Bridging the Gap: An Innovative Community-based Training Program for Respiratory Infection Triage, Post-COVID-19 Era, Thailand

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ABSTRACT

Background. Respiratory infections, including COVID-19, continue to pose a major global health burden, highlighting the need for effective community-based healthcare strategies. Community health workers (CHWs), particularly Thailand's village health volunteers, play a critical role in surveillance, prevention, and primary care delivery; however, evidence-based respiratory triage tools and continuing training programs for CHWs remain limited. Addressing these gaps may strengthen community health systems and improve preparedness for future public health emergencies.

Objective. This research aimed to evaluate Community Health Worker (CHW) readiness in respiratory infection triage and implemented an innovative, theoretically grounded training program in Khon Kaen, Thailand.

Methods. A two-phase action research was conducted. Phase 1 assessed CHW knowledge and skill gaps using Priority Needs Index analysis. Phase 2 designed, developed, and implemented an innovative training program with workshops, field training, and a 4-color triage card. Multi-stage sampling selected 215 CHWs and 111 providers for assessment; 50 CHWs and 14 providers participated in workshops and practical training. Three expert-validated instruments ensured reliability. We collected the data from October 2022 to September 2023.

Results. In Phase 1, significant gaps were identified, with 89.3% of CHWs indicating low-moderate knowledge and 70.23% triage skill. PNI (modify) discovered significant differences between CHW capabilities and provider expectations (p = 0.026). Most CHWs positively expanded the triage role. In Phase 2, researchers found that CHW knowledge significantly improved from 10.56 to 11.38 (p = 0.018), along with an increase in triage skill, which had a mean score of 4.48. Both CHWs (4.51) and providers (4.82) achieved high levels of satisfaction. Success factors were stakeholder participation, context-based design, and simple tools.

Conclusion. The innovative training program effectively bridged critical competency gaps, significantly enhancing CHWs' knowledge and practical skills in respiratory triage while garnering high stakeholder satisfaction. By empowering the community workforce with user-friendly tools such as a 4-color triage card, this evidence-based model offers a scalable solution to reduce the disease burden. Consequently, this adaptable framework serves as a vital mechanism for strengthening global health security and community resilience in resource-limited settings post-COVID.

Keywords: community health workers, innovative program, knowledge, skills, respiratory infection, triage

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INTRODUCTION

The COVID-19 pandemic has changed health systems worldwide, changing how community health workers (CHWs) function across countries. Respiratory infections remain a major burden in global health, with lower respiratory tract infections causing 2.18 million deaths worldwide in 2021.[1] In Thailand, it's responsible for 15.25% of all deaths; 287 new COVID-19 patients are hospitalized with one death per week, creating a significant health burden requiring innovative community-based solutions.[2]

Community health workers (CHWs), who we call village health volunteers (VHVs) in Thailand, have become essential people in primary healthcare systems globally, especially in resource-limited settings where they serve as the first contact between communities and formal healthcare services.[3,4] Health systems increasingly recognize them as a key player in advancing health security. Thailand has over one million VHVs representing one of the world's most developed CHW systems. During COVID-19, these volunteers helped Thailand achieve the fifth-highest global ranking in health security without nationwide lockdowns.[5] This success positions Thailand as an important model for developing community-based health interventions with global applicability.[3]

The roles of CHWs since the COVID-19 pandemic have changed to advancing health security and resilient health systems. The study in the Southeast Asia region found they played critical roles in assisting with surveillance and contact tracing, including in prevention and preparedness.[4,6,7] However, research reveals critical knowledge gaps in this area. They constructed many tools for triage that exist in hospitals, but there is a significant lack of evidence-based triage tools that are designed for CHWs managing the community.[8] Studies across Asia show CHWs receive basic training but lack continuing education, particularly in respiratory triage, or lack adequate training.[4,9] Previous research has mainly evaluated CHW skills from patients' perspectives, lacking studies examining healthcare providers' views on CHW triage skills.[10] Research also has rare evidence on respiratory triage innovation tools for CHWs that can be integrated into existing health systems and sustained over time.

This study identified the gaps from the literature review to develop the potential of CHWs by designing and implementing the innovation training program with multiple theoretical frameworks to explain training innovation, technology adoption, and behavior change in community health settings. Kirkpatrick's Four-Level Training Evaluation Model provides the framework for measuring training effectiveness.[11] Bandura's Social Cognitive Theory explains learning processes and confidence building.[12] The Technology Acceptance Model of Davis helps understand the CHW adoption of triage cards.[13] This study is based on the design, implementation, and evaluation process outlined by Kemmis S. and MacTaggart R.[14] Based on the action research, this study identified the gaps by employing a two-phase approach aimed at enhancing the respiratory triage capabilities of CHWs in Thailand's post-COVID era. Phase 1 systematically assesses current CHW knowledge, skill gaps, and challenges in respiratory triage, plus healthcare providers' expectations versus actual CHW skills. Phase 2 designs, develops, and implements an innovative training program with a specialized triage card for CHWs and healthcare providers. A simple 4-color triage card designed as a tool for CHWs for triage, management, and instruction to care for patients with respiratory infections. The specific objectives were evaluation of knowledge achievement, practical skills, and stakeholder satisfaction.

Thailand succeeded in a strategic position through its innovative respiratory patient care and management during the COVID-19 pandemic. CHWs are formally incorporated into primary health care in the health system. They have the Acts for operation and patient referral pathways, training programs, and supervision by the Ministry of Public Health. This effective model addresses individual capacity building and demonstrates adaptability for implementation in countries with similar characteristics.[3,15] This study will make a significant contribution to the empirical evidence base for enhancing CHWs' capabilities in respiratory patient care management. The contextual assessment will provide data for local skill guidelines and subsequent national scaling, while the training model will be a replicable framework. Effective evaluation through CHW and healthcare provider satisfaction will enhance understanding of stakeholders for sustainable program implementation. This research aligns with the World Health Organization's (WHO) emphasis on policy-relevant health research for developing countries in respiratory patient care management to reduce the burden of respiratory illness. The findings can inform similar projects and ultimately enhance CHW capacity for community-based respiratory patient care, strengthening national health security.

MATERIALS AND METHODS

Study Setting

This action research was conducted between October 2022 and September 2024. The study population comprised 32,374 CHWs in Khon Kaen Province.[16] It is a province that wants to create innovation in reducing deaths from respiratory infections, which are a significant cause of death in this area. The sample size was calculated using Cochran's formula with a finite population in the following:[17]

$$\frac{n = [N Z^2_{a/2} \sigma^2]}{[e^2(N-1) + Z^2_{a/2} \sigma^2]}$$

Sample Size and Sampling

Based on Yaowalak Chaobanpho, CHWs had high COVID-19 prevention skills (mean 4.39, SD 0.57). Multi-stage sampling in Khon Kaen yielded 215 VHWs and 111 providers, slightly above the calculated 207 due to the actual number of CHWs in each sub-district.[18]

For the trial program, we used simple random sampling of 7 urban and 7 rural areas of health-promoting hospitals in Khon Kaen, including 1 provider who responded to primary care as 14, purposive selected 4 of the CHWs in each health-promoting hospital. The inclusion criteria were CHWs who were on active duty for a health-promoting hospital, had a primary education level or higher, were able to read and write, were over 20 years old, and had a working period of more than 3 years. There were 56 CHWs from 14 health-promoting hospitals. Details are shown in Figure 1.

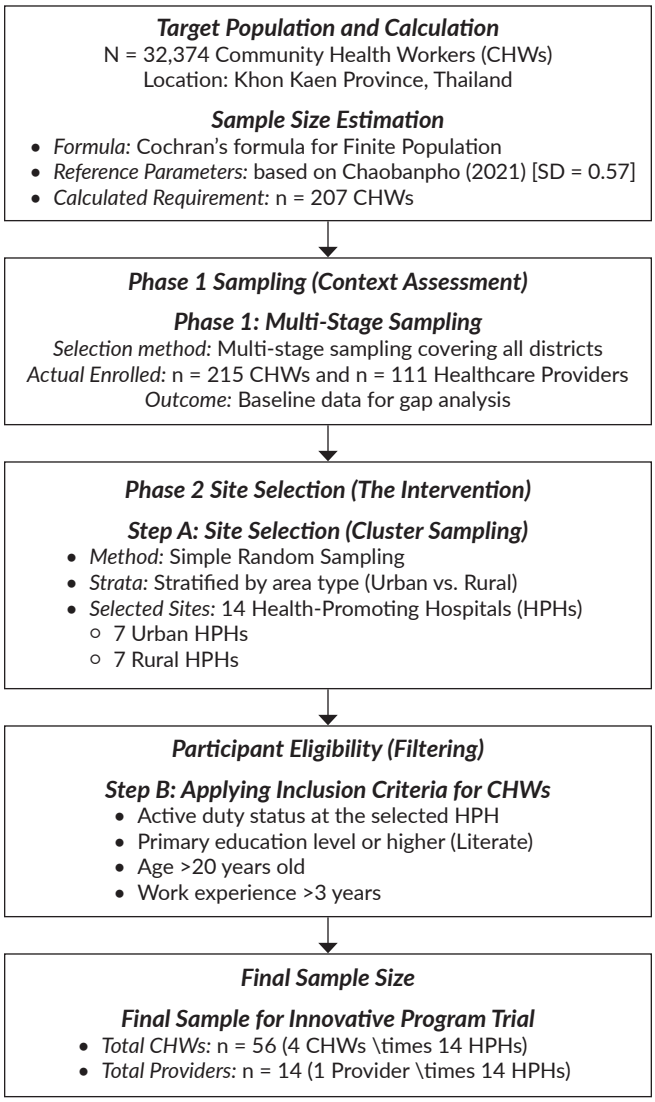


Figure 1. Schematic representation of the sampling procedure and participant selection process.

Instruments and Data Collection

The research instruments were developed by the researchers based on a literature review and expert validation to ensure content validity. All tools were administered in the Thai language to ensure understanding. The instruments were categorized into two phases:

Phase 1: Context Assessment Tools

Data were collected from 215 CHWs and 111 healthcare providers using four instruments:

1. CHW Knowledge Test: A True/False test assessing respiratory infection knowledge. Scores were classified as Good (≥80%), Moderate (60–79%), and Low (≤60%).
2. CHW Triage Skill Questionnaire: A 5-point Likert scale self-assessment covering key skills, including triage for risk of infection.
3. Challenges and Obstacles Questionnaire: Assessed operational barriers faced by CHWs.
4. Provider Expectation Questionnaire: A 5-point Likert scale completed by healthcare providers to compare CHWs' current skills versus expected skills.

Phase 2: Program Evaluation Tools

We created the innovation program driven by stakeholders and structured a context-based design and a simple 4-color triage card. Data were collected from 50 CHWs (excluding 6 participants who were absent during the training session) and 14 healthcare providers. The tools included:

1. Knowledge Test: Identical to the Phase 1 assessment.
2. Triage Skill Assessment Form: A checklist used by healthcare providers to observe and evaluate CHWs' practical performance, specifically focusing on triage at risk of infection and the application of the 4-color triage card.
3. Satisfaction Questionnaire: A survey evaluating stakeholder satisfaction with the innovative training program and the usability of the 4-color triage card.

Instrument Quality

Three (3) experts validated all the instruments. Reliability was confirmed with Cronbach's alpha: knowledge test (KR-21) = 0.77, skill/satisfaction = 0.90, and conditions/challenges questionnaires = 0.82.

Research stage

The study was conducted in two phases (Figure 2). Key activities and outcomes are summarized in Table 1.

Statistical Analysis

We analyzed the data using mean, percentage, standard deviation, chi-square test, and paired t-test. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

This study complied with the Declaration of Helsinki and was approved by the Sirindhorn College of Public Health Ethics Committee (IRB: HE 652093). All participants provided written informed consent.

RESULTS

Pre-implementation Results

Demographic characteristics

Most of the 215 CHWs were female (83.3%), over 45 years old (80.00%), had primary education (39.50%), and had more than 10 years of work experience (58.1%). Most of the 111 healthcare providers were female (82.0%), held

Table 1. Summary of Key Activities and Outcomes according to Research Stage

Research Stage	Key Activities and Methodologies	Participants and Key Outcomes
Phase 1		
1. ***Preparation and Situational Analysis***	• **Literature review:** Synthesized global and local data on CHWs' roles post-COVID. • **Problem definition:** Contextual analysis and identification of needs; identified the lack of evidence-based triage tools for community settings. • **Instrument development:** Created and validated 3 instruments (Knowledge, Skill, Challenges) with experts.	• **Outcome:** Conceptual framework established based on Kirkpatrick's Model and Bandura's Social Cognitive Theory.
2. ***Diagnosis (Data Collection)***	• **Survey administration:** Assessed current knowledge, perceived skills, and operational challenges. • **Expectation gap analysis:** Measured the disparity between CHW capabilities and Healthcare Provider expectations.	• **Participants:** n = 215 CHWs; 111 Healthcare Providers (Multi-stage Sampling). • **Method:** Cross-sectional survey.
3. ***Analysis and Reflection***	• **Gap analysis:** Applied **Priority Needs Index (PNI-Modified)** to identify critical skill deficits.	• **Outcome:** Confirmed urgent need for targeted intervention.
4. ***Planning (Intervention Design)***	• **Stakeholder engagement:** Collaborative meetings to define training principles. • **Innovation development:** Designed the **"4-Color Triage Card"** (White-Green-Yellow-Red) based on the Technology Acceptance Model. The triage card is a simple, 4-color design made of A4-sized colored paper. It comprises a process of triage, organizing the priority of patient treatment, criteria for color-coding, and advice for conduct by CHWs. Details are shown in Figure 3. • **Curriculum design:** Structured a context-based learning module.	• **Output:** A validated "Innovative Triage training program" and physical Triage card prototypes ready for deployment.
Phase 2		
5. ***Action (Implementation)***	• **Workshop execution**: Conducted a 3-hour intensive workshop on respiratory pathology and triage principles. The training program was set up at the meeting hall, including triage knowledge of respiratory infection disease, disease prevention, how to use a 4-color triage card, and demonstrating patient triage with respiratory infection, complemented by practical field training managing two patients with respiratory infections. All 14 healthcare providers were trained in how to use a 4-color triage card and evaluation technique and underwent a standardized training session to ensure consistent application of the skill assessment. • **Tool adoption**: Training on the practical application of the 4-Color Triage card. • **Experiential learning**: Field training sessions managing real/simulated respiratory cases.	• **Participants:** n = 50 CHWs (Intervention Group); 14 Healthcare Providers (Mentors/Observers). • Setting: 7 Urban and 7 Rural Health Promoting Hospitals.
6. ***Observation (Evaluation)***	• **Knowledge assessment**: Administered Pre-test and Post-test (True/False). • **Skill verification**: Direct observation by providers using a simple checklist-based assessment during field practice, provided them with feedback, and recorded their outcomes. • **Satisfaction survey**: Collected feedback from both CHWs and Providers.	• **Data collected:** Quantitative scores on knowledge retention, practical skill proficiency, and program satisfaction.
7. ***Reflection (Data Analysis)***	• **Statistical testing**: Used a paired t-test for knowledge and descriptive stats for skills. • **Performance review**: Analyzed skill gaps post-training vs. pre-training expectations. • **Process evaluation**: Reviewed satisfaction levels and barriers.	• Result (Knowledge): • Result (Skill): • Result (Satisfaction):
8. ***Conclusion and Sustainability***	• **Final synthesis:** Confirmed the model's efficacy in bridging the competency gap. • **Success factors identified**: Stakeholder participation, simple visualization (4-color), and context-based pedagogy. • **Scaling plan**: Recommended flexible framework adaptation for national health security.	• **Final output:** An evidence-based, scalable training model for CHWs in resource-limited settings. • **Impact:** Enhanced community health resilience.

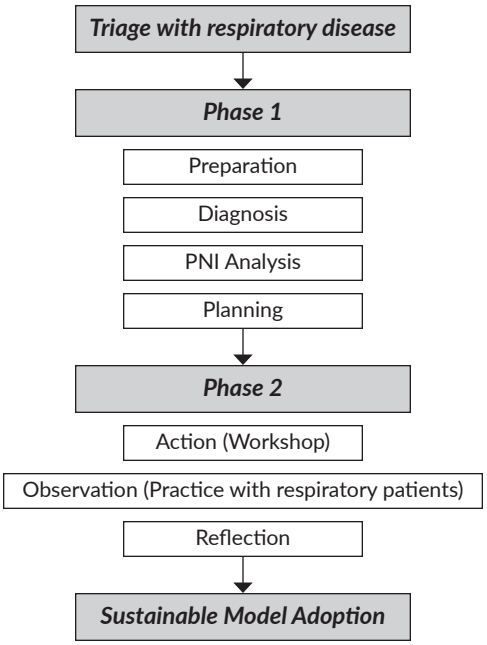


Figure 2. Flow diagram for the study.

a bachelor's degree (74.8%), and had more than 10 years of experience (73.90%), with nearly equal numbers of nurses and academic public health officers. Details are shown in Table 2.

Knowledge and skills in triage of CHWs

A 15-item true-false test evaluated CHWs' triage knowledge. The average score was 9.88 (SD = 1.39), indicating moderate knowledge. Most CHWs found low to moderate knowledge (89.30%). Most CHWs had triage skill scores in the low-to-moderate range. Overall, 70.23% of CHWs were classified as having low or moderate triage skills, whereas only 29.77% achieved high skill levels. However, in detail, they believe they should isolate patients, 79% see themselves as part of the triage process, and 74% agree that triage should not be limited to doctors and nurses. However, fewer CHWs feel confident in effectively triaging mild cases (41%), serious respiratory illnesses (21.9%), and managing patients based on their severity (21.8%). Details can be seen in Figure 4.

We examined potential confounding by personal characteristics of CHWs for their triage knowledge and skills. Sex, age group, and work duration were not significantly associated with either triage knowledge or skill. Education level was the only personal factor showing a statistically significant association, with CHWs who had secondary education demonstrating higher respiratory triage knowledge (p-value = 0.033) and skill (p-value = 0.000) than those with primary education (Tables 3 and 4).

Challenges and obstacles in triage of CHWs

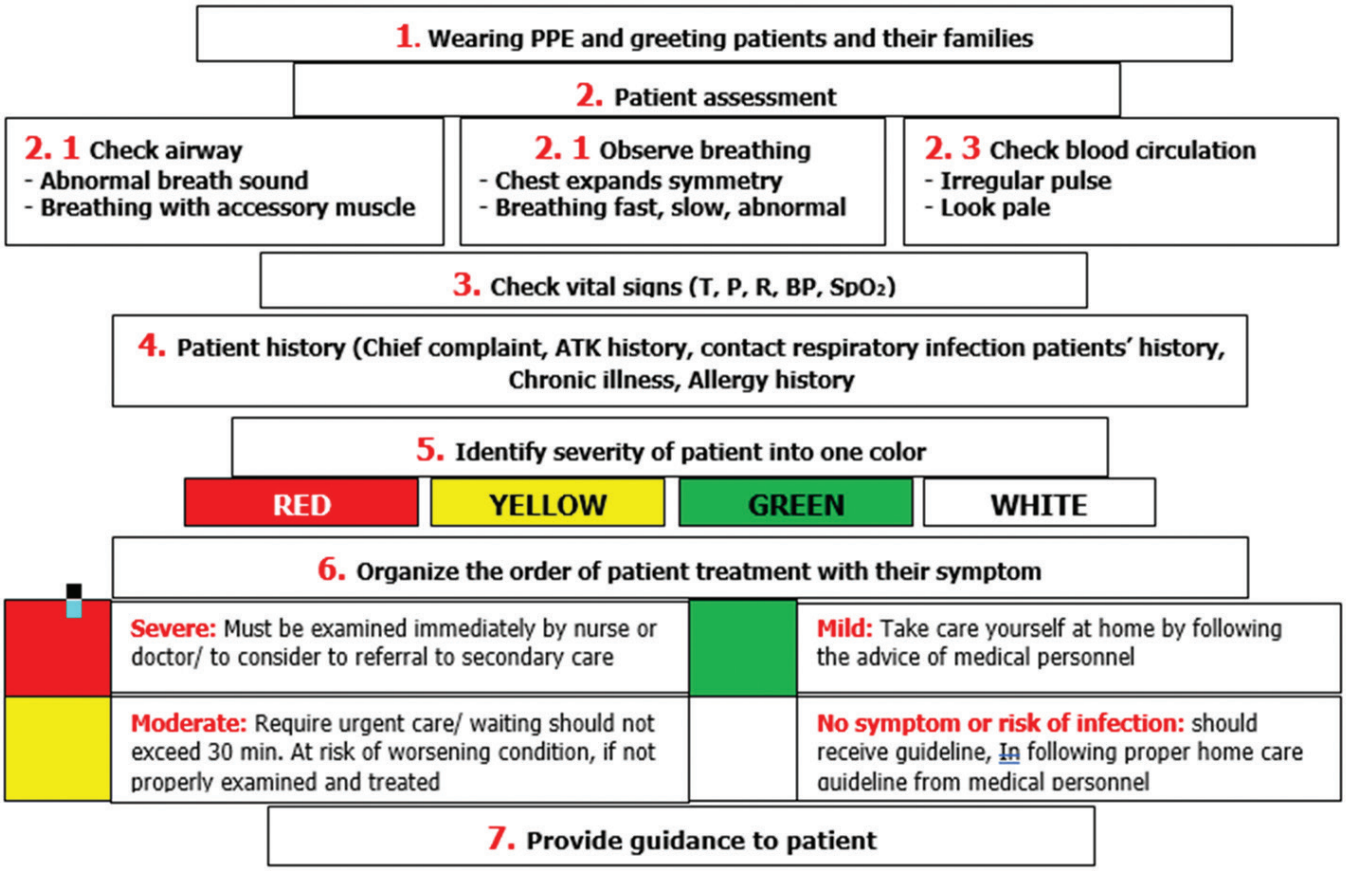
CHWs had moderate obstacles in triage, management, and care for patients (mean 3.23, SD 0.66). The top challenges were insufficient equipment, inadequate facility readiness, and insufficient personnel at 59.10%, 50.70%, and 43.70%, respectively (Table 5). These areas need attention to enhance CHWs' effectiveness in managing and caring for patients.

Table 2. Demographic Characteristics of Study Population

Sample characteristics		Number	Percentage
Personal factors of CHWs			
Sex	Male	36	16.70
	Female	179	83.30
Age (years)	25-35	19	8.80
	36-45	24	11.20
	>45	86	40.00
	>55	86	40.00
Education level	Elementary school	85	39.50
	Middle school	58	27.00
	High school	71	33.00
	Bachelor's degree	1	0.50
Working period of volunteers (years)	<5	12	5.60
	5-10	18	36.30
	>10	125	58.10
Personal factors of health care provider			
Sex	Male	20	18.00
	Female	91	82.00
Age (years)	<25	8	7.20
	25–35	42	37.80
	36–45	30	27.00
	46–55	27	24.30
	>55	4	3.60
Highest education	Certificate	8	7.20
	Bachelor's degree	83	74.80
	Master degree	13	11.70
	>Master degree	7	6.30
Position	Community health officer	4	3.60
	Academic public health officers	45	40.50
	Nurse	47	42.30
	Director of health promoting hospital	15	13.50
Working period of health care provider (years)	<5	29	26.10
	5-10	16	14.40
	>10	66	59.50

CHWs' triage skill gaps for respiratory infections current vs. expected by healthcare providers

Priority Needs Index analysis revealed significant gaps between CHWs' current skill and healthcare provider expectations (p = 0.026, overall PNI (modified) = 0.05). Their urgent priority was basic clinical skills: basic physical examination (PNI = 0.08), triage patients by severity, and triage at risk of infection (PNI = 0.07). Basic physical examination and triage of patients were urgent priorities



Criteria for color-coding severity for CHWs to advise						
Vital signs	Red	Yellow	Green	White	Signs & symptoms	Self care guidelines
Temp.	T>38°C > 24 hrs.	T37.5°C-38°C >24 hrs.	T<37.5°C	Normal	Fever	1. Take Paracetamol for fever 2. Use sponge bath for high fever, seek medical care if fever persists 3. Fever should reduce within 2 days, if not visit medical facility immediately
Pulse rate	>120	101-120	Normal 60-100	Normal 60-100		
Respiration rate times/ min.	>30	25-30	21-24	Normal 12-20	Nasal congestion, Runny nose	1. take antihistamine, may cause drowsiness 2. Might be use essential oils to help to clear airways
Systolic BP	161-180	131-160	90-130	90-130	Cough, Sore throat	1. Drink warm water to dissolve mucus 2. Use throat lozenges or herbal lozenges
Diastolic BP	60-90	60-90	60-90	60-90		
					Fatigue over body	Rest and reduce energetic activities
Oxygen sat.	<95%	<95%	≥95%	≥95%	Nauses, vomiting, Loss of appetite	1. Eat soft food, eat small amount but frequently 2. Sip on saline water or rice porridge water
More signs or symptom (* Any one of symptoms in that color)	T>30C more than 24 hrs. even taking medicine but it still hasn't gone down, Fast breathing, Tried, Breathless, Lethargic, Eating less, Body aches	T37.5-38C Rapid breathing, Tired, Fatigue, Diarrhea > 3 times a day, Age 60+, Has underlying chronic diseases	T≤37.5C, Slightly abnormal breathing, Cough with mucus, Sore throat, No underlying chronic diseases	No fever, Nasal congestion, Slightly cough and sneeze, No underlying chronic diseases	Diarrhea	1. Drink electrolytes to replenish minerals 2. For severe diarrhea, exhaustion or watery stools, seek medical care immediately
Underlying diseases: Chronic respiratory disease, Heart disease, Chronic vascular disease, Stroke, Diabetes, Cancer						

Figure 3. Card for respiratory infection triage by CHWs.

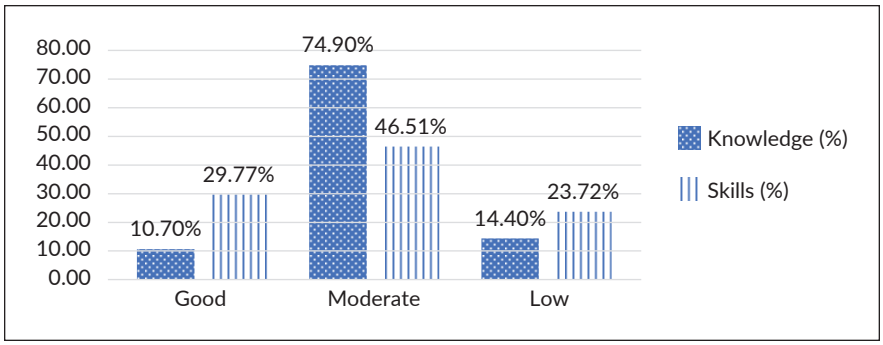


Figure 4. Knowledge and skills of triage among CHWs.

Table 3. Association between Personal Factors and Knowledge of Triage, Management, and Care for Patients with Respiratory Infections (n = 215)

Personal factors		Knowledge of the triage of patients with respiratory infections			χ^2	*p*-value
		High, n (%)	Moderate, n (%)	Low, n (%)		
Sex	Male	2 (5.56)	28 (77.78)	6 (16.67)	1.269	0.530
	Female	21 (11.73)	133 (74.30)	25 (13.97)		
Age group (years)	25-45	3 (6.98)	32 (74.42)	8 (18.60)	1.350	0.509
	>45	20 (11.63)	129 (75.00)	23 (13.37)		
Education level	Primary school	4 (4.71)	71 (83.53)	10 (11.76)	6.808	0.033
	Secondary school	19 (14.62)	90 (69.23)	21 (16.15)		
Working period of volunteers (years)	5-10	10 (11.11)	66 (73.33)	14 (15.56)	0.213	0.899
	>10	13 (10.40)	95 (76.00)	17 (13.60)		

Table 4. Association between Personal Factors and Practices in Triage, Management, and Care for Patients with Respiratory Infections (n = 215)

Personal factors		Skills in the triage of patients with respiratory infections			Fisher's Exact Test
		High, n (%)	Moderate, n (%)	Low, n (%)	
Sex	Male	9 (25.00)	27 (75.00)	0 (0.00)	0.498
	Female	57 (31.84)	117 (65.36)	5 (2.79)	
Age group (years)	25-45	9 (20.93)	32 (74.42)	2 (4.65)	0.142
	>45	57 (33.14)	112 (65.12)	3 (1.74)	
Education level	Primary school	14 (16.47)	67 (78.82)	4 (4.71)	0.000
	Secondary school	52 (40.00)	77 (59.23)	1 (0.77)	
Working period of volunteers (years)	5-10	27 (30.00)	59 (65.56)	4 (4.44)	0.273
	>10	39 (31.20)	85 (68.00)	1 (0.80)	

Table 5. Challenges and Obstacles in the Triage of Patients with Respiratory Infections by CHWs

Problems and barriers	CHWs' perceived level of challenges and barriers		
	High (%)	Very high (%)	High + very high (%)
1. Insufficient equipment	27.90	31.20	59.10
2. Inadequate facility readiness	28.80	21.90	50.70
3. Insufficient personnel	26.50	17.20	43.70
4. Lack of knowledge of disease	21.90	15.80	37.70
5. Lack of knowledge in triage	20.00	13.00	33.00
6. Lack of confidence in triage	23.30	8.40	31.70
7. Anxiety about infection	11.20	4.20	15.40

Overall mean = 3.23 (SD 0.66)

Table 6. CHWs' Triage Skill Gaps for Patients with Respiratory Infections: Current vs Expected from the Healthcare Providers' Perspective (n = 111)

Competency area	Current skill	Expectation skill	Gap score	PNI modified	Ranking
1. Basic physical examination	3.00	3.26	0.26	0.08	1
2. Triage patients by severity	3.07	3.30	0.23	0.07	2
3. Triage at risk of infection	3.15	3.38	0.23	0.07	2
4. Taking patient history	3.24	3.42	0.18	0.05	4
5. Use of assessment tools	3.28	3.44	0.16	0.05	4
6. Self-protection and prevention	3.35	3.47	0.12	0.04	6
7. Follow-up and advice to home care	3.45	3.51	0.60	0.02	7
Overall mean scores of current and expected skill	3.26 (SD 0.76)	3.42 (SD 0.87)	0.16	0.05	

A paired t-test showed a statistically significant difference between the mean current and expected skill (p = 0.026).

Table 7. Comparison of Triage Knowledge before and after Training with the Innovative Program Using the Paired t-test (n = 50)

Knowledge triage score	n	mean	SD	mean difference (d^-)	SD difference (SD d^-)	95% CI	*P*-value
After implementation	50	11.38	1.64	0.82	2.38	0.15-1.50	0.018*
Before implementation	50	10.56	1.76				

of training, while follow-up and advice on home care were nearly at expected levels. The modest PNI values suggest that there are manageable gaps that can be addressed through targeted training interventions, which will provide evidence-based priorities for building the respiratory triage capacity of community health workers (CHWs) (Table 6).

Post-implementation Results

Sample characteristics

Among the 50 CHWs, most were female, over 45 years old, and had a secondary education and 5–10 years of work experience. Of the 14 healthcare providers, most were female, held a bachelor's degree, worked as nurses, and had 5–10 years of experience.

Knowledge in triage

CHWs' triage knowledge was moderate before the start of the program (mean 10.56, SD 1.76) and increased significantly after implementation (mean 11.38, SD 1.64; *p*-value = 0.018). Prior to selecting the statistical tests, the assumption of normality was verified using the Shapiro-Wilk test. The analysis confirmed that the distribution of the pre- and post-training score differences was normal (p >0.05). Consequently, a paired t-test was employed to compare the mean differences, ensuring the appropriateness and statistical power of the analysis without the need for non-parametric alternatives (Table 7).

Skill in triage of CHWs

Healthcare providers assessed CHWs' practical triage skills during practical training and found the overall mean of high skill (mean 4.48, SD 0.21). The top of the very highest skill was greeting patients, and the lowest skill was still basic physical examination (Table 8).

Satisfaction with quality and appropriateness of the innovative program

CHWs reported very high satisfaction with the innovative program (mean 4.51, SD 0.62), especially for its ease of use and applicability. Healthcare providers were even more satisfied (mean 4.82, SD 0.38), rating all aspects highest.

Table 8. Skill in Triage of CHWs after Training with the Innovative Program from the Healthcare Providers' Perspective (n = 14)

Issues	Mean	SD	Interpretation
1. Greeting patients	4.84	0.54	Very high
2. Use of assessment tools	4.66	0.77	Very high
3. Self-protection and prevention	4.51	0.86	Very high
4. Follow-up and advice to home care	4.51	0.88	Very high
5. Categorizing patients to treat	4.45	0.89	Very high
6. Taking patient history	4.40	0.92	Very high
7. Triage at risk of infection	4.38	0.93	Very high
8. Basic physical examination	4.09	1.00	Very high
Overall CHWs' triage skill	4.48	0.21	Very High

Table 9. Satisfaction between CHWs (n = 50) and Healthcare Providers (n = 14) regarding the Quality and Suitability of the Innovative Program

Satisfaction regarding the quality and suitability of the innovative program	CHWs (n = 50)		Healthcare Providers (n = 14)	
	x̄ (SD)	Interpreted	x̄ (SD)	Interpreted
1. Facilitates easier learning of triage	4.62 (0.60)	Very high	4.78 (0.42)	Very high
2. Can be used for triage, management, and care of respiratory patients at home	4.60 (0.57)	Very high	4.78 (0.42)	Very high
3. Applicable to other areas for triaging	4.58 (0.57)	Very high	4.92 (0.26)	Very high
4. Should be further developed and implemented in other areas	4.58 (0.49)	Very high	4.64 (0.49)	Very high
5. Accuracy and consistency in triage processes	4.54 (0.61)	Very high	4.92 (0.36)	Very high
6. Useful for disease prevention and control	4.54 (0.61)	Very high	4.92 (0.26)	Very high
7. Program is interesting and user-friendly	4.51 (0.61)	Very high	4.78 (0.42)	Very high
8. Program is easy to use	4.18 (0.82)	High	4.78 (0.42)	Very high
Overall Satisfaction	4.51 (0.43)	Very high	4.82 (0.29)	Very high

The CHWs were the most satisfied with the details shown in Table 9.

DISCUSSION

The study found that CHWs had only moderate knowledge and skill in triaging patients with respiratory infections. According to another study by Nyagah LM et al., actual skill was substandard compared to healthcare providers' expectations (p-value <0.05), mainly due to lack of equipment and personnel.[19] Numerous studies confirm that the majority of CHWs continue to excel in their roles, providing care to individuals at home. The results validate recent research by Hartzler et al. and Kalin Werner et al. similarly found that CHWs often lack the necessary knowledge and skills for triaging and managing respiratory infections, particularly during disease outbreaks.[20,21] The study of PNI (modified) identified significant gaps that persisted in basic clinical skills (p-value = 0.026), underlining the urgent need for targeted skill development and system support to enhance CHWs' effectiveness.

The innovative program was based on the action research approach, integrating content, learning management, and authentic assessment. A simple 4-color triage card (white-green-yellow-red) reduced memorization errors and promoted stakeholder participation. This aligns with Seneviratne S et al., who found participatory, skill-based training improved knowledge and skills in the community, and Yaebkai Y. and Wongsawat P. who recommended training to enhance CHWs' attitudes and motivation while identifying training as key for CHWs' development.[22-24] Studies from India and Nepal also confirm that hands-on training significantly boosts CHWs' knowledge, skills, and confidence in respiratory care.[25,26] These results reflect the study of Bhaumik S. (2020), who concludes it is critical to ensure role clarity, training, and supportive supervision of CHWs during the pandemic.[7] Furthermore, we found success factors included stakeholder participation, context-based design, and simple tools.

After implementing the innovative program, CHWs' knowledge increased significantly from 10.56 to 11.38 (p = 0.018), aligning with studies showing 30–40% post-training gains.[27] Although these findings are preliminary, they suggest that longer or repeated training and follow-up may be required because triage knowledge can decline over time.[28-30] We found triage skills to be high to very high (4.09-4.84/5), mostly in greeting patients and measuring vital signs. Satisfaction was very high among CHWs (mean 4.51) and healthcare providers (mean 4.82). The high satisfaction levels found by both CHWs and healthcare providers indicated acceptance and feasibility for this program and its process. The results support the importance of CHWs, who are frontline workers in community health, particularly in triage and managing respiratory infections. This aligns with the study of Kok et al., which found that CHWs play a crucial role in reducing barriers to primary healthcare access, especially among vulnerable populations, by building trust and creating linkages between communities and health systems.[31] The findings improved the capabilities of CHWs and indicated an effective strengthening of the response to respiratory infections. However, we did not follow up with the six CHWs who missed the class, but with the health care providers who participated in the training group; they are willing to train them about knowledge and skills to use the triage card.

CONCLUSION

The assessment from Phase 1 of the research process revealed gaps in CHW knowledge and skills that require intervention. We conducted a PNI (modify) analysis to identify gaps between the current capabilities and the expectations of healthcare providers. Data were analyzed to interpret findings and prioritize areas for improvement.

Stakeholder participation agreements and context assessments guided the planning for intervention. Phase 2: Intervention follow-through: the plan was organized for healthcare providers and CHWs. The results showed an increase in knowledge and skills in CHWs after the program. It indicated that the evidence-based innovation program was effective in respiratory diseases. Stakeholders achieved very high satisfaction and validated acceptance of the program and the 4-color triage card. Success factors were stakeholder participation, context-based design, and simple tools. The success of improving knowledge and competency will reduce the global burden and contribute to global health security. The flexible framework can be changed to enhance preparedness for burden diseases, strengthening community and health resilience in resource-limited settings post-COVID-19.

Limitations of the Study

The research was conducted in one province, which may limit its generalizability to other countries and healthcare contexts. The short follow-up period prevents assessment of long-term knowledge retention and skill maintenance.

Recommendations

The authors recommend the following for the implementation of research findings:

1. Develop a simple triage process that briefly outlines triage care before expanding and adapting a simple 4-color triage card for the local area, creating user-friendly manuals, and establishing ongoing healthcare provider mentoring for CHWs.
2. Integrate a simple 4-color triage card system into national CHW curricula and adopt Kirkpatrick's model for training evaluation, aligning with WHO policy and Universal Health Coverage.
3. Expand and continuously build CHW capacity with refresher training to strengthen competency in respiratory infection triage for local and national adaptation.
4. Apply supportive technologies, such as developing applications and centralized databases, to assist with patient triage.

Future research may include conduct of multi-site randomized controlled trials comparing innovative simple 4-color triage card training with traditional CHW methods across different geographical and cultural contexts to provide stronger evidence for generalizability and intervention superiority, implementation of long-term follow-up evaluations (6-12 months post-training) to assess knowledge sustainability and simple 4-color triage card use in community settings, and integration of digital health technologies with triage cards, investigating mobile applications and telemedicine platforms to enhance CHW decision-making.

CONCLUSION

The study, based on action research, was conducted in two phases. Phase 1: A contextual assessment, which found that most CHWs had low to moderate knowledge (89.30%) and skill (70.23%) in respiratory infection triage. Positive findings included most CHWs positively embracing patient isolation and expanding triage responsibilities beyond doctors and nurses. They challenged moderate obstacles in triage, management, and patient care (mean 3.23, SD 0.66). The mean scores for current skill (3.26, SD 0.76) and healthcare provider expectations (3.42, SD 0.87) were moderate, while the modified PNI found significant gaps between them (p = 0.026; overall modified PNI = 0.05). The urgent training priority identified was basic physical examination and patient triage. This assessment led to the planning and design of interventions and the development of an innovative program, drawing on multiple relevant theories to enhance CHWs' capacity in the triage, management, and care of patients with respiratory infections. A triage card was developed, and implementation plans were made in collaboration with stakeholders. Phase 2: Implementing the intervention for healthcare providers and CHWs, including 3-hour workshops and field training managing two patients with respiratory infections using a 4-color triage card. Results showed a statistically significant increase in CHW knowledge from 10.56 (SD 1.76) to 11.38 (SD 1.64) (p = 0.018). The overall skill of triage, management, and patient care improved significantly from a moderate level (mean 3.26, SD 0.76) to a high level (mean 4.48, SD 0.21). CHWs (mean = 4.51) and healthcare providers (mean = 4.82) indicated high satisfaction. We conclude that the innovative training program effectively bridged critical competency gaps, significantly enhancing CHWs' knowledge and practical skills in respiratory triage while garnering high stakeholder satisfaction. By empowering the community workforce with user-friendly tools of a 4-color triage card, this evidence-based model offers a scalable solution to reduce the disease burden. Consequently, this adaptable framework serves as a vital mechanism for strengthening global health security and community resilience in resource-limited settings post-COVID.

Success factors included stakeholder participation, context-based design, and simple tools. The intervention demonstrated reliability and stakeholder acceptance, validating its effectiveness.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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