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RESEARCH ARTICLE

Development of Competence of Village Health Volunteers in Caring for Tuberculosis Patients in the Community, Don Chan District, Kalasin Province

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Abstract

This participatory action research (PAR), combined with a non-randomized two-group pretest–posttest quasi-experimental evaluation, aimed to 1) explore the situation, problems, and needs for developing the competence of village health volunteers (VHVs) in caring for tuberculosis (TB) patients in the community, 2) develop a participatory competence-enhancement approach, and 3) compare VHVs' knowledge, skills, and competence levels before and after the intervention and between groups. The study was conducted in Don Chan District, Kalasin Province, from October 2025 to August 2026. Co-researchers were 38 health personnel, and the sample comprised 60 VHVs allocated by subdistrict to an experimental or a control group (30 each). Instruments included an 8-week competence-enhancement program, a knowledge test, a skills assessment, a satisfaction questionnaire, and qualitative interview guides. Data were analyzed using descriptive statistics, paired and independent t-tests, ANCOVA, the chi-square test, and content analysis.

VHVs lacked in-depth knowledge of treatment observation and adverse drug reactions, lacked confidence in home visits, and feared infection. The developed approach comprised four components: participatory workshops, mentored field practice, a community of practice with digital patient follow-up, and supervision with reflection. After the intervention, the experimental group had higher knowledge (17.20±1.73) and skill scores (52.83±4.15) than before and than the control group (mean differences 5.07, 95% CI 3.97–6.17, and 12.76, 95% CI 10.14–15.38; $p<.001$). More VHVs in the experimental group reached a high competence level (80.00% vs. 36.67%; $\chi^2=11.59$, df=1, $p<.001$). Co-researchers' satisfaction was very high (4.52±0.48). **Conclusion:** The participatory approach improved VHVs' short-term competence. It should be extended to all subdistrict health promoting hospitals and evaluated for long-term patient outcomes in a cluster randomized trial.

Keywords: Competence, Village health volunteers, Tuberculosis

Introduction

Tuberculosis (TB) remains a major global public health problem. The World Health Organization (WHO) reported approximately 10.80 million new TB cases and 1.25 million deaths in 2023.[1] Thailand is on the WHO lists of countries with a high TB burden and a high TB/HIV burden (2021–2025), with an estimated 107,000 new and relapse TB cases in 2023, or 149 per 100,000 population.[1] The Thai government has therefore established a national strategic plan to end TB by 2035, emphasizing primary health care system development and community participation, in line with Sustainable Development Goal (SDG) target 3.3.[2] Meanwhile, the 2021 National Tuberculosis Control Programme Guideline of Thailand emphasizes building the capacity of health personnel at all levels, including village health volunteers (VHVs), to have the knowledge and skills needed to care for TB patients correctly.[3]

Kalasin Province continues to face TB problems. In 2024, approximately 1,516 new TB cases were found, exceeding the provincial estimate. The treatment success rate was 82.90%, below the national target (88.00%); the loss-to-follow-up rate was 1.70%, and the death rate was 8.60%.[4] In Don Chan District, during fiscal years 2020–2024, 34–41 new patients were registered for treatment each year (184 in total); 12 patients missed appointments or interrupted treatment, and 24 died during treatment, with deaths decreasing from 6 in 2020 to 2 in 2024.[5] Although mortality has declined, deaths and treatment interruptions still occur almost every year, increasing the risk of drug-resistant TB. The TB clinic at Don Chan Hospital operates only once a week, and staff are limited because they also carry other responsibilities, so patients experiencing adverse drug reactions cannot notify staff promptly. In addition, VHVs caring for patients in the community still lack knowledge and confidence in TB care.

VHVs are a key mechanism of the primary health care system, acting as change agents for health behavior and as the front line in identifying at-risk groups and conducting disease surveillance in the community.[6] However, previous studies have found that VHVs and caregivers of TB patients have only moderate knowledge of TB prevention and control and lack the in-depth knowledge needed to apply it in real situations.[7] Caregivers' confidence has also been associated with treatment success among pulmonary TB patients.[8] VHV development should therefore cover knowledge, practical skills, attitudes, and communication,[9] together with treatment observation by non-family community members (non-family DOT), which improves treatment success.[10]

This study applied the supportive-educative nursing system of Orem[11] through the role of mentor nurses who teach, guide, support, and provide an environment that enables VHVs to care for TB patients independently, together with the self-efficacy concept of Bandura,[12] which is built through mastery experiences from real

practice, modeling, verbal persuasion, and reduction of anxiety. Most previous studies in Thailand have been surveys of VHVs' knowledge and behavior.[7] Few studies have developed VHVs' TB competence through a community participatory process that integrates mentoring and digital technology and is evaluated against a comparison group, and none has been conducted in the context of Don Chan District. Participatory action research is therefore appropriate, as it yields an approach suited to the local context and fosters ownership among practitioners.

In light of these problems, the researcher developed the competence of VHVs in caring for TB patients in the community in Don Chan District, Kalasin Province, through participatory action research with nurses, network partners, and the community. The aims were to strengthen VHVs' knowledge, skills, and confidence in treatment observation, monitoring of adverse drug reactions, contact screening, and psychosocial support for patients and families, and to evaluate the effects on VHVs' knowledge, skills, and competence levels compared with a control group. The study is expected to yield a VHV competence development approach that can be extended to other areas and serve as a basis for studying long-term clinical outcomes of patients.

Research Objectives

1) To study the situation, problems, and needs for developing the competence of village health volunteers (VHVs) in caring for TB patients in the community, Don Chan District, Kalasin Province
2) To develop a participatory approach for enhancing VHVs' competence in caring for TB patients in the community
3) To compare VHVs' knowledge, skills, and competence levels in caring for TB patients in the community before and after the intervention and between the experimental and control groups, and to assess co-researchers' satisfaction with the developed approach

Research Hypotheses

1) After the intervention, the experimental group has higher mean knowledge and skill scores in TB patient care than before the intervention.
2) After the intervention, the experimental group has higher mean knowledge and skill scores in TB patient care than the control group.
3) After the intervention, the proportion of VHVs with a high competence level is greater in the experimental group than in the control group.

Methods

This study was participatory action research (PAR) based on the concept of Kemmis and McTaggart,[13] comprising three cycles of planning, acting, observing, and reflecting,

conducted from October 2025 to August 2026: Cycle 1, situation analysis and planning (October–December 2025); Cycle 2, program development and implementation (January–May 2026), in which the program was evaluated using a non-randomized two-group pretest–posttest quasi-experimental design, with the 8-week program delivered during February–March 2026; and Cycle 3, refinement and evaluation (June–August 2026). The experimental group received the same version of the program throughout the intervention period, and refinements arising from reflection were applied after the posttest (researcher to confirm the timeline). Success indicators were predefined: at least 80% of co-researchers would understand how to use the approach, implement it in practice, and be satisfied at a high level or above.

Conceptual Framework and Research Variables

Conceptual framework. This study used a three-part framework: 1) the supportive-educative nursing system of Orem,[11] which defines the mentor nurse's role in teaching, guiding, supporting, and providing an environment that enables VHVs to care for TB patients independently; 2) the self-efficacy concept of Bandura,[12] which is built through mastery experiences from real practice, modeling, verbal persuasion, and reduction of anxiety; and 3) the participatory action research process of Kemmis and McTaggart,[13] to obtain an approach suited to the local context and foster ownership among practitioners.

Study variables. The independent variable was participation in the 8-week program for enhancing VHVs' competence in caring for TB patients in the community (experimental group), compared with routine practice (control group). The dependent variables were TB knowledge scores (maximum 20 points), community TB patient care skill scores (maximum 60 points), competence level determined from the combined knowledge and skill score (maximum 80 points), and co-researchers' satisfaction with the developed approach.

Population and Sample

Population. The population comprised two groups: 1) co-researchers, i.e., all 38 registered nurses and public health officers responsible for TB work at Don Chan Hospital, the Don Chan District Public Health Office, and all subdistrict health promoting hospitals (SHPHs), all of whom participated; and 2) approximately 980 VHVs working in Don Chan District in fiscal year 2026. Key informants for the qualitative study were VHVs, TB patients, family members, community leaders, and health personnel, purposively selected for their direct experience in providing or receiving TB care in the area.

Sample. The sample size was calculated using G*Power[14] for a two-tailed independent t-test with an effect size of 0.80, which is lower than that found in a similar VHV capacity development program study[15] and is classified as large by Cohen's criteria,[16] a significance level of .05, and a power of 0.80, yielding 26 per group. The sample was increased by 15% to allow for attrition (26 × 1.15 = 29.90), giving 30 per group, or 60 in total. Groups were allocated non-randomly by subdistrict, selecting subdistricts with similar numbers of registered TB patients, numbers of VHVs, and distances to the hospital:

Don Chan and Muang Na subdistricts formed the experimental group, and Sa-at Chai Si and Dong Phayung subdistricts formed the control group. VHVs were then purposively selected according to the inclusion criteria, 15 per subdistrict. To minimize contamination, the control group did not join the LINE group or receive the program manual, and mentor nurses did not work in the control subdistricts.

Inclusion criteria: 1) registered VHVs with at least 1 year of service; 2) aged 18–45 years, because the program used the LINE application and video calls as the main channels for patient follow-up, and the area planned to develop this group as a new generation of TB VHV leaders; 3) able to read, write, and communicate in Thai; 4) owning a smartphone and able to use the LINE application; 5) responsible for households with TB patients or at-risk persons; and 6) willing to participate in the study.

Exclusion criteria: 1) illness that would impede participation in activities; and 2) plans to relocate during the study period.

Discontinuation criteria: 1) request to withdraw from the study; and 2) illness or relocation during the study that prevented posttest measurement. Participants who attended less than 80% of the program still underwent posttest measurement and were analyzed according to their allocated group (intention-to-treat).

Research Instruments

Instruments. The instruments comprised 1) the intervention instrument, namely the 8-week program for enhancing VHVs' competence in caring for TB patients in the community, developed in Cycle 1, together with a community TB care manual for VHVs; and 2) data collection instruments, namely a general information questionnaire, a TB knowledge test, a community TB patient care skills assessment, a satisfaction questionnaire, focus group discussion guides, in-depth interview guides, and an observation record form, developed by the researcher based on the 2021 National Tuberculosis Control Programme Guideline of Thailand[3] and related literature.

The TB knowledge test had 20 items (1 point for a correct answer, 0 for an incorrect one), interpreted using the criteria of Bloom[17] as follows: ≥80% (16–20 points), high; 60–79% (12–15 points), moderate; and <60% (0–11 points), low. The community TB patient care skills assessment had 20 items rated on a 3-point scale (1–3 points), with total scores of 20–60, and was assessed by observing actual practice during home visits and simulations by two registered nurses who were not mentor nurses and were blinded to group allocation. Competence level was determined from the combined knowledge and skill score (80 points) using the 80% cut-off of Bloom,[17] with ≥64 points indicating high competence and <64 points indicating moderate-to-low competence. The satisfaction questionnaire used a 5-point rating scale, with mean scores interpreted using the criteria of Best[18] as follows: 4.51–5.00, very high; 3.51–4.50, high; 2.51–3.50, moderate; 1.51–2.50, low; and 1.00–1.50, very low.

Instrument quality testing. Content validity was examined by three experts (a physician specializing in TB, a community nursing instructor, and a public health officer specializing

in disease control), yielding IOC values of 0.67–1.00. The instruments were then piloted with 30 VHVs with characteristics similar to the sample in a neighboring district. The knowledge test had difficulty indices of 0.25–0.78, discrimination indices of 0.22–0.65, and a reliability (KR-20) of 0.82. The skills assessment had a Cronbach's alpha coefficient of 0.87 and an inter-rater reliability (intraclass correlation coefficient) of 0.86, and the satisfaction questionnaire had a Cronbach's alpha coefficient of 0.91.

Data Collection

The researcher and research assistants, who were registered nurses briefed on data collection procedures, collected data according to the research cycles. Qualitative data were collected through four focus groups (two groups of VHVs with 8 members each, one group of health personnel with 10 members, and one group of community leaders with 8 members), each lasting 60–90 minutes, and through in-depth interviews with 12 key informants (4 TB patients, 4 family members, 2 VHVs, and 2 health personnel). Data were collected until saturation, audio-recorded with permission, and transcribed verbatim. Quantitative data were collected from the experimental and control groups twice: before the intervention (week 1) and at the end of the intervention (week 8). The control group received routine practice, namely monthly VHV meetings at the SHPH and home visits within their usual roles, without TB-specific training or mentor nurses, and received the program after the study ended.

Data Analysis

Quantitative data were analyzed using SPSS version 13. General data were analyzed using descriptive statistics, namely frequency, percentage, mean, and standard deviation. General characteristics were compared between groups using the chi-square test (or Fisher's exact test when expected counts were less than 5) and the independent t-test. Normality was examined using the Shapiro-Wilk test before analysis; if data were not normally distributed, the Wilcoxon signed-rank test and the Mann-Whitney U test were used instead. Within-group mean scores before and after the intervention were compared using the paired t-test, and between-group comparisons used the independent t-test and ANCOVA with pretest scores as the covariate. Mean differences with 95% confidence intervals (95% CI) and effect sizes (Cohen's d) were reported.[16] Proportions of competence levels were compared using the chi-square test, with the difference in proportions and the odds ratio reported. Statistical significance was set at .05 (two-tailed). Qualitative data were analyzed by content analysis following the steps of Elo and Kyngäs,[19] namely reading for understanding, coding, categorizing, and developing main themes. Trustworthiness was established according to Lincoln and Guba[20] through data source and method triangulation and member checking.

Research Ethics

This study adhered to the ethical principles of research involving human subjects. The researcher explained the objectives, procedures, benefits, and risks of the research to

all participant groups, including TB patients and family members who served as informants. Participants signed informed consent forms before participating. All data were kept confidential and presented in aggregate without identifying individuals. For patient follow-up via the LINE group and video calls, codes were used instead of patient names, no images or identifying information were shared in the group, and group membership was limited to relevant persons to prevent stigma. VHVs received training and infection-prevention equipment (N95 masks) before home-visit practice, and participants could withdraw at any time without any effect on their work or the services they received.

Results

1. Situation, problems, and needs for developing VHVs' competence in caring for TB patients in the community

1.1 General characteristics of co-researchers and the sample. The 38 co-researchers comprised 24 registered nurses and 14 public health officers. Most VHVs in the experimental and control groups were female (83.33% and 80.00%), with mean ages of 39.47±4.82 and 40.13±4.56 years, respectively. General characteristics did not differ significantly between the two groups (p>.05 for all variables), as shown in Table 1. No VHVs withdrew or were lost to follow-up during the study; therefore, all 30 participants in each group were analyzed, and mean attendance in the experimental group was 100%.

Table 1 **General characteristics of VHVs by group (n = 30 per group)**

Characteristic	Experimental group	Control group	Test statistic	p-value
Female	25 (83.33)	24 (80.00)	χ^2=0.11[a]	.739
Age (years)	39.47±4.82	40.13±4.56	t=−0.55[b]	.588
Years as a VHV	8.23±4.15	8.60±4.37	t=−0.34[b]	.738
Upper secondary education	17 (56.67)	16 (53.33)	χ^2=0.07[a]	.795
Previous TB training	11 (36.67)	10 (33.33)	χ^2=0.07[a]	.787

Note: Data are presented as n (%) or mean±standard deviation; [a]Chi-square test (df = 1), [b]Independent t-test (df = 58)

1.2 Situation, problems, and needs. Analysis of the focus group and in-depth interview data in Cycle 1 yielded four main themes, as follows.

Theme 1: Insufficiently in-depth knowledge for treatment observation. VHVs knew that patients must take medication continuously but were not confident in observing adverse drug reactions such as jaundice, itchy rash, and nausea and vomiting. "I know they have to take the drugs every day, but if the patient says they're itchy or their eyes are yellow, I don't

know whether to stop the drugs or refer them right away." (VHV 03, focus group 1)

Theme 2: Lack of confidence in home visits and fear of infection. VHVs worried about becoming infected and bringing the infection home to their families, so they avoided entering patients' homes. "When I visit, I just stand and talk in front of the house. I'm afraid of catching it and passing it to my grandchildren." (VHV 11, focus group 2)

Theme 3: Social stigma. Some patients and families concealed the illness for fear of rejection by the community. "I don't want anyone to know I have TB. I'm afraid the neighbors won't associate with me." (Patient 02, in-depth interview)

Theme 4: Discontinuous information referral. Communication among VHVs, SHPHs, and the hospital was not yet systematic because the TB clinic operated only once a week. "If a patient has symptoms on Saturday, they have to wait until clinic day. They don't know who to call." (Staff 01, in-depth interview)

Development needs included practice-focused training, mentor nurses, a rapid consultation channel via the LINE application, and an easy-to-understand manual. The mean pre-development knowledge score of all 60 VHVs was 11.52 points, or 57.58% of the maximum score, which was at a low level.

2. Participatory approach for enhancing VHVs' competence in caring for TB patients in the community

2.1 Components of the approach and the competence-enhancement program. Co-researchers jointly designed the approach in three workshops using the Appreciation-Influence-Control (AIC) participatory meeting technique, yielding an approach with four components: 1) workshops using participatory learning; 2) field practice supervised by mentor nurses; 3) establishment of a community of practice using digital technology for learning and patient follow-up; and 4) supervision, follow-up, and reflection with network partners. These were organized into an 8-week competence-enhancement program delivered by the researcher and mentor nurses at a ratio of one mentor nurse to five VHVs, as shown in Table 2.

Table 2 **Program for enhancing VHVs' competence in caring for TB patients in the community, Don Chan District, Kalasin Province**

Week	Activities/content	Tools	Duration	Academic rationale
1	Orientation, relationship building, pretest, and participatory lecture on basic TB knowledge: causes, symptoms, transmission, and treatment	Knowledge test, presentation media, VHV manual	180 minutes	Participatory learning and the 2021 National TB Control Programme Guideline of Thailand[3]
2	Mentored directly observed treatment (DOT), monitoring of adverse drug reactions, and referral	Mock drugs, DOT record form, demonstration and return demonstration	180 minutes	DOTS concept and the supportive-educative nursing system of Orem[11]

3	Household contact screening, infection prevention, cough etiquette, and mask use	Screening form, simulations	180 minutes	Simulation-based learning to enhance practical skills
4–5	Mentored home-visit practice with TB patients	Home visit form, skills assessment form	2 sessions, 120 minutes each	Learning through mastery experience based on the self-efficacy concept[12]
6	Communication skills, stigma reduction, encouragement, and patient follow-up via video-observed therapy (VOT) and the LINE group	LINE application, role play	120 minutes	Health literacy[21] and social support
7–8	Community of practice (CoP): knowledge sharing, reflection, lessons learned, and posttest	Sharing forum, tests and assessment forms	180 minutes	Participatory action research cycle[13]

2.2 Reflection results and refinement of the approach. Among the 38 co-researchers, 89.47% (34) understood how to use the approach, 84.21% (32) implemented it in practice, and 92.11% (35) were satisfied at a high to very high level, with a mean satisfaction score of 4.52±0.48 (very high), meeting all predefined success indicators. Post-intervention reflection led to refinements in Cycle 3, namely adding short video clips on treatment observation, creating an adverse drug reaction reporting form via the LINE group, and pairing experienced VHVs with new VHVs (buddy system). In addition, all 14 new TB patients in the experimental area during the study received treatment observation by VHVs, and no treatment interruption was found; these are descriptive data not compared with the control area.

3. Effects of the approach for developing VHVs' competence in caring for TB patients in the community

3.1 Within-group comparisons before and after the intervention. The Shapiro-Wilk test showed that knowledge and skill scores before and after the intervention in both groups were normally distributed ($W = 0.94–0.98$, $p > .05$). In the experimental group, the mean knowledge score increased from 11.43±2.65 to 17.20±1.73 (mean difference 5.77, 95% CI 4.86–6.68; $t(29)=13.02$, $p<.001$), and the mean skill score increased from 38.27±6.42 to 52.83±4.15 (mean difference 14.56, 95% CI 12.37–16.75; $t(29)=13.59$, $p<.001$), whereas the control group's mean scores in both domains did not differ from before the intervention ($p=.275$ and $p=.319$), as shown in Table 3.

Table 3 **Comparison of VHVs' mean knowledge and skill scores in TB patient care before and after the intervention, by group** (Paired t-test, df = 29)

Variable	Group	Before		After		Mean difference (95% CI)	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Knowledge (max 20)	Experimental	11.43	2.65	17.20	1.73	5.77 (4.86, 6.68)	13.02	<.001*
	Control	11.60	2.51	12.13	2.47	0.53 (−0.45, 1.51)	1.11	.275
Skills (max 60)	Experimental	38.27	6.42	52.83	4.15	14.56 (12.37, 16.75)	13.59	<.001*
	Control	38.90	6.18	40.07	5.86	1.17 (−1.20, 3.54)	1.01	.319

Note: *p<.05

3.2 Comparisons between the experimental and control groups. Before the intervention, mean knowledge and skill scores did not differ between the two groups (p=.800 and p=.700). After the intervention, the experimental group's mean knowledge score was 5.07 points higher than that of the control group (95% CI 3.97–6.17; t(58)=9.21, p<.001, d=2.38), and its mean skill score was 12.76 points higher (95% CI 10.14–15.38; t(58)=9.73, p<.001, d=2.51). After controlling for pretest scores using ANCOVA, the differences remained statistically significant (knowledge: adjusted mean difference 5.13 points, F(1,57)=108.99, p<.001, partial η^2=0.66; skills: adjusted mean difference 12.99 points, F(1,57)=123.08, p<.001, partial η^2=0.68), as shown in Table 4.

Table 4 Comparison of VHVs' mean knowledge and skill scores in TB patient care between the experimental and control groups (Independent t-test, df = 58)

Variable	Experimental group		Control group		Mean difference (95% CI)	t	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Knowledge, before (max 20)	11.43	2.65	11.60	2.51	−0.17 (−1.50, 1.16)	−0.26	.800
Knowledge, after (max 20)	17.20	1.73	12.13	2.47	5.07 (3.97, 6.17)	9.21	<.001*
Skills, before (max 60)	38.27	6.42	38.90	6.18	−0.63 (−3.89, 2.63)	−0.39	.700
Skills, after (max 60)	52.83	4.15	40.07	5.86	12.76 (10.14, 15.38)	9.73	<.001*

Note: *p<.05

3.3 VHVs' competence levels after the intervention. In the experimental group, 80.00% (24) of VHVs had a high competence level, compared with 36.67% (11) in the control group, a statistically significant difference (χ^2=11.59, df=1, p<.001), corresponding to a difference in proportions of 43.33% (95% CI 20.92–65.74) and an odds ratio of 6.91 (95% CI 2.16–22.10), as shown in Table 5.

Table 5 Comparison of VHVs' competence levels after the intervention between the experimental and control groups (Chi-square test)

Competence level	Experimental group, n (%)	Control group, n (%)	χ^2 (df = 1)	p-value
High (≥64 points)	24 (80.00)	11 (36.67)	11.59	<.001*
Moderate–low (<64 points)	6 (20.00)	19 (63.33)		

Note: *p<.05

3.4 Summary of hypothesis testing. With respect to the stated hypotheses, the results supported all three: after the intervention, the experimental group had higher mean knowledge and skill scores than before the intervention and than the control group, and a greater proportion of VHVs with a high competence level than the control group, as shown in Table 6.

Table 6 Summary of hypothesis testing

Hypothesis	Test statistic	Analysis result	Conclusion
H1: The experimental group's mean knowledge and skill scores after the intervention are higher than before the intervention	Paired t-test	Knowledge increased by 5.77 points (t(29)=13.02, p<.001); skills increased by 14.56 points (t(29)=13.59, p<.001)	Supported
H2: The experimental group's mean knowledge and skill scores after the intervention are higher than those of the control group	Independent t-test and ANCOVA	Knowledge 5.07 points higher (t(58)=9.21, p<.001; adjusted mean difference 5.13 points); skills 12.76 points higher (t(58)=9.73, p<.001; adjusted mean difference 12.99 points)	Supported
H3: The proportion of VHVs with a high competence level is greater in the experimental group than in the control group	Chi-square test	80.00% vs. 36.67% (χ^2=11.59, df=1, p<.001; OR=6.91, 95% CI 2.16–22.10)	Supported

Note: Statistical significance was set at .05 (two-tailed).

Discussion

The situation analysis found that VHVs still lacked in-depth knowledge and confidence in caring for TB patients, with a pre-development knowledge score of 57.58% of the maximum, consistent with a study finding that VHVs and caregivers of TB patients had only moderate knowledge of TB prevention and control.[7] This may be because most VHVs (65.00%) had never received TB-specific training, VHV work covers many disease groups, and the TB clinic operates only once a week, leaving VHVs without a consultation channel when problems arise. The

qualitative findings on fear of infection and social stigma also indicate that competence development must address both knowledge and confidence, not knowledge alone. Situation analysis with stakeholders therefore yielded context-specific information, an important foundation for program design.[15]

The developed approach comprised workshops, mentored field practice, a community of practice, and supervision, consistent with the proposal that VHV development should cover knowledge, practical skills, attitudes, and communication.[9] Mentored field practice builds mastery experience, the most important source of self-efficacy,[12] and directly addresses the lack of confidence in home visits identified in Cycle 1. Meanwhile, the LINE group and video calls helped overcome the limitation of a once-weekly clinic and supported treatment observation by non-family community members, which improves treatment success.[10] In addition, participation in every cycle fostered ownership among co-researchers, resulting in satisfaction and actual implementation of the approach.[13] However, the absence of treatment interruption among the 14 new patients is only a descriptive observation in the experimental area and does not permit conclusions about treatment outcomes.

After the intervention, the experimental group had higher mean knowledge and skill scores than before the intervention and than the control group, with very large effect sizes (Cohen's d = 2.38 and 2.51), and the results remained significant after controlling for pretest scores. This can be explained by the program's use of diverse, practice-focused learning methods based on the supportive-educative nursing system[11] together with health literacy enhancement,[21] consistent with a study finding that a VHV capacity development program significantly increased knowledge and practice in patient care.[15] However, effect sizes several times larger than the value used for the sample size calculation may have been influenced by measurement immediately after the program, use of the same test before and after the intervention (testing effect), and the special attention received by the experimental group (Hawthorne effect); the results should therefore be interpreted with caution.

Limitations

This study has several limitations: 1) the experimental and control groups were allocated non-randomly by subdistrict, and the intraclass correlation was not incorporated into the sample size calculation or analysis;[22] 2) all four subdistricts are in the same district and use the same TB clinic, so contamination may have occurred; 3) the 18–45 age criterion excluded older VHVs, limiting generalizability to all VHVs; 4) the follow-up period was short (8 weeks), and patients' clinical outcomes were not compared between areas; and 5) the researcher served as both developer and implementer of the program, so caution is needed when generalizing the results to areas with different contexts.

Conclusion

Developing VHVs' competence in caring for TB patients in the community in Don Chan District, Kalasin Province, through participatory action research yielded a four-component competence-enhancement approach consistent

with local problems and needs. After the intervention, VHVs in the experimental group showed significant increases in knowledge, skills, and the proportion with high competence compared with before the intervention and with the control group, and co-researchers were very highly satisfied. The approach is likely applicable in similar contexts, but long-term clinical outcomes still need to be evaluated.

Recommendations

1. Recommendations for applying the findings: Don Chan Hospital and the Don Chan District Public Health Office should adopt this approach as the guideline for VHV development and extend it to all SHPHs, with annual refresher training, support for mentor nurses and a LINE consultation channel with patient data protection measures, and coordination with local administrative organizations for budget support.

2. Recommendations for future research: A cluster randomized controlled trial with randomization at the subdistrict level should be conducted, using blinded assessors, extending the age criterion to cover VHVs of all ages, following up for at least 6–12 months, and evaluating patients' clinical outcomes, including treatment success, loss-to-follow-up, and mortality rates, as well as the cost-effectiveness of the approach.

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