Supplemental materials for:

Hartzler AL, Tuzzio L, Hsu C, Wagner EH. Roles and functions of community health workers in primary care. *Ann Fam Med*. 2018;16(3):240-245.

Appendix 1. Systematic review inclusion criteria, search strategy, data extraction, quality assessment, data extraction, and PRISMA flow diagram

Inclusion Criteria

To be included in our review, studies needed to meet the following criteria:

1. Report findings in English from a primary study of a CHW program implemented in primary care within the US context. We excluded reviews, editorials, news, commentaries, and other secondary sources not defined by the publication type "journal article";
2. Provide sufficient detail in the article's full text to describe the CHW-PC position;
3. Describe a CHW-PC position filled by an individual without formal medical training. We excluded articles describing roles filled by trained medical personnel (e.g., medical assistant, nurse);
4. Describe a CHW-PC position in which the primary work setting, supervision, decision-making, and/or interaction is within primary care, including safety net, community, and public health clinics. We excluded CHW-PCs working in hospitals and non-clinic community settings.

Search strategy and study selection

The first author (AH) searched MEDLINE using PubMed and Google Scholar for English-language studies published up to October 2015 about primary care and any of the following: health coaches, lay health workers, community health workers, promotoras, health aides, health educators, patient navigators, peer counselors, or outreach workers using the search query below. Based on inclusion criteria, titles, abstracts and full text articles were selected independently by two authors (AH, LT).

On October 16 2015, the first author (AH) searched the following databases:

1. Searched MEDLINE using PubMed (https://www.ncbi.nlm.nih.gov/pubmed/) for English-language studies published up to October 16 2015 using the following query restricted to Medical subject headings (MeSH) and keywords in the title and abstract (TIAB): Primary Health Care[MeSH] AND (Health coach[TIAB] OR Lay health worker[TIAB] OR Community health worker[MeSH] OR Promotora[TIAB] OR Promotoras[TIAB] OR health aide[TIAB] OR health educator[MeSH] OR patient navigation[MeSH] OR peer counselor[TIAB] OR outreach worker[TIAB]).
2. Searched Google Scholar (https://scholar.google.com/) using advanced search for English-language studies published up to October 2015 using the following query for article titles excluding patents and citations:
    - With the exact phrase: primary care
    - With at least one of the words: "health coach" "lay health worker" "community health worker" promotora "health aide" "health educator" "patient navigator" "peer counselor" "outreach worker"
    - Where my words occur: "in the title of the article"
    - Return articles dated between: --2015

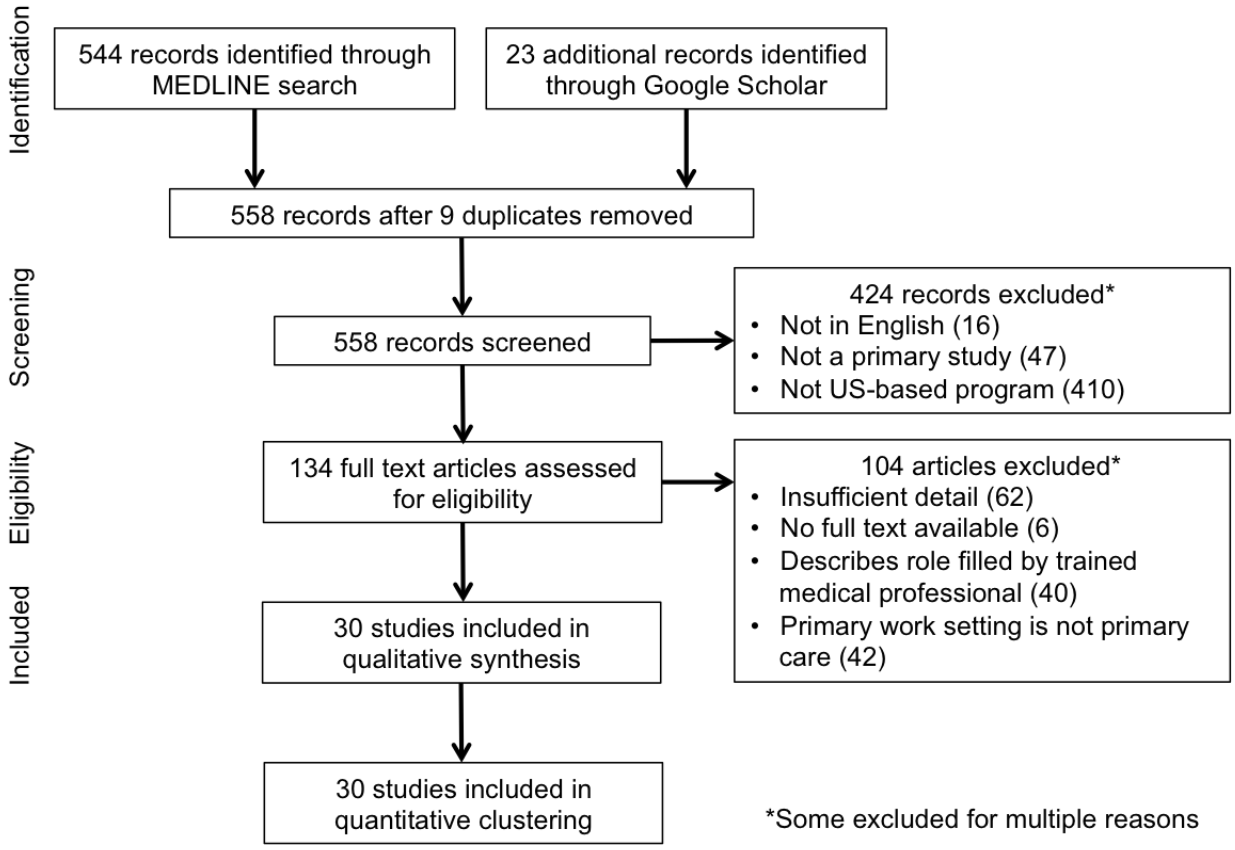
Quality assessment

Two authors (AH, LT) independently assessed methodological quality of included studies using Mixed Methods Appraisal Tool (MMAT), which provides criteria for qualitative, quantitative, and mixed methods designs for integration of different types of results. Studies were scored based on study design and primary outcome/objective. Because there is limited evidence on which to base exclusion decisions for mixed studies and because our focus was on the description of CHW-PC programs, studies were included without regard to quality. However, we examined the impact of lower quality studies on results.

Data extraction

Two reviewers (AH, LT) independently extracted and coded data. A third team member (EW) reviewed selected articles to resolve disagreements and confirm eligibility. From included studies, we abstracted the following data items: clinical focus, target population, CHW-PC functions, CHW-PC characteristics (i.e., educational prerequisites, qualifications, training, clinical support structure), and impact on primary outcomes. We also recorded study design using MMAT to distinguish qualitative studies, randomized controlled trials (RCT), non-randomized quantitative designs, descriptive quantitative designs, and mixed methods.

PRISMA flow diagram



Appendix 2 Detailed description of included study

	Study	Clinical focus	Study design	Target population	Primary impact
Cluster 1: Clinical services (n=11)	Burns et al, 2014[21]	Transitional care (from hospital to primary care)	**Mixed methods randomized controlled trial (RCT) and qualitative interview study** to compare the feasibility and impact of CHW-PC program (n=110) versus usual care (n=313) that connects patients with primary care to reduce hospital readmission after discharge over 4 weeks	Low income, ethnically diverse patients with 1 of 5 risk factors for hospital readmission within 30 days	70% of patients received at least one post-discharge CHW-PC call; only 38% of patients received at least four calls as intended. Hospital readmission rates were lower among CHW-PC patients (15.4%) compared with usual care (17.9%); the difference was not statistically significant. The authors suggest strategies to address barriers reported by the CHW-PC.
	Findley et al, 2014[22]	Community health care	**Qualitative study** with CHW-PC interviews (n=7) and document review describing integration of CHW-PC program into the patient-centered medical home	Low income primary care patients	Integration was linked to clear definition of the care coordination role of the CHW-PC within the care team, meticulous recruitment, training and supervision by a senior CHW-PC, shared leadership of the care management team, and documented value for money.
	Krantz et al, 2013[23,53]	Chronic illness prevention (Coronary heart disease)	**Non-randomized observational cohort study** (single group) to evaluate the impact of CHW-PC program on improving coronary heart disease risk in individuals at risk over 3 months in a state-wide initiative (n=4,743)	Residents in 34 counties in Colorado	From 2010 to 2011, 53.5% of participants received medical or lifestyle referrals and 14.7% were retested 3 or more months after screening. The study observed statistically significant improvements in diet, weight, blood pressure, lipids, and Framingham risk score (FRS) with the greatest effects among those with uncontrolled risk factors. Successful phone interaction by the CHW-PC was associated with lower FRS at retest (P = .04).
	Golnick et al, 2012[24]	Rural health care	**Descriptive quantitative study** to evaluate the scope of health problems seen in visits within CHW-PC program over 2	Residents of remote Alaskan villages	CHW-PC provided care for acute, chronic, preventive, and emergency problems at 176,957 (65%) visits. The remaining 95,285 (35%) were for administrative or medication-related encounters.

		years (n=272,242 visits)		The most common diagnostic codes were: pharyngitis (11%), respiratory infections (10%), otitis media (8%), hypertension (6%), skin infections (4%), and chronic lung disease (4%). Respiratory distress and chest pain accounted for 75% (n=10,552) of all emergency visits.
Margolius et al, 2012[25,55]	Chronic illness management (Hypertension)	**RCT** to compare the impact of CHW-PC program with (n=129) and without (n=108) home-titration of blood pressure medications on blood pressure control over 6 months	Low income, racial and ethnic minority primary care patients	Both the home-titration arm and the no–home-titration arm had a reduction in systolic blood pressure, with no significant difference between them. When both arms were combined and analyzed as a before-after study, there was a mean decrease in systolic blood pressure of 21.8 mm Hg (P <.001). The more coaching encounters patients had, the greater their reduction in blood pressure.
Battaglia et al, 2012[26]	Chronic illness prevention (Mammography, smoking, depression, obesity)	**Mixed methods study with qualitative interviews and descriptive observational cohort study** (single group) to evaluate the feasibility and impact of CHW-PC program on completion of follow-up appointments within 30 days (n=109)	Low income, racial and ethnic minority women receiving care from a primary care clinic	94% of participants scheduled and 73% completed a mammography appointment. 71% agreed to schedule a primary care appointment and 54% completed that appointment. Although patients were generally acceptable of telephone outreach, language barriers and inability to reach patients limited program feasibility.
Naar-King et al, 2009[27]	HIV	**RCT** to compare impact of CHW-PC program (n=39) versus program lead by masters level staff (MLS) (n=44) on treatment fidelity and patient retention in primary care over 1 year	Adolescents and young adults 16-29 years old with HIV who were largely African American and received care through an HIV-oriented primary care program	While both groups improved the regularity of primary care appointments, the effect size for CHW-PC on retention in care and intervention dose was larger than that of MLS. Both conditions had large effect sizes (using pre to post-change) d=1.73 for CHW-PC and d =0.94 for MLS.

	Sherer et al, 1994[28,56]	Rural health care	**Qualitative study** of CHW-PC program to improve care access and outcomes by delivering emergency and primary care over 25 years	Low income residents of remote Alaskan villages	Program improved Alaskan natives' neonatal infant mortality rate, which decreased 27% over 10 years while the rate of accidental death decreased by 40%. The Incidence of hepatitis B and gonorrhea also declined. Complications of acute disease such as rheumatic fever decreased from 69 cases in 1972 to only two cases in 1989. CHW-PC acceptance was high among surveyed patients (77%).
	Swider et al, 1990 [29]	Community health care	**Qualitative case study** of a demonstration project to improve basic health care access through CHW-PC teamed with public health nurse in a neighborhood clinic	Low income Latino women who receive care at a neighborhood clinic	Indicators of success included interest of other communities in the implemented model, development of CHW-PC training manual and curriculum, and development of community-based service plans.
	Deuschle et al, 1983[30]	Community health care	**Descriptive quantitative study** of CHW-PC program demonstration project to improve Navajo health care system over 5 years	Medically underserved residents of Navajo tribal population	Despite the documented success of the CHW-PC in this project, the program was not immediately adopted potentially due to lack of government interest.
	Hudson et al, 1973[31]	Rural health care	**Non-randomized observational cohort study** (two group) to evaluate the impact of CHW-PC program in 9 villages with and 4 villages without satellite-based physician consultation to increase patient treatment over 2 years	Residents of remote Alaskan villages	The average number of patient treatment episodes before (1970-71) and after (1971-1972) installation of satellite-based consultation for CHW-PC program changed from 47.1/330 to 184.6/1291 in 9 sites with satellite and from 24.7/286 to 15.0/173 in 4 sites without satellite. CHW-PC communication with providers and other CHW-PC was important for success.
Cluster 2.	Wennerstrom et al, 2015[32]	Chronic illness management (Diabetes, hypertension)	**Qualitative study** with patient focus groups (n=47), 4-month program evaluation (n=31), and patient satisfaction survey (n=24) regarding CHW-PC program	Vietnamese primary care patients with diabetes and/or hypertension	Findings describe community needs for disease management support, program successes, challenges and proposed solutions for integrating CHW-PC into care teams (e.g., co-locating CHW-PC in primary care practices), and high rate of patient satisfaction (90%).

			integrated into the patient-centered medical home		
	Collinsworth et al, 2013[33]; 2014[34]	Chronic illness management (Diabetes)	**Mixed methods qualitative Interviews and non-randomized observational cohort study** (single group) to evaluate the effectiveness of CHW-PC program on diabetes-related health outcomes over 1 year (n=497).[35] Interviews with patients (n=12), CHW-PC (n=5), and providers (n=7) focused on extending diabetes care with CHW-PC on primary care teams.[36]	Uninsured, largely Hispanic primary care patients with diabetes	Patients who participated in the program experienced a statistically significant decrease in mean A1C levels (from 8.7% to 7.4%, p<.00) and systolic blood pressure readings (from 129.8 mmHg to 127.3 mmHg, p=.03) 1 year post baseline.[35] Integration of CHW-PC into care teams was perceived to improve patient knowledge and activation levels, the ability of PCPs to identify and proactively address specific patient needs, care delivery, and patient outcomes.[36]
	Volkmann et al, 2011[35]	Rural heath care	**Mixed methods qualitative CHW-PC interviews and provider surveys (n=12), and descriptive time/task observational evaluation** of 2 CHW-PC programs for primary care delivery in a migrant health center that served as ambulatory primary care clinics over 2 months	Low income, underinsured, racially/ethnically diverse patients who receive care from a community and migrant health center	Findings document the types and time of case management services provided by 2 CHW-PC programs and how they affected the care team's ability to deliver efficient, effective primary care.
	Waitzkin et al, 2011[36]	Mental health (Depression)	**Mixed methods RCT and qualitative ethnographic** to compare the impact of CHW-PC program versus enhanced usual care on depression (n=120) over 1 year	Underserved, low income primary care patients with depression from community health centers	The CHW-PC intervention did not lead to statistically significant improvements in depression (odds ratio 4.33, confidence interval overlapping 1). Patients, CHW-PC, primary care providers, and staff reported a positive response to the intervention.

Holtrop et al, 2008 [37]	Chronic illness prevention (e.g., diet, physical activity, tobacco use, alcohol use)	**Non-randomized observational cohort study** (single group) to improve unhealthy behaviors in patients (n=446) in 15 primary care practices in 3 communities	Adult primary care patients identified by providers for needing improvement in 1 of 4 unhealthy behaviors (diet, physical activity tobacco use, or alcohol use)	Despite limited program reach due to LWH capacity, enrolled patients demonstrated improvements at 6 months for BMI, dietary patterns, alcohol use, tobacco use, health status, and days of limited activity (all p<0.001)
Thompson et al, 2007 [38]	Chronic illness management (Diabetes)	**Non-randomized observational cohort study** (single group) of CHW-PC pilot project to improve diabetes outcomes over 1 year (n=142)	Latino patients with type II diabetes and elevated HbA1c, comorbid depression, inadequate social support who receive care from a community health center	Contact with CHW-PC showed significant reduction in glycosylated hemoglobin (HbA1c) from baseline to 1 year (P < .004). Patients with a higher frequency of CHW-PC contact showed a greater decline in HbA1c.
Adelman et al, 2005[39]	Chronic disease prevention (Obesity)	**Mixed methods with qualitative interviews and descriptive observational cohort study** (single group) to evaluate the effectiveness of CHW-PC program to improve diet and physical activity over 6 months (n=92)	Obese patients who receive care from a primary care family practice clinic	Use of CHW-PC program led to 44 (48%) of patients initiating a behavior change in eating habits, physical activity, or both. Patients reported preferring face-to-face meetings to telephone or email contacts.
Torrey et al, 1973[40,54]	Community health care	**Qualitative case study** of CHW-PC program to provide social advocacy, health education, and nursing support to patients over 5 years	African Americans and Spanish Americans who receive care at a neighborhood health center	Problems initially anticipated for CHW-PC did not materialize but others emerged: lack of self-esteem, lack of upward mobility, inadequate evaluation of the validity of their training and role, and to some extent paternalism. The authors suggest potential solutions and lessons learned.

Cluster 3: Health education and coaching (n=11)	Perez-Escamilla et al, 2015[41]	Chronic illness management (Diabetes)	**RCT** to compare the impact of CHW-PC program (n=105) versus standard care (n=106) on glycemic control over 18 months	Latino primary care patients with diabetes	Relative to the control group, CHW-PC program had a positive impact on HbA1c at 3 months (20.42% [24.62 mmol/mol]), 6 months (20.47% [25.10 mmol/mol]), 12 months (20.57% [26.18 mmol/mol]), and 18 months (20.55% [26.01 mmol/mol]). The overall repeated-measures group effect was statistically significant (mean difference 20.51% [25.57 mmol/mol], 95% CI 20.83, 20.19% [29.11, 22.03 mmol/mol], P = 0.002).
	Percac-Lima et al, 2015[42]	Cancer screening (Mammography)	**Nonrandomized observational cohort study** (two group) to evaluate the impact of CHW-PC program (n=132) versus usual care (n=168) on timely follow-up care	Low income women with an abnormal mammogram who receive care from a community health center	The percentage of women with appropriate follow-up care was higher in the practice with CHW-PC than in non-CHW-PC practices (90.4% vs. 75.3%, adjusted p = 0.006).
	Matiz et al, 2014[43]	Chronic illness management (Asthma)	**Descriptive observational cohort study** (single group) to evaluate the impact of CHW-PC program on care coordination referrals among 5 patient-centered medical homes.	Predominately Latino families with children who have Asthma and Medicaid	More than 750 families of children with asthma received education and support from CHW-PC from February 2011 through December 2013. The number of referrals to the care coordination program increased 7-fold during this time (P < .001) and use of care plans increased from 5% to 39% when prompted by a CHW-PC.
	Percac-Lima et al, 2014[44,51]	Cancer screening (Colonoscopy)	**Nonrandomized observational cohort study** (two group) to evaluate the impact of CHW-PC program versus usual care on colorectal cancer screening rates among practices in a primary care network over 4 years	Vulnerable patients, including low income predominately Latinos and immigrants, who receive care in a patient-centered medical homes.	Differences in cancer screening rates diminished among patients at the practices with and without CHW-PC between 2006 (49.2% vs. 62.5%, respectively; P<.001) and 2010 (69.2% vs. 73.6%, respectively; P<.001). The adjusted rate of increase over time was higher at the practice with CHW-PC versus other practices (5% vs. 3.4% per year; P<.001). Adjusted screening rates increased more for Latino and non-English speakers at the practice with the CHW-PC compared with other practices (both p<0.001).

Kangovi et al, 2014[45]	Transitional care (from hospital to primary care)	**RCT** to compare the impact of CHW-PC program (n=222) versus usual care (n=224) on 14-day primary care follow-up	Low income, underinsured patients who were hospitalized	Intervention patients were more likely to obtain timely post-hospital primary care (60.0%vs 47.9%; p = 0.02; adjusted odds ratio [OR], 1.52; 95%CI, 1.03-2.23).
Lasser et al, 2013[46]	Smoking cessation	**RCT** to compare the impact of a CHW-PC program (n=24) versus brochure-based control (n=23) on treatment engagement over 3 months	Low income primary care patients who contemplated quitting	9/19 (47.4%) of CHW-PC participants engaged in smoking cessation treatment by three months versus 6/14 (42.9%) of control participants (chi-square p=NS).
Thom et al, 2013[47,52]	Chronic illness management (Diabetes)	**RCT** to compare the impact of CHW-PC program (n=148) versus usual care (n=151) on glycemic control over 6 months	Low income primary care patients with poorly controlled diabetes who receive care from a public health clinic	HbA1C levels decreased by 1.07% in the CHW-PC group and 0.3% in the usual care group, a difference of 0.77% in favor of CHW-PC (p = 0.01, adjusted). HbA1C levels decreased 1.0% or more in 49.6% of CHW-PC patients vs. 31.5% of usual care patients (p = 0.001, adjusted), and levels at 6 months were less than 7.5% for 22.0% of CHW-PC vs. 14.9% of usual care patients (p = 0.04, adjusted).
Adair et al, 2012[20]	Chronic illness management (Diabetes, hypertension, or congestive heart failure)	**Non-randomized observational cohort study** (single group) to evaluate the impact of CHW-PC program on meeting recommended care goals over 1 year (n=332)	Primary care patients with diabetes, hypertension, or congestive heart failure	At 1 year, failure to meet nationally recommended guidelines was reduced by 28%, p < 0.001. Improvement was seen in tobacco usage, blood pressure control, pneumonia vaccination, low-density lipoprotein cholesterol levels, annual eye examinations, aspirin use, and microalbuminuria testing.
Otero-Sabogal et al, 2010[48]	Chronic illness management (Diabetes)	**Mixed methods study with patient survey (n=31), provider focus group (n=6) and non-randomized observational cohort study** (single group) to evaluate the impact of a CHW-PC program on clinical and self-management	Low income Latino primary care patients who receive diabetes care at a safety net clinic	CHW-PC program had a positive impact, improving HbA1c among high-risk patients with type 2 diabetes (HbA1c $\geq$ 9.0) and maintaining glycemic control among patients with controlled glycemic level at baseline (HbA1c<7.0). In addition, LDL, total cholesterol and self-management outcomes significantly improved

			outcomes over 1 year (n=114)		(all $p \leq 0.05$). The majority of patients (97%) were satisfied with CHW-PC. Providers expressed high level of comfort referring patients to CHW-PC
	McElmurry et al, 2009[49]	Chronic illness management (Diabetes)	**Mixed methods study with qualitative surveys** (n=18 clinic personnel) **and non-randomized observational cohort study** (single group) of CHW-PC program demonstration project to improve diabetes care and outcomes over 3 years (n=392)	Latino patients who receive care from an ambulatory care clinic	Positive outcomes for patients included a significant decrease in HbA1c from 9.65 to 8.61 ($p < 0.001$). Health care professionals perceived CHW-PC to improve patient self-care and serve as a bridge between patients and health care professionals
	Poland et al, 1991[50]	Maternal and child care	**Descriptive quantitative study** of telephone surveys with prenatal patients (n=214) and postpartum patients (n=91), and a case comparison study (n=128) to assess CHW-PC program demonstration project to improve quality of prenatal health care	Low income mothers and infants who received care from hospitals and health departments	And about half of surveyed prenatal patients reported barriers to care and only 43% of postpartum patients reported adequate prenatal care. Lack of prenatal care was associated with fewer calls to the neonatal intensive care unit, fewer visits, fewer questions asked of the transport team and more protective service referrals. Four goals were emphasized for program improvement: 1) continuity of services from pregnancy through infancy; 2) needs assessment procedures sensitive to a broad range of health and social problems; 3) an ongoing personal relationship with a CHW-PC; 4) reduction in barriers to prenatal care.

Appendix 3. Summary of CHW-PC characteristics across studies

Clinical focus	
Cancer Screening	6.7% (2/30)
Smoking cessation	3.3% (1/30)
Chronic illness prevention (e.g., obesity, cardiovascular risk)	13.3% (4/30)
Chronic illness management (e.g., diabetes, hypertension asthma)	33.3% (10/30)
Mental health	3.3% (1/30)
HIV	3.3% (1/30)
Maternal and child care	3.3% (1/30)
Transitional care (i.e., post hospital discharge)	6.7% (2/30)
Rural or community-based primary health care	26.7% (8/30)
Target population (categories are not mutually exclusive**)**	
Local residents	16.7% (5/30)
General primary care	53.3% (16/30)
Specific chronic condition or risk factor	53.3% (16/30)
Underserved groups (e.g., low income, uninsured)	56.7% (17/30)
Specific racial or ethnic groups	56.7% (15/30)
Women	13.3% (4/30)
Infants, children, or adolescents	10.0% (3/30)
Name of CHW-PC	
Community health worker	36.7% (11/30)
Patient navigator	13.3% (4/30)
Community health aide	13.3% (4/30)
Health coach	10.0% (3/30)
Other (e.g., promotora, peer outreach worker, health promoter, care guide)	26.7% (8/30)
Educational prerequisites (categories are not mutually exclusive**)**	
6th grade education	6.7% (2/30)
Some high school or high school degree	20.0% (6/30)
Some college or college degree	20.0% (6/30)
Certification program (i.e., community health worker)	6.7% (2/30)
Not specified	50.0% (15/30)
Qualifications (categories are not mutually exclusive**)**	
Member of patients' community (e.g., trusted, shared demographics)	43.3% (13/30)
Bilingual (i.e., shared language with patient population)	50.0% (15/30)
Interpersonal skills (e.g., natural helper, active listener, communicative)	23.3% (7/30)
Experience in health care setting	23.3% (7/30)
Have own transportation	3.3% (1/30)
Proficiency in electronic communication	3.3% (1/30)
No qualifications specified	10.0% (3/30)
Training* (e.g., self-management, motivational interviewing)	
=<40 hours (mean = 20, range = 5-40)	27% (8/30)
41-99 hours (mean = 83, range = 80-90)	13% (4/30)
100-300 hours (mean = 178, range = 100-240)	20% (6/30)
>300 hours (mean = 720, range = 640-960)	13% (4/30)
Hours of training not specified	27% (8/30)

*Estimated 1 week = 40 hours and 1 month = 160 hours for studies reporting training time in weeks or months.