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Effectiveness of Training and Supportive Supervision in Improving Community Health Workers' Knowledge, Self-Efficacy, and Capacity for Hypertension and Diabetes Screening and Referral in Rural Kenya: A Mixed-Methods Quasi-Experimental Study.

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Abstract

Background: Community health workers (CHWs) are central to community-based screening and referral for hypertension and diabetes in Kenya, yet their capacity is often limited with minimal long-term support. We assessed whether training, with or without supportive supervision, improves CHW knowledge, self-efficacy, and capacity for these tasks in rural Siaya County.

Methods: We conducted a mixed-methods, controlled before-and-after quasi-experimental study with three arms: training plus six months of supportive supervision (n=11), training only (n=11), and routine practice (n=16). Thirty-eight CHWs were assessed. Knowledge and self-efficacy were measured at baseline and endline, and intervention effects estimated using linear regression. We analysed four focus group discussions thematically.

Results: Participants' mean age was 48 years, and 87% were female. Knowledge improved across all arms. Low diabetes knowledge was eliminated in the full-intervention arm. Compared with control, the full intervention showed non-significant positive trends in diabetes knowledge (coefficient 2.32; 95% CI −0.12 to 4.75; p=0.062) and hypertension knowledge (2.23; −0.29 to 4.74; p=0.083). Training only significantly improved hypertension knowledge (3.23; 0.71 to 5.74; p=0.012). The largest effects were on self-efficacy, in both the full-intervention arm (33.06; 17.81 to 48.31; p<0.001) and the training-only arm (34.06; 18.81 to 49.31; p<0.001). High self-confidence rose from 18.2% to 100% with full intervention and from 9.1% to 81.8% with training only. At endline, the arms differed significantly in confidence for capillary glucose screening (p=0.010), risk-assessment tools (p=0.006), referral counseling (p=0.006), and advising on NCD risk factors (p=0.001). Six themes emerged from the focus groups. Qualitative findings indicated that training improved knowledge and confidence, while supportive supervision facilitated application of skills in community settings. Key implementation barriers included poor connectivity, workload, limited supplies, and transport constraints.

Conclusions: Training substantially improved CHW self-efficacy and practice-related competence, with more modest, condition-specific knowledge gains. Training with support supervision helps translate learning into practice. Larger, longer studies are needed to confirm these preliminary effects and test their impact on screening and referral outcomes.

Keywords: Community health workers; supportive supervision; hypertension; diabetes; non-communicable diseases; screening; self-efficacy; Kenya.

Background

Hypertension and diabetes are among the leading causes of morbidity, mortality, and disability worldwide, with their burden increasing rapidly in low- and middle-income countries (LMICs). In sub-Saharan Africa, rising urbanization, population ageing, unhealthy diets, physical inactivity, and obesity have accelerated the prevalence of these conditions, placing substantial pressure on already constrained health systems. In Kenya, hypertension and diabetes account for an increasing proportion of non-communicable disease (NCD) morbidity and mortality, particularly in rural communities where access to screening, diagnosis, and long-term management services remains limited (1) .

Strengthening primary health care (PHC) systems is a key strategy for improving NCD prevention, early detection, and management. Community Health Workers (CHWs), also referred to as Community Health Promoters (CHPs) or Community Health Volunteers (CHVs), play a critical role in extending PHC services to underserved populations and advancing Universal Health Coverage (UHC). As trusted links between communities and formal health facilities, they support health promotion, disease prevention, household screening, referrals, and follow-up services. While CHWs have traditionally focused on maternal, child, and infectious disease programs, their responsibilities have increasingly expanded to include community-based prevention and management of hypertension and diabetes (2).

In Kenya, particularly in rural counties such as Siaya, CHWs have become central to efforts aimed at improving early detection, referral, and follow-up of individuals at risk of hypertension and diabetes. However, evidence suggests that many CHWs encounter challenges in effectively performing these roles. Previous studies have reported gaps in knowledge of NCD risk factors and management, limited confidence in conducting blood pressure and blood glucose measurements, inconsistent use of referral pathways, and inadequate digital literacy for utilizing emerging digital health technologies (3–5). Although several digital health initiatives, including mobile health (mHealth) applications and the electronic Community Health Information System (eCHIS), have been introduced to support

community health services, successful implementation depends on CHWs possessing the necessary knowledge, skills, and confidence to use these tools effectively (6,7).

Existing training programs for CHWs are often fragmented, short-term, and inadequately supported by ongoing mentorship or supportive supervision(7–9). Furthermore, many digital health intervention studies have focused on technological outcomes rather than frontline health workers' readiness and capacity to adopt and sustain use (10,11). Consequently, evidence regarding the effectiveness of integrated approaches that combine training, supportive supervision, and digital health support for hypertension and diabetes screening and referral remains limited, particularly in rural Kenyan and broader sub-Saharan African settings (12,13).

To address these gaps, this study evaluated the effectiveness of a targeted training and supportive supervision intervention designed to strengthen CHWs' capacity to conduct hypertension and diabetes screening, referral, and follow-up in Siaya County, Kenya. Specifically, the study assessed baseline CHW knowledge, self-efficacy, and capacity related to hypertension and diabetes screening and referral. We also examined the effects of training and supportive supervision to improve CHWs' knowledge, confidence, and community-based hypertension and diabetes service delivery practices.

Methods

Intervention and Research Design

The training and supportive supervision intervention was designed to strengthen the capacity of CHWs to conduct household screening, promote healthy behaviors, facilitate referrals, and provide follow-up care through community-based diabetes and hypertension screening services in rural Siaya County, Kenya. The intervention was implemented among selected groups of CHWs within the community health units to which they are attached, and delivered in phases throughout the study period.

Phase 1 involved the collection of baseline data from the selected CHWs within the county. Information collected included sociodemographic characteristics, current capacity to conduct screening, referral, and follow-up activities through community health services, knowledge of the causes, risk factors, prevention, and management of hypertension and diabetes, as well as confidence and competence in digital literacy and the use of digital health tools.

Phase 2 involved training the two groups of CHWs based on the findings of the baseline assessment. The training focused on the risk factors, causes, prevention, management, and complications of hypertension and diabetes. Following the training, participants were followed for a period of six months. The intervention included a three-day workshop conducted between December 09, 10, and 11, 2024, followed by two days of community-based practical sessions, which involved household visits by the CHPs to screen household members for hypertension and diabetes, create awareness, and motivate them on modifiable risk factors. These practical sessions provided hands-on experience in measuring blood pressure using digital blood pressure monitors using a calibrated Omron digital blood pressure machine, conducting blood glucose testing using on-call glucometers and strips, household and community-level infection prevention, and entering data into the electronic Community Health Information System (eCHIS). Further, counselling and referral motivation skills were also assessed. In addition, monthly follow-up meetings were conducted to monitor progress, address implementation challenges, and reinforce learning through observation and real problem-solving. A total of six-monthly meetings were held at the community level within the villages served by the participating CHWs.

During the follow-up period, CHWs received ongoing on-site coaching, mentorship, supportive supervision, and continuing medical education (CME). These components were evaluated separately from the initial training intervention. The combination of hotel-based learning and field-based supervision was intended to promote experience sharing, problem-based learning, and practical problem-solving.

The training curriculum was adapted from the national Community Health Worker training manual and contextualized to address the core roles of CHWs in community-based diabetes and hypertension management, including screening, health promotion, referral, and follow-up. The workshop employed interactive presentations, group discussions, practical demonstrations, and case-based learning approaches. Training modules included: (i) introduction to non-communicable diseases (NCDs), specifically diabetes mellitus (DM) and hypertension (HTN); (ii) patient counselling and self-care support; (iii) monitoring, mentorship, supportive supervision, and team-based care; (iv) practical skills sessions, including blood pressure and blood glucose measurement; and (v) intervention assessment and feedback sessions.

In addition, a Caregiver's Guide and Toolkit for People with Hypertension and Diabetes was co-developed through a participatory process and used as an information, education, and

communication (IEC) resource during community activities. Detailed descriptions of the training materials are provided in Supplementary File 2 (CHW Training Guide-ppt), Supplementary File 3 (Caregiver's Guide and Toolkit for People with Hypertension and Diabetes), and Supplementary File 4 (screening and referral algorithm for hypertension and diabetes adapted for Siaya County). Participants received both hard and electronic copies of the training materials, including presentation slides, the caregiver guide and toolkit, and the screening and referral algorithm.

The training emphasized experiential learning and practical skill acquisition. Participants were observed and assessed while conducting blood pressure and blood glucose measurements, as well as during patient Counseling sessions using the 5As framework (Ask, Advise, Assess, Assist, Arrange), an evidence-based behavior change counselling approach widely used in primary care settings (14). Findings from the CHWs' readiness assessment were also used to tailor the training content to identified local capacity gaps (1).

The training was facilitated by a multidisciplinary team comprising a master trainer who was appointed based on his previous experience with CHV involvement and training, county and sub-county health management personnel, non-communicable disease coordinators, community health focal persons, researchers, and research assistants from Siaya County and Jaramogi Oginga Odinga University of Science and Technology (JOOUST). Additional support was provided by members of the county and sub-county health management teams. Participants were supplied with screening, referral, and follow-up tools necessary for implementing the intervention within their communities.

A mixed-methods controlled before-and-after quasi-experimental study design involving three study arms: (i) training only, (ii) training plus supportive supervision, and (iii) a control group receiving routine practice was used to evaluate the effectiveness of the training and supportive supervision intervention in strengthening CHWs' capacity to perform their community-based roles in Siaya County, Kenya. The evaluation framework was guided by the first three levels of the Kirkpatrick Model, as adapted by McDonagh (15)which provides a structured approach for assessing training outcomes across multiple domains.

Specifically, the evaluation assessed:

- Level 1: Reaction - CHWs' immediate perceptions of the training, including its relevance, acceptability, feasibility, and alignment with their expectations.

- Level 2: Learning -the extent to which CHWs acquired the intended knowledge, skills, and competencies related to diabetes and hypertension prevention and management.
- Level 3: Behavior -the extent to which CHWs applied newly acquired knowledge and skills in their routine community health practice.

Level 4: Results, which focuses on the broader organizational and population-level impact of training interventions, was not included in the present study. The assessment of long-term outcomes and impact was beyond the scope of this paper and will be addressed in a subsequent phase of the research. The decision to focus on Levels 1 to 3 was informed by the study's objective of examining the immediate and intermediate effects of the training and supportive supervision intervention on CHW knowledge, skills, and practice.

Study Setting

The study was conducted in Siaya County, western Kenya, a predominantly rural area with a growing burden of NCDs alongside ongoing infectious disease challenges. Three sub-counties were purposively selected: Alego Usonga served as the intervention site, Ugunja/Ugenya as comparison sites, and Bondo for piloting study procedures.

Siaya County has a well-established primary health care system supported by Community Health Workers (CHWs), who provide preventive, promotive, and basic curative services at household level. In line with Kenya's NCD response strategy, CHWs have increasingly been engaged in community-based screening, referral, and follow-up for hypertension and diabetes.

The selected sites represented both rural and peri-urban contexts, allowing evaluation of the training, supervision, and digital health interventions across diverse community settings. Variations in health system readiness, population characteristics, and previous exposure to NCD programs enhanced the contextual relevance of the study. This setting provided an opportunity to assess how structured training, mentorship, and digital support can strengthen frontline health worker capacity in resource-limited environments and generate lessons for broader primary health care and NCD control efforts in Kenya.

Study Population and Recruitment

The study recruited 39 CHWs, of whom 38 completed both assessments and were analyzed; they were formally registered with the Ministry of Health, actively providing household-level

services, had served continuously for at least six months, and provided informed consent. CHWs who were inactive, on leave, or unavailable during the study period were excluded. Participants were recruited from three Community Health Units (CHUs): Kakum/Kombewa (n = 11), Umala (n = 11), and Ugunja B (n = 16). In addition, one Community Health Assistant (CHA) from each participating CHU was purposively selected to provide supervisory perspectives and ensure integration with existing community health structures. Quantitative data were not collected from them. Study design and participant flow are shown in Figure 1.

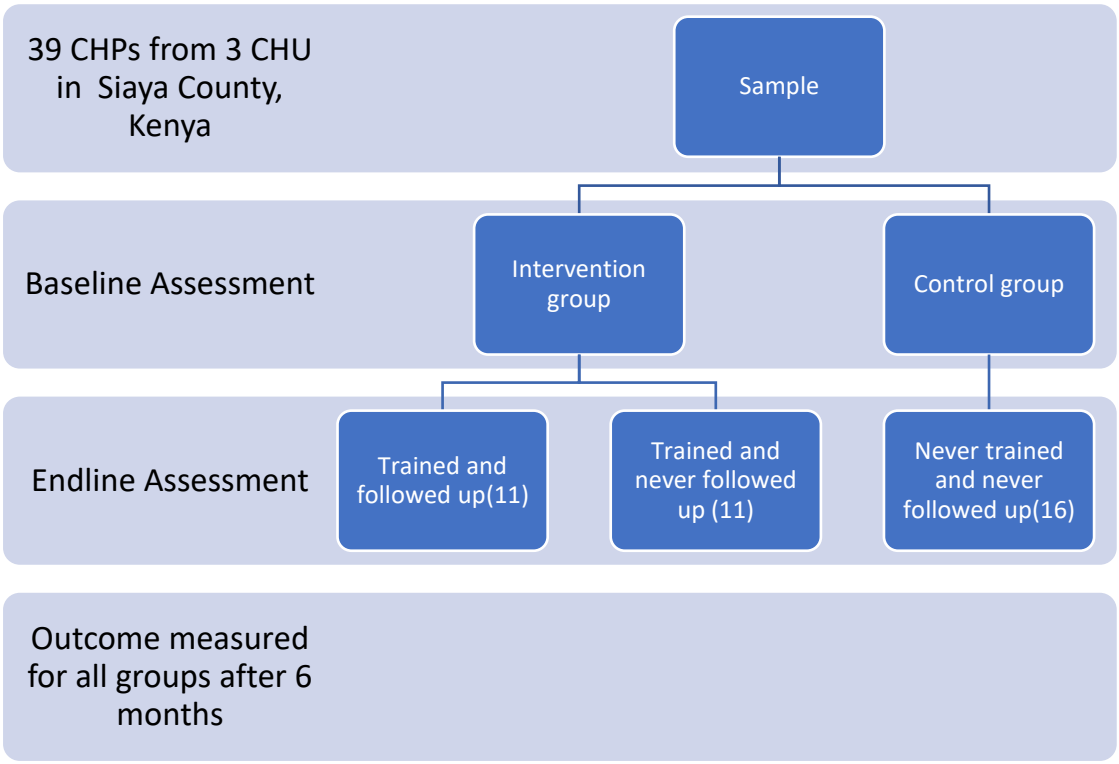


Figure 1. Study design and participant flow. Numbers show community health workers recruited per study arm.

Description of the Intervention Approaches

The study evaluated three intervention approaches that differed in the level of training and post-training support provided to CHWs in the prevention and management of hypertension and diabetes.

1. Training Plus Supportive Supervision (Group A)

CHWs in the full intervention group received comprehensive training on hypertension and diabetes, including risk factors, screening and referral procedures, anthropometric and

clinical measurements, digital health tools, community awareness creation, communication skills, and data management. Following the training, they received six months of structured supportive supervision, mentorship, and coaching. Supervisors conducted regular follow-up visits to provide hands-on guidance, reinforce knowledge and skills, address implementation challenges, and support CHWs in conducting household-level screening, referral, health education, and follow-up activities. This approach combined knowledge acquisition with continuous performance support and practical mentorship.

2. Training Only (Group B)

CHWs in the training-only group received the same comprehensive training curriculum as those in Group A. The training covered hypertension and diabetes prevention and management, screening and referral procedures, anthropometric and clinical measurements, use of digital health tools, communication skills, and community engagement. However, after the training, we provided no structured mentorship, coaching, or supportive supervision during the six-month follow-up period. This approach allowed assessment of the training's impact without additional post-training support.

3. No Training and No Supportive Supervision (Group C)

CHWs in the control group did not receive any study-related training or supportive supervision for hypertension and diabetes during the study period. They continued performing their routine Ministry of Health responsibilities in accordance with existing policies and guidelines. This group served as the comparison arm for evaluating the effects of the training and supportive supervision interventions.

Comparison of Intervention Approaches

The three study groups represented increasing levels of intervention intensity in the Kenyan healthcare system. Group C received no intervention beyond routine practice, Group B received training only, and Group A received both training and ongoing supportive supervision. This design allowed the study to assess the incremental benefits of structured training and determine whether the addition of mentorship and supportive supervision enhanced CHWs' knowledge, skills, confidence, and application of hypertension and diabetes screening, referral, and follow-up practices beyond what could be achieved through training alone.

Data Collection Instruments and Measurements

Data were collected using a structured digital questionnaire administered through the Research Electronic Data Capture (REDCap) platform. The questionnaire was designed to assess CHWs' capacity, practices, knowledge, and digital literacy related to hypertension and type 2 diabetes screening, referral, and follow-up. The instrument was administered at baseline and endline to evaluate changes associated with the intervention.

The questionnaire comprised six domains aligned with the study objectives.

Socio-demographic Characteristics

Participants' demographic and professional characteristics were collected, including age, sex, marital status, education level, village of residence, and years of service as a CHW. These variables were used to describe the study population and explore potential differences in outcomes by participant characteristics.

CHWs' Self-Reported Competence in Hypertension and Diabetes Screening, Referral, and Management

Self-reported competence was assessed using a 21-item Likert-scale instrument adapted from Bandura's Social Cognitive Theory (16). Participants rated their confidence in conducting hypertension and diabetes-related tasks, including measurement and interpretation of blood pressure and blood glucose, household health education, lifestyle counselling, risk factor identification, referral counselling, follow-up, medication adherence support, and use of digital screening tools. Composite mean scores were used to measure overall competency levels.

Knowledge Assessment on Hypertension and Diabetes

Knowledge was assessed using a 45-item structured true/false questionnaire. The diabetes component evaluated knowledge of disease causes, symptoms, insulin function, lifestyle risk factors, prevention, and complications. The hypertension component assessed understanding of blood pressure measurement, medication adherence, dietary and lifestyle modification, and complications such as cardiovascular disease, stroke, kidney disease, and visual impairment. Responses were coded as correct (1), incorrect (0), don't know (99), or refused (88). Total knowledge scores were calculated by summing correct responses, with higher scores indicating greater knowledge.

Intervention Measurements and Outcome Variables

The effectiveness of the intervention was evaluated using measurements aligned with Levels 1-3 of the Kirkpatrick Training Evaluation Model.

Reaction Outcomes (Level 1)

Participants' perceptions of the training were assessed after the intervention. Assessment included satisfaction with training content, relevance to CHW roles, acceptability of the training approach, feasibility of implementing acquired skills in community settings, and perceived usefulness of the training materials and digital tools.

Learning Outcomes (Level 2)

Learning outcomes focused on changes in knowledge, digital literacy, and self-reported competence. Key indicators included:

- Hypertension and diabetes knowledge scores.
- Self-reported competence in screening, referral, health promotion, counselling, and follow-up.
- Confidence in using digital tools for community-based NCD management.

Changes in these indicators between baseline and endline were used to assess knowledge and skill acquisition.

Behavioral Outcomes (Level 3)

Behavioral outcomes evaluated the extent to which CHWs applied newly acquired skills in their routine practice. Measurements included:

- Performance of blood pressure and blood glucose screening.
- Conduct of community-based health education and awareness activities.
- Referral and follow-up practices for individuals at risk of or living with hypertension and diabetes.
- Use of digital tools and eCHIS for data entry, screening, referral, and follow-up.
- Utilization of screening and referral algorithms during household visits.
- Adoption of recommended counselling practices for lifestyle modification and medication adherence.

For the supportive supervision group, additional monitoring data were collected through mentorship visits and supervision records to assess implementation fidelity, skill application, challenges encountered, and progress over the six-month intervention period. Together, these measures enabled comparison of outcomes across the three study groups (training plus supportive supervision, training only, and control) and provided evidence on the effectiveness of training and ongoing mentorship in strengthening CHW capacity for hypertension and diabetes prevention, screening, referral, and follow-up.

Data Collection and Measurements

Quantitative Methods

Data were collected at two time points (baseline and endline) aligned with the study objectives to capture the trajectory of the training and supportive supervision interventions. Baseline assessments were conducted before the intervention to establish CHWs' initial knowledge, self-reported competence, digital literacy, and perceptions of hypertension and diabetes screening, referral, and follow-up services. Immediate post-training assessments were conducted to evaluate participants' reactions to the training and short-term learning gains, while a six-month follow-up assessment examined knowledge retention, sustained competence, acceptability, and the application of acquired skills in routine community practice.

For Objective 1, pre- and post-intervention assessments were conducted using structured digital questionnaires. A prospective baseline survey was administered to CHWs before training to assess their existing capacity, knowledge, digital literacy, and perceptions regarding hypertension and diabetes prevention and management. Following the intervention, a retrospective acceptability and feasibility survey was administered to assess participants' perceptions of the training after they had sufficient opportunity to apply the acquired knowledge and skills in real-world settings. Responses were recorded using five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). Composite scores were calculated for domains including training acceptability, feasibility, digital literacy, and self-reported competence, with higher scores indicating more favorable perceptions and greater levels of competence. Details of the survey instruments are provided in Supplementary File 6.

For Objective 2, CHWs' knowledge of hypertension and diabetes and their ability to apply recommended practices in community service delivery were assessed using a standardized True/False questionnaire administered at baseline and six months post-intervention. The

questionnaire covered disease causes, risk factors, prevention, screening, referral, management, and complications of hypertension and diabetes. Each correct response was scored as 1 and each incorrect response as 0. Total knowledge scores were calculated by summing correct responses, with higher scores indicating greater knowledge.

In addition, intervention-related data were collected to assess changes in CHWs' capacity and practice following exposure to the different intervention approaches. These included self-reported competence in conducting blood pressure and blood glucose screening, health education and lifestyle counselling, referral and follow-up practices, use of digital health applications, and confidence in delivering community-based hypertension and diabetes services. For participants in the supportive supervision arm, supervision records and mentorship reports were also used to document engagement, implementation fidelity, and challenges experienced during the six-month intervention period.

Qualitative Methods

Qualitative data were collected through focus group discussions (FGDs) to gain a deeper understanding of participants' experiences, perceptions, and views regarding the training and supportive supervision interventions.

A total of four FGDs were conducted. One FGD comprising 12 CHPs, 4 from each study arm, was conducted at baseline and before the intervention to explore baseline perceptions, expectations, anticipated benefits, and concerns regarding training on hypertension and diabetes. Following the intervention, three separate FGDs were conducted, one for each study group, to explore participants' experiences with the intervention, perceived benefits and limitations, barriers and facilitators to implementation, challenges encountered during service delivery, and recommendations for improving future training and supportive supervision programs.

Participants were purposively selected based on their level of involvement in training and support supervision activities, supportive supervision, and household-level service delivery. Community Health Assistants (CHAs), county and sub-county health officials, and healthcare providers were selected to ensure representation of individuals involved in mentorship, supervision, implementation, and oversight of the intervention.

All FGDs were conducted in private and quiet environments and lasted between 55 and 90 minutes. Discussions were facilitated in English and Swahili to enable participants to express their views comfortably and openly. All sessions were digitally audio-recorded with

participants' consent and subsequently transcribed verbatim. The focus groups were facilitated by members of the project team who had formal training and prior experience in qualitative research methods and facilitation. The qualitative findings complemented the quantitative data by providing contextual insights into the acceptability, feasibility, implementation experiences, and perceived impact of the training and supportive supervision interventions.

Data Management and Analysis

Quantitative Data

Quantitative data were collected electronically using REDCap and exported to R software for cleaning and analysis. Data quality assurance procedures included range checks, consistency checks, and assessment of missing values. All participant records were anonymized using unique identification codes to ensure confidentiality.

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize participant characteristics and baseline study outcomes. Composite scores were generated for hypertension knowledge, diabetes knowledge, digital literacy, and self-reported competence by summing relevant questionnaire items. Knowledge scores were further categorized into low (≤50%), moderate (51-75%), and high (>75%) levels, while self-confidence scores were dichotomized into lower and higher confidence based on the mean score.

Group differences in categorical variables were assessed using Chi-square tests, while differences in ordinal practice-related outcomes measured using Likert scales were examined using the Kruskal-Wallis test. Continuous outcomes, including knowledge and self-confidence scores, were analyzed using linear regression models to estimate intervention effects while accounting for baseline differences between study groups.

To evaluate the impact of the interventions over time, a difference-in-differences (DiD) approach was implemented using mixed-effects linear regression models. The models accounted for repeated measurements within participants and assessed whether changes between baseline and endline differed significantly across the three study groups (training plus supportive supervision, training only, and control). The primary parameter of interest was the interaction between study group and time point. Predicted mean scores and post-estimation comparisons were used to quantify intervention effects. Statistical significance

was set at $p < 0.05$, with findings approaching significance ($p < 0.10$) also reported given the exploratory and feasibility nature of the study.

Qualitative Data Analysis

Audio recordings from focus group discussions were transcribed verbatim and translated into English. Data were analyzed using a thematic analysis approach. Transcripts were reviewed repeatedly to achieve familiarity with the data, after which codes were generated and grouped into broader categories and themes. Emerging themes focused on participants' experiences with the training and supportive supervision interventions, perceived benefits, barriers and facilitators to implementation, acceptability, feasibility, challenges encountered, and recommendations for improvement.

Integration of Quantitative and Qualitative Findings

Qualitative findings were used to triangulate and contextualize quantitative results. Participant narratives helped explain observed changes in hypertensive and diabetes knowledge, self-confidence, and service delivery practices across the intervention groups. The integration of quantitative and qualitative evidence provided a more comprehensive understanding of the effectiveness, acceptability, feasibility, and implementation of the training and supportive supervision interventions among Community Health Workers.

Ethical Considerations

Ethical approval was obtained from JOOTRH-ERC, IRB-UA, NACOSTI, and the Siaya County Health Research Ethics Committee. All participants provided informed consent. Data collection adhered to principles of confidentiality, and data were anonymized during analysis and reporting.

Results

Socio-demographic Characteristics

The study initially recruited 39 CHWs across the 3 study arms. However, one participant in the control group did not complete the endline assessment, resulting in 38 CHWs being included in the final analysis. The study comprised 11 in the full-intervention arm, 11 in the training-only arm, and 16 in the control arm (Table 1).

The majority of participants were female (33; 87%), and the mean age was 48 years (SD = 9). Participants in the full-intervention arm were slightly older (mean age = 51 years, SD = 6) than those in the training-only (49 years, SD = 9) and control arms (45 years, SD = 11). More

than half of the participants (58%) had attained primary-level education, while 24% had completed secondary education. The average duration of service as a CHW was 13 years (SD = 6) (Table 1).

Table 1. Sociodemographic characteristics of study participants

Characteristic	Overall (n=38)	Full Intervention (n=11)	Training only (n=11)	Control (n=16)
Gender				
Female	33 (87%)	9 (82%)	10 (91%)	14 (88%)
Male	5 (13%)	2 (18%)	1 (9.1%)	2 (13%)
Age, years, mean (SD)	48 (9)	51 (6)	49 (9)	45 (11)
Education level				
Primary	22 (58%)	5 (45%)	8 (73%)	9 (56%)
Secondary	9 (24%)	2 (18%)	2 (18%)	5 (31%)
Certificate	5 (13%)	4 (36%)	1 (9.1%)	0
Diploma	2 (5.3%)	0	0	2 (13%)
Years in service, mean (SD)	13 (6)	12 (3)	15 (9)	13 (6)

Note. Values are n (%) unless stated. SD, standard deviation. Percentages are within each column.

Effect of Training and Supportive Supervision on CHWs' Knowledge of Hypertension and Diabetes

Figures 2 and 3 summarize changes in diabetes and hypertension knowledge among Community Health Workers (CHWs) across the three study arms at baseline and endline.

Diabetes Knowledge

At baseline, diabetes knowledge was generally low across all study arms, and no participant was classified as having high diabetes knowledge (Table 2). By endline, improvements in diabetes knowledge were observed across all groups, although the magnitude of change varied.

The full-intervention arm demonstrated the most steady pattern, with the low-knowledge category eliminated and 18.2% (2/11) of participants attaining high diabetes knowledge at endline. In the training-only arm, 9.1% (1/11) attained high diabetes knowledge, although

some participants remained in the low-knowledge category. Improvements were also observed in the control arm, where 12.5% (2/16) attained high diabetes knowledge by endline. Overall, CHWs receiving both training and supportive supervision demonstrated a stronger shift toward higher diabetes knowledge than those receiving training alone or routine practice.

Table 2. Diabetes knowledge at baseline and endline

Diabetes knowledge -Baseline	**Full intervention**	**Training only**	**Control**	**p-value**
Diabetes knowledge				p = 0.345
Low	3 (27.3%)	6 (54.5%)	5 (31.3%)	
Moderate	8 (72.7%)	5 (45.5%)	11 (68.8%)	
High	0	0	0	
Diabetes knowledge - Endline	Full intervention	Training only	Control	p-value
Diabetes knowledge				p = 0.292
Low	0	4 (36.4%)	5 (31.3%)	
Moderate	9 (81.8%)	6 (54.5%)	9 (56.3%)	
High	2 (18.2%)	1 (9.1%)	2 (12.5%)	

Note. Values are n (%) within each study arm. p-values refer to the comparison across the three arms.

Hypertension Knowledge

Hypertension knowledge was generally higher than diabetes knowledge at baseline, reflecting greater prior familiarity with hypertension-related concepts among CHWs. At endline, both intervention arms demonstrated improvements, particularly through the elimination of the low-knowledge category.

In the full-intervention arm, the proportion of CHWs with high hypertension knowledge increased from 72.7% (8/11) at baseline to 81.8% (9/11) at endline, while no participants remained in the low-knowledge category. In the training-only arm, high hypertension knowledge increased from 36.4% (4/11) to 63.6% (7/11), with low knowledge similarly eliminated. Improvements were also observed in the control arm, although two participants remained in the low-knowledge category at endline. These findings suggest that both

intervention approaches contributed to improved hypertension knowledge among CHWs. (Table 3).

Table 3. Hypertension knowledge at baseline and endline

Hypertension knowledge -Baseline	**Full intervention**	**Training only**	**Control**	**p-value**
Hypertension knowledge				p = 0.369
Low	1 (9.1%)	1 (9.1%)	1 (6.3%)	
Moderate	2 (18.2%)	6 (54.5%)	4 (25.0%)	
High	8 (72.7%)	4 (36.4%)	11 (68.8%)	
Hypertension knowledge - Endline	**Full intervention**	**Training only**	**Control**	**p-value**
Hypertension knowledge				p = 0.306
Low	0	0	2 (12.5%)	
Moderate	2 (18.2%)	4 (36.4%)	2 (12.5%)	
High	9 (81.8%)	7 (63.6%)	12 (75.0%)	

Note. Values are n (%) within each study arm. p-values refer to the comparison across the three arms.

Practice and Ability of CHWs to Perform Assessed Activities

Significant improvements were observed across several domains of CHWs' perceived ability to perform hypertension- and diabetes-related tasks. Confidence in conducting capillary glucose screening improved substantially among participants in the intervention arms, with statistically significant differences observed at endline (p = 0.010). Similarly, confidence in using NCD risk-assessment tools increased significantly across intervention groups (p = 0.006).

The ability to provide referral counselling also improved considerably following the interventions, with significant differences between groups at endline (p = 0.006). Confidence in advising clients about social support groups for NCD management increased in the intervention arms and reached statistical significance (p = 0.048).

Confidence in interpreting blood pressure measurements improved significantly over time, with differences between groups remaining significant at endline (p = 0.026). Similarly,

confidence in conducting household communication on hypertension and diabetes improved among intervention participants and was significantly different across groups at endline (p = 0.019). The largest improvement was observed in CHWs' confidence in advising clients about NCD risk factors, where endline differences were highly significant (p = 0.001).

Overall, participants receiving training, particularly when combined with supportive supervision, reported greater confidence in carrying out hypertension- and diabetes-related screening, education, counselling, and referral activities than those in the control group.

Table 4. Self-reported confidence in hypertension- and diabetes-related tasks

Baseline - practice item/response	**Full intervention**	**Training only**	**Control**	**p-value**
I am confident in measuring blood pressure				p = 0.001
Strongly disagree	0	6	2	
Disagree	5	3	1	
Neutral	2	0	1	
Agree	4	1	4	
Strongly agree	0	1	8	
I am confident in interpreting blood pressure measurements				p = 0.042
Strongly disagree	1	7	2	
Disagree	4	3	2	
Neutral	2	1	4	
Agree	3	0	6	
Strongly agree	1	0	2	
I am confident in conducting household communication on HTN and T2D				p = 0.445
Strongly disagree	1	4	2	
Disagree	7	5	7	
Neutral	1	2	2	

Baseline - practice item/response	Full intervention	Training only	Control	p-value
Agree	1	0	4	
Strongly agree	1	0	1	
I am confident in advising clients about risk factors associated with NCDs				p = 0.579
Strongly disagree	0	3	2	
Disagree	7	5	8	
Neutral	2	2	3	
Agree	1	1	3	
Strongly agree	1	0	0	
I am confident in conducting capillary glucose test screening				p = 0.189
Strongly disagree	2	3	3	
Disagree	7	7	5	
Neutral	0	1	5	
Agree	2	0	3	
Strongly agree	0	0	0	
I am confident to screen clients at risk of NCDs using risk assessment tools				p = 0.186
Strongly disagree	2	3	3	
Disagree	2	7	6	
Neutral	4	0	2	
Agree	3	1	5	
Strongly agree	0	0	0	
I am confident to provide referral counselling to clients before referral				p = 0.116

Baseline - practice item/response	**Full intervention**	**Training only**	**Control**	**p-value**
Strongly disagree	0	0	1	
Disagree	1	2	1	
Neutral	4	8	4	
Agree	1	1	0	
Strongly agree	5	0	10	
I am confident to advise clients on social support groups for NCD clients				p = 0.084
Strongly disagree	4	1	1	
Disagree	3	7	3	
Neutral	2	1	4	
Agree	1	1	7	
Strongly agree	1	1	1	
Endline - practice item/response	Full intervention	Training only	Control	p-value
I am confident in measuring blood pressure				p = 0.232
Strongly disagree	0	1	1	
Disagree	0	0	2	
Neutral	0	0	1	
Agree	6	2	8	
Strongly agree	5	8	4	
I am confident in interpreting blood pressure measurements				p = 0.026
Strongly disagree	0	2	1	
Disagree	1	0	3	
Neutral	0	0	5	

Baseline - practice item/response	Full intervention	Training only	Control	p-value
Agree	4	2	5	
Strongly agree	6	7	2	
I am confident to conduct household communication on HTN and T2D				p = 0.019
Strongly disagree	0	2	1	
Disagree	2	0	7	
Neutral	1	0	4	
Agree	3	2	3	
Strongly agree	5	7	1	
I am confident in advising clients about risk factors associated with NCDs				p = 0.001
Strongly disagree	0	2	1	
Disagree	0	0	5	
Neutral	0	0	3	
Agree	5	1	7	
Strongly agree	6	8	0	
I am confident to conduct capillary glucose test screening				p = 0.01
Strongly disagree	0	1	1	
Disagree	1	1	8	
Neutral	0	2	5	
Agree	6	3	2	
Strongly agree	4	4	0	
I am confident to screen clients at risk of NCDs using risk assessment tools				p = 0.006

Baseline - practice item/response	Full intervention	Training only	Control	p-value
Strongly disagree	0	1	4	
Disagree	0	1	5	
Neutral	0	2	5	
Agree	7	4	2	
Strongly agree	4	3	0	
I am confident to provide referral counselling to clients before referral				p = 0.006
Strongly disagree	0	0	0	
Disagree	0	1	0	
Neutral	0	1	5	
Agree	0	1	6	
Strongly agree	11	8	5	
I am confident to advise clients on social support groups for NCD clients				p = 0.048
Strongly disagree	0	1	1	
Disagree	1	1	3	
Neutral	0	2	4	
Agree	5	1	8	
Strongly agree	5	6	0	

Note. Values are numbers of participants. Eight of the 21 self-efficacy items are shown. p-values refer to the between-arm comparison of Likert responses (Kruskal–Wallis test).

Self-Confidence / Self-Efficacy

Self-efficacy demonstrated one of the strongest improvements observed in the study. At baseline, low self-confidence was common across the intervention groups. By endline, substantial gains in confidence were evident, particularly among CHWs who received training and supportive supervision.

In the full-intervention arm, low self-confidence was eliminated, while the proportion reporting high self-confidence increased from 18.2% (2/11) at baseline to 100% (11/11) at endline. In the training-only arm, high self-confidence increased from 9.1% (1/11) to 81.8% (9/11), with only two participants remaining in the lower-confidence category. In the control arm, confidence levels changed little over time, despite a modest increase in the number reporting higher confidence.

These findings indicate that training substantially improved CHWs' confidence to perform hypertension- and diabetes-related tasks, with supportive supervision further reinforcing these gains by facilitating practical application of newly acquired knowledge and skills. See Table 5 below.

Table 5. Self-efficacy at baseline and endline

Self-confidence - Baseline	**Full intervention**	**Training only**	**Control**	**p-value**
Confidence level				p = 0.046
Lower self-confidence	9 (81.8%)	10 (90.9%)	8 (50.0%)	
Higher self-confidence	2 (18.2%)	1 (9.1%)	8 (50.0%)	
Self-confidence - Endline	Full intervention	Training only	Control	p-value
Confidence level				p = 0.028
Lower self-confidence	0	2 (18.2%)	7 (43.8%)	
Higher self-confidence	11 (100.0%)	9 (81.8%)	9 (56.3%)	

Note. Values are n (%) within each study arm. Self-confidence was dichotomized as lower or higher relative to the mean score. p-values refer to the comparison across the three arms.

Self-efficacy among CHWs increased markedly in the full-intervention group, eliminating low confidence and greatly increasing high confidence, underscoring the role of supervision in boosting practical capability.

Effect of Training and Supportive Supervision on CHWs

Regression analyses demonstrated varying effects of the interventions on diabetes knowledge, hypertension knowledge, and self-efficacy (Table 6).

For diabetes knowledge, the full-intervention arm showed a positive trend compared with the control group (coefficient - 2.32, 95% CI: -0.12 to 4.75; p = 0.062), although this did not reach conventional levels of statistical significance. The training-only arm showed a smaller, non-significant improvement (coefficient = 1.05, 95% CI: -1.39 to 3.48; p = 0.400).

For hypertension knowledge, the full-intervention arm also demonstrated a positive but non-significant effect compared with the control group (coefficient = 2.23, 95% CI: -0.29 to 4.74; p = 0.083). In contrast, the training-only arm achieved a statistically significant improvement in hypertension knowledge (coefficient = 3.23, 95% CI: 0.71 to 5.74; p = 0.012).

The strongest intervention effects were observed for self-efficacy. Compared with the control group, both the full-intervention arm (coefficient = 33.06, 95% CI: 17.81 to 48.31; p < 0.001) and the training-only arm (coefficient = 34.06, 95% CI: 18.81 to 49.31; p < 0.001) demonstrated large and highly significant improvements in self-confidence.

Taken together, these findings suggest that the interventions were particularly effective in strengthening CHWs' self-efficacy, while improvements in knowledge outcomes were more modest and varied by condition and intervention type.

Table 6: Training and supportive supervision effect across the arms/groups

Outcome	**Full Intervention vs control Coefficient (95% CI)**	**p-value**	**Training only vs control Coefficient (95% CI)**	**p-value**
Diabetes knowledge	2.32(-0.12-4.75)	0.062	1.05(-1.39-3.48)	0.400
Hypertension knowledge	2.23(-0.29-4.74)	0.083	3.23(0.71-5.74)	0.012
Self-confidence	33.06(17.81-48.31)	<0.001	34.06(18.81-49.31)	<0.001

Note. Coefficients are adjusted differences in score relative to the control arm (reference), estimated by linear regression adjusted for baseline score. CI, confidence interval.

Qualitative findings

Qualitative findings from the focus group discussions revealed that the training and supportive supervision interventions were generally acceptable and perceived as beneficial in strengthening CHWs' capacity to prevent, identify, refer, and follow up individuals with hypertension and diabetes. Six interrelated themes emerged: (1) improved knowledge and understanding of hypertension and diabetes, (2) enhanced confidence and competence in service delivery, (3) supportive supervision as a mechanism for translating knowledge into

practice, (4) strengthened use of digital health tools, (5) barriers to implementation, and (6) perceived benefits for community health service delivery. While positive perceptions were reported across all intervention groups, participants receiving supportive supervision, particularly physical supportive supervision, described greater opportunities for mentorship, problem-solving, and sustained skills application.

Improved Knowledge and Understanding of Hypertension and Diabetes

Participants across the training groups reported that the training enhanced their understanding of hypertension and diabetes, including disease risk factors, prevention strategies, screening procedures, referral pathways, and follow-up practices. Many indicated that prior to the intervention, non-communicable disease services received limited attention during routine household visits.

A participant from the training-only group explained:

> *"Before this training, I could only give general health messages. Now I understand the risk factors for hypertension and diabetes and can explain them to community members more confidently." (CHW, Training-Only Group)*

Similarly, another participant stated:

> *"The training opened my eyes to things I did not know before, especially on screening and referral. I now feel better prepared to support households with these conditions." (CHW, Training-Only Group)*

Participants described gaining a better understanding of the importance of early identification and referral of individuals at risk of hypertension and diabetes. This increased knowledge was perceived as contributing to improved community awareness and engagement in preventive health practices.

Enhanced Confidence and Competence in Community Service Delivery

Participants reported that the training increased their confidence in conducting community-based screening, providing health education, counselling clients, and making referrals to health facilities. They noted feeling more prepared to respond to questions from community members and provide accurate information regarding hypertension and diabetes.

One participant observed:

> *"I now have confidence when talking to households about hypertension and diabetes because I understand the conditions much better than before." (CHW, Training-Only Group)*

However, some participants from the training-only group indicated that although their knowledge improved, confidence in applying new skills sometimes declined over time without continued guidance and reinforcement.

As one participant explained:

> *"After the training, we tried to apply what we had learned, but there were situations where we needed advice, and there was no one immediately available to consult." (CHW, Training-Only Group)*

Supportive Supervision Facilitated Translation of Knowledge into Practice

Participants receiving supportive supervision consistently described mentorship and follow-up support as critical for reinforcing training content and strengthening practical implementation. Both virtual and physical supervision provided opportunities to discuss challenges encountered during service delivery and receive technical guidance.

Participants in the virtual supervision arm appreciated the opportunity for continuous interaction with supervisors and peers.

One participant stated:

> *"The virtual meetings reminded us of what we learned during training and allowed us to discuss challenges we were facing in the field." (CHW, virtually supported participant, in the Supportive Supervision Group)*

Another CHP who had been virtually supported noted:

> *"Whenever I was unsure about a referral or screening procedure, I could raise the issue during the online sessions and receive guidance from the supervisors." (CHW, Virtually Supported participant in the support supervision group)*

Participants highlighted further that the virtual discussions promoted peer learning and helped maintain motivation throughout the intervention period.

Physical Supportive Supervision Strengthened Practical Skills and Accountability

Participants in the physical supportive supervision group described face-to-face mentorship as particularly valuable because supervisors could directly observe service delivery activities, identify mistakes, and provide immediate feedback.

A participant explained:

> *"The supervisor observed me while conducting blood pressure screening and corrected mistakes immediately. That practical guidance improved my*

confidence." (CHW, Physical supported participant in Supportive Supervision Group)

Another participant emphasized the importance of real-time feedback:

"During supervision visits, we received feedback on our work and discussed challenges we were experiencing. This helped us improve the way we delivered services." (CHW, Physical supported participant in Supportive Supervision Group)

Several participants also reported that regular supervisory visits increased accountability and encouraged consistent implementation of acquired skills.

As one participant stated:

"It is one thing to learn in a classroom and another to apply the skills in the community. The supportive supervision helped bridge that gap." (CHW, physically supported in Supportive Supervision Group)

Participants further described supervisory visits as motivating and supportive, fostering stronger relationships between CHWs and supervisors.

Improved Use of Digital Health Tools

Participants in both supportive supervision groups reported improvements in their ability to use digital health applications and electronic reporting tools. Virtual supervision participants particularly valued ongoing technical support related to digital platforms currently in use, eCHIS.

One participant observed:

"Using the digital tools and eCHIS became easier because we were guided continuously after the training." (CHW, Supportive Supervision Group)

Participants indicated that improved digital literacy enhanced their efficiency in recording, accessing, and sharing information related to hypertension and diabetes services.

Barriers to Intervention Implementation

Despite generally positive experiences, participants identified several barriers that affected implementation. Participants in the support supervision group reported challenges related to internet connectivity, network coverage, and occasional disruptions during online or sometimes virtual engagements or meetings with their mentors.

One participant explained:

"The online support was convenient to me sometimes, but network connectivity was not always reliable, especially when working in our remote areas." (CHW)

Participants across all groups also reported challenges associated with workload, limited screening supplies, transport constraints, and difficulties reaching some households. However, many indicated that supportive supervision helped identify practical solutions to some of these barriers.

Perceived Benefits for Community Health Service Delivery

Participants perceived that the intervention improved the quality of hypertension and diabetes services provided within communities. They reported increased confidence in conducting screening activities, enhanced referral practices, and greater community awareness regarding non-communicable diseases.

A participant summarized the perceived value of the intervention by stating:

"The training gave me the knowledge, but the supervision helped me apply that knowledge in real household visits, and my community outreach program…….where I can now take blood pressure measurements, blood glucose, and counsel my clients appropriately." (CHW, Post-Intervention FGD)

Another participant added:

"Continuous support made a difference because we were not left on our own after the training." (CHW, Post-Intervention FGD)

Overall, participants perceived supportive supervision as an important complement to training, helping to sustain learning, strengthen competence, and facilitate the application of acquired knowledge and skills in routine community practice. While training improved knowledge and awareness across all groups, supportive supervision, particularly face-to-face supervision, played an important role in translating learning into effective service delivery.

Discussion

This mixed-methods quasi-experimental study examined the effects of training and supportive supervision on CHWs' knowledge, self-efficacy, and capacity to conduct hypertension and diabetes screening and referral in rural Kenya. The findings suggest that training improved CHWs' knowledge and practice-related competencies, while supportive supervision played an important role in reinforcing learning, strengthening confidence, and facilitating the translation of acquired knowledge into routine service delivery. Although improvements in diabetes and hypertension knowledge were observed across intervention

arms, the most consistent and statistically significant gains were observed in self-efficacy and practice-related competencies. Qualitative findings complemented these results by demonstrating that mentorship, feedback, and ongoing problem-solving support enabled CHWs to apply newly acquired skills more confidently in community settings.

As a feasibility study, the primary aim was to assess the potential effects of the interventions and to generate preliminary effect estimates to inform future larger-scale studies rather than to establish definitive intervention effectiveness. The observed improvements across multiple outcomes provide encouraging evidence regarding the potential value of combining training with supportive supervision in strengthening community-based non-communicable disease (NCD) services.

Diabetes Knowledge

Diabetes knowledge improved across all study arms, with the most favorable changes observed among CHWs who received both training and supportive supervision. In the full-intervention arm, low diabetes knowledge was eliminated, and a greater proportion of participants attained high knowledge levels by endline compared with the training-only and control groups. Although the regression analysis indicated a positive trend favoring the full intervention, the effect did not reach conventional levels of statistical significance. This finding is not unexpected given the small sample size and feasibility nature of the study.

The observed improvements may reflect the relatively low baseline understanding of diabetes among CHWs, creating greater opportunity for knowledge gains following training (17–19). Qualitative findings supported this interpretation, with participants reporting improved understanding of diabetes risk factors, prevention strategies, screening procedures, referral pathways, and follow-up practices. Similar improvements in diabetes-related knowledge among community health workers have been reported in other low- and middle-income countries following structured training interventions (20). Together, these findings suggest that training can strengthen CHWs' capacity to support diabetes prevention and management, while supportive supervision may help consolidate and sustain these gains through ongoing reinforcement and mentorship (20).

Hypertension Knowledge

Hypertension knowledge was generally higher at baseline than diabetes knowledge, suggesting that CHWs were more familiar with hypertension-related concepts before the intervention. Nevertheless, improvements were observed across intervention arms,

particularly through the elimination of low-knowledge categories among CHWs who received either training alone or training combined with supportive supervision.

Interestingly, the statistically significant improvement observed in the training-only arm suggests that structured training may be sufficient to improve hypertension-related knowledge among CHWs when baseline familiarity is already relatively high. The additional benefit of supportive supervision was less apparent for knowledge acquisition alone, although qualitative findings suggest that supervision enhanced the application of this knowledge in practice (21). Similar findings have been reported in task-sharing and community-based hypertension programs, where CHWs have demonstrated effectiveness in blood pressure screening, patient education, and referral following targeted capacity-building interventions (18,22).

Self-Efficacy and Practice Competence

The most notable finding of this study was the substantial improvement in CHWs' self-efficacy. Both intervention arms demonstrated large and statistically significant gains in confidence compared with the control group. In the full-intervention arm, low self-confidence was eliminated by endline, while all participants reported high self-confidence. Similar, although slightly less pronounced, improvements were observed in the training-only arm.

These findings are important because self-efficacy is a key determinant of health-worker performance and behavior change. CHWs who are confident in their ability to perform screening, counselling, referral, and follow-up activities are more likely to apply these skills consistently in routine practice. The quantitative findings were reinforced by qualitative accounts in which participants described feeling more confident discussing hypertension and diabetes with community members, conducting screening activities, and making referrals.

The significant improvements observed in practical competencies, including capillary glucose testing, risk assessment, referral counselling, communication with households, and counselling on NCD risk factors, further support the role of training and supportive supervision in strengthening service delivery capacity. Participants receiving supportive supervision frequently described mentorship, feedback, and troubleshooting support as critical factors that helped bridge the gap between classroom learning and real-world implementation. These findings are consistent with evidence showing that supportive supervision enhances health worker motivation, competence, accountability, and performance beyond what can be achieved through one-off training alone (23–30).

Strengths and Limitations

A major strength of this study is its three-arm quasi-experimental design, which enabled comparison of training plus supportive supervision, training only, and routine practice. This design provided valuable insights into the relative contribution of supportive supervision beyond training alone. The mixed-methods approach further strengthened the study by enabling triangulation of quantitative and qualitative findings and providing a richer understanding of how and why the intervention influenced participant outcomes.

Several limitations should be acknowledged. First, the small sample size limited statistical power and may have reduced the ability to detect significant differences in some outcomes, particularly knowledge measures. Second, the relatively short follow-up period did not allow assessment of the long-term sustainability of observed improvements. Third, the study was conducted within a specific rural Kenyan context, which may limit generalizability to other settings. Fourth, baseline imbalances existed between arms (for example, higher baseline self-confidence and confidence in measuring blood pressure in the control arm), and the practice items were compared between arms at endline rather than modelled as change over time. Finally, because participants were not randomly assigned to study arms, the possibility of residual confounding cannot be excluded. Nevertheless, the study provides important preliminary evidence regarding the feasibility and potential value of integrating supportive supervision into CHW-based NCD programs.

Implications for Policy and Practice

The findings have several practical implications for community health systems. First, training alone may be insufficient to maximize CHW performance in NCD prevention and management. Integrating structured supportive supervision into routine community health programs may strengthen confidence, improve service delivery competencies, and support the consistent application of acquired knowledge. Second, different NCD areas may require different capacity-building approaches. Areas such as diabetes and hypertension measurement interpretation, where baseline knowledge was relatively limited, may benefit from more intensive reinforcement and continuous support. Finally, strengthening CHW self-efficacy may represent an important pathway through which community health programs improve screening, referral, and early detection of NCDs at the community level.

Future Research

Future studies should include larger samples, longer follow-up periods, and more robust quasi-experimental or randomized designs to confirm the effectiveness of supportive supervision for strengthening NCD service delivery. Research should also assess whether improvements in CHW knowledge, confidence, and competence translate into improved screening coverage, referral completion, treatment initiation, and patient health outcomes. Economic evaluations would further help determine the cost-effectiveness and scalability of supportive supervision models within community health systems.

Conclusion

This study demonstrated that training improved CHWs' knowledge, self-efficacy, and capacity to support hypertension and diabetes screening and referral in rural Kenya. Supportive supervision complemented training by strengthening confidence, reinforcing learning, and facilitating the application of acquired knowledge in routine practice. While knowledge gains were modest and varied across conditions, substantial improvements were observed in self-efficacy and practice-related competencies, highlighting the importance of ongoing mentorship and feedback. These findings provide preliminary evidence supporting the integration of supportive supervision into community health programs and offer important insights for the design of larger studies aimed at strengthening community-based NCD prevention and management.

Data availability

Data are accessible and available upon reasonable request to the corresponding author (SOO) to ensure that the use is in line with the terms of ethics approvals and principles.

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Contributions

SOO conceptualized the study, conducted the literature review, developed data collection tools, analyzed the data, and wrote the manuscript. AO, JO, DA, JB, and JVO contributed to the study conception and reviewed the manuscript. SOO helped with programming data collection tools in REDCap and handled data cleaning and analysis. AO, JO, JB, HH, JU, EM, and JVO provided technical guidance and critical feedback on the manuscript. All authors read and approved the final version. SOO assumes full responsibility for the study, including data access and publication decisions.

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Ethics declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by Jaramogi Teaching and Referral Hospital (JOOTRH), Jaramogi University of Science and Technology (JOOUST), and the National Commission for Science, Technology, and Innovation (NACOSTI), with approval license numbers... Additionally, approvals were obtained from the University of Antwerp, ERC, the County Government of Kisumu, and the individuals who participated in the study both before and during the study period. The consenting process ensured that participants understood the voluntary nature of the study, along with the risks and benefits. We confirm that all methods were carried out in accordance with the guidelines and standards currently available and adhered to the protocol.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Appendices

Appendix 1. Questionnaires

Instruments used to assess the current practice and capacity of community health workers in hypertension and type 2 diabetes screening and referral, including digital literacy.

Table A1. Socio-demographic questions

No.	Question	Response options
	Participant ID	_____
1.	Gender	Female Male Other
2.	Age (years)	_____
3.	Level of education	KCPE KCSE Certificate Diploma Degree Other
4.	Marital status	Single Married Separated Widowed
5.	Residence (village code/ID)	_____
6.	Years in community service (complete years since first deployment as CHP)	Complete years

Table A2. Perceived usefulness of a digital application for CHW work

No.	Statement: a digital application would help me to…	Response (1 = strongly disagree; 5 = strongly agree)
10.1	Have faster data access	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.2	Easy access to health education	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.3	Easy data collection	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.4	Easy data dissemination	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.5	Easy diagnosis of illness	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.6	Improved screening	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.7	Timely Referrals	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.8	Structured Follow-up	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.9	Improve community health engagement	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.10	Reduce errors in data, screening and referral	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

No.	Statement: a digital application would help me to…	Response (1 = strongly disagree; 5 = strongly agree)
10.11	In chronic disease management	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.12	Reduce duplication of activities	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.13	Increase frequent contact with community members	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.14	Increase frequent contact with healthcare providers	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
12.6	Others (specify)	_____

Table A3. Perceived barriers to digital health use

Barriers to digital health use: statement	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Limited or No Internet Access: How much do you agree with the statement: "Limited or no internet access is a barrier for individuals in my community when accessing digital health services?"	☐	☐	☐	☐	☐
Lack of Power Supply: How much do you agree with the statement: "Lack of electricity is a significant barrier for individuals in my community when using digital health applications?"	☐	☐	☐	☐	☐
Inadequate Device Compatibility: How much do you agree with the statement: "Using non-Android supported devices limits access to digital health services in my community?"	☐	☐	☐	☐	☐
High Cost of Internet Services: How much do you agree with the statement: "The high cost of internet services is a barrier for individuals in my community to access digital health resources?"	☐	☐	☐	☐	☐
High Cost of Devices: How much do you agree with the statement: "The high cost of smartphones or other devices prevents individuals in my community from accessing digital health services?"	☐	☐	☐	☐	☐

Barriers to digital health use: statement	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
Limited Experience with Technology: How much do you agree with the statement: "Limited experience with technology among community members is a barrier to using digital health services?"	☐	☐	☐	☐	☐
Preference for Face-to-Face Interaction: How much do you agree with the statement: "Many individuals in my community prefer face-to-face interactions over using digital health services?"	☐	☐	☐	☐	☐
Trust in Technology Reliability: How much do you trust that digital technologies (e.g., apps, devices) provide reliable information for health management?	☐	☐	☐	☐	☐
Confidence in Digital Interactions: I feel confident when interacting with digital health technologies (e.g., telemedicine platforms, health monitoring apps).	☐	☐	☐	☐	☐
Perceived Security of Digital Health Data: I believe that my personal health data is secure when using digital health technologies.	☐	☐	☐	☐	☐
Trust in Automation: I trust automated systems (e.g., AI diagnostics, robotic surgeries) to make accurate decisions regarding my health.	☐	☐	☐	☐	☐
Overall, Trust in Digital Health Technologies: Overall, I trust digital technologies to improve my healthcare experience.	☐	☐	☐	☐	☐

Table A4. Self-reported confidence in hypertension and diabetes prevention and management tasks

Self-reported confidence: statement	**Strongly disagree (1)**	**Disagree (2)**	**Neither agree nor disagree (3)**	**Agree (4)**	**Strongly agree (5)**
I am confident to measure blood pressure?	☐	☐	☐	☐	☐
I am confident to interpret blood pressure measurements?	☐	☐	☐	☐	☐
I am confident to conduct house hold communication on HTN and T2D?	☐	☐	☐	☐	☐
I am confident to advise clients a bout risk factors associated with NCDs?	☐	☐	☐	☐	☐
I am confident to advise clients about harm of drinking any form of alcohol?	☐	☐	☐	☐	☐
I am confident to advise clients about the harm of cigarette smoking and any other forms of cigars?	☐	☐	☐	☐	☐
I am confident to advise clients on benefits of regular physical activity?	☐	☐	☐	☐	☐
I am confident to advise clients about benefits of fruits and vegetables?	☐	☐	☐	☐	☐
I feel confident to advise clients on NCD prevention techniques?	☐	☐	☐	☐	☐
I am confident to provide guidance on medication adherence?	☐	☐	☐	☐	☐
I am confident to screen clients at risk of NCDs in the community by use of risk assessment tools?	☐	☐	☐	☐	☐
I am confident to provide referral counselling to clients before referral?	☐	☐	☐	☐	☐
Am confidently aware of complications of hypertension?	☐	☐	☐	☐	☐
I am confident to conduct capillary glucose test screening?	☐	☐	☐	☐	☐
I am confident to advise diabetes patients about the foot care?	☐	☐	☐	☐	☐

Self-reported confidence: statement	Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)
I am confident to advise clients on social support groups for NCD clients?	☐	☐	☐	☐	☐
I am confident to advise treatment supporters/caregivers on care of clients with NCDs	☐	☐	☐	☐	☐
I am confident to advise clients on complications of diabetes mellitus?	☐	☐	☐	☐	☐
I am confident in interpreting blood glucose reading?	☐	☐	☐	☐	☐
Am confident to advise clients with diabetes after screening?	☐	☐	☐	☐	☐
I am confident to use digital screening and referral tool for people at risk of HTN/T2D	☐	☐	☐	☐	☐

Table A5. Availability of community-based registers for hypertension and diabetes screening and referral

No.	Question	Response
12.18	Do you currently have a community-based digital Register for HTN/DM screening and referral? If YES, List all observed registers	☐ Yes ☐ No
12.19	Do you currently have any community-based register for HTN and DM screening and referral? If YES, List all observed registers	☐ Yes ☐ No

Table A6. Diabetes and hypertension knowledge assessment (true/false items; 99 = do not know, 88 = refused)

No.	Statement	Response
Diabetes Knowledge		
Q13	Eating too much sugar and other sweet foods is a cause of diabetes.	☐ False ☐ True
Q14	The usual cause of diabetes is a lack of effective insulin in the body. *Interviewer hint: insulin "the hormone which is responsible for regulating the glucose/sugar in the blood and controls the normality of blood glucose"*	☐ False ☐ True
Q15	Diabetes is caused by failure of the kidneys to keep sugar out of the urine.	☐ False ☐ True

No.	Statement	Response
Q16	Kidneys produce insulin. *Interviewer hint: insulin "the hormone which is responsible for regulating the glucose/sugar in the blood and controls the normality of blood glucose"*	☐ False ☐ True
Q17	In untreated diabetes, the amount of sugar in the blood usually increases.	☐ False ☐ True
Q18	If I am diabetic, my children have a higher chance of being diabetic.	☐ False ☐ True
Q19	Diabetes can be cured.	☐ False ☐ True
Q20	A fasting blood sugar level of 3.5mmol/l is too high. *Interviewer hint: Show a photo of On-Call Plus*	☐ False ☐ True
Q21	The best way to check my diabetes is by testing my urine.	☐ False ☐ True
Q22	Regular exercise will increase the need for insulin or other diabetic medication.	☐ False ☐ True
Q23	There are two main types of diabetes: Type 1 (insulin-dependent) and Type 2 (non-insulin-dependent). *Interviewer hint: diabetes "type 1" occurs at any age (mostly young people) and "type 2" occurs mostly in adults*	☐ False ☐ True
Q24	An insulin reaction is caused by too much food.	☐ False ☐ True
Q25	Medication is more important than diet and exercise to control my diabetes.	☐ False ☐ True
Q26	Diabetes often causes poor circulation.	☐ False ☐ True
Q27	Cuts and abrasions in diabetes heal more slowly.	☐ False ☐ True
Q28	Diabetes should take extra care when cutting their toenails.	☐ False ☐ True
Q29	A person with diabetes should cleanse a cut with iodine and alcohol.	☐ False ☐ True
Q30	The way I prepare my food is as important as the foods I eat.	☐ False ☐ True
Q31	Diabetes can cause loss of feeling in my hands, fingers, and feet.	☐ False ☐ True
Q32	Shaking and sweating are signs of low blood sugar.	☐ False ☐ True
Q33	Frequent urination and thirst are signs of low blood sugar.	☐ False ☐ True
Q34	Tight elastic shoes or socks are not bad for diabetics.	☐ False ☐ True
Q35	A diabetic diet consists mostly of special foods.	☐ False ☐ True
Hypertension Knowledge		
Q36	Increased diastolic blood pressure also indicates increased blood pressure. *Interviewer hint: Show a photo of OMRON machine*	☐ False ☐ True

No.	Statement	Response
Q37	High diastolic or systolic blood pressure indicates increased blood pressure. *Interviewer hint: Show a photo of OMRON machine*	☐ False ☐ True
Q38	Drugs for increased blood pressure must be taken every day.	☐ False ☐ True
Q39	Individuals with increased blood pressure must take their medication only when they feel ill.	☐ False ☐ True
Q40	Individuals with increased blood pressure must take their medication throughout their life.	☐ False ☐ True
Q41	Individuals with increased blood pressure must take their medication in a manner that makes them feel good.	☐ False ☐ True
Q42	If the medication for increased blood pressure can control blood pressure, there is no need to change lifestyles.	☐ False ☐ True
Q43	Increased blood pressure is the result of aging, so treatment is unnecessary.	☐ False ☐ True
Q44	If individuals with increased blood pressure change their lifestyles, there is no need or treatment.	☐ False ☐ True
Q45	Individuals with increased blood pressure can eat salty foods as long as they take their drugs regularly.	☐ False ☐ True
Q46	Individuals with increased blood pressure can drink alcoholic beverages.	☐ False ☐ True
Q47	Individuals with increased blood pressure must not smoke.	☐ False ☐ True
Q48	Individuals with increased blood pressure must eat fruits and vegetables frequently.	☐ False ☐ True
Q49	For individuals with increased blood pressure, the best cooking method is frying.	☐ False ☐ True
Q50	For individuals with increased blood pressure, the best cooking method is boiling or grilling.	☐ False ☐ True
Q51	The best type of meat for individuals with increased blood pressure is white meat.	☐ False ☐ True
Q52	The best type of meat for individuals with increased blood pressure is red meat.	☐ False ☐ True
Q53	Increased blood pressure can cause premature death.	☐ False ☐ True
Q54	Increased blood pressure can cause heart diseases, such as heart attack.	☐ False ☐ True
Q55	Increased blood pressure can cause strokes.	☐ False ☐ True
Q56	Increased blood pressure can cause kidney failure.	☐ False ☐ True
Q57	Increased blood pressure can cause visual disturbances.	☐ False ☐ True

Appendix 2. Focus Group Discussion Guides

Study title: *Effect of Training and Supportive Supervision on Community Health Workers' Capacity to Conduct Hypertension and Diabetes Screening, Referral, and Follow-up in Siaya County, Kenya*

Participants: Community Health Workers (CHWs)

Moderator guidance: Obtain informed consent, assure confidentiality, encourage participation, and use probes for clarification and examples.

Baseline FGD Guide

1. Knowledge of Hypertension and Diabetes

- What do you know about hypertension and diabetes?
- What questions do community members commonly ask about these conditions?

Probes: risk factors, symptoms, prevention, treatment, complications.

2. Capacity for Service Delivery

- What role do you play in hypertension and diabetes screening, referral, and follow-up? (Reflect on policy and new roles in the CHW guideline)
- How confident do you feel performing these activities?

Probes: health education, risk identification, referral decisions, follow-up.

3. Referral and Follow-up Practices

- How are referrals and follow-up conducted in your community?
- What challenges do you encounter?

Probes: communication, resources, transport, patient adherence.

4. Digital Literacy

- Describe your experience using smartphones or digital tools in your work.
- What challenges affect their use?

Probes: reporting, data entry, connectivity, digital skills.

5. Training and Support Needs

- What training or support would strengthen your ability to provide hypertension and diabetes services?

Probes: mentorship, supervision, refresher training, job aids.

Endline FGD Guide (All Intervention Arms)

1. Intervention Experiences

- How would you describe your experience with the intervention (mention the specific intervention)?
- Which components were most useful?
- Any challenges and recommendations?

2. Changes in Knowledge, Skills, and Confidence

- How has the intervention influenced your knowledge and confidence in supporting hypertension and diabetes services?
- Can you provide examples of how you applied what you learned?

3. Service Delivery and Implementation

- What changes have you observed in screening, referral, and follow-up activities?
- What factors facilitated or hindered implementation?

4. Recommendations

- What improvements would you recommend for future implementation or scale-up?

Final Question (All Groups)

- What should be retained, strengthened, or modified to improve CHWs' capacity to support hypertension and diabetes services?

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFilesbmc08.11.26.docx