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An RCT to Increase Breast and Colorectal Cancer Screening

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Abstract

Introduction: Adherence to breast and colorectal cancer screening reduce mortality from these cancers, yet screening rates remain suboptimal. This 2 X 2 RCT compared three theory-based interventions to usual care to simultaneously increase breast and colon cancer screening in women who were non adherent to both at study entry.

Study design: RCT.

Setting/participants: Women (N=692) who were non-adherent to both breast and colon cancer screening and aged 51–75 years were recruited. Enrollment, intervention delivery, and data collection were completed between 2013 and 2017 and data analyzed in 2018.

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Trial registration: This study is registered with the clinical trials identifier NCT03279198 at www.clinicaltrials.gov.

Intervention: The randomized intervention included four groups: three intervention arms (personally tailored messages using a web-based intervention, phone delivery by a trained navigator, or both) compared to usual care. Women at average risk for colon cancer were allowed to select either colonoscopy or stool test as their preferred colon cancer screening. Mammography was promoted for breast cancer screening.

Main outcome measures: Outcome data at 6 months included self-report and medical records for screening activity.

Results: All intervention arms significantly increased receipt of either a mammogram or stool test compared with control (web: $p<0.0249$, phone: $p<0.0001$, web + phone: $p<0.0001$). When considering receipt of both mammogram and stool test, all intervention arms were significantly different from usual care (web: $p<0.0249$, phone: $p<0.0003$, web + phone: $p<0.0001$). Additionally, women who were adherent to mammography had a 4.5 times greater odds of becoming adherent to colonoscopy.

Conclusions: The tailored intervention simultaneously supporting both breast and colon cancer screening significantly improved rates of obtaining one of the screenings and increased receipt of both tests.

INTRODUCTION

Breast cancer (BC) and colorectal cancer (CRC) together account for 22% of all cancer deaths among U.S. women, despite the fact that guideline-based screening could significantly reduce mortality from both cancers.[1] Both BC and CRC screening rates are low among U.S. women, with 64% adherent to BC screening and 62.2% adherent to CRC guidelines.[2] Current recommendations for average-risk women include mammography either annually (screening can start at age 40 years) or biannually (for those aged 55 years and older), and the choice of multiple CRC screening tests (e.g., fecal immunochemical test [FIT] annually or colonoscopy every 10 years) for individuals aged 50–75 years.[1,2]

In the last 2 decades, tailored interventions to increase either BC or CRC screening alone have been tested using a variety of media.[3–10] Most studies have found that tailored messages significantly increased screening and that interventions with several points of contact (e.g., print and telephone) were generally more effective than a single contact.

Although interventions targeting only one screening have dominated the research literature, a few researchers have investigated interventions to simultaneously increase BC and CRC screening. For instance, low-income participants were randomized to mailed letters, automated telephone messaging, mailed stool blood kits, and point-of-care prompts compared to usual care. Both BC screening and CRC screening were increased with the biggest increase realized in CRC screening after mailed receipt of a stool blood kit.[11] A second study randomized primary care patients to either personalized mailed letters, automated telephone calls, or a combination of both that included messages for the needed screening (mammography, CRC screening, or both).

Researchers found a significant intervention effect for combining a personalized letter and automated call compared with an intervention using either alone.[12] Most recently, a

two-group delayed treatment trial randomized 116,407 Medicaid participants who were overdue for one or both screenings to a persuasive messaging letter for either mammography or colonoscopy with telephone support coupled with a $20 incentive if screening was completed. Separate letters were sent as prompts for encouraging mammography or CRC screening depending on need. Both receipt of a mammogram and colonoscopy were significantly higher in the treatment group than control.[13]

Both breast and colon cancer share common risk factors such as age and family history, and not surprisingly, research has demonstrated that screening behaviors for BC and CRC are positively correlated.[14,15] Although some interventions have included both BC and CRC screening messages simultaneously, most have delivered separate messages, not capitalizing on the potential that increasing one screening may enhance the intervention effect on the other. In a combined intervention delivered simultaneously, women from federally qualified health clinics in rural Louisiana who were non-adherent to both breast and colon cancer screening were randomized to enhanced care, health literacy–informed education, or health literacy–informed education with nurse support. The combination of health literacy education and nurse support was more than two times more effective in increasing both screenings than health literacy–informed education only.[16]

The current randomized prospective trial supported by the National Cancer Institute sought to simultaneously increase both BC and CRC screening in women who were non-adherent to both screening behaviors. A 2 X 2 factorial design was used to test tailored content delivered by a web intervention, a phone intervention, or a combination of both the web and phone intervention compared to usual care. Tailored intervention content included messages for perceived and actual risk, knowledge, benefits and barriers to screening, self-efficacy, test preference, and access to obtaining a stool blood test or information promoting scheduling mammography or colonoscopy. If women had a strong family history of CRC, as defined by the American Cancer Society, the intervention focused on colonoscopy as the recommended CRC screening modality.[17,18] Women were identified as higher than average risk if they had one first-degree relative who was diagnosed with colorectal cancer before age 60 years or two first-degree relatives diagnosed after age 60 years. If the woman was at average risk, she was allowed to choose either a stool test or colonoscopy as a preferred screening. Although the desired outcome was receipt of both a mammogram and CRC screening test, obtaining at least one of the tests was also a desirable outcome. Therefore, research questions that guided the study for this dual outcome intervention were:

1. Is there a difference between usual care and the intervention arms (web, phone, or web + phone intervention) on adherence to obtaining either a mammogram or CRC screening, or both a mammogram and CRC (stool test or colonoscopy) screening?
2. Did women who became adherent to mammography by 6 months post-intervention (atTime 3 [T3]) have greater odds of becoming adherent to any CRC screening (stool test or colonoscopy) at T3?

METHODS

This study was a subset analysis of an RCT reported in another manuscript.[19] About half of women accrued to the parent study were adherent to BC screening but not adherent to CRC screening, and half were non-adherent to both CRC and BC screening. This manuscript details the intervention and outcomes delivered to this subset of women non-adherent to both screenings. Figure 1 illustrates the consort diagram for the women who were non-adherent to both CRC and BC screening.

Study Sample

Two healthcare systems that included primary care practices participated. Medical records from each healthcare system identified women non-adherent to both BC and CRC screening. An encrypted file of women identified as non-adherent was sent to a Survey Center supported through Indiana University. The Survey Center sent mailed letters explaining the study with a postage paid opt-out postcard or an 800 opt-out number if they did not want to be contacted. Women who had not opted out by 2 weeks were called by the Survey Center and if they expressed interest, verbal confirmation of breast and colorectal cancer screening status was obtained by trained interviewers. Following verbal consent, women were randomized to one of four groups: (1) usual care, (2) tailored web-based program, (3) tailored phone counseling, or (4) a web-based and phone counseling intervention. Randomization to study arm was performed in a Microsoft SQL database, using SQL random ordering functions without stratification. Women were interviewed at baseline followed by an intervention that simultaneously encouraged being screened for BC and CRC. Women were again interviewed at 4 weeks and 6 months post-intervention. Following verbal consent and baseline interview, a Health Portability and Accountability Form was mailed to enrolled participants to allow investigators to access medical records at 6 months. Participants also had the opportunity to complete the medical records release form online. Medical records were abstracted at 6 months to confirm self-reported screening data. A $20 gift certificate was mailed to participants following each data collection. Women were enrolled, intervention delivered, and all data collected between 2013 and 2017. The study was approved by the IRB at Indiana University and at the health system level. This study is registered with the clinical trials identifier NCT03279198 at www.clinicaltrials.gov.

Women aged 51–75 years who were non-adherent to CRC and BC screening guidelines and had access to the Internet were eligible to participate. Non-adherence was defined by not having: either a fecal occult blood test or a FIT in the last 15 months, sigmoidoscopy >5 years ago, or colonoscopy >10 years ago and a mammogram in the last 15 months. Although guidelines for both mammogram and FIT called for annual testing, a 15-month window for FIT and mammogram allowed a grace period for annual screening before women were considered non-adherent. Women were excluded from the study if they had: a personal history of CRC, colorectal polyps, or inflammatory bowel disease and any medical conditions that would prohibit CRC screening. At baseline, information on family history of CRC and BC was obtained.

Intervention

The tailored messages supporting the interventions were developed based on the Theory of Planned Behavior, Health Belief Model, and Transtheoretical Model, which identified demographic variables, knowledge and beliefs, and past experiences to predict behavior change.[20–25]

The web-based program was built to provide tailored messages based on the individual's knowledge; perceived and actual risk of BC and CRC; and benefits, barriers, and self-efficacy for both BC and CRC screening. The web-based program first queried women about demographics and cancer/screening-related beliefs. After women entered answers to queries, tailored messages were delivered in real time via an algorithm built into the interactive program. Because women were non-adherent to both BC and CRC screenings, intervention messages simultaneously addressed the need to become adherent to both screenings. Women at higher-than-average risk for CRC received an intervention that encouraged colonoscopy for CRC screening, whereas women at average risk could select either stool test or colonoscopy followed by program content consistent with their preferred test. Video clips illustrated the screening procedures of mammography, stool tests, and colonoscopy. Audio dialogue accompanied each question, allowing women with low literacy to use the program. The web-based program had a talk show format. Women who had not completed the intervention by 4 weeks were sent a reminder e-mail.

A single phone-based tailored intervention (average time of 19 minutes) delivered tailored messages consistent with algorithms used in the web-based programing. Participants were asked if they wanted a mailed FIT or scheduling of an appointment. Phone interventionists were trained during a 2-day program with role playing. With the consent of the participant, all telephone interventions were audio recorded for quality control, and the audio tapes were later reviewed for appropriate delivery of content using a fidelity checklist.

The combined intervention prompted women to first complete the web program followed by the phone intervention that was delivered 2–4 weeks later. The average time for delivery of the phone intervention in this arm was similar to the average time used to deliver the phone intervention alone (19 minutes).

Women received usual care from their healthcare providers and depending on the provider may have received a postcard reminder for cancer screenings.

Measures

Demographic variables, family history, and cancer screening history were assessed using standard questions at baseline and at 6 months. Screening beliefs were assessed with scales that have been developed and tested for validity and reliability in past research.[26–28] The belief scales assessed perceived risk, self-efficacy, fatalism, fear, as well as benefits of and barriers to BC and CRC screening. Intent to screen for BC and CRC were assessed by questions used in past research.[29]

The outcomes of interest were defined as either: receipt of either a mammogram or CRC screening (stool test or colonoscopy) or receipt of both a CRC screening test and

mammogram. The outcomes were assessed with a combination of a 6-month self-report and medical records audit (Figure 2). Use of both self-report and medical record data served to decrease potential bias due to missing data in either interview or medical record information. The κ coefficient of chance-corrected agreement between self-report and medical records among those who had both sources of data was 0.71 for mammography, 0.76 for stool test, and 0.85 for colonoscopy. If either self-report or medical records indicated that a screening test was received, the outcome variable was scored as "yes."

Statistical Analysis

Statistical analyses were conducted in 2018. All groups were compared for distributional properties on baseline characteristics using the general linear model omnibus *F*-test for continuous variables and Pearson chi-square test for categorical variables. A binary logistic regression was used for analyses of intervention effect. Demographic and other theoretically based variables were entered as potential confounders of the relationship between the interventions and mammography or CRC screening.[30] Wald chi-square tests, AORs, and 95% CIs were used to test independent variables and covariates in the logistic regression models. Interactions between the intervention and baseline covariates were tested for potential moderating effects. All tests were two-sided, using $\alpha=0.05$, except moderating effects, which were tested using $\alpha=0.01$ because they were considered exploratory. The study was designed to achieve a sample size of ≥100 in each of the three groups at 6 months, considering attrition, to insure ≥80% power to detect 20% differences in 6-month screening between any pair of randomized groups. Table 2 shows the total and group sample sizes unadjusted for covariates. The Table 3 footnote provides analysis sample sizes for models adjusted for covariates which was slightly greater on average than 100 per arm. An intent-to-treat analysis was used (i.e., participants were analyzed according to randomized groups regardless of behavioral dosage of intervention received and the study team attempted to obtain medical record-based screening outcomes for all women including for participants who were missing their follow-up interviews).

RESULTS

A total of 692 women met eligibility, signed a written consent form, and were randomized to one of the four groups (Figure 1). Although groups were randomized, a few baseline characteristics are expected to differ by chance. Randomized groups were significantly different at the 0.05 level for the number the times they saw a healthcare provider in the past year, total number of self-reported health problems, limitation of activities due to depression (yes versus no), and BMI. These were included as covariates along with other theoretically identified variables, all of which are known to be least moderately associated with the screening outcomes (Table 1). Furthermore, estimated SEs were similar for adjusted and unadjusted models, and Hosmer–Lemeshow goodness-of-fit tests were not significant ($\alpha=0.05$) for any models, demonstrating absence of overfitting and model misfit, respectively. The average age for women across intervention groups was 58.7 (SD=6.0) years. More than 28% completed ≥4 years of college, 43% completed some college, and 29% completed high school or less. Most women were Caucasian (85%). Of note, only 26%

were included in the normal BMI category; 27% were considered overweight and 47% were obese.

Research Question 1: Is there a difference, while controlling for baseline characteristics, between usual care and the intervention arms (web, phone, or web + phone intervention) on adherence to obtaining either a mammogram or CRC screening, or both a mammogram and CRC screening? Unadjusted rates are shown in Table 2; results are emphasized while controlling for baseline-imbalanced variables and theoretically potentially confounding covariates. In Table 3, AORs are listed by intervention groups for receipt of either mammogram or stool test or both, and receipt of either mammogram or colonoscopy or both. Tests for receipt of either mammogram or stool test indicated that all intervention arms were significantly more efficacious than usual care: (web: $p<0.0249$, phone: $p<0.0001$, web + phone: $p<0.0001$). Receipt of either mammogram or colonoscopy did not differ by intervention arms and usual care (Table 3).

The second part of Research Question 1 was to determine if intervention groups differed when the outcome was receipt of both BC and CRC screening (either stool test or colonoscopy). When considering the outcome of receiving both mammogram and stool test, all intervention arms were significantly different from usual care: (web: $p<0.0249$, phone: $p=0.0003$, web + phone: $p<0.0001$) (Table 3). When considering both a mammogram and colonoscopy, intervention groups did not differ from usual care. No moderation effect was found for analyses of Research Question 1. A sensitivity analysis was run for participants missing both medical record and interview for T3 screening outcome. When it was assumed missing data be “no” for the screening outcomes, results were similar to findings reported in Table 3.

Research Question 2: Did women who became adherent to mammography by 6 months post-intervention (at T3) have a greater odds of becoming adherent to any CRC screening (stool test or colonoscopy) at T3? A binary logistic regression model was used to test the association between adherence to BC screening and CRC screening, with stool test or colonoscopy as dependent variables. The independent variable of interest was T3 mammography screening, and the baseline characteristics were adjusted for as in the earlier models. There was not a significant interaction between the association of T3 mammography screening, and either T3 stool screening or T3 colonoscopy screening, by randomized groups. Therefore, results are shown for all groups combined (Table 4). Women who became adherent to a mammogram at 6 months post-intervention did not have a greater odds to complete a stool test ($p<0.1574$) but had a 4.5 times greater odds to complete a colonoscopy ($p<0.001$) while controlling for demographic and theoretically important variables.

DISCUSSION

When testing an intervention that was designed to simultaneously increase adherence to both BC and CRC screening, all three intervention arms significantly increased women getting either a mammogram or a stool test and also increased the receipt of obtaining both a mammogram and stool test. However, the intervention arms varied in effectiveness. Women

in the web-only intervention had more than two times greater odds of receiving at least one screening (mammogram or stool test), whereas women in an intervention arm who received a phone call had five to six times greater odds of receiving at least one of the screenings. The obvious efficacy of the phone component in promoting either BC screening or stool testing over usual care, with effect sizes larger than that for web over usual care, was probably influenced by the telephone interventionist offering a mailed stool kit to be returned in a postage-paid envelope. A smaller effect size in the web-only group could be related to intervention uptake, which was less for women in the web-only group (n=81) compared with the phone group (n=26) and phone + web group (n=33). The web intervention required participants to call a toll-free number and actively request a stool test be mailed to their home. By contrast, there was not a significant effect for any intervention when considering uptake of mammography and colonoscopy.

Two issues may be relevant to the significant intervention effect on stool test. First, average-risk women comprised 95% of the sample, and these women were allowed to select either a stool test or colonoscopy to complete CRC screening. Most women (66%) selected stool testing as their preferred screening test. Myers et al.[31] found that those with a personal preference for stool test compared with colonoscopy were more likely to be screened following a personal navigation, which was essentially the active component of this study's phone intervention. Other research has found that directly mailing stool test kits significantly increased CRC screening rates.[32] By contrast, a multimodal intervention in a safety net primary care practice found a significant increase in CRC screening intervention compared with control (37.7% vs 16.7%) when participants were allowed to select type of CRC screening.[33] Therefore, when the preferred CRC screening test was a stool test, interventions significantly increased receipt of either breast or CRC screening compared with controls.

In this study, the overall purpose of developing interventions targeting dual screenings was to simultaneously increase screening for both BC and CRC. The authors did not adjust α for multiple pairwise comparisons between randomized intervention and usual care arms on outcomes because these were pre-planned comparisons; however, this write-up emphasizes that the findings for any CRC screening were largely driven by the stool screening outcome. All intervention arms were significant in increasing the likelihood of a woman receiving both a mammogram and stool test. The intervention arms which included a phone contact had more than twice the effect of the web intervention alone.

It is interesting to note that in all intervention arms, the intervention effect for increasing both mammogram and stool test simultaneously had greater ORs than those associated with increasing only one screening. Women in the web intervention arm had more than five times greater odds of receiving both a mammogram and stool test compared with usual care. Based on these data, the authors are 95% confident that women in the population receiving a phone intervention have at least three times greater odds than usual care and women in the web + phone intervention have at least four times greater odds of receiving both screenings, and that the true population ORs are likely much larger than this (i.e., the best estimates from the data are ORs of 13 and 18). It is noted, however, that their 95% CIs are wide, and therefore the authors emphasize the lower limit of their 95% CI instead of their particular point estimates. In a study in underserved counties in South Carolina,

Davis and colleagues[16] studied the effect of an intervention to simultaneously increase both mammography and stool testing comparing educational materials delivered in clinic with and without adding nurse navigation. All patients received a stool kit at clinic visit. The nurse supported arm showed a significantly greater increase in obtaining both screenings than either of the compared intervention arms, although all groups received a stool kit. As the intervention arms in this study that included personal navigation via phone also included automatic mailing of a stool test, the authors cannot unravel the effect that personal contact had compared to automatic receipt of a stool kit. Their prior analyses demonstrated that significant interventions effects were probably due to mailing a stool kit.[19]

An underlying assumption of this study was that promoting screening simultaneously for BC and CRC would increase the likelihood that both tests would be completed. When considering all groups, this study found that when women received a mammogram, they had 4.5 times greater odds of receiving a colonoscopy but did not have significantly greater odds of receiving a stool test. Perhaps the fact that receiving both a mammogram and colonoscopy required making an appointment outside of the normal healthcare visit accounted for the association between these two behaviors.

To the authors' knowledge, this is the only simultaneous intervention supporting both BC and CRC screening that assessed the intervention effect of obtaining both screenings. The intervention effect for obtaining both screenings was significant only for women who selected a stool test instead of colonoscopy. However, when considering all groups irrespective of intervention, there was not an association between obtaining a mammogram and stool test, whereas there was an association between receiving a mammogram and colonoscopy.

Limitations

Results may not be generalizable to populations outside of a healthcare system. Women enrolled in this study were insured members of two healthcare systems who were non-adherent to both BC and CRC screening and who consented to be in this randomized trial. The majority of participants were Caucasian. Additionally, although all women who were enrolled had access to a web-based program, some women assigned to the computer group may have been more comfortable with technology than others. It is also possible that some women did not have a computer within their home and had to use public facilities such as a library. However, as technology and Internet access increase, problems with access will decrease. With the advent and penetration of smartphones, programs such as the one reported here could be used on personal devices, making interactive programs easier and more compelling to use.

CONCLUSIONS

The tailored intervention simultaneously supporting both BC and CRC screening significantly improved rates of obtaining one of the screenings (either mammogram or stool test) and increased receipt of both tests in women for whom a high percentage (66%) selected stool testing as their screening test of choice for colorectal cancer. A second question sought to determine the association of becoming adherent to CRC screening

if a mammogram was received regardless of intervention effect. A strong association existed between receiving a mammogram and obtaining a colonoscopy, but no association between receiving a mammogram and stool blood test. Intervention arms did not affect this association.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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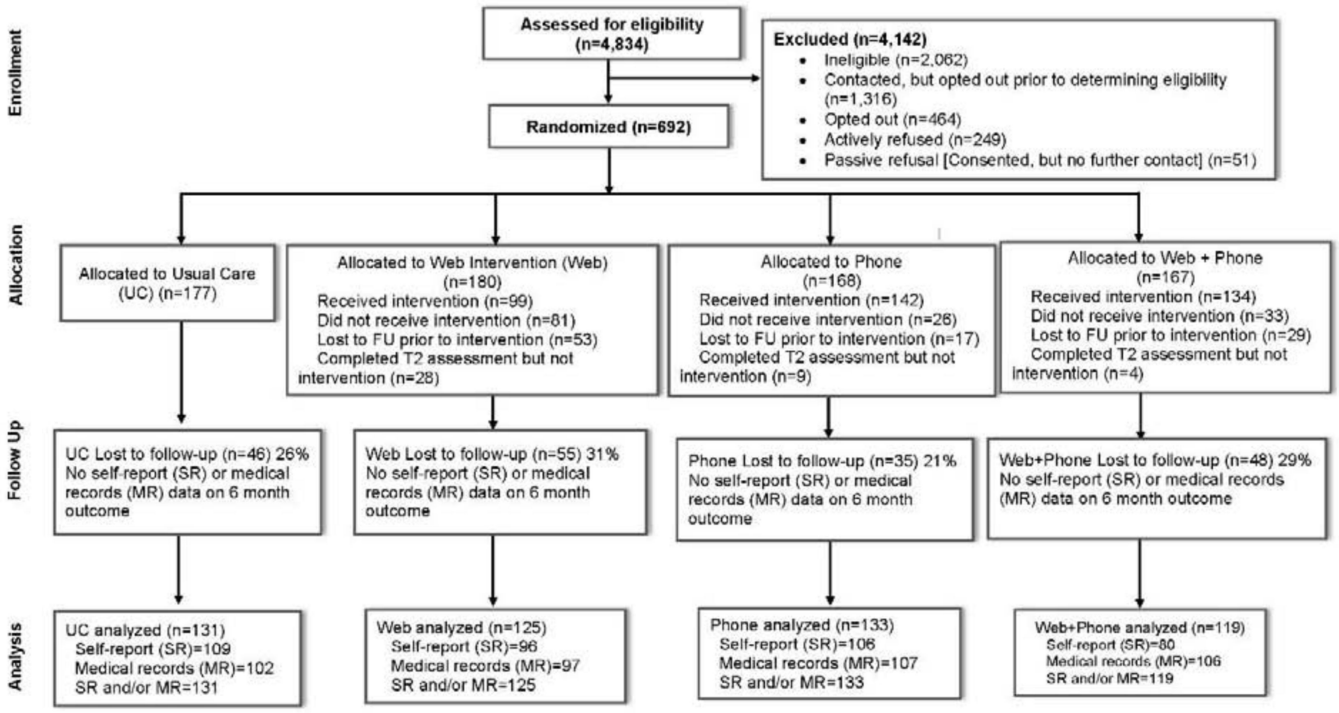

Figure 1.
CONSORT diagram.

Table 1.

Baseline Characteristics by Randomized Group

Baseline characteristics	Total sample (n=692) n (%)	Web (n=180) n (%)	Phone (n=168) n (%)	Web + phone (n=167) n (%)	Usual care (n=177) n (%)	*p*-value
Age, mean (SD)	58.7 (6.0)	59.5 (6.2)	58.6 (6.0)	58.0 (5.8)	58.6 (6.1)	0.1243
Health site						0.6089
Regenstrief	134 (19.4)	31 (17.2)	32(19.1)	38 (22.8)	33 (18.6)	
Community	558 (80.6)	149 (82.8)	136 (80.9)	129 (77.2)	144 (81.4)	
Highest education						0.6182
High school graduate or less	199 (28.8)	51 (28.3)	45 (26.8)	56 (33.5)	47 (26.7)	
Some college	297 (43.0)	83 (46.1)	69 (41.1)	68 (40.7)	77 (43.8)	
4 year college graduate to graduate degree	195 (28.2)	46 (25.6)	54 (32.1)	43 (25.8)	52 (29.6)	
Race						0.1495
Black or African American	78 (11.3)	23 (12.8)	16 (9.5)	22 (13.2)	17 (9.6)	
White or Caucasian	587 (84.8)	153 (85.0)	149 (88.7)	134 (80.2)	151 (85.3)	
Asian, Pacific Islander, or Other	27 (3.9)	4 (2.2)	3 (1.8)	11 (6.6)	9 (5.1)	
Married or living with a partner	384 (55.7)	91 (50.6)	106 (63.1)	91 (54.5)	96 (54.9)	0.1217
Total combined yearly household income before taxes						0.1501
≤$30,000	243 (36.4)	72 (41.6)	51 (30.9)	66 (40.5)	54 (32.3)	
$30,001-$75,000	262 (39.2)	66 (38.2)	75 (45.5)	56 (34.4)	65 (38.9)	
≥$75,001	163 (24.4)	35 (20.2)	39 (23.6)	41 (25.2)	48 (28.7)	
In the past year, how many times have you seen your doctor or other HCP? (not counting dentist or eye doctor)						
≥3 times	293 (42.8)	92 (51.4)	65 (38.7)	71 (42.8)	65 (37.8)	**0.0397**
BMI						**0.0091**
Underweight/Normal	171 (25.8)	37 (21.4)	47 (29.4)	41 (25.6)	46 (27.2)	
Overweight	180 (27.2)	47 (27.2)	47 (29.4)	29 (18.1)	57 (33.7)	
Obese	311 (47.0)	89 (51.5)	66 (41.3)	90 (56.3)	66 (39.1)	
Total number of self-reported health problems, mean (SD)	1.9 (1.8)	2.1 (1.8)	1.7 (1.7)	1.8 (1.6)	1.7 (1.6)	**0.0250**
Does depression limit your activities? (Yes)	61 (9.0)	19 (10.7)	11 (6.8)	24 (14.5)	7 (4.0)	**0.0048**
Perceived age-adjusted risk for breast cancer						0.7415
About the same or not sure	424 (61.4)	109 (60.6)	102 (60.7)	109 (65.7)	104 (58.8)	
Higher risk	54 (7.8)	15 (8.3)	15 (8.9)	8 (4.8)	16 (9.0)	
Lower risk	213 (30.8)	56 (31.1)	51 (30.4)	49 (29.5)	57 (32.2)	
Mammography stage						0.6352
Pre-contemplation	356 (51.5)	90 (50.0)	82 (48.8)	86 (51.5)	98 (55.4)	
Contemplation	336 (48.5)	90 (50.0)	86 (51.2)	81 (48.5)	79 (44.6)	
Has doctor or HCP suggested you get a mammogram? (Yes)	622 (90.5)	158 (88.8)	158 (94.1)	143 (86.7)	163 (92.6)	0.0771
Have any of your close blood relatives (parents, sisters, brothers, children) had breast cancer? (Yes)	120 (17.3)	25 (13.9)	32 (19.1)	36 (21.6)	27 (15.3)	0.2171

Baseline characteristics	Total sample (n=692) n (%)	Web (n=180) n (%)	Phone (n=168) n (%)	Web + phone (n=167) n (%)	Usual care (n=177) n (%)	*p*-value
Have 1 or more close blood relatives (parents, sisters, brothers, children) had colon cancer? (Yes)	79 (11.4)	13 (7.2)	17 (10.1)	21 (12.6)	28 (15.8)	0.0711
Cancer and cancer screening beliefs						
Fatalism	20.9 (7.0)	20.6 (6.4)	21.2 (7.6)	21.2 (7.1)	20.9 (6.9)	0.8944
Fear	22.7 (7.0)	22.7 (7.5)	22.5 (7.5)	23.5 (7.8)	22.2 (7.6)	0.5026
Susceptibility to breast cancer	6.3 (2.3)	6.4 (2.3)	6.1 (2.4)	6.3 (2.4)	6.3 (2.2)	0.5675
Benefits of mammography	13.3 (3.0)	13.7 (2.8)	13.2 (3.1)	13.0 (3.2)	13.3 (2.9)	0.1797
Barriers to mammography	27.6 (7.3)	27.6 (6.7)	27.4 (7.9)	28.2 (7.4)	27.3 (7.0)	0.6518
Self-efficacy for mammography	41.0 (5.6)	40.9 (5.6)	41.6 (5.6)	40.5 (5.3)	40.9 (5.8)	0.3346
Knowledge for mammography	4.9 (1.7)	5.1 (1.7)	4.9 (1.7)	4.6 (1.6)	5.0 (1.7)	0.0689
Mammography outcome indicators						
Has self-report data	404 (58.4)	97 (53.9)	109 (64.9)	86 (51.5)	112 (63.3)	**0.0242**
Has medical record data	412 (59.5)	97 (53.9)	107 (63.7)	106 (63.5)	102 (57.6)	0.1771
Has either self-report or medical record (best estimate)	515 (74.4)	126 (70.0)	133 (79.2)	123 (73.7)	133 (75.1)	0.2685

Note: Boldface indicates statistical significance ($p<0.05$). The *p*-values for continuous variables are from the general linear model omnibus F test, and for categorical variables are from the omnibus Pearson chi-square test.

HCP, healthcare provider; CRC, colorectal cancer.

Table 2.

Unadjusted T3 Screening Outcomes Between Randomized Group (N=507)

Screening outcomes	Web (N=125)		Phone (N=133)		Web + Phone (N=118)		Usual care (N=131)
	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)
Separate screening outcomes							
Stool test	17 (13.6)	3.28 (1.25, 8.61)	53 (39.9)	13.80 (5.70, 33.59)	38 (32.2)	9.89 (4.00, 24.47)	6 (4.6)
Colonoscopy	13 (10.4)	0.78 (0.36, 1.68)	17 (12.8)	0.98 (0.48, 2.02)	15 (13.6)	1.05 (0.51, 2.19)	17 (13.0)
Any CRC screening	29 (23.2)	1.42 (0.77, 2.62)	63 (47.4)	4.23 (2.40, 7.43)	47 (39.8)	3.11 (1.74, 5.56)	23 (17.6)
Mammogram	39 (31.2)	1.40 (0.81, 2.43)	41 (30.8)	1.38 (0.80, 2.37)	34 (28.8)	1.25 (0.71, 2.20)	32 (24.4)
Synergistic screening outcomes							
Mammogram or any CRC	34 (27.2)	1.67 (0.92, 3.05)	60 (45.1)	4.28 (2.40, 7.64)	41 (34.8)	2.62 (1.44, 4.76)	25 (19.1)
Both Mammogram and any CRC	17 (13.6)	1.39 (0.65, 2.98)	22 (16.5)	2.62 (1.25, 5.49)	20 (17.0)	2.13 (1.01, 4.49)	15 (11.5)
Mammogram or stool test	40 (32.0)	1.68 (0.96, 2.94)	58 (43.6)	3.29 (1.90, 5.70)	44 (37.3)	2.37 (1.35, 4.17)	30 (22.9)
Both mammogram and stool test	8 (6.4)	2.52 (0.73, 8.68)	18 (13.5)	7.66 (2.47, 23.75)	14 (11.9)	5.66 (1.78, 17.99)	4 (3.1)
Mammogram or colonoscopy	32 (25.6)	1.33 (0.74, 2.40)	38 (28.6)	1.54 (0.87, 2.74)	28 (23.7)	1.22 (0.67, 2.24)	27 (20.6)
Both mammogram and colonoscopy	10 (8.0)	1.02 (0.41, 2.52)	10 (7.5)	0.99 (0.40, 2.46)	11 (9.3)	1.18 (0.48, 2.86)	11 (8.4)

Note: The authors thank a reviewer for suggesting reporting this table of unadjusted percentages and unadjusted ORs (95% CI) compared to Usual Care. The multivariable *p*-values and AORs (95% CI) are reported in Tables 3 and 4, where results have been adjusted for potentially confounding covariates.

CRC, colorectal cancer.

Table 3.

Models of 6 (T3) Month Outcomes - Either Breast or Colon or Both Breast and Colon

Outcomes and randomized groups	Best-estimate data (medical records and self-report)[a, b]					
	T3 Mammogram or CRC screening			T3 Both mammogram and CRC screening		
	Coeff (SE)	AOR (95% Cl)	*p*-value	Coeff (SE)	AOR (95% Cl)	*p*-value
Mammogram or any CRC or both (N=471)						
Web only	0.77 (0.36)	2.15 (1.07,4.33)	**0.0320**	1.02 (0.48)	2.77 (1.08, 7.11)	**0.0341**
Phone only	1.78 (0.35)	5.92 (2.96, 11.82)	**<0.0001**	1.56 (0.49)	4.77 (1.84, 12.40)	**0.0013**
Web + phone	1.56 (0.37)	4.78 (2.30, 9.94)	**<0.0001**	1.76 (0.50)	5.79 (2.16, 15.51)	**0.0005**
Mammogram or stool or both (N=470)						
Web only	0.76 (0.34)	2.14 (1.10,4.15)	**0.0249**	1.68 (0.75)	5.37 (1.24,23.32)	**0.0249**
Phone only	1.50 (0.34)	4.50 (2.32, 8.75)	**<0.0001**	2.61 (0.71)	13.56 (3.36, 54.75)	**0.0003**
Web + phone	1.44 (0.36)	4.20 (2.07, 8.55)	**<0.0001**	2.88 (0.74)	17.82 (4.22, 75.26)	**<0.0001**
Mammogram or colonoscopy or both (N=474)[c]						
Web only	0.54 (0.34)	1.72 (0.88,3.38)	0.1161	0.20 (0.57)	1.22 (0.40, 3.73)	0.7282
Phone only	0.55 (0.34)	1.73 (0.89,3.37)	0.1047	−0.10(0.60)	0.91 (0.28,2.93)	0.8674
Web + phone	0.38(0.36)	1.47 (0.73,2.96)	0.2874	0.25 (0.57)	1.29 (0.42, 3.94)	0.6566

Note: Boldface indicates statistical significance ($p<0.05$).

[a]Models were adjusted for baseline characteristics including mammography medical record indicator, health site, age, race (African American vs Other), education, income, marital status, BMI, whether depression limits patient's activities (yes/no), family history of 1or more blood relatives with colon cancer (yes/no), family history of 1 or more blood relatives with breast cancer (yes/no), perceivedrisk of breast cancer, doctor recommendation for mammography (yes/no), number of past-year primary care visits excluding eye care and dentistry (≥3), number of self-reported health problems, baseline stage of readiness, and scale scores measuring knowledge, susceptibility, benefits, fear, fatalism, self-efficacy, and barriers. Self-efficacy and barriers that were specific for mammography and CRC screening were used in all models.

[b]Multinomial Logistic Regression Model (reference category = T3 Neither Mammogram nor CRC).

[c]Removed doctor recommendation for mammography (yes/no) and mammography medical record indicator from baseline covariates due to quasi-complete separation if included.

CRC, colorectal cancer.

Table 4.

AORs for Having vs Not Having T3 CRC Screening for Women Who had T3 Mammography Screening[a]

Variable	Obtained T3 mammography		AOR (95% Cl)	*p*-value
	Yes n (column %)	No n (column %)		
T3 stool (Model 1; N=470)			1.52 (0.85,2.73)	0.1574
Yes	44(30.1)	70(19.4)		
No	102 (69.9)	291 (80.6)		
T3 colonoscopy (Model 2; N=471)			4.59(2.24,9.42)	**<0.0001**
Yes	42 (28.8)	22 (6.1)		
No	104(71.2)	340 (93.9)		

Note: Boldface indicates statistical significance ($p<0.05$).

[a]Models were adjusted for baseline characteristics including intervention group, mammography medical record indicator, health site, age, race (African American vs Other), education, income, marital status, BMI, whether depression limits patient's activities (yes/no), family history of 1 or more blood relatives with colon cancer (yes/no), family history of 1 or more blood relatives with breast cancer (yes/no), perceived risk of breast cancer, doctor recommendation for mammography (yes/no), number of past-year primary care visits excluding eye care and dentistry (≥3), number of self-reported health problems, baseline stage of readiness for mammography, and scale scores measuring knowledge, susceptibility, benefits, fear, fatalism, self-efficacy, and barriers. Self-efficacy and barriers that were specific for mammography and CRC screening were used in all models.

CRC, colorectal cancer.