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Outcomes of a community health worker capacity-building intervention for addiction care in Vietnam

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ABSTRACT

Background: Community health workers (CHWs) are essential for expanding addiction care in low- and middle-income countries; however, gaps in training, institutional support, and persistent stigma toward people who use drugs limit their effectiveness. Evidence-based, scalable interventions are needed to strengthen CHW capacity for community-based addiction service delivery. This study examined whether a community-based intervention increased CHWs' support for addiction services and broadened the range of addiction services they provided in Vietnam.

Methods: We conducted a cluster randomized controlled trial across 58 communes in three provinces in Vietnam. A total of 174 CHWs were randomized to intervention (n = 87) or control (n = 87) conditions and were assessed at baseline and at 3-, 6-, 9-, and 12-month follow-ups. The Community Care Consortium (CCC) intervention comprised structured group training and ongoing booster sessions for CHWs and their home visits for families with people who use drugs. Primary outcomes included CHW support for addiction services (e.g., counseling, reminders, and encouragement) during the preceding three months and addiction service provision domains. Mixed-effects regression models with random effects at CHW, commune health center, and province levels were used to estimate intervention effects over time, adjusting for prespecified covariates.

Results: The CCC intervention produced significant and sustained improvements in both outcomes across all follow-up time points. Compared with controls, intervention CHWs demonstrated higher levels of support for addiction services (β range: 4.54 - 5.71) and a broader range of service provision (incidence rate ratios: 1.92 - 2.40). These effects were shown at 3 months and maintained through 12 months (all $p < .0001$). Older age and prior addiction training were also associated with greater support and service provision.

Conclusions: The CCC intervention produced significant and sustained improvement in CHWs' capacity to deliver addiction services and strengthen support for people who use drugs. As a community-embedded, scalable model, CCC offers promise for strengthening addiction care systems. These findings underscore the value of CHW-centered interventions in advancing decentralized, community-based addiction care.

Introduction

Substance use disorders, particularly opioid use disorder, remain a major global public health challenge, contributing substantially to morbidity, mortality, and social burden (Chen et al., 2025; United Nations Office on Drugs and Crime, 2021). Medication-assisted treatment (MAT), including methadone maintenance treatment (MMT), is highly effective in reducing opioid-related overdose risk and preventing transmission of infectious diseases, including HIV (Bell & Strang, 2020; Fairley et al., 2021; Oesterle et al., 2020; Volkow et al., 2014). Despite strong evidence of its effectiveness, access to and utilization of MAT remain limited, particularly in resource-constrained settings where shortages of trained addiction specialists hinder service delivery (Eibl et al., 2017; Jones et al., 2015). These challenges underscore the need for scalable, community-based approaches to expand addiction care (Penzenstadler et al., 2020).

Community health workers (CHWs) have emerged as a critical workforce for bridging the gap between underserved populations and

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health systems, particularly for people who use drugs (PWUD) (Carson et al., 2022; Hirschhorn et al., 2023; Morgan et al., 2015). As frontline primary care providers embedded within communities, CHWs are well positioned to facilitate engagement across the addiction care continuum, including outreach, linkage to treatment, adherence support, and retention in care. However, the quality of CHW-delivered addiction services depends substantially on their level of training, professional confidence, and attitudinal readiness to work with PWUD. Prior research suggests that provider-level factors, such as training, professional attitudes, and job satisfaction, play an important role in shaping CHWs' readiness and confidence to deliver addiction-related services (Kim et al., 2020; Nguyen et al., 2024). However, many CHWs face persistent challenges, including limited formal training in addiction care, stigmatizing attitudes toward PWUD, and insufficient institutional support, all of which may constrain their effectiveness.

Vietnam provides a particularly relevant context for examining whether structured interventions can improve CHWs' addiction care support and service delivery in community settings. As of February 2025, Vietnam recorded 388,136 people identified as using or suspected of using drugs, representing about 0.4% of the national population. As of 2024, approximately 50,000 people with opioid use disorder were receiving MMT in 343 clinics nationwide (Trang et al., 2026). In recent years, MMT has been gradually decentralized from centralized treatment facilities to community settings in Vietnam, with CHWs playing a central role in service delivery (Tran et al., 2018; UNAIDS, 2019). Despite the national scale-up, significant challenges persist. Access to addiction care is also affected by financial and organizational barriers. Research among MMT patients in Vietnam has identified difficulties obtaining and using health insurance, including limited information and difficulty affording insurance premiums (Tran et al., 2017). At the community level, barriers included inadequate staffing, limited institutional and technical support, training gaps, and persistent stigmatizing attitudes toward PWUD (Lin et al., 2018; Madden et al., 2025; Mlunde et al., 2024; Nguyen et al., 2023). These barriers have contributed to gaps in addiction care support and service provision, with downstream consequences for PWUD's compromised treatment adherence and retention (Khue et al., 2017; Nguyen et al., 2017). Targeted, evidence-based interventions are needed to strengthen CHW capacity for comprehensive, community-based addiction care.

To address these gaps, we developed and evaluated the Community Care Consortium (CCC), a structured, multi-component intervention designed to strengthen CHW capacity for community-based addiction care. Using a cluster randomized design, this study examined the effects of the CCC intervention on CHW support for addiction services and addiction service provision domains in Vietnam. Findings are expected to inform scalable workforce development strategies for sustainable, community-based addiction care more broadly.

Methods

Study design

This study employed a cluster randomized controlled trial design conducted across three provinces in Vietnam (Ninh Binh, Da Nang, and Can Tho) from May 2024 to November 2025 (Li et al., 2023). The study included 58 communes (Vietnam's smallest administrative geographic units): 28 were in Ninh Binh, 14 in Da Nang, and 16 in Can Tho. The number selected in each province reflected the availability of known PWUD in the communes considered for the study.

Communes were first matched in pairs within each province based on the number of known PWUD. The Vietnam-based research team enrolled CHCs. After the baseline assessments were completed, the US-based research team generated the random allocation sequence using SAS PROC PLAN and assigned one CHC from each matched pair to the intervention group and the other to the control group. Outcomes were assessed at baseline and at 3-, 6-, 9-, and 12-month follow-ups. The study protocol was approved by the Institutional Review Boards of participating institutions, and the trial was registered with ClinicalTrials.gov (NCT05315492).

Study participants

Participants were CHWs employed at CHCs. In Vietnam's healthcare system, each CHC typically comprises three to five staff, including physicians, assistant physicians, nurses, midwives, and pharmacists. Eligible participants were aged 18 years or older and actively engaged in delivering healthcare services to community residents. Non-clinical personnel (e.g., accountants, administrative staff) were excluded from participation. During recruitment, project staff explained study objectives, procedures, and potential risks and benefits. CHWs were informed that participation was entirely voluntary and independent of their job duties, and that their decision to participate or not would have no bearing on their employment status or performance evaluations. A total of 174 CHWs were enrolled, with a refusal rate of less than 1%. Written informed consent was obtained from all participants prior to data collection.

Intervention

The CCC intervention was designed to equip CHWs with the knowledge and skills needed to deliver patient-centered, individualized addiction care and support. Intervention development was informed by formative work with local stakeholders, including community service providers, addiction specialists, educators, PWUD, and family members. Prior to the trial, the intervention was pilot tested in three communities, with one community selected from each study region. Stakeholder feedback from the pilot phase was systematically incorporated to refine the intervention content and delivery procedures. The pilot communities were excluded from participation in the main study. During the trial, trained local health educators implemented the intervention, each having completed a comprehensive facilitator training program covering research ethics, facilitation techniques, core intervention principles, delivery protocols, and content-specific practice rehearsal.

The CCC intervention comprised three primary components: in-person group sessions, home visits, and periodic in-person booster sessions. The intervention was initiated with two consecutive weekly in-person group sessions (approximately 90 minutes each). Session 1 oriented CHWs to their role in addiction treatment and care, addressed common challenges in working with PWUD and potential strategies for navigating them, and introduced a continuum-of-care framework encompassing seek, test, treat, and retain (STTR) components (National Institute on Drug Abuse, 2017), alongside principles of patient-centered individualized care. Session 2 focused on communication skill building, equipping CHWs with practical tools such as the decisional balance sheets and motivation rulers to assess and respond to service needs and addiction related stigma.

Following the two group sessions, CHWs conducted structured home visits with PWUD and their family members, applying the skills and tools acquired during training. CHWs received detailed home visit instructions and completed mock practice sessions with peers prior to implementation. Home visits involved interactions with PWUD and family members, conducted jointly or individually depending on disclosure status and participant preferences. Following the home visits, session 3 was an in-person group meeting focused on reflection and experience sharing, during which CHWs discussed home visit experiences, shared successes, identified challenges, and developed solutions. Subsequent in-person booster sessions were held once every two to three months throughout the study period to reinforce knowledge and skills, support peer learning, and facilitate ongoing problem-solving. Intervention engagement was high: all intervention CHWs attended the in-person training and booster sessions, and 98.8% conducted home visits. CHWs in the control group continued their usual health care

activities and received no study intervention during the trial.

Data collection

Data were collected through an assessment survey conducted in private offices at each CHC. All instruments were administered in Vietnamese using Computer-Assisted Self-Interviewing (CASI), which presents survey questions on a computer screen. Participants entered their responses directly into the system to enhance privacy and reduce social desirability bias. Each assessment took approximately 30–45 minutes. A trained interviewer was available on-site to assist with technical issues or clarify survey questions as needed. Each participant received compensation of 230,000 VND (approximately 10 USD). Follow-up assessments were conducted at 3, 6, 9, and 12 months after baseline. All enrolled CHWs completed every follow-up assessment, with no attrition in either study arm (see participant flow diagram in Supplementary Fig. S1).

Measures

Support for addiction services was measured using an 8-item instrument developed and pilot-tested based on findings from prior projects and the current study's formative phase. This instrument uses context-specific indicators tailored to CHWs' unique supportive roles in community-based addiction care (Li et al., 2026). CHWs reported how often they engaged in each of the following activities in the past three months: (1) providing counseling to PWUD; (2) answering PWUD patients' questions; (3) motivating PWUD to seek addiction treatment; (4) encouraging PWUD to remain in addiction treatment; (5) inquiring about the reasons for missed appointments; (6) reminding PWUD to take prevention and treatment-related tests; (7) discussing the harms of untreated addiction or drug use with PWUD; and (8) praising PWUD for making progress in seeking or staying in treatment. Responses were rated on a 5-point Likert scale: 1 = none of the time, 2 = a little of the time, 3 = some of the time, 4 = most of the time, and 5 = all the time. A total score was computed by summing all items (range: 8–40), with higher scores indicating greater support for addiction services. The scale demonstrated excellent internal consistency (Cronbach's $\alpha = 0.97$).

Addiction service provision domains, the range of addiction services provided in the past three months, was assessed using a 10-item composite index covering the following service categories: (1) community outreach related to substance use; (2) provision of MMT and/or needle and syringe programs; (3) referrals to MMT or other addiction services; (4) home visits for PWUD; (5) counseling or treatment reminders to support PWUD engagement; (6) basic preventive health services for PWUD; (7) one-on-one meetings with PWUD; (8) group education activities for PWUD; (9) telephone-based communication with PWUD; and (10) digital communication with PWUD via text messaging or online platforms. Each category was coded as a binary indicator (yes/no), and affirmative responses were summed to generate a total score (range: 0 – 10), with higher scores reflecting a broader range of addiction services delivered during the past three months.

CHW demographic and professional background information was collected, including age, gender, occupation, medical training, years in medical field, years of employment at the current CHC, and whether they had ever received training in addiction services prior to the study.

Statistical analysis

All analyses were conducted using SAS (version 9.4; SAS Institute Inc., Cary, NC). Descriptive statistics were used to summarize baseline characteristics by intervention condition. Categorical variables were compared using chi-square tests and reported as frequencies and percentages; continuous variables were compared using t-tests and reported as means and standard deviations.

To evaluate intervention effects over time, we used mixed-effects regression models to account for repeated measures within CHWs across study visits (baseline, 3-, 6-, 9-, and 12-month follow-ups) and the hierarchical data structure. Random effects were specified at the CHW, CHC, and province levels to account for within-CHW correlations over time and clustering of CHWs within CHCs and provinces. Linear mixed-effects models were applied to the continuous outcome (support for addiction services), while generalized linear mixed models with a Poisson distribution and log link were used for the count outcome (addiction service provision domains). The primary independent variables included intervention condition, visit (categorical), and their interaction, assessing differential changes over time between conditions. Models were adjusted for prespecified covariates, including sex, age, professional role (doctor/assistant doctor vs. others), years in CHCs, and prior addiction training. Medical education level and years in the medical field were excluded due to multicollinearity. For the Poisson models, exponentiated coefficients were reported as incidence rate ratios (IRRs) with corresponding confidence intervals.

Results

Sample characteristics

At baseline, 174 enrolled CHWs were randomized equally to intervention (n = 87) and control (n = 87) groups. The sample was predominantly female (72.4%), and most participants were aged 36–55 years (74.7%). Half held graduate-level medical training (50.0%), with 17.8% college-level and 32.2% intermediate training. The most common professions were assistant doctor (38.5%), doctor (20.7%), and nurse (19.5%). Most participants had more than 10 years of experience both in the medical field (77.6%) and in CHCs (65.5%). Fewer than half reported prior addiction training (46.6%). No significant baseline differences were observed between intervention and control groups across any characteristic (all $p > .05$; see Table 1).

Table 1
Baseline sample characteristics by intervention condition.

	Total	Control	Intervention	
Characteristic	(n = 174)	(n = 87)	(n = 87)	*p*
Gender				
Male	48 (27.6)	22 (25.3)	26 (29.9)	.4975
Female	126 (72.4)	65 (74.7)	61 (70.1)	
Age group				
18 to 35	37 (21.3)	21 (24.1)	16 (18.4)	.3100
36 to 45	64 (36.8)	27 (31.0)	37 (42.5)	
46 to 55	66 (37.9)	34 (39.1)	32 (36.8)	
56 and above	7 (4.0)	5 (5.8)	2 (2.3)	
Medical training				
Graduate and above	87 (50.0)	47 (54.0)	40 (46.0)	.3423
College (3 years)	31 (17.8)	12 (13.8)	19 (21.8)	
Intermediate (2 years)	56 (32.2)	28 (32.2)	28 (32.2)	
Profession				
Doctor	36 (20.7)	19 (21.8)	17 (19.5)	.1399
Assistant doctor	67 (38.5)	30 (34.5)	37 (42.5)	
Nurse	34 (19.5)	17 (19.5)	17 (19.5)	
Midwife	16 (9.2)	13 (14.9)	3 (3.4)	
Pharmacist	10 (5.8)	4 (4.6)	6 (6.9)	
Other	11 (6.3)	4 (4.6)	7 (8.0)	
Years in medical field				
≤ 10 years	39 (22.4)	19 (21.8)	20 (23.0)	.8926
11-20 years	74 (42.5)	36 (41.4)	38 (43.7)	
> 20 years	61 (35.1)	32 (36.8)	29 (33.3)	
Years in CHC				
≤ 10 years	60 (34.5)	30 (34.5)	30 (34.5)	.6360
11-20 years	67 (38.5)	31 (35.6)	36 (41.4)	
> 20 years	47 (27.0)	26 (29.9)	21 (24.1)	
Prior addiction training				
Yes	81 (46.6)	37 (42.5)	44 (50.6)	.2874
No	93 (53.4)	50 (57.5)	43 (49.4)	

Note. Values are presented as n (%). *p*-values from chi-square tests.

Trends in outcome measures

Fig. 1 illustrates trends in CHW support for addiction services and addiction service provision domains across study time points. At baseline, mean support scores were comparable between conditions (control: 21.54 ± 8.31; intervention: 23.23 ± 8.88; p = .5391), as were service provision domains scores (control: 2.41 ± 2.48; intervention: 2.57 ± 2.52; p = .671).

The intervention group showed marked and sustained improvements on both outcome measures. Support scores increased sharply from baseline to 3 months (29.45 ± 5.35) and remained elevated through 6 months (29.80 ± 3.67), 9 months (30.36 ± 4.34), and 12 months (31.25 ± 5.38). The control group showed only modest change over the same period, from 21.54 ± 8.31 at baseline to 24.15 ± 7.55 at 12 months. Similarly, the addiction service provision domains score increased steeply in the intervention group from baseline to 3 months (6.21 ± 1.89) and was maintained through 6 months (5.98 ± 2.33), 9 months (6.32 ± 1.88), and 12 months (6.23 ± 1.90), while the control group remained largely stable between 2.41 and 3.02 over time. Between-condition differences were statistically significant at all post-baseline time points for both outcome measures (all p < .0001).

Intervention effects

Table 2 presents the results from mixed-effects models. The intervention was associated with significant improvements in both outcomes at all follow-up time points. For CHW support for addiction services, intervention effects, estimated as differential changes at follow-up visits from baseline between intervention and control conditions, were statistically significant at 3 months (β = 4.82, 95% CI: 2.92, 6.73, p < .0001), 6 months (β = 4.54, 95% CI: 2.63, 6.45, p < .0001), 9 months (β = 5.71, 95% CI: 3.80, 7.62, p < .0001), and 12 months (β = 5.42, 95% CI: 3.51, 7.33, p < .0001). For addiction service provision domains, the intervention significantly increased the range of addiction services delivered at all follow-up visits, with IRRs of 2.40 (95% CI: 1.75, 3.27) at 3 months, 1.92 (95% CI: 1.44, 2.54) at 6 months, 2.40 (95% CI: 1.82, 3.14) at 9 months, and 1.96 (95% CI: 1.44, 2.68) at 12 months (all p < .0001).

Among the covariates, older age and prior addiction training were associated with greater support for addiction services and a broader range of services provided. Being a doctor or assistant doctor was associated with greater support for addiction services. More years working at CHC were associated with a broader range of services provided. Sex was not significantly associated with either outcome.

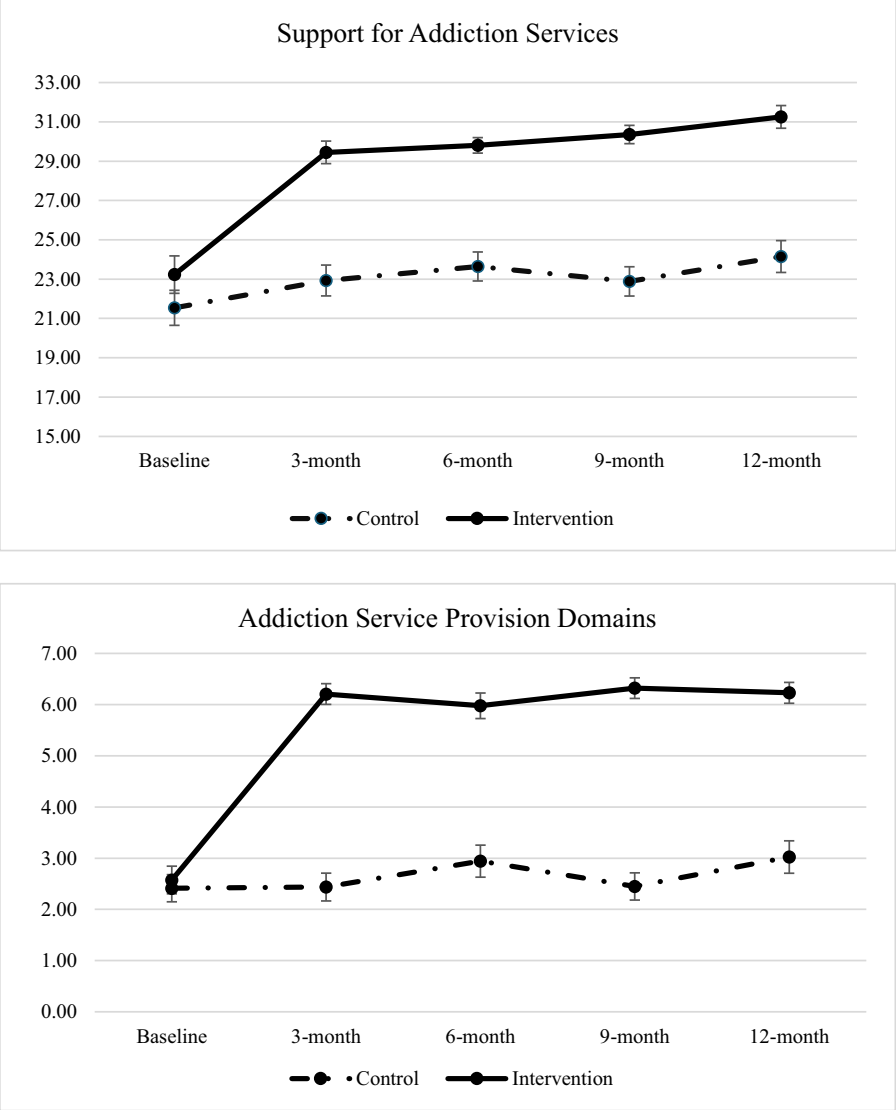


Fig. 1. Trends in CHW support for addiction services (top) and CHW addiction service provision domains (bottom) by intervention condition.
Note. Data points represent group means; error bars indicate standard errors.

Table 2
Mixed-effects model estimates of intervention effects.

	Support for Addiction Services			Service Provision Domains		
	Estimate	95% CI	*p*	IRR	95% CI	*p*
Intervention effect						
At 3 months	4.82	(2.92, 6.73)	<.0001	2.40	(1.75, 3.27)	<.0001
At 6 months	4.54	(2.63, 6.45)	<.0001	1.92	(1.44, 2.54)	<.0001
At 9 months	5.71	(3.80, 7.62)	<.0001	2.40	(1.82, 3.14)	<.0001
At 12 months	5.42	(3.51, 7.33)	<.0001	1.96	(1.44, 2.68)	<.0001
Covariates						
Female sex	−1.12	(−2.66, 0.42)	.1541	0.87	(0.70, 1.08)	.2033
Age	0.16	(0.06, 0.27)	.0020	1.02	(1.00, 1.03)	.0129
Doctor/assistant doctor	1.20	(0.02, 2.38)	.0455	1.03	(0.91, 1.17)	.5973
Years in CHC	0.00	(-0.08, 0.08)	.9841	1.01	(1.00, 1.01)	.0448
Prior addiction training	1.56	(0.66, 2.46)	.0007	1.39	(1.23, 1.55)	<.0001

Note. Intervention effects represent differential changes from baseline between intervention and control conditions at each follow-up visit. β = regression coefficient from linear mixed-effects models (support for addiction services); IRR = incidence rate ratio from Poisson mixed-effects models (addiction service provision domains). CI = confidence interval. Medical education level and years in the medical field were excluded due to multicollinearity.

Discussion

This study evaluated the outcomes of the CCC intervention using a cluster randomized design in Vietnam. Findings demonstrate that the CCC intervention produced significant, sustained improvements in two primary outcomes: CHW support for addiction services and addiction service provision domains. Unlike traditional clinic-based models reliant on specialized providers, the CCC approach leverages existing community health infrastructure to support task-shifting in low- and middle-income country contexts, contributing to a growing evidence base for community-based models in global addiction care.

The observed intervention effect on CHW addiction service provision domains indicates that the CCC model was effective in equipping frontline health workers with the practical competencies needed to deliver addiction-related services in community settings. CHWs in Vietnam and similar settings play a critical but often underutilized role in health systems, serving as the primary interface between formal healthcare institutions and underserved populations, including PWUD (Ahmed et al., 2022). Yet structured training pathways and institutional support for addiction care are frequently lacking, limiting CHWs' capacity to address substance use disorder in community settings (Lin et al., 2023; Nguyen et al., 2024). The CCC intervention appears to have addressed this gap by empowering CHWs to deliver a spectrum of services, from outreach and referral to counseling and follow-up, representing a scalable and sustainable strategy. The high level of CHW engagement observed across all intervention components further suggests that practical tools and continuous support can translate into meaningful improvements in service delivery. The CCC model's alignment with continuum-of-care frameworks, targeting multiple stages of engagement rather than a single outcome, could also enhance its long-term impact.

Equally important is the intervention's effect on CHWs' support for PWUD, reflecting improvements in the behavioral dimensions of care. In Vietnam and other similar settings, stigma toward drug use and addiction remains a significant barrier to treatment engagement and retention (Jahn et al., 2020; Paquette et al., 2018; Tomori et al., 2014). CHWs often serve as trusted intermediaries between the health system and marginalized populations, making their supportive behaviors essential for sustaining engagement in care. Unlike most existing studies that have relied on general measures of social support, the use of context-specific support measures in this study provides a more precise understanding of how CHWs operationalize support in real-world settings. Improvements in these support behaviors are particularly important given the chronic, relapsing nature of substance use disorder, where sustained engagement and trust are essential for service outcomes.

Several factors likely contributed to the positive intervention outcomes. First, the CCC intervention was designed to position CHWs as both recipients and active providers of the intervention, particularly through home visits, thereby strengthening professional role identity, reinforcing accountability, and building confidence across the care continuum. This design feature likely contributed to improvements in both structural outcomes (service provision) and interpersonal processes (support for PWUD). Second, the combination of in-person skill-building sessions, structured home-based engagement, and ongoing booster activities created a continuous learning environment that facilitated translation of training into practice. This multifaceted approach aligns with evidence on the importance of ongoing CHW training for health systems strengthening in low- and middle-income countries (Heijdra Suasnabar & Hipple Walters, 2020; O'Donovan et al., 2018). Third, the intervention's cultural and contextual fit likely enhanced its acceptability and feasibility. As a homegrown intervention, its design was informed by substantial input from local providers, patients, and family members to ensure responsiveness to community needs and local care contexts. Home visits and family engagement are particularly relevant in Vietnam, where family members play a central role in health decision-making. Delivery by local health educators within familiar community settings further enhanced relevance and potential for scale-up within the existing health system.

Some limitations should be acknowledged. First, the present analysis focused on CHW-level outcomes, and it remains unclear whether these improvements translate into downstream benefits for PWUD, such as increased treatment engagement, retention, or improved health outcomes. Second, both outcome measures were based on CHW self-report, which may be subject to reporting and social desirability bias. Future research could incorporate objective service delivery data or triangulate findings across multiple sources. Third, although the study was conducted across multiple regions in Vietnam, contextual differences between regions may have influenced implementation and outcomes; heterogeneity should be carefully considered in future scale-up efforts. Fourth, the main trial was powered for its primary outcome among PWUD, and no separate sample size calculation was conducted for CHW outcomes. The number of CHWs and randomized communes limited our ability to assess whether intervention effects differed by CHW characteristics, such as years of experience. Future studies with larger samples could explore such differences.

These findings have direct implications for addiction health policy and practice. For policymakers and public health practitioners seeking to expand community-based addiction services, the CCC model offers a scalable, evidence-informed approach for strengthening CHW capacity in resource-constrained settings. Integrating core CCC components such as structured training, home-based engagement, and ongoing shared learning and technical support into national CHW training curricula could help standardize service delivery at the community level. Formally recognizing and supporting CHWs' expanded role in addiction

care may also provide a feasible strategy to address workforce shortages without requiring substantial increases in specialized clinical personnel.

Conclusion

The CCC intervention demonstrated efficacy in improving CHW support for addiction services and service provision domains, affirming its potential as a scalable model for strengthening community-based addiction care. These findings highlight the value of CHW-centered approaches in settings undergoing transitions toward decentralized, community-based treatment systems such as Vietnam. Sustained investment in evidence-based CHW interventions, alongside efforts to address structural barriers, will be critical for maintaining intervention gains.

Data availability

De-identified participant data will be made available upon reasonable request to the corresponding author, Dr. Li Li (lililili@ucla.edu), subject to applicable ethical and institutional requirement.

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Ethics declaration

Written informed consent to take part in the study and to publish the article has been obtained from all participants or their legal representatives. The privacy rights of participants have been observed.

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place. This study was approved by the Institutional Review Boards (IRB) of the University of California, Los Angeles (UCLA), USA. (Approval No. UCLA IRB-23- 1845-CR-001)

The results of this clinical trial and any associated work have been posted in a registry. This clinical trial was registered with number NCT05315492 (ClinicalTrials.gov).

CRediT authorship contribution statement

Li Li: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Chunqing Lin:** Writing – review & editing, Writing – original draft, Software, Methodology, Funding acquisition, Formal analysis. **Tuan Anh Nguyen:** Writing – review & editing, Supervision, Project administration, Investigation, Funding acquisition. **Van Thi Nguyen:** Writing – review & editing, Project administration, Investigation, Data curation. **Than Dang Phan:** Writing – review & editing, Supervision, Project administration. **Ha Thi Thanh Nguyen:** Writing – review & editing, Data curation. **Thang Hong Pham:** Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2026.105572.

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