A Prospective Study of Perceived Susceptibility to Breast Cancer and Nonadherence to Mammography Screening Guidelines in African American and White Women Ages 40 to 79 Years

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Abstract

This prospective study examined the influence of perceived susceptibility to breast cancer on nonadherence to recommended mammography screening guidelines. The study population included 1,229 African American and White women ages 40 to 79 years who obtained an index mammography screening examination at one of five urban hospitals in Connecticut between October 1996 and January 1998. Information on perceived susceptibility to breast cancer and on multiple covariates was obtained by telephone interview on average 1.5 months after the index screening. Subsequent adherence to mammography screening guidelines was ascertained by follow-up interview on average 29 months after the index exam. Across race, age, and family breast cancer history, women who believed that their susceptibility was high (i.e., ''very likely'' to develop breast cancer) were less likely to adhere to screening guidelines than women who believed that their susceptibility was moderate [adjusted odds ratio (OR), 2.83; 95% confidence interval (CI), 1.51-5.30], but the effect was stronger in older women. Women ages 40 to 49 years (but not ages 50-79 years) who believed that their susceptibility was low (i.e., ''not likely'' or ''a little likely'' to develop breast cancer) were also less likely to adhere to guidelines than those who reported moderate susceptibility (adjusted OR, 3.07; 95% CI, 1.66-5.68, and adjusted OR, 2.78; 95% CI, 1.63-4.73). In contrast to most previous studies that found a positive linear relationship between perceived susceptibility to breast cancer and mammography screening, these findings suggest a more complex relationship that should be considered when developing interventions to improve adherence to mammography screening guidelines. (Cancer Epidemiol Biomarkers Prev 2004;13(12):2096–105)

Introduction

Women who adhere to recommended mammography screening guidelines may bring smaller and more treatable tumors to medical attention and may experience less mortality from breast cancer than those who do not participate in regular screening (1). However, whereas most women ages ≥40 years have had a least one mammogram, the proportion who screen at annual or biennial intervals, in accordance with recommended guidelines, is suboptimal (2, 3). Because the efficacy of screening is enhanced by adherence to a regular screening schedule (1), identifying and intervening on factors that specifically promote adherence (rather than one-time use of mammography) will more effectively decrease disease burden.

Perceived susceptibility to disease is a factor central to many theories of health behavior and is used to explain cancer screening behavior and to inform interventions to promote screening (4). In two meta-analytic reviews (5, 6) greater perceived susceptibility to breast cancer was positively associated with several mammography screening outcomes. Accordingly, interventions aimed at increasing women's perceptions of their susceptibility to breast cancer have frequently been used to increase this screening behavior (7, 8).

Among the studies included in the two meta-analytic reviews (5, 6), however, only a minority examined the effect of perceived susceptibility on *adherence to screening guidelines*. Additional studies that specifically examine this outcome are needed to establish whether perceived susceptibility bears the same relationship to adherence as to one-time mammography use. Furthermore, most previous studies used cross-sectional designs. Given the potential for a woman's screening behavior to influence self-reported perceptions of susceptibility in cross-sectional analyses (a phenomenon often described as ''reverse causation''), prospective assessment of perceived susceptibility in relation to adherence is needed to clarify the causal relationship between these variables. Moreover, whereas

Received 1/26/04; revised 6/14/04; accepted 7/2/04.

Grant support: National Cancer Institute grant RO1-CA-CA70731 (B.A. Jones), Agency for Healthcare Research and Quality grant RO3 HS11603 (L. Calvocoressi), and National Institute of Mental Health grant 5T32-MH-14235 (L. Calvocoressi).

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there is some evidence that the influence of perceived susceptibility on adherence may differ by race/ethnicity (9), age (10), and family breast cancer history (11), the potential modifying effects of these variables have not been examined in prospective studies of community-based samples. Identifying potential differences in the effect of perceived susceptibility on adherence to screening guidelines in these population subgroups may aid in developing more refined and effective intervention strategies.

From the study Race Differences in Screening Mammography Process,[3] we report on the effect of perceived susceptibility to breast cancer examined at baseline and analyzed in relation to nonadherence to mammography screening guidelines assessed at 2-year follow-up, thus overcoming some of the methodologic limitations of prior work. The cohort included White and African American women, the two race/ethnic groups in the United States with the highest breast cancer incidence and mortality rates, respectively (12). In addition to women ages 50 to 79 years, this study included women ages 40 to 49 years who are often excluded from studies of mammography screening. Women with and without a family breast cancer history were also included. These subgroups were represented in sufficient numbers to conduct analyses of their potential modifying effects on the relationship between perceived susceptibility and nonadherence.

Materials and Methods

Study Population. African American and White women ages 40 to 79 years, who presented for a *screening* mammogram (hereafter referred to as the ''index screening'') between October 1996 and January 1998 at five hospital-based mammography facilities in the Connecticut cities with the largest African American populations, were eligible for enrollment. Based on the results of a statewide survey (13) conducted in preparation for this study, these facilities were selected because they served a relatively high proportion (over 20%) of African Americans, thus ensuring adequate numbers of this race/ethnic group. To ensure a relatively equal distribution of participants by race, all eligible African Americans who obtained screening mammograms at these sites were selected for inclusion. An equal number of Whites, randomly selected and frequency matched to the African Americans on hospital and date of mammogram, were also invited to participate.

Because the study focused on assessment of screening behavior, women who obtained diagnostic or follow-up mammograms to assess a breast problem were ineligible, as were women who reported prior breast problems and/or histories of breast cancer, cyst aspiration, and breast biopsy. In accordance with age recommendations for regular mammography screening in the general population (14, 15), women younger than age 40 were not included. In addition, those older than age 79 were excluded to minimize potential recall problems that are assumed to be more common among the elderly, and to limit age-related illnesses and complications that might compromise data collection and adversely influence adherence to mammography screening regimens.

Procedures. Approvals of the institutional review boards of Yale University School of Medicine and each participating hospital were maintained throughout the study period. Study staff reviewed intake sheets of women presenting for mammograms at participating facilities to identify potentially eligible subjects who were then mailed letters of invitation that included a study information sheet and a written consent form to obtain mammography records. Trained interviewers administered a baseline telephone interview to women who gave oral consent and met eligibility criteria. Written consent to review mammography records was returned by mail after the baseline interview. Baseline telephone interviews were conducted 1 to 6 months after the index screening mammogram (mean, 1.5 months; SD $\pm$ 0.85 month). Women who completed the baseline interview were contacted 26 months after the index screening to arrange a follow-up interview. The time interval between baseline and follow-up interview averaged 29.4 months (SD $\pm$ 1.42 months), with a range of 27 to 41 months.

Study Participation. Recruitment, eligibility, and retention of participants in this study are summarized in Fig. 1, along with additional exclusion criteria specific to this analysis. Of 2,359 potentially eligible women identified from mammography facility intake sheets, 1,982 women were contacted and eligible to participate. Of these, 531 declined, leaving 1,451 (73.2%) who completed a baseline telephone interview. Participation differed significantly across race group (African American, 69%; White, 77%; $P < 0.0001$) and marginally by age (ages 40-49 years, 76%; $\geq$50 years, 72%; $P < 0.0517$).

Of the 1,451 women who participated in the baseline interviews, 1,249 completed follow-up interviews. Twenty of these women were excluded from this analysis; 11 who were diagnosed with cancer at the index screening or soon thereafter and did not subsequently follow a regular screening schedule and 9 who did not provide adequate self-reported information to determine adherence to mammography screening guidelines and did not consent to review of mammography records. Thus, 86.9% of those who completed the baseline interview completed the follow-up interview and were included in this analysis ($N = 1,229$). Those included differed from those lost to follow-up by race (African American, 78%; White, 93%; $P < 0.0001$) but not by age. Women included in the analysis also differed from those lost to follow-up by history of nonadherence to screening guidelines ($P < 0.0001$) and by perceived susceptibility to breast cancer ($P < 0.0001$). Those lost to follow-up were more likely to be nonadherent (32.1% versus 19.3%) and to report that they were ''very likely'' to develop breast cancer (8.3% versus 4.9%).

Variables and Measures. Baseline and follow-up interviews were developed from (*a*) consultation with radiologists and technicians who provide mammograms to ethnically diverse groups, (*b*) pertinent issues identified

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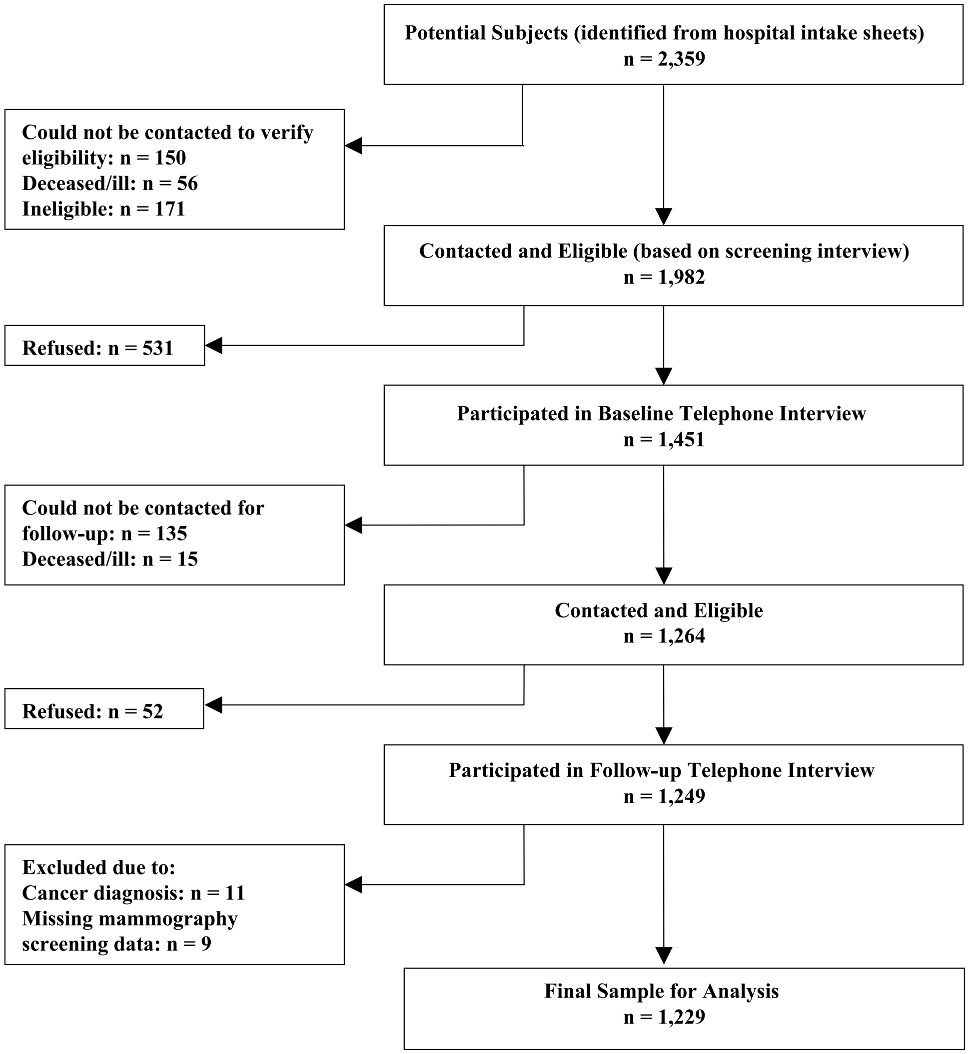

Figure 1. Subject eligibility and retention.

in a focus group of African American women; and (*c*) the published literature (13, 16-22).

The main predictor, perceived susceptibility to breast cancer, was assessed during the baseline interview with the following question: "How likely do you think is it that you will get breast cancer during your lifetime?" Response categories included (*a*) not at all likely, (*b*) a little likely, (*c*) somewhat likely, (*d*) very likely, and (*e*) don't know.

The outcome variable, nonadherence to mammography screening guidelines, was assessed at follow-up, based on American Cancer Society screening guidelines in effect in 1996, at the onset of the data collection period of this study (23). Women ages 40 to 49 years were considered nonadherent if they did not obtain at least one screening within 2 years (+ 2 months) of the index exam. Women ages ≥50 years were considered nonadherent if they did not obtain at least two screenings within 2 years (+ 2 months) of the index exam. The "+ 2 months" allowed for potential inaccuracies in recall of self-reported dates and for reasonable delays in obtaining a screening appointment. Women who obtained diagnostic or follow-up mammograms for a breast abnormality in the interval between screenings were included in this analysis; however, the diagnostic and follow-up mammograms they obtained were excluded from assessment of adherence to screening guidelines.

For 1,126 respondents (92%), the outcome was determined by self-report, in keeping with the original study design. The remaining 103 women (8%) did not provide sufficient self-reported information to ascertain the outcome (i.e., could not recall the month or year of at least one screening) but did consent to review of mammography records. We included these women in this analysis and used records to determine outcome status. These 103 women did not differ from respondents for whom self-reported data were used on recruitment site or family breast cancer history, but they were more likely to be African American (55% versus 38%, $P < 0.0005$) and to be age ≥50 (78% versus 63%, $P < 0.0025$). In a random sample of 150 study participants (identified from a single facility), there was substantial agreement (83%; $\kappa = 0.656$) between self-report and medical record outcome data, with no significant difference in agreement between these data sources by race, age, or family history of breast cancer.

A set of primary covariates (sociodemographic, access to medical care, and mammography-related factors) were included in all adjusted analyses. Sociodemographic variables included (*a*) self-identified race/ethnicity (African American versus White), (*b*) age (40-49 versus ≥50 years), (*c*) marital status (married/living together versus other), (*d*) education (<12 years, 12 years, >12 years), (*e*) annual family income (<$15,000; $15,000-49,999; ≥$50,000), and (*f*) number of household occupants (1, 2, 3, 4 or more). Access to care variables, coded yes versus no, included (*a*) full, annual mammography insurance coverage and (*b*) having the same (i.e., usual) health care provider over the past year. Mammography-related factors included (*a*) knowledge of age-specific mammography screening guidelines (correct versus not correct), (*b*) receipt of a health care provider's recommendation to obtain a mammogram subsequent to the index screening (yes/no), (*c*) history of breast cancer in a first- or second-degree relative (yes/no), and (*d*) history of nonadherence to mammography screening guidelines prior to the index screening (adherent versus nonadherent). The latter was calculated based on the respondent's age and available data on the number of lifetime mammography screenings she reported (0, 1, 2, 3, 4, or 5+). Women ages 40 to 49 years were considered nonadherent if they did not obtain at least one screening every 2 years. Women ages ≥50 years were considered nonadherent if they did not obtain at least 5 screenings.

A wide range of potential confounders of the association between perceived susceptibility and nonadherence was also examined (breast cancer risk factors, health status and behaviors, practical barriers to screening, features of the index screening, and psychosocial factors). Breast cancer risk factors included (*a*) age at menarche (<12, 12-14, >14 years), (*b*) age at first birth (nulliparous, first birth at age <30, first birth at age ≥30); (*c*) menopausal status (completed, not completed, hysterectomy prior to menopause), (*d*) use of hormone replacement therapy (never, <1, 1-5, >5 years), (*e*) height (in inches), and (*f*) body mass index. Health status and behaviors included (*a*) self-rated health (excellent, good, fair, poor), (*b*) pack-years of smoking, (*c*) physical exercise at least once per week (yes/no), (*d*) consumption of alcoholic beverages in the year prior to the index screening (yes/no), (*e*) regular use of vitamin supplements (yes/no), and (*f*) attendance at religious services (never, once/twice per year, once every few months, 1-3 times per month, once a week, more than weekly). Practical barriers to screening included (*a*) travel time to index screening appointment (0-15 versus >15 minutes), (*b*) special arrangements (e.g., childcare) needed to attend the screening appointment (yes/no), and (*c*) took time off from work to attend the screening appointment (yes with pay, yes without pay, no). Features of the index screening included (*a*) hospital where index screening was obtained, (*b*) whether the index screening was obtained in clinic or mobile van, (*c*) time to receipt of index screening results (not received, 0-1, 2-7, 8-14, 15-28, >28 days), (*d*) result of the index screening (abnormal versus normal), and (*e*) whether the index examination was the first screening ever obtained (yes/no). Psychosocial factors included (*a*) perceived benefits of screening (mammograms very useful versus somewhat/a little/not useful/don't know), (*b*) embarrassment experienced during the index screening (none versus a little/somewhat/a lot), (*c*) pain experienced during the index screening (none versus a little/somewhat/a lot), (*d*) pain experienced during the index screening compared to expectations (greater than, less than, equal to, no expectations), (*e*) anxiety experienced during the index screening (none versus a little/somewhat/a lot), (*f*) anxiety experienced during the index screening compared to expectations (greater than, less than, equal to, no expectations), (*g*) worry over the results of the index screening upon leaving the mammography facility (none, a little/somewhat, a lot), (*h*) effect of the index screening on breast cancer worry (increased, decreased, no effect), (*i*) confidence in one's ability to obtain a future mammogram (very confident versus somewhat/a little/not confident/don't know), (*j*) perceived control over remaining healthy (a lot/some versus a little/none), (*k*) perceived control over developing cancer (a lot/some/a little, none, don't know), (*l*) perceived control over recovering from cancer (a lot/some/a little, none, don't know), and (*m*) received a reminder notice to obtain a mammogram in the 2 years since the index screening (yes/no).

Statistical Analysis. Preliminary analyses involved characterizing the study sample using descriptive statistics. Bivariable analyses examined the unadjusted associations between nonadherence to screening guidelines and (*a*) perceived susceptibility and (*b*) each of the primary covariates. The association between perceived susceptibility and nonadherence was then examined in multivariable models in the total sample, adjusted by the primary covariates and additional confounders. The primary covariates were added first and retained in subsequent multivariable models. All additional potential confounders were next added to the model as a set. Then, following the procedure described by Kleinbaum and colleagues (24), we selected a reduced model that provided adjusted estimates of the relationship between perceived susceptibility and nonadherence equivalent to that obtained when all additional potential confounders were included, thus providing complete adjustment by all additional confounders in a more parsimonious model. The potential modifying effects of race, age, and family breast cancer history on the adjusted relationship between perceived susceptibility and nonadherence were then assessed by adding two-way interaction terms between each category of perceived susceptibility and each potential effect modifier to the reduced model.

These bivariable and multivariable analyses used logistic regression to generate maximum likelihood estimates of odds ratios (OR) with 95% confidence intervals (95% CI) and two-sided *P* values. For ease of interpretation, we selected the category of perceived susceptibility with the lowest nonadherence (the ''somewhat likely'' category) as the reference group. For significant two-way interactions of perceived susceptibility by race, age, and family breast cancer history, ORs and 95% CIs for each subgroup were calculated by summing the relevant estimates and calculating the respective variances of these sums. Multicollinearity was ruled out with Spearman and Pearson's correlation coefficients and with multivariable multicollinearity diagnostics (25). In multivariable models, values for missing data were multiply imputed using a data augmentation algorithm (26). A comparison of multiply imputed and complete case models yielded substantively similar results.

To assess the robustness of the findings, we conducted a time-to-event analysis to determine if an alternative mammography screening outcome, time to first screening since the index exam, would bear the same relationship to perceived susceptibility as nonadherence, adjusted by the same covariates used in the reduced model above. Hazard ratios and 95% CIs were generated for this analysis using Cox regression. All analyses were carried out with SAS software, version 8.2 (SAS System for Windows, SAS Institute Inc., Cary, NC).

Results

Characteristics of the Study Population. As shown in Table 1, sizeable proportions of African Americans and women ages 40 and 49 years were included in the study population; the remaining respondents were White and were ages 50 to 79 years. Most respondents were married or living with a partner and had at least a high school education. Less than half had annual family incomes of $50,000 or more. The majority retained the same health care provider over the year prior to the baseline interview, received a provider's recommendation to obtain a mammogram during the 2 years subsequent to the index screening, reported full, annual insurance coverage for screening mammograms, and correctly identified the mammography screening guidelines for their age group. Nearly a third reported a first- or second-degree relative with breast cancer. Less than 20% of respondents reported a history of nonadherence to mammography screening guidelines *prior to* the index screening (measured at baseline). In contrast, 48% did not adhere to mammography screening guidelines *subsequent to* the index screening (i.e., the outcome variable, measured at follow-up). However, these measures are not directly comparable; the outcome variable was based on detailed assessment of all mammograms obtained subsequent to the index screening, whereas measurement of history of adherence was constrained by available baseline data (i.e., 0, 1, 2,3, 4, and 5+ lifetime mammograms) and likely underestimates nonadherence.

Bivariable Logistic Regression Analysis. Table 2 indicates that the unadjusted odds of nonadherence among women who reported low perceived susceptibility to breast cancer (i.e., not likely or a little likely to develop breast cancer) were higher than among those who reported moderate susceptibility (i.e., somewhat likely to develop the disease; OR, 1.99; 95% CI, 1.46-2.69; OR, 1.52; 95% CI, 1.14-2.01, respectively). Furthermore, among women who believed that their susceptibility was high (i.e., very likely to develop breast cancer), the odds of nonadherence were also elevated compared with the moderate susceptibility group (OR, 3.35; 95% CI, 1.89-5.96). Women who indicated that they did not know their susceptibility were also more likely to be nonadherent than those who reported moderate susceptibility (OR, 2.33; 95% CI, 1.40-3.86).

Also shown in Table 2, African American race/ethnicity, older age, not being married or living with a partner, less education, lower income, lack of a usual health care provider, history of nonadherence to mammography screening guidelines, incorrect knowledge of mammography screening guidelines, the absence of a provider's recommendation to obtain a screening, and not having a relative with breast cancer, were associated with nonadherence. Having mammography insurance coverage was not associated with this outcome.

Table 1. Characteristics of the study population (*N* = 1,229)

Domain	Variables	*n** (%)
Sociodemographic factors	Race	
	African American	484 (39.4)
	White	745 (60.6)
	Age	
	40-49	443 (36.1)
	50+	786 (63.9)
	Marital status	
	Married/living as married	697 (57.0)
	Other	525 (43.0)
	Education (y)	
	>12	682 (55.8)
	12	360 (29.5)
	<12	180 (14.7)
	Annual family income	
	$50,000+	489 (42.7)
	$15,000-$49,999	389 (33.9)
	<$15,000	268 (23.4)
Access to medical care	Mammography insurance (full, annual coverage)	
	Yes	838 (68.5)
	No	386 (31.5)
	Usual health care provider	
	Yes	1,100 (90.2)
	No	120 (9.8)
Mammography-related factors	Knowledge of mammography screening guidelines	
	Correct	1028 (83.8)
	Not correct	199 (16.2)
	Health care provider recommended a mammogram	
	Yes	890 (72.6)
	No	335 (27.4)
	Breast cancer in a first- or second-degree relative	
	Yes	354 (28.9)
	No	869 (71.1)
	History of adherence to mammography screening guidelines	
	Adherent	986 (80.7)
	Nonadherent	236 (19.3)
	Adherence to mammography screening guidelines in the 2 years subsequent to the index screening	
	Adherent	642 (52.2)
	Nonadherent	587 (47.8)

*May not sum to 1,229 due to missing values on some variables.

Multivariable Logistic Regression Analysis. Table 3 displays the effect of perceived susceptibility on nonadherence in the total sample, adjusted by the primary covariates and additional potential confounders. Compared with those who reported moderate susceptibility, the odds of nonadherence were no longer significantly elevated among those who indicated that they did not know how susceptible they were, once this association was adjusted by the primary covariates. However, the odds of nonadherence among women who reported that their susceptibility to breast cancer was low *or* high did remain significantly elevated after adjustment by these covariates. Including numerous additional potential confounders in the model did not substantially impact the association between any category of perceived susceptibility and nonadherence. In a reduced model that provided estimates nearly identical to the model that included all primary covariates and additional potential confounders, the largest OR was observed for women who reported that they were very likely (versus somewhat likely) to develop breast cancer (adjusted OR, 2.83; 95% CI, 1.51-5.30). The adjusted odds of nonadherence among women who reported that they were not likely or a little likely to develop breast cancer were also elevated compared with the somewhat likely category (OR, 1.51; 95% CI, 1.07-2.12, and OR, 1.64; 95% CI, 1.20-2.23, respectively).

When added to the reduced model, interactions of each category of perceived susceptibility by race and by family breast cancer history were not statistically significant (data not shown) and these terms were removed from the model. The reduced model that included interactions of age and each category of perceived susceptibility is illustrated in Fig. 2. Interactions

Table 2. Unadjusted ORs and 95% CIs for associations between nonadherence to mammography screening guidelines and perceived susceptibility and nonadherence and the primary covariates, Connecticut, 1996-2000

Domain	Variables	Adherent, n = 642,* n (%)	Nonadherent, n = 587,† n (%)	OR (95% CI)
Perceived susceptibility	Perceived likelihood of developing breast cancer			
	Very likely	20 (33.3)	40 (66.7)	3.35 (1.89, 5.96)
	Somewhat likely	238 (62.6)	142 (37.4)	1.00 (referent)
	A little likely	209 (52.5)	189 (47.5)	1.52 (1.14, 2.02)
	Not likely	141 (45.8)	167 (54.2)	1.99 (1.46, 2.69)
	Don't know	31 (41.9)	43 (58.1)	2.33 (1.40, 3.86)
Sociodemographic factors	Race			
	White	418 (56.1)	327 (43.9)	1.00 (reference)
	African American	224 (46.3)	260 (53.7)	1.48 (1.18-1.87)
	Age (y)			
	40-49	296 (66.8)	147 (33.2)	1.00 (reference)
	50+	346 (44.0)	440 (56.0)	2.56 (2.00-3.26)
	Marital status			
	Married/living as married	405 (58.1)	292 (41.9)	1.00 (reference)
	Other	234 (44.6)	291 (55.4)	1.75 (1.37-2.17)
	Education (y)			
	>12	401 (58.8)	281 (41.2)	1.00 (reference)
	12	177 (49.2)	183 (50.8)	1.48 (1.14-1.91)
	<12	62 (34.4)	118 (65.6)	2.72 (1.93-3.83)
	Annual family income			
	$50,000+	302 (61.8)	187 (38.2)	1.00 (reference)
	$15,000-$49,999	206 (53.0)	183 (47.0)	1.44 (1.10-1.88)
	<$15,000	98 (36.6)	170 (63.4)	2.80 (2.06-3.81)
Access to medical care	Mammography insurance (full, annual coverage)			
	Yes	436 (52.0)	402 (48.0)	1.00 (reference)
	No	203 (52.6)	183 (47.4)	0.98 (0.77-1.25)
	Usual health care provider			
	Yes	586 (53.3)	514 (46.7)	1.00 (reference)
	No	52 (43.3)	68 (56.7)	1.49 (1.02-2.18)
Mammography-related factors	History of nonadherence to mammography screening guidelines			
	Adherent	558 (56.6)	428 (43.4)	1.00 (reference)
	Nonadherent	80 (33.9)	156 (66.1)	2.54 (1.89-3.42)
	Knowledge of mammography screening guidelines			
	Correct	568 (55.3)	460 (44.8)	1.00 (reference)
	Not correct	74 (37.2)	125 (62.8)	2.09 (1.53-2.85)
	Health care provider recommended a mammogram			
	Yes	507 (57.0)	383 (43.0)	1.00 (reference)
	No	133 (39.7)	202 (60.3)	2.01 (1.56-2.60)
	Breast cancer in a first- or second-degree relative			
	Yes	207 (58.3)	148 (41.7)	1.00 (reference)
	No	434 (49.9)	435 (50.1)	1.40 (1.09-1.80)

*May not sum to 642 due to missing values.
†May not sum to 587 due to missing values.

Table 3. Adjusted ORs and 95% CIs for the association between nonadherence to mammography screening guidelines and perceived susceptibility to breast cancer in the total sample (*N* = 1,229), Connecticut, 1996-2000

Covariates included in each model	Perceived lifetime susceptibility to breast cancer	OR (95% CI)
Primary covariates (sociodemographic factors,* access to care,† and mammography-related factors‡)	Very likely	2.86 (1.53-5.35)
	Somewhat likely	1.00 (reference)
	A little likely	1.64 (1.20-2.23)
	Not likely	1.51 (1.08-2.12)
	Don't know	1.54 (0.89-2.66)
Primary covariates*,†,‡ + all additional covariates (breast cancer risk factors,§ health status and behaviors,∥ practical barriers,¶ features of the index screening,** and psychosocial variables††)	Very likely	2.82 (1.45-5.48)
	Somewhat likely	1.00 (reference)
	A little likely	1.63 (1.18-2.26)
	Not likely	1.52 (1.05-2.19)
	Don't know	1.51 (0.82-2.78)
Primary covariates*,†,‡ + subset of additional covariates‡‡	Very likely	2.83 (1.51-5.30)
	Somewhat likely	1.00 (reference)
	A little likely	1.64 (1.20-2.23)
	Not likely	1.51 (1.07-2.12)
	Don't know	1.52 (0.87-2.64)

*Age, race, marital status, education, income, and household size.
†Mammography insurance, usual health care provider.
‡Knowledge of screening guidelines, received a recommendation from a health care provider to obtain a mammogram, family breast cancer history, and history of adherence to screening guidelines.
§Age at menarche, nulliparity/age at first pregnancy, menopausal status, hormone replacement therapy, height, and body mass index.
∥Self-rated health, alcohol consumption, pack-years of smoking, regular exercise, use of vitamin supplements, and attendance at religious services.
¶Travel time to index screening appointment, needed to make special arrangements to attend index screening, and time off from work to attend index screening.
**Index screening hospital, van versus hospital clinic, how long to receive index screening results, index examination was first screening ever obtained, and result of index screening.
††Usefulness of mammograms for detecting breast abnormalities; pain, embarrassment, and anxiety experienced during the index screening; worry over the result of the index screening; effect of index screening on breast cancer worry; confidence in one's ability to obtain a future screening; perceived control over remaining healthy, developing cancer, and recovering from cancer; and received a reminder notice to obtain a mammogram.
‡‡Menopausal status, self-rated health, pack-years of smoking, and pain experienced at index screening compared to expectations.

between age and reporting that one was not likely or a little likely to develop breast cancer were significant ($P < 0.0058$ and $P < 0.0167$, respectively). Women ages 40 to 49 years who reported that they were not likely or a little likely to develop breast cancer were less likely to adhere to screening guidelines than those who reported that they were somewhat likely to develop the disease. In contrast, among women ages ≥50 years, reporting that one was either not likely or a little likely to develop breast cancer did not significantly impact nonadherence. Interactions between age and reporting that one was very likely to develop breast cancer (or that one did not know how susceptible one was) were not significant ($P < 0.6016$ and $P < 0.7659$, respectively). Among those who did not know their susceptibility, nonadherence was not significantly elevated in either age group. Among those reporting that they were very likely (compared with somewhat likely) to develop breast cancer, the odds of nonadherence were elevated in both age groups but were significant only in those ages ≥50 years.

Time-to-Event Analysis. Time to screening was calculated from date of the index screening to the date of the first screening obtained subsequent to that index exam; women who did not obtain at least one screening mammogram subsequent to the index examination were censored at the date that concluded the follow-up period. Perceived susceptibility bore the same relationship to time to first screening obtained subsequent to the index examination as to nonadherence, with one exception; whereas the adjusted association between nonadherence and not knowing one's susceptibility (versus believing one was somewhat likely to develop breast cancer) was not significant in the nonadherence analysis, the association between time to one screening and the "don't know" category was significant in the total sample in this analysis (adjusted hazard ratio, 0.66; 95% CI, 0.49-0.89).

Similar to the nonadherence analysis, in the total sample believing that one was "very" compared with "somewhat" likely to develop breast cancer had an adverse effect on screening (adjusted hazard ratio, 0.67; 95% CI, 0.48-0.92) as did believing that one was "not" or "a little," compared with "somewhat" likely to develop this disease (adjusted hazard ratio, 0.75; 95% CI, 0.63-0.89, and adjusted hazard ratio, 0.77; 95% CI, 0.66-0.90, respectively). Also similar to the nonadherence analysis, two-way interactions between age and the (*a*) very likely; and (*b*) don't know categories were not significant. The interaction of age and the "a little likely" category was significant ($P < 0.0346$) and the interaction of age and the "not likely" category was $P < 0.0819$. Although not quite as robust as the comparable interaction terms in the nonadherence analysis, the effects were similar; these categories of perceived susceptibility were more strongly associated with less frequent screening in women ages 40 to 49 years than in women ages ≥50 years.

Discussion

In this study, women who reported moderate susceptibility to breast cancer were most likely to adhere to mammography screening guidelines. High perceived susceptibility adversely influenced adherence in the total sample, but its influence was stronger among women ages ≥50 years. In contrast, the adverse effect of low perceived susceptibility was found only in women ages 40 to 49 years. These effects of perceived susceptibility were found in relation to time to first screening as well as to nonadherence.

Miller (27) proposed that health beliefs, such as perceived disease susceptibility, have less influence on a health behavior once that behavior is habitually practiced. One reason for the stronger effect of low perceived susceptibility on women ages 40 to 49 years than on women ages ≥50 years may be that mammography screening was a relatively new behavior and may not yet have become a habit for many of the younger women. In addition, during the data collection period of this study, controversy was rife over the efficacy

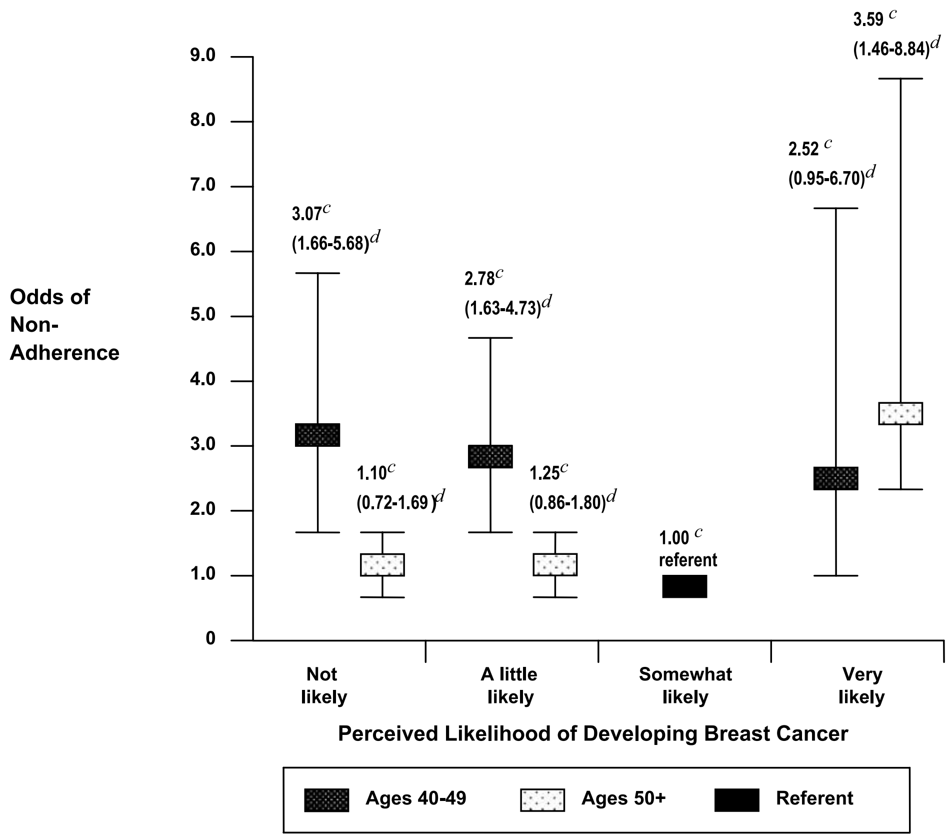

Figure 2. Adjusted[a] ORs and 95% CIs for nonadherence to mammography screening guidelines by perceived susceptibility to breast cancer,[b] Connecticut, 1996-2000. [a]Adjusted by race, marital status, education, income, household size, mammography insurance, usual health care provider, knowledge of screening guidelines, received a recommendation from a health care provider to obtain a mammogram, family breast cancer history, history of adherence to screening guidelines, menopausal status, self-rated health, pack-years of smoking, pain experienced at index screening compared to expectations. [b]The ''don't know'' category of perceived susceptibility is excluded from this figure. [c]Odds ratio. [d]95% confidence interval.

of mammography screening in women ages <50 years. In January 1997, the majority report of a divided National Institute of Health Consensus Development panel concluded that universal screening recommendations for women ages 40 to 49 years were unwarranted and that each woman, with available information on risks and benefits, should decide for herself whether to obtain screening mammograms (28). Although most medical and preventive health organizations (e.g., American Cancer Society and National Cancer Institute) implemented annual screening recommendations for all women ages ≥40 years soon thereafter (29), the panel's highly publicized report may have discouraged screening among women with low perceived susceptibility in the 40 to 49 years age group.

As noted, although its effect was stronger among older women, high compared with moderate perceived susceptibility was associated with greater nonadherence in the total sample. This is a departure from most previous findings and, in accordance with previous work, a recent meta-analytic review of 13 studies (6) found that across screening outcomes (e.g., intention to screen, one-time screening, and adherence to guidelines) perceived susceptibility was positively associated with screening. However, three of six studies in that review that specifically measured adherence found a negative association with perceived susceptibility (30–32), consistent with our finding. It may be that the adverse effect of high perceived susceptibility is a more salient factor in studies that examine regular screening behavior.

However, several characteristics of previous studies may have decreased the likelihood of detecting an adverse effect of high perceived susceptibility. For example, most studies used cross-sectional designs. In those studies, some women who did not screen according to guidelines may have minimized their perceived susceptibility to breast cancer as a rationale for nonadherence. Our prospective analysis eliminated the potential for such reverse causation. In addition, in a recent study (33) that found a curvilinear relationship between adherence and breast cancer worry (a construct associated with perceived susceptibility), the investigators attributed their unique finding to the large sample (n = 6,512) of the study. These investigators speculated that prior studies of average-risk samples did not include sufficient numbers of severely worried women to discern a negative effect of worry on adherence. In our analysis

(*N* = 1,229), only a small minority of women (*n* = 60) considered themselves very susceptible to breast cancer, suggesting that a similar phenomenon may be operative in studies of adherence and perceived susceptibility. Moreover, most prior studies included samples that predominantly consisted of White women. The substantial number of African Americans in our analysis increased the size of the very susceptible category, which, in turn, increased the likelihood of detecting a significant association in a sample of this size. Of the 60 women who composed the very susceptible group, 35 were African American (7.3% of the African American sample) and 25 were White (3.3% of the White sample). More important, though, the relationship of high perceived susceptibility to nonadherence held for both race groups.

If our results are replicated in large, prospective studies, the implications for intervention are substantial. If the optimal level of perceived susceptibility to breast cancer needed to maintain adherence is moderate rather than high, interventions that increase perceived susceptibility beyond this optimal level may result in less, rather than more, screening. Population-level interventions (e.g., public health media campaigns, community education programs, and medical education literature) that provide a uniform message aimed at increasing awareness of breast cancer risk may not, therefore, be effective in promoting adherence in all women. Avenues such as telephone counseling and interactions with health care providers may be more efficacious; differences in the effect of perceived susceptibility (e.g., by age) can be considered and individual perceptions of susceptibility can be elicited and addressed in the context of other interrelated and important motivators of health behavior (e.g., beliefs about breast cancer, individual resources, and the utility of prevention strategies; ref. 34).

Furthermore, the relationship between perceived susceptibility and ''actual'' risk of breast cancer should be considered. Information on actual risk, derived from several risk assessment models, is increasingly available to consumers. A recent Cochrane review of 13 studies found that providing actual risk information increased utilization of screening tests, including mammography (35). But it is possible that the impact of actual risk information on adherence may vary, depending on how susceptible a woman believes she is and on whether her perceived risk is consistent with or differs from her actual risk.[4] Adding to this complexity, current risk models do not account for many yet to be identified risk factors for breast cancer (36) and, owing to error or uncertainty, cannot provide precise individual risk estimates (34, 37). Moreover, these models may be of particularly limited value to African American women who are at high risk of developing aggressive disease and who tend to be diagnosed with breast cancer at an earlier age than White women, on whom the models were validated (36). Better models of breast cancer risk that are applicable to population subgroups are needed, as is further study of the role of perceived susceptibility in comprehensive strategies to increase adherence to screening guidelines.

Our findings should be evaluated in the context of the limitations and strengths of this study. Among its limitations, the study examined perceived susceptibility with a single item, so there is potential for measurement error. Furthermore, we included history of nonadherence to mammography screening guidelines among the covariates to enable us to examine the influence of perceived susceptibility on nonadherence subsequent to the index examination independent of the effect of past screening behavior; but, given the limitations of available data, this variable likely undercontrols for screening history. In addition, the study relied on self-reported mammography data that are vulnerable to inaccurate recall. Substantial agreement between self-reported adherence and mammography records in a random sample of study participants was reassuring, but these methods of outcome ascertainment were not in complete agreement in that subsample. Furthermore, because subject recruitment was restricted to urban, hospital-based facilities, the study findings may not generalize to women who receive screenings in rural areas or from private radiology/medical offices or freestanding mammography clinics. Nonparticipation and loss to follow-up may also have compromised the generalizability of the study findings, especially among African American women who were less inclined to participate or to provide follow-up data than their White counterparts. In addition, women lost to follow-up were more likely than those who completed the study to report high perceived susceptibility to breast cancer and to report a *history* of nonadherence during the baseline interview. This suggests that loss to follow-up led to an underestimation of the prevalence of high perceived susceptibility and might have attenuated the effect of high perceived susceptibility on nonadherence assessed at follow-up.

The strengths of this study include its prospective design, relatively large sample size, diversity of the study population, and adjustment of the primary association by multiple covariates that have been associated with mammography screening in prior studies (19, 38–48). In addition, we showed that the effect of perceived susceptibility that we observed held for time to first screening subsequent to the index exam, as well as for nonadherence. The diverse study population enabled us to determine that the negative effect on adherence of high perceived susceptibility applied to African American and White women with and without a family breast cancer history across a broad age range, whereas the adverse effect of low perceived susceptibility was limited to younger women. These findings thereby contribute to clarifying the causal relationship between perceived susceptibility to breast cancer and nonadherence and to refining our understanding of the impact of perceived susceptibility on specific population subgroups for which screening is recommended. These results also suggest that efforts to increase adherence to mammography screening guidelines should account for individual perceptions of susceptibility to breast cancer, reflecting the potentially complex nature of the relationship between these variables.

[4] In this study, 40% of women who reported high perceived susceptibility had a first-degree relative with breast cancer and may have been at actual higher-than-average risk of developing breast cancer, whereas the remaining women who reported high perceived susceptibility did not report breast cancer in a first-degree relative and may have been at lower actual risk.

Acknowledgments

We thank the following hospitals in Connecticut that allowed access to their patients and medical records: Bridgeport Hospital, Lawrence and Memorial Hospital, St. Francis Hospital and Medical Center, Waterbury Hospital, and Yale-New Haven Hospital, and Lisa Schlenk for her invaluable assistance with data collection and management.

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A Prospective Study of Perceived Susceptibility to Breast Cancer and Nonadherence to Mammography Screening Guidelines in African American and White Women Ages 40 to 79 Years

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Cancer Epidemiol Biomarkers Prev 2004;13:2096-2105.