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Risk-Reducing Salpingo-oophorectomy and Ovarian Cancer Screening in 1077 Women After *BRCA* Testing

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Abstract

Background—For women at potentially increased risk for ovarian cancer, data regarding screening and risk reduction are limited. Previous studies have reported on the behaviors of *BRCA* mutation carriers, but less is known about the behaviors of non-*BRCA* carriers. We surveyed a large cohort of women after *BRCA* testing to identify the prevalence and posttest predictors of risk-reducing and screening interventions.

Methods—A median of 3.7 years after *BRCA* testing, 1447 women who received genetic counseling and *BRCA* testing at 2 hospital sites were surveyed, with a 77.6% response rate. We analyzed data from 1077 survey respondents. We performed univariate and multivariate logistic regression analyses to identify predictors of risk-reducing salpingo-oophorectomy (RRSO), screening transvaginal ultrasonography (TVUS), and screening serum cancer antigen 125 (CA-125).

Results—Among the respondents, 201 women (18.7%) received positive test results for a deleterious mutation, 103 women (9.6%) received true-negative results, and 773 women (71.8%) received uninformative results. Overall, 19.1% of eligible women underwent RRSO and 39.6% used screening procedures. A positive *BRCA* result predicted RRSO (odds ratio [OR], 28.1; 95% CI, 16.2-48.6), TVUS (9.5 [4.3-21.0]), and serum CA-125 (13.0 [5.5-29.0]). Similarly, a true-negative *BRCA* result reduced the OR for RRSO (0.1 [0.0-0.6]), TVUS (0.2 [0.1-0.5]), and serum CA-125 (0.3 [0.1-0.7]). Of the 71.8% of women who received uninformative results after *BRCA* testing, 12.3% subsequently underwent RRSO, 33.8% reported ever having undergone screening

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serum CA-125 since *BRCA* testing, and 37.3% reported ever having undergone screening TVUS since *BRCA* testing.

Conclusions—Results of *BRCA* testing strongly predict RRSO and ovarian cancer screening. Use of RRSO and ovarian screening was reported in a sizable percentage of non-*BRCA* carriers despite insufficient data to determine the effectiveness of these interventions.

Ovarian Cancer is The leading cause of death from gynecologic malignant neoplasms in the developed world, with an estimated 21 880 new cases diagnosed in the United States in 2010 and 13 850 predicted deaths.[1] The lifetime risk of developing ovarian cancer is only 1% to 2% in the general population; however, women with deleterious *BRCA* mutations have a cumulative lifetime risk of developing ovarian cancer of approximately 40% in *BRCA1* carriers and approximately 20% in *BRCA2* carriers.[2,3] In light of these statistics, there has been significant interest in defining the role of ovarian cancer screening in individuals who might be at higher-than-average risk.

There is growing evidence that *BRCA* carriers who undergo risk-reducing salpingo-oophorectomy (RRSO) significantly reduce ovarian cancer and breast cancer risk, ovarian cancer–related mortality, and even all-cause mortality.[4,5] Studies have reported rates of RRSO in *BRCA* carriers ranging from 12% to 78%. Some researchers have examined the time to RRSO in these women; multiple studies[6-11] have shown a median time of 6 months from learning of *BRCA*-positive results to RRSO in *BRCA* carriers.

For female *BRCA* carriers who choose to forego or delay this risk-reducing surgery, recommendations for ovarian cancer screening are conflicting and ambiguous (Table 1). Furthermore, for the vast majority of women who receive uninformative *BRCA* test results, no guidelines exist.

A substantial body of research has shown that current screening modalities—principally the serum cancer antigen 125 (CA-125) test and transvaginal ultrasonography (TVUS)—have poor diagnostic test characteristics in an average-risk population, with a positive predictive value anywhere from 1.5% for CA-125 and TVUS combined to 14.0% for TVUS alone.[17,18] Furthermore, these tests may not improve mortality and may actually lead to significant harm.[17,19,20] For example, of 3285 women with false-positive results of ovarian cancer screening in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial, 1080 underwent surgical follow-up and 15.0% of these experienced at least 1 serious complication.[19]

In a population of higher-risk women, several small studies have examined the usefulness of regular CA-125 and TVUS surveillance and found that the positive predictive value of these tests was not significantly improved and that most screening-detected cancers were in advanced stages at the time of detection.[17,21-24] Although guidelines[13] from several organizations suggest that routine screening TVUS and/or serum CA-125 testing may be offered to high-risk women, evidence is insufficient to demonstrate that these tests provide a survival benefit.

Literature regarding risk-reducing and screening interventions after *BRCA* testing has been limited to small populations, has reported short follow-up, or has not differentiated the impact of *BRCA*-positive, *BRCA*-negative, or uninformative test results. In this study, we expanded on previous work[7-10] by reporting on a cohort of 1077 women at risk for hereditary breast and ovarian cancer syndrome who received *BRCA* testing and were surveyed a median of 3.7 years after genetic testing. We classified ovarian cancer risk-reducing and screening interventions on the basis of *BRCA* results. Our goals were to describe and compare the rate of RRSO and ovarian cancer screening by *BRCA* status and to confirm predictors of RRSO and ovarian cancer screening in a large and diverse population with varying levels of ovarian cancer risk.

Methods

Patients

Participants were recruited from the University of California, San Francisco (UCSF) Cancer Risk Program, which provides genetic counseling and *BRCA* testing at 2 locations: the Helen Diller Family Comprehensive Cancer Center (Diller), a tertiary referral cancer center, and San Francisco General Hospital (SFGH), a public county hospital. Both locations use the same genetic counselors and *BRCA* testing protocol, in which women are typically eligible for testing if their prior probability of carrying a *BRCA* mutation is estimated to be at least 5% as calculated using BRCAPRO software (BayesMendel Lab).[25]

More than 95% of patients who undergo *BRCA* testing through the Cancer Risk Program agree to an institutional review board–approved follow-up protocol, details of which have been published elsewhere.[26] Women tested for *BRCA* mutations at either UCSF testing site between January 1996 and March 2008 and who were living in the United States in 2008 were considered eligible for this survey. Informed consent was obtained from all participants.

Survey Methods

A comprehensive 22-page survey was designed by method and content experts to examine risk-reducing and screening interventions in all women who received *BRCA* testing within the UCSF Cancer Risk Program. The survey consisted of a 16-page follow-up module for all participants and a 6-page cancer module for participants who reported any prior cancer diagnosis. Average survey completion time was 20 minutes. We mailed the survey to all women eligible for *BRCA* testing from both testing sites in 2008. Participants at SFGH were offered the option of completing the survey by telephone or in person in their preferred language (Spanish, Russian, Cantonese, or Mandarin), since 30% of the SFGH population communicates in a language other than English compared with less than 3% of the Diller population.

Measurements

***BRCA* Test Results—**Test results were categorized as either *BRCA1/2* mutation positive, true-negative, uninformative negative, or variant of undetermined significance. Positive results occurred when a participant was shown to carry a known deleterious *BRCA*

mutation. True-negative results occurred when a participant received negative test results for a known deleterious family *BRCA* mutation. Uninformative negative results occurred when a participant received negative *BRCA* test results without a known family mutation. Variant of undetermined significance results occurred when a participant was found to have a change in DNA that has unknown effects on BRCA protein function. For analyses, participants with variant of undetermined significance results were grouped with participants with uninformative negative results into a single group of uninformative results.

Sociodemographic and Clinical Data—To assess socioeconomic status, we enlisted a third-party company (Nielsen Claritas) to determine income-producing assets for each participant. Nielsen Claritas was provided with anonymized census demographic data to estimate income-producing assets per individual household using several variables, including income and home ownership.[27]

We collected demographic characteristics, basic medical history, and surgical history. Cancer-specific medical history detailed previous treatments and prior use of risk-reducing and screening measures for breast, ovarian, skin, and colon cancer. Time since testing was calculated as the interval between the date of receiving *BRCA* test results, verified by medical record, and the date of survey completion.

Risk-Reducing Surgery and Screening Test Use—To assess for RRSO, participants were asked, “Have you undergone surgery at any time to prevent ovarian cancer (prophylactic oophorectomy)?” If they answered yes, follow-up questions included the dates of surgery and whether the fallopian tubes and/or uterus were removed. For participants whose reason for salpingo-oophorectomy was unclear, medical records were reviewed individually and categorized appropriately.

To query screening test use, participants were asked, “Have you ever had a screening CA-125 blood test for ovarian (or primary peritoneal) cancer screening?” A similar question was asked regarding TVUS. For both CA-125 and TVUS, participants were asked to report whether they had received the test in the past year and approximately how many tests they had received in the past 3 years.

Statistical Analysis

The χ^2 and standard 2-tailed unpaired *t* tests were used to identify univariate predictors of RRSO after *BRCA* testing and ovarian cancer screening within the past year. Because ovarian cancer screening can be a recurrent event, we tallied the number of TVUS and CA-125 screenings by participant in the prior 3 years. Significant variables in univariate analyses were considered for multivariate logistic regression models, specifically, variables initially significant at $P < .20$ and with proportions large enough to produce stable model estimates. *P* values estimated from pairwise comparisons with a reference group and group tests of heterogeneity were presented. All analyses were carried out with commercial software (SAS, version 9.2; SAS Institute Inc).

Results

Population Characteristics

Among the 1447 eligible participants, 1123 women (77.6%) responded to the survey. Respondents did not differ significantly from nonrespondents in age, race, *BRCA* test result, cancer history, or year of *BRCA* testing (data not shown). The mean (SD) age of participants at the time of the survey was 53 (11) years (Table 2), with a median time since testing of 3.7 years. Forty-six respondents reported undergoing RRSO before their *BRCA* testing date and were excluded from analyses, leaving 1077 respondents in the study population.

Of these 1077 respondents, 201 received positive test results for *BRCA1* or *BRCA2* mutations (18.7%), 103 received a true-negative result (9.6%), 59 received a variant of undetermined significance (5.5%), and 714 received an uninformative negative result (66.3%). Overall, 773 women received uninformative results (71.8%). None of the women in our study who received uninformative negative test results had developed ovarian cancer during the follow-up period. Most of the study population was white (83.7%) and 38.7% was Ashkenazi Jewish (Table 2).

Predictors of RRSO

At the time of survey completion, 70.3% of respondents (757 of 1077) had at least 1 ovary. Two hundred six (19.1%) reported RRSO since *BRCA* testing, and the remaining 114 (10.6%) had their ovaries removed for other reasons (78 for ovarian cancer treatment and 36 for reasons other than risk reduction or ovarian cancer treatment). Seventy-two percent of women who reported removal of their ovaries for reasons other than risk reduction had undergone surgery before *BRCA* testing. Ovarian cancer was detected incidentally in 7 women during RRSO.

Among *BRCA* carriers, 69.6% reported undergoing RRSO after *BRCA* testing. An additional 12.3% of participants with uninformative and 2.0% with true-negative results reported RRSO. In multivariate analysis, women were 28.1 times more likely to undergo RRSO if they were *BRCA* carriers compared with women whose *BRCA* results were uninformative (Table 3); women who received true-negative results were significantly less likely to undergo RRSO. Additional multivariate predictors of RRSO included age 40 to 49 years at the time of RRSO, more than $500 000 in income-producing assets, 2 or more children, a history of breast cancer, and a first-degree relative with ovarian cancer.

Predictors of Ovarian Cancer Screening

Among women with at least 1 ovary, 39.6% reported ever having received ovarian cancer screening by TVUS and 36.1% with serum CA-125. Of all the women surveyed, 39.6% underwent at least 1 screening test. Of eligible *BRCA* carriers, 26.3% underwent screening TVUS and 26.3% reported receiving serum CA-125 testing 3 or more times in the 3 years before the survey (Figure). Among participants with uninformative *BRCA* results, 33.8% and 37.3% ever received serum CA-125 or TVUS, respectively, since *BRCA* testing, while 10.4% and 6.5% received serum CA-125 or TVUS, respectively, 3 or more times in the 3 years prior to survey.

Predictors of TVUS and serum CA-125 screening were similar to predictors of undergoing RRSO, with the exception of a history of breast cancer, which increased the likelihood of RRSO but decreased the likelihood of screening interventions (Table 4 and Table 5). Women who received screening TVUS and screening serum CA-125 testing were more likely to be *BRCA* carriers or to have a first-degree relative with ovarian cancer and less likely to have received a true-negative result. We observed a trend toward higher screening rates among women aged 40 to 49 years and those who were tested at Diller, which did not achieve statistical significance for TVUS but was significant for serum CA-125. In contrast to RRSO, higher parity did not predict screening practices.

Comments

Women who may be at risk for hereditary ovarian cancer face difficult decisions after *BRCA* testing regardless of the test result. For *BRCA* carriers, the invasive and potentially life-altering nature of RRSO, as well as the ambiguity in screening recommendations should they forego or delay RRSO, contribute to these difficulties. For most women who receive uninformative results of *BRCA* testing, the lack of clear guidelines and the imprecise ability to predict the individual risk of ovarian cancer may foster uncertainty in patients and physicians. This study sheds light on current practices in ovarian cancer risk-reduction and screening interventions in both of these populations.

In this study, the women at highest risk—*BRCA* carriers—were the most likely to receive aggressive interventions, with a 69.6% use of RRSO and a 28-fold higher odds of receiving RRSO compared with women with uninformative *BRCA* results. The proportion of *BRCA* carriers in this study who underwent RRSO is at the higher end relative to rates reported in earlier studies[6-10,28-30] of RRSO among *BRCA* carriers. One potential reason for the higher rate of RRSO in this study is its longer follow-up period of 3.7 years compared with 1 to 2 years in earlier studies.[6,7,9] Another potential difference from previous studies relates to the fact that the population in the present study was surveyed during a period of rapidly accumulating evidence for the benefit of RRSO in *BRCA* carriers. In 2009, 1 year after our survey was administered, the American College of Obstetricians and Gynecologists[31] published its guidelines recommending RRSO in *BRCA* carriers at age 40 years or when childbearing is complete. Our results suggest that *BRCA* carriers in this study are generally following these guidelines for RRSO.

In contrast, women in this study with true-negative *BRCA* results had significantly lower odds of receiving RRSO and ovarian cancer screening compared with women with uninformative *BRCA* results. Earlier studies[32] indicated that women with true-negative *BRCA* results face a lifetime ovarian cancer risk of approximately 1% to 2%, which is similar to that of the general population. With this low lifetime risk, as well as the demonstrated harms of false-positive screening tests, there is insufficient evidence to recommend ovarian cancer screening for women with true-negative *BRCA* results.[7,19-23]

More than 70% of *BRCA*-tested women in this study—and in the United States—receive uninformative results.[33] In this understudied but important population, a substantial proportion underwent RRSO (12.3%) and reported receiving ovarian cancer screening

(30.2%) at least once in the preceding 3 years. Long-term ovarian cancer risk in women with uninformative *BRCA* results has not been carefully defined. Because this population likely represents a heterogeneous group, however, it is possible that certain subgroups, such as women with strong family histories of ovarian cancer, may be at higher-than-average risk. In the face of such uncertainty, patients and physicians may opt to obtain screening tests despite the absence of evidence-based guidelines and the questionable efficacy of these tests.[31]

For ovarian cancer, which is rare in the general population, most women do not benefit from screening, even those at highest risk.[17,21,22] The most aggressive intervention to reduce risk, RRSO, has been carefully studied in *BRCA* carriers, and strong evidence supports its usefulness in reducing the incidence of ovarian cancer.[4-6,19,34] Testing for *BRCA* in high-risk families can discriminate ovarian cancer risk and help women with positive and true-negative results determine whether further interventions are appropriate. For most women with uninformative *BRCA* results, RRSO and ovarian cancer screening may not be appropriate, barring strong family histories of ovarian cancer. The development of ovarian cancer would be expected to be a rare event during a median follow-up of 3.7 years, and none of the women who received uninformative negative test results subsequently received a diagnosis of ovarian cancer.

Several limitations of this study should be noted. As in all survey-based studies, available data were largely limited to self-reported survey responses, thereby introducing recall bias. Although the longer time since testing is a strength of our study, the lag between *BRCA* testing and survey completion could have allowed predictor variables to occur after the outcome of interest. There is the potential for volunteer bias in survey-based studies; however, there was no significant difference between responders and nonresponders in our analysis. Finally, respondents could have misinterpreted the survey questions, with subsequent inaccuracies in the data. Unmeasured disparities in health literacy may have augmented this effect, and, in particular, patients may have received the studied interventions for reasons other than risk reduction or screening. Additional large-scale, multi-institutional studies are needed to confirm the generalizability of our findings.

Our inability to assess the contribution of patient preferences and provider recommendations to the high prevalence of self-reported ovarian cancer screening is particularly important to this study. Practice setting or practitioner background may be an unmeasured predictor of behavior in this study. A recent vignette-based physician survey[35] found that 6% routinely offer ovarian cancer screening to patients at low risk; this increased to 24% in women at medium risk, suggesting that physicians are partially driving increased screening rates. Physicians were also more likely to order ovarian cancer screening tests if requested by patients, regardless of their ovarian cancer risk. Future studies would benefit from surveying patient attitudes toward ovarian cancer screening and including provider characteristics in their analyses.

Strengths of this study include the large and diverse population, the excellent survey response rate, and the length of time since *BRCA* testing. To our knowledge, these data characterize ovarian cancer risk-reducing and screening interventions in one of the largest

cohorts of high-risk women to date. In comparison with previous studies, the population included more racial and socioeconomic diversity.[26] Although prior studies have typically examined either populations at average risk or populations of only *BRCA* carriers, the present study stratified participants according to *BRCA* test result and analyzed risk-reduction and screening interventions among all groups. In light of increasing data suggesting that screening, even in higher-risk women, may not improve outcomes, an updated assessment of screening prevalence may be beneficial as revised guidelines are considered.[19]

In summary, this study characterizes risk-reducing and screening interventions after *BRCA* test results in a large and diverse cohort of potentially high-risk women. We identified *BRCA* results to be the strongest predictor of RRSO and ovarian cancer screening in this study population. We also identified associations between breast cancer history and family history of ovarian cancer with RRSO and ovarian cancer screening. When ovarian cancer screening rates in the preceding 3 years were compared on the basis of *BRCA* results, we found that approximately 69.6% of *BRCA* carriers, 30.2% of women with uninformative *BRCA* results, and 9.6% of women with true-negative *BRCA* results reported having undergone screening. The RRSO and ovarian screening were reported in a sizable percentage of non-*BRCA* carriers despite insufficient data to determine the effectiveness of these interventions in this population.

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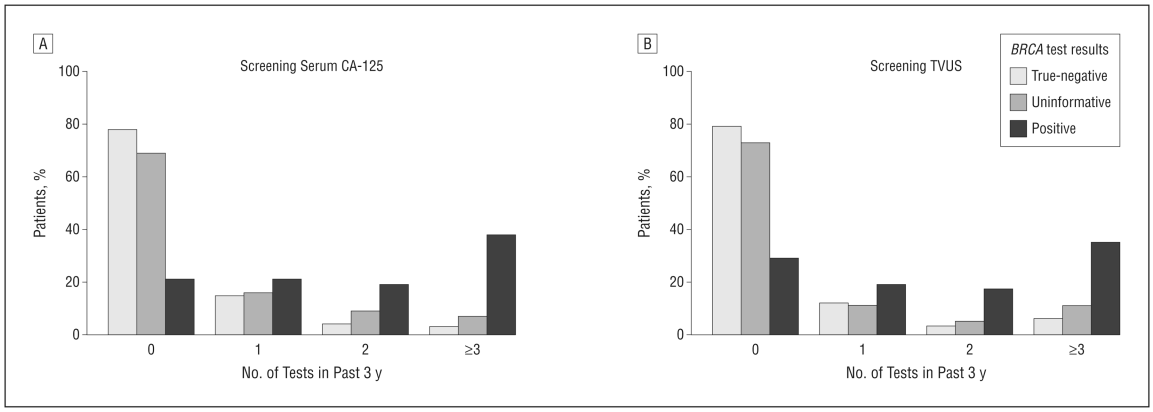

Figure.

Rate of ovarian cancer screening tests in the 3 years before the survey by *BRCA* results. A, Screening serum cancer antigen 125 (CA-125). B, Screening transvaginal ultrasonography (TVUS).

Table 1
Recommendations for Ovarian Cancer Screening in High-Risk Women

Organization	Recommendation
American Cancer Society	Women may be screened, but it is not known how helpful the screening tests are.[12]
American College of Obstetricians and Gynecologists	If appropriate, these women may be offered ovarian cancer screening. Screening with CA-125 measurement and TVUS every 6 mo has been recommended by the National Comprehensive Cancer Network, although evidence is insufficient to demonstrate that current screening methods improve survival rates for these women.[13]
Canadian Task Force on Preventive Health Care	Insufficient evidence to recommend for or against screening, but expert opinion suggests that these women be referred to an academic health center for regular combination screening.[14]
National Comprehensive Cancer Network	Screen with TVUS and CA-125 every 6 mo starting at age 35 y or 5-10 y before the youngest relative received an ovarian cancer diagnosis.[15]
United States Preventive Services Task Force	The positive predictive value of an initially positive screening test would be more favorable for women at higher risk; if ongoing clinical trials show that screening has a beneficial effect on mortality rates, then women at higher risk are likely to experience the greatest benefit.[16]

Abbreviations: CA-125, cancer antigen 125; TVUS, transvaginal ultrasonography.

Table 2
Characteristics of 1077 High-Risk Women Who Underwent *BRCA* Testing

Characteristic	No. (%)			
	Overall (N = 1077)	True-Negative (n = 103)	Uninformative (n = 773)	*BRCA* Positive (n = 201)
Demographics				
Age at survey, mean (SD), y	52.9 (11.2)	49.9 (13.5)	54.3 (10.7)	49.5 (10.7)
<40	120 (11.1)	19 (18.4)	58 (7.5)	43 (21.4)
40-49	299 (27.8)	39 (37.9)	197 (25.5)	63 (31.3)
50-59	357 (33.1)	21 (20.4)	280 (36.2)	56 (27.9)
≥60	301 (27.9)	24 (23.3)	238 (30.8)	39 (19.4)
White race	901 (83.7)	96 (93.2)	641 (83.0)	164 (81.6)
Ashkenazi Jewish	416 (38.7)	47 (45.6)	274 (35.5)	95 (47.3)
Socioeconomic status				
Income-producing assets, $				
≤100 000	196 (18.2)	19 (18.4)	139 (18.0)	38 (19.0)
100 001-500 000	357 (33.2)	36 (35.0)	237 (30.7)	84 (42.0)
500 001-1 000 000	148 (13.8)	13 (12.6)	109 (14.1)	26 (13.0)
≥1 000 001	375 (34.9)	35 (34.0)	288 (37.3)	52 (26.0)
Testing site				
SFGH	74 (6.9)	2 (1.9)	63 (8.2)	9 (4.5)
Diller	1003 (93.1)	101 (98.1)	710 (91.8)	192 (95.5)
Health status				
BMI, mean (SD)	24.7 (5.1)	24.4 (5.1)	24.7 (5.0)	25.0 (5.5)
General health, self-report				
Excellent	413 (38.3)	46 (44.7)	295 (38.2)	72 (35.8)
Good	536 (49.8)	51 (49.5)	384 (49.7)	101 (50.2)
Fair/poor	128 (11.9)	6 (5.8)	94 (12.2)	28 (13.9)
Postmenopausal	733 (69.4)	36 (35.6)	544 (71.9)	153 (77.3)
Personal history of any cancer	757 (70.3)	17 (16.5)	609 (78.8)	131 (65.2)
Personal history of breast cancer	660 (61.3)	10 (9.7)	546 (70.6)	104 (51.7)
Family cancer history				
First-degree relative with breast cancer	433 (40.4)	53 (51.5)	276 (35.8)	104 (52.3)
First-degree relative with ovarian cancer	182 (17.0)	35 (34.0)	90 (11.7)	57 (28.8)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); Diller, Helen Diller Family Comprehensive Cancer Center; SFGH, San Francisco General Hospital.

Table 3
Characteristics of Women Who Underwent RRSO After *BRCA* Testing

Characteristic	No. (%)		Adjusted OR (95% CI)	*P* Value
	No RRSO (n = 757)	RRSO (n = 206)		
BRCA result				
Uninformative	605 (87.7)	85 (12.3)	1 [Reference]	
Positive	52 (30.4)	119 (69.6)	28.1 (16.2-48.6)	<.001
True-negative	100 (98.0)	2 (2.0)	0.1 (0.0-0.6)	.01
Age at RRSO or survey, y[a]				
<40	106 (79.1)	28 (20.9)	1 [Reference]	
40-49	216 (71.3)	87 (28.7)	2.6 (1.2-5.6)	.01
50-59	237 (78.7)	64 (21.3)	2.1 (1.0-4.6)	.06
≥60	198 (89.6)	23 (10.4)	0.8 (0.3-2.0)	.63
Race				
Nonwhite	120 (78.9)	32 (21.1)	1 [Reference]	
White	636 (78.5)	174 (21.5)	1.2 (0.6-2.2)	.59
Ashkenazi Jewish[b]				
No	418 (78.3)	116 (21.7)	1 [Reference]	
Yes	300 (78.7)	81 (21.3)	0.9 (0.6-1.4)	.63
Income-producing assets, $				<.001
≤100 000	148 (85.5)	25 (14.5)	1 [Reference]	
100 001-500 000	255 (78.9)	68 (21.1)	1.8 (0.9-3.5)	.11
500 001-1 000 000	100 (74.1)	35 (25.9)	3.3 (1.5-7.4)	.004
≥1 000 001	254 (76.7)	77 (23.3)	3.5 (1.7-7.3)	<.001
Testing site[c]				
SFGH	55 (88.7)	7 (11.3)		
Diller	702 (77.9)	199 (22.1)		
BMI, mean (SD)	24.4 (4.8)	25.0 (5.6)	1.0 (1.0-1.1)	.84
No. of live births				
Mean (SD)	1 (1)	2 (1)		
0	226 (82.8)	47 (17.2)	1 [Reference]	
1	163 (81.5)	37 (18.5)	1.3 (0.7-2.5)	.46
≥2	362 (74.9)	121 (25.1)	2.3 (1.3-3.9)	.003
Personal history of breast cancer	476 (77.4)	139 (22.6)	2.2 (1.3-3.7)	.004
First-degree relative with breast cancer	303 (75.4)	99 (24.6)	1.12 (0.8-1.8)	.48
First-degree relative with ovarian cancer	102 (61.1)	65 (38.9)	4.2 (2.4-7.4)	<.001

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); Diller, Helen Diller Family Comprehensive Cancer Center; OR, odds ratio; RRSO, risk-reducing salpingo-oophorectomy; SFGH, San Francisco General Hospital.

[a] Age at RRSO for respondents reporting RRSO. For respondents who did not report RRSO, age at survey.

[b] Forty-seven participants responded that they did not know whether they had Ashkenazi Jewish ancestry.

[c]Testing site was not included in the final multivariate model because of the low absolute number of RRSOs (n = 7) in the SFGH population per the statistical analysis plan described in the “Methods” section.

Table 4

Characteristics of Women Who Did Not Undergo RRSO and Received TVUS for Ovarian Cancer Screening in the Past Year[a]

Characteristic	No. (%)		Adjusted OR (95% CI)	*P* Value
	No TVUS (n = 596)	TVUS (n = 156)		
BRCA result				
Uninformative	491 (81.7)	110 (18.3)	1 [Reference]	
Positive	15 (29.4)	36 (70.6)	9.5 (4.3-21.0)	<.001
True-negative	90 (90.0)	10 (10.0)	0.2 (0.1-0.5)	<.001
Age at survey, y				
<40	70 (67.3)	34 (32.7)	1 [Reference]	
40-49	164 (76.3)	51 (23.7)	1.5 (0.7-2.9)	.27
50-59	197 (83.5)	39 (16.5)	0.9 (0.4-1.8)	.75
≥60	165 (83.8)	32 (16.2)	1.1 (0.5-2.3)	.85
Race				
Nonwhite	93 (78.2)	26 (21.8)	1 [Reference]	
White	503 (79.5)	130 (20.5)	0.9 (0.5-1.6)	.60
Ashkenazi Jewish[b]				
No	333 (80.0)	83 (20.0)	1 [Reference]	
Yes	233 (78.2)	65 (21.8)	0.9 (0.6-1.5)	.79
Income-producing assets, $				
≤100 000	114 (78.1)	32 (21.9)	1 [Reference]	
100 001-500 000	191 (74.9)	64 (25.1)	0.9 (0.5-1.7)	.73
500 001-1 000 000	86 (86.0)	14 (14.0)	0.5 (0.2-1.1)	.09
≥1 000 001	205 (82.1)	46 (18.3)	1.1 (0.6-1.9)	.85
Testing site				
SFGH	48 (87.3)	7 (12.7)	1 [Reference]	
Diller	548 (78.6)	149 (21.4)	2.3 (0.8-6.6)	.12
BMI, mean (SD)	24.5 (5.7)	24.1 (5.1)	1.0 (0.9-1.0)	.33
No. of live births				
0	167 (74.6)	57 (25.4)	1 [Reference]	
1	130 (79.8)	3 (20.2)	1.2 (0.7-2.0)	.60
≥2	296 (82.0)	65 (18.0)	1.0 (0.6-1.6)	.91
Personal history of breast cancer	394 (83.5)	78 (16.5)	0.5 (0.3-0.9)	.01
First-degree relative with breast cancer	242 (80.1)	60 (19.9)	0.8 (0.5-1.1)	.19
First-degree relative with ovarian cancer	62 (60.8)	40 (39.2)	3.1 (1.8-5.6)	<.001

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); Diller, Helen Diller Family Comprehensive Cancer Center; OR, odds ratio; RRSO, risk-reducing salpingo-oophorectomy; SFGH, San Francisco General Hospital; TVUS, transvaginal ultrasonography.

[a] Five participants did not respond to the survey question about TVUS.

[b] Thirty-eight participants responded that they did not know whether they had Ashkenazi Jewish ancestry.

Table 5

Characteristics of Women Who Did Not Undergo RRSO and Received Serum CA-125 Testing for Ovarian Cancer Screening in the Past Year[a]

Characteristic	No. (%)		Adjusted OR (95% CI)	*P* Value
	No CA-125 (n = 592)	CA-125 (n = 156)		
BRCA result				
Uninformative	485 (81.4)	111 (18.6)	1 [Reference]	
Positive	17 (32.7)	35 (67.3)	13.0 (5.5-29.0)	<.001
True-negative	90 (90.0)	10 (10.0)	0.3 (0.1-0.7)	.002
Age at survey, y				
<40	76 (73.1)	28 (26.9)	1 [Reference]	
40-49	163 (76.2)	51 (23.8)	2.4 (1.1-5.1)	.02
50-59	191 (82.0)	42 (18.0)	1.7 (0.8-3.8)	.16
≥60	162 (82.2)	35 (17.8)	2.0 (0.9-4.6)	.10
Race				
Nonwhite	88 (74.6)	30 (25.4)	1 [Reference]	
White	504 (80.0)	126 (20.0)	0.7 (0.4-1.2)	.17
Ashkenazi Jewish[b]				
No	323 (77.8)	92 (22.2)	1 [Reference]	
Yes	237 (80.1)	59 (19.9)	0.7 (0.5-1.1)	.16
Income-producing assets, $				
≤100 000	113 (77.9)	32 (22.1)	1 [Reference]	
100 001-500 000	189 (75.0)	63 (25.0)	1.1 (0.6-2.0)	.67
500 001-1 000 000	82 (82.0)	18 (18.0)	0.8 (0.4-1.6)	.47
≥1 000 001	208 (82.9)	43 (17.1)	0.8 (0.4-1.5)	.51
Testing site				
SFGH	48 (87.3)	7 (12.7)	1 [Reference]	
Diller	544 (78.5)	149 (21.5)	4.3 (1.4-14.0)	.01
BMI, mean (SD)	24.4 (4.6)	24.5 (5.3)	1.0 (1.0-1.1)	.94
No. of live births				
0	169 (76.1)	53 (23.9)	1 [Reference]	
1	122 (74.81)	41 (25.2)	1.8 (1.0-3.1)	.045
≥2	298 (83.0)	61 (17.0)	0.9 (0.5-1.4)	.57
Personal history of breast cancer	383 (82.0)	84 (18.0)	0.5 (0.3-0.8)	.009
First-degree relative with breast cancer	253 (84.3)	47 (15.7)	0.4 (0.2-0.6)	<.001
First-degree relative with ovarian cancer	64 (62.7)	38 (37.3)	2.3 (1.3-4.2)	.004

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CA-125, cancer antigen 125; Diller, Helen Diller Family Comprehensive Cancer Center; OR, odds ratio; RRSO, risk-reducing salpingo-oophorectomy; SFGH, San Francisco General Hospital.

[a] Nine participants did not answer the survey question about CA-125 screening.

[b] Seventeen participants reported not that they did not know whether they had Ashkenazi Jewish ancestry.