

Assessing an educational strategy to improve community health provider-led provision of cervical cancer screening services in western Kenya: A secondary analysis of the Elimisha-HPV cluster-randomized controlled trial

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Abstract: Cervical cancer disproportionately impacts women in low- and middle-income countries (LMICs), where over 90% of global cervical cancer deaths occur. Lay health workers, such as community health promoters (CHPs), with appropriate training and support, can play a pivotal role in cervical cancer prevention. Our team developed a multi-level intervention, Elimisha-HPV, to support CHP-delivered human papillomavirus (HPV) testing in Kenya. The present analysis evaluates impact of Elimisha-HPV on the following CHP outcomes: *i*) knowledge of screening delivery and privacy, confidentiality, and professionalism; *ii*) stigma associated with cervical cancer, human immunodeficiency virus (HIV), and HPV; and *iii*) confidence to counsel in screening delivery. We used descriptive statistics and linear mixed effects regression models to evaluate intervention effects (intervention group, $n = 64$; control group, $n = 60$). For knowledge and privacy, no statistically significant effects were observed (knowledge: $\beta = -0.08$ [95% CI, -0.22 to 0.07]; privacy: $\beta = 0.04$ [95% CI, -0.05 to 0.13]). No statistically significant intervention effects were observed for stigma associated with cervical cancer, HIV, or HPV (cervical cancer: $\beta = 0.02$ [95% CI, -0.13 to 0.16]; HIV: $\beta = 0.01$ [95% CI, -0.11 to 0.13]; HPV: $\beta = 0.02$ [95% CI, -0.11 to 0.14]). For the confidence to counsel Likert scale-style questions, evaluated using descriptive and regression approaches, proportional increases were observed across both arms, but the main effect was not statistically significant ($\beta = 0.01$ [95% CI, -0.09 to 0.11]). Our findings align with previous work demonstrating that stigma surrounding cervical cancer in LMICs is difficult to effectively influence, and provide a foundation for shaping future stigma-reduction campaigns. ClinicalTrials.gov identifier: NCT05736588.

Keywords: reproductive health, global health, health services, implementation science

1. Introduction

Cervical cancer continues to pose a significant health threat to women in low- and middle-income countries (LMICs), with over 90% of global cervical cancer deaths occurring in LMICs, particularly in sub-Saharan Africa (1). Eastern Africa bears the highest burden globally, with elevated rates of both incidence and mortality (incidence rates of 40.1/100,000 compared to 6.2/100,000 in North America, and mortality rates of 28.6/100,000 compared to 2.1/100,000 in North America) (2). In Kenya, cervical cancer is the leading cause of cancer-related deaths among women, bearing an age-standardized incidence

rate of 33.8/100,000 (3). Low rates of screening and uptake of preventative treatment among eligible women persist as significant challenges in cervical cancer prevention efforts, driven by interplay of structural, individual, and sociocultural factors (4,5).

In addition to financial and logistical challenges to achieving population-wide coverage of screening, stigma related to human papillomavirus (HPV) and cervical cancer can pose obstacles to cervical cancer prevention efforts, similar to the effects of stigma associated with human immunodeficiency virus (HIV) (6,7). In many LMICs, stigma surrounding cervical cancer is fueled by multiple factors, including visible manifestations of

advanced cervical cancer (*e.g.*, wasting and bleeding) as well as real or perceived lack of treatment options. Furthermore, cervical cancer's association with HIV/AIDS and the fact that HPV is a sexually transmitted infection (STI) can add a layer of moral judgment that perpetuates cervical cancer stigma (7,8). These drivers of stigma may impact women's decisions to seek HPV/cervical cancer prevention services and affect trust in, and acceptability of, these services.

Healthcare providers' attitudes and behaviors in delivering cervical cancer services are shaped by these societal attitudes, which may impact their counseling and management of women (9). Anticipated or experienced discrimination, loss of confidentiality, and disrespect in healthcare settings can lead to hesitancy and a lack of trust among affected women, further complicating efforts to improve cervical cancer outcomes (8,10). As countries work to achieve the World Health Organization (WHO) goal to eliminate cervical cancer in the next century, it will be essential to implement strategies that effectively address stigma (11,12).

One increasingly common approach to screening delivery is through the use of lay providers from the community, who take on roles as community educators, advocates, and role models (13-15). In Kenya, this cadre is called Community Health Promoters (CHPs). CHPs' strong community ties, mobility, and cultural understanding enable them to reach rural populations that may otherwise be difficult to access (16). With appropriate training and support, CHPs are uniquely positioned to spearhead initiatives aimed at raising awareness, dispelling myths and misconceptions, and fostering acceptance of cervical cancer prevention services within their communities (12,17). However, despite their potentially pivotal role in cervical cancer prevention, they receive limited training in identifying and addressing stigma surrounding HPV and cervical cancer prevention. The majority of training CHPs receive on cervical cancer prevention is focused on HPV and cervical cancer risk factors, and signs and symptoms of invasive cancer, much of which can be stigmatizing (10,18). Educational interventions and counseling strategies for CHPs must be designed in a way that will not inadvertently increase stigma while equipping CHPs with knowledge and skills to convey accurate and actionable steps. Furthermore, previous research has demonstrated low baseline levels of health domain-specific knowledge and inadequate training and support resources for CHPs (19). Additionally, few CHPs are trained in client-centered approaches to patient care, which have also been found to improve patient satisfaction and outcomes (20).

Our team developed "Elimisha-HPV", a multi-level, stigma-responsive service delivery model for CHP-led, home-based HPV-screening in western Kenya. This work builds on primary analysis assessing the effect of the Elimisha-HPV intervention on cervical cancer screening

and follow-up. In complement to this analysis of primary effects of Elimisha-HPV, we sought to evaluate the intervention's specific components: *i*) CHPs' confidence in their ability to counsel women and provide HPV and cervical cancer prevention services; *ii*) CHPs' knowledge of cervical cancer prevention and privacy, confidentiality, and professionalism; and *iii*) CHPs' levels of stigma associated with cervical cancer, HIV, and HPV.

2. Materials and Methods

2.1. Study design, setting, and participants

Our study team partnered with the Kisumu County Health Management Team (CHMT) to conduct a cluster-randomized controlled trial (cRCT) of Elimisha-HPV in twelve community health units (CHUs) in two Kisumu sub-counties. Kisumu County is located in western Kenya, an area with high HIV prevalence and low coverage of cervical cancer screening services. In Kisumu, health facilities are linked with home-based services provided by CHPs through CHUs. Each CHU has approximately ten CHPs attached, as well as a facility-based supervisor.

After agreement with health facility management and CHU supervisors, all CHPs assigned to the selected CHUs were approached by our study team and invited to participate in the study activities. A CHP was included if they demonstrated an understanding of the study's objectives and commitment to participate in all training sessions.

2.2. Intervention and training procedures

Training across the twelve study health centers was carried out in six waves, each with CHPs and supervisors from two CHUs within the same study arm. Post-training, CHPs had hands-on mentorship with study staff before they were deployed to their respective communities to administer HPV/cervical cancer education, outreach, and HPV-based self-sampling services to women in their homes, utilizing either Elimisha-HPV or control strategies.

Training curriculum for both arms included two modules covering: *i*) HPV and cervical cancer pathogenesis, risk factors, HPV vaccination, screening, and treatment guidelines, and *ii*) counseling of women diagnosed with HPV/cervical cancer (see Supplement 1, <https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=127>). The Elimisha-HPV curriculum also contained a module on communication, stigma, privacy, and confidentiality, with specific training on motivational interviewing. This module included definitions of stigma and examples of stigmatizing behavior and attitudes. Content on privacy, confidentiality, and motivational interviewing was provided through examples and role playing. The

additional Elimisha-HPV module was approximately half-a-day in length. Further details on differences between the standard training module and the Elimisha-HPV module are specified in Supplement 1 (<https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=127>).

Although the third module was unique to the Elimisha-HPV curriculum, all three modules were reviewed to ensure patient-centered communication and stigma-reducing language. Content of the curriculum was designed to address gaps in CHP training identified from our experience working in the region, incorporating best practices from the literature (21,22). Input from the Community Health Department of Kisumu County was sought to ensure linguistic, contextual, and cultural appropriateness. We adapted the WHO and the Kenya National guidelines for HPV-based cervical cancer screening (23,24).

Training was conducted in English by two experienced multilingual trainers fluent in Dholuo, Kiswahili, and English, because many CHPs asked questions in Dholuo or Kiswahili. We utilized a variety of instruction methods, including slide presentations, role plays, pictorials, scenario-based case studies, group discussions, and a video. Training sessions were held at locations chosen by the CHU supervisors, with approximately twenty CHPs from two CHUs attending each. For the intervention arm, training spanned two full days, while for the control group, it was conducted in one and a half days. The same trainers facilitated both intervention and control group sessions. Training was followed by mentorship in the field until the CHP was felt to be proficient. The post-test assessment was conducted after the second day of group training.

2.3. Survey administration and outcome measures

A self-administered pre/post-training survey in participants' preferred language, either English or Luo, was used to evaluate outcomes of interest. The first part of the survey aimed to evaluate CHPs' confidence in providing cervical cancer prevention services (3 Likert-scale items; minimum number of completed items required to be included in score calculation = 2), knowledge of HPV and cervical cancer prevention (5 closed-ended items; minimum number of completed items required to be included in score calculation = 3), and understanding of privacy, confidentiality, and professionalism in delivering HPV/cervical cancer services (9 vignette-based items; minimum number of completed items to be included in score calculation = 6) (25). The minimum number of completed items required for inclusion was set at approximately two-thirds of the total number of items.

Knowledge scores were measured numerically as the sum of all knowledge-related questions (theoretical sum score range: 5–24). Privacy, confidentiality, and

professionalism scores were measured numerically as the sum of all privacy-related questions (theoretical sum score range: 5–21). Missing values, "prefer not to answer" and "don't know" responses were excluded.

Confidence scores were measured using Likert-scale measurement (either "Strongly Agree", "Agree", "Disagree", "Strongly Disagree", "Don't know", "Prefer not to answer" or "Poor", "Fair", "Good", "Very Good", "Excellent", "Don't know"). In a supplementary analysis, a numerical composite confidence score was calculated, by converting Likert scale responses to a numeric scale ("Strongly Agree" = 4, "Agree" = 3, "Disagree" = 2, "Strongly Disagree" = 1; "Excellent" = 5, "Very Good" = 4, "Good" = 3, "Fair" = 2, "Poor" = 1), summing item scores for each participant-time observation, and then calculating mean composite score; no standardization or rescaling was applied. The dataset comprised 248 participant-time observations from 124 CHPs assessed at two time points (preintervention and postintervention). Five participant-time observations containing at least one "Don't know" or "Prefer not to answer" response were excluded, leaving 243 participant-time observations for supplementary analysis. Higher knowledge and privacy, confidentiality, and professionalism scores indicate better outcomes. In order to compare scores across domains, outcomes were analyzed using the mean item score.

The second section of the survey was a validated and pre-tested stigma assessment tool adapted from our prior work, consisting of 66 four-point Likert scale items with options to select "Strongly Agree", "Agree", "Disagree", or "Strongly Disagree" to the provided statements, measured numerically on a theoretical scale of 0–3 (0 = "Strongly Disagree", 1 = "Disagree", 2 = "Agree", 3 = "Strongly Agree"). This tool assessed CHPs' level of stigma associated with HPV (28 items; theoretical sum score range = 0–84; minimum number of completed items to be included in score calculation = 24), cervical cancer (14 items; theoretical sum score range = 0–42; minimum number of completed items to be included in score calculation = 10), and HIV (24 items; theoretical sum score range = 0–72; minimum number of completed items to be included in score calculation = 20).

In order to compare scores across domains, domains were analyzed using mean rather than sum scores. For all stigma domains, higher scores indicate higher levels of stigma (worse outcomes). For all stigma domains, no "missing" responses were observed. Additionally, participants' sociodemographic data, including age, gender, marital status, education level, number of years working as a CHP, and HPV/cervical cancer screening history were collected. Our outcomes were pre-specified secondary outcomes of the Elimisha-HPV trial.

2.4. Statistical analysis

Baseline CHP demographics were summarized using

means and standard deviations for continuous variables and counts and percentages for categorical variables. For stigma, knowledge, and privacy scores, a linear mixed effects constrained longitudinal regression model was used to determine the intervention effect (26). This model was implemented using the approach described in Equation 1 (see Supplement 2 for R code used to implement model, <https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=127>).

This model adjusts for individual (CHP) and cluster (CHU) variations, accounting for clustering of observations by CHU (12 total CHUs) and CHP using random intercepts for both CHU and CHP. CHPs were not treated as nested within CHUs (*i.e.*, separate random intercepts were employed for CHU and CHP).

The main intervention effect is indicated by the *Main Effect* coefficient, which reflects the effect of receiving the Elimisha-HPV training on post-test scores; this corresponds to the time-by-arm interaction term. Time was coded as numeric (1 = pre-intervention period; 2 = post-intervention period); study arm was coded as character ("Control" or "Intervention"); the time-by-arm interaction was coded as the product of time and study arm terms (1*Control, 1*Intervention, 2*Control, or 2*Intervention). Fixed effects were also included for time, whether the CHU was in a rural or urban area (reference category = rural), and the subcounty (Kisumu or Nyando) of the CHU (reference category = Kisumu).

For the Likert scale style confidence to counsel in cervical cancer screening delivery questions, descriptive statistics were used to summarize changes in distribution of confidence levels from the pre- to post-intervention periods. For supplementary analysis of the composite confidence score, the same linear mixed effect regression model used for the score-based analyses was employed (Supplement 3, <https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=127>).

Confidence intervals, *p*-values, and degrees of freedom were obtained using the "gtsummary" package in R (27). 95% confidence intervals were calculated using the standard formula of (estimate +/- 1.96 * standard error); two-tailed tests were used for *p*-value calculations, and degrees of freedom were calculated using the standard formula of number of observations minus number of constraints. Confidence intervals and *p*-values were calculated using default function employed by "gtsummary" (*i.e.*, "car: Anova").

Although cluster sample size was relatively small (*n* = 12 CHUs), given the sufficiently large total sample size (*n* = 124 CHPs, each observed twice, in the pre- and post-intervention period), no small-sample correction or degrees-of-freedom adjustment was applied. Confirmation using the Kenward-Roger small sample adjustment verified that parameter estimates, *p*-values, and confidence intervals were similar in adjusted and unadjusted models.

The constrained longitudinal model was implemented

using the lme4 package (Linear Mixed-Effects Model) and the linear mixed effects regression model function ("lme4::lmer") (28). All analysis were performed in R version 4.2 (29).

$$\text{Score} \sim \text{Time} + \text{Arm} * \text{Time} + \text{Rural} + \text{Sub-County} + (1 | \text{CHU}) + (1 | \text{CHP}) \quad (\text{Eq. 1})$$

2.5. Ethical approval

Ethical approval was obtained from the Institutional Review Board (IRB) at Duke University (protocol number: Duke Pro00111929) and the Scientific Ethics Review Unit (SERU) of the Kenya Medical Research Institute (KEMRI) (protocol number: KEMRI SERU 4692). This secondary analysis was conducted within the Elimisha-HPV cluster-randomized trial, which was registered on ClinicalTrials.gov at ID: NCT05736588.

3. Results

3.1. Study sample sociodemographic characteristics

Between September 25 and November 15, 2023, we conducted training and assessment of 124 CHPs attached to twelve CHUs situated across two sub-counties in Kisumu, western Kenya (64 in the intervention arm and 60 in the control arm) (Figure 1). The majority were female, married, and had worked as CHPs for at least three years (Table 1). Mean ages were similar across study arms (intervention: mean (SD) = 48.0 (8.2); control: mean (SD) = 49.4 (11.5)). Over half of the female CHPs reported a personal history of previous cervical cancer screening (51% in intervention; 62% in control), and among those who had screened, the majority had been screened with the Visual Inspection with Acetic Acid (VIA) method in the intervention and control arms (52% and 73%, respectively).

3.2. CHPs' stigma, knowledge, and privacy scores at baseline

Table 2 illustrates baseline average stigma scores across stigma, knowledge, and privacy domains. Baseline average stigma scores were generally low, reflecting low levels of stigma across all three health domains. Scores did not differ significantly between intervention and control arms for cervical cancer and HPV-related stigma; however, the intervention arm had a statistically significant higher score at baseline for HIV-related stigma (*p* = 0.023). Notably, cervical cancer stigma levels were generally higher than HPV and HIV-related stigma levels in intervention and control arms. For knowledge and privacy scores, no statistically significant differences were observed between intervention arms at baseline.

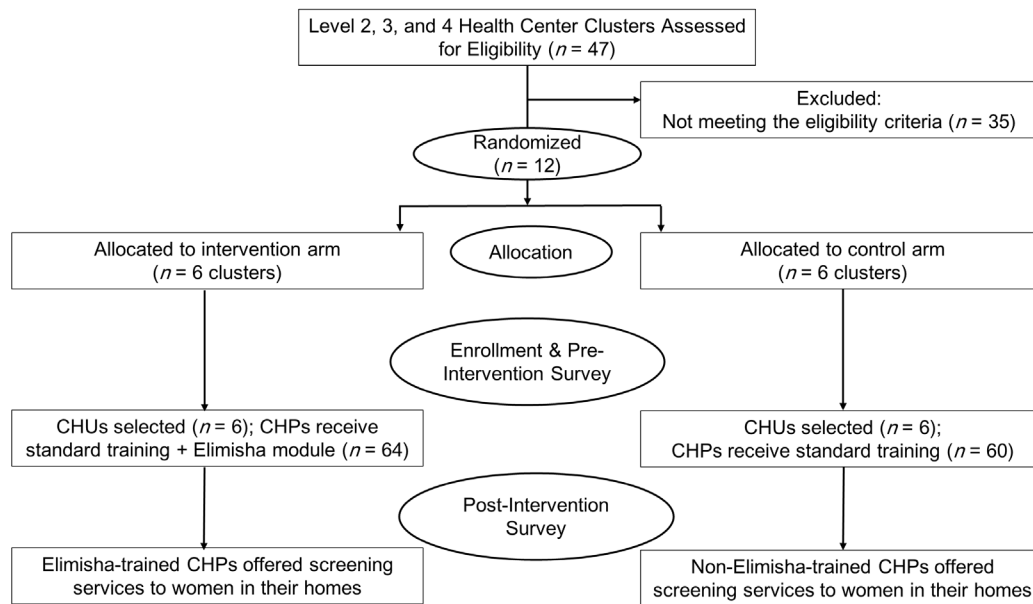


Figure 1. Flowchart of Elimisha-HPV study activities: study site selection, CHU randomization procedure, and participation in Elimisha-HPV activities (pre-intervention survey, CHP training, post-intervention survey, and screening delivery). Abbreviations: CHP, community health promoter; CHU, community health unit.

Table 1. Demographic characteristics of community health promoters participating in Elimisha-HPV

Characteristic	Control (n = 60) ¹	Intervention (n = 64) ¹
Age	49.4 (11.5)	48.0 (8.2)
Gender		
Female	50 (83%)	53 (83%)
Male	10 (17%)	11 (17%)
Marital Status		
Single	8 (13%)	5 (7.8%)
Married	43 (72%)	50 (78%)
Divorced/Separated	2 (3.3%)	1 (1.6%)
Widowed	7 (12%)	8 (13%)
Years as CHP ²		
< 1 year	4 (6.9%)	3 (4.7%)
1–3 years	0 (0%)	3 (4.7%)
≥ 3 years	54 (93%)	58 (91%)
Highest Education Level		
Up to Primary	15 (25%)	18 (28%)
Up to Secondary	42 (70%)	41 (64%)
Secondary+	3 (5.0%)	5 (7.8%)
Language		
English	45 (75%)	48 (75%)
Luo	15 (25%)	16 (25%)
Screening History (Women Only) ³		
Yes	31 (62%)	27 (51%)
No	15 (30%)	24 (45%)
Don't know	2 (4.0%)	0 (0%)
Prefer not to answer	2 (4.0%)	2 (3.8%)
Screening Method (Women Only) ⁴		
VIA	22 (73%)	14 (52%)
HPV Self-Sampling	2 (6.7%)	8 (30%)
Pap Smear	5 (17%)	1 (3.7%)
Other	1 (3.3%)	0 (0%)
Don't know	0 (0%)	4 (15%)

¹Mean (SD) for numerical variables; n (%) for categorical variables. ²Among (n = 58) non-missing CHPs for the control arm. ³Among (n = 50) female CHPs in the control arm, and (n = 53) female CHPs in the intervention arm. ⁴Among (n = 30) non-missing female respondents in the control arm, and (n = 27) non-missing female respondents in the intervention arm. Abbreviations: CHP, community health promoter; VIA, visual inspection with acetic acid; HPV, human papillomavirus.

Table 2. CHPs' average stigma, knowledge, and privacy scores at baseline

Characteristic	Control (n = 60) ¹	Intervention (n = 64) ¹	p-value ²
Stigma Scores ³			
Cervical Cancer	0.84 (0.64)	0.95 (0.54)	0.2
HIV	0.47 (0.44)	0.68 (0.54)	0.023
HPV	0.67 (0.48)	0.79 (0.41)	0.2
Knowledge and Privacy Scores ⁴			
Knowledge	2.67 (0.63)	2.46 (0.67)	0.12
Privacy	1.69 (0.38)	1.68 (0.35)	> 0.9

¹Mean (SD). ²Two-tailed tests. ³All stigma scores measured on a 0–3 point scale. Higher stigma scores indicate higher levels of stigma (worse outcomes). ⁴Knowledge and privacy questions are measured on scales ranging from 1–4 or 1–7, depending on the question. Higher knowledge and privacy scores indicate better outcomes. *Abbreviations:* CHP, community health promoter; HIV, human immunodeficiency virus; HPV, human papillomavirus.

3.3. Impact of Elimisha-HPV on stigma, knowledge, and privacy scores: linear mixed effects regression model results

The main effects of the Elimisha-HPV intervention on stigma and knowledge and privacy scores are summarized in the regression results illustrated in Table 3. The main effect of the intervention is indicated by the *Main Effect* coefficient, reflecting the effect of being in the intervention arm in the post-training period. Across all stigma domain outcomes (cervical cancer, HIV, and HPV), no statistically significant intervention effect was detected (cervical cancer: $\beta = 0.02$ [95% CI, –0.13 to 0.16], $p = 0.8$; HIV: $\beta = 0.01$ [95% CI, –0.11 to 0.13], $p = 0.9$; HPV: $\beta = 0.02$ [95% CI, –0.11 to 0.14], $p = 0.8$). For knowledge and privacy, confidentiality, and professionalism outcomes, no statistically significant effects were observed. For knowledge scores, intervention was associated with a non-statistically significant, negative effect ($\beta = -0.08$ [95% CI, –0.22 to 0.07]; $p = 0.3$). For privacy scores, intervention was associated with a non-statistically significant, positive effect ($\beta = 0.04$ [95% CI, –0.05 to 0.13]; $p = 0.4$).

3.4. Change in CHPs' confidence to counsel in cervical cancer screening delivery: pre- vs. post-intervention

Results of the Likert scale questions assessing CHP confidence to counsel women in cervical cancer screening delivery are summarized in Table 4. In the post-test period, confidence scores generally increased, with greater magnitudes of score increases observed in the control arm across all questions. For question 1 ("Confidence to counsel women about cervical cancer screening and treatment") increases in percentages of CHPs reporting "Strongly Agree" were substantial: in the control arm, 63% of respondents reported "Strongly Agree" in the post-intervention period, compared to

Table 3. Linear mixed effects regression models measuring the effect of Elimisha-HPV training on CHP stigma levels and knowledge and privacy scores

Variable	Cervical Cancer ¹	p-value ²	HPV ¹	p-value ²	HIV ¹	p-value ²	Knowledge ¹	p-value ²	Privacy ¹	p-value ²
Time										
Rural	–0.21 (–0.35, –0.07)	0.003	–0.19 (–0.30, –0.07)	0.002	–0.08 (–0.20, 0.04)	0.2	0.51 (0.35, 0.66)	<0.001	–0.02 (–0.10, 0.06)	0.7
Rural	—	0.3	—	0.5	—	0.4	—	0.3	—	0.2
Urban	0.17 (–0.12, 0.46)		0.09 (–0.18, 0.35)		0.12 (–0.14, 0.37)		0.16 (–0.12, 0.44)		–0.11 (–0.30, 0.08)	
County		0.2		0.3		0.068				0.13
Kisumu	—		—		—		—		—	
Nyando	0.23 (–0.09, 0.54)		0.14 (–0.14, 0.43)		0.26 (–0.02, 0.53)		0.12 (–0.19, 0.43)		–0.16 (–0.36, 0.05)	
Main Effect ³	0.02 (–0.13, 0.16)	0.8	0.02 (–0.11, 0.14)	0.8	0.01 (–0.11, 0.13)	0.9	–0.08 (–0.22, 0.07)	0.3	0.04 (–0.05, 0.13)	0.4

¹ β (95% CI); ²Two-tailed tests; ³*Main Effect* coefficient represents the interaction of the *Time* and *Arm* coefficients, reflecting the effect of being in the intervention arm in the post-intervention period. Reference categories: for the "Rural" variable, "Rural" represents the reference category; for the "County" variable, "Kisumu" represents the reference category. *Abbreviations:* CHP, community health promoter; HPV, human papillomavirus; HIV, human immunodeficiency virus.

Table 4. CHPs' confidence to counsel in cervical cancer screening delivery: pre- vs. post-intervention by study arm

Questions	Control <i>n</i> = 60 ¹		Intervention <i>n</i> = 64 ¹	
	pre-test	post-test	pre-test	post-test
1. Confidence to counsel women about cervical cancer screening and treatment				
Strongly Agree	27 (45%)	38 (63%)	35 (55%)	41 (64%)
Agree	25 (42%)	18 (30%)	26 (41%)	18 (28%)
Disagree	5 (8.3%)	2 (3.3%)	1 (1.6%)	2 (3.1%)
Strongly Disagree	3 (5.0%)	2 (3.3%)	1 (1.6%)	3 (4.7%)
Don't Know	0 (0%)	0 (0%)	1 (1.6%)	0 (0%)
2. Knows where to refer women for screening				
Strongly Agree	30 (50%)	41 (68%)	44 (69%)	45 (70%)
Agree	27 (45%)	15 (25%)	19 (30%)	16 (25%)
Disagree	1 (1.7%)	2 (3.3%)	1 (1.6%)	2 (3.1%)
Strongly Disagree	2 (3.3%)	2 (3.3%)	0 (0%)	0 (0%)
Don't Know	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Prefer not to answer	0 (0%)	0 (0%)	0 (0%)	1 (1.6%)
3. Rate your current knowledge and understanding of cervical cancer				
Poor	2 (3.3%)	0 (0%)	0 (0%)	1 (1.6%)
Fair	19 (32%)	2 (3.3%)	17 (27%)	2 (3.1%)
Good	24 (40%)	19 (32%)	32 (50%)	23 (36%)
Very Good	8 (13%)	26 (43%)	9 (14%)	25 (39%)
Excellent	6 (10%)	13 (22%)	5 (7.8%)	12 (19%)
Don't Know	1 (1.7%)	0 (0%)	1 (1.6%)	1 (1.6%)

¹*n* (%).

45% in the pre-intervention period; in the intervention arm, 64% of respondents reported "Strongly Agree" in the post-intervention period, compared to 55% in the pre-intervention period. For question 2 ("Knows where to refer women for screening"), larger increases in confidence were observed in the control than intervention arm: 68% of control respondents reported "Strongly Agree" in the post-intervention period, compared to 50% in the pre-intervention period; in the intervention arm, 70% of respondents reported "Strongly Agree" in the post-intervention period, compared to 69% in the pre-intervention period. The largest increases in scores were observed for question 3 ("Rate your current knowledge and understanding of cervical cancer"). From the pre- to post-intervention period, the control arm demonstrated increases in selection of the "Very Good" response option of 13% to 43%, and the intervention arm demonstrated increases from 14% to 39%. Supplement 3 (<https://www.globalhealthmedicine.com/site/supplementaldata.html?ID=127>) contains regression analyses of confidence scores, employing a numerical coding of the Likert scale confidence questions. These results indicate a positive, non-statistically significant main effect of the intervention on confidence scores ($\beta = 0.01$ [95% CI, -0.09 to 0.11]; $p = 0.8$).

4. Discussion

In order to understand the components that impacted outcome of a multi-level cervical cancer prevention program, we examined impact of a novel educational

curriculum utilizing stigma-sensitive, patient-centered approaches for training CHPs to provide HPV-based cervical cancer screening in Kenya. Relative to other interventions, our CHP training incorporated a unique, four-tiered educational approach addressing: *i*) HPV, HIV, and cervical cancer stigma, *ii*) confidence to counsel of cervical cancer screening service delivery, *iii*) knowledge of privacy, confidentiality, and professionalism, and *iv*) motivational interview skills. Previous CHP-focused cervical cancer-related educational interventions typically address one of these dimensions (*e.g.*, stigma, knowledge of risk factors, or knowledge of service delivery) (30,31). Our training sought to augment knowledge alone with an understanding of drivers of screening decision-making and skills to help women determine whether to screen, in addition to enhancing understanding of and reducing cervical cancer-related stigma among CHPs in LMICs.

Our findings suggest that the educational intervention did not have a statistically significant effect on CHPs' stigma associated with cervical cancer, HIV, and HPV, knowledge of cervical cancer and awareness of privacy and confidentiality, or confidence to counsel in screening delivery. The effect estimates for HIV, HPV, and cervical cancer are all positive (HIV: $\beta = 0.01$ [95% CI, -0.11 to 0.13]; HPV: $\beta = 0.02$ [95% CI, -0.11 to 0.14]; cervical cancer: $\beta = 0.02$ [95% CI, -0.13 to 0.16]), though small in magnitude relative to the possible score ranges for these effects (theoretical range of 0–3). These point estimates correspond to 0.33%–0.67% of the total possible score range. Estimated intervention effects for the knowledge and privacy scores were also small in

magnitude (knowledge: $\beta = -0.08$ [95% CI, -0.22 to 0.07]; privacy: $\beta = 0.04$ [95% CI, -0.05 to 0.13]). For the Likert scale confidence questions, while proportional comparisons indicated increases in confidence to counsel from the pre- to post-test period, supplemental regression analyses indicated that the intervention effect on CHP confidence was not statistically significant ($\beta = 0.01$ [95% CI, -0.09 to 0.11]; $p = 0.80$). No established threshold for meaningful change to contextualize these effect sizes is available; as such, practical significance of these observed differences cannot be determined conclusively. Null results are possibly attributable to spillover effects between intervention arms. Specifically, given that the same instructors were used for both arms, there is a possibility of contamination between arms. Since trainers were familiar with the concepts of stigma and the use of non-stigmatizing language, some of their experience with Elimisha-HPV may have translated into the control training. The short duration between training and post-training surveys (two days) may have also limited our ability to evaluate changes in knowledge and behavior over the long-term.

Our findings are consistent with some studies conducted among community health workers in LMICs aiming to improve knowledge of HPV and cervical cancer and reduce stigma (30). For example, in a study of the effectiveness of an educational intervention aimed at reducing stigma and improving knowledge of HPV and cervical cancer among Nigerian men and women, Nkwonta *et al.* (2021) found that no significant changes were observed between study arms in the majority of stigma domains (30). However, still other interventions in LMICs have effectively influenced community health worker knowledge of cervical cancer; Ochomo *et al.* (2023) developed a dialogue-based training for community health workers in Nyando, Kenya, and found that overall knowledge scores, and knowledge of various aspects (risk factors, signs and symptoms, and screening) significantly improved post-training (31).

Our non-statistically significant findings may indicate spillover effects that minimize differences between study arms. Minimal between-arm differences could also be due to a lack of sufficient isolation of control and intervention participants, or a need for more pronounced differences between control and intervention arm educational materials, pedagogical strategies, and training instructors. Finally, it is also possible that a pedagogical approach that differs more starkly from the cultural norm would more effectively incite attitude and belief change. Though efforts were taken to ensure linguistic and cultural appropriateness of the intervention, it may be possible that inclusion of some culturally atypical educational methods would more significantly impact stigma and knowledge, due to their comparative novelty. Dedicating more attention to striking balance between cultural sensitivity and educational methods that effectively incite attitude and belief change may

represent a promising direction for future cervical cancer stigma-reduction focused interventions among CHPs in LMICs. In addition, previous stigma-reduction focused research has found that employing longer training periods, scheduling repeated trainings, and incorporating more contact-based and multicomponent interventions may enhance training effectiveness (32,33).

Although we had the opportunity to test a real-world educational intervention, our study had several limitations in its design and implementation. First, the training period lasted only two days, limiting CHPs' ability to fully internalize the concepts and actively engage with both the content and trainers. The short duration between training and post-training surveys also limited our ability to evaluate sustained retention of knowledge and behavior change over the long term, especially given that the two-day training was followed by mentored field work to further cement concepts and practices introduced in the training. Furthermore, given emphasis on relationship-building in the intervention arm, some of the impacts on CHP practice may not be fully captured by the written survey results. More robust assessment methods that capture subtle behavioral aspects of discrimination and stereotyping not captured by the Likert scale structure of our survey questions could improve representativeness of our findings. Finally, we employed the same trainers for both the intervention and control groups. As they were quite familiar with the concepts of stigma and the use of non-stigmatizing language, it is likely that some of their experience with Elimisha-HPV carried over into the control training, which would have minimized differences between arms.

5. Conclusion

Despite these limitations, our study provides insights on the gaps in CHP knowledge of key concepts and practices in cervical cancer service delivery and related stigma attitudes. As a key component of Elimisha-HPV, the CHP training may benefit from further refinement and evaluation. In future design and assessment of CHP programs, it will be vital to consider the inputs and perspectives of the community, CHPs themselves, and other healthcare professionals working with CHPs. Insight from this evaluation provides the foundation for shaping design of future content, assessment techniques, and support mechanisms to ensure quality of cervical cancer prevention services provided by CHPs. Such measures will be critical in improving cervical cancer screening uptake in western Kenya and similar areas, a key intervention to address high cervical cancer incidence rates in the region.

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