

A Multilevel Study of Socioeconomic Predictors of Regular Mammography Use Among African-American Women

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Abstract

Background: Little is known about the predictors of adherence to mammography guidelines by African-American women. We assessed individual-level and group-level socioeconomic predictors of regular mammography use in a large cohort of African-American women.

Methods: We included 14,706 participants in the Black Women's Health Study who were 40 to 69 years of age at baseline in 1995. Data were obtained through mail questionnaires at entry and biennially during three 2-year follow-up periods until 2001. We linked the women's addresses to census block (neighborhood) socioeconomic data. With multilevel multivariable regression analysis, we assessed the relation of individual-level and neighborhood socioeconomic factors to "regular" mammography use (use in all three follow-up periods) relative to nonregular use, with control for other predictors.

Results: Most participants had health insurance and almost half had graduated college. Having health insurance was the

socioeconomic variable most strongly associated with regular mammography use (odds ratio, 3.59; 95% confidence interval 3.02-4.28); the association was present at all levels of educational attainment, household income, and neighborhood socioeconomic status. Regular mammography use increased with individual household income: odds ratio, 2.00 (95% confidence interval, 1.58-2.53) for household income >\$100,000 relative to <\$15,001. Regular mammography use did not vary across level of education. Higher neighborhood socioeconomic status was significantly associated with regular mammography use before, but not after, control for household income.

Conclusions: Access to health insurance is strongly associated with regular mammography use among African-American women, even at higher levels of educational attainment and socioeconomic status. Neighborhood socioeconomic characteristics do not materially influence regular use. (Cancer Epidemiol Biomarkers Prev 2005;14(11):2628-33)

Introduction

Breast cancer is the most commonly diagnosed cancer and the second most common cause of cancer mortality among African-American women (1-3). Although incidence rates after age 45 years are lower among Black women than among White women, mortality rates are higher in Black women at all ages (4). Black women tend to be diagnosed at more advanced stages of breast cancer compared with White women (5). Regular mammography screening could lead to earlier diagnosis and treatment and possibly reduce mortality (6-12). In 1997, the National Cancer Institute adopted new mammography screening guidelines: the previous recommendation that women ages ≥ 50 years who are at average breast cancer risk should be screened every 1 to 2 years was changed to include women ages 40 to 49 years (13). Mammography use by African-Americans has increased greatly in recent years and now equals that of White women (14-16).

There have been numerous studies of socioeconomic factors associated with ever and recent mammography use. National data collected in the Behavioral Risk Factor Surveillance System (17, 18) and the National Health Interview Survey (19) indicate that health insurance or access to medical care, higher income, higher level of education, and higher neighborhood socioeconomic status (SES) are important correlates of

ever and recent use. Thus far, no study has assessed all of these factors simultaneously. In addition, little is known about factors that influence *regular* mammography use among African-American women (20).

We previously reported a cross-sectional analysis of recent mammography use in relation to age, education, and several breast cancer risk factors at baseline in the Black Women's Health Study (BWHS), a national follow-up study of the health of African-American women (21). In the present article, we report a prospective multilevel study of the influence of individual-level and group-level (neighborhood) socioeconomic factors on regular mammography use. The individual- and group-level socioeconomic factors were assessed simultaneously while also taking into account other potential predictors of regular mammography use.

Materials and Methods

The BWHS began in 1995 when African-American women ages 21 to 69 years from across the U.S. completed mailed health questionnaires (22-24). Most respondents were subscribers to *Essence* magazine, a general readership magazine targeted to African-American women, and a small proportion were friends and relatives of early respondents or members of selected professional organizations. The median age of respondents at baseline was 38 years, 97% had completed high school, and 45% had completed college or a higher level of education. The 59,084 respondents whose addresses were judged to be valid 1 year after entry were sent follow-up mail questionnaires every 2 years; follow-up rates of $\geq 80\%$ were achieved in each follow-up cycle. The BWHS was approved by the Institutional Review Boards of Boston University Medical Center and Howard University Cancer Center.

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The 1995 baseline questionnaire collected information on many factors, including when the participant had her most recent mammogram (never, <1 year ago, 1-2 years ago, 3-4 years ago, and 5+ years ago). The 1997, 1999, and 2001 follow-up questionnaires asked about disease and risk factors in the preceding 2 years, including whether the participant had a mammogram.

We assessed potential predictors of mammography use during three 2-year follow-up periods, 1995 to 1997 (1997 questionnaire data), 1997 to 1999 (1999 questionnaire data), and 1999 to 2001 (2001 questionnaire data). Among the 25,717 women who were ages ≥ 40 years and cancer-free at baseline in 1995, 18,075 (70.3% of age-eligible women) completed all three follow-up questionnaires; among the latter, 15,862 (61.7% of age-eligible women) completed the mammography questions on all three follow-up questionnaires. The latter women were linked to 2000 census block data by geocoding their 1995 addresses; the addresses of 1,156 women could not be geocoded, leaving a final study group of 14,706 women (57.2% of age-eligible women).

The individual-level socioeconomic factors assessed were health insurance status, years of education completed, having a second job, and household income. Neighborhood socioeconomic factors assessed were percentage of households below the poverty level, percentage of residents ages ≥ 25 years who had completed college, percentage of employed persons ages ≥ 16 years in white collar occupations, median housing value, percentage of households with dividend, rental, or interest income ("nonsalary" income), and percentage of residents who were African-American.

We also assessed individual-level factors that could confound the associations of the socioeconomic factors with mammography use. These included demographic variables (age, geographic region of residence, marital status), breast cancer risk factors (fibrocystic breast disease, breast cancer in a mother or sister, body mass index (kg/m^2), parity, menopausal status), health habits and behaviors (participation in strenuous physical activity, cigarette smoking, alcohol use, use of multivitamins, use of female hormone supplements, breast self-exam, Pap screening), and child care responsibilities.

Data on all individual-level factors were derived from the 1995 baseline questionnaire with the exception of health insurance status, which was taken from the 1997 questionnaire, and household income, which was taken from the 2003 questionnaire.

The analysis was conducted in three stages. First, with multiple logistic regression analysis (SAS version 8.02; ref. 25), we assessed the associations of all individual-level factors except household income with "regular" mammography use (use in all three 2-year follow-up periods) relative to non-regular use (26). We included educational attainment and geographic region in all models, but other factors were kept in the model only if the odds ratio for at least one category of the variable was statistically significant at the 0.05 level. Second, with control of the individual-level factors that remained from the first stage, we assessed the association of each of the census block variables with regular mammography use in multilevel models (27) that considered each census block variable separately (MLWIN version 2.1e; ref. 28). Multilevel models account for clustering of two or more women within a census block. Of the census variables, the only ones found to be associated with regular mammography use were the percentage who had completed college and the percentage with nonsalary income (P for trend < 0.05 for each considered as a continuous variable). These two variables were combined into a neighborhood SES score, derived as follows. For each of the two census variables, a Z -score for each census block was calculated by subtracting the mean of all census blocks in the sample from the value for the particular block group and dividing by the SD; the neighborhood score was the sum of the

Z -scores for the two census variables, with higher scores indicating higher SES (29). In the final stage of the analysis, we included the individual factors and the neighborhood SES score in the multilevel model. We were interested in whether there would be an effect of neighborhood SES after control for individual-level SES. Therefore, we ran the final analysis with and without control for individual household income. Results from the final analyses are presented.

The above analyses were confined to women who completed the mammography questions on all three follow-up questionnaires from 1997 to 2001. To assess whether these women differed from potentially eligible women who were excluded because of failure to meet that criterion, we compared the included and excluded women. Similar proportions of included and excluded women reported having health insurance in 1997 (95% versus 93%). Greater proportions of included women than excluded women reported household incomes $> \$50,000$ (55% versus 48%), lived in neighborhoods in the top quartile of the neighborhood SES score (28% versus 22%), and had completed ≥ 16 years of education (49% versus 40%). We also compared the proportion of included women who reported mammography use on each of the questionnaires with the proportion among excluded women who had answered those questions. The proportions of included and excluded women who reported having undergone mammography were 94% and 90% on the 1995 questionnaire, 95% and 93% on the 1997 questionnaire, 93% and 91% on the 1999 questionnaire, and 91% and 82% on the 2001 questionnaire, respectively.

Results

Among the 14,706 women studied, distributed over 10,484 census blocks, mammography use in all three 2-year follow-up periods was reported by 79.8%, use in two periods only by 14.0%, use in one period only by 3.9%, and no use in any period by 2.3%.

As shown in Table 1, health insurance was the socioeconomic factor most strongly associated with regular mammography use. With control for individual-level factors other than household income, the odds ratio was 4.00 (95% confidence interval (CI), 3.38-4.73). After control for household income, the estimate was attenuated by $\sim 10\%$ to 3.59 (95% CI, 3.02-4.28). Household income was also associated with regular mammography use: with control for all other factors, the odds ratio was 2.00 (95% CI, 1.58-2.53) for income $> \$100,000$ relative to income $< \$15,001$. Neighborhood SES was significantly associated with regular mammography use when family income was not controlled: odds ratio, 1.25 (95% CI, 1.10-1.42) for the highest quartile of score relative to the lowest (P trend = 0.0013). After control for family income, the corresponding estimate was smaller, 1.15, and no longer statistically significant (95% CI, 1.00-1.31; P trend = 0.064). The results for neighborhood SES were similar when we restricted the analysis to women who had not moved between 1995 and 2001. Level of education was not associated with regular mammography use, whether or not household income was controlled.

As shown in Table 2, having health insurance was associated with regular mammography use across strata of educational attainment, household income, and neighborhood SES. The odds ratios ranged from 2.37 to 5.57 and none of the 95% CIs included 1.0. Among women with family incomes $> \$50,000$, with 16+ years of education, and in the highest quartile of neighborhood SES score, the odds ratios were 4.57 (95% CI, 3.03-6.89), 3.85 (95% CI, 2.79-5.29), and 3.83 (95% CI, 2.41-6.10), respectively.

Table 3 provides data on mammography use for individual-level factors other than socioeconomic variables. Odds ratios are presented from the analysis in which household income

Table 1. Relation of regular mammography use (use during all three 2-year follow-up periods) to socioeconomic factors among 14,706 BWHS participants

Factor	No.*	Regular mammography use (%)	OR [†] (95% CI)	OR [‡] (95% CI)
Health insurance				
Yes	13,937	81.5	4.00 (3.38-4.73)	3.59 (3.02-4.28)
No	716	48.0	Ref	Ref
Household income (in U.S. \$)				
<15,001	716	67.7	not included	Ref
15,001-25,000	1,085	76.1		1.29 (1.02-1.64)
25,001-50,000	4,035	79.8		1.61 (1.31-1.98)
50,001-100,000	4,959	81.9		1.78 (1.44-2.19)
>100,000	2,102	83.2		2.00 (1.58-2.53)
Years of education				
<12	347	74.4	Ref	Ref
12	2,424	79.3	1.03 (0.76-1.41)	0.95 (0.70-1.29)
13-15	4,747	78.5	0.96 (0.71-1.30)	0.85 (0.63-1.15)
≥16	7,085	81.2	0.99 (0.73-1.33)	0.82 (0.61-1.11)
Neighborhood SES (quartile)				
1 (lowest)	3,683	76.3		Ref
2	3,669	79.5	1.10 (0.98-1.24)	1.05 (0.94-1.19)
3	3,678	80.7	1.11 (0.98-1.25)	1.05 (0.92-1.18)
4	3,676	83.0	1.25 (1.10-1.42)	1.15 (1.00-1.31)

*Women with missing values for a particular factor were excluded.

†Odds ratio and 95% CI for regular mammography use relative to nonregular use with control for all socioeconomic and individual factors *except* household income.

‡Odds ratio and 95% CI for regular mammography use relative to nonregular use with control for all socioeconomic factors and individual factors, including household income.

was controlled; the results were closely similar when this factor was not controlled. Having had a Pap smear within the 2 years before baseline was significantly associated with regular mammography use, with an odds ratio of 3.30 (95% CI, 2.92-3.73), relative to a smear a longer time ago or never. Women ages ≥50 years at baseline were more than twice as likely to be regular mammography users as women ages 40 to 49 at baseline. Odds ratios were also significantly increased, ranging from 1.23 to 1.74, for women who had fibrocystic breast disease, had a family history of breast cancer, practiced breast self-exam, took multivitamins, took female hormone supplements, did not smoke, or had no childcare responsibilities.

Because women ages ≥65 years are eligible for health insurance through Medicare, we repeated the analyses among women <65 years of age. The results were similar to those reported above. Having health insurance was strongly associated with regular mammography use (odds ratio, 3.60; 95% CI, 3.02-4.28), and the association was present within all levels of education, income, and neighborhood SES. The results for other factors were also closely similar to those reported above.

Discussion

Among the well-insured African-American women assessed here, more than three quarters reported regular mammography use, i.e., use in all three of the 2-year follow-up periods studied. The proportion of women in other studies who adhered to mammography guidelines has varied greatly because of differences in the definition of adherence, differences in the populations studied, and secular increases in mammography use over time (20, 30-47). In their 2003 review of such studies, Jones et al. concluded that all ethnic groups, including African-Americans, had lower than recommended rates of regular mammography use (20). For example, the Mammography Attitudes and Usage Studies found that only 48% of African-American women were in compliance with screening guidelines in 1995. However, that frequency was about double the frequency in 1992 (35, 43).

Among the socioeconomic characteristics studied in the BWHS, having health insurance was most strongly associated with regular mammography use, and the association was observed at all the levels of educational attainment, household income, and neighborhood SES studied. Recent Pap smear and

Table 2. Relation of regular mammography use (use during all three 2-year follow-up periods) to health insurance status within strata of income, education, and neighborhood SES

Factor*	Had health insurance		Did not have health insurance		OR [†] (95% CI)
	No.	Regular mammography use (%)	No.	Regular mammography use (%)	
Family income (in \$)					
<25,001	1,509	76.7	272	51.1	2.37 (1.75-3.20)
25,001-50,000	3,784	81.9	234	44.4	4.70 (3.49-6.32)
>50,000	6,941	82.8	110	50.0	4.57 (3.03-6.89)
Years of education					
≥12	2,504	81.4	242	50.0	3.42 (2.47-4.74)
13-15	4,469	80.3	263	47.5	3.51 (2.65-4.63)
16+	6,868	82.3	204	46.6	3.85 (2.79-5.29)
Neighborhood SES (quartile)					
1 (lowest)	3,356	78.7	308	49.7	2.74 (2.08-3.61)
2	3,476	81.2	177	47.5	3.90 (2.74-5.54)
3	3,526	82.3	141	41.8	5.57 (3.76-8.25)
4	3,579	83.7	90	53.3	3.83 (2.41-6.10)

*Women with missing values were excluded.

†Odds ratio and 95% CI for regular mammography use (use in all three 2-year periods) relative to nonregular use.

Table 3. Relation of regular mammography use (use during all three 2-year follow-up periods) to other individual-level factors among 14,706 participants

Factor	No.*	Regular mammography use (%)	OR [†] (95% CI)
Age			
40-49	9,187	75.2	Ref
50-59	4,021	87.5	2.21 (1.97-2.48)
60-69	1,498	87.7	2.58 (2.16-3.08)
Region			
South	3,890	80.6	Ref
Northeast	4,007	79.4	1.11 (0.99-1.25)
Midwest	3,789	79.6	1.01 (0.90-1.14)
West	3,020	79.7	0.91 (0.80-1.03)
Pap smear			
>2 years ago or never	1,514	58.4	Ref
≤2 years ago	12,167	82.5	3.30 (2.92-3.73)
Family history of breast cancer			
Yes	1,279	86.6	1.71 (1.43-2.03)
No	13,427	79.2	Ref
Cystic breast disease			
Yes	3,878	86.0	1.57 (1.41-1.75)
No	10,828	77.7	Ref
Breast self-exam			
Yes	11,435	80.8	1.35 (1.20-1.51)
No	2,198	74.3	Ref
Multivitamin use			
Yes	9,028	81.4	1.23 (1.13-1.35)
No	4,951	77.3	Ref
Female hormone use			
Yes	4,378	86.9	1.74 (1.53-1.98)
No	9,970	76.8	Ref
Cigarette smoker			
Yes	2,476	72.5	Ref
No	12,137	81.4	1.48 (1.33-1.65)
Childcare responsibilities			
Yes	5,586	75.7	Ref
No	8,626	82.6	1.23 (1.13-1.35)

*Women with missing values of a particular factor were excluded.

[†]Odds ratio and 95% CI for regular mammography use (use in all three 2-year periods) relative to nonregular use.

female hormone use, indicators of access to the medical care system, were also associated with regular use. Previous studies have found health insurance to be a major correlate of mammography use (17, 19, 44, 47, 48). Regular mammography use in the BWHS was positively associated with household income but not with level of education. Neighborhood SES was weakly and significantly associated with regular mammography use before control for individual-level household income. However, after control for income, the association was attenuated and not statistically significant. Some studies have found lower educational level to be associated with decreased use of mammography (16, 20, 30, 31, 47). However, there was little variation across level of education beyond high school in two recent studies of regular mammography use, one conducted in Colorado (44) and the other in Maryland, New York, Ohio, and Texas (45). Regular mammography use was associated with median income per ZIP code in the Colorado study (44) and with higher personal income in a health maintenance organization study in Michigan (41) and in the National Health Interview Survey (48), but these studies did not have data on both neighborhood and individual-level SES.

With respect to other variables, we found that women ages ≥50 years reported regular mammography use more frequently than younger women, as in earlier reports (16, 19, 20); the recommendation for screening of women ages 40 to 49 years was made relatively recently (13). "Healthy" behaviors, such as breast self-examination, multivitamin use, and nonsmoking were also associated with regular use, as expected (19). Consistent with previous results (47), BWHS participants with breast cancer risk factors—fibrocystic breast disease or a family history of breast cancer—were more likely to have regular mammography use than women without these factors. A

potential barrier to regular mammography use, having childcare responsibilities, was associated with decreased mammography use, but only weakly.

The present study is much larger than any previous study of mammography use in Black women. The rich database permitted the assessment of a wide range of potential predictors of use. The multilevel assessment of SES took into account individual-level and group-level socioeconomic factors simultaneously, made allowance for the clustering of women within neighborhoods, and controlled for other correlates of mammography use. It seems that mammography use is reported accurately, although there is a tendency to underestimate the time interval since last screening (49, 50). The prospective design of the BWHS, with follow-up every 2 years, allowed for timely reporting of mammography use; that and the high level of education would have contributed to reporting accuracy. Some of the mammograms reported by women who developed breast cancer may have been for diagnostic purposes rather than for screening, but because the percentage of women who developed breast cancer during the 6 years of follow-up was small (2%), their reports could not have materially distorted the results. There have been numerous changes of address by women in the BWHS (51), and misclassification of the neighborhood characteristics of women who had moved during the follow-up period would have tended to weaken associations with neighborhood SES. However, the results were similar to those presented when we restricted the analysis to women who had not moved. We had information on health insurance status in 1997 only, and on income in 2003. These variables are likely to have changed over the course of follow-up. Misclassification of these variables, if unrelated to mammography use, would have resulted in underestimation of associations.

The women included in the present analysis were a select group of BWHS respondents insofar as they had completed all three follow-up questionnaires and the mammography questions in them. A comparison with women of the same ages who were excluded indicated that the included women were better educated and had higher incomes than the excluded women, but the differences were not large. The included women reported greater use of mammography than those excluded, but use in both groups was high. We are unable to postulate any mechanism by which the exclusions could have accounted for the associations seen in the present study. Moreover, subgroup analyses among women in different education and SES strata produced similar results.

The BWHS is not a representative sample of African-American women. Virtually all BWHS participants have completed high school, whereas the corresponding percentage nationally among Black women of the same ages is ~83% (52). More than twice as many BWHS participants completed college compared with Black women nationally. The participants who completed health questionnaires in all three of the 2-year follow-up cycles assessed in this report are the most cooperative members of the BWHS cohort. It is noteworthy that in this educated and health-conscious group of Black women, health insurance was the most important correlate of mammography use. The implication of this finding is that loss of health insurance, which is a growing problem nationally (53), can be expected to adversely affect adherence to mammography guidelines in the future, even among women who have a higher SES and who are aware of the benefits of regular screening (54, 55). For poor and underserved women, it will be important to continue programs such as the Centers for Disease Control's National Breast and Cervical Cancer Early Detection Program in order to assure their access to mammography screening.

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