Impact of an HMO-based Intervention to Increase Mammography Utilization

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Abstract
A health maintenance organization (HMO)-based program designed to increase breast cancer screening was evaluated, focusing on changes in mammography utilization. The program consisted of a multistage intervention aimed at women members and primary care physicians of the HMO. This report examines the effect of the intervention on mammography utilization. The program was evaluated using a quasiexperimental design in which a random sample of women aged 50-74 from the HMO (intervention) was compared to a similarly aged geographic control group selected through random digit dialing. From 1988 to 1990, 450 intervention women and 450 control women were sampled (without replacement) each year and surveyed about breast cancer screening practices and related knowledge. A clear increase in self-reported mammography utilization was associated with the intervention. The percentage of women who reported a mammogram in the 12 months prior to the survey increased from 41% in 1988 (baseline) to 68% in 1990 among HMO women, compared to a change from 39% to 49% among control women. Comparing postintervention rates of mammography in HMO versus control women yielded a rate ratio (RR) of 1.4. However, this effect was strongly modified by income and race. Women with annual incomes of $31,000 or more showed little (whites, RR = 1.2) or no (blacks, RR = 1.0) effect of the intervention. Among women with incomes less than $31,000, the effect among whites (RR = 1.9) was much stronger than among blacks (RR = 1.2).

Introduction
Breast cancer is the second leading cause of cancer mortality in women in the United States, and its incidence is rising. In 1991, 195,000 women were diagnosed with breast cancer; 44,000 women died of the disease (1). It is now established that the lifetime risk of breast cancer for American women is 1 in 9. Early-stage breast cancers can be detected through mammography, clinical breast examinations, and breast self-examinations (2). Randomized controlled trials show that a mortality reduction of about 35% can be expected when women over 50 are screened regularly (3, 4). There has been a sharp rise in the proportion of women who report ever having had regular mammograms—from 37% of women in the 1987 National Health Interview Study (5) to over 60% of women in the 1990 Mammography Attitudes and Usage Study (6). Yet, mammography has not become a regular practice for most women. According to the Mammography Attitudes and Usage Study, less than one-third of the surveyed women were being screened according to widely accepted national guidelines (6). Until mammography becomes regularly utilized, the expected reductions in mortality are unlikely to be fully achieved.

A number of factors have been associated with variation in adherence to mammography recommendations. A physician recommendation or referral has repeatedly exhibited the strongest association with obtaining a mammogram (5, 7, 8). Other factors associated with mammography include a preventive health orientation and regular check-ups (9-11); low cost, convenience, and knowledge of breast cancer risk screening guidelines and mammogram efficacy (10, 12, 13); and sociodemographic characteristics (14, 15). In most studies, older and minority women are less likely to have had mammograms (5-7).

The findings presented here are from a study designed to test the effect of stepped interventions on breast cancer screening among women aged 50-74 in a large HMO. The interventions were intended to increase women's knowledge of breast cancer risks and screening and remove barriers to screening such as cost, inconvenience, and fear. National Cancer Institute guidelines for annual mammography and clinical breast examinations in this age group were incorporated into the intervention. The study is part of a National Cancer Institute-sponsored consortium of six cancer centers concerned with increasing the early detection of breast cancer (7).

In this report, the effect of the intervention is evaluated by comparing self-reported mammography prac-
tics among HMO and control women, with data collected during three annual telephone surveys conducted in 1988, 1989, and 1990. A companion report will evaluate whether the intervention was associated with a shift to earlier-stage disease by comparing data on HMO women to state tumor registry data.

Materials and Methods

Breast Cancer Screening Program. The study interventions are delivered through a joint program of the Health Maintenance Organization of Pennsylvania and New Jersey and Fox Chase Cancer Center initiated in 1988. All age-eligible women members of the HMO are “exposed” to the intervention. The program offers free breast screening to all age-eligible members of the Health Maintenance Organization of Pennsylvania and New Jersey, an independent practice association model health maintenance organization with over 600,000 members in the Delaware Valley and about 50,000 women aged 50–74 (16). The physicians are organized in a network with 800 primary care physicians (generally internists and family physicians) and 5,000 specialists. Rigorous standards are used to qualify radiology practices for delivery of mammography services, and educational interventions are directed at both primary care physicians and radiologists.

The interventions consist of a stepped approach to health education in conjunction with the provision of free mammograms to promote mammography. In this approach, increasingly intensive educational strategies are used to reach women who do not obtain mammograms. Every year, women members of the HMO (aged 50 or older) are sent a breast cancer screening packet which includes a letter from the program medical director endorsing mammography, an informational brochure, and a referral for a free mammogram within 90 days at the approved radiology site listed on the form. Forty-five days after the initial mailing, women for whom mammogram reports are not available are mailed a reminder urging them to have a mammogram. Ninety-five days later, women on whom mammogram referrals still are not available and who are, therefore, presumed to be nonadherent to the referral are assigned randomly to one of three compliance-enhancing interventions: (a) a second mailed reminder; (b) a letter from their primary physician emphasizing the importance of mammography and urging them to schedule an appointment for a preventive office visit; or (c) counseling by telephone from specially trained counselors. Thus, the goal was to use the simplest interventions (e.g., print materials and a mailed referral) to reach women who required little encouragement. Then, additional interventions were used to motivate women who did not respond to the initial screening notification.

Interventions also are directed at physicians. These include a tutorial covering breast cancer screening and treatment provided to primary care physicians, office-based clinical breast examination training, and courses for participating radiologists.

Participants. Telephone interviews were used to survey women aged 50–74 from the HMO (intervention group) and non-HMO women in the general population (geographic control group) each January from 1988 to 1990 (see “Telephone Interviews”). Approximately 450 intervention and 450 control women were randomly sampled and interviewed in each of the 3 years, for a total of 1365 women in the intervention group and 1359 in the control group. Women in the control group were selected by random-digit dialing and were frequency matched to the intervention group on the basis of age and area of residence. Women with a prior history of breast cancer were excluded from the surveys. No women were surveyed in more than 1 year.

Because the intervention was not initiated by the HMO until 1988, the survey data collected during 1988 (the first survey year) reflected women’s mammography experience prior to intervention. Thus, the 1988 data served to assess the baseline comparability of HMO and control women. Data collected during the 1989 and 1990 surveys allowed assessment of the intervention effect, controlling for secular trends. Some women surveyed in 1990 will have been exposed to the intervention for 2 years in a row (1988, 1989), while newer members will have been exposed only once (in 1989). In each of the survey years, about 73% of the sample was interviewed. In no year were there significant differences in response rates between the intervention and control group women.

Telephone Interviews. Evaluation of the intervention effect was based on self-reported mammography experience in response to survey questions. Previous research with this study population has indicated that such self-reports are valid measures of screening (18). Survey data were collected during a brief 10-minute interview administered by professional telephone interviewers. The survey also included questions on women’s sociodemographic characteristics, breast cancer screening practices, knowledge of cancer risks, and attitudes toward cancer and screening. The latter were usually assessed as forced-choice Likert scale variables. Many of the items were developed and used by members of the Breast Cancer Screening Consortium of the National Cancer Institute.

Data Analysis. The objective of the analysis reported here was to determine the effect of the HMO-based interventions (the “exposure”) on mammography. The major dependent variable of interest was whether the woman had obtained a mammogram in the 12 months prior to interview. Thus, the study design is prospective in nature, since sampling was done on the basis of exposure. The proportions of women who obtained mammograms in each group are estimates of the corresponding population rates, so the intervention effect can be estimated by the rate ratio. It is not always appreciated that the odds ratio (commonly derived from logistic regression analyses) may significantly overestimate the rate ratio when the outcome under study is not “rare” (e.g., occurs in at least 10% of the population). In such cases, interpreting the odds ratio as the proportional
change in rate can result in substantial overestimation of the intervention effect. Thus, in this study, the impact of the intervention was first expressed as a rate ratio. The 95% confidence interval for the rate ratio was calculated using a Taylor series approximation (19). Then, logistic regression analysis was used to determine whether the intervention effect was modified by other factors (confounding or interaction).

Because of the many factors influencing adherence to mammography and the nonrandom allocation of subjects to intervention or control groups careful attention to confounding was required. $\chi^2$ contingency table analyses were used to identify variables exhibiting statistically significant univariate associations with both the outcome variable and the intervention. Variables so identified were then tested for multicollinearity, based on the Spearman rank correlation coefficient (20). Among pairs of correlated variables, exclusion of some variables from multivariable analysis was based on validity considerations, with retention of the variable that most meaningfully represented the characteristic of interest (19). Logistic regression models were developed utilizing a backward stepwise approach, deleting variables manually based on the likelihood ratio test and the change in parameters already in the model. All two-way interactions with the study group were evaluated similarly after arriving at a reduced model. Three-way interactions were not routinely tested in the models because such terms are often imprecise and of uncertain clinical significance. Because mammography adherence reported in the first survey year pertained to the period before the intervention program was initiated by the HMO, the analyses were stratified by survey year (1988, 1989, 1990). Confidence intervals were computed using the variance-covariance matrices of the estimated parameters (19).

**Results**

Table 1 presents sociodemographic characteristics of HMO (intervention) and control women. Intervention women were significantly younger than control women, but the differences were small (the mean age was 61.0 for controls and 59.6 for HMO women). The proportion of nonwhites was representative of the general population. Health insurance coverage other than the Health Maintenance Organization of Pennsylvania and New Jersey (including Medicare) differed between the groups, as would be expected, with 18% of controls reporting no health insurance coverage. No consistent differences in sociodemographic variables between intervention and control groups were noted within individual survey years. Furthermore, no differences in cigarette smoking (a possible surrogate for preventive health behaviors) were observed between the groups (data not shown). Thus, HMO women were similar to women in the community.

Table 2 compares the proportion of women who obtained a mammogram within the preceding year in each group for each year of the study. Prior to the intervention (1988), the proportions were similar for HMO (0.41) and control (0.39) women. However, mammography use among HMO women increased dramatically (to 0.62) in 1989. This was the first full year in which the intervention effect would have been expected. Among controls, only a modest increase was observed, to 0.43. In 1990, an additional increase above the secular trend was observed among HMO women. Comparing the proportions in HMO to control women yielded rate ratios of 1.4 in each postintervention year.

Potential confounding variables and their association with the outcome variable (obtaining a mammogram within the previous year) are listed in Table 3 for all three survey years combined (distributions of these variables were similar across all three survey years). Education was not included since it did not differ between HMO and control women (Table 1) and so was unlikely to confound the intervention effect. Age was collapsed to a binary variable, because significant differences in mammog-

![Table 1](attachment:table1.png)

![Table 2](attachment:table2.png)

![Table 3](attachment:table3.png)
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Based on $45,000), it represented the division which included age strata. The income cutpoint ($31,000) was chosen because:

(a) the median income for the Philadelphia area; and

(b) women did not have a regular source of health care. This of only modest clinical significance, but the $P$ values reflect the large sample size. Also, fewer than 10% of women did not have a regular source of health care. This is consistent with other studies of mammography (7). Overall, mammography rates did not differ significantly by race, but race is included in the table (and the regression models that follow) due to the a priori hypothesis of racial differences in mammography.

The variables from Table 3 were tested in a series of hierarchical logistic regression models to examine the effect of confounding factors on the intervention. The analysis was stratified by survey year, dichotomized as 1988 (preintervention) and 1989–1990 (postintervention). The decision to combine 1989 and 1990 was based on the comparability of the (unadjusted) intervention effect in both years (Table 2).

Table 4 shows the most parsimonious models within survey year strata. As expected, there was no significant effect of the intervention in 1988 (prior to implementation of the HMO program). However, in 1989–1990, a significant intervention effect was observed, and interactions were seen with both race and income (Table 4A). Table 4B shows that the effect of the intervention decreased with income and was stronger among white women than black women within each income category. For women with annual incomes less than $31,000, the intervention increased the odds of obtaining a mammogram more than 3-fold for white women, compared to a 50% increase among black women. Among women with incomes of $31,000 or more, the intervention increased the odds of obtaining a mammogram within the year (95% Cl, 2.7, 4.9) OR = 1.5 (95% Cl, 1.9, 2.8) OR = 0.7 (95% Cl, 0.4, 1.3)
odds ratios in Table 4B). White women exhibited rate ratios of 1.9 and 1.2 for incomes of <$31,000 and ≥$31,000, respectively, while among black women the rate ratios were 1.2 and 1.0 for the same income groups. Table 5 also shows that the effect of income was entirely on the controls within both race groups. Mammography rates did not change with income for HMO women but increased with income among control women. Furthermore, the difference between black and white women was strongest for women in the intervention group. Within income strata, no differences in confounding factors were found to explain the different impact of the intervention between blacks and whites. Factors examined included age, income, education, marital status, and concerns related to mammogram cost or radiation.

Discussion

The impact of an HMO-based program to increase rates of mammography was evaluated after 2 years of operation. The intervention was evaluated using a quasiexperimental design, as opposed to a fully randomized design, because the intervention was part of an HMO program aimed at breast cancer screening, rather than a research study. It would be contrary to the philosophy of the HMO and ethically unacceptable to randomize this intervention. Because factors that are strongly associated with mammography usage have been previously identified, imbalances in such factors arising through sampling artifact could be controlled in the analyses.

Because the interventions were delivered only to women in a specific HMO, it is conceivable that mammography utilization may have been influenced by a "preventive orientation" or that health habits of HMO members may have differed from those of women with other health care sources. However, there was no evidence of such differences in this study. The two groups exhibited no important differences in sociodemographic characteristics that might influence mammography or in cigarette smoking (a surrogate for preventive orientation; data not shown). Furthermore, there was no difference in mammography utilization between HMO and control women prior to introduction of the intervention.

A clear increase in mammography use was associated with the intervention; overall rates of having had a mammogram in the past year were 40% higher among intervention women than among a comparable group of geographic controls. This effect was observed against a secular trend of rising mammography utilization in all women. However, the effect of intervention was strongly modified by both income and race. Among women with a household income less than $31,000, the intervention was associated with a 90% increase in utilization of mammography for white women but only a 20% increase among black women. The intervention had little effect on mammography among women with incomes of $31,000 or more: a 20% increase among white women and no effect among black women. The smaller intervention impact among black women was not associated with differences in other measured confounding factors.

The increased adherence to mammography among women in the intervention (HMO) group appears to have been due at least in part to removal of the cost barrier. This is suggested by the fact that mammography rates increased with income among women in the control group but not the intervention group (regardless of race), which attenuated the difference between study groups for higher-income women. However, it is important to note that income was correlated (within strata of race and study group) with factors such as age, education, and marital status, the impact of which on adherence to mammography may be similar to aspects of the interventions. These differences were consistent in each of the three study years and of similar magnitude for HMO and control women (data not shown). Therefore, it is conceivable that the lack of intervention effect in the upper-income group was influenced not only by cost factors but also by greater prior knowledge of screening and its importance and fewer barriers.

In fact, many studies now show that although cost is a barrier for some women, such as minority women, it is not the most important barrier (5, 7–9, 12). In this study, a number of factors support the notion that components of the intervention in addition to free mammograms affected adherence: (a) There was no difference in mammography between HMO and control women prior to introduction of the intervention (1988), although mammograms were free to HMO members at that time. (b) The intervention was still associated with higher adherence among women with incomes of $31,000 or more, although the size of the increase was much smaller and was confined to white women. (c) Even in the control group, most women paid less than $25 for their last mammogram, indicating that for many of them it was a covered benefit. (d) Women who reported that they were extremely concerned over mammography costs were only slightly less likely to obtain mammograms than those reporting no concerns (Table 3). (e) Mammography was more frequent among white HMO members than black members, despite similar income and availability of free mammograms.

It is unclear why the intervention effect was smaller among black women. Table 5 reveals lower rates for blacks in the intervention group but rates among controls that are equal to or greater than those of whites. No other factors explained these differences. It is possible that some of the black-white difference represents chance variation due to the small number of blacks within.

### Table 5  Proportion of women who obtained a mammogram within the year preceding survey, by study group (intervention, control), race, and income (1989-90)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Proportion of women obtaining mammogram</th>
<th>Intervention vs. control rate ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, &lt;$31,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>371</td>
<td>0.68</td>
<td>1.9 (1.6, 2.2)</td>
</tr>
<tr>
<td>Control</td>
<td>345</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>White, ≥$31,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>240</td>
<td>0.68</td>
<td>1.2 (1.0, 1.4)</td>
</tr>
<tr>
<td>Control</td>
<td>272</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Black, &lt;$31,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>69</td>
<td>0.54</td>
<td>1.2 (0.8, 1.7)</td>
</tr>
<tr>
<td>Control</td>
<td>68</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Black, ≥$31,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>17</td>
<td>0.58</td>
<td>1.0 (0.6, 1.6)</td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>0.59</td>
<td></td>
</tr>
</tbody>
</table>
among HMO members within race) suggests chance variation is unlikely to entirely explain the differences. Unmeasured factors related to the intervention should be sought to explain the lower adherence among black HMO members, who are otherwise comparable to whites with respect to known predisposing factors for mammography. Such factors could include proximity to HMO mammography sites or physician communications. With respect to the latter, more white HMO members than black reported a previous physician recommendation for mammography (68% versus 55%); no difference was seen for control women. The identification of factors contributing to lower adherence in black women could permit the development of new interventions tailored to address those specific barriers (the current intervention was not so tailored).

This study demonstrates that mammography utilization can be significantly increased, particularly among women with lower income, through a combined approach to reduce barriers associated with cost, access, knowledge, and psychosocial factors, along with education of both primary care physicians and radiologists. Although caution is required in generalizing these results to non-HMO populations, the lack of apparent differences between the HMO and control women in the study suggests that similar interventions may be widely applicable. Of course, these data are based on respondents to surveys and, hence, are subject to selection bias. However, any program for screening asymptomatic individuals will be similarly dependent on self-selection. Furthermore, the effects of the intervention were measured by self-reported mammography experience. We have previously shown that self-reports accurately describe true mammography utilization among the HMO women (18). Although we were not able to validate self-reports among control women, we have no reason to suspect that errors in reporting were systematically in the direction of underreporting. Thus, although we cannot rule out misclassification among control responses, it is unlikely to have had a major impact on the observed intervention effect.

Because the intervention effect differed by income and race, it is important to determine the relative contributions of different components of the interventions. Such analyses are under way and include cost effectiveness analyses. If factors other than cost have a major impact on mammography utilization, then mortality reduction through early detection will require programs that go beyond expanded insurance coverage for preventive services. Comprehensive programs such as the one described herein are not widespread.

This study also provides an instructive example of the need to interpret the results of logistic regression analyses with caution. It is common (but often incorrect) practice to interpret odds ratios from such analyses as being identical to rate ratios (i.e., the outcome was 3 times more likely in the intervention group). However, when the outcome is not a rare event, the odds ratio may considerably overstate the true increase (or decrease) associated with a factor of interest. The potential for misinterpretation can be easily seen by comparing Tables 4B and 5. When prospective data are available, use of rate ratios within strata of confounding factors (identified by logistic regression) are preferable for interventional purposes.

Acknowledgments
This study could not have been conducted without the continuing support of Dr. Larry Kessler, Robert Young, George Bonney, Ronald Myers, and Eric Ross who helped to improve the manuscript. We are also grateful to Kathy Smith, Terry Torres, and Lucki Andrews for assistance in preparing the manuscript.

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