Breast Cancer Risk and Participation in Mammographic Screening

STEPHEN TAPLIN, MD, MPH, CAROLYN ANDERMAN, MPH, AND LOUIS GROTHAUS, MA

Abstract: Within the context of an organized breast cancer screening program we conducted a prospective evaluation of the relation between breast cancer risk and participation in mammographic screening. The influence on participation of known breast cancer risk factors, as well as a summary risk label, (i.e. "high", or "moderate") were examined. The overall participation rate was 71 percent among 2,422 women, 50 to 79 years of age, invited to a centralized clinic. Multivariate analyses showed participation to be somewhat decreased among women with late menopause and definitely increased among women with any of the following factors: 1) increased age; 2) a family history of breast cancer; and 3) a previous breast biopsy. Women in the high-risk group were most likely to participate but the effect of the label was stronger among women ages 50 to 59 compared to women ages 60 to 79. The study results are generally consistent with previous findings that participants in screening programs have higher rates of breast cancer. The results also suggest the possibility that providing breast cancer risk information may encourage participation in screening. (*Am J Public Health* 1989; 79:1494–1498.)

Introduction

Self-selection bias has been a major concern in the assessment of cancer screening modalities.[1–3] The Health Insurance Plan (HIP) randomized trial of mammography demonstrated that breast cancer rates were higher among women who complied with an invitation to obtain a mammogram (participants) compared to those in the study population who did not comply with that invitation.[4] Several investigators have shown a higher prevalence of breast cancer symptoms among participants, but the influence of breast cancer risk factors on screening behavior has not been thoroughly evaluated.[5]

Investigators have examined the relationship between women's use of mammography and three risk factors: age, family history, and previous benign breast disease.[5–10] All but one of the studies were conducted retrospectively.[7] Participation appears to decrease with advancing age,[5–7] although one report showed increased participation,[8] and yet another found no association.[9] Two studies found no association between family history and participation.[5,6] A third study reported that participants in screening were more likely to have a family history of breast cancer, but this finding was based on very small numbers.[9] One study has examined the role of previous benign breast disease and showed an association in a negative direction with subsequent participation in screening, but the definition of this disorder was not explicit.[9]

The study reported here prospectively evaluates the association between participation in an organized screening program and the following six risk factors: age, family history of breast cancer, having a previous benign breast biopsy, nulliparity to age 30, early age at menarche, and late age at menopause. Previous work has suggested that perceived vulnerability to breast cancer is positively associated with participation in screening.[5,7,8] We, therefore, hypothesized that those factors which might be readily identified by a woman as increasing her risk of breast cancer (i.e., increased age, family history, and having needed a breast biopsy) would show positive associations with participation in screening. In contrast, we expected that nulliparity, early age at menarche, and late age at menopause would not be associated with participation in screening, as women are less likely to be aware that these factors increase their risk for breast cancer. In addition to the association between specific risk factors and participation in screening, this study also assessed the effect of being informed that one is at high risk vs moderate risk for breast cancer.

Methods

The study was conducted at Group Health Cooperative of Puget Sound (GHC), a 360,000-member closed panel health maintenance organization (HMO) that includes two hospitals and 21 primary care facilities in Western Washington state. Women GHC enrollees are slightly better educated and more likely to be in households with higher incomes than the general population of comparably aged women residing in Washington state.[11]

In March of 1985, Group Health Cooperative initiated a risk-based Breast Cancer Screening Program.[12,13] All female enrollees 40 years of age and older were mailed a two-page questionnaire which elicits information concerning breast cancer risk factors, medical and screening history, and selected lifestyle behaviors. Seven of 21 items on the questionnaire pertain to specific breast cancer risk factors. The response rate to this survey has been 85 percent.[13,14] Based on their personal constellation of risk factors, all women are assigned by the screening program to one of four risk categories: "high," "moderate," "borderline," or "no increased risk" which represent 18, 27, 12, and 43 percent of the population, respectively (see Appendix). Each woman who completes and returns this questionnaire is sent a follow-up letter, within two months, which indicates her risk category and a recommendation to: perform monthly breast self-examination, obtain a breast physical examination annually, and be seen in the breast cancer screening center for a mammogram every 1, 3, or 5 years according to risk level. Letters of invitation do not convey any risk factor information other than a woman's risk category. An automated data system maintains the survey data and documents all screening activity. These data served as the basis for the analysis of participation presented here.

The sample for this analysis consisted of women who had completed a risk factor questionnaire, were invited for a screening visit between March 1, 1985 and December 31, 1985, reported no mammogram during the one year prior to

Address reprint requests to Stephen Taplin, MD, MPH, Associate Director, Preventive Care Research, Center for Health Studies, Group Health Cooperative of Puget Sound, 521 Wall Street, Seattle, WA 98121. Ms. Anderman is Research Associate, and Mr. Grothaus is Biostatistician, both also at the Center for Health Studies. This paper, submitted to the Journal January 30, 1989, was revised and accepted for publication May 31, 1989.

being surveyed, and were continuously enrolled at GHC since being invited to come in for screening. The study group was limited to women ages 50 to 79 who were in the "high" and "moderate" risk categories (Table 1). Of the 2,722 women in this group, 2,422 received invitations to the screening program during this period and constitute the study population. The non-study population consists of the 300 women from this group who did not receive invitations during the study period plus 4,498 women whose only risk factor was age. At the time of this study, these women were placed in a group designated as "no increased risk" and were not invited for a screening visit. This policy has subsequently changed.[13]

Participation was defined as scheduling and completing an appointment in the screening center by June 30, 1986. There was no fee for this visit which included instruction in breast self-examination and a physical examination of the breast, as well as the mammogram. Subjects had a minimum of six and maximum of 15 months opportunity to come in for screening following their invitation. At the time of this study, the wait time to obtain a mammogram was approximately one month. Analysis of overall program data shows that 93 percent of women who participate within one year do so within the first six months after being invited. Women received only one invitation and were not sent any reminders.

The relation between participation in screening and the following six factors was considered: age, family history of breast cancer, previous benign breast disease, menarche at 10 years of age or younger, menopause at 55 years of age or older, and nulliparity to age 30. A positive family history was defined as having one or more first or second degree family members with a history of breast cancer (i.e., mother, sister, daughter, grandmother, or aunt). Benign breast disease was defined as having reported one or more breast biopsies which were non-cancerous. In addition to considering the six individual risk factors, the effect on participation of being assigned a "high" vs "moderate" risk label was examined.

Bivariate contingency table analyses were carried out initially to assess the association between participation and each of the seven variables considered individually. Logistic regression was then used to estimate the effect of each variable controlling for the influence of all others. The logistic analysis was done in two steps. First, models were fit to test if there were any significant interactions between risk label and the other variables. Then, a final logistic model was fit containing the seven main effects plus any significant interactions.

Results

Since the study population was composed of women who were invited for screening because they were at increased risk for breast cancer, each woman necessarily had one or more risk factors for the disease. As expected, a higher proportion of study women had any given risk factor compared to non-study women (Table 1).

Table 2 shows the percentage of study women with each of the six risk factors according to their risk category. As expected, a larger proportion of high-risk women have any particular risk factor.

Of the 2,422 women in the study population, 71 percent came in to the screening center as requested by the letter of invitation. Table 3 shows the crude odds ratios (OR) for the association between breast cancer risk factors and participation in mammography. The strongest association is between the risk category and participation (OR = 2.59), followed by family history (OR = 1.83), previous biopsy (OR = 1.60), and age (OR = 1.45). Age is dichotomized in this bivariate analysis since participation varies little among women above age 60 when grouped into five-year intervals (73 percent to 75 percent). Three factors (age ≥ 55 at menopause, nulliparity to age 30, and age ≤ 10 at menarche) show no association with participation.

Table 4 shows odds ratios estimated from the logistic regression analysis. Since there is a significant interaction between age and risk designation, the final logistic model consists of the six risk factors, the risk designation, and this interaction term. Family history of breast cancer and previous benign breast biopsy continue to be associated with increased participation although the odds ratio is slightly less. Neither nulliparity to age 30 nor menarche at age 10 or

TABLE 1—Risk Factor Comparison in Study vs Non-Study Women

Characteristics	Study[a] Women (n = 2,422)		Non-Study[a] Women (n = 4,798)	
	Number	Percent	Number	Percent
Age (years)				
60–79	1515	62.6	2715	56.6
50–59	907	37.4	2083	43.4
Risk Category[b]				
High	875	36.1	193	4.0
Moderate	1547	63.9	107	2.2
No Increased Risk[c]	0	0	4498	93.8
Family History Breast Cancer				
Yes	886	36.6	499	10.4
No	1536	63.4	4299	89.6
Previous Benign Breast Biopsy				
Yes	541	22.7	383	8.2
No	1841	77.3	4281	91.8
Nulliparity to Age 30				
Yes	1856	35.3	163	3.4
No	1566	64.7	4634	96.6
Menarche Age < 10				
Yes	166	7.0	41	0.9
No	2214	93.0	4661	99.1
Menopause Age ≥ 55				
Yes	427	17.6	128	3.2
No	1995	82.4	3822	96.8

[a]Among GHC women 50 years of age and older who completed and returned a risk factor questionnaire before December 31, 1985 and had not reported having a mammogram within one year: "Study Women" are those women who were invited for screening; "Non-Study Women" represent those who were not invited by December 31, 1985.
[b]There are no "Borderline" risk women in the age group studied (see Appendix).
[c]These women have none of the risk factors listed, except age.

TABLE 2—Proportion of Women in Moderate and High-Risk Categories Who Have a Particular Risk Factor

Risk Factors	Risk Category[a]	
	Moderate (N = 1547)	High (N = 875)
Age 60–79 years	61%[b]	66%
Family History of Breast Cancer[c]	21%	63%
Previous Benign Breast Biopsy	15%	37%
Nulliparity to Age 30	31%	43%
Age ≤ 10 at Menarche	5%	10%
Age ≥ 55 at Menopause	14%	24%

[a]Risk category is the designation given by the screening program according to the algorithm in the Appendix.
[b]For example, 61 percent of moderate-risk women are 60 to 79 years of age compared to 66 percent of high-risk women.
[c]First and second degree family history result in different risk designations (see Appendix).

TABLE 3—Bivariate Analysis of Breast Cancer Risk and Participation in Mammographic Screening

Characteristics	% Participation	Unadjusted Odds Ratio (95% CI)[a]
Age (years)		
60–79	73.3	1.45
50–59	65.7	(1.21, 1.73)
Risk Category		
High	82.2	2.59
Moderate	64.1	(2.12, 3.15)
Family History of Breast Cancer		
Yes	78.2	1.83
No	66.2	(1.52, 2.22)
Previous Benign Breast Biopsy		
Yes	77.6	1.60
No	68.4	(1.28, 2.00)
Nulliparity to Age 30		
Yes	71.3	1.05
No	70.2	(.87, 1.26)
Age ≤ 10 at Menarche		
Yes	68.7	.90
No	70.7	(.64, 1.26)
Age ≥ 55 at Menopause		
Yes	66.4	.84
No	71.4	(.67, 1.05)

[a]95% confidence interval for odds ratio.
[b]Referent group for odds ratio is women without the risk factor.

TABLE 4—Results of Logistic Regression Analysis of Breast Cancer Risk and Participation in Mammographic Screening

Characteristics	Adjusted Odds Ratio[a]	(95% CI)
Family History Breast Cancer	1.35	(1.02, 1.79)
Previous Benign Breast Biopsy	1.36	(1.02, 1.81)
Nulliparity to Age 30	0.97	(0.75, 1.24)
Age ≤ 10 at Menarche	0.82	(0.55, 1.22)
Age ≥ 55 at Menopause	0.73	(0.55, 0.97)
Age and Risk Category[b]		
Moderate Risk Category		
Age 50–59	1.00	
Age 60–79	1.86	(1.49, 2.32)
High Risk Category		
Age 50–59	3.94	(2.61, 5.96)
Age 60–79	3.09	(2.21, 4.31)

[a]Odds ratios estimated from the logistic regression model including all six risk factors and a variable for the interaction between "age" and "risk category." Odds ratios are defined so that those without the characteristic are the reference group.
[b] Odds ratios are defined so that women ages 50–59 who are at "moderate" risk are the reference group.

younger show any association with participation. Controlling for other risk factors in the multivariate model increased the association between late menopause and participation.

The association of age with participation depends on whether the risk label was "moderate" or "high." Increasing age is associated with participation only among women with the "moderate" risk label. For women labeled high-risk, participation is essentially the same or even slightly less among older women (OR = 3.09/3.94 = 0.78).

As seen in the bivariate analysis, the high-risk label shows the strongest association with participation. However, the four odds ratios for the joint factors in Table 4 reveal that the association between the high-risk label and participation was more than two times as strong in younger (OR = 3.94) compared to older women (OR = 3.09/1.86 = 1.66, Table 4).

Discussion

The results of this study substantiate our hypothesis that risk factors recognizable by lay persons such as age, family history, previous benign breast biopsy, and the high-risk label are each positively associated with compliance with a mailed recommendation to obtain a screening mammogram. Since risk factor information was collected prior to screening visits, recall bias was avoided. The prospective observation of the entire population in the course of their usual care also eliminates any Hawthorne effect created in the process of selecting and observing a separate study population.

Performing the study in the context of a formal screening program also creates some potential limitations. First, all candidates for the study were respondents to the screening survey; the relation between risk and participation might be different for non-respondents. However, since 85 percent of women complete the risk factor questionnaire, this potential threat to generalizability is expected to be minimal. Second, as a result of the screening program's design, all study women had at least one risk factor in addition to age. In considering each individual risk factor, the referent group consisted of women without any factor but possessing "other" risk factors. While it is not possible to determine from these data whether the magnitude of the associations might differ substantially if the referent population included women whose only risk factor is age, it is likely that the associations would be stronger.

A final limitation is that the results may be biased due to residual confounding by two factors. The first is socioeconomic status (SES) for which no data were available. Since higher socioeconomic status has been associated with increased risk of breast cancer[15] and with increased participation in screening,[5,7] it must be considered a potential confounder. However, any effect of SES would be expected to be small since GHC is somewhat more homogeneous with respect to SES compared to the surrounding SMSA population.[11] Second, there may be residual confounding due to the presence of breast cancer symptoms. Participants in the HIP study were more likely to report pre-menstrual breast tenderness or having previously felt a breast lump.[5] However, when women call for an appointment at the GHC screening center, the policy is to ask about pain, lumps, or the presence of nipple discharge. Women with any of these symptoms are advised to see their primary care physician, so it is expected that the majority of screened women were asymptomatic. Symptomatic women who called for an appointment and were referred to their physician would have been misclassified as non-participants in this study since the program does not document these calls in its automated data base. This misclassification would weaken the observed associations.

Our data show that family history of breast cancer is significantly associated with participation even after controlling for other risk factors. French's work found that participants were more likely to have a family history of breast cancer than non-participants, but the difference was not statistically significant.[9] In the HIP study, there was no significant difference in "family history of cancer" between women who completed all four screening examinations compared to those who did not.[5] However, that study did not evaluate the relationship between family history of breast cancer and participation.

Our finding of increased participation among older women is not consistent with previous reports which show

associations in the opposite direction.[5–7] However, none of these studies included women beyond 64 years of age and only one was conducted prospectively.[7] The data presented here suggest women 60 to 79 years of age are more likely to participate than women 50 to 59 years of age. While the reason for lower participation in younger women is not clear, one possible explanation is that these women are more likely to be employed and therefore have conflicts during usual screening clinic hours.

Our finding of increased participation in older women is important because more women are living longer and the incidence of breast cancer increases greatly with advancing age. Celentano has pointed out that primary care providers often fail to offer cancer screening procedures to the elderly.[16] Others have suggested that cost is a barrier.[17,18] The relative importance of these two factors is not clear. With the advent of Medicare coverage for mammography every two years, it will be important to observe whether the use of mammography increases among older women in other populations. Our data suggest that senior women will use mammography if it is offered to them, and cost is not an issue.

No other studies to our knowledge have examined the association between participation and the three other risk factors studied here: nulliparity to age 30, early age at menarche, and late age at menopause. Our findings are not completely consistent with our hypothesis that these factors would be unassociated with participation. No associations exist in the bivariate analysis. However, after controlling for all other risk factors in the multivariate model, a negative association appears between late menopause and participation. The explanation for this is not clear, but one consideration is that there is confounding by some other factor such as estrogen use. This relation needs closer examination in future studies.

The increased participation among women with particular risk factors that is demonstrated in this study is consistent with the Health Belief Model[19,20] which suggests that perceived vulnerability to disease should influence the likelihood that a person will undertake preventive behaviors. We hypothesized that women with certain risk factors would be more likely to perceive themselves as vulnerable, and therefore participate in screening. While the increased participation has been demonstrated with our data, we did not directly evaluate women's perception of their vulnerability.

The risk assessment/feedback process used in Group Health Cooperative's Breast Cancer Screening Program is similar to Health Risk Appraisal (HRA) and may be a way to increase the use of mammography. The HRA process provides individuals with quantitative and/or qualitative disease risk estimates based on self-reported risk factors obtained through questionnaires.[21] Proponents of HRA argue that it is an effective strategy for facilitating positive health-related behavior. Our finding that women given a high-risk designation were most likely to participate suggests that this may be true. However, more needs to be learned about the effect of different risk labels, and the influence of these designations on other behaviors. Experience from hypertensive labeling suggests that there are potential negative effects such as increased depressive symptoms, and lower self-perceived health.[22]

In conclusion, overall our study found the expected positive associations between participation and those risk factors that could be easily identified by women. Self-selection for screening by women at increased risk has been identified as a major concern in the non-experimental evaluation of screening.[1–3] Our findings give substance to these concerns but also raise the possibility that informing women of all their risk factors or using a summary risk label may take advantage of the motivation behind self-selection and encourage participation.

APPENDIX
Risk Algorithm*

High-Risk Group	• Previous breast cancer • Mother with breast cancer • Age 50+ and 2 VRF listed below
Moderate-Risk Group	• Age 40–49 and 2 VRF listed below • Over age 50 and 1 VRF listed below
Borderline Risk	• Age 40–49 and 1 VRF listed below
No Increased Risk	• No VRF, any age
Variable Risk Factors (VRF)	• Previous cancer (other than breast) • First or Second degree relative (other than mother) with breast cancer • Menarche age 10 or under • Nulliparity • 1st pregnancy age ≥ 30 • Menopause age ≥ 55 • Previous benign breast disease

*Risk algorithm used in Group Health Cooperative's Breast Cancer Screening Program until April 1988.[13]

ACKNOWLEDGMENTS

This work was supported in part by grant #CA34847 from the National Cancer Institute. The guidance and critical comments of Ed Wagner, MD, MPH, were instrumental in the preparation of this work, and greatly appreciated.

REFERENCES

1. Prorok P, Hankey B, Bundy B: Concepts and problems in the evaluation of screening programs. J Chronic Dis 1981; 34:159–171.
2. Weiss N: Control definition in case-control studies of the efficacy of screening and diagnostic testing. Am J Epidemiol 1983; 118:457–460.
3. Sasco AJ, Day NE, Walter SD: Case-control studies for the evaluation of screening. J Chronic Dis 1986; 39:399–405.
4. Shapiro S, Venet W, Strax P, Venet L, Roesser R: Ten-to-fourteen year effect of screening on breast cancer mortality. JNCI 1982; 69:349–355.
5. Fink R, Shapiro S, Roester R: Impact of efforts to increase participation in repetitive screenings for early breast cancer detection. Am J Public Health 1972; 328–336.
6. Hobbs P, Smith A, George DW, Sellwood RA: Acceptors and rejectors of an invitation to undergo breast screening compared with those who referred themselves. J Epidemiol Community Health 1980; 34:19–22.
7. Calnan M: The health belief model and participation in programs for the early detection of breast cancer: A comparative analysis. Soc Sci Med 1984; 19:823–830.
8. Schwoon DR, Schmoll H: Motivation to participate in cancer screening programs. Soc Sci Med 1979; 13A:283–286.
9. French K, Porter AMD, Robinson SB, McCallum FM, Howie JGR, Roberts MM: Attendance at a breast cancer screening clinic: A problem of administration or attitudes. Br Med J 1982; 285:617–620.
10. Hobbs P: The behavioral aspects of breast and cervical screening. Radiography 1986; 52:287–290.
11. Pearson DC, Grothaus LC, Thompson RS, Wagner EW: Smokers and drinkers in a health maintenance organization population: Lifestyles and health status. Prev Med 1987; 16:783–795.
12. Carter AP, Thompson RS, Bourdeau RV, Andenes J, Mustin H, Straley H: A clinically effective breast cancer screening program can be cost-effective, too. Prev Med 1987; 16:19–34.
13. Thompson RS, Taplin S, Carter AP, Schnitzer F, Anderman C, Anderson E, White E, Wagner E: Risk-based breast cancer screening program. HMO Practice 1988; 2:177–191.

14. Taplin SH, Anderman C: Risk-based breast cancer screening in an HMO: The first year's experience. Group Health Association of America. Group Health Institute Proceedings June 1987; 381–384.
15. Kelsey JL: A review of the epidemiology of human breast cancer. Epidemiol Rev 1979; 1:74–109.
16. Celentano DD, Shapiro S, Weisman CS: Cancer preventive screening behavior among elderly women. Prev Med 1982; 11:454–463.
17. Gold RH, Bassett LN, Fox SA: Mammography screening: Successes and problems in implementing widespread use in the United States. Radiol Clin North Am 1987; 25:1039–1046.
18. Dodd GD, Fink DJ, Bertram DA: Mammography. Addressing the needs and solutions to increase the use of low-cost screening mammography. Cancer 1987; 60:1669–1670.
19. Janz NK, Becker MH: The health belief model: A decade later. Health Educ Q 1984; 11:1–47.
20. Becker M, Haefner DP, Kasl SV, Kirscht JP, Maiman LA, Rosenstock IM: Selected psychosocial models and correlates of individual health-related behaviors. Med Care 1977; 15(Suppl):27–46.
21. Wagner EW, Beery WL, Schoenbach VJ, Graham RM: An assessment of health hazard/health risk appraisal. Am J Public Health 1982; 72:397–352.
22. Bloom JR, Monterossa S: Hypertension labeling and sense of well-being. Am J Public Health 1981; 71:1228–1232.

RWJ Foundation Awards Grant to Study Child Abuse Responses in 50 States

The first 50-state survey of child abuse policies and regulations will be launched by the American Bar Association (ABA) with a grant from the nation's largest health care philanthropy. The $280,464 two-year grant has been awarded to the ABA Fund for Justice and Education from the Princeton-based Robert Wood Johnson Foundation. The ABA, in conjunction with the American Academy of Pediatrics, will develop recommendations about policies and procedures related to prevention, intervention, and investigations of child abuse.

Under the direction of Susan J. Wells, PhD, the ABA survey will gather and analyze information from child welfare agencies, physicians, coroners, police officials, prosecutors, and legislators in all 50 states to determine how state and local governments are currently responding to child abuse.

It is estimated that child deaths from abuse have increased 34 percent since 1985, resulting in about 5,000 deaths a year, said Leighton E. Cluff, MD, Foundation president. "But because states don't collect child abuse data uniformly, there is little information to guide policymakers and other officials working to prevent these deaths," he added. Cluff termed the ABA project "an important first step" in addressing the problem and in understanding the effect of interventions intended to prevent child abuse.

In addition to collecting data, the ABA will provide consultation to selected states that have expressed interest in revising their policies regarding child abuse.

The Robert Wood Johnson Foundation was established as a national philanthropy in 1972. Since then, it has awarded more than $996 million in grants to improve health care for such US populations as adolescents, children and mothers, the elderly, the homeless, the mentally ill, people with AIDS, and the uninsured. For further information, contact the RWJ Foundation, PO Box 2316, Princeton, NJ 08543-2316. Tel: (609) 452-8701.