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Are physician recommendations for *BRCA 1/2* testing among breast cancer patients appropriate? A population based study

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Abstract

Background—Few population-based studies have examined utilization of *BRCA 1/2* testing or patterns of physician recommendations for genetic testing among women diagnosed with breast cancer. The objective of the current study was to evaluate the rates and predictors of physician recommendation for *BRCA 1/2* testing among breast cancer patients.

Methods—Women aged 18–64 years diagnosed with invasive breast cancer in 2007 were identified from the Pennsylvania State Cancer Registry and mailed a survey on family history of cancer, physician treatment recommendations, and *BRCA 1/2* testing. Of the 4009 women who were sent surveys, 2258 responded (56%). Based on age at diagnosis and family history, women were categorized as high, moderate, or low-risk for *BRCA 1/2* mutations.

Results—Nearly 25% of participants were at high risk for carrying a *BRCA 1/2* mutation based on age at breast cancer diagnosis and family history of breast and/or ovarian cancer. Physician recommendations for *BRCA 1/2* testing were strongly associated with risk of carrying a mutation, with 53% of high-risk women reporting a testing recommendation compared to 9% of low-risk women. In addition, physician recommendations were strongly correlated with use of testing in all risk groups. Among high-risk women, lack of a recommendation for *BRCA 1/2* testing was more common among older, low income, and employed women.

Conclusions—Although *BRCA 1/2* testing recommendations appear to be appropriately correlated with mutation risk, a significant proportion of breast cancer patients who meet criteria for *BRCA 1/2* testing may not receive recommendations for such testing from their providers.

Introduction

Testing for mutations in *BRCA1* and *BRCA2* can be useful among women with a breast cancer diagnosis. Being found to carry a mutation may have treatment implications, such as eligibility for contralateral mastectomy, prophylactic oophorectomy, and experimental therapeutic agents such as PARP inhibitors. In addition, *BRCA 1/2* testing can provide information for familial risk assessment. If a woman with cancer is found to have a mutation, her relatives may undergo testing for that mutation and make cancer risk reduction decisions based upon those test results.[1–3] The risk of carrying a *BRCA 1/2* mutation is

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approximately 5–10% among women diagnosed with breast cancer, and mutation risk is higher for women with early onset disease or a family history of breast and/or ovarian cancer.[4, 5] Clinical guidelines suggest that breast cancer patients should receive personalized risk assessment and consider genetic counseling and testing if they have early onset disease (Age ≤45), bilateral breast cancer, triple negative disease (ER-/PR-/HER2-), Ashkenazi Jewish ancestry, a strong family history of breast and/or ovarian cancer or a combination of these characteristics.[6]

Currently, relatively little is known about the use of *BRCA 1/2* testing among women with a breast cancer diagnosis. Although breast cancer patients are more likely to undergo genetic testing than women without breast cancer, studies suggested that rates of *BRCA 1/2* testing among breast cancer patients are relatively low.[7–13] Two surveys of convenience samples of breast cancer survivors found that less than 15% reported undergoing testing, with higher rates of testing among women with a family history of breast cancer, younger age at diagnosis, or Jewish ancestry.[14, 15]

Like breast cancer treatment decisions, the use of *BRCA 1/2* testing among breast cancer patients is likely influenced by both patient preferences and the recommendations of their health care providers.[15–18] Although there has been a growing interest in the use of *BRCA 1/2* testing at the time of diagnosis among surgeons and oncologists, the degree to which these providers are recommending *BRCA 1/2* testing, particularly to patients at high risk of carrying a mutation, is currently unknown. Thus, we conducted a retrospective cohort study of breast cancer patients in the state of Pennsylvania to examine provider recommendations for genetic testing, receipt of *BRCA 1/2* testing, and factors associated with not receiving a recommendation for testing among women at high risk for carrying a mutation.

Patients and Methods

Study design & Participants

Study participants were identified through the Pennsylvania State Cancer Registry (PCR), which has achieved NAACCR Gold certification for the accuracy and completeness of data. The institutional review boards of the University of Pennsylvania and the PCR approved the study protocol. Women diagnosed with invasive breast cancer at age 18–64 in Pennsylvania between January 1 and December 31, 2007 (N=4920) were mailed an introductory letter explaining the study, followed by a second mailing with a consent form, study questionnaire, prepaid return envelope, and an unconditional incentive of five dollars. Non-respondents were sent two additional mailings. Women were excluded if they were deceased (N=252), had invalid addresses (N=645), or were otherwise ineligible (reported not having cancer and/or not able to read/speak English N=14). Of the 4009 women eligible for the study with valid addresses, 2258 women returned the questionnaire (56%).

Data collection

The study questionnaire elicited socio-demographic characteristics, detailed family history of breast and ovarian cancer, and tumor characteristics. Women were asked to list their treatment recommendations, including whether BRACA Analysis® or *BRCA 1/2* testing was recommended. Women were asked about recommendations for genetic testing rather than genetic counseling, based upon prior work and pilot studies indicating that women reported referral for counseling as referral for testing and were confused when asked about recommendation for genetic counseling. Women were also asked if they had undergone *BRCA 1/2* testing, and the approximate date of the test. Because of privacy concerns given the mailed questionnaire, results of genetic testing were not ascertained. Participants' responses were linked to tumor characteristics from the PCR.

Women were asked whether their provider recommended *BRCA 1/2* testing, and possible responses included "no", "yes", or "don't know." Ten percent of respondents indicated "don't know," and 37% of respondents left this item unanswered. We combined those who responded "no", "don't know", and non-responses into a "no recommendation" group for the main analysis. Sensitivity analyses limiting the study population to those who answered "yes" or "no" to testing recommendations were performed. Women were categorized into three groups based on contact with a medical oncologist and treatment: saw an oncologist and received chemotherapy, saw an oncologist and did not receive chemotherapy, did not see an oncologist and did not receive chemotherapy. Based on cancer registry data, women were categorized as estrogen receptor (ER) or progesterone receptor (PR) positive, negative, or unknown. Because collection of HER2/neu status was not required by the PCR until 2010, self-reported HER2/neu status was used in this analysis.

BRCA 1/2 mutation risk categories

Established guidelines and other data regarding mutation prevalence[4, 6, 19] were used to categorize patients into three levels of risk for *BRCA 1/2* mutations based upon their age at diagnosis and family history (Figure 1). We were conservative in our definition of high-risk so as to capture women who would have been clear candidates for *BRCA 1/2* testing in 2007, as well as anticipated to have insurance coverage for genetic testing and therefore should have received a recommendation from their provider. High-risk women were those diagnosed with breast cancer at age 40 or younger, women with Ashkenazi Jewish heritage, or women diagnosed at age 50 or younger who met one of the following criteria: first or second degree female relative diagnosed with breast cancer at age ≤50, first or second degree relative diagnosed with ovarian cancer, first or second degree male relative with breast cancer, or two relatives on the same side of the family diagnosed with breast or ovarian cancer. Moderate risk women were those age 41–49 not meeting the high risk criteria, women diagnosed at 50 or older with a family history of breast or ovarian cancer, and women younger than 60 with triple negative disease. Low risk women were those diagnosed 50 and older who did not have triple negative disease with no family history, or women aged 60–64 with no family history regardless of tumor biology.

Statistical analysis

Patient characteristics, rates of testing recommendations, and rates of testing were compared across risk groups using t-tests and chi square tests. Agreement between recommendations and *BRCA 1/2* testing and between physician recommendations was assessed using kappa statistics. Differences in the proportion of women with recommendations for *BRCA1/2* testing who reporting undergoing testing were compared using chi square tests. Multivariable logistic regression was performed to estimate the odds of having a provider recommendation for *BRCA1/2* testing by various patient and tumor characteristics. In addition, among high risk women we estimated the odds of lacking test recommendation by patient and tumor characteristics. All statistical tests were two-sided with alpha of 0.05.

Results

Of the 4009 eligible women with valid addresses, 2258 women returned the questionnaire (56%). The mean age of respondents (52.1 years) was the same as that of the full PA registry population of women diagnosed with breast cancer before age 65 (Table 1). Respondents were slightly more likely to be white, have ER/PR positive disease, and earlier stage at diagnosis than the full registry population.

Demographic and tumor characteristics and report of *BRCA 1/2* test recommendations for the 2258 respondents are listed in Table 2. Ninety percent of participants reported having

health insurance, 95% identified having a medical oncologist, and 97% identified their surgeon (data not shown). Most women were diagnosed with localized disease (65%) and received chemotherapy (61%). Ninety percent of respondents were white, over 60% reported post-secondary education, and 38% reported annual household income greater than $70,000.

In total, 26% of patients reported a recommendation for genetic testing, and a similar percentage reported undergoing *BRCA 1/2* testing. We validated self-report of *BRCA 1/2* testing by reviewing medical records of the 55 respondents who received breast cancer treatment at the University of Pennsylvania, of whom 40 reported *BRCA 1/2* testing and 15 reported no testing. *BRCA 1/2* testing was confirmed in 37 out of 40 women who reported testing (Positive Predictive Value=93%). Evidence of *BRCA 1/2* testing was found in one of the 15 women who reported not being tested (Negative Predictive Value =93%).

Of the 2258 respondents, 24% met our definition of high-risk for carrying *BRCA 1/2* mutation (Table 2, N=546), 38% were moderate risk (N=860), and 38% were low risk (N=852). We chose a conservative high risk definition in order to identify breast cancer patients who should have been clear candidates for genetic testing based on 2007 guidelines. In addition to the criteria for high risk listed in Figure 1, current National Comprehensive Cancer Network criteria for *BRCA 1/2* testing include all women diagnosed at age ≤45, women age ≤60 with triple negative disease, and women with two or more affected relatives in the same lineage regardless of age at diagnosis.[6] When these three additional guidelines were applied, 43% of the study population met these testing guidelines.

Women in the high risk group were younger (by definition), had higher education and household income and were more likely to see an oncologist and receive chemotherapy than women in the moderate or low risk groups ($p<0.001$). High-risk women were less likely to have ER/PR positive disease and more likely to have HER2/neu positive disease than women in the low risk group ($p<0.001$). Fifty-three percent of high risk women, 25% of moderate risk women, and 9% of low risk women reported receiving a recommendation for *BRCA 1/2* testing from a provider. Among high risk women who received a recommendation, 30% reported recommendation from a medical oncologist only, 22% reported a recommendation from a surgeon only, and 49% reported a recommendation from both providers. There was fair agreement between medical oncologists' and surgeons' recommendations for *BRCA 1/2* testing among high risk women (72% agreement, Kappa=0.43), and the characteristics of patients referred by each type of provider were similar (data not shown).

Provider recommendations and undergoing *BRCA 1/2* testing were strongly correlated (91% agreement, kappa = 0.77). The percentage of women who underwent *BRCA 1/2* testing by testing recommendation is shown in Table 3. A high percentage of women who reported a provider recommendation underwent testing (83%), particularly among the high risk group (89%), and few women without a provider recommendation reporting receiving *BRCA 1/2* testing (6%), regardless of risk group (3–12%). Very few women reported *BRCA 1/2* testing prior to 2007 (<1%, data not shown), and therefore the majority of *BRCA 1/2* tests occurred after breast cancer diagnosis.

After adjusting for age at diagnosis, tumor characteristics, demographics, and socioeconomic factors (Table 4), receiving a recommendation for *BRCA 1/2* testing was strongly associated with risk category; women at high risk had six times the odds (OR=5.84, 95% CI 4.03–8.46, $p<0.001$) and women at moderate risk had three times the odds (OR=2.98 95% CI 2.19–4.04, $p<0.001$) of a recommendation compared to low risk women. Receiving a *BRCA 1/2* test recommendation was inversely associated with age at diagnosis ($p<0.001$) and was less common among women who did not see an oncologist or receive

chemotherapy (OR=0.48, 95% CI 0.25–0.91, p=0.018). Education and annual household income were strongly associated with test recommendation. (OR=1.75 95% CI 1.21–2.54, p=0.007 for income >$70,000 compared to <$30,000 and OR=1.54, 95% CI 1.19–1.99, p=0.001 for any college vs. high school or less).

Among high risk women, we examined the risk factors for not receiving a *BRCA 1/2* test recommendation from a provider (Table 5). Age at diagnosis was the strongest predictor of not receiving a recommendation for testing. Compared to women age 40 and younger, women who were age 41–50 at diagnosis had over twice the odds of no test recommendation (OR=2.20, 95% CI 1.47–3.30, p<0.001), and women 51 to 64 had over five times the odds of no test recommendation (OR=5.55, 95% CI 2.40–12.8, p<0.001). Low income women (< $30,000) were more than twice the odds of lacking test recommendation as women in the highest income group (OR=2.36, 95% CI 1.24–4.51, p=0.009). In addition, women who were employed were more likely to lack testing recommendation compared to unemployed women (OR=1.57, 95% CI 1.04–2.36, p=0.031). We repeated the logistic regression analyses among women who definitively answered “yes” or “no” as to whether their physician had recommended *BRCA 1/2* testing, excluding those who answered “don’t know” or did not respond, and the results were similar to the full analyses.

Discussion

To our knowledge, this is the first population based study to examine the rates of physician recommendation for *BRCA 1/2* testing in breast cancer patients. Our results confirm that physician recommendations are a critical determinant of the use of genetic testing among all risk groups; few patients received genetic testing without first receiving a physician recommendation. Testing recommendations among breast cancer patients appear to be largely and appropriately driven by patient risk factors for carrying a mutation (i.e. risk group), with 53% of high risk women reporting a physician recommendation for genetic testing compared to 9% of women at low risk of carrying a mutation. Nearly 25% of breast cancer patients diagnosed before age 65 met our conservative definition of high mutation risk, and over 40% met current NCCN guidelines.[6] While testing guidelines vary somewhat across professional organizations and change over time, patients categorized as high-risk in our study should have been clear candidates for referral to genetic counseling and testing at the time of breast cancer diagnosis. Our results suggest that a significant proportion of women with high risk of carrying a *BRCA1/2* mutation may not receive a testing recommendation from their provider. In addition to risk group, factors independently associated with testing recommendation included age at diagnosis, ER/PR status, and higher socioeconomic status.

Among high risk women, risk factors for failure to receive a testing recommendation included relatively late age at diagnosis, lower household income, and employment outside of the home. While it is appropriate that early age at diagnosis was used to target genetic testing recommendations among cancer patients, these results suggest that some strong candidates for genetic testing may be more likely to be overlooked by providers if they are older. This underscores the importance of detailed family history assessment for breast cancer patients regardless of age at diagnosis. The strong association of household income with testing recommendation among high risk women was surprising given that the vast majority of our study population reported having health insurance, and most health insurers cover *BRCA 1/2* testing in high risk populations. However, coverage criteria and copays may continue to represent substantial barriers to testing among patients with financial concerns or inadequate insurance coverage, or may be perceived as creating such barriers by providers.[20] In addition, among women in the high risk group, those who were employed were more likely to lack recommendation for testing. This could be due to concerns about

discrimination or loss of insurance coverage[21] given that women in the study were diagnosed with cancer prior to passage of the Genetic Information Nondiscrimination Act (GINA) in 2008,[22] or due to time constraints limiting women's ability to participate in pre-test genetic counseling.

Providers appear to be successful at limiting testing among women at low risk of carrying a mutation. The small number of women who received a recommendation for testing in the low risk group (9%) limited our ability to identify the determinants of testing recommendations in that group. However, in studies that included women with and without breast cancer, physician recommendation for testing was associated with family history, age at diagnosis, education, and income, which have been previously identified as predictors of both *BRCA 1/2* test recommendation[15] and uptake of genetic testing[9, 11, 12, 14, 23]. Minority race was not significantly associated with testing recommendation in this sample; however the small number of minority women limited the power to identify an association.

The main strength of our study is the population-based design with recruitment from the PCR, which provided a large sample of women with cancer diagnosed prior to age 65. Many studies of genetic testing have relied on convenience samples or patients referred to genetic testing clinics, and such sampling techniques are subject to bias.[7, 11, 23–25] Recruiting from the cancer registry provides a well-defined cohort and allows us to better assess the generalizability of our results. In addition, our study elicited detailed information on family history, allowing us to categorize individuals' mutation risk level relative to NCCN guidelines.[6] We chose a conservative definition of high-risk of mutation in order to focus on those who should have been clear candidates for referral for genetic testing in 2007.

Several limitations of the data should be considered. First, we relied on self-report of physician recommendations and *BRCA 1/2* testing. We found good agreement between self-reported *BRCA 1/2* testing and medical records in the small subset of women treated at our institution; however, we cannot validate physician recommendations for testing. Patients may not have remembered a recommendation for genetic testing, and therefore our rates of physician recommendation may be underestimated.[26] Underreporting of physician recommendations is also of concern, particularly in the high-risk group, since it suggests lack of effective communication between patients and providers. Recommendations for genetic testing should ideally be accompanied by genetic counseling. It is likely that women who participated in genetic counseling and who underwent genetic testing would be more likely to recall a physician's recommendation for *BRCA 1/2* testing, and this may partly explain the high concordance between physician recommendation and *BRCA 1/2* testing rates. The response rate to the mailed questionnaire was modest, and minority women and women with later stage disease were slightly underrepresented, limiting our ability to evaluate genetic testing utilization in these groups. Finally, our sample was drawn only from Pennsylvania and may not be generalizable to other areas of the country.

In summary, our results from a population-based study of breast cancer patients diagnosed before age 65 suggest that a significant number of women who meet established testing criteria may not receive recommendations for *BRCA 1/2* testing. Women at high risk for mutations who were older at diagnosis, had lower incomes, or were employed were less likely to report a physician recommendation for genetic testing. Interventions aimed at standardizing the use of familial risk assessment, increasing physician referrals for genetic counseling and testing for high risk women, and facilitating provider-patient communication regarding genetic testing may be warranted to help identify breast cancer patients who are most likely to benefit from *BRCA 1/2* testing.

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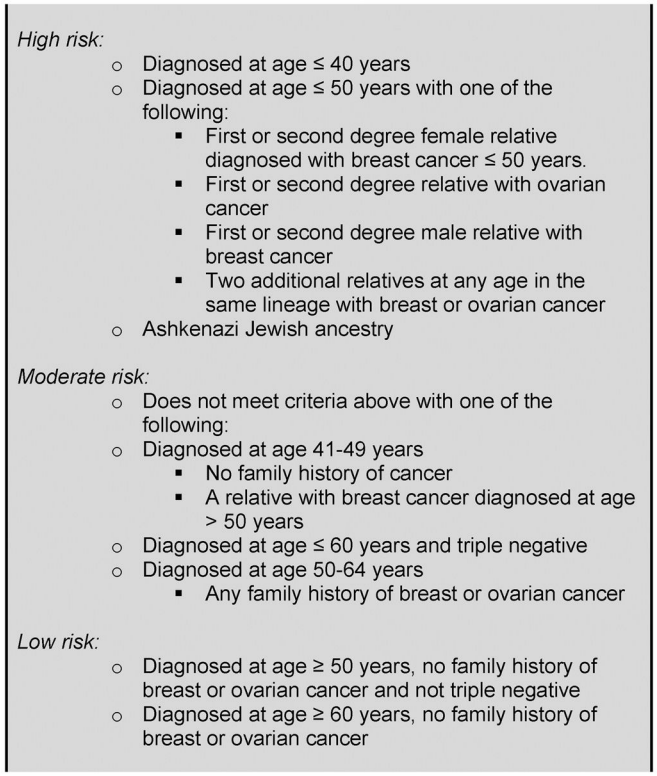

Figure 1.
Categories of risk for *BRCA 1/2* mutation

Table 1

Comparison of Characteristics of Women Aged 18–64 Diagnosed with Invasive Breast Cancer from the Pennsylvania Cancer Registry in 2007 and Survey Respondents

	2007 Registry Population (N=4920)	Respondents (N=2258)
Age at diagnosis (Mean ± SD)	52.1 ± 8.2	52.1 ± 8.1
ER/PR status, N (%)		
Positive	3728 (76)	1779 (79) *
Negative	940 (19)	411 (18)
Unknown	252 (5)	67 (3)
Stage at Diagnosis, N (%)		
Local	3005 (61)	1460 (65) *
Regional	1591 (32)	719 (32)
Distant	225 (5)	50 (2)
Unstaged/Unknown	96 (2)	29 (1)
Race		
White	4273 (87)	2026 (90) *
Black	494 (10)	145 (6)
Hispanic	82 (2)	34 (2)
Other/Unknown	68 (1)	31 (1)

* $p<0.05$, one sample t-test

Table 2

Characteristics of Survey Respondents Aged 18–65 Diagnosed with Invasive Breast Cancer in Pennsylvania in 2007, stratified by risk of *BRCA 1/2* mutation (N=2258)

	Total (N=2258)		High risk (N=546)		Moderate risk (N=852)		Low risk (N=860)		
	N	%	N	%	N	%	N	%	p-value*
Age at Diagnosis									
40 and under	203	9%	203	37%	---	---	---	---	<0.001
41 to 50	696	31%	264	48%	379	44%	53	6%	
51 to 60	973	43%	47	9%	349	41%	577	68%	
61 to 64	386	17%	32	6%	132	15%	222	26%	
ER/PR positive	1780	79%	417	76%	648	75%	715	84%	<0.001
HER2/neu positive	387	17%	107	20%	140	16%	140	16%	<0.001
Stage at Diagnosis									
Local	1460	65%	329	60%	587	60%	544	64%	0.051
Regional	719	32%	198	36%	246	29%	275	32%	
Distant	50	2%	13	2%	14	2%	23	3%	
Unstaged/Unknown	29	1%	6	1%	13	2%	10	1%	
Medical oncologist care									
Saw an oncologist and received chemotherapy	1383	61%	406	74%	529	62%	448	53%	<0.001
Saw an oncologist, did not receive chemotherapy	753	33%	125	23%	285	33%	343	40%	
Did not see an oncologist, did not receive chemotherapy	122	5%	15	3%	46	5%	61	7%	
White	2026	90%	497	91%	779	91%	771	90%	0.975
Employed	1243	55%	358	66%	501	58%	384	45%	<0.001
Jewish	134	6%	122	22%	9	1%	3	0%	<0.001
Married	1560	69%	397	73%	580	67%	583	68%	0.099
Educational attainment									
High School or Less	813	36%	130	24%	342	40%	341	40%	<0.001

	Total (N=2258)		High risk (N=546)		Moderate risk (N=852)		Low risk (N=860)		
	N	%	N	%	N	%	N	%	p-value*
College (2 or 4 year)	960	43%	249	46%	373	43%	338	40%	
Graduate School	464	21%	164	30%	139	16%	161	19%	
Missing	21	1%	3	1%	6	1%	12	1%	
Annual household income									
<$ 30,000	468	21%	83	15%	182	21%	203	24%	<0.001
$ 30 001 to $ 70 000	776	34%	177	32%	318	37%	281	33%	
> $ 70 000	867	38%	262	48%	316	37%	289	34%	
Missing	147	7%	24	4%	44	5%	79	9%	
Recommendation for *BRCA 1/2* testing									
No Recommendation	1673	74%	255	47%	643	75%	775	91%	<0.001
Total Recommended	585	26%	291	53%	217	25%	77	9%	
Medical oncologist only†	186	32%	86	30%	71	33%	29	38%	
Surgeon only†	134	23%	64	22%	50	23%	20	26%	
Both providers†	265	45%	141	49%	96	44%	28	36%	
Underwent *BRCA 1/2* Testing	587	26%	290	53%	214	25%	83	10%	<0.001

*p-value from chi square test comparing risk groups,

†Percentage of total recommended

Table 3

Proportion of Women with Breast Cancer Undergoing *BRCA 1/2* Testing by Provider Recommendation (N=2258)

	Percent Reporting *BRCA 1/2* testing				
Testing Recommendation	**Total**	**High risk**	**Moderate Risk**	**Low Risk**	**p-value***
No Recommendation	6%	12%	7%	3%	<0.001
Any Recommendation	83%	89%	77%	75%	<0.001

* p-value from chi square test of percent reporting *BRCA 1/2* test by risk groups

Table 4

Predictors of Recommendation for *BRCA 1/2* testing, N=2258 *

	Any *BRCA 1/2* test recommendation		
	OR	**95% CI**	**p-value**
Risk Group			
Low Risk	1.00	Reference	
Moderate Risk	2.98	2.19–4.04	<0.001
High Risk	5.84	4.03–8.46	<0.001
Age at Diagnosis			
40 and under	1.00	Reference	
41 to 50	0.41	0.28–0.60	<0.001
51 to 60	0.30	0.19–0.47	<0.001
61 to 64	0.29	0.17–0.47	<0.001
ER/PR status			
ER/PR Positive/Unknown	1.00	Reference	
ER/PR Negative	1.09	0.83–1.43	0.525
HER2 status			
HER2 Negative/Unknown	1.00	Reference	
HER2 Positive	1.13	0.86–1.49	0.372
Medical Oncologist Care			
Saw oncologist, received chemotherapy	1.00	Reference	
Saw oncologist, did not receive chemotherapy	0.88	0.68–1.15	0.145
Did not see oncologist, did not receive chemotherapy	0.48	0.25–0.91	0.018
Race			
White	1.00	Reference	
Non-white	0.81	0.55–1.19	0.375
Employment status			
Not employed	1.00	Reference	
Employed	0.87	0.69–1.10	0.264
Education			
High School or less	1.00	Reference	
College (2–4 year)	1.54	1.19–1.99	0.001
Graduate School	1.58	1.15–2.18	0.005
Missing	2.08	0.63–6.84	0.229
Annual Household Income			
<$30,000	1.00	Reference	
$30,001–70,000	1.56	1.10–2.20	0.018
>$70,000	1.75	1.21–2.54	0.007

	Any *BRCA 1/2* test recommendation		
	OR	**95% CI**	**p-value**
Missing	1.33	0.76–2.30	0.288

* Logistic regression adjusted for all factors in the model, stage at diagnosis, and marital status

Table 5

Predictors of Lack of Recommendation for *BRCA 1/2* testing among High Risk Women (N=546)

	***BRCA 1/2* test recommendation**				**Lack of *BRCA 1/2* test Recommendation***		
	No N=255		**Yes N=291**				
	N	**%**	**N**	**%**	**Odds Ratio**	**95% CI**	**p-value**
Age at Diagnosis							
40 and under	66	26	137	47	1.00	Reference	
41 to 50	134	53	130	45	2.20	1.47–3.30	<0.001
51 to 64	55	22	24	8	5.55	2.40–12.8	<0.001
ER or PR Positive							
ER/PR Positive/Unknown	208	82	225	77	1.00	Reference	
ER/PR Negative	47	18	66	23	0.83	0.52–1.32	0.431
HER2 positive							
HER2 Negative/Unknown	207	81	232	80	1.00	Reference	
HER2 Positive	48	19	59	20	1.12	0.70–1.78	0.644
Medical oncologist care							
Saw an oncologist and received chemotherapy	175	69	231	79	1.00	Reference	
Saw an oncologist, did not receive chemotherapy	69	13	56	19	1.24	0.77–1.99	0.381
Did not see an oncologist, did not receive chemotherapy	11	4	4	1	---	---	---
Race							
White	228	89	262	90	1.00	Reference	
Non-White	27	11	29	10	1.37	0.74–2.53	0.320
Employed							
Not employed	84	33	104	36	1.00	Reference	
Employed	171	67	187	64	1.57	1.04–2.36	0.031
Educational attainment							
High School or Less	73	29	57	20	1.00	Reference	

	***BRCA 1/2* test recommendation**						
	No N=255		**Yes N=291**		**Lack of *BRCA 1/2* test Recommendation***		
	N	**%**	**N**	**%**	**Odds Ratio**	**95% CI**	**p-value**
College (2 or 4 year)	113	44	136	47	0.71	0.45–1.13	0.150
Graduate School	68	27	96	33	0.59	0.33–1.04	0.069
Missing	1	0	2	1	---	---	---
Jewish Ancestry							
No	183	72	241	83	1.00	Reference	
Yes	72	28	50	17	1.10	0.57–2.11	0.785
Annual household income							
>$ 70,000	107	42	155	53	1.00	Reference	
$30,001 to $ 70,000	88	35	89	31	1.51	0.96–2.36	0.073
<$30,000	49	19	34	12	2.36	1.24–4.51	0.009
Missing	11	4	13	4	1.11	0.44–2.75	0.828

* Logistic regression, odds of lack of recommendation for *BRCA 1/2* testing, adjusted for all factors in the table, stage at diagnosis and marital status