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HEALTH BELIEF MODEL FACTORS IN MAMMOGRAPHY SCREENING: TESTING FOR INTERACTIONS AMONG SUBPOPULATIONS OF CARIBBEAN WOMEN

Objectives: To explore the implementation of health belief models in breast cancer screening and elucidate its potential to offer avenues for intervention among variables that may be easily amenable to change.

Design: The relations between three major cognitive factors—cancer knowledge, perceived personal risk, and beliefs about treatment efficacy—and mammography utilization were examined by using analysis of variance (ANOVA) and regression analyses.

Participants: A large sample of women (N=1364) between 50 and 70 years of age. The women were of six ethnicities: US-born European Americans, US-born African Americans, Dominicans, Haitians, English-speaking Caribbeans, and Eastern Europeans.

Results: All three variables were significantly associated with screening behavior in zero-order correlations. However, only perceived risk and treatment efficacy remained significant in multiple regressions controlling for background variables. Perhaps most importantly, while there were mean-level differences in the cognitive variables across the six groups, only one of the 15 interaction terms was significant, attesting to the generalizable effect of these health belief variables upon screening behavior in understudied groups of minority women.

Conclusions: The results are discussed in the context of health belief models and implications for interventions tailored to the health belief profiles characterizing women from each group are presented. (*Ethn Dis.* 2005;15:444–452)

Key Words: Caribbean Women, Cognitive Factors, Health Belief Model, Minority Women, Mammography, Screening

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INTRODUCTION

Despite a lower breast cancer incidence among African-American women, the five-year survival rate is considerably lower; African-American women are more likely to die of the disease.[1–3] Although additional differences in tumor characteristics exist,[4] tumors are routinely more advanced at diagnosis in African Americans,[1,5] probably because of differences in screening. The current study investigates the relationship between health belief variables and mammography among women from six ethnic groups—US-born African and European Americans and immigrant women from the English-speaking Caribbean, Haiti, the Dominican Republic, and Eastern Europe—and tests the generalizability of core health belief constructs across groups.

Although some recent data suggest that the mammography screening rate among African-American women may be converging with that of European-American women,[6–9] minority women nonetheless bear an unequal cancer burden in the United States.[10] Hispanic women are less likely to be screened than either Whites or Blacks.[11–15] For example, year 2000 data show that while 71% of non-Hispanic White and 68% of African-American women reported a mammogram in the last two years, only 62% of Hispanic women did so.[11] The small literature on America's growing African-Caribbean populations reinforces the need for continued research. For example, approximately 25% of English-speaking Caribbean immigrant women (N=228) reported no

prior cancer screening, compared to 10% of US-born Black women (N=264).[16] Since screening has been linked to lower mortality[13] and is thought to represent an important means of decreasing breast cancer death rates,[9,17,18] understanding the origins of ethnic differences is a clear mandate to the sciences.

Consistent links have been described between more frequent breast cancer screening and younger age,[5,19] higher socioeconomic status and greater education,[7,20,21] being married,[19] physician's recommendation,[9,22,23] as well as White ethnicity. However, at least two good reasons exist to expand our consideration to other factors. Many structural variables/barriers[24] are extremely difficult to modify. As such, while characteristics such as low socioeconomic status, older age, or being single may identify the subgroups of women at greatest risk, the nature of the variables themselves means deriving viable interventions on this basis is problematic. Variables such as age and socioeconomic status are not directly amenable to intervention, and the reasons that they are associated with poorer profiles remain unclear. Second, although background factors are associated with screening rates, ethnic differences in screening persist even when variables such as socioeconomic status or income do not differ across groups or are statistically controlled.[18,25,26]

Perhaps because attitudinal factors target variables that are more directly amenable to behavioral intervention, studies have begun to examine screening behaviors in the context of health belief

The current study investigates the relationship between health belief variables and mammography among women from six ethnic groups.

models (HBMs).[27–31] Although they vary somewhat, HBMs all emphasize explaining when health-promoting behaviors will (and will not) occur as a function of cognitive processes. The HBM of Leventhal and colleagues conceptualizes the individual's response to health threats as a two-pronged, self-regulatory process in which internal and external stimuli are assessed. In an interwoven process, a representation of the health threat is evaluated, and assessments of subjective risk and the costs of the threat are made. Concurrently, the emotional response to the threat and relevant coping options are considered. Leventhal's model is further distinguished from other HBMs in that it provides a means within which to consider the impact of culture.[27,28]

We focus on three cognitive variables: cancer knowledge, estimates of personal risk, and belief in treatment efficacy. We chose these variables because: 1) they have been linked to screening behavior; and 2) data indicate mean-level differences across ethnic groups. Poorer knowledge,[32–35] a belief that cancer treatments do not work,[15,24,36,37] and lower estimates of personal risk,[9,15,38,39] have all been associated with poorer screening practices. Consistent with this literature, we expected poorer knowledge, lower estimates of personal risk, and low estimates of treatment efficacy to be predictive of poorer screening behavior in our samples of minority women. In addition, however, we also expected an interaction between treatment

efficacy and perceived personal risk. This expectation was based upon the logic that where treatment efficacy beliefs are very low or where women are highly fatalistic about cancer, as is often the case among minority women,[40,41] perceptions of risk are unlikely to relate to screening behavior.

In addition, the current study was also framed as a test of the generalizability of HBM factors across six ethnically well-defined groups of women. In addition to research documenting ethnic differences in cancer knowledge,[33–35] the benefits of early detection,[32] and the immediacy of breast cancer threat/perceived risk,[9,20,42,43] psychological variables have also been shown to relate to health outcome differently across minority groups.[44] Hindering the derivation of formal hypotheses, however, was the absence of screening or health belief data with the requisite degree of ethnic specificity.[13,45,46] Sampling among African Americans, for example, may often include Caribbeans or immigrants from the continent of Africa, although determining this is impossible in most screening research.[17,20,47]

This absence noted, a growing body of research has demonstrated psychosocial differences among Caribbean subpopulations,[48] thus providing the theoretical[49,50] and empiric[44,49,51] grounds for exploring the possibility of interactions between ethnicity and psychological variables. One recent study that directly examined such interactions found that the effect of emotion inhibition on arthritis, hypertension, and respiratory distress was reduced among Eastern Europeans.[44] Although preliminary, this study provides some grounds for expecting that psychological phenomena may relate to health outcomes differentially across groups, although the absence of prior research precluded the derivation of specific hypotheses.

We present health belief and screening data from six clearly defined ethnic groups of women: US-born African Americans, US-born European Ameri-

cans, and Caribbean immigrant groups who were either from the English-speaking territories (ie, Barbados, Trinidad and Tobago, and Jamaica), Spanish-speaking Dominican Republic, or Creole-speaking Haiti. We also include a White immigrant control group of women from Eastern Europe. The size of our sample allows us to conduct a preliminary test for interaction effects, thus testing whether health belief variables are operating the same way across minority groups. The following hypotheses were derived:

1. Minority women will have lower scores on knowledge of risk factors, lower perceptions of personal risk, and lower beliefs about cancer treatment efficacy than US-born European Americans.
2. Poorer cancer knowledge, lower estimates of personal risk, and lower estimates of breast cancer treatment efficacy will be predictive of worse screening behavior in our samples of minority women, above and beyond background variables and physician recommendation.
3. An interaction effect between treatment efficacy and perceived personal risk is expected, based upon the assumption that perceptions of risk are unlikely to promote screening if the screening and its associated treatments for cancer are not perceived as efficacious methods of dealing with the risk.
4. Finally, we tested whether the health belief variables related to self-reported screening behavior equivalently across groups.

METHOD

Participants

The participants in this study were 1364 women, ranging from 50 to 70 years of age, living in Brooklyn, New York. We excluded women with a history of breast cancer (*N*=43). Respondents were recruited on the basis of a

Table 1. Means and standard deviations of demographic characteristics of the sample broken down by ethnic group and results of chi-square or ANOVA

	Ethnic Group						F or χ² Value	Post hoc Comparisons
Variable	African American (N=295)	English Caribbean (N=299)	Haitian (N=305)	Dominican (N=160)	Eastern European (N=151)	European American (N=154)		
Mean age	58.9 (6.2)	58.4 (7.0)	60.4 (6.5)	58.2 (6.1)	60.8 (6.1)	59.4 (6.5)	5.7*	H, EE>AA, EC, D
Mean income ($K)	30.0 (26.5)	34.9 (20.3)	22.5 (15.5)	25.3 (14.5)	30.1 (22.7)	46.3 (34.6)	26.5*	EA>all; EC>H D; EE>H
Mean yrs. education	13.5 (12.1)	13.3 (8.3)	7.4 (8.1)	7.2 (8.2)	16.2 (13.0)	14.3 (13.1)	194.4*	EE>EA>AA, EC>H, D
% Married	21.0	31.1	37.0	51.9	58.3	42.2	83.1*	EE>D>EA>H>EC>AA

* P<.01.

AA=African American; EC=English-speaking Caribbean; H=Haitian; D=Dominican; EE=Eastern European; EA=US-born European American.

stratified cluster sampling plan. At the initial stage, data on census blocks were gathered from the Household Income and Race Summary Tape File 3A of the 1990 Census files. Blocks were then stratified by ethnic group and on the basis of income (high, medium, and low). Random selection without replacement was used to choose samples of block groups from each stratum. Trained interviewers were sent to conduct interviews with respondents who lived within the selected blocks. Respondents were paid $25 for their participation.

The mean age of the sample was 59.3 years (standard deviation [SD]=6.5). The mean level of education was 12.8 years (SD=12.1), and the mean household income was $30,700 (SD=$23,685). Table 1 presents the demographic characteristics of the sample, broken down by ethnic group and the results of chi-square test or analysis of variance (AN-OVA). As indicated, significant ethnic differences were seen in age, income, level of education, and percentage married. In subsequent ANOVAs and regressions, the demographic differences are taken into account.

Procedures

Data were collected during face-to-face interviews that lasted approximately 1 ½ hours and were conducted in the respondent's home or another location of their choice, such as a senior center or church. Measures were administered in a standard order for all respondents.

Measures

Demographics Questionnaire

Respondents provided information on age, ethnic background, household income, level of education, and marital status.

Questions Pertaining to Breast Cancer Screening and Physician Recommendation

Participants were asked to indicate the frequency with which they had mammograms during the past 10 years. Validation studies, at least across shorter time frames, have returned consistently good results,[52–55] although evidence suggests that validity may vary by ethnicity.[56] Reported confirmation rates for mammography over the previous year were 88%,[52] 88.1%,[53] and 94%.[55] Women were also asked whether or not their physicians had recommended they have a mammogram (scored 1=yes, 0=no).

Knowledge of Breast Cancer Risk

A 10-item scale assessed women's knowledge of the risk factors for breast cancer. The scale contained 9 risk factors that are fairly well established in the literature (older age, family history of breast cancer, personal history of breast cancer, alcohol consumption, late age at first birth, being overweight, early menarche, late menopause, and history of biopsy) and one misconception (bumping or bruising the breast). Women in-

dicated the extent to which the 10 items constituted risk factors for breast cancer by using a rating scale ranging in values from 1 (extremely unlikely) to 6 (extremely likely). An "accuracy" score was derived by summing scores on the 9 known risk factors and subtracting the score on the misconception item (bumping or bruising) to yield an adjusted breast cancer knowledge score, which became the dependent variable in subsequent analyses. The alpha for the 9 known risk factors was .75.

Perception of Personal Risk and Treatment Efficacy

Respondents were asked to assess their personal risk of breast cancer relative to other women: higher than other women their age, the same as their peers, or lower than that of other women.[43] Beliefs about the efficacy of breast cancer treatments were assessed with three items: efficacy of radiation therapy, surgery, and chemotherapy, rated on a scale from 1 to 7. The alpha for the three items was .86.

Data Analysis

We first report demographic data for the six ethnic groups. We next present an analysis of ethnic differences in screening rates, followed by analysis of the accuracy of knowledge and perception of personal risk by using ANOVA and a consideration of the zero-order relations among the major variables. Finally, we regressed frequency of mam-

Table 2. Mean and standard deviation of frequency of mammograms (over 10 years) and results of ANOVA

Variable	Ethnic Group						F Value	Post hoc Comparisons
	African American (N=295)	English Caribbean (N=299)	Haitian (N=305)	Dominican (N=160)	Eastern European (N=151)	European American (N=154)		
# Mammograms	6.6 (4.1)	5.2 (3.7)	3.6 (3.3)	5.6 (3.7)	4.5 (3.7)	6.9 (4.0)	26.1*	EA, AA>EC, H, EE; EC, D>H
Phys. recomm.	.93 (.26)	.93 (.25)	.83 (.38)	.95 (.22)	.93 (.26)	.92 (.27)	6.2*	H<all
Knowledge	23.8 (7.3)	25.1 (6.8)	21.1 (7.1)	17.9 (5.9)	24.1 (5.3)	26.9 (6.7)	11.8*	H,D<all; AA, EE<EA
Risk	1.7 (.64)	1.4 (.57)	1.3 (.55)	1.8 (.47)	2.0 (.45)	1.9 (.69)	50.2*	H, EC<AA<EA, EE, D
BC tmt. efficacy	15.0 (3.9)	14.2 (3.5)	10.8 (4.2)	15.1 (3.8)	15.7 (3.3)	16.5 (4.0)	68.5*	H<all; EA>AA, EC, H, D; EE>EC

* *P*<.01.

AA=African American; EC=English-speaking Caribbean; H=Haitian; D=Dominican; EE=Eastern European; EA=US-born European American.

mograms on risk, knowledge, efficacy, and the product term of efficacy and risk with demographic variables and presence or absence of physician recommendation as covariates. We also tested the generalizability of the cognitive factors across six groups of minority women by systematically creating interaction terms between ethnicity and the variables from the health belief model.

RESULTS

Ethnic Differences in the Rate of Mammography

We first conducted an analysis of covariance (ANCOVA) with the ethnic group as the independent variable, frequency of mammograms as the dependent variable, and age, education, income, and marital status as covariates. The main effect of ethnicity, as well as those for all four covariates, was significant; therefore, the covariates were dichotomized and entered as factors in a subsequent multi-way ANOVA. Main effects were seen for ethnicity, $F(5,1363)=5.7$, $P<.01$; income, $F(1,1363)=7.6$, $P<.01$; and education, $F(1,1363)=4.2$, $P<.05$; and no significant interactions were seen. Table 2 displays the means and standard deviations for rates of mammography by ethnic group and results of ANOVA and Games-Howell post hoc tests. African Americans and European Americans had higher screening rates than English Caribbeans, Haitians, and

Eastern Europeans, but not Dominicans. English Caribbeans and Dominicans had higher rates than Haitians.

Ethnic Differences in Physician Recommendation

ANCOVA was applied to the data with physician-recommended screening as the dependent variable, ethnicity as the independent variable, and age, income, marital status, and education as covariates. Income and ethnicity were significant. Thus, income was dichotomized and entered as a factor, along with ethnicity, in a subsequent ANOVA. A main effect was seen for ethnicity, $F(5,1363)=3.9$, $P<.01$, which was qualified by an ethnicity × income interaction, $F(5,1363)=2.6$, $P<.05$. Post hoc Games-Howell tests indicated that Haitians reported the lowest rate of physician-recommended screening. However, a graph of the interaction of ethnicity and income indicated that physicians recommended screening at a lower rate among higher income Haitians versus lower income Haitians. For Eastern Europeans, the reverse was true; ie, physicians tended to recommend screening at a higher rate to higher income versus lower income women. For the other ethnic groups, the level of income did not make a difference. Irrespective of income or other demographic variables, the rate at which physicians were recommending mammography was high: the rates for African Americans, English Caribbeans, Haitians, Dominicans,

Eastern Europeans, and European Americans were 93%, 93%, 83%, 95%, 93%, and 92%, respectively.

Ethnic Differences in Knowledge of Risk Factors

ANCOVA was applied to the data with ethnicity as the grouping variable, knowledge of breast cancer risk score as the dependent variable, and age, marital status, income, and education as covariates. Two of the covariates, education and age, were significant. Therefore, these two variables were dichotomized and entered as factors, along with ethnicity, in a subsequent ANOVA. A main effect was seen for ethnicity, $F(5,1363)=11.9$, $P<.01$. Post hoc Games-Howell tests applied to the means for ethnicity indicated that Haitians and Dominicans had lower knowledge scores than all other groups; African Americans and Eastern Europeans had lower scores than European Americans. Main effects were also seen for age, $F(1,1363)=71.6$, $P<.01$, and education, $F(1,1363)=5.0$, $P<.05$. Those participants who had a higher level of education had better knowledge. The main effect for age was qualified by a significant age × ethnicity interaction. Inspection of a plot of the interaction indicated that younger women were more knowledgeable than older women in the following groups: African Americans, English Caribbeans, Haitians, and Eastern Europeans. The reverse trend was true for European Americans and Dominican women.

Table 3. Intercorrelations among study variables (*N*=1364)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. # Mammograms	—	.02	.12*	−.15*	.02	.22*	.17*	−.01	−.23*	.03	−.07†	.08*	.06†	.19*
2. Age		—	−.12*	−.10*	−.08*	.01	−.03	−.07*	.09*	−.06†	.08*	−.13*	−.00	−.04
3. Education (Educ.)			—	−.22*	.10*	.07†	.04	−.07*	−.32*	−.25*	.51*	.25*	.17*	.20*
4. Income (Inc.)				—	.12*	−.09*	−.12*	.07†	.24*	.08*	−.18*	.18*	−.15*	−.08*
5. Marital status (MS)					—	.01	−.17*	−.06†	.00	.11*	.16*	−.03	.02	−.01
6. Physician recom. (PR)						—	.03	.05	−.15*	.05	.02	.01	−.02	.04
7. African American (AA)							—	−.28*	−.28*	−.19*	−.19*	.05	.04	.11*
8. Eng. Caribbean (EC)								—	−.28*	−.19*	−.19*	.14*	−.21*	.00
9. Haitian									—	−.20*	−.19*	−.15*	−.23*	−.42*
10. Dominican										—	−.13*	−.27*	.14*	.08*
11. Eastern European											—	.05	.22*	.13*
12. Accuracy of knowledge												—	.03	.14*
13. Perceived risk													—	.17*
14. Treatment efficacy														—

* *P*<.01; † *P*<.05.
AA=African American; EC=English-speaking Caribbean; H=Haitian; D=Dominican; EE=Eastern European; EA=US-born European American.

Ethnic Differences in Perception of Personal Risk

ANCOVA was conducted with ethnicity as the grouping variable and perceived risk as the dependent measure, with age, marital status, income, and education as covariates. A significant effect of ethnicity was seen, $F_{(5,1354)}=37.7$, *P*<.01, but none of the covariates were significant. Subsequent ANOVA and Games-Howell post hoc tests indicated that the three African descent groups (African Americans, English Caribbeans, Haitians) had the lowest perceived risk scores, followed by African Americans who had lower scores than Dominican, Eastern European, and European American groups.

Ethnic Differences in Beliefs about Breast Cancer Treatment Efficacy

ANCOVA, with ethnicity as the independent variable and breast cancer treatment efficacy as the dependent variable, and with demographic variables of age, marital status, income, and education as covariates, indicated that the demographic variables were not significant. Subsequent ANOVA with ethnicity as the grouping variable was significant, $F_{(5,1363)}=68.5$, *P*<.01. Post hoc Games-Howell tests indicated that Haitians had lower beliefs in breast cancer treatment efficacy than all other groups; European Americans had higher scores than African Americans, English Caribbeans, Haitians, and Dominicans; Eastern Europeans had higher scores than English Caribbeans.

Relative Contributions, Controlling for Demographic Variables and Physician Recommendation

Before conducting regression analysis we examined the inter-correlation of the predictor variables and their zero-order correlation with screening rates. Table 3 presents the inter-correlation matrix. As indicated, the frequency of mammograms was positively correlated with education, physician recommendation, being African-American, estimates of increased risk, more accurate knowledge, and stronger beliefs about treatment efficacy; it was negatively correlated with income, being Haitian, and being Eastern European.

Hierarchical multiple regression was then used to assess the relative contributions of ethnicity and the three cognitive variables to the frequency of mammography. First, background demographics and physician recommendation, along with the three cognitive variables and dummy variables contrasting each minority group with the European-American majority, were entered. We also included a product term between perceived risk and treatment efficacy to capture the expected interaction between these two variables. Second, product terms for the interactions between ethnicity and the cognitive variables were entered by using a forward stepwise procedure with a liberal alpha set at .01. This analysis provides a direct (and liberal) test of whether cognitive variables predict mammography equivalently across ethnic groups.

With one exception, none of these variables came close to the inclusion level. One third-order interaction between being Haitian and a second-order interaction between risk and efficacy approached inclusion (*P*=.02). However, when we added this third-order interaction along with the two second-order relatives (Haitian ethnicity × risk and Haitian ethnicity × efficacy) to the model, none of the additional terms approached significance. We concluded, therefore, that the three cognitive variables do not interact in their prediction of mammography in these women.

Table 4 contains the unstandardized or raw coefficients (B), their standard errors (SE), and the standardized regression coefficients (β). The multiple R^2 was significant, $F_{(14,1346)}=17.72$,

Table 4. Raw and standardized coefficients of the regression of frequency of mammograms on demographic variables, physician recommendation, ethnicity, cognitive variables (knowledge, risk perception, and beliefs regarding treatment efficacy), and the product terms of risk and efficacy

Independent Variables	B	SE B	β
Demographic variables			
Age	.05	.02	.08*
Education	.18	.05	.14*
Income	.00	.00	.01
Marital status	.39	.22	.05
Physician recommendation	2.6	.34	.19*
Ethnicity			
African American (AA)	.33	.38	.04
English Caribbean (EC)	−.87	.39	−.09†
Haitian (H)	−1.4	.44	−.15*
Dominican (D)	−.18	.46	−.02
Eastern European (EE)	−2.6	.44	−.21*
Cognitive variables			
Accuracy of knowledge	.02	.02	.04
Personal risk (PR)	1.2	.43	.20*
Treatment efficacy (T × E)	.25	.06	.28*
T × E × PR	−.10	.04	−.28*

* $P<.01$; † $P<.05$.
B=unstandardized or raw coefficients; SE B=B's standard errors; β=standardized regression coefficients.
Marital status and ethnicity are dummy coded such that 1=married, AA, EC, H, D, and EE; AA=African American; EC=English-speaking Caribbean; H=Haitian; D=Dominican; EE=Eastern European; R^2=.16.

$P<.01$, and accounted for 16% of the variance in mammography screening. Consistent with the bivariate results presented in Table 3, frequency of mammography was greater among women who were older, better educated, and who had had mammography recommended by their physician; neither income nor marital status had significant effects. Three significant effects were for ethnicity, with mammography being lower among Haitian, Eastern European, and English-speaking Caribbean women relative to European Americans.

As expected, significant main effects of beliefs were also seen about personal risk and efficacy of cancer treatment. Knowledge about cancer, however, had no effect. Both belief in personal risk and greater treatment efficacy were associated with greater screening, although the main effects were qualified by a significant interaction between risk and efficacy.

Further consideration of this interaction suggested that this finding was because the effect for each variable was strongest for the low values of the other variable. Table 5 presents the fitted and observed means for the three levels of perceived risk and three levels of treatment efficacy obtained by collapsing efficacy into low (approximately 25%), medium (approximately 50%), and high (approximately 25%) categories. Fitted means were obtained by using the coefficients from a regression of mammography on risk, efficacy, and their product term. As the regression equation presented with Table 5 and the values themselves demonstrate, our prediction of mammography without controlling for ethnicity and the other variables reported in Table 4 leads to coefficients with somewhat higher values. This noted, they are within two standard errors of the coefficients in Table 4 and do not differ significantly from the observed means.

Table 5 shows that mammography rates among women who perceive their risk of breast cancer to be low increase substantially as their perceived efficacy increases. Among the small group of women who view their risk as higher than that of other women, however, the mean level of mammography does not vary as a function of efficacy beliefs.

DISCUSSION

As expected, knowledge of breast cancer risk factors, perceived personal risk, and beliefs about breast cancer treatment efficacy—the core cognitive variables within health belief models—continued to predict mammography in a diverse sample of women even when

Table 5. Fitted and observed means of number of mammograms by perceived risk of cancer and belief in treatment efficacy

Treatment Efficacy (z)	Participant's Perceived Risk (x)		
	Lower than Other Women of Same Age	Same as Other Women of Same Age	Higher than Other Women of Same Age
High (16)	6.43	6.06	5.59
	(7.06)	(5.73)	(6.10)
	n=115	n=230	n=41
Medium (11)	5.21	5.43	5.65
	(5.15)	(5.31)	(6.24)
	n=350	n=287	n=42
Low (5)	3.79	4.74	5.72
	(3.66)	(4.97)	(5.53)
	n=171	n=109	n=19

Observed means in brackets; fitted means obtained using the following equation and the values of x and z given in the margins of the Table: y=.901 + 1.624x + .372z − .128xz.

background variables were controlled. Despite the predicted variation in the mean level of these variables across groups, however, our results indicate that they relate to mammography outcome in virtually the same way across different women from six different ethnic groups. Given the size of our sample and our consequent ability to detect potential interactions, this latter finding can be interpreted as support for the generalizability of the impact of these cognitive variables across women from diverse ethnic groups and, secondarily, as demonstrating a method of testing models developed in majority samples for ethnic generalizability.

Our results are consistent with a large literature detailing a poor screening profile for minority women[47] and Caribbean women,[18,19] although they also suggest that minority status is a more differentiated entity than simply "not being European American." Our data circumscribe marked differences across six ethnically distinct groups of women in terms of both their screening profile and their scores on both structural and psychological variables that prior research has shown to be predictive of screening.

However, while these older urban women screened at below recommended levels—both minority groups and immigrant and non-immigrant White groups—our data provide some grounds for encouragement. Consistent with the claims of some recent research,[6–9] our data suggest that a well-defined group of African-American women may now be screening at a rate equal to that of European-American women. However, the mammography rates of other groups of women of African descent, who are typically subsumed within a less precisely operationalized ethnic rubric, was less heartening, as were the data regarding Dominican and Eastern European women. Women from the English-speaking Caribbean, the Dominican Republic, and Eastern European immigrant women all reported screening at

> *. . . our data suggest that a well-defined group of African-American women may now be screening at a rate equal to that of European-American women.*

lower rates than either of the two US-born groups, while Haitian women screened at lower rates than all other groups, reporting only 3.6 mammograms during the last decade.

In accordance with our hypotheses, women from different ethnic groups displayed disparate scores on the cognitive variables even when the demographic/structural characteristics linked to screening behaviors in the previous literature—age,[5,19] socioeconomic status and/or education,[7,20,21] marital status,[19] and physician recommendation[9,22,23]—were controlled. Consistent with previous research,[7,21] ethnic differences were seen in knowledge, with women from ethnic minority groups having poorer knowledge than European-American women. Haitians and Dominicans had the poorest knowledge, followed by Eastern European and English-speaking Caribbean women. US-born African-American and Eastern European women had significantly less knowledge than European-American women. Consistent with past research, knowledge scores were correlated with higher screening rates across the groups in both zero-order and regression analyses.[32–35] Knowledge was associated with younger age and higher income and most strongly with years of education. The four ethnic groups with the most accurate knowledge of breast cancer risk factors had between 13.3 and 16.2 years of education, while Haitians and Dominicans—the two groups with the lowest knowledge scores—had 7.4 and 7.2 years, respec-

tively. This pattern suggests a clear link between education levels and more accurate cancer knowledge.[7,20,21]

Only moderate correspondence between knowledge and perceptions of risk was seen. For example, even though Dominicans had the lowest mean knowledge score, their risk estimates were as high as those of the two groups of European women. African-American women rated their risk as lower than Dominicans and the two groups of European descent, with Haitian and English-speaking Caribbean women rating their risk as lower still.

Breast cancer treatment efficacy beliefs also varied widely across the groups. Previous research suggested that the belief that breast cancer treatments are not effective was associated with poorer screening.[15,24,36,37] Consistent with this assertion, women with low breast cancer treatment efficacy beliefs, notably Haitians, had among the poorest screening profiles. In addition, however, marked differences were seen among the six groups in the faith they had in the efficacy of breast cancer treatments. European Americans generally believed breast cancer treatment to be effective, with Eastern Europeans next, and African-American, English-speaking Caribbean, and Dominican women behind them.

Overall, women from distinct ethnic groups report patterns of health beliefs that would appear to place them at risk for a poor screening profile in different ways, thus confirming our suggestion that women from diverse Caribbean subpopulations must be considered separately.[44,48] Haitian women, for example, reported having poor faith in treatment and low estimates of personal risk. This pattern suggests that they might benefit from education that develops improved efficacy beliefs and more accurate assessment of risk. Conversely, Dominican women had superior perceptions of treatment efficacy but still had low knowledge accuracy and poor perceptions of personal risk. In contrast to the Haitian women, this pattern suggests that psy-

choeducational interventions should focus not so much on improving perceptions of treatment efficacy, but on improving knowledge and perceptions of personal risk.

When multiple regressions controlling for the effects of background and structural variables were run, the predictive utility of knowledge and assessments of personal risk and treatment efficacy changed substantially, if not totally. Perceived personal risk and efficacy beliefs both retained significant main effects as well as produced an interaction effect, but knowledge ceased to predict mammography in the model. Although some previous literature has controlled for education when considering cancer knowledge, the failure of knowledge to hold a significant independent relation with mammography is somewhat contrary to expectations; a proportion of the variance associated with knowledge may be absorbed by education. Alternately, mean-level or non-linear effects may exist in our data that the current analyses did not elucidate; knowledge may relate to outcome differently among extremely low SES and poorly educated samples, or interact with another cognitive variable.

Lower perceptions of personal risk were associated with lower frequency of mammography,[9,15,38,39] in theory because where there is a low perception of risk, there is no need to screen. Conversely, greater faith in cancer treatments—improved efficacy belief—was associated with greater mammography.[15,24,36,37] The interaction between these two key health belief variables was also significant. The mammography rate of women with low risk perceptions increases in line with greater efficacy beliefs, while the rate of women who believed themselves at medium risk increases less drastically with efficacy, and the rate of women believing themselves at high risk did not vary as a function of efficacy beliefs.

Exactly why this pattern emerges and whether it will replicate is unclear at this time, although inspection of the marginal means provided in Table 5 provides a number of explanatory possibilities. First, women who view their risk as either equal to or exceeding that of other women their age may screen at a given rate irrespective of treatment efficacy. These women may be screening simply because they believe they are at high risk, irrespective of whether they actually think that cancer treatments will work. For these women, screening may alleviate anxiety, irrespective of whether they report having a great deal of faith in the procedure. Alternately, efficacy beliefs and outcome may relate differently depending on the level of self-assessed risk. For example, women who rate their risk as high may be basing their screening decisions on a variety of other "access"-type factors rather than on whether they think the treatment will work. Finally, complex floor effects may operate in the data. Relatively few (<10%) women rated their risk as greater than average, and nearly 50% rated their risk as lower than that of other women. This finding creates the possibility that the mean screening rate, which is related to a host of factors (see Table 4), is somewhat unreliable at this data point.

A final aspect of the analysis involved explicitly testing the generality of health belief effects on six groups of women. Previous research has typically had neither the sample sizes nor the carefully constructed ethnic groupings to permit systematic testing of interaction hypotheses; the impact of perceptions of personal risk and treatment efficacy were not moderated by ethnicity and, with the exception of one apparently chance finding, affected the screening rates of women from six different ethnic groups in an almost identical fashion. Importantly, this consistency held despite variations in the mean level of the cognitive variables across groups. Such a pattern is encouraging because it provides some preliminary data attesting to the generalizability of core constructs from the health beliefs models. Although different ethnic groups appear to be placed at risk by slightly different cognitive constellations, the fac-tors themselves are relating to outcome in consistent and theoretically predictable ways. Future research should continue to build upon this base, systematically considering other minority populations, such as Asians, who tend to be grouped within global categories.[46]

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