the significant association of an interaction between sexual minority women's greater discrimination experiences and worse physical health. To further understand the relationship between discrimination and PCS, analyses explored whether differences in PCS can be linked to survivors' different types of discrimination. As

Table 5 Modeling MCS, using stepwise regression

Variable	Registry sample		Combined sample	
	Coefficient	SE	Coefficient	SE
Sexual orientation (SMW)	−0.50	1.44	1.53	1.04
Age	0.23	0.07	0.18	0.05
Employed	2.71	1.44	–	–
Income	–	–		
<\$30,000 (ref)				
\$30,000–\$70,000			1.42	1.17
\$70,000 +			3.18	1.23
<i>R square</i>	0.04		0.04	

Sexual orientation was forced into each model; remaining variables were excluded and retained when *P* value was >0.1 or <0.1, respectively. The *P* values for sexual orientation were 0.2671 in the Registry Sample model and 0.1394 in the Combined Sample model

types, no discrimination, sexual orientation discrimination, and other types of discrimination were distinguished. Survivors' types of discrimination were not significantly related to their physical health. Additional analyses explored the possibility that among sexual minority survivors only the level of discrimination affects physical health. Discrimination experiences could not be linked to sexual minority survivors' physical health.

Fewer factors were found to relate to survivors' mental health, and the final models only explained about four percent of the variance in survivors' mental health. None of the clinical factors significantly contributed toward explaining breast cancer survivors' mental component summary score, whereas some demographic factors contributed. Older women and employed women had significantly better mental health. After the sample was expanded to include more sexual minority women, employment was no longer significant, but higher income related to better mental health. These results suggest that clinical factors are more suitable for explaining long-term survivors' physical health, whereas survivors' mental health is not significantly impacted by clinical factors, such as cancer stage, comorbidities, or treatment-specific factors, such as chemotherapy or the type of surgical treatment. Of course, based on the low amount of variance in survivors' MCS that was explained, these findings are not particularly illuminating with respect to survivors' mental health, which suggests the need for future studies to identify stronger predictive factors of survivors' mental health.

In this study, equal proportions of sexual minority and heterosexual long-term breast cancer survivors, about ten percent, reported fair or poor health. In contradistinction, in a recent population-based study of California cancer survivors, the prevalence of fair or poor health varied from 27% to 40% depending on women's sexual orientation, with lesbians and bisexuals having 2.0 and 2.3 times the odds of reporting fair or poor health compared to heterosexual survivors [27]. These inconsistencies raise interesting questions as to how one may explain these different findings with respect to sexual orientation and the

differences in the prevalence of fair and poor health. The earlier California-based survivor study [27] entailed survivors of any type of cancer, irrespective of their stage of disease, current treatment, recurrence, and time since diagnosis, similar to a national cancer survivor sample from the National Health Interview Survey [40], which reported a 30% prevalence of fair or poor health. In comparison, the breast cancer sample in this study is restricted to primary cancer, nonmetastatic stage of disease, diagnoses between the years 2000 and 2005, recurrence-free survivors, and completion of cancer therapies. Similarly, in a registry-based study of long-term breast cancer survivors, without recurrence 5 years after receiving a diagnosis of nonmetastatic breast cancer, eight percent of survivors reported fair or poor health [37], comparable to the ten percent reporting fair or poor health in this sample.

The juxtaposition of these studies' results suggests that differences in the eligibility criteria of these studies likely explain differences in the prevalence rates of fair and poor health. The exclusion of other cancers, multiple primary cancers, metastatic stage of disease, recurrences, and patients currently undergoing cancer therapies, reduces the amount of fair or poor health. These eligibility criteria may also explain the inconsistencies with respect to sexual orientation; this was significantly associated with perceptions of fair or poor health in the California-based study, whereas no significant association was found in our sample of healthy long-term breast cancer survivors. Eligibility criteria for this study biased against recruitment of sexual minority women with diagnoses of later stage disease, metastatic disease, a second cancer, or cancer recurrence, and it may be these sexual minority women have a greater likelihood of having fair or poor health. Thus, the recruited sample of sexual minority women with breast cancer may represent a subgroup that has better QOL than sexual minority survivors with other and later stage cancers, explaining their better QOL. This is a speculation to be explored by future studies that include sexual minority survivors who are diverse with respect to cancer stage, recurrence, time since diagnosis. Others may suggest the

inconsistencies in results between the California-based study of cancer survivors and this sample of breast cancer survivors are linked to geographic differences, possibly indicating better conditions for sexual minority women in Massachusetts due to same-sex marriage rights. The authors doubt that geographic differences are an explanation, because recent noncancer population-based data indicate that sexual minority women in Massachusetts have significantly greater odds of reporting fair or poor health than heterosexual women in Massachusetts [41]. Moreover, the registry-derived sexual minority survivors have been previously compared to the mostly non-Massachusetts, convenience sample of sexual minority survivors with respect to many characteristics, including MCS, PCS, and sexual orientation-related experiences, and no differences between these samples were found [28].

This study also generated novel findings with respect to discrimination experiences. Less than half of sexual minorities reported discrimination due to sexual orientation. However, the sexual minority survivors reported more experiences of discrimination due to all other characteristics. Sexual minorities reported more gender, cancer, and race/ethnicity discrimination than were reported by heterosexual survivors, even though these two groups of women shared being female, having cancer and were similar with respect to race/ethnicity. Sexual minorities were significantly younger and had higher income compared to heterosexual women who reported fewer discrimination experiences due to age and income. This suggests sexual minorities have a different appraisal of discrimination experiences beyond discrimination due to sexual orientation. This is consistent with earlier findings of a national sample of lesbian and bisexual women, which also attributed 58% of their discrimination experiences to causes other than sexual orientation and 42% to sexual orientation discrimination [24].

There are a number of limitations to be acknowledged in the context of this study. The data are cross-sectional and do not provide an understanding of change over time in these survivors' QOL. The sample of breast cancer survivors is highly educated and mostly of white race, which interferes with the ability to confidently reach conclusions about the QOL of racial and ethnic minority women or breast cancer survivors with lower education levels. Although sexual minority women differed by sample type, the authors believe that the geographic differences of the samples largely explain these differences between sexual minorities, including differences in marital status, education, and clinical presentation. For example, Massachusetts is a socially progressive state that allowed same-sex marriage in 2004. Greater proportions of the Massachusetts population have advanced educational attainment. Similarly, clinical differences in sexual minorities by sample

type also appear to be consistent with geographic differences. Higher screening rates in areas with more availability of mammography [42] have been documented and the highest percentage of early stage breast cancer at presentation is reported in the Northeast [43]. Nevertheless, the authors are unable to unequivocally attribute these differences to geographic variation, as the samples may indeed be different for other unexplained reasons. Similarly, both the registry and the convenience sample are limited by a nonresponse bias, which cannot be determined or quantified, given the absence of recorded sexual orientation data.

The novel findings of this study, based on a population-based sample of long-term breast cancer survivors of diverse sexual orientations, represent a broad assessment of health outcomes and may point to an absence of disparity. The understanding of specific QOL domains requires additional studies that identify areas of similarities and difference between sexual minority and heterosexual survivors. Further research on mechanisms, such as social support or coping, including identifying previously unknown mechanisms, will greatly add to the understanding of the finding that sexual minority survivors have similar QOL compared to heterosexual women.

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