Relation Between Intervention Exposures, Changes in Attitudes, and Mammography Use in the North Carolina Breast Cancer Screening Program

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Abstract

Objective: Many past interventions have been based on the assumption that improving attitudes about mammography can increase mammography use. We studied changes in breast cancer and mammography attitudes over time in mediating the effect of intervention exposures on mammography use in the North Carolina Breast Cancer Screening Program. Data came from interviews with a cohort of 331 black women who said they had heard of mammography at baseline interview. Methods: We created scores and score changes for mammography (7 items) and breast cancer (11 items) attitudes at baseline (1993–1994) and follow-up interviews (1996–1997). We modeled intervention exposures, attitude changes, and mammography use in linear risk and logistic regression. Intervention exposures were defined for mammography discussion with a project lay health advisor (''LHA advice''), mammography discussion with anyone besides a doctor or nurse, and project awareness. Results: Positive change in mammography attitudes was associated with intervention exposures and mammography use and appeared to account for a large percentage (34–98%) of the effect of mammography discussion variables on increased mammography use. Greatest effect of attitude improvement was found for women without a recent mammogram at baseline and with the least positive baseline attitude scores. Conclusion: Using cohort data enabled us to examine the role of attitude change over time on mammography use. Breast cancer screening programs should target women with the most negative mammography attitudes and the least mammography use to start with and concentrate their messages on improving attitudes specific to mammography rather than improving attitudes about breast cancer risk. (Cancer Epidemiol Biomarkers Prev 2004;13(5):741–7)

Introduction

In rural parts of the United States, black women are less likely to have had a recent mammogram and less likely to have ever had a mammogram than white women (1–4). There are many potential reasons for this disparity, among them are lack of a physician recommendation (2, 5), less contact with the health care system in general, and a greater number of personal and system barriers to getting screened (6–13). Attitudes toward mammography, cultural beliefs inconsistent with the perceived need for mammography, or less awareness about breast cancer's causes and consequences are possible barriers to routine mammography use among this group of women.

Because negative attitudes toward mammography can create barriers to use among minority women, interventions that improve attitudes may improve minority mammography use, reducing racial disparities (14). The North Carolina Breast Cancer Screening Program (NC-BCSP) was a lay health advisor (LHA)-based intervention conducted from 1993 to 2002 that aimed to increase rates of mammography screening among black women in eastern North Carolina (4, 15, 16). Goals of the North Carolina Breast Cancer Screening Program included changing or correcting beliefs about what does and does not cause breast cancer and moving women's attitudes toward a greater acceptance of the need for regular mammography screening. Previous studies that have examined associations between attitudes and mammography use have usually measured attitudes at a single point in time (9–11, 13, 17, 18). Most (9, 13, 18) but not all (17) studies have found that mammography attitudes are positively associated with mammography use when measured this way.

Positive associations between attitudes and screening behavior at a single point in time may not explain whether changing attitudes over time can change screening behavior. In the present study, we examine changes over time in responses to questions regarding attitudes about the usefulness of mammography and about what does and does not cause breast cancer in a cohort of rural black women. In this manner, we

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examined not only the causes of change in mammography and breast cancer attitudes but also the impact of these changes on mammography use.

Materials and Methods

Study design and recruitment have been described in detail elsewhere (4). Briefly, we implemented a multicomponent intervention that relied on a network of LHAs (19) diffusing information about mammography screening in five counties in rural, eastern North Carolina. Between 1993 and 1997, 160 LHAs were trained in the five intervention counties. Training was informed by focus group results about local women's unique barriers and specific issues about screening. It included a minimum of 12 h instruction about breast cancer, mammography, and other breast cancer detection procedures as well as eligibility for screening payment programs (20).

Our research was informed by two theoretical perspectives: social cognitive theory (21) and diffusion of innovations (22). Social cognitive theory was relevant because we expected that the LHAs would achieve their impact by serving as positive role models within their communities; moreover, diffusion of innovation theory suggests that people are more likely to change behaviors when the change agent is perceived as like themselves, a process known as homophyly.

This social network and diffusion of innovations strategy was supplemented by other interventions targeting communities, health care organizations, and providers (23). Following their training, LHAs worked to promote awareness of breast cancer screening through presentations to local community groups and community events, engaging in one-on-one conversations with women they knew, and use of tailored materials informed by focus group data and behavioral change theory (15).

As part of the evaluation of the intervention, 494 African American women were interviewed from the five intervention counties at baseline (1993–1994) and 390 of these women participated again at follow-up interview in 1996–1997 (response rate at follow-up = 89%; Ref. 4). Of these 390 women, 50 women reported having never heard of a mammogram at baseline and another 9 women reported hearing of a mammogram at baseline but not at follow-up. These 59 women were excluded from the analyses because they were not asked about their attitudes toward mammography at either one or both time points. In addition, three women were missing data on their mammography use at follow-up interview, resulting in a final analysis sample of 328 women. In this report, we examined results from these 328 intervention cohort members who had heard of a mammogram at baseline and had data at both interviews.

Intervention Exposure Variables. At follow-up, we asked women about possible intervention exposures since the baseline interview. We examined three exposures in these analyses: (*a*) mammography discussion specifically with a project LHA (''LHA advice''), (*b*) mammography discussion with anyone besides a doctor or a nurse (''diffused discussion''), and (*c*) awareness of the project (''project awareness''). These three exposure measures are not independent, and they were chosen to reflect different levels of specificity of exposure ranging from general awareness of the project to actual contact with a project LHA.

The *project awareness* variable was defined as positive for women who specifically identified ''North Carolina Breast Cancer Screening Program's Save Our Sisters'' from a list of organizations active in these communities. The variable *diffused discussion* was defined as a positive response to either of two questions: ''During the past year or two, has anyone from one of these groups who works in the community to educate people about breast cancer spoken with you about getting a mammogram?'' or ''Since you last talked to me a couple of years ago, has any other person, not a doctor or a nurse, talked with you about getting a mammogram?'' The variable *LHA advice* was operationalized in two ways. Women who named the project as the group that had spoken to them about mammography and those who reported discussing mammography with an actual North Carolina Breast Cancer Screening Program LHA by name were both defined as positive for LHA advice.

Measures of Attitude Change. We defined positive attitudes about mammography as those attitudes that were consistent with the notion that the benefits of mammography outweighed the barriers. We defined positive attitudes about breast cancer as attitudes about risk that were in agreement with what is known about what does and does not cause breast cancer.

At interview, women were asked to rate their level of agreement (agree strongly, agree, disagree, or disagree strongly) with 7 statements pertaining to mammography and 11 statements pertaining to breast cancer risk. The seven mammography questions were as follows: (*a*) unless a doctor recommends it, a woman your age does not need a mammogram every year; (*b*) mammograms give off unsafe amounts of radiation; (*c*) a mammogram is most useful for women under age 50; (*d*) a woman your age does not need a mammogram unless she has problems with her breasts; (*e*) if a woman has one mammogram, she usually does not need another one; (*f*) women over age 65 need yearly mammograms as much as women under 65; and (*g*) if it is done wrong, a mammogram can cause cancer. The 11 breast cancer questions included questions about both traditional risk factors (age, childbearing, breast feeding, and family history) and factors generally not related to risk (bruising, having lumpy breasts, having ''high or thin'' blood, etc.).

Responses to the above variables were dichotomized by combining the categories ''agree strongly'' and ''agree'' and the categories ''disagree strongly'' and ''disagree'' and then recoded as ''positive'' or ''negative'' to reflect our definitions of attitudes regarding breast cancer and mammography.

The number of positive responses was then summed to create two scores for breast cancer attitudes (baseline and follow-up) and two scores for mammography attitudes (baseline and follow-up). Separately for breast cancer and mammography attitudes, we calculated the difference in scores (follow-up score minus baseline score). A positive change in mammography attitude score was interpreted as a change in attitudes toward a greater acceptance over time of the benefits of mammography. A positive change in breast cancer attitudes

was interpreted as an increased awareness over time of what does and does not cause breast cancer. From each score change, we proceeded to define a dichotomous variable representing any positive change *versus* no change or negative change, and we used this variable for most of our analyses to produce consistent interpretations across analyses. We also created an ordinal variable with six categories: negative or no score change (0), positive score change of one (1), two (2), three (3), four (4), or five or more (5). The ordinal variable was used when examining attitude change as a mediator in the association between exposures and mammography use.

Mammography Outcome Variable. The outcome variable of interest in these analyses was self-reported mammogram in the past two years at follow-up interview. Most results were stratified for users and nonusers at baseline, with nonusers referring to those who had never had a mammogram or who had had one prior to two years before the baseline interview.

Analyses. We relied for the most part on linear risk models, which are similar to logistic regression models except that, rather than modeling the log odds (or logit) of the outcome measure, linear risk models model the probability of the outcome directly. Parameter estimates from linear risk models represent percentage point differences (PPD) in the outcome (rather than odds ratios as in logistic regression). First, we re-examined the effect of intervention exposures on mammography use at follow-up interview. We modeled mammography use at follow-up interview (separately among baseline users and nonusers) as a function of the three intervention exposures: LHA advice, diffused discussion, and project awareness. These results were similar to those published previously (4) and are presented here to provide the background for subsequent analyses.

We then conducted analyses to answer the following four questions: (*a*) Were intervention exposures associated with positive change in attitude scores? (*b*) Was positive change in attitude scores associated with mammography use? (*c*) Did positive change in attitude scores account for the effect of intervention exposures on mammography use? and (*d*) Did the effect of positive change in attitude scores vary by baseline attitudes?

To answer our first question, whether intervention exposures were associated with positive change in attitude scores, we modeled the probability of any positive change by exposure status using linear risk models before and after adjusting for baseline attitude score.

To answer our second question, whether positive change in attitude score was associated with mammography use, we modeled the probability of a recent mammogram (separately for recent users and nonusers at baseline) by positive change in linear risk regression before and after adjusting for baseline attitude score.

To answer our third question, whether positive change in attitude score accounted for the associations between exposures and use, we modeled the PPD in recent mammography by exposure status and calculated the percentage reduction in this difference that resulted from adjusting for ordinal attitude score change. For this analysis, we used the ordinal change variables rather than the dichotomous variables to allow for the full potential of positive change in attitude scores as mediators without loss of interpretability. All models were adjusted for baseline attitude score. Models were run separately for each intervention exposure and separately among recent mammography users and nonusers at baseline.

To answer the last question, whether the effect of positive change in attitude scores varied by baseline attitudes, we modeled the interaction between positive attitude change and baseline attitudes on recent mammogram at follow-up interview using logistic regression by including the two main effects along with their product term.

Results

Distribution of Attitude Score and Score Changes. Among this group of women who reported having heard of mammography at baseline interview, 28% had a mammography attitude score of 2 or fewer out of 7 items and 21% had a breast cancer attitude score of 3 or fewer out of 11 items (Table 1). With respect to change in scores at follow-up interview, 34% had a negative change in mammography attitude score while 41% had a positive change. An equal percentage of women had both a negative and a positive change in breast cancer attitude score (42%; Table 1).

Intervention Exposures and Mammography Use. Among women without a recent mammogram at baseline, 15% reported LHA advice, 26% reported diffused discussion, and 37% reported project awareness; all three intervention exposures were associated with a 17–18 percentage point increase in use at follow-up (Table 2). Among women with a recent mammogram at baseline, 18% reported LHA advice, 29% reported diffused discussion, and 45% reported project awareness; LHA discussion and project awareness were marginally associated with use at follow-up while diffused discussion was unassociated with use at follow-up (Table 2).

(a) Were Intervention Exposures Associated with Positive Change in Attitude Scores? All three intervention exposures were associated with a positive change in mammography attitude scores (Table 3). Positive change was more likely among women reporting LHA advice (58%) than among women not reporting LHA advice (38%; adjusted PPD = 17, 95% CI 3–31). Positive change was also more likely for women reporting diffused discussion and project awareness (Table 3).

With respect to changes in breast cancer attitude score, LHA advice was strongly associated with positive change (adjusted PPD = 16, 95% CI 3–29) while diffused discussion (adjusted PPD = 8, 95% CI −2 to 18) and project awareness (adjusted PPD = 6, 95% CI −2 to 14) were more modestly associated with positive change.

(b) Were Positive Changes in Attitude Scores Associated with Use? Positive changes in mammography attitude scores were associated with greater mammography use both among women with and without a recent mammogram at baseline (Table 4). For example, among women without a recent mammogram at baseline, a recent mammogram at follow-up was more likely among women with positive change (54%) than among women without positive change (40%). After adjusting

Table 1. Distribution of baseline scores and change in scores relating to attitudes about mammography and breast cancer risk factors (*n* = 328)

Mammography attitude scores		Breast cancer attitude scores	
Score value (7 items)	*n* (%)	Score value (11 items)	*n* (%)
Baseline score			
0	22 (7)*	0	8 (2)
1–2	69 (21)	1–3	62 (19)
3–4	102 (31)	4–7	200 (61)
5–7	134 (41)	8–11	57 (17)
Missing	1	Missing	1
Score change			
−(5–7)	6 (2)	−(8–11)	1 (0)
−(3–4)	27 (8)	−(4–7)	29 (9)
−(1–2)	78 (24)	−(1–3)	107 (33)
0	79 (24)	0	51 (16)
1–2	81 (25)	1–3	106 (33)
3–4	40 (12)	4–7	29 (9)
5–7	14 (4)	8–11	1 (0)
Missing	3	Missing	4

*Percentages may not add exactly to 100 due to rounding. Missing values were not included in percentages.

for baseline attitude score, positive change in mammography attitude score was associated with a 26 percentage point greater likelihood of a recent mammogram at follow-up interview (adjusted PPD = 26, 95% CI 9–44).

Positive change in breast cancer attitude score was not associated with mammography use at follow-up interview. There was no effect of positive change on the likelihood of a recent mammogram at follow-up interview for either nonusers (adjusted PPD = −1, 95% CI −12 to 12) or users (adjusted PPD = 6, 95% CI −12 to 25) of recent mammography at baseline interview.

(c) Did Positive Change in Attitude Scores Account for Associations between Exposure and Use? Positive change in mammography attitude score appeared to account for about half of the difference in mammography use related to LHA advice and about 40% of the difference in mammography use related to diffused discussion among nonusers at baseline (Table 5). Among mammography users at baseline, positive change in mammography attitude score appeared to account for about one-third of the difference in mammography resulting from LHA advice and virtually all of the difference related to diffused discussion. Positive change explained less of the associations with project awareness.

(d) Did the Effect of Positive Change in Attitude Score Vary by Baseline Attitudes? Among women without a recent mammogram at baseline, positive change in mammography attitudes was strongly associated with follow-up mammography use regardless of the baseline attitude score (*P* for product term = 0.6). Among mammography users at baseline, however, positive change in mammography attitudes was strongly associated with follow-up mammography use only among women with lower baseline attitude scores (*P* for product term = 0.25; Fig. 1). There was no effect of breast cancer attitude score on follow-up mammography regardless of the initial baseline value of breast cancer attitude scores (results not shown).

Discussion

From these analyses, positive change in attitudes toward mammography apparently was a mediator in the associations between intervention exposures and mammography use. We found that (*a*) exposures were associated with positive changes in mammography attitudes; (*b*) these changes, in turn, were associated with greater mammography use; (*c*) adjusting for these changes reduced the magnitude of the associations between intervention exposures and mammography use; and (*d*) the effect of these changes was greatest for women with the least mammography use and the least positive attitudes toward mammography at baseline. Although intervention exposures were associated with positive changes in attitudes toward breast cancer risk, these changes were not associated with greater mammography use.

While the intervention had several components, the primary one consisted of women talking to other women, spreading the message about the importance of mammography in the early detection of breast cancer. Apparently, discussion with a LHA was effective in changing attitudes about mammography and breast cancer risk. When defining our general discussion variable (''diffused discussion''), we could not disaggregate direct LHA advice from advice by others. The inclusion of LHA advice as part of the general discussion variable is consistent with the theory of the intervention, in which discussion about mammography that begins with an LHA diffuses into the population as women talk

Table 2. PPD in mammography use at follow-up interview by intervention exposures

Exposure	No baseline mammogram: mammogram at follow-up			Baseline mammogram: mammogram at follow-up		
	n	%	PPD (*P*)*	*n*	%	PPD (*P*)
LHA advice						
No	149	44		126	82	
Yes	26	62	18 (0.09)	27	93	11 (0.17)
Diffused discussion						
No	129	42		109	83	
Yes	46	59	17 (0.05)	44	86	3 (0.57)
Project awareness						
No	109	40		84	80	
Yes	65	57	17 (0.03)	69	88	8 (0.15)

*P from a binomial (linear) risk model (unadjusted).

Table 3. PPD in positive mammography attitude change by intervention exposures before and after adjusting for baseline attitude score

	Positive change (%)	Unadjusted		Adjusted for baseline knowledge	
		PPD (95% CI)	*P**	PPD (95% CI)	*P*
Intervention exposure					
LHA advice					
No	38				
Yes	58	21 (6–35)	0.005	17 (3–31)	0.01
Diffused discussion					
No	37				
Yes	53	17 (5–29)	0.006	14 (3–25)	0.02
Project awareness					
No	38				
Yes	46	8 (−3 to 19)	0.14	11 (3–19)	0.008

*P from a binomial (linear) risk model.

to other women about the benefits of screening (22). For many of our cohort respondents, LHA may have spoken with their friends and relatives who then may have spoken to the respondents themselves.

Whether attitudes and mammography use are associated at a single point in time may not explain whether changing attitudes can change screening behavior. We believe our study is the first to examine, in a random sample of the population, the impact on mammography use of changes over time in attitudes toward mammography and breast cancer. In this cohort of rural, African American women, positive change in mammography attitudes was associated with greater mammography use, suggesting that changing perceptions about the risks and benefits of mammography can result in increased mammography use. Positive change in attitudes toward breast cancer risk, on the other hand, was not related to greater mammography use. Education about breast cancer risk might dispel certain myths about what causes breast cancer; this, in turn, could either increase or decrease the perceived need for mammography. A better strategy for future mammography interventions would appear to be one that focuses on the need for mammography and dispelling myths related to that need rather than focusing on what does and does not cause breast cancer.

The effect of mammography attitude change on mammography use was strengthened considerably by adjusting results for variation in baseline attitude scores. As a confounder, baseline mammography attitude score attenuated the positive relation between attitude change and mammography use through its negative association with attitude change but positive association with mammography use. This observation reinforces the notion that, when examining the effect of score change on any outcome of interest, the analysis needs to account for the potential confounding effects of the initial values of the score.

The effect of positive change in mammography attitudes was generally greater among women without recent mammography at baseline. Furthermore, for women with recent mammography at baseline, it appeared that the greatest effect of positive attitude change was among those women with the lowest scores to begin with. These results suggest that interventions should target women with the least positive attitudes toward mammography and the least mammography use, women who are also likely to be lower in socioeconomic status and to have less access to health care (2, 8, 18). In our sample, women without a recent mammogram at baseline tended to have lower income and be less

Table 4. PPD in recent mammogram by positive mammography attitude change before and after adjusting for baseline attitude scores

	Recent mammogram (%)	Unadjusted		Adjusted for baseline knowledge	
		PPD (95% CI)	*P**	PPD (95% CI)	*P*
Without a recent mammogram at baseline					
Positive change					
No	40				
Yes	54	13 (−1 to 28)	0.08	26 (9–44)	0.003
With a recent mammogram at baseline					
Positive change					
No	82				
Yes	86	4 (−8 to 15)	0.54	12 (1–23)	0.04

*P from a binomial (linear) risk model.

Table 5. PPD in recent mammogram by intervention exposures before and after adjusting for mammography attitude change

	Unadjusted PPD	Adjusted PPD	Reduction in PPD (%)
No recent mammogram at baseline			
LHA advice	18	9	50
Diffused discussion	16	10	42
Project awareness	17	15	12
Recent mammogram at baseline			
LHA advice	12	8	34
Diffused discussion	5	0	98
Project awareness	8	5	35

Note: All models are adjusted for baseline mammography attitude score.

educated and less likely to have a regular provider, health insurance, or a physician recommendation for mammography. That is, they are representative of the national group at risk for underuse of mammography (24). Women with the least positive attitudes toward mammography also tended to be older, less educated, and less likely to have insurance or a physician recommendation for mammography (results not shown).

These findings apply to women who have heard of a mammogram and are not generalizable to women not having hearing of one. Because women with the least positive attitude scores were impacted the most by a positive attitude change, we would expect a greater impact of attitude change on mammography use among the roughly 10% of women who had never heard of mammography to begin with and who were not included in these analyses. More than one-third (36%) of the 390 women overall had either never heard of a mammogram or had poor mammography attitude scores at baseline, representing a substantial portion of this population.

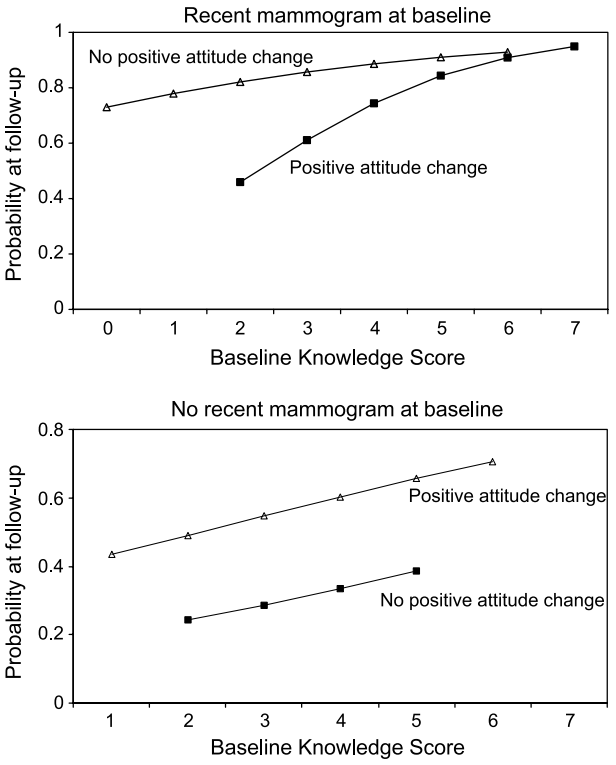

Figure 1. The effect of positive change in mammography attitude score on the predicted probability of mammography use plotted against baseline mammography attitude score and stratified by recent *versus* no recent mammogram at baseline.

Despite their strength as cohort data, these analyses are limited by the fact that variables defined for intervention exposures, changes in attitudes, and recent mammography use were all based, at least in part, on data collected at the same (follow-up) interview. As a result, it was not possible to distinguish whether exposure occurred before or after attitude changes nor whether attitude changes occurred before or after mammography use. For example, a woman might encounter a project material at the clinic where she had gone for her mammogram appointment; the process of obtaining a mammogram could also have changed her mammography attitudes.

Because these associations could be opposite to the direction we hypothesize, this bidirectionality could potentially explain the apparent mediating effects of mammography attitude changes on the relation between intervention exposures and mammography use. Additional questions on the timing of exposures and the timing of mammography use in the interval between baseline and follow-up interview would have been helpful in teasing out the order of events. Nonetheless, our results are consistent with a causal relation between exposures and attitude changes, between attitude changes and mammography use, and between exposures and mammography use.

These results are also inherently limited by the nature of self-report data. Women may be overreporting their intervention exposures and/or mammography use if they sense that affirmative responses to these questions are socially desirable. Self-reported mammography use tends to be overreported, often by reporting a more recent date than the actual date for the most recent mammogram (25).

Because six of seven mammography attitude questions were structured so that ''agree'' was defined as a positive attitude, acquiescence bias may have inflated attitude scores at both interviews, because women may have tended to agree rather than to disagree with statements presented to them. We believe that acquiescence bias may have less of an impact on our constructs of attitude change than it might have on attitude scores constructed at a single point in time. Biases that are present at both time points may tend to cancel each other out in a measure of change. For example, if women tended to

overreport their positive attitudes at both interviews by a similar number of items, this would artificially increase the value of the scores at each interview but would not impact the value of the attitude change score. This is an additional advantage of focusing on changes in attitudes rather than attitudes at a single point in time.

The association between project awareness and mammography use was not mediated by mammography attitude changes. One explanation could be that project awareness represented several different encounters with the intervention and its association with use was mediated by a variety of mechanisms. Alternatively, the positive association between project awareness and mammography use might be an artifact of overreporting both measures. Finally, our analysis did not account for design effects that may have been introduced by the sampling strategy in this cohort.

Using cohort data, we were able to look beyond associations at a single point in time to examine the role of attitude changes on mammography use over time. Interventions that move women toward a greater acceptance of the usefulness of mammography can be effective at increasing mammography use. Such interventions should concentrate their messages on increasing positive attitudes about mammography rather than on increasing general knowledge about breast cancer risk factors. To have the greatest impact, breast cancer screening programs should target women with the least acceptance and lowest awareness of mammography and the least mammography use to start with. These women are very likely to be socioeconomically disadvantaged and to have less access to health care.

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