Model of prevention and control of COVID-19 from village health volunteers to strengthen community immunity and support future infectious disease outbreaks

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ABSTRACT:
The coronavirus disease 2019 (COVID-19) has significantly affected the world health systems. Each country must find strategies to control the outbreak, including Thailand, which has brought in village health volunteers (VHVs) to help control the outbreak. This research aimed to modify a model and promote the potential for the inhibition and control of COVID-19 by VHVs in the community in Buriram Province, Thailand. We used a mixed-methods approach to examine and enhance VHV competencies in infection prevention, community surveillance, and risk communication. The research was divided into 2 phases as follows: Phase 1 involved a sample of 1,589 VHVs and used a cross-sectional survey design to assess the level of competence and factors influencing the skills of VHV to inhibit and control COVID-19. Phase 2 used a four-step action research cycle: planning, implementing, observing, and reflecting on developing a model for strengthening the potential VHVs of controlling COVID-19, and analyzed data from focus group discussions with stakeholders and experts on potential VHVs and data from participatory observations before and after the development. The results showed significant associations between VHVs' COVID-19 prevention and control competencies and factors such as role perception, work motivation, and training ($p < 0.001$, < 0.001, 0.017, respectively). In addition, implementation of the development model significantly improved the VHVs' knowledge, skills, and satisfaction ($p < 0.001$). This model underscores the pivotal role of VHVs in strengthening community immunity, and highlights the importance of capacity-building initiatives for sustainable public health responses to future outbreaks.

1. Introduction

Healthcare systems and economies worldwide have been severely affected due to the COVID-19 outbreak [1-3]. The outbreak occurred in the first quarter of 2020, raising concerns about what would happen if the disease spread to low-income countries [4]. Different countries and areas within the same country had different outbreak periods [5]. Disease symptoms are similar to those of the common cold, causing it to spread rapidly [6]. These issues significantly impact disease control, particularly in low-income countries and those with low economic liquidity [7]. The shortage of human health resources is a global issue. It is particularly acute in low- and middle-income countries and poses a fundamental challenge to health equity. This shortage directly impacts the achievement of Sustainable Development Goal (SDG) 3, which aims to guarantee good health and well-being for people of all ages and limits progress toward Target 3.8: Achieving universal health coverage [8–11]. Therefore, countries have addressed the deficiency of human health properties through different means, including shifting tasks and deploying various community health workers, including volunteers. Village health volunteers (VHVs) play an important role in disease control [12]. Therefore, supporting factors for disease surveillance and implementation of disease prevention measures are essential. Many studies have been conducted on the lessons learned from the COVID-19 outbreak. The research revealed that the practical experience of officials, including VHVs, knowledge, understanding, and participation in problem-solving, and the provision of up-to-date knowledge significantly impact disease control [13-16]. In addition to the knowledge that plays a role in COVID-19 prevention and control, studies have

hown that the main factors, including support for personal and medical prevention, proactive disease control, awareness of disease severity, motivation and pride, communication and planning, personal healthcare, and accurate data collection [17-19], are important for disease control. However, the strength of Thai communities is associated with the prevalence of positive relationships among their members, which is an important factor supporting VHVs working effectively in disease surveillance [20-21].

The study of lessons learned from the COVID-19 outbreak revealed a lack of information on the implementation of potential building for VHVs and the sustainability of other emergency epidemic responses, namely, training on disease prevention and control, increasing health knowledge, and providing a strong support system. Therefore, it is essential to prepare for future epidemics. In supposition, enhancing health literacy and providing robust support systems for VHVs are essential strategies for improving COVID-19 prevention behaviors. These efforts not only help manage the current pandemic, but also prepare communities for future public health challenges.

This research aimed to study the context and factors affecting the competency of VHVs in Buriram Province in COVID-19 prevention and control. This study was focused on developing a model for enhancing VHVs competency and evaluating the efficiency of this model in improving community disease status, and discussing the impact on sustainable and effective public health practices for other epidemics.

2. Materials and Methods

2.1 Study design and approval

This study was conducted using a mixed-methods research design comprising two phases. In Phase 1, a cross-sectional survey was used to assess the level of competence and factors influencing the skill of VHVs to inhibit and control COVID-19. In Phase 2, an action research approach guided by the conceptual framework of Kemmis and McTaggart [22] was adopted to develop the VHVs' competence in COVID-19 prevention and control. The Human Research Ethics Committee of the Mahasarakham University (Reference No. 254-215/2565) approved this study. Data were collected between June 2021 and December 2022, coinciding with the COVID-19 pandemic period.

2.2 Population and sample size

2.2.1 Phase 1

Quantitative data were collected from 27,834 registered VHVs in Buriram Province. The sample size was initially determined using Daniel's formula for estimating the mean in a known population [23], with a standard deviation of 0.846 obtained from a pilot study, resulting in a calculated sample size of 1,059. To account for multistage random sampling, the sample size was adjusted using Cochran's concept [24], setting a design effect (Deff) of 1.5. However, the total sample size for the study was 1,589 participants. The multi-stage random sampling process consisted of two steps. In Step 1, the population was stratified into four zones based on geographic characteristics, and four districts were selected through simple random sampling. In Step 2, a systematic random sampling technique was applied to the list of VHVs in each of the selected districts, resulting in the selection of 397 and 398 participants per district. (Figure 1)

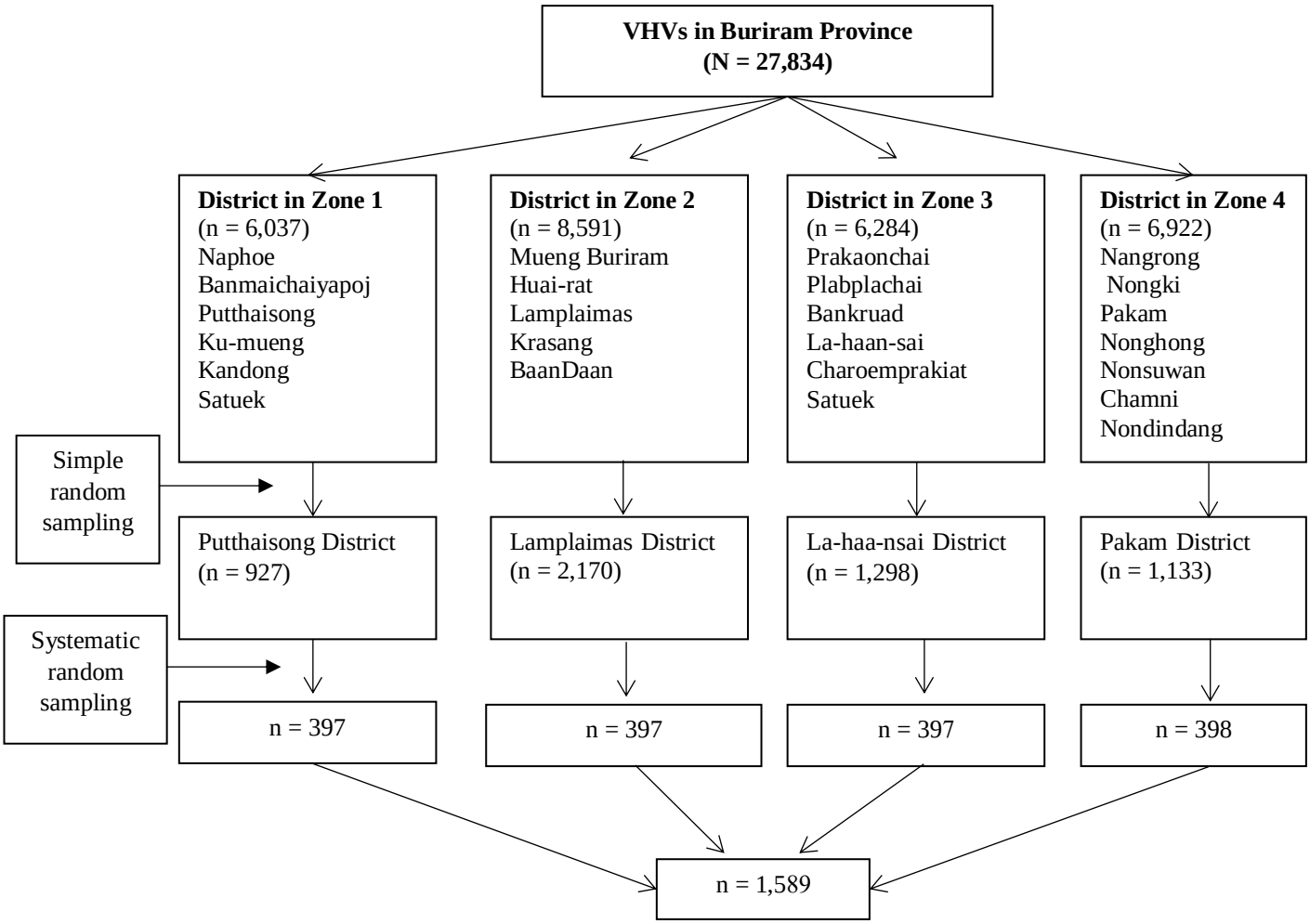

Figure 1. Random sampling process

2.2.2 Phase 2

The sample group involved in the enhancement of the VHVs' competencies for COVID-19 prevention and control consisted of 10 stakeholders and experts in COVID-19 prevention and control. These individuals were selected using purposive sampling and included one representative from the Buriram Provincial Communicable Disease Committee, one representative from the Buriram Provincial Public Health Office, two representatives from the District Public Health Office, two representatives from Local Administrative Organizations, two representatives from sub-district health-promotion hospitals, and two representatives from the community leadership. The sample group for action research to develop public health volunteer competencies was divided into the following three subgroups:

2.2.2.1 Competency development group: A sample of VHVs from Mueang Buriram District, Buriram Province, was selected through simple random sampling for competency development in COVID-19 prevention and control.

2.2.2.2 Satisfaction of the public health officers' group: Satisfaction with the developed potential of VHVs was evaluated using a simple random sampling method, and consisted of thirty public health officers working on COVID-19 prevention and control in Mueang Buriram District, Buriram Province.

2.2.2.3 Satisfaction of service recipients' group: Fifty individuals who received COVID-19 screening and quarantine services from VHVs with developed competencies in Mueang Buriram District, Buriram Province, were randomly selected to study their satisfaction with the services provided.

2.3 Instruments for analysis

2.3.1 Phase 1

Quantitative data were collected using a questionnaire comprising five sections: demographic characteristics of VHVs, including sex, age, income, education level, main occupation, work experience as a VHV and positions held, and training on COVID-19 prevention and control; perception of VHV roles in preventing and controlling COVID-19 in accordance with guidelines of the Thai Ministry of Public Health [25], measured with 18 items; social support according to House's concept [26], measured with 11 items; motivation to follow Herberg's 2-factor theory [27], measured with 33 items; and skill of VHVs to inhibit and control COVID-19 in accordance of approach with the Thai Ministry of Public Health [28], measured with 29 items, with questions in the form of a 5-choice rating scale: most, much, moderate, little, and least. The questionnaire was reviewed by three experts, with index of item objective congruence (IOC) values of 0.50–1.00 and tested among 30 VHVs in Chumphon Buri District, Surin Province. The reliability of the questionnaire on role perception, social support, work motivation, and performance in COVID-19 prevention and control was analyzed using Cronbach's alpha coefficient: 0.75, 0.72, 0.79, and 0.86, respectively.

2.3.2 Phase 2

The tools used are detailed as follows: (1) Focus group discussion among experts and stakeholders on developing VHVs' competency in COVID-19 inhibition and control, which comprised three topics: how COVID-19 prevention and control has been performed by VHVs in the past and present, current and future COVID-19 prevention and control competencies of VHVs, and factors influencing success in developing VHVs' competency in COVID-19 prevention and control; (2) A questionnaire on knowledge about COVID-19 administered before and after competency development, consisting of 13 items, with an IOC value between 0.5–1.0, KR-20 of 0.87, and a test difficulty level ranging from 0.2 to 0.8; (3) A questionnaire on COVID-19 prevention and control skills of VHVs, comprising 17 items, administered before and after competency development; and (4) A questionnaire on satisfaction of volunteer groups, public health officers, and service recipients, with IOC values of 0.5–1.0 and reliability values of 0.81, 0.75, and 0.87, respectively.

2.4 Collection of data

2.4.1 Phase 1

Data collection using questionnaires. Research assistants were trained on data collection guidelines, and they collected data from the homes of the participants. They introduced themselves, informed the participants of their rights, and obtained signed consent forms.

2.4.2 Phase 2

This study phase used a four-step action research cycle: planning, implementation, observation, and reflection (PIOR) to develop a model for strengthening the potential VHVs of intercepting COVID-19.

Step 1 - P: In this data was studied from situation, problems, causes, and context of VHVs. The research results from Phase 1 will be used to plan and determine strategies for developing COVID-19 prevention competency.

Step 2 - I: organize a meeting to explain the plan details and action plan, and evaluate VHVs' competency in preventing COVID-19 by setting development of guiding principles with stakeholders to prevent and control COVID-19 in the community and target groups. Organize activities in accordance with the action plan, such as reviewing knowledge and skills to prevent and control COVID-19, building motivation, and creating awareness of roles and responsibilities. Conduct activities to develop VHVs' capacity to prevent and control COVID-19.

Step 3 - O: Follow up on the improvement of the actions and check the results in accordance with action plan. Evaluate VHVs' knowledge and skills in preventing and controlling COVID-19 through participatory observation.

Step 4 - R: Summarize the operations, development, problems and obstacles, and trainings academic. Finally, the conclusion report was presented to the community.

2.5 Data analysis

All steps were studied using SPSS for quantitative data, as detailed below.

In Phase 1: The data was determined frequency and percentage were used to analyze demographic characteristics. The relationship between demographic characteristics and ability to prevent and control COVID-19 was analyzed using chi-square test. The level of role perception, social support, work motivation, and work performance in COVID-19 prevention and control were analyzed using mean ($\bar{x}$), standard deviation (S.D.), and the relationship between role perception, social support, work motivation, and work performance in COVID-19 prevention. Pearson's correlation coefficients and stepwise multiple regression was investigated the control.

In Phase 2: The content analysis was used to analyze data from focus group discussions with stakeholders and experts regarding VHV competency and data from participatory observation before and after development. Paired t-tests were used to compare the knowledge, skills, and satisfaction of VHVs, as well as satisfaction of public health officers, before and after VHV competency development.

3. Results and Discussion

3.1 Factors related to the competencies of VHVs to prevent and control COVID-19

From the sample of 1,589 people, age, occupation, and experience as a VHV were significantly related to the level of competence in preventing and controlling COVID-19 (p-values (p): < 0.001, 0.03, 0.011), as shown in Table 1. However, perception of the role, social support, and motivation to prevent and control COVID-19 among the VHVs were high ($\bar{x}$ = 4.24, S.D. = 0.52, $\bar{x}$ = 4.13, S.D. = 0.52, $\bar{x}$ = 4.16, S.D. = 0.47, respectively), and all three factors had a significant positive relationship with VHVs' competency in preventing and controlling COVID-19 ($p < 0.001$), as shown in Table 2. Therefore, the result from the analysis of the results, it was found that the results showed that the factors that influenced the competency in preventing and controlling COVID-19 were motivation to perform, perception of the role, and receiving training related to COVID-19. All three factors can predict their competency by 76.4% and can be written as a linear equation: COVID-19 prevention and control competence of VHVs = -0.171 + 0.776 work motivation + 0.235 role perception + 0.06 The training received related to COVID-19 is presented in Table 3.

The relationship between the demographic characteristics of VHVs, work motivation, role perception, and receiving training on COVID-19 on the ability to control COVID-19, which are similar, was studied to understand the motivation and performance of community health volunteers participating in a health project in Kampala, Uganda. Volunteers should enhance their skills and increase their knowledge. The three important factors of volunteer motivation are autonomy, competence, and connectedness [9]. In addition, the study observed that self-esteem, sense of duty, self-efficacy, and the feeling of being treated significantly affected the performance of community volunteers [10]. The results of this study are consistent with those of previous studies. Qualitative data from in-depth interviews revealed that VHVs is an important group of people monitoring, controlling, and preventing COVID-19 in communities, together with government officials. Because they are a group of people who are familiar with the area, they understand the language, the local conditions, and the context of the community. Therefore, they are trusted to reach out to the public more than are government officials. There are six main problems and obstacles in their work: 1) This research indicates a lack of knowledge and skills in the work, which is consistent with previous findings, it was found that knowledge and preventive behaviors for COVID-19 were statistically significantly related [11]. In addition, a positive relationship was found between health knowledge and preventive performances against COVID-19 among VHVs in Samut Songkhram Province. Previously, it was found that overall health knowledge and preventive behaviors were significantly correlated, indicating that higher health literacy was associated with better preventive practices [15]. 2) Insufficient supporting equipment, 3) Lack of morale and anxiety at work, 4) A few people do not cooperate, 5) Managing rumors and false news, and 6) Insufficient budget support. The results of the study of related factors from the case

study in this research are consistent with previous research [29]. This study observed that it promoted the introduction of correct knowledge from reliable sources. The success of VHVs in preventing and controlling COVID-19 is due to nine main factors: personal protective equipment, proactive disease-prevention, awareness of the severity of the disease, pride and motivation, support for medical equipment, communication and planning, emphasizing the role of VHVs in providing knowledge, creating awareness, and strengthening responsibility in the community [17-19].

Table 1: Relationship between demographic characteristics and COVID-19 prevention and control competencies among VHVs (n = 1,589)

Categories data	**COVID-19 prevention and control competency level (n (%))**			χ^2	**p-value**
	low	**medium**	**high**		
Sex				0.121	0.941
male	0(0.0)	27(18.0)	123(82.0)		
female	1(0.1)	234(18.2)	1,050(81.7)		
Age (years)				22.993	<0.001
less than 30	0(0.0)	5(13.9)	31(86.1)		
30-60	0(0.0)	190(16.2)	980(83.8)		
more than 60	1(0.4)	68(28.7)	168(70.9)		
Occupation				4.474	0.031
agriculturist	0(0.0)	227(18.5)	1,002(81.5)		
not agriculturist	1(0.5)	31(16.4)	157(83.1)		
Income (Baht/month)				4.794	0.091
less than 15,000	1(0.1)	182(17.0)	889(82.9)		
greater than or equal to 15,000	0(0.0)	81(21.8)	290(78.2)		
Experience in VHVs role (years)				8.965	0.011
less than 10	0(0.0)	57(13.7)	358(86.3)		
greater than or equal to 10	1(0.1)	206(20.0)	821(79.9)		
Status				10.201	0.116
married	1(0.1)	214(19.1)	903(80.8)		
single	0(0.0)	16(12.6)	111(87.4)		
divorced/separated	0(0.0)	31(17.3)	148(82.7)		
Education				3.000	0.223
less than bachelor's degree	1(0.1)	255(18.6)	1,118(81.4)		
greater than or equal to bachelor's degree	0(0.0)	5(9.8)	46(90.2)		
Awarded in VHVs role				0.485	0.785
no	1(0.1)	214(18.4)	946(81.5)		
yes	0(0.0)	47(17.7)	218(82.3)		
VHVs trained				5.406	0.067
no	1(0.5)	44(21.2)	163(78.4)		
yes	0(0.0)	214(17.6)	1,003(82.4)		
Covid-19 trained				2.238	0.327
no	0(0.0)	16(25.4)	47(74.6)		

Categories data	**COVID-19 prevention and control competency level (n (%))**			χ^2	**p-value**
	low	**medium**	**high**		
yes	1(0.1)	243(17.8)	1,122(82.1)		

Table 2: Relationship between role perception, social support and motivation at work with COVID-19 prevention and control competencies among VHVs (n = 1,589)

variable	$\bar{x}$	**S.D.**	**Levels**	**r**	**p-value**
Role perception	4.24	0.52	high	0.759	<0.001
preparation	4.31	0.62	high	0.555	<0.001
self-protection	4.35	0.54	high	0.616	<0.001
operations	4.21	0.584	high	0.716	<0.001
reporting	4.03	0.75	high	0.635	<0.001
Social support	4.13	0.52	high	0.763	<0.001
psychological support	4.16	0.60	high	0.650	<0.001
information support	4.18	0.59	high	0.687	<0.001
resource support	3.98	0.69	high	0.561	<0.001
evaluation Support	4.14	0.60	high	0.661	<0.001
Motivation	4.16	0.47	high	0.867	<0.001
performance achievement	4.19	0.54	high	0.771	<0.001
respect	4.09	0.61	high	0.713	<0.001
nature of work performed	4.14	0.58	high	0.709	<0.001
responsibility	4.33	0.57	high	0.668	<0.001
career Advancement	4.18	0.63	high	0.698	<0.001
salary and compensation	3.59	0.87	moderate	0.379	<0.001
interpersonal relationships	4.29	0.58	high	0.704	<0.001
command and control	4.13	0.61	high	0.665	<0.001
policy and management	4.10	0.60	high	0.740	<0.001
working conditions	4.15	0.58	high	0.704	<0.001
occupational status	4.36	0.61	high	0.626	<0.001
job security	4.15	0.60	high	0.693	<0.001
private life	4.17	0.62	high	0.685	<0.001

Table 3: Stepwise multiple regression analysis between predictors COVID-19 prevention and control competencies among VHVs (n = 1,589)

Predictors	b	S.E. of b	Beta	t	p-value
Work motivation	0.776	0.029	0.687	27.034	<0.001
Role reception	0.235	0.026	0.234	9.199	<0.001
Covid-19 trained	0.060	0.025	0.040	2.401	0.017

****Constant (a) = -0.171, R = 0.874, R Square = 0.765, Adjusted R Square = 0.764, F = 2,463.778, P<0.001, Mean square = 59.162

3.2 Development of COVID-19 prevention and control competencies among VHVs

The data obtained from the study of the relationship of factors influencing competence in preventing and controlling COVID-19 of VHVs in Phase 1 led to the development of competence in preventing and controlling COVID-19 in VHVs, as shown in Table 4. The competency development model for the VHVs demonstrated significant improvements across multiple domains. The mean knowledge score regarding COVID-19 prevention and control increased from 5.80 (S.D. = 1.98) before the intervention to 11.90 (S.D. = 0.90) afterward, while the mean skill score improved from 8.30 (S.D. = 2.37) to 15.30 (S.D. = 1.30), both with statistical significance ($p < 0.001$). Satisfaction levels showed notable enhancements, with the satisfaction of VHVs rising from 4.22 (S.D. = 0.53) to 4.45 (S.D. = 0.50) ($p = 0.011$), public health officers' satisfaction with VHVs' performance increasing from 4.00

(S.D. = 0.74) to 4.33 (S.D. = 0.48) (p = 0.001), and service recipients' satisfaction improving from 4.08 (S.D. = 0.87) to 4.34 (S.D. = 0.77) (p = 0.005). These results underscore the effectiveness of the program in enhancing the knowledge, skills, and satisfaction of VHVs and their related stakeholders, as shown in Table 4. Therefore, the study of factors influencing COVID-19 prevention and control competencies among VHVs revealed gaps for improvement, leading to the development of COVID-19 prevention and control competencies among VHVs using the action research process based on Kemmis's concept [30], which comprises four steps: planning, implementation, observation, and reflection. Findings from the group discussions with 14 experts and stakeholders showed that VHVs should be competent in seven areas: having correct and up-to-date knowledge; preventing infection at the individual, family, and community levels; monitoring and screening for initial disease in the community; communicating risks and applying technology to communicate risks; reporting data; applying technology to report data; managing infectious waste; and creating social measures to sustainably prevent infection in social activities (Figure 2). These results are consistent with those showing that effective prevention of COVID-19 requires diverse skills, such as disease prevention and control, public health, and healthcare learning. The results of this study show that knowledge and practical skills acquired after training affected the performance of village health volunteers. They reported confidence in their performances. Similar to other disease control studies, knowledge about tuberculosis, attitudes toward tuberculosis care, and tuberculosis care skills in the experimental group before and after the intervention were significantly different ($p < 0.05$) [31]. Examination of the competence of public health personnel was needed to cope with the challenges of COVID-19, and a training program for new learning skills, promoting creativity and self-learning skills, was used to increase opportunities for higher education and personnel potential development [32]. In addition, data from studies on COVID-19 prevention and control in many countries have shown that providing knowledge related to COVID-19 control operations is crucial [33]. The nurse training project to enhance competency in COVID-19 prevention observed that the nurse's knowledge scores before joining the project decreased (32.9%), but the knowledge scores after joining the project improved to (90.0%), which was significantly improved statistically [34]. Important skills include infection prevention and control training, leadership, communication, and the ability to implement comprehensive preventive measures [31-37].

In addition, the ability of public health volunteers with secondary scholarship or higher was better than that of volunteers with primary education. This study emphasized the influence of improving the abilities of public health volunteers with lower educational levels. It is necessary to train individuals according to their educational level to increase the efficiency of VHVs reporting [38]. A training curriculum was then created to develop the competency of public health volunteers and train them according to the planned guidelines. The competence development curriculum was used to train and develop a sample group to conduct COVID-19 prevention and control operations in the community. The results of the performance of the sample group showed a statistically significant increase in knowledge, skills, and satisfaction with COVID-19 prevention and control work, compared with before competency development (p: < 0.001, < 0.001, and 0.011, respectively).

Satisfaction of public health officers and service recipients with the COVID-19 prevention and control work of the sample group also increased significantly ($p < 0.001$ and 0.005, respectively; Table 4) The results of this study, similar to those of research conducted in Israel, revealed the necessary competencies for public health personnel to respond to the COVID-19 outbreak. From qualitative interviews with stakeholders, six main themes emerged: concerns about the expert status of public health personnel, importance of communication competence, essential to enhance health promotion, role of leadership and innovation, and linkages between communities and higher education institutions. This study emphasizes the influence of improving personnel competencies and readiness to respond to global health emergencies [39].

Table 4: Development of VHVs competence by comparing the Mean scores (before and after) of knowledge and skills in COVID-19 prevention and control

Factors	**n**	$\bar{x}$	**S.D.**	**t**	**deff**	**mean different**	**95%CI of mean different**	**p-value**
VHVs of knowledge				18.28	39	6.10	5.42-6.77	<0.001
before	40	5.80	1.98					
after	40	11.90	0.90					
VHVs of skill				19.62	39	6.98	6.26-7.69	<0.001
before	40	8.30	2.37					
after	40	15.30	1.30					
VHVs of satisfied				2.68	39	0.23	0.06-0.39	0.011
before	40	4.22	0.53					
after	40	4.45	0.50					
Health officers satisfied								
before	30	4.00	0.74	3.81	29	0.33	0.15-0.51	0.001
after	30	4.33	0.48					
Customer of satisfied								
before	50	4.08	0.87	2.91	49	0.26	0.08-0.44	0.005
after	50	4.34	0.77					

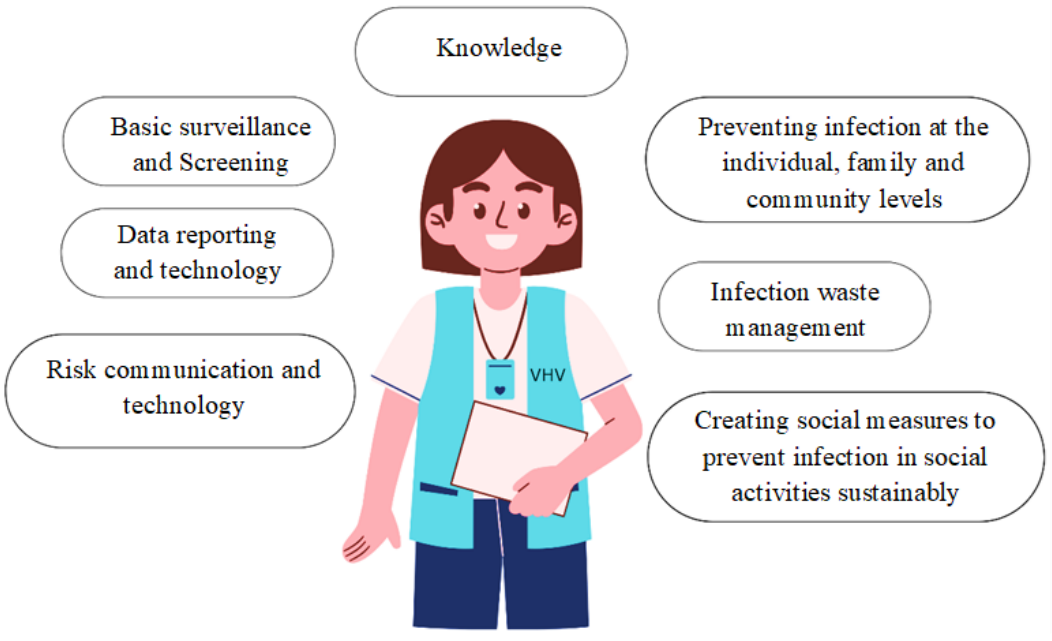

Figure 2. Areas of COVID-19 prevent and control competencies among VHVs

4. Conclusions

We investigated a COVID-19 prevention and control model based on the outbreak in Buriram Province by extracting lessons to increase the competencies of VHVs in various aspects, including knowledge, understanding, infection prevention, surveillance, and risk communication, using an action research approach consisting of four phases: planning, implementation, observation, and reflection. The factors related to the competence of VHVs in preventing and controlling COVID-19 were age, occupation, and experience. However, role reception, social support, and motivation were positively related to the

competence in the prevention and control of COVID-19. Finally, the results of the development of VHVs were trained to enhance their knowledge and skills related to COVID-19 control, and their perceptions, motivations, and roles in the community were assessed. The research revealed that VHVs had significantly increased capacity to prevent and control COVID-19, with significant improvements in their knowledge, skills, and overall satisfaction after training ($p < 0.001$). Key factors for success included motivation and pride, appropriate training, and social support, emphasizing the importance of community engagement in public health actions. This study was conducted during the ongoing COVID-19 pandemic. The applicability of the model to other infectious disease outbreaks should consider the social and environmental contexts. Therefore, for the model to be effective, it should be compared with other social conditions. This model should be tested in other regions, especially in rural and underserved areas, to assess its adaptability and impact on broader community health outcomes and to promote the use of mobile health technology and data analytics to enhance VHVs' capacity to deliver real-time health information and coordinate community interventions more effectively.

Declaration of competing interests

There are no conflicts of interest to declare.

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