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Cancer Epidemiology, Biomarkers & Prevention

Review

# Do Community Health Worker Interventions Improve Rates of Screening Mammography in the United States? A Systematic Review

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## Abstract

**Background:** Community health workers (CHW) are lay individuals who are trained to serve as liaisons between members of their communities and health care providers and services.

**Methods:** A systematic review was conducted to synthesize evidence from all prospective controlled studies on effectiveness of CHW programs in improving screening mammography rates. Studies reported in English and conducted in the United States were included if they: (i) evaluated a CHW intervention designed to increase screening mammography rates in women 40 years of age or older without a history of breast cancer; (ii) were a randomized controlled trial (RCT), case–controlled study, or quasi-experimental study; and (iii) evaluated a CHW intervention outside of a hospital setting.

**Results:** Participation in a CHW intervention was associated with a statistically significant increase in receipt of screening mammography [risk ratio (RR): 1.06 (favoring intervention); 95% CI: 1.02–1.11, $P = 0.003$]. The effect remained when pooled data from only RCTs were included in meta-analysis (RR: 1.07; 95% CI: 1.03–1.12, $P = 0.0005$) but was not present using pooled data from only quasi-experimental studies (RR: 1.03; 95% CI: 0.89–1.18, $P = 0.71$). In RCTs, participants recruited from medical settings (RR: 1.41; 95% CI: 1.09–1.82, $P = 0.008$), programs conducted in urban settings (RR: 1.23; 95% CI: 1.09, 1.39, $P = 0.001$), and programs where CHWs were matched to intervention participants on race or ethnicity (RR: 1.58, 95% CI: 1.29–1.93, $P = 0.0001$) showed stronger effects on increasing mammography screening rates.

**Conclusions:** CHW interventions are effective for increasing screening mammography in certain settings and populations.

**Impact:** CHW interventions are especially associated with improvements in rate of screening mammography in medical settings, urban settings, and in participants who are racially or ethnically concordant with the CHW. *Cancer Epidemiol Biomarkers Prev; 20(8); 1580–98. ©2011 AACR.*

## Introduction

In 2010, an estimated 207,090 women were diagnosed with breast cancer (BC) in the United States (1). The U.S. Preventive Services Task Force recommends screening mammography every 2 years for women aged 50 to 74 years and recommends screening for women aged 40 to 49 years be based on an individual's risk factors (2). The American Cancer Society recommends yearly mammography beginning at age of 40 (3). Early detection of BC is associated with reductions in mortality and improvements in survival rates (4, 5).

There are significant racial and socioeconomic disparities in BC mortality, survival rates, and cancer stage at diagnosis in the United States (6–10). Women who are less likely to adhere to screening mammography guidelines include those who belong to ethnic or racial minorities; lack comprehensive health insurance or a usual source of medical care; are non-English speakers; are immigrants; live in rural areas; or are socioeconomically disadvantaged (11–19).

One model of BC screening promotion that has been implemented and evaluated frequently is the community health worker (CHW) model. CHWs are lay individuals trained to serve as liaisons between members of their communities and health care providers and services (20). Historically, CHWs serve low-income, medically underserved, racial/ethnic minority, and hard-to-reach populations (21).

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**Note:** This study was presented at the Third AACR Conference on The Science of Cancer Health Disparities in Racial/Ethnic Minorities and the Medically Underserved on October 1, 2010.

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Previous systematic reviews on the effectiveness of CHWs on increasing screening mammography have several limitations. These reviews combined mammography with other health behaviors (22), combined CHW interventions with other mammography-enhancing intervention strategies (23–25), and combined between-group studies (comparing CHW interventions to comparison group) and within-group studies (comparing mammography rates over time in a CHW intervention group; ref. 26), making it difficult to draw conclusions about effectiveness of CHW interventions in improving screening mammography. To conclusively assess effect of CHW interventions in increasing screening mammography rates, we conducted a systematic review. The objective was to synthesize and critically appraise available evidence on effectiveness of CHW interventions in increasing screening mammography rates compared with a control group in any population.

## Materials and Methods

A study protocol was developed clearly outlining *a priori* all stages of the systematic review process.

### Search strategy

We conducted a comprehensive search of CINAHL, Medline, PsychInfo, and Web of Science databases for years 1980 through January 31, 2008. A broad search strategy was used to identify relevant articles and included 21 terms for CHW plus 5 BC terms to capture all studies evaluating CHW interventions to improve mammography screening. These terms included both MeSH terms and other identified key words.

Each search provided citations that were downloaded into an Endnote database (27). After duplicate citations were removed, all titles and abstracts were reviewed by 2 study authors independently for their eligibility for inclusion. If a decision on inclusion was not made on initial review, the full text article was obtained. Reference lists of all eligible articles were also reviewed, and authors of the present article were asked to provide any additional publications not captured by the search.

### Inclusion criteria

Studies published in English and conducted in the United States were eligible for inclusion if they: (i) evaluated a CHW intervention designed to increase screening mammography rates in women 40 years of age or older without a history of BC; (ii) were a randomized controlled trial (RCT), case–controlled study, or quasi-experimental study; and (iii) were studies in which the CHW intervention was delivered outside of a hospital. Studies were limited to those conducted in the United States because of vast differences between health systems in the United States and those in other English-speaking countries. Because CHW interventions are known by many terms, a definition of CHW was created to differentiate CHW studies from other interventions: "any health care worker who is involved with carrying out the intervention but who does not necessarily have formal professional or paraprofessional education." This definition is similar to other definitions in previous reviews evaluating CHW research (22, 28).

### Data abstraction

The primary outcome variable, receipt of mammography, was abstracted from each article as it was reported prior to the CHW intervention (baseline) and following intervention (follow-up) for both participants who received CHW as well as comparison groups. Data were extracted for prespecified sensitivity analyses on sample source (medical or community setting and urban or rural setting), description of intervention, components of intervention, and characteristics of CHWs. The following data were collected to assess methodologic quality of research reported in each publication: generation of randomization sequence, matching of control to intervention participants in quasi-experimental studies, and use of intent-to-treat (ITT) analysis.

Data extraction was conducted by 2 reviewers independently using a standardized data abstraction form. Any disagreements in data abstraction were resolved by consensus in collaboration with a third author. Data were entered into separate SPSS databases (29). Using GraphPad Software (30), Kappa coefficients were calculated to assess agreement between the 2 raters on 6 study variables used in sensitivity analysis. Kappa coefficients calculated for 6 variables indicated agreement ranged from "moderate" (0.410) to "almost perfect agreement" (0.885; ref. 31).

### Statistical analysis

Dichotomous data (i.e., number of participants who did and did not receive screening mammography in both intervention and comparison groups at follow-up) were used to calculate a risk ratio (RR), and summary results (RR) from each study were pooled under a random-effects model. A formal statistical test for heterogeneity using an $I^2$ test was conducted (32). The main study analyses were conducted using Review Manager (32).

Because cluster or group randomized trials (CRT) are frequently used in research on efficacy of CHWs, we explored the impact of various imputed values of intraclass correlation (ICC) on pooled estimates. ICC is the "similarity" of individuals within clusters, such as clinics or communities. A CONSORT guideline pertaining to CRTs explicitly recommends statistical adjustments for cluster randomization be used in power calculations and analysis of primary outcomes, with reporting of ICC (33). Not accounting for clustering in analysis of CRTs creates a "unit of analysis error" when CRTs are combined with trials that randomized individuals in a meta-analysis. Correcting for clustering inflates variance of point estimates (RRs or ORs) in individual CRTs, giving less weight to these studies in random-effects meta-analysis.

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A recent meta-analysis of enhanced care for depression concluded that CRTs produced similar results to individually randomized trials. However, the analysis was based on relatively small values of ICC (ICC = 0.02 and 0.05; ref. 34). In contrast, a recent study reported ICC estimates in screening mammography CRTs to be as high as 0.2166 (35). A lack of adjustment for clustering tends to inflate treatment effects (36). We also explored the effect of cluster imbalance on pooled results.

To conduct these analyses, similarities between individuals within a cluster are measured by ICC. Given the average cluster size $m$, the design effect (DE), defined by DE $= 1 + (m - 1)$ ICC, measures effect on variance of an estimate of treatment effect attributed to clustering. The ICC-adjusted random-effects meta-analysis was conducted in the Bayesian setting due to ease of adjusting ICCs for an empirical prior distribution. Using Winbugs version 1.4.1. (37, 38), adjustment of cluster size imbalance was applied to DE minimum variance weights corrected estimates, based on the Pareto principle in which 80% of participants belong to 20% of clusters (39). For each outcome, 5,000 burn-in simulations were used, with the additional 45,000 simulations to obtain OR estimates. A flat uniform distribution on 0 to 1 range has been recommended for priors of ICCs in case of absence of prior knowledge (40). However, on the basis of a recent study of ICC estimates for cancer screening outcomes (35), unadjusted ICC estimates for mammography screening rates ranged from 0.0009 to 0.2166, so we adopted a conservative but informative empirical uniform prior on (0, 0.5), for imputed values of ICC

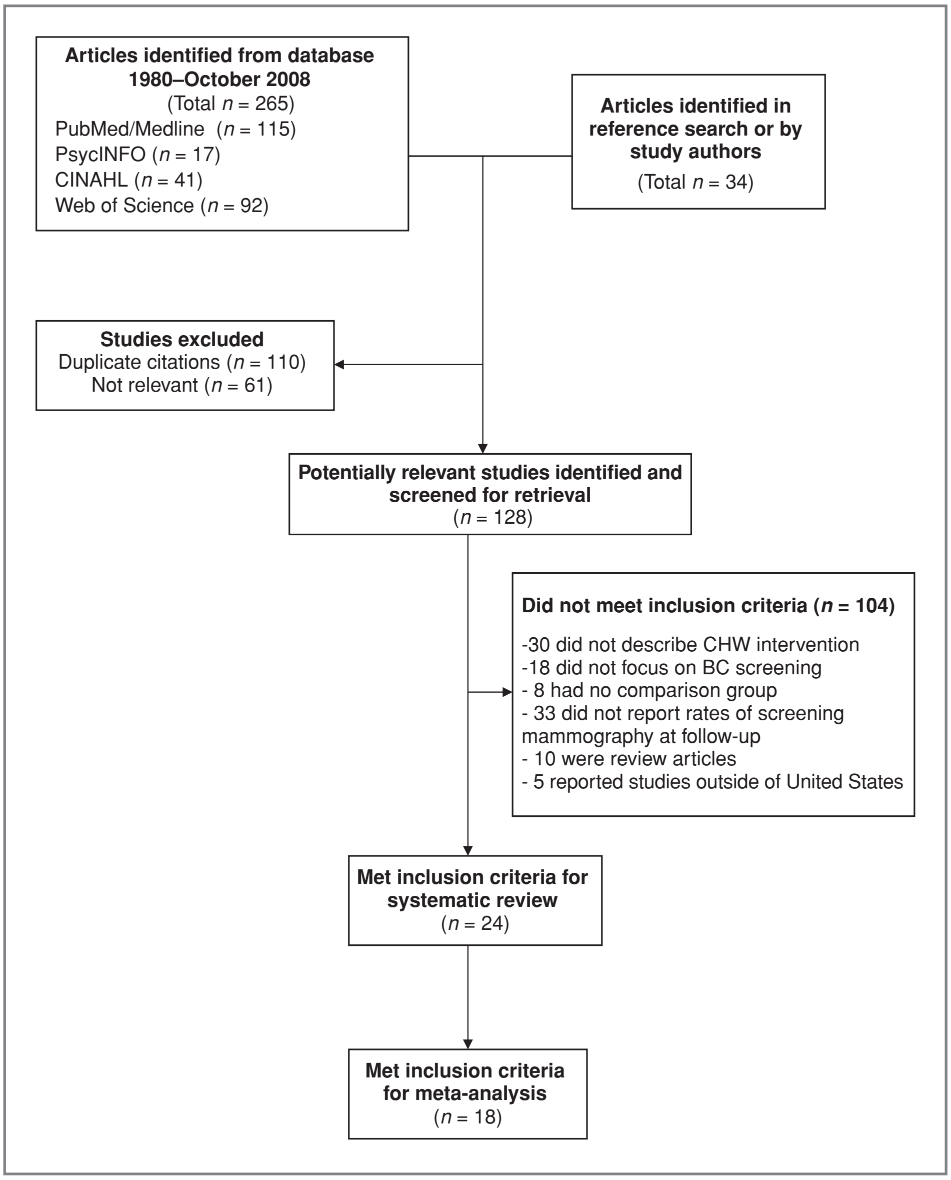


**Figure 1.** Flow diagram of literature review process for identifying studies evaluating use of community health workers to improve screening mammography rates.

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**Table 1.** Summary of community health worker interventions for BC screening by target group

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| **African American** | | | | | |
| Earp (46) | Rural, African American women 50+ years | 170 volunteer lay health advisors<br>4 paid community outreach specialists (indigenous community leaders) | 3–5 sessions, 10–12 hours instruction; role playing, BC, and screening practices. | 2 community outreach activities per month<br>Lay health advisors conducted 2 weekly individual sessions | UC in comparison counties |
| Erwin (47) | Rural, African American women, Mississippi River Delta, AR | 7 African American BC survivors | Training provided; interviewing strategies, breast health education | Church-based group about early detection and screening<br>Free mammogram vouchers | UC in comparison counties |
| Paskett (55) | Predominately African-American women 40+ years, low-income housing, Winston–Salem, NC (intervention) and Greensboro, NC (control) | ND | ND | Educational sessions by lay health educators<br>Church program conducted by lay health educator | UC in comparison city |
| Sung (60) | Low-income, inner city African American women | Lay health workers recruited from National Black Women's Health Project | 10 weeks; interviewing and health education | Two home visits, 1 booster session.<br>Education about breast and cervical cancer, Pap test and breast exam video<br>Reproductive health education | Cancer screening educational materials |
| West (63) | Rural, low-income African American women 50–80 | Indigenous African American female health care workers. | Training provided; semi-structured interview's content, counseling style | Personalized reminder letters followed by intensive phone counseling<br>Phone call included semi-structured interview eliciting barriers, facilitators to mammography<br>Problem solving to overcome barriers<br>Provided phone numbers for scheduling mammography | Eligible for a no-cost mammogram; tailored letter describing risk for BC |

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**Table 1.** Summary of community health worker interventions for BC screening by target group (Cont'd)

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| Zhu (64) | Single African American women 65+, living in public housing | African American women from same housing complex | Four 3-hour sessions; BC, screening practices, possible barriers | Home-based BC screening education<br>Taught participants to overcome barriers<br>Brochures | Public housing complexes, no intervention |
| **Hispanic/Latina** | | | | | |
| Fernandez (48) | Hispanic farm workers | Lay health workers | Lay health workers given training curriculum including teaching guide (12 lessons) | Individual and group intervention sessions with lay health worker<br>Education sessions included videos, flip charts, discussions of breast and cervical screening | Comparison clinics, no intervention |
| Navarro (53) | Low-income Latinas, San Diego, CA | 36 *consejeras* | Training provided; conducting small group sessions on health topics | 12-week, 90-minute group session program<br>*Consejeras* taught cancer prevention with culturally-appropriate materials. | 12-week Community Living Skills program |
| Navarro (54) | Latinas, San Diego, CA | 36 *consejeras* | Training provided; following *consejera* manual to conduct weekly educational group sessions | 12-week group sessions on breast and cervical cancer early detection | 12-week Community Living Skills program |
| Navarro (51) | Latinas, San Diego, CA | 36 *consejeras* | Training provided; conducting small group sessions on breast and cervical cancer screening | 12-week group cancer screening intervention following educational materials | 12-week Community Living Skills program |
| Navarro (52) | Low-income, low acculturated Latinas, San Diego, CA | 17 *consejeras* | Five 2-hour sessions; 14 program sessions, recruitment strategies, role playing to lead sessions | Twelve 90-minute weekly group sessions and 2 monthly sessions focusing on breast and cervical cancer | Friends and/or family (learning partners) who received information from class participants |
| Sauaia (57) | Latinas, CO | "Peer counselors," 4 Catholic churches, Denver, CO (Promotoras) | Training provided | Bimonthly meetings after mass and other church events | 209 Catholic churches sent: |

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**Table 1.** Summary of community health worker interventions for BC screening by target group (Cont'd)

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| | | | | Respected leader delivered homilies addressing breast health at least twice at each church<br>1–3 home-based health groups per church<br>Newsletter | Letter describing project<br>Bilingual printed materials<br>display unit<br>short messages for delivery at pulpit and church bulletin |
| Suarez (59) | Low-income Mexican American women 40+, Texas | Mexican-American volunteers, Spanish speakers | ND | Verbal and newsletter cancer-screening education | Comparison community, no intervention |
| Welsh (62) | Latinas, CO | "Peer counselors", 4 Catholic churches, Denver, CO | Training provided; standardized curriculum | Monthly visits to each church<br>*Promotoras* approached peers after Sunday masses and during church fairs, other church related activities<br>*Promotoras* facilitated home-based *platicas* (health groups) about breast health | 209 churches mailed:<br>introductory letter<br>NCI BC screening educational materials<br>display unit<br>messages to be delivered at pulpit or church bulletins |
| **Asian American/ Pacific Islander** | | | | | |
| Bird (43) | Vietnamese-American women 18+, California | 16 indigenous lay health worker neighborhood leaders<br>68 neighborhood assistants | Training provided; delivery of prevention education<br>Provided training manual | Small-group home-based educational sessions<br>Focused on general prevention, routine checkups, breast and cervical cancer screening<br>Flip chart and facilitated discussion | Comparison city, no intervention |
| Gotay (49) | Native Hawaiian women, 18+, Oahu, HI | Native-Hawaiian lay health educators | Training provided; breast, cervical cancer screening. | Small-group, traditional Hawaiian "talk-story" methods | Comparison area, no intervention |

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**Table 1.** Summary of community health worker interventions for BC screening by target group (Cont'd)

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| | | | | Free mammogram and Pap test vouchers<br>Audiovisual aids used | |
| **Other Populations** | | | | | |
| Allen (41) | Women who work in sites with Service Employees International Union representation | 80 female employee peer health advisors | 16 hours; cancer screening guidelines, epidemiology, early detection methods, community resources | 16-month program, 6 small group discussions, role modeling individual outreach, counseling, social support focused on screening.<br>2 worksite-wide campaigns | Workshop at study conclusion |
| Andersen (42) | Women 50–80, rural Washington | Women from participating communities | Training provided | Telephone intervention using barrier-specific counseling to promote mammography<br>Brochures | Control communities, no intervention |
| Calle (44) | African American and White women 40+ | 80 ACS volunteer peer educators, Jacksonville, Orlando, FL | Half-day; mammography and mammography facilities, breast health guidelines, intervention process, intervention practice sessions, BC fact sheet, resource guide for mammography centers | Phone intervention emphasized importance of regular mammograms<br>Set and confirmed date appointment would be scheduled and completed. | No intervention |
| Duan (45) | African-American, Latina, and White women 50–80, churches in Los Angeles County, CA | Part-time peer counselors | ND | Peer counselors provided telephone barrier-focused mammography counseling annually for 2 years<br>Women provided information about risk status, BC prevalence rates, encouraged to ask physician for referral | Churches, no intervention |

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**Table 1.** Summary of community health worker interventions for BC screening by target group (Cont'd)

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| Margolis (50) | African American, Native American, and White women 40+, non–primary-care outpatient clinics | Low-income, lay female senior aides (lay health advisors) | One month; peer education techniques, breast health, communication skills, cultural diversity, principles of randomization, adherence to research protocol | Appointments scheduled with female nurse practitioner for those due for screening<br>Women who declined screening encouraged to follow up with health care provider<br>Women who were up-to-date were encouraged to get regular screening and offered mailed reminder | UC |
| Paskett (56) | African-American, Native American, and White women from rural areas and low-income background. | 2 Native American and African American lay health advisors | 1 week plus follow-up sessions; breast health, practice on breast models, resource manual, practice intervention sessions | 3 in-person individual visits, follow-up phone calls, mailings over 9–12 months.<br>Educational materials about cancer risk, overcoming barriers to mammography<br>Discussion of mammography, BC, breast self-exam, scheduling mammography<br>2 postcard mailings addressing women's readiness to change | Letter and NCI brochure about cervical cancer screening; after follow up, letter and NCI brochure about mammography |
| Slater (58) | Low-income women, public housing | ACS and resident volunteers | Training provided; volunteers provided intervention scripts and protocols. | 60 minute "Friend to Friend" program with health professional speaker, small group discussions, assistance in obtaining mammogram, mammogram reminder<br>Free mammograms<br>Assistance with appointment scheduling<br>Free transportation | Delayed intervention |

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**Table 1.** Summary of community health worker interventions for BC screening by target group (Cont'd)

| First author (ref.) | Target population | CHW number and characteristics | Length; type of training | Intervention description | Control description |
|---|---|---|---|---|---|
| Weber (61) | African-American, Latina, and White low-income, urban women 52–77, 6 primary care facilities Rochester, NY | 6 women from local community (4 African American, 1 Hispanic, 1 White) | ND | 1 personalized mammography reminder letter from physician<br>1 low literacy mammography reminder letter from community health educator<br>Patient education and reminders<br>Identification and removal of barriers | 1 personalized mammography reminder letter from physician plus usual care |

Abbreviations: ND, not described; UC, usual care.

(ICC = 0.05, 0.1, 0.2). The pooled results are reported as ORs with corresponding 95% credibility intervals.

## Results

### Study identification

The initial database search yielded 265 articles (Fig. 1), of which 24 met inclusion criteria (41–64). Of the 24 articles included in the systematic review (Table 1), 18 (75%; refs. 41–47, 50, 52, 55–63) had extractable data. Three articles (41, 42, 62) provided data enabling calculation of multiple effect sizes. One study provided data on multiple interventions (42), one study reported results in 2 different strata based on age (41), and one study reported results separately by race and ethnicity (62). Of the 24 included studies (Table 1), 14 were (58%) RCTs (41, 42, 44, 45, 50, 51, 53, 54, 56, 58, 60, 61, 63, 64) and 10 were quasi-experimental studies (43, 46–49, 52, 55, 57, 59, 62).

### Outcomes of CHW intervention on receipt of screening mammography

***All trials.*** Most studies (75%) collected data on screening mammography use via self-report interviews or surveys (41–47, 49, 51–55, 58–60, 63, 64). Other studies collected mammography data through chart reviews (56, 61), health insurance claims data (57, 62), or through a combination of self-report and chart reviews (50). The most common time frame in which screening mammography was collected was 1 year (45, 49–51, 54–56, 64) and 2 years (41, 46, 49, 50, 55, 57, 59, 61, 62, 64), with 2 studies reporting time frames in between 1 and 2 years (43, 58). Several studies evaluated the CHW intervention's effect on lifetime receipt of screening mammography (43, 47, 49, 52, 53).

Of 18 studies with sufficient data to evaluate receipt of screening mammography in the meta-analysis, 10 (56%) were RCTs (41, 42, 44, 45, 50, 56, 58, 60, 61, 63) and 8 were quasi-experimental (43, 46, 47, 52, 55, 57, 59, 62). The pooled RR of obtaining screening mammography based on 28,836 mammography events (9,342 intervention; 19,494 control) was 1.06 (95% CI: 1.02–1.11, $P = 0.003$), indicating a statistically significant effect of CHW interventions on improving rate of screening mammography (Fig. 2). However, there was a statistically significant heterogeneity among included studies ($I^2 = 80\%$; $P < 0.00001$).

***Quasi-experimental studies.*** The pooled RR of obtaining screening mammography based on 14,677 mammography events (2,235 intervention; 12,442 control) in 8 quasi-experimental studies (9 comparisons; refs. 43, 46, 47, 52, 55, 57, 59, 62) was 1.03 (95% CI: 0.89–1.18, $P = 0.71$; Fig. 2), indicating no effect of CHW interventions on rate of screening mammography. There was a statistically significant heterogeneity among included studies ($I^2 = 84\%$; $P < 0.00001$).

***RCT.*** The pooled RR of obtaining screening mammography based on 14,159 mammography events (7,107 intervention; 7,052 control) in 10 RCTs (14 comparisons;

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| Study or subgroup | Intervention Events | Intervention Total | Control Events | Control Total | RR IV, Random, 95% CI |
|---|---|---|---|---|---|
| **RCTs** | | | | | |
| Allen, 2001 a | 709 | 817 | 628 | 731 | 1.01 (0.97–1.05) |
| Allen, 2001 b | 532 | 573 | 519 | 560 | 1.00 (0.97–1.03) |
| Andersen, 2000 a | 786 | 856 | 799 | 867 | 1.00 (0.97–1.02) |
| Andersen, 2000 b | 813 | 855 | 799 | 867 | 1.03 (1.01–1.06) |
| Andersen, 2000 c | 470 | 776 | 462 | 800 | 1.05 (0.97–1.14) |
| Andersen, 2000 d | 446 | 745 | 462 | 800 | 1.04 (0.95–1.13) |
| Calle, 1994 | 142 | 289 | 104 | 305 | 1.44 (1.19–1.75) |
| Duan, 2000 | 321 | 416 | 285 | 397 | 1.07 (0.99–1.17) |
| Margolis, 1998 | 535 | 772 | 447 | 711 | 1.10 (1.02–1.19) |
| Paskett, 2006 | 184 | 433 | 114 | 418 | 1.56 (1.29–1.89) |
| Slater, 1998 | 94 | 151 | 85 | 163 | 1.19 (0.98–1.45) |
| Sung, 1997 | 71 | 163 | 54 | 158 | 1.27 (0.97–1.68) |
| Weber, 1997 | 41 | 142 | 17 | 157 | 2.67 (1.59–4.48) |
| West, 2004 | 18 | 119 | 15 | 118 | 1.19 (0.63–2.25) |
| **Subtotal (95% CI)** | | **7,107** | | **7,052** | **1.07 (1.03–1.12)** |
| Total events | 5,162 | | 4,790 | | |
| Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 60.35$, df = 13 ($P < 0.00001$); $I^2 = 78\%$ | | | | | |
| Test for overall effect: $Z = 3.49$ ($P = 0.0005$) | | | | | |
| **Quasi-experimantal studies** | | | | | |
| Bird, 1998 | 108 | 197 | 54 | 193 | 1.96 (1.51–2.54) |
| Earp, 2002 | 224 | 387 | 274 | 409 | 0.86 (0.77–0.96) |
| Erwin, 1999 | 98 | 152 | 89 | 140 | 1.01 (0.85–1.20) |
| Navarro, 2007 | 56 | 80 | 43 | 63 | 1.03 (0.82–1.28) |
| Paskett, 1999 | 94 | 168 | 54 | 134 | 1.39 (1.09–1.78) |
| Sauaia, 2007 | 359 | 590 | 3,338 | 5,708 | 1.04 (0.97–1.11) |
| Suarez, 1997 | 171 | 450 | 205 | 473 | 0.88 (0.75–1.03) |
| Welsh, 2005 a | 25 | 84 | 574 | 1,323 | 0.69 (0.49–0.96) |
| Welsh, 2005 b | 48 | 127 | 1,756 | 3,999 | 0.86 (0.69–1.08) |
| **Subtotal (95% CI)** | | **2,235** | | **12,442** | **1.03 (0.89–1.18)** |
| Total events | 1,183 | | 6,387 | | |
| Heterogeneity: $\tau^2 = 0.03$; $\chi^2 = 50.24$, df = 8 ($P < 0.00001$); $I^2 = 84\%$ | | | | | |
| Test for overall effect: $Z = 0.37$ ($P = 0.71$) | | | | | |
| **Total (95% CI)** | | **9,342** | | **19,494** | **1.06 (1.02–1.11)** |
| Total events | 6,345 | | 11,177 | | |
| Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 111.43$, df = 22 ($P < 0.00001$); $I^2 = 80\%$ | | | | | |
| Test for overall effect: $Z = 2.98$ ($P = 0.003$) | | | | | |

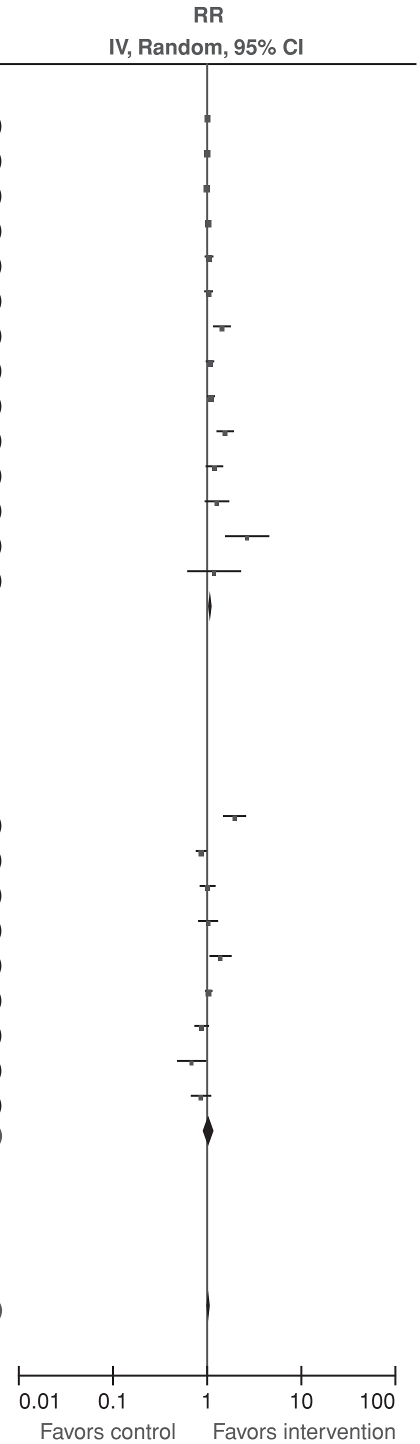


Figure 2. Forest plot of comparison: intervention versus no intervention, outcome: receipt of mammography.

refs. 41, 42, 44, 45, 50, 56, 58, 60, 61, 63) was 1.07 (95% CI: 1.03–1.12, $P = 0.0005$; Fig. 2) indicating a statistically significant effect of CHW interventions on improving rate of screening mammography. There was a statistically significant heterogeneity among included trials ($I^2 = 78\%$; $P < 0.00001$).

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**Sensitivity analyses**

To assess robustness of our findings and account for observed heterogeneity among included studies, we conducted additional analyses. Results from quasi-experimental studies varied both in magnitude and direction of effect. Therefore, quasi-experimental studies were excluded from further sensitivity analysis. Sensitivity analysis focused on the following factors that may be associated with success of CHW interventions in the 10 RCTs: methodologic quality (cluster vs. individual randomization, ITT analysis), choice of control intervention, method of measuring study outcome (self-report vs. chart review), setting of participant recruitment (medical vs. community and rural vs. urban), number of CHW intervention components, and characteristics of CHWs.

***Methodologic quality.*** A critical appraisal of methodologic quality of all studies was conducted, including information about study design and analyses (Table 2).

*Unit of randomization.* Six RCTs (60%) randomized individual participants to either CHW intervention or comparison group (44, 50, 56, 60, 61, 63), whereas in the other 4, unit of randomization was a cluster or group to which participants belonged, such as a work site or church (41, 42, 45, 58). None of the CRTs reported power calculations or whether they were adjusted for clustering effects. Three trials (41, 42, 45) incorporated clustering effects in the main statistical analysis but did not report estimated ICC values. The fourth trial (58) reported the value of ICC ($-0.0015$), which was appropriately assumed to indicate no design effect for the primary outcome measure, and data were analyzed at individual rather than cluster level.

In RCTs that randomized individual participants, CHW intervention was associated with a statistically significant increase in screening mammography (RR: 1.39; 95% CI: 1.13–1.70, $P = 0.002$). In RCTs that randomized groups to treatment condition, CHW interventions were not associated with increases in screening mammography (RR: 1.02; 95% CI: 1.00–1.04, $P = 0.05$). There was statistically significant heterogeneity among included trials that used individuals as unit of randomization ($I^2 = 80\%$; $P = 0.0002$). RCTs that used groups as unit of randomization did not show heterogeneity ($I^2 = 27\%$; $P = 0.22$). Compared with unadjusted estimates, OR estimates adjusted for ICC and imbalance were statistically significant, indicating that CHWs improve rates of screening mammography. However, adjusted ORs were closer to the point of no effect (Fig. 3).

*ITT analysis.* Pooled data from 3 RCTs which conducted ITT analysis (50, 61, 63) indicate that a CHW intervention was not associated with increases in screening mammography (RR: 1.48; 95% CI: 0.85–2.59, $P = 0.17$). In 7 studies (11 comparisons) that did not conduct ITT analysis (41, 42, 44, 45, 56, 58, 60), a CHW intervention was associated with increases in screening mammography (RR: 1.06; 95% CI: 1.02–1.10, $P = 0.004$). Both studies that conducted ITT analysis ($I^2 = 82\%$; $P = 0.004$) and studies that did not conduct ITT analysis ($I^2 = 77\%$; $P < 0.00001$) showed significant heterogeneity.

***Choice of control intervention.*** RCTs comparing CHW interventions to routine care (7 trials involving 11 comparisons due to multiple intervention groups or different comparisons by age; refs. 41, 42, 44, 45, 50, 58, 60) were associated with a statistically significant increase in screening mammography (RR: 1.04; 95% CI: 1.01–1.07, $P = 0.007$). The only RCT employing health education as control (56) compared with CHW also showed a statistically significant benefit with use of a CHW intervention (RR: 1.56; 95% CI: 1.29–1.89; $P < 0.00001$). The pooled RR from 2 RCTs that used mammography reminders as control (61, 63) showed a statistically nonsignificant difference compared with CHW (RR: 1.82; 95% CI: 0.83–4.01, $P = 0.14$). However, there was statistically significant heterogeneity among included trials that used routine care ($I^2 = 65\%$; $P = 0.002$) or mammography reminders ($I^2 = 73\%$; $P = 0.05$) as control.

***Method of measuring study outcome.*** There was significant variation in measurement of study outcome, receipt of mammography, which limited sensitivity analyses that could be conducted on length of time in which mammography was measured (Table 2). The interval of measurement reported in the RCTs ranged from receipt of mammography in the past 6 months to receipt of mammography in the past 3 years. Seven of 10 RCTs measured screening mammography outcome using participant self-report (41, 42, 44, 45, 58, 60, 63). Two studies measured screening mammography with chart review (56, 61) and one combined self-report and a review of patients' medical records (50). CHW interventions were effective at increasing screening mammography when mammography was measured by chart review alone (RR: 1.93; 95% CI: 1.15–3.23, $P = 0.01$) or by chart review plus self-report (RR: 1.10; 95% CI: 1.02–1.19, $P = 0.009$). The pooled RR for the 7 RCTs (11 comparisons) which measured mammography using self-report indicated that CHW interventions were not associated with increases in screening mammography (RR: 1.03; 95% CI: 1.00–1.06, $P = 0.02$). There was statistically significant heterogeneity among included trials that used chart review alone ($I^2 = 73\%$; $P = 0.06$) and self-report alone ($I^2 = 59\%$; $P = 0.007$) to measure the mammography outcome.

***Study setting.*** *Medical versus community setting.* Five studies recruited participants from a medical setting (50, 56, 60, 61, 63) and 4 (7 comparisons) recruited participants from a community setting (e.g., church, neighborhood; refs. 42, 44, 45, 58). In one study, participants were recruited from a work setting (41) which was not coded as either a community or medical setting and was therefore excluded from sensitivity analysis. CHWs were effective in increasing rates of screening mammography in RCTs recruiting participants from a medical setting (RR: 1.41; 95% CI: 1.09–1.82, $P = 0.008$) or community setting (RR: 1.05; 95% CI: 1.01–1.10, $P = 0.02$). There was a statistically significant heterogeneity among included

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**Table 2.** Randomized controlled trial characteristics and study quality

| First author (ref.) | Number of participants, baseline | Mean age CHW intervention participants, y | Mean age control participants, y | Length of intervention, mo | Time from baseline to follow-up, mo | Generation of randomization sequence | Power analysis | Described drop outs | Participants selected because of lack of adherence | Definition and measurement of mammography outcome | ITT analysis conducted |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Allen (41) | 2,943 | ND | ND | 16 | 30 | Work sites blocked on size of worksite and type of agency to create 4 blocks. Within each block random-number generator assigned work sites to each condition. | ND | Yes | No | Past 12–24 mo; self-report | No |
| Anderson (42) | 8,907 | ND | ND | 24 | 36 | 40 communities assigned to 10 blocks of 4 communities for block randomization. Each community within one of ten blocks randomly assigned to a study arm using one of 24 permutation patterns of 4 for each block. | ND | Yes | No | Within 24 mo of follow up interview; self-report | No |
| Calle (44) | 738 | ND | ND | 6 | 8 | American Cancer Society volunteers each generated list of 10 women. Lists collected and women randomized to either intervention or control groups. | ND | Yes | No | Because start of intervention; self-report | No |

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**Table 2.** Randomized controlled trial characteristics and study quality (Cont'd)

| First author (ref.) | Number of participants, baseline | Mean age CHW intervention participants, y | Mean age control participants, y | Length of intervention, mo | Time from baseline to follow-up, mo | Generation of randomization sequence | Power analysis | Described drop outs | Participants selected because of lack of adherence | Definition and measurement of mammography outcome | ITT analysis conducted |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Duan (45) | 1,113 | ND | ND | 24 | 12 | 30 churches matched to 12 blocks and randomized half the churches in each block to peer counseling and other half to control. Matching variables included race/ethnicity, membership size, resources, and denomination. | ND | Yes | No | Past 12 mo; self-report | No |
| Margolis (50) | 1,658 | 54.5 | 55.9 | 1 day plus mailed reminders | 12+ | Patients assigned to intervention or usual care according to whether medical record number was odd or even | ND | Yes | No | 12 or 24 mo (depending on age); self-report plus chart review | Yes |
| Paskett (56) | 897 | 54.5 | 55.7 | 12–14 | 12–14 | Stratified selection, blocked randomization by race and clinic, conducted by study statistician | Yes | Yes | Yes | Past 12 months; chart review | No |
| Slater (58) | 427 | 68.9 | 67.4 | 24 | 12 | 41 public housing high rise buildings randomized to treatment or control groups. Buildings stratified based on number of women per building who were 40 years and older. | ND | Yes | No | Within 15 mo of intervention; self-report | No |

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**Table 2.** Randomized controlled trial characteristics and study quality (Cont'd)

| First author (ref.) | Number of participants, baseline | Mean age CHW intervention participants, y | Mean age control participants, y | Length of intervention, mo | Time from baseline to follow-up, mo | Generation of randomization sequence | Power analysis | Described drop outs | Participants selected because of lack of adherence | Definition and measurement of mammography outcome | ITT analysis conducted |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sung (60) | 321 | ND | ND | 11 | 17 | Participants randomly assigned to intervention or control groups | ND | Yes | No | Depended on age (within 4 y if 35–39; within 3 y if 40–49; yearly if older than 49); self-report | No |
| Weber (61) | 376 | 63 | 63 | 4 | 7 | Patients randomized to one of two groups. Randomization stratified by practice site | Yes | Yes | Yes | During intervention period; chart review | Yes |
| West (63) | 320 | ND | ND | 1 day | 6 | Envelope containing randomization group opened by CHW after completing telephone interview | ND | Yes | Yes | Past 6 mo; self-report | Yes |

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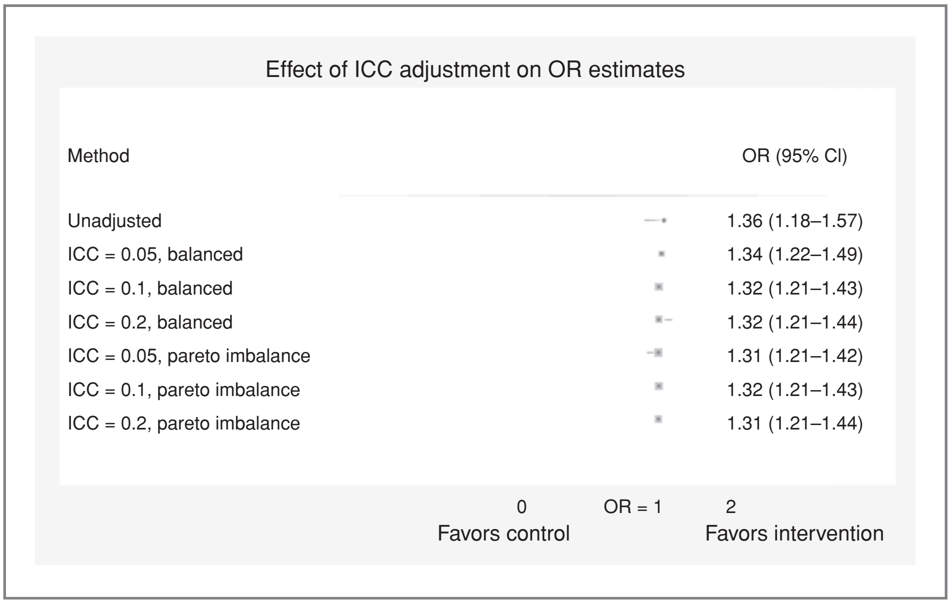


**Figure 3.** Effect of ICC adjustment on OR estimates.

trials for both subgroups (medical setting: $I^2 = 81\%$; $P = 0.0003$; community setting: $I^2 = 70\%$; $P = 0.003$).

*Urban versus rural setting.* Six RCTs were conducted in an urban setting (44, 45, 50, 58, 60, 61), 3 (7 comparisons) in a rural setting (42, 56, 63), and 1 (ref. 41; 2 comparisons) did not report information on setting. Studies conducted in an urban area showed (RR: 1.23; 95% CI: 1.09–1.39, $P = 0.001$) a statistically significant benefit associated with CHW compared with control. Pooled results for studies conducted in a rural setting (RR: 1.05; 95% CI: 1.00–1.11, $P = 0.06$) or unknown setting (RR: 1.01; 95% CI: 0.98–1.03, $P = 0.69$) did not show a benefit associated with CHW compared with control. There was a statistically significant heterogeneity among the subgroup of studies conducted in an urban ($I^2 = 74\%$; $P = 0.002$) or rural setting ($I^2 = 78\%$; $P = 0.0003$) but not the 2 included comparisons for the study that did not report setting ($I^2 = 0\%$; $P = 0.75$).

***Number of intervention components.*** The CHWs were described using several different terms, such as indigenous community leaders (46), *consejeras* (51–54), *promotoras* (57), lay health advisors (46, 50, 56), lay health educators (49, 55, 64), community health educators (61), lay health workers (43, 60), peer health advisors, (41) peer counselors (45), community health care workers (63), and volunteers (42, 44, 58, 59). The most commonly reported components of CHW interventions included health education (41–43, 45–49, 51–54, 56, 57, 59–64), referrals to health care (42, 43, 45, 47, 48, 50, 58, 59, 63), appointment scheduling (48, 50, 56, 61), and vouchers, free mammograms, or lower cost mammograms (46–49, 63). Less common intervention components included emotional or social support (41, 61), financial paperwork (48, 61), communication with the health care team (61), mailed reminders (50, 61), and child care (61). Sensitivity analysis showed a statistically significant increase in receipt of screening mammography associated with increase in number of interventions. RCTs where CHW interventions included 1 intervention component (refs. 44, 45, 60; RR: 1.23; 95% CI: 1.00–1.52, $P = 0.05$) or 2 intervention components (refs. 41, 42, 56, 58; RR: 1.03; 95% CI: 1.00–1.07; $P = 0.06$) were associated with a statistically nonsignificant increase in rates of screening mammography. Interventions that included 3 intervention components (refs. 50, 63; RR: 1.10; 95% CI: 1.03–1.19, $P = 0.008$) or more than 3 intervention components (ref. 61; RR: 2.67; 95% CI: 1.59–4.48, $P = 0.0002$) were associated with a statistically significant increase in rates of mammography. There was a statistically significant heterogeneity among included RCTs in subgroups where CHW used 1 ($I^2 = 75\%$; $P = 0.02$) or 2 intervention components ($I^2 = 74\%$; $P = 0.0004$). There was a statistically nonsignificant heterogeneity among included RCTs in the subgroup with 3 CHW intervention components ($I^2 = 0\%$; $P = 0.81$).

***Racial or ethnic concordance of CHW and target population.*** The studies reviewed targeted a number of different populations. Ninety-two percent of the studies included ethnic or racial minority participants or focused on low-income populations. Pooled results from RCTs that reported matching CHW and target population by race or ethnicity (refs. 44, 56, 61, 63; RR: 1.58; 95% CI: 1.29–1.93, $P < 0.0001$) and that did not report matching CHW and target population by race or ethnicity (refs. 41, 42, 45, 50, 58, 60; RR: 1.03; 95% CI: 1.01–1.05, $P = 0.02$) showed a statistically significant improvement in adherence to screening mammography; however, the effect was stronger for the RCTs that matched CHWs to participants by race and ethnicity. There was not statistically significant heterogeneity among either subgroup of studies (concordant: $I^2 = 45\%$; $P = 0.14$; not concordant: $I^2 = 45\%$; $P = 0.06$).

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## Discussion

The result from this meta-analysis of 18 studies enrolling a total of 26,660 participants indicates that CHW interventions are associated with a statistically significant increase in rates of screening mammography but tend to have stronger effects in specific settings and study designs and when participants and CHWs were similar ethnically or racially. When RCTs were compared with quasi-experimental studies, the significant increase in screening mammography rates due to CHW interventions was observed in RCTs but not in quasi-experimental studies. In RCTs, all studies showed either a neutral (intervention neither increased nor decreased mammography rates) or positive intervention effect (intervention increased mammography rates), indicating that CHWs were more effective than control in improving screening mammography rates. In quasi-experimental studies, direction of intervention effects was both positive and negative. These findings point out to inherent biases associated with observational study designs. Overall, there was a significant heterogeneity in studies, with varying populations, varying lengths of intervention, varying lengths of follow-up after intervention, and varying time frames for the mammography outcome. Imputing different values of ICC had minimal effect on the distribution of point estimates of ORs or credibility intervals. So, there was little impact of similarity of different clusters (e.g., clinics) as a result of using a CRT design on overall effectiveness of CHW interventions on screening mammography.

Overall, our findings are similar to results of previous studies (21, 65). Results of the present study are also similar to findings of a recent systematic review (26) which found that a subset of CHW interventions was associated with significantly greater screening mammography utilization rates when compared with controls or other interventions (mail, print, minimal CHW). Our study improves on this recent review by providing a meta-analysis of all studies evaluating impact of CHWs on screening mammography. In addition, through sensitivity analyses of data from RCTs, the present study provides information about specific situations where CHW interventions are most likely to be beneficial (interventions conducted in urban settings, recruitment of participants from medical settings, measuring mammography outcome using a chart review, CHW interventions with 3 or more components, and interventions where CHW and patients are racially or ethnically concordant). The findings of our study differ from those of Lewin and colleagues (22), who found no beneficial effect (RR: 1.05; 95% CI: 0.99–1.12, $P = 0.10$) of CHW interventions on screening mammography based on a meta-analysis of 4 RCTs conducted internationally. While our analysis includes 3 of the 4 studies reported by Lewin and colleagues (22), our analysis also includes twice as many RCTs as well as quasi-experimental studies. Thus, our results came from a larger pool of data that may not be as strongly influenced by results of an individual study.

A lack of information reported in articles did not allow for detailed sensitivity analysis of methodologic study quality. Sensitivity analysis comparing unit of randomization indicates CRTs of CHW interventions did not lead to increased mammography rates, whereas studies that randomized individuals were associated with a significant increase in mammography. In addition, there was no significant increase in mammography screening in 3 studies that utilized ITT analysis to evaluate a CHW intervention (50, 61, 63), but there was a significant increase in studies without ITT analysis. This lack of intervention effect may be related to smaller pooled sample size of the 3 studies ($n = 2{,}019$) or may suggest possible biases favoring intervention effect in studies that used per-protocol analyses, rather than ITT (66).

CHW interventions were associated with increases in rates of screening mammography in studies with routine care or health education but not in studies with mammography reminders. Screening reminders may exert a strong effect on mammography rates, as noted by others (67, 68). Most RCTs reviewed included mammography referrals, reminders, or appointment scheduling as 1 CHW intervention component (42, 44, 45, 50, 56, 58, 61, 63). This finding points to the need to determine components of CHW interventions most strongly associated with increases in screening mammography to improve efficiency of CHW programs.

Both community and medical settings of recruitment were associated with increases in screening mammography related to a CHW intervention, but the effect was stronger in participants recruited from a medical setting. Connecting patients to a medical setting is important in designing a CHW program as establishing a usual source of care is a known predictor of mammography screening (16, 69). In addition, CHW interventions that took place in an urban setting were associated with screening mammography increases, whereas CHW interventions conducted in rural settings were not. These differences may reflect difficulties in obtaining a mammogram in a rural area (19).

RCTs that delivered at least 3 types of interventions were associated with increases in screening mammography. These findings concur with previous findings (24) indicating that interventions with multiple intervention components were associated with stronger increases in screening mammography rates. While the studies reviewed tended to focus or include historically or medically underserved populations, the RCTs that reported concordance between participants and CHWs on race or ethnicity indicated a stronger CHW intervention effect on screening mammography than studies where race and ethnic concordance was not described or conducted. In contrast, a previous systematic review found concordance between physicians' and patients' race or ethnicity was not associated with improved health outcomes or patients' utilization of health care (70). Sensitivity analyses could not be conducted to evaluate differences in effectiveness of CHW interventions by different population groups because the majority of the RCTs targeted multiple underserved populations. Thus, there was no way to categorize them in a meaningful way for comparisons.

There are several limitations to this systematic review and meta-analysis. The study may be biased as it included only published peer-reviewed articles. Although unpublished works were eligible for inclusion in the review, none met inclusion criteria. This review was limited to studies published in English and implemented in the United States. Thus, meta-analysis results may not generalize to countries providing better or worse access to mammography screening services. In addition, sensitivity analyses were based on a small number of RCTs and should be interpreted with caution. The systematic review is also limited by reporting of data in original articles. Several sensitivity analyses could not be conducted because of significant variability in populations, interventions, and study designs reported. This variability is expected in the context of conducting research on interventions designed to meet local needs of various populations and under different breast screening guidelines in place throughout the years, but variability makes it difficult to combine data into meaningful categories.

The findings have significant implications for public health practice by indicating that CHW interventions are associated with improvements in rate of 1 time screening mammography, especially in medical settings, urban settings, and in participants who are racially or ethnically concordant with the CHW. However, as mammography is a behavior that must be repeated multiple times, there is still much that is unknown about efficacy of CHW interventions in increasing repeated BC screening. A recent systematic review and meta-analysis of the effectiveness of various types of interventions designed to promote repeat BC screening found studies that utilized screening reminders only and studies that used more intensive interventions (including CHWs) were both associated with increases in repeat mammography (68). Future research should evaluate whether CHW interventions are associated with repeat mammography screening and initiation of mammography screening. Future systematic reviews are necessary to compare CHW interventions to other mammography promoting interventions such as media interventions (71). In addition, future systematic reviews should evaluate whether CHW interventions are associated with other cancer screening behaviors. Finally, future research should be conducted to definitively determine which participants and populations benefit most from CHW interventions and why.

## Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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