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Preventative Health and Risk Behaviors among Adolescent Girls with and without Family Histories of Breast Cancer

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Abstract

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Potential Conflicts of Interest:

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Purpose: To compare health behaviors (smoking, alcohol use, fruit and vegetable intake, exercise frequency) and breast self-exam (BSE) between girls with breast cancer family history (BCFH+) and without (BCFH-) and assess associates of behaviors across all girls.

Methods: 208 BCFH+ girls (11–19 yo), with first-or-second degree relatives with breast cancer or a mother with a *BRCA1/2* mutation, and 112 BCFH- peers reported their health behaviors, beliefs and psychosocial function.

Results: Despite higher BCFH+ girls' greater perceived breast cancer risk, there were no differences between BCFH+ and BCFH- girls on diet, exercise, alcohol initiation, or BSE. BCFH+ girls were slightly more likely to report trying cigarettes (11% vs 5%, $p=0.04$). In multivariable models with all girls, categorical associations with behaviors included: developmental and demographic factors with smoking, alcohol, diet, and exercise; family breast cancer history and experience with smoking, alcohol, and diet; psychosocial factors with smoking; girls perceptions of cancer controllability and mother support for health behaviors with alcohol, diet, exercise, and BSE; and mother behaviors with diet.

Conclusions: Adolescent girls from BCFH+ families reported similar health behaviors to BCFH- peers, signaling that they are not translating their higher perceived risk into cancer control behaviors. Both uncontrollable (i.e., breast cancer experiences) and modifiable factors relate to health behaviors and warrant further investigation. Results indicate that interventions with teens and parents that target modifiable variables such as controllability perceptions, maternal modeling, and communication may relate to better health behaviors and reduced future breast cancer risk.

Clinical Trial Registration:

This study was not a clinical trial.

Keywords

Breast Neoplasms; BRCA1 protein; BRCA 2 protein; Healthy Lifestyle; Adolescent; Female; Risk-taking; Breast self-examination; Mothers; Maternal behavior

Family history of breast cancer and genetic mutations such as *BRCA1/2* are well-known non- modifiable risk factors for breast cancer. Studies show that most parents report discussing heritable breast cancer risk with their children (1, 2) and most adolescent girls in breast cancer families are aware of their own potentially elevated future risk.(3, 4) Furthermore, studies suggest that childhood is a key period of carcinogenic vulnerability(5) and that modifiable health behaviors (smoking, alcohol use, fruit and vegetable intake, exercise) that begin or become solidified in adolescence may affect risk for adult breast cancer,(6, 7) above and beyond genetic risk.(8) Equally important, psychosocial distress in adolescence can be associated with health behaviors.(9, 10) Thus, targeted health promotion around modifiable risk factors for breast cancer, in the context of prevention across the lifespan, is especially relevant for adolescent daughters in high risk families.(11) Adolescent health providers play a critical role in educating adolescents and families about health behaviors related to cancer prevention.(11) As such, it is important to understand preventative health and risk behaviors and their associates among adolescent girls, especially among those growing up in breast cancer families with elevated risk.

In the LEGACY Girls (<http://legacygirlsstudy.org/>) and SOFT (Study of Female Teens) studies led by members of our team, girls from breast cancer families had higher breast cancer-specific distress and perceived future risk compared to peers from families without a breast cancer family history (BCFH).(3, 4) Additionally, LEGACY results (the only prior study to our knowledge to explore health behaviors of girls in BCFH+ families) found no differences in alcohol use, smoking, or exercise between BCFH positive (+) and negative (–) 10- to 13- year-old girls, indicating that knowledge of increased risk was not associated with improved health behaviors at this young age.(4) However, health behaviors have not been described in older adolescent girls who may exhibit more variability related to behavior choices and more awareness of future personal risk than preadolescents, yet still lack appreciation of how modifiable factors affect the risk of breast cancer.(12) Additionally, adolescent egocentrism and impulsiveness may make current behavior change for distal gains difficult.(13) Alternatively, recognition of future breast cancer risk, particularly amongst BCFH+ girls, may motivate preventative behaviors.

The current study is the first to our knowledge that aimed to elucidate engagement in and associates of health behaviors that relate to adult breast cancer risk among adolescents ages 11–19, an age range with great variability in health harming and promoting behaviors, and well as a range of experiences with and exposures to breast cancer. We evaluated the data in two ways. First, we determined if adolescent girls from breast cancer families (BCFH+) differ from their (BCFH-) peers in preventive health (fruit and vegetable intake and exercise) and risk behaviors (smoking and alcohol use), as well as breast self-exam (BSE). BSE is relevant as it may signal adolescents' awareness of risk and/or attention to breast cancer prevention, while providing a false sense of protection.(14) We also reported perceptions of cancer controllability and maternal encouragement of health behaviors for each group.

Second, we evaluated associates of health behaviors informed by prior literature on individual and family associates (15) and the Self-Regulation Theory of Health Behavior (SRTHB).(16) The SRTHB emphasizes the role of adolescents' perceptions of cancer risk, their psychosocial responses and their impact on health behaviors, as previously described in our prior research.(3, 4). As such, the SRTHB purports that perceptions and emotions, not just objective factors (e.g., familial breast cancer) are critical to health behaviors and outcomes. Given the diverse experiences of girls in breast cancer families, as well as expected variation in exposure to breast cancer experiences from girls without known breast cancer risk, we evaluated a model of associates across all girls. This allowed for assessment of relative contribution of breast cancer variables (family history, experiences, and perceived risk) in girls from families with and without breast cancer history, as well as potential associates that may relate to health behaviors among a cohort with a variable degree of future breast cancer risk and presumed range of frequency of engagement in health behaviors of interest. Specific categories of associates in the model included: developmental and demographic variables; breast cancer factors (family history, acquaintances with breast cancer, perceived risk); perceived controllability; psychosocial factors (family functioning, distress); and maternal health behaviors. We expected results to inform understanding of factors that relate to poor health behaviors and tailored cancer prevention communication, especially for families of adolescents with advice-seeking mothers and elevated cancer risk.

PARTICIPANTS AND METHODS

Participants and Procedures

As previously described,(3) we recruited 320 11–19 year old girls and their biological mothers from 247 BCFH+ and BCFH- families. Per maternal report, BCFH+ girls included those with one or more first- or second-degree relatives (F/SDRs) with breast cancer or a mother with a *BRCA1/2* mutation. BCFH- girls had no known family history of breast cancer in F/SDRs and no known *BRCA1/2* mutation in the mother. Girls were recruited from clinical cancer genetics programs, a national advocacy organization, pediatric practices, community advertisements and mothers' friend nominations (see Table 1 for recruitment sources). Institutional Review Board approval was obtained across sites. Mothers provided verbal informed consent and signed an online Statement of Research and girls provided assent (< 18 years) or consent (>=18 years).

Measures

Health Behaviors (outcome variables).: Health behaviors were assessed with items from the Youth Risk Behavior Survey, which has tracked health and risk behaviors of >10,000 youths. Behaviors included whether they ever tried smoking or alcohol, fruit and vegetable consumption in the last week, and how many days they engaged in physical exercise last week. Girls were also asked, "Have you ever done a self-breast exam (feeling your breasts for any lumps or changes)?"

Demographic and Developmental Information, and Family Breast Cancer History and Experiences.: Mothers reported demographic information for themselves and their daughters; daughters reported their age at menarche and current pubertal development via a Tanner stage illustration.(17) Mothers also reported family history including their *BRCA1/2* status and cancer history of F/SDRs. Daughters reported total breast cancer acquaintances (number of relatives and those outside the family they knew with breast cancer). They were also asked if they were aware of *BRCA1/2* genes and mother's testing. Girls' perception of their future breast cancer risk was assessed on a Likert-type scale question: "Do you think your chances of getting breast cancer when you are an adult are the same or different than other girls your age when they become adults?"(18)

Psychosocial Factors.: The Behavioral Assessment System for Children –2nd Edition assessed Anxiety and Depression percentiles compared to normative samples.(19) Girls' breast cancer-specific distress was evaluated with the 8-item Child-Impact of Events Scale (Cronbach's $\alpha = 0.83$ – 0.90), a developmentally appropriate version of the Revised Impact of Event Scale.(20) Girls completed the general family function and communication subscales of the McMaster Family Assessment Device (Cronbach's $\alpha=0.78$ – 0.88). (21)

Perceived Controllability.: Girls rated on a 5-point Likert-type scale how much they agreed that diet, exercise, or leading a healthy lifestyle could help her prevent or delay breast cancer and doing breast self-exam could increase chances of detecting breast cancer.

Mothers' behaviors and encouragement: Mothers were asked parallel questions regarding their diet, exercise, cigarette use, binge drinking last month, and BSE. Girls reported on a 5-point Likert-type scale how much their mother encourages healthy diet, exercise and BSE.

Statistical Analyses

To compare health behaviors between BCFH+ and BCFH- girls, we used simple linear regressions and simple logistic regressions with robust cluster-adjusted standard errors that accounted for within-family correlation of data.(22) Exploratory analyses evaluated differences between girls with a *BRCA1/2*+ mother and BCFH+ girls whose mother reported no known *BRCA1/2*+. To assess associates of health behaviors among all girls, we used multiple linear or logistic regressions with within-family cluster adjusted standard errors. $P < 0.05$ (2-sided) was the criterion for statistical significance. To assess whether the inclusions of groups of variables improved regression model fits as a whole, we calculated the Wald p-values, testing, in a stepwise fashion, whether all variables in a group had no association with the outcome versus at least one having an association. We used Wald tests, which are compatible with robust cluster corrected standard errors. To assess model predictive ability with the logistic regressions, we calculated the areas under the curve (AUC) among the imputed datasets with each additional variable group added. For the linear regressions, we reported the R^2 value changes with the addition of the variable groups. We initially designed the study with 80% power to detect differences using linear regressions for standardized effect sizes 0.28, anticipating imbalanced access to each group and assuming 150 BCFH- girls and 300 BCFH+ girls. Our final sample size gave us power to detect standardized differences between the groups of 0.33, which are also modest sized associations. To account for missing data in the multivariable regressions, we used the multiple imputation methods of Raghunathan and colleagues(23) with 25 imputed datasets. Imputed data included that of BASC Anxiety and Depression scores from 44 assessments which failed overall BASC validity checks.

RESULTS

Participant characteristics (Table 1)

Among 335 eligible girls from 263 families, 320 girls (96%) from 247 families enrolled and completed surveys. 208 girls were classified as BCFH+, of which 69 had a *BRCA1/2*+ mother and 24 had breast cancer on their father's side only. All girls accurately reported their mother's history of breast cancer. As with previous report, BCFH+ girls had higher perceived risk for future breast cancer.(3)

Mothers of BCFH+ versus BCFH- girls were more likely to be married (87% vs 74%; $p=0.02$) and were slightly older (47.9 vs 45.3 years; $p=0.06$), but there were no differences in mother's education, fruit and vegetable consumption (12% met daily serving recommendations), exercise frequency (mean=2 days/week), current smoking (3%), or binge drinking (15%). Mothers in the BCFH+ group (excluding those with bilateral mastectomy) were more likely to report doing BSE last month (63% vs 46%; $p=0.018$) than mothers of BCFH- girls.

Psychosocial factors, perceptions of cancer controllability and maternal support of health behaviors (Table 2)

As previously reported, the BCFH+ girls had higher breast cancer-specific distress (albeit, relatively low) than BCFH- peers, but there were no differences on other psychosocial outcomes (3), beliefs, or maternal encouragement. The majority across groups agreed that BSE could detect breast cancer. Almost all daughters reported mother encouragement of healthy diet and exercise and less than half of girls reported mothers encouraged BSE. A small majority endorsed that diet, exercise, and a healthy lifestyle could help them prevent breast cancer.

Differences in BCFH+ and BCFH- girls' behaviors (Table 3)

There were no differences in fruit and vegetable consumption, exercise frequency, alcohol initiation, or BSE between BCFH+ and BCFH- girls. BCFH+ girls were more likely to have tried cigarettes (11% vs 5%; $p=0.04$). There were no significant differences between the subgroup of BCFH+ girls with a *BRCA1/2*+ mother and those whose mother reported no known *BRCA1/2*+. (Supplemental Tables 5–7).

Associates of preventive health and risk behaviors and BSE among all girls (Table 4)

We conducted multivariable analyses with all girls to evaluate how the following categories of variables related to daughter health behaviors: developmental and demographic; breast cancer (family history, experiences and perceived risk); psychosocial; perceived controllability and maternal encouragement; and maternal health behaviors. When entered by steps in the regression, each category was related to at least one of the health behaviors. The specific variables significantly associated with two or more behaviors were perceived controllability and perceived maternal encouragement.

Significant associates of individual behaviors were as follows. Cigarette use was associated with age and depression, while having a mother with a history of breast cancer was protective. Alcohol use was associated with age and knowing more acquaintances with breast cancer; having a mother with a history of breast cancer and perception that lifestyle behaviors can prevent breast cancer were protective. Greater intake of fruits and vegetables was associated with mothers' education and fruit and vegetable intake, fewer relatives with breast cancer, and perception that diet can prevent breast cancer. Exercise was associated with mother's encouragement of exercise, lower age, and more positive family communication. Having done BSE was the only variable significantly associated with mother's encouragement of BSE.

Discussion

This is the first study to evaluate preventative health and risk behaviors that may modify future cancer risk in adolescent girls from families with and without a family history of breast cancer. Study strengths include exploration of theoretically-informed predictors of health and risk behaviors, a large sample size, inclusion of a comparison group, inclusion of many variables that capture the range of breast cancer experiences and exposures, and a focus on adolescence. Adolescence is a vulnerable window for breast health, a critical

developmental time for adopting healthy behaviors, and a time of increasing direct communication with physicians, especially in the context of adolescent medicine. (5, 11, 24)

Similar to our findings in younger girls,(4) there were no differences in alcohol use, diet or exercise in BCFH+ girls compared to BCFH- girls, despite girls from BCFH+ girls reporting greater breast cancer risk. The reported health behaviors were generally similar or better than that reported with national YRBS sample (25) While almost all girls reported similar endorsement of high maternal encouragement of health behaviors, only a small majority across groups endorsed positive beliefs about healthy lifestyle behaviors contributing to breast cancer risk reduction. Some findings of associates of behaviors (e.g., age related to smoking, alcohol use, and exercise (26, 27); depression relating to smoking; (27, 28) were consistent with the general literature, while other predictors related to breast cancer experience and awareness were unique. Thus, we found a range of “typical” and breast cancer specific associates that vary in modifiability.

The negative finding of no increase in cancer prevention behaviors or positive beliefs about cancer control behaviors among BCFH+ girls is concerning. The perceived greater risk for breast cancer among BCFH+ girls did not translate to more optimal behaviors and sense of control. Also concerning is that BCFH+ girls endorsed having tried cigarettes at a higher rate than peers, albeit rates were relatively low. Even low rates are noteworthy given tobacco’s role in cancer and other adverse health outcomes, (29) particularly for those who begin smoking as teens.(30) Moreover, over one-third of girls used alcohol. Although low compared to national data, any alcohol use is concerning given the strong relationship between alcohol and breast cancer risk and low general awareness of this link.(31) Studies of adults at familial risk of breast cancer have also found no better adherence to cancer-reducing recommendations (i.e., exercise, smoking, alcohol, fruit and vegetable consumption), despite higher rates of breast cancer screening for those with known risk. (32–34) Thus, there remains a need for interventions to optimize important cancer prevention behaviors, especially in the context of increased cancer risk.

Having a mother with a breast cancer history (a subset of the BCFH+ group) was associated with lower cigarette and alcohol use. (35) This is consistent with the SRTHB and research on teachable moments in that positive effects are more likely if there is a perception of personal risk, strong affective or emotional response, and a redefined self-concept or social role.(36) However, other breast cancer variables related to less optimal health behaviors— notably greater exposure to breast cancer acquaintances was associated with alcohol and having more F/SDRs with a breast cancer history was associated with less fruit/vegetable intake. In the case of alcohol, sociability may be the common variable between having more acquaintances and trying alcohol. Alternatively, having vague awareness of suspected genetic risk in the family or awareness of breast cancer outside the family may have limited impact on improving adolescent health risk behaviors if it seems too distal to matter to one’s health. Clearly, more research is needed as these findings indicate that some aspects of exposure to breast cancer may confer risk, while the direct experience of having a mother with breast cancer may be protective.

Modifiable factors also related to health behaviors, even after accounting for demographic and breast cancer variables. Perceptions about controllability of cancer risk via lifestyle was related to alcohol use and fruit/vegetable intake, thus indicating the value of targeting controllability factors related to cancer risk reduction. Similar to other samples, greater intake of fruits and vegetables related to maternal education and mother's diet.(37, 38) Exercise was associated with mother's encouragement of exercise and better family communication.(39) These findings highlight maternal influence on health behaviors, both through encouragement, modeling, and communication. Given that many mothers at high risk for breast cancer are concerned about their daughters' risk, educating them about the positive impact they may have on daughter behavior could be a powerful message from providers. Moreover, interventions that include mothers could be effective in optimizing health behaviors in adolescent girls, particularly in BCFH+ families.(24)

Almost half of BCFH+ girls reported having done BSE; 40% reported mother BSE encouragement was a significant predictor of BSE. However, national guidelines no longer recommend breast self-exam as screening for women of any age.(14) Communication between providers and mother and daughters should convey that BSE doesn't reduce risk, but may have a role in making girls familiar and comfortable with their bodies.

There are several limitations of this study. Self-report can be associated with recall errors, response bias, and shared variance. The study included few ethnic minorities, thus potentially limiting generalizability to a more diverse population. This study only included biological mother-daughters and may not reflect outcomes in daughters of mothers who were deceased or too sick to participate. We also did not measure details of the breast cancer experiences that may impact exposure and relative perceived threat. For example, we do not know if the daughter witnessed first-hand their mother's cancer or that of other relatives or acquaintances. However, our model accounted for great variation in breast cancer experiences that may be relevant across the sample. Finally, although our sample was recruited from many sources, that a small percentage included friend nominations from BCFH+ mothers may have introduced some bias given their assumed shared cancer experience.

Conclusion

Although most BCFH+ adolescent girls are aware of their potentially elevated future risk,(3, 4) they do not engage in cancer control behaviors at higher rates than their peers. The role of breast cancer experiences and family risk warrant further investigation to confirm what aspects are protective and/or confer risk for adverse health behaviors and why. Awareness that current behaviors can reduce future breast cancer risk, as well as mother encouragement and modeling of preventive health behaviors, are potential foci for interventions and communication among providers and mothers and daughters, particularly for adolescent girls with familial breast cancer risk. Adolescent medicine providers should seize the teachable moment provided by teen girls' awareness of familial risk to make salient the importance of creating lifelong healthy behavioral habits that can reduce the risk for cancer as well as other adult-onset diseases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

BCFH	Breast cancer family history
BSE	Breast self-exam
F/SDRs	First- or second-degree relatives
SRTHB	Self-Regulation Theory of Health Behavior

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Implications and Contribution:

Health behaviors play an important role in cancer prevention throughout the lifespan. Girls with genetic and familial breast cancer risk have elevated risk perceptions, but similar health behaviors as peers. Modifiable variables such as daughter controllability beliefs and maternal encouragement, are potential foci for cancer control behavioral interventions and education.

Table 1.

Characteristics of girls from families with and without breast cancer (n=320)

	BCFH+ n= 208	BCFH- n= 112	
Recruitment source	N (%)	N (%)	P value
Fox Chase Cancer Center Risk Assessment Program	73 (35)	9(8)	<0.0001
UPenn Cancer Risk Assessment Program	64 (31)	3 (3)	
FORCE	38 (18)	1 (1)	
Community advertisement	11 (5)	38 (34)	
Community pediatric practices	12 (6)	36 (32)	
Friend nomination by mothers	10 (5)	25(22)	
Developmental Factors	Mean (SD)	Mean (SD)	
Girl's Age	15.4 (2.5)	15.1 (2.3)	0.30
Age at Menarche	12.3 (1.2)	12.2 (1.2)	0.79
Tanner Stage, Breast ^a	4.0 (1.0)	4.1 (0.9)	0.58
Family Breast Cancer History ^b and Experiences	N (%)	N (%)	
Mother had breast cancer	90 (43)	-	<0.0001
Mother had a bilateral mastectomy	63 (31)	0 (0)	
Mother had genetic testing	134(71)	6 (10)	
Mother tested negative for <i>BRCA1/2</i> ^c	63 (47)	6 (100)	
<i>BRCA1/2</i> + mother with BC	34 (49)	-	
<i>BRCA1/2</i> + mother without BC	35 (51)	-	
Daughter knows of <i>BRCA</i> + mother's genetic testing	39 (57)	-	
# FDR/SDR with BC (mean, SD, range)	1.4 (0.7) 0–4	0 (0.2) 0–1 ^d	
BC acquaintances ^e reported by girls (mean, SD, range)	1.9 (1.2) 0–6	0.6 (0.7) 0–3	p<0.0001
Report perceived lifetime risk of BC higher than other girls	150 (73)	35 (32)	

Abbreviations: BCFH +, breast cancer family history positive; BCFH -, breast cancer family history negative; FDR/SDR, first degree relative/second degree relative; BC, breast cancer.

^aRange is 1–5;

^bBy Mother-report- 4 mothers had missing data;

^cthere were no variants of uncertain significance reported;

^dRelatives of True Negative Parents;

^edaughters reported how many individuals they knew with breast cancer (including both relatives and individuals outside their family);

Table 2.

Girls' psychosocial factors, perceptions of cancer controllability, and maternal support for health behaviors

	BCFH+	BCFH-	
	N=208	N=112	
			<i>P</i> Value
Daughter Psychosocial Factors	Mean (SD)	Mean (SD)	
Anxiety percentile ^a	60.6 (28.1)	61 (28.9)	0.93
Depression percentile ^a	40.3 (28.5)	42.8 (26.9)	0.52
Total Breast Cancer-specific distress ^b	4.9 (7.8)	1.8 (4.3)	p<0.0001
General Family Functioning ^c	1.93 (0.43)	1.95 (0.48)	0.81
Family Communication ^d	2.20 (0.40)	2.20 (0.42)	0.94
Endorsement of Controllability perceptions	n (%)	n (%)	
"A healthy diet can help me prevent or delay breast cancer" ^e	130 (63)	69 (63)	0.95
"Exercise can help me prevent or delay breast cancer" ^e	118 (57)	62 (57)	0.98
"If I lead a healthy lifestyle, I believe I can prevent or delay getting breast cancer" ^e	131 (63)	74(68)	0.41
"Doing breast self-examination will greatly increase my chances of detecting breast cancer" ^e	159(78)	82 (76)	0.75
Perceived Maternal Support for Health Behaviors			
Mother encourages eating healthily ^f	196 (95)	108 (96)	0.59
Mother encourages exercise ^f	187 (90)	100 (89)	0.86
Mother encourages BSE ^f	84 (41)	40 (36)	0.44

Abbreviation: BSE, breast self-exam;

^a range is 1–99, 44 scores were discarded due to poor validity (29 BCFH+ and 15 BCFH-);^b range is 0–38;^c range is 1–3.5;^d range is 1–3.13;^e Positive response included "agree" and "agree strongly";^f Positive response included "a little bit", "moderately", "quite a bit", or "very much" on a Likert-type scale.

Table 3.

Health Behaviors of girls from families with and without breast cancer (n=320)

	BCFH+ N=208	BCFH- N=112	
Preventative Health and Risk Behaviors	n (%)	n (%)	P Value
Tried alcohol	78 (39)	37 (35)	0.48
Tried cigarettes	23 (11)	5 (5)	0.04
Exercise- Mean days/week, SD	3.6 (2.1)	3.6 (2.1)	0.9
Fruit/Veg servings per day in the last week			
5	18 (9)	7 (6)	0.82
3-4	40(19)	21 (19)	
1-2	121(58)	65 (58)	
<1	29 (14)	19 (17)	
Breast Self-Exam			
BSE ever	98 (48)	41 (38)	0.1
Age at 1st BSE	14.5 (2.1)	14.1 (2.4)	0.46

Abbreviation: BSE, breast self-exam

Table 4.

Regression Models of Factors Associated with Daughter Health Behaviors

	Ever tried cigarettes	Ever tried alcohol	Daily Servings of Fruit/Veget able	Hours of Exercise	Ever did Breast Self- Exam
	n= 274 OR (95% CI)	n=265 OR (95% CI)	n=274 β (95% CI)	n=266 β (95% CI)	n=209 OR (95% CI)
Developmental and Demographic Factors	AUC=0.78; P<0.0001	AUC=0.70; P <0.0001	R ² =0.05; df 4; p<0.0001	R ² =0.10; df 4; p<0.0001	AUC=0.70; P< 0.0001
Daughter age	1.47 ^b (1.09–1.98)	1.95 ^c (1.6–2.39)	–0.05 (–0.15–0.04)	–0.16 ^b (–0.3–0.02)	1.12 (0.94–1.33)
Breast Development	2.04 (0.65–6.38)	1.53 (0.97–2.39)	0.02 (–0.21–0.25)	–0.14 (–0.43–0.16)	1.08 (0.77–1.51)
Mother's education ^a	0.76 (0.47–1.24)	1.09 (0.74–1.61)	0.21 ^b (0.03–0.4)	0.12 (–0.13–0.37)	1.15 (0.84–1.59)
Married mother	0.59 (0.17–1.98)	0.75 (0.3–1.83)	0.24 (–0.18–0.66)	0.59 (–0.06–1.25)	1.03 (0.46–2.32)
Family Breast Cancer History and Experiences	AUC=0.85; p=0.03	AUC= 0.70; p=0.04	R ² =0.07; df 10; p=0.34	R ² =0.12; df 10; p=0.38	AUC= 0.70; p=0.59
<i>BRCA1/2</i> + mother	1.04 (0.19–5.82)	0.37 (0.11–1.22)	–0.13 (–0.72–0.46)	0.49 (–0.19–1.17)	1.09 (0.41–2.9)
Mother has history of BC	0.11b (0.01–0.76)	0.37 ^b (0.16–0.88)	0.27 (–0.19–0.73)	0.37 (–0.22–0.96)	1.14 (0.54–2.42)
# FDR/SDR with BC history	1.74 (0.8–3.79)	1.15 (0.68–1.92)	–0.27 ^b (–0.54–0.01)	0.3 (–0.02–0.61)	0.94 (0.62–1.43)
BC acquaintances reported by girls	1.51 (0.87–2.6)	1.46 ^b (1.03–2.06)	0.12 (–0.06–0.3)	–0.19 (–0.39–0.01)	1.09 (0.81–1.48)
Daughter knows of mother's <i>BRCA1/2</i> testing	0.28 (0.03–2.57)	3.66 (0.93–14.42)	0.44 (–0.27–1.16)	–0.83 (–1.81–0.14)	1.39 (0.44–4.46)
Daughter perceived risk higher	1.5 (0.37–5.99)	0.99 (0.48–2.05)	–0.03 (–0.39–0.33)	–0.29 (–0.78–0.2)	1 (0.56–1.79)
Psychosocial Factors	AUC= 0.89; p=0.008	AUC= 0.72; p=0.775	R ² =0.11; df 15; p=0.05	R ² =0.15; df 15; p=0.09	AUC= 0.72; p=0.575
Anxiety	0.98 (0.96–1)	1 (0.98–1.01)	0 (–0.01–0.01)	0 (–0.01–0.01)	1 (0.99–1.01)
Depression	1.04 ^b (1.01–1.06)	1 (0.99–1.02)	–0.01 (–0.01–0)	0 (–0.01–0.01)	1 (0.99–1.01)
Breast cancer-specific Distress	1.05 (0.98–1.12)	1.01 (0.96–1.05)	0.01 (–0.02–0.03)	–0.01 (–0.05–0.02)	1 (0.96–1.05)
Poor general family functioning	0.31 (0.06–1.51)	1.78 (0.58–5.42)	–0.1 (–0.76–0.56)	0.14 (–0.66–0.93)	0.98 (0.4–2.43)
Poor family communication	4.96 (0.71–34.49)	0.42 (0.13–1.35)	–0.22 (–0.93–0.49)	–0.87 ^b (–1.74–0.01)	0.98 (0.36–2.72)
Girls' perceptions of cancer controllability and Maternal support for health behaviors	AUC=0.90; p=0.20	AUC= 0.78; p=0.026	R ² =0.13; df 17; p=0.11	R ² =0.19; df 17; p=0.001	AUC= 0.78; p<0.0001
If I lead a healthy lifestyle, I believe I can prevent or delay getting breast cancer. / Exercise/A healthy diet can help me prevent or delay breast cancer./ Doing breast self-examination will greatly increase my chances of detecting breast cancer. Daughter reports Mother	0.52 (0.19–1.38)	0.46 ^b (0.23–0.93)	0.33 ^b (0.01–0.65) –0.73 (–1.75–0.29)	0.24 (–0.18–0.67) 1.2 ^c (0.52–1.88)	1.28 (0.6–2.7) 2.09 ^c (1.58–2.76)

	Ever tried cigarettes	Ever tried alcohol	Daily Servings of Fruit/Veget able	Hours of Exercise	Ever did Breast Self- Exam
	n= 274 OR (95% CI)	n=265 OR (95% CI)	n=274 β (95%CI)	n=266 β (95%CI)	n=209 OR (95% CI)
encourages behavior (healthy diet/exercise/BSE)					
Mother Behaviors	AUC= 0.90; p= 0.43	AUC= 0.79; p= 0.49	R2=0.18; df 18; p=0.0003	R2=0.19; df 18; p=0.30	AUC=0.79; p=0.17
Mother smokes now Mother binge drank in last 30 Days Mother's daily servings of fruit/veg Mother's exercise Mother did BSE in the last month ^d	0.73 (0.04–12.02)	1.4 (0.53–3.69)	0.24 ^c (0.11–0.36)	0.06 (–0.05–0.17)	0.62 (0.31–1.24)

Models account for within family clustering; Abbreviations: FDR/SDR, first degree relative/second degree relative; BC, breast cancer; BSE, breast self-exam.

^a ordinal variable with 4 levels: <=HS, Some College, College, Grad School;

^b P<0.05;

^c P 0.001;

^d A secondary model was tested replacing *mother did BSE in the last month* with *mother had a history of bilateral mastectomy*. Findings did not differ- mothers' report of mastectomy was not associated with daughters' BSE in the alternate model.