Factors Influencing Adherence to Guidelines for Screening Mammography Among Women Aged 40 Years and Older

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Objective: To explore patterns of adherence to guidelines for screening mammography among participants in the Colorado Mammography Project (CMAP) surveillance database.

Methods: An algorithm was developed to assess factors associated with adherence to mammography screening guidelines.

Results: Of the 27,778 women ranging from 40–90 years of age included in the analysis, 41.4% were adherent with mammography screening guidelines. According to the model tested in this study, race/ethnicity (Black vs White, OR=0.76, 95% CI=0.64–0.91); educational attainment (high school vs <high school, OR=1.10, 95% CI=1.04–1.18, college graduate vs <high school OR=1.33, 95% CI=1.25–1.42); insurance status, (any coverage vs no coverage, OR=1.62, 95% CI=1.25–2.12); and community economic status as defined by median income by zip code of residence ($15,000–$24,999 vs <$15,000, OR=0.84, 95% CI=0.76–0.94, >$55,000 vs <$15,000, OR 1.14, 95% CI=1.03–1.26) were statistically significant predictors of adherence to guidelines. A significant interaction between age and family history of breast cancer (BC) was also found. Younger females with a family history of BC were less likely to be adherent than their counterparts without a family history (OR=0.93, 95% CI=0.90–0.96). In general, elderly women were more likely to be adherent compared with the youngest group in this cohort (OR=1.21, 95% CI=1.11–1.33). Inclusion or exclusion of women aged 70 years and older did not change the outcome of the analysis.

Conclusion: Adherence with screening mammography guidelines was found to be associated with women's personal characteristics including race/ethnicity, age, and family history of BC. In addition, socioeconomic status, as measured by educational level and community economic status, are important predictors of adherence. Efforts to increase adherence may need to be specific to race/ethnic group and age, but the effect of age is mediated by family history of BC and vice versa. (*Ethn Dis.* 2003; 13:477–484)

Key Words: Surveillance, Adherence, Breast Cancer, Mammography, Screening, and Utilization

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Introduction

Breast cancer ranks second in cancer deaths among women in the United States. The American Cancer Society estimates that in 2003, 211,300 new invasive cases and 39,800 deaths from breast cancer (BC) will occur among women in the United States.[1] For decades screening mammography has been offered to the public and, consequently, it has been studied extensively. This research has provided a substantial body of information describing factors associated with women obtaining screening mammograms.[2–4]

This study examined data from screening mammograms performed on women aged 40 and older who participated in the Colorado Mammography Project (CMAP) from January 1, 1994 to December 31, 1998. The CMAP is a National Cancer Institute (NCI)-funded project that obtains data on mammograms from approximately half of all mammography facilities in the 6-county Denver Metropolitan Area of Colorado.[5] The overall purpose of CMAP is to study the performance of mammography provided in community settings. Mammography facilities participate voluntarily in CMAP and participating facilities, distributed widely throughout the 6-county area, provide services to women of all race/ethnic and economic groups. Personal history, BC risk factor data, and results of mammograms are collected by mammography facilities and shared with CMAP. Results of mammograms are measured using the American College of Radiology BI-RADS™ system.[6] Breast cancers within the database are identified through semi-annual matches with the Colorado Central Cancer Registry. The CMAP, in turn, conducts analyses on sensitivity, specificity, and predictive values and provides reports to facilities. To ensure confidentiality, personal identifiers are removed and participants are assigned a unique facility identifier. The CMAP is reviewed by Institutional Review Boards annually.

For the last 2 decades, most studies of regular screening have defined adherence as having had more than one mammogram after becoming eligible for screening or having had a mammogram in the last 2 years.[7–22] A few studies have defined adherence by women's self-reporting of regular screening.[17,23] To study adherence to the guidelines recommended by expert organizations, we have included several factors, including age at the time of mammogram, mammography date, previous mammography, year of previous mammography, family history of BC and continuous or discontinuous pattern of mammography utilization.

Though several factors were recorded in the surveillance database, for this study we selected factors that are based on behavioral theories or guided by behavioral theories. Based on Health Belief Model[24–25] and Andersen's Behavior-

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al Model[26–28] of health services utilization, a prediction model was developed. Predisposing factors, such as age, race, education and enabling factors such as community economic status and insurance coverage, were hypothesized to influence adherence to screening mammography. Additional factors influencing adherence to screening mammography guidelines include need factors, such as family history of BC, current breast problem, or need for hormone replacement therapy. In this paper, we report on analysis of data from CMAP, with the objective of describing factors that influence adherence to guidelines for screening mammography among women in a large metropolitan area.

Table 1. Pattern of mammography utilization in 1994–98

1994	1995	1996	1997	1998	Frequency	%	Cumulative Frequency	Cumulative %
0	0	0	0*	1†	5291	19.05	5291	19.05
0	0	0	1	0	2219	7.99	7510	27.04
0	0	0	1	1	1441	5.19	8951	32.22
0	0	1	0	0	1573	5.66	10524	37.89
0	0	1	0	1	1596	5.75	12120	43.63
0	0	1	1	0	746	2.69	12866	46.32
0	0	1	1	1	1029	3.70	13895	50.02
0	1	0	0	0	824	2.97	14719	52.99
0	1	0	0	1	792	2.85	15511	55.84
0	1	0	1	0	640	2.30	16151	58.14
0	1	0	1	1	845	3.04	16996	61.19
0	1	1	0	0	744	2.68	17740	63.86
0	1	1	0	1	739	2.66	18479	66.52
0	1	1	1	0	511	1.84	18990	68.36
0	1	1	1	1	1135	4.09	20125	72.45
1	0	0	0	1	447	1.61	20572	74.06
1	0	0	1	0	415	1.49	20987	75.55
1	0	0	1	1	266	0.96	21253	76.51
1	0	1	0	0	939	3.38	22192	79.89
1	0	1	0	1	512	1.84	22704	81.73
1	0	1	1	0	305	1.10	23009	82.83
1	0	1	1	1	642	2.31	23651	85.14
1	1	0	0	0	251	0.90	23902	86.05
1	1	0	0	1	264	0.95	24166	87.00
1	1	0	1	0	330	1.19	24496	88.18
1	1	0	1	1	502	1.81	24998	89.99
1	1	1	0	0	623	2.24	25621	92.23
1	1	1	0	1	525	1.89	26146	94.12
1	1	1	1	0	482	1.74	26628	95.86
1	1	1	1	1	1150	4.14	27778	100.00

* Denotes a year in which a record of a screening mammogram is not in the CMAP database.
† Denotes a year in which a record of a screening mammogram is in the CMAP database.

METHODS

For this report, screening mammography is defined as mammograms performed on women who are designated by radiologists as asymptomatic at the time of their mammogram. Based on this criterion, a total of 199,717 women and 401,976 mammogram results were included in this study.

In 1988, 12 influential health organizations agreed that beginning at age 40 all women should receive mammograms every one or 2 years, and annually after age 50.[29] The National Cancer Institute included another condition for recommending mammography during ages 40 to 49; specifically, to screen if there is family history of BC.[30] Incorporating this recommendation into this study, definitions of adherence were derived as follows: 1) For women 50 and over, as well as for women between 40 and 49 with a family history of BC, adherence was defined as completing at least 2 mammograms within a one-year interval; 2) For women between 40 and 49 without a family history of BC, adherence was defined as completing at least 2 mammograms within a 2-year interval.

Based on age at the time of mammogram, mammography date, previous mammography, year of previous mammography and family history of BC, 139,445 (39.3%) of the women in the study population were defined as adherent with screening guidelines. We further limited the study population by including only those participants with complete records, which yielded a total of 27,778 women and their multiple mammography records. Data management and all statistical procedures were performed using SAS Software, version 8.1.[31]

To facilitate analyses, a binary variable (where adherence to mammography screening guidelines = 1 and nonadherence = 0) was created to indicate whether a woman had a mammogram during a given year. Using this approach, we observed 30 patterns of mammography utilization (see Table 1). These patterns neither reflect probable attrition over time, nor do they consider staggered entry into the surveillance database, which implies that a woman

might have had mammography results not included in the database at various times. As a result, an operational definition of 'adherence' using these patterns alone would lead to a misclassification bias. One way for this type of bias to occur is to assume, for example, the 5,291 women in Table 1 (with pattern 1) who had a mammogram in 1998 did not have a mammogram at any time during 1994 through 1997. Although this assumption makes the adherence calculations easier, leading to an underestimate of the actual utilization frequencies and adherence duration, the patterns do not reflect known exposure time. To reduce the effects of this type of misclassification bias, the results of the most recent mammography were identified and a record of all previous procedures during the study period was reconstructed from the database.

As Table 1 shows, 5,291 women who were categorized as having one mammography procedure were included in the database in 1998. There were 1,150 women who reported having received a mammogram every year during 1994–1998. If a woman older than 40 in 1998 did not have a previous mammogram, she was coded as non-adherent to the screening guidelines. On the other hand, women who had turned 40 and had a mammogram in 1998 had just became eligible for screening and were considered adherent to recommended guidelines. Women aged 40 to 50 without a family history of BC, if the time between their 1998 mammogram and the previous mammogram was more than 2 years, were coded as non-adherent with surveillance mammography guidelines. If the difference was between zero to 2 years, they were considered adherent.

For women who had a continuous pattern of mammography (eg, a pattern of 10, 11, 100, 110, 111, 1000, 1100, 1110, 1111, 11000, 11100, 11110, 11111 using "1" for having a mammogram and "0" for not having a mammogram), a similar method was used to measure adherence based on age and family history. The first mammogram date and year of each mammogram in the study period were used to calculate the differences between the last mammogram date and the first appearance of a mammogram in the database. Thus, based on a women's age at the first year when a mammogram was obtained during the study period, and family history, women were defined as adherent and non-adherent. Any women who were at least 40 years of age with one mammogram, without any prior mammograms in the database, were considered non-adherent. If the difference between the first mammography year and previous mammogram was more than 2 years, then women without a family history of BC, between ages 40 and 50 at the time of their first mammogram, were considered non-adherent. If the difference was within 2 years, they were considered adherent. Women between 40 and 50 with a family history of BC and women age 51 and older with a one-year difference between their first and previous mammography year were considered adherent. The rest were coded as non-adherent.

For women who had a discontinuous pattern of mammograms, (eg, 101, 1001, 1010, 1011, 1101, 10001, 11001, 11101, 10010, 10011, 10101, 10100, 10110, 10111, 11010, 11011), a different method was used to measure adherence. When a gap in mammograms was detected it was considered as 2 separate time periods. For example, the pattern "00101" indicates that these women had their first mammogram in 1996, failed to have the procedure in 1997, but resumed the test in 1998. Women who were older than age 40 in 1996, without any prior mammograms, as determined by examining the last mammogram date before 1996 (from the 1996 record), were considered non-adherent. Women who were 40 in 1996 were considered adherent since they also had a mammogram within 2 years. Women, aged 40 to 50, without a family history of BC were coded as adherent, if the difference between their last mammogram and their mammogram in 1996 was less than 2 years. If the difference was greater than 2 years, however, they were coded as non-adherent. Women, aged 40 to 50 with a family history of BC and women aged 51 and older, were coded as adherent if the difference between their last mammogram in the database and their mammogram in 1996 was one year. If the difference was greater than one year, they were non-adherent. If a woman was between 40 and 48 and did not have a family history of BC, she was considered adherent in 1996. If she had a family history of BC then her last mammography in 1998 was considered. If her last mammography as assessed in 1998 was in 1997, she was considered as adherent. If not, she was considered non-adherent.

The dependent variable was dichotomous (where adherence=1 and non-adherence=0). Independent variables included predisposing (age, race, and education), enabling (insurance and community economic status) and need factors (family history of BC, current breast problem, follow-up test recommendation, and Hormone Replacement Therapy). The community economic status was defined by the median income per zip code of the woman's residence. Current breast problem was included as a variable in this study. Diagnostic mammography, conducted to evaluate the current breast problem was not included, since only asymptomatic mammography was considered for screening.

Wald chi-square test was used to assess the main effects and interaction terms. All main effects were kept in the final model and only the significant interaction terms were kept using a 2-sided significance level of 5%. Maximum likelihood procedures were used to estimate the model parameters for the logistic model. Thus, the regression coefficients in the logistic model provided information about the relationships of the predictors or influencing factors in

the model to the adherence status of a woman. This relationship is quantified as the odds ratio.

RESULTS

Table 2 presents characteristics of women in this study. A total of 41.4% of the women were adherent to the guidelines of screening mammography as defined in this study. The study population was predominated by women who were aged 40 to 49 (37%), White (91%), and educated at the college level or higher (38%). Ninety nine percent of the women possessed some form of health insurance and 28% of women came from communities having median annual income of $25,000 to $34,999 based on zip code of residence. No family history of BC for study participants was determined to be 80.6%, with 94% of women reporting no current breast problem. Significantly, 90.6% of the women did not receive a recommendation for follow-up testing.

Both univariate and multivariate analyses were conducted. A full model including all potential 2-way interaction terms and main effects resulted in significant race by family history and age by family history interaction terms ($P<.05$). Re-fitting a reduced model with all main effects and these 2 interaction terms revealed that only the age by family history interaction was needed in the final model ($P<.05$).

Table 3 shows both univariate and adjusted odds ratios for the factors included in the final model. Black women were 24% less likely to adhere to guidelines than White women. Educational level was a significant predictor of adherence. High school graduates had greater odds of adherence to guidelines than did those who had less than high school education (OR=1.11, 95% CI=1.04–1.18). Some college attendance, college, and graduate degree attainment also had a positive influence on adherence to mammography guidelines (OR=1.33, 95% CI=1.25–1.42). Insurance status also was a significant predictor of adherence (OR=1.63, 95% CI=1.25–2.13), with insured women having 63% greater odds of adherence to mammography guidelines than women in the uninsured group. In the final model, community economic status, as estimated by median annual income within zip code[32–33] of residence was also found to be a predictor of adherence to mammography guidelines. Those with an annual median income between $15,000 and $24,999 were less likely to adhere to screening guidelines than women who had an annual median income of less than $15,000 (OR=0.84, 95% CI=0.76–0.94). Those with median incomes between $35,000 and $44,999 had more favorable odds of adherence to guidelines than did women who had median income of less than $15,000, but this association was recorded at borderline significance (OR=1.08, 95% CI=1.00–1.16). Women with an annual median income greater than $55,000 were more likely to adhere to guidelines than were women who had median incomes less than $15,000 (OR=1.14, 95% CI=1.03–1.26). Follow-up test recommendation and current breast problems were not significantly associated with adherence. The effects of age and family history were not independent.

As shown in Table 4, when effects of age are fixed, younger women with a family history of BC were less likely to be adherent compared to younger women who did not have a family history of BC. (OR=0.93, 95% CI=0.90–0.96). No apparent effect of family history of BC in the older (older than 50) age groups (all confidence intervals include 1.0) was evident. For women with a family history of BC, there is a clear age effect, although not as prominent in women without family history. In general, elderly women with family history of BC were more likely to adhere to mammography screening guidelines than the youngest group in the cohort (OR=1.21, 95% CI=1.11–1.33). Even though the same age trend exists for women without a family history of BC, the effects are more modest.

DISCUSSION

When adherence status of women was regressed on individual predisposing, enabling, and need factors and adjusted for other factors, race, education, insurance status, and community economic status were significant predictors, in addition to a significant interaction between age and family history of BC. An association was detected between community economic status measured by the median income per zip code of residence[32–33] and adherence to screening guidelines. Compared with women with an annual median income of less than $15,000, women with an annual median income of $15,000 to $24,000 were less likely to be adherent. On the other hand, women with higher median incomes, such as those with $35,000 to $44,999 and those with more than $55,000, were more likely to be adherent.

Our findings are inconsistent with previous studies, where older women were less likely to be adherent to screening guidelines than were younger women.[34–37] Those studies, however, did not report an interaction between age and family history. Previous studies have also shown that African-American women were underutilizers of screening mammography[38–41] and less likely to be adherent to guidelines.[42–43] Minority populations such as Hispanics, Asians, and American Indians are also less likely to have repeat mammograms.[35,44] In this study, Black women were the least likely to be adherent to mammography screening guidelines. Both in univariate and adjusted analyses, the odds of Black women being adherent were 24% lower than for White women.[45–47] Hispanic women had 14% less odds than White women to be adherent in univariate

Table 2. Characteristics of women (adherent vs non-adherent) and frequency distribution of factors

Factors	All (*N*=27,778)		Adherent (*N*=11,486)		Nonadherent (*N*=16,292)	
	N	%	*N*	%	*N*	%
Predisposing factors						
Age						
40–49	10,267	37.0	4,271	41.6	5,996	58.4
50–59	8,031	28.9	3,309	41.2	4,722	58.8
60–69	4,692	16.9	2,003	42.7	2,689	57.3
≥70	4,788	17.2	1,903	39.8	2,885	60.3
Race/Ethnicity						
White	25,274	91.0	10,543	41.7	14,731	58.3
Black	587	2.1	204	34.8	383	65.3
Asian	342	1.2	127	37.1	215	62.8
Indian American	75	0.3	32	42.7	43	57.3
Hispanic	1,366	4.9	520	38.1	846	61.9
Other	134	0.5	60	44.8	74	55.2
Education						
<High school graduate	7,670	27.6	2,899	37.8	4,771	62.2
High school graduate	9,542	34.4	3,844	40.3	5,698	59.7
Some college, college, or post graduate	10,566	38.0	4,743	44.9	5,823	55.1
Enabling factors						
Health insurance						
Yes (Medicare, Medicaid or other)	27.507	99.0	11,408	41.5	16,099	58.5
No	271	0.9	78	28.8	193	71.2
Community economic status (median income per zip code)						
<$15,000	9,087	32.7	3,737	41.1	5,350	58.9
<$15,000–$24,999	1,854	6.7	676	36.5	1,178	63.5
$25,000–$34,999	7,858	28.3	3,171	40.4	4,687	59.7
$35,000–$44,999	3,826	13.8	1,645	43.0	2,181	57.0
$45,000–$54,999	3,234	11.6	1,380	42.7	1,854	57.3
≥$55,000	1,919	6.9	877	45.7	1,042	54.3
Need/Health status factors or cues to action						
Family history of breast cancer						
Yes	5,401	19.4	2,004	37.1	3,397	62.9
No	22,377	80.6	9,482	42.4	12,895	57.6
Current breast problems						
Yes	1,661	6.0	693	41.7	968	58.3
No	26,117	94.0	10,793	41.3	15,324	58.7
Follow-up test recommended						
Yes	2,621	9.4	1,082	41.3	1,539	58.7
No	25,157	90.6	10,404	41.4	14,753	58.6
Hormone use*						
Yes	10,013	49.1	4,563	45.6	5,450	54.4
No	10,376	50.9	4,257	41.0	6,119	59.0

Note: Total number does not add to 27,778 because of missing values.

analysis, but after adjustment for other factors, being of Hispanic race became non-significant.

Women's educational attainment was a consistently strong predictor of adherence to screening guidelines making these findings consistent with previous studies. Age as a predisposing factor, interacts strongly with family history of BC, suggesting the biologically plausible phenomenon that as age increases, so does the probability of getting BCs among family members.

Insurance status was consistently associated with adherence to screening mammography. These findings are consistent with most studies on predictors of mammography utilization.[48–49] Although different categories of insurance, such as Medicaid, Medicare, or having an HMO and other private insurance,

Table 3. Univariate and adjusted odds ratios for the factors influencing screening mammography adherence

Factors	Univariate OR	95% CI	Adjusted OR	95% CI
Age†				
49–49	1.00		—	
50–59	0.98	0.93–1.04	—	—
60–69	1.05	0.98–1.12	—	—
70+	0.93	0.86–0.99*	—	—
Race/Ethnicity				
White	1.00		1.00	
Black	0.74	0.63–0.88*	0.76	0.64–0.90*
Asian	0.83	0.66–1.03	0.83	0.66–1.03
Indian American	1.04	0.66–1.64	1.13	0.71–1.79
Hispanic	0.86	0.77–0.96*	0.95	0.84–1.06
Other	1.13	0.81–1.59	1.12	0.79–1.57
Education				
<High school graduate	1.00		1.00	
High school graduate	1.11	1.04–1.18*	1.11	1.04–1.18*
Some college, college or postgraduate	1.34	1.26–1.42*	1.33	1.25–1.42*
Health insurance				
Yes (Medicare, Medicaid, or other)	1.75	1.35–2.28*	1.63	1.25–2.13*
No	1.00		1.00	
Community economic status (median income per zip code)				
<$15,000	1.00		1.00	
$15,000–$24,999	0.82	0.74–0.91*	0.84	0.76–0.94*
$25,000–$34,999	0.97	0.91–1.03	0.96	0.91–1.03
$35,000–$44,999	1.08	1.00–1.17*	1.08	1.00–1.16*
$45,000–$54,999	1.07	0.98–1.16	1.03	0.95–1.12
≥$55,000	1.21	1.09–1.33*	1.14	1.03–1.26*
Family history of breast cancer†				
Yes	0.80	0.76–0.85*	—	—
No	1.00		—	
Current breast problem				
Yes	1.02	0.92–1.12	1.04	0.94–1.15
No	1.00		1.00	
Follow-up test recommended				
Yes	0.99	0.92–1.08	0.99	0.92–1.08
No	1.00		1.00	
Age by family history interaction†				

Note: OR = Odds ratio; CI = Confidence interval.
* Statistically significant.
† There was an age/family history interaction in the adjusted model and therefore these results are presented in Table 4.

were not considered separately, overall presence of any form of insurance had a positive influence on screening mammography behavior. Analyses of the relationship between insurance status and adherence to screening mammography should, however, be interpreted with caution. In the study database, 99% of women were insured and only 0.9% were uninsured, which indicates presence of selection bias. Moreover, some women had multiple insurance providers and different levels of coverage, which may have changed over time.

In previous studies enabling factors such as household income, insurance status, and access to transportation were examined. Few studies have considered median income per zip code and transportation options per zip code as a measure of community resources for health services utilization. In this study we have measured median income by interpreting a woman's zip code as an indicator of community economic status. This method of measurement was consistently associated with adherence to screening guidelines.

Family history of BC was a significant predictor of adherence in the univariate analysis, and strongly interacted with age in the final model. In other studies, the association between family history and adherence or repeated mammography is inconsistent. A follow-up survey study sponsored by NCI, for ex-

Table 4. Interaction of age and family history on probability of adherence to mammography screening

	Effect of Family History for a Fixed Age Category		Effect of Age for a Fixed Family History			
	Family History (Yes/No)		Family History			
			Yes		No	
Age	OR	95% CI	OR	95% CI	OR	95% CI
40–49	0.93	0.90, 0.96)	1.00		1.00	
50–59	1.02	(0.92, 1.14)	1.08	(0.99, 1.17)	0.98	(0.92, 1.03)
60–69	0.96	(0.85, 1.08)	1.20	(1.10, 1.32)	1.16	(1.09, 1.23)
70+	1.06	(0.94, 1.19)	1.21	(1.11, 1.33)	1.06	(1.00, 1.13)

Our findings are inconsistent with previous studies, where older women were less likely to be adherent to screening guidelines than were younger women.[34–37]

ample, found that family history of BC in 1987 was associated with repeated mammograms in 1987; however, this study revealed no association between family history of BC and repeated testing of those participants in 1990.[50] The authors reasoned that this result occurred because the women's physicians were more likely to advise having mammograms in 1987 than in subsequent years. However, several study findings support an alternative explanation suggesting that family history of BC may increase fear of getting the disease and result in a psychological response inhibiting women from having mammograms.[51–52] In many studies, positive results and anxiety about procedures have been viewed as negative factors influencing compliance behavior.[53] In this study, data on participants who were identified as having a current breast problem and advised to seek followup testing, were not significantly associated with repeated mammography.

Women Aged 70 and Older

The benefits of screening mammography for women aged 70 and older are not clearly indicated by the recommending organizations.[54–55] Several decision analysis models have shown that screening mammography saves lives at all ages between 65 and 85 even though screening mammography after 69 results in a small gain in life expectancy and is moderately cost-effective.[56–57] In this study, age, as a cutoff point for participation, was not utilized as a qualifying factor. Women, aged 70 and older, constituted 17.2% of total women in this database, but inclusion or exclusion of these women did not change any result.

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