

A covariance-based structural equation model of structural pathways influencing the performance of village health volunteers in Kranuan District, Khon Kaen, Thailand

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ABSTRACT

This cross-sectional study aimed to develop and test a model explaining the performance of Village Health Volunteers (VHVs) in Kranuan District, Khon Kaen Province, Thailand. VHVs are community residents selected and trained under the guidelines of the Ministry of Public Health and play a key role in community participation and access to primary healthcare services. A total of 413 VHVs were randomly selected for the study, of whom 384 completed the structured questionnaire and were included in the analysis (response rate: 92.98%). Covariance-based structural equation modeling (CB-SEM) was employed, with the measurement model first evaluated using confirmatory factor analysis (CFA) prior to testing the structural model. The final model demonstrated good fit to the data ($\chi^2 = 323.72$, $df = 286$, $p = 0.062$; RMSEA = 0.019, 90% CI: 0.000 – 0.028; SRMR = 0.033; CFI = 0.994; TLI = 0.991) and explained 73% of the variance in VHV performance ($R^2 = 0.73$). Empowerment and job satisfaction were directly associated with performance, whereas leadership, social networks, and work motivation were indirectly associated with performance through mediated pathways. In terms of total effects, empowerment emerged as the strongest factor associated with performance. Overall, the findings suggest that motivation, empowerment, leadership, and social networks are closely interrelated and jointly associated with VHV performance. These results highlight the importance of empowerment-oriented and motivation-supportive strategies within routine primary health care systems to strengthen VHV performance.

Keywords:

village health volunteer, performance, covariance-based structural equation modeling, Thailand

Citation:

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INTRODUCTION

Primary health care (PHC), formally endorsed by the Alma-Ata Declaration in 1978, emphasizes equality, community participation, and universal access to essential health services. Core components of PHC include integrated service delivery, multisectoral action, and the empowerment of individuals and communities to manage their own health needs. From a theoretical perspective, PHC emphasizes human agency and community empowerment as key mechanisms for sustaining health system performance. Within this framework, community health workers (CHWs) and health volunteers are widely recognized as a foundational workforce for strengthening community engagement and extending primary health care services, particularly in settings with limited health system resources.¹⁻⁵

In Thailand, Village Health Volunteers (VHVs) are individuals chosen from local villages or communities and trained in accordance with the regulations set by the Ministry of Public Health (MOPH). VHVs implement health policies at the community level by delivering health promotion and disease prevention activities, providing basic services, conducting public health surveillance, facilitating access to health care entitlements, coordinating with health professionals and local organizations, and mobilizing community participation in accordance with national standards. Through these routine functions, VHVs serve as a key link between communities and the formal health system.^{1, 6} Since its inception in 1978, the VHV program has expanded to approximately 1.04 million volunteers nationwide.⁷ Their multifaceted roles suggest that VHV performance is not merely task-based but reflects a complex interplay of individual, psychosocial, and organizational factors.

Performance is defined as the actions or behaviors displayed by individuals to achieve organizational goals.⁸ Evidence from low- and middle-income countries indicates that the performance of community health volunteers is shaped by multiple interrelated factors, including motivation and incentives, training and competency development, availability of resources, supportive supervision, and linkages with the health system.^{9, 10} Studies conducted in Thailand similarly demonstrate that VHV performance is associated with role clarity, social support, work motivation, knowledge, attitudes, and perceived organizational support.^{9, 11} Collectively, this evidence suggests that VHV performance emerges from both individual and organizational influences rather than from isolated factors. However, most existing studies have relied on bivariate or regression-based analyses, limiting understanding of how these factors operate simultaneously and through indirect or mediated pathways.¹²

Theoretical and empirical evidence points to five key determinants that influence VHV performance through direct and indirect pathways: empowerment, leadership, social networks, work motivation, and job satisfaction. Empowerment is defined as processes that enable individuals and communities to gain greater control over decisions and actions affecting their health and work roles.^{3, 13} Prior research indicates that empowerment is influenced by access to information and health literacy and is closely linked to leadership capacity, job satisfaction, and work performance.¹⁴⁻¹⁶ Evidence from Thailand further shows that empowered VHVs demonstrate higher performance in community-based service delivery, including chronic disease management.¹⁷ Leadership plays an important role in translating empowerment into effective practice by

responding to followers' needs, facilitating coordination, and enhancing performance.¹⁸ Previous research, including studies on transformational leadership, has demonstrated a positive association between leadership and job satisfaction among health volunteers¹⁵, suggesting that leadership may act as a key mediating mechanism linking empowerment to performance-related outcomes. Beyond individual-level mechanisms, social networks provide essential contextual support for VHVs. Social networks refer to people-centered connections among relatives, neighbors, and co-workers^{19, 20}, and prior evidence indicates that strong community relationships are associated with greater empowerment and collaborative performance among VHVs.²¹ Work motivation, encompassing financial and non-financial components such as training, incentives, and supportive working conditions, enhances commitment and work effectiveness.^{22, 23} Previous studies have shown that motivation, incentives, and logistical support are positively associated with VHV performance and closely linked to leadership and job satisfaction.^{12, 24, 25} Job satisfaction reflects individuals' attitudes toward their work and has been consistently linked to volunteer role performance.²⁶⁻²⁸ Collectively, existing evidence suggests that empowerment, leadership, motivation, social networks, and job satisfaction are interrelated rather than independent determinants of VHV performance. However, most prior studies have emphasized direct associations, leaving the indirect and mediating pathways operating simultaneously within an integrated structural framework insufficiently examined. Accordingly, this study applies CB-SEM to investigate the interconnected pathways influencing VHV performance.

In 2024, MOPH elevated the primary health care system by expanding home- and community-based services, enhancing access to diagnostics and medications at local service units, implementing telemedicine, and promoting

the development of Smart VHVs.²⁹ These policy shifts increase both task complexity and psychosocial demands on VHVs, underscoring the need to understand performance through a theoretically grounded, multivariate framework. In parallel, national policy specifies that each VHV is responsible for approximately 15–20 households. In the Seventh Health Region, particularly in Khon Kaen Province, VHVs shoulder one of the highest household workloads, averaging around 20 households per volunteer.³⁰

In this study, VHV performance is defined as the extent to which VHVs effectively carry out their routine primary health care roles, including health promotion and disease prevention activities, community engagement, service coordination, health surveillance, and support for access to health services, in accordance with national VHV performance standards.^{1, 6} This operational definition directly informed the performance indicators used in the SEM measurement model. Performance monitoring reports of VHVs during recent public health operations demonstrated that the Seventh Health Region consistently achieved high overall performance compared with other regions nationwide, with Khon Kaen Province ranking among the strongest performers within the region. Among its districts, Kranuan District has repeatedly been classified among the top-performing areas. Therefore, Kranuan District was selected as the study setting because it represents a high-performing context under substantial routine service demands.³¹

This research aims to examine the performance of VHVs in Kranuan District, Khon Kaen Province, Thailand, by applying CB-SEM to assess the underlying performance framework and the causal relationships among the influencing factors. By explicitly modeling direct and indirect pathways among key constructs, this study addresses an important

methodological and theoretical gap in the VHV performance literature. CB-SEM was selected because it allows the simultaneous analysis of complex causal pathways among latent variables, providing a more comprehensive understanding of the interrelationships than conventional regression techniques.

OBJECTIVES

1. To validate the measurement model of the latent constructs using CFA prior to structural model testing.
2. To develop and evaluate a CB-SEM explaining the performance of VHVs.
3. To examine the direct, indirect, and total effects of empowerment, leadership, job satisfaction, social networks, and work motivation on VHV performance.

METHODS

Study design and study population

This research utilized a cross-sectional analytical survey conducted from 13 June 2024 to 30 April 2025 in Kranuan District, Khon Kaen Province, Thailand. The study population comprised 1,562 VHVs registered in the official VHV roster maintained by the Kranuan District Health Office. Sample size planning was conducted prior to data collection to ensure adequate statistical power. An initial minimum sample size of 375 was estimated using G*Power version 3.1.9.6³², based on an effect size of 0.45³³, a significance level (α) of 0.05, and a target power of 0.80. To account for potential non-response and incomplete questionnaires, an additional 10% was added, resulting in a target sample size of 413 VHVs. Prior to analysis, the hypothesized measurement and structural models were specified. The model degrees of freedom were determined using the standard SEM formula, $df = p(p + 1)/2 - q$, where p represents the number of observed

indicators and q the number of free parameters. Based on the conceptual framework, the model included 30 observed indicators and 64 estimated parameters, yielding 401 degrees of freedom. The final analytic sample comprised 384 VHVs, which exceeded commonly recommended minimum sample size thresholds for CB-SEM, supporting stable parameter estimation and model testing.

The inclusion criteria were participants aged 18 years or older who possessed at least one year of experience as a VHV. A proportional sampling technique was used by first classifying the nine sub-districts. Secondly, the proportion of VHVs in each sub-district was compared. Finally, simple random sampling was used without replacement.

Instrument

The structured questionnaire was developed based on a review of the literature and expert input, comprising three main sections: (1) general demographic information (10 items), (2) VHV performance (9 items; Cronbach's $\alpha = 0.92$), and (3) factors influencing performance measured on a 5-point Likert scale, including empowerment (5 items; Cronbach's $\alpha = 0.87$), motivation (4 items; Cronbach's $\alpha = 0.86$), job satisfaction (13 items; Cronbach's $\alpha = 0.76$), leadership (6 items; Cronbach's $\alpha = 0.70$), social networks (4 items; Cronbach's $\alpha = 0.70$). Items in Sections 2 and 3 were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher levels of the measured constructs. Negatively worded items were reverse coded prior to analysis to ensure consistent scoring direction. Content validity was assessed by three public health and survey research experts using the item-objective congruence (IOC) index, and

revisions were made accordingly. A pilot study with 30 VHV's confirmed the questionnaire's clarity, feasibility, and internal consistency, with minor wording adjustments applied.

Data collection

Data collection occurred in-person by the researcher, following official permission from the Khon Kaen Provincial Administrative Organization and ethical clearance approved by the Faculty of Graduate Studies, Mahidol University (protocol No. 62/2024; Certificate of Approval No. MUPH-2024-059, approval

date: 13 June 2024). We first gathered the number of VHV's in Kranuan district, which covers 9 sub-districts (N = 1,562). Then, proportional allocation and simple random sampling without replacement were used to select the number of VHV's from each of the 9 sub-districts, as shown in Figure 1 (n = 413). Of the 413 distributed questionnaires, 29 were excluded during the initial screening due to incomplete responses (any missing items). Consequently, only questionnaires with 100% completion were included in the final analysis, resulting in a final analytic sample of 384 VHV's (response rate: 92.98%).

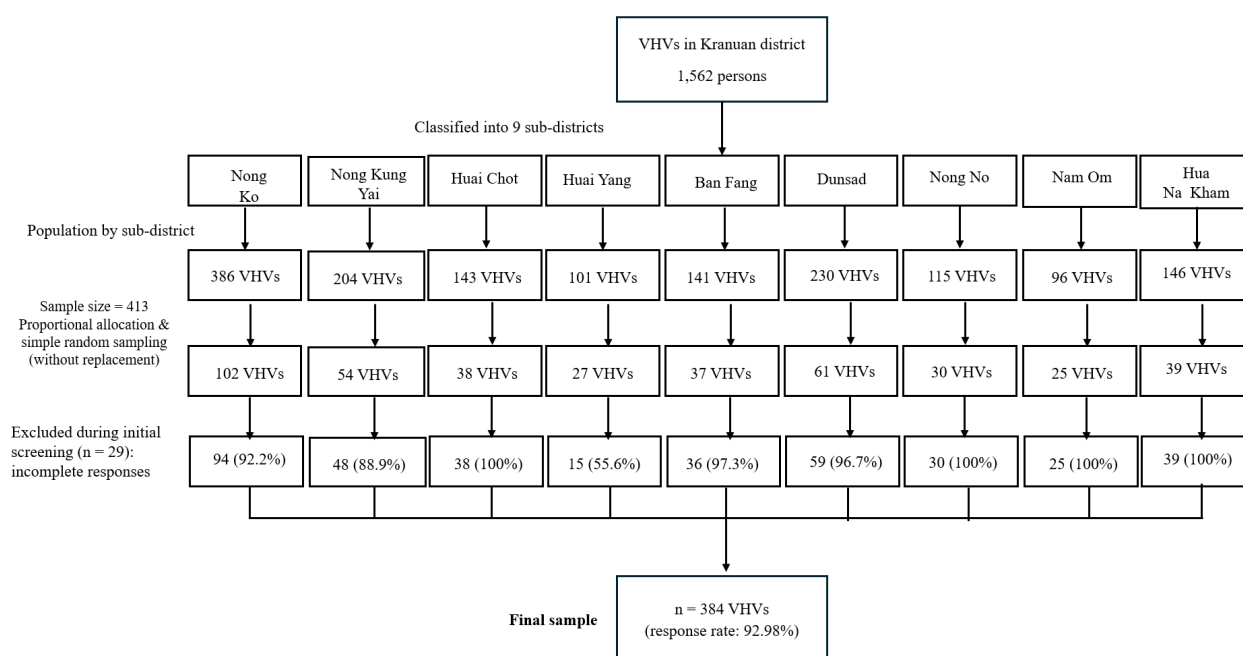


Figure 1 Flow diagram of the sampling and data collection process among VHV's in Kranuan District, Khon Kaen Province, Thailand.

Data analysis

The STATA version 17 program was used to analyze the data set.³⁴ For descriptive statistics, the authors described demographic characteristics, namely frequency, percentage, median, and IQR. The CB-SEM was used for inferential statistics. The overall model fit was determined based on chi-square (χ^2) with degrees of freedom ($p > 0.05$), Root Mean Square Error of Approximation (RMSE) with 90% CI, Comparative Fit Index (CFI),

Standardized Root Mean Square Residual (SRMR), and Tucker Lewis Index (TLI). The structural model estimated the direct, indirect, and total effects among latent constructs. Indirect effects were calculated using the product-of-coefficients approach. Bootstrap resampling (2,000 iterations) was used to obtain 95% confidence intervals for the indirect effects.³⁵ Regarding missing data, a complete case analysis approach was adopted. Questionnaires with missing values on any item were excluded during

the data cleaning phase. As a result, the final analytic dataset contained no missing data, ensuring the robustness of the CB-SEM estimations.

RESULTS

Demographic characteristics

Using proportional sampling, 413 VHV's from nine subdistricts in Krunuan District, Khon Kaen Province were invited to participate in the study. Of these, 384

completed the questionnaire, yielding a response rate of 92.98%. The sample comprised 269 females (70.05%) and 115 males (29.95%), with a median age of 56 years and a median service duration of 16 years. Most respondents were married and cohabiting (76.82%), had children (93.75%), were engaged in agricultural work (75.26%), and reported no underlying health conditions (73.70%). Overall demographic characteristics are presented in Table 1.

Table 1. Demographic characteristics of the sample (n = 384)

Demographic characteristics	Number (%)
<i>Categorical variables</i>	
Sex	
Male	115 (29.95)
Female	269 (70.05)
Status	
Single	26 (6.77)
Married and living together	295 (76.82)
Married but separated	12 (3.13)
Divorce	16 (4.17)
Widowed	35 (9.11)
Children	
Childless	24 (6.25)
Having a child	360 (93.75)
Education	
Not studying	2 (0.52)
Primary school	180 (46.88)
Junior high school	71 (18.49)
Senior high school or Voc. Cert.	117 (30.47)
High Voc. Cert or Diploma	7 (1.82)
Bachelor's degree or post-graduate	7 (1.82)
Occupation	
Do not work	12 (3.13)
Agriculture	289 (75.26)
Merchant / Trade	34 (8.85)
Freelancer	44
Government or state enterprises or local official	5 (1.3)
Underlying health condition	
No disease	283 (73.7)
Have a disease	101 (26.03)
NCDs	
- Diabetes	91 (90.10)
	31 (30.69)

Demographic characteristics	Number (%)
- Hypertension	34 (33.66)
- Diabetes and Hypertension	2 (1.98)
- Gout	5 (4.95)
- Thyroid	5 (4.95)
- Other	14 (13.86)
Non-NCDs	10 (9.90)
- Allergy	4 (3.96)
- Asthma	3 (2.97)
- Other	3 (2.97)

Continuous variables

Age (years) Median (IQR) = 56 (10)

Time of work period (years) Median (IQR) = 16 (16)

Number of children Median (IQR) = 2 (0)

Income per month (Baht) Median (IQR) = 5,000 (7,400)

Exploratory Factor Analysis and Confirmatory Factor Analysis

Before developing the structural equation model, exploratory factor analysis (EFA) was conducted to identify the underlying structure of the variables. Factor retention followed standard criteria, including inter-item correlations ≥ 0.30 , a Kaiser-Meyer-Olkin (KMO) measure ≥ 0.50 , and eigenvalues greater than 1.0.³⁶ The results supported the adequacy of the data for factor analysis across all constructs. The VHV performance scale demonstrated excellent sampling adequacy (KMO = 0.916, $p < 0.001$) and yielded a single-factor solution (eigenvalue = 5.203). Similarly, empowerment showed good factorability (KMO = 0.836, $p < 0.001$; eigenvalue = 3.044). Work motivation (KMO = 0.767, $p < 0.001$; eigenvalue = 2.520), job satisfaction (KMO = 0.744, $p < 0.001$; eigenvalue = 2.409), leadership (KMO = 0.772, $p < 0.001$; eigenvalue = 2.527), and social networks (KMO = 0.737, $p < 0.001$; eigenvalue = 2.262) also each yielded a unidimensional factor structure.

Subsequently, confirmatory factor analysis (CFA) was conducted to evaluate the measurement properties of the latent constructs. Model fit was assessed using multiple fit indices, including the chi-square test (χ^2), RMSEA (90% CI), SRMR, CFI, and TLI.³⁷ All standardized factor loadings ($\lambda_{std.}$) were statistically significant ($p < 0.05$). Composite Reliability (CR) and Average Variance Extracted (AVE) were used to assess construct reliability and convergent validity.³⁸ Overall, all constructs demonstrated acceptable reliability and adequate convergent validity. Detailed CFA results are presented in Table 2 and Table 3.

Indirect effects were not estimated during the CFA stage, as it focuses solely on the measurement model. Instead, these effects were analyzed within the structural model using the product-of-coefficients approach with bootstrapping.

Table 2. Measurement model fit indices (CFA)

Measurement model	χ^2 (df), p-value	RMSEA (90% CI)	SRMR	CFI	TLI
Performance	28.87 (21), p = 0.117	0.031 (0.000 – 0.057)	0.020	0.996	0.992
Empowerment	2.82 (3), p = 0.421	<0.001 (0.000 – 0.084)	0.011	1.000	1.000
Leadership	0.55 (1), p = 0.154	<0.001 (0.000 – 0.122)	0.005	1.000	1.000
Job satisfaction	0.69 (2), p = 0.707	0.001 (0.000 – 0.074)	0.007	1.000	1.000
Social networks	0.53 (1), p = 0.468	<0.001 (0.000 – 0.121)	0.007	1.000	1.000
Work Motivation	3.74 (2), p = 0.154	0.048 (0.000 – 0.122)	0.016	0.997	0.990

Table 3 Construct reliability and validity

Construct	Std. loading range	CR	AVE
Performance	0.68 – 0.78	0.91	0.54
Empowerment	0.58 – 0.81	0.83	0.50
Leadership	0.61 – 0.84	0.79	0.49
Job satisfaction	0.28 – 0.87	0.79	0.51
Social networks	0.52 – 0.88	0.74	0.42
Work Motivation	0.58 – 0.87	0.81	0.52

Std. loading = standardized factor loading, CR = Composite Reliability, AVE= Average Variance Extracted

Model performance of village health volunteers

The initial model, based on the conceptual framework derived from the literature, identified significant causal pathways among empowerment, leadership, job satisfaction, social networks, work motivation, and VHV performance. However, the initial model did not fit the data. The researchers

modified the model based on modification indices to achieve consistency. Following this model modification, the CB-SEM demonstrated a good fit to the data, with a $\chi^2 = 323.72$ (df = 286), $p = 0.062$, which indicated that the adjusted model adequately represented the observed data, as shown in Table 4 and Figure 2.

Table 4 Model fit result

Fit indices	Result	Criteria	Interpretation
χ^2 (df), p-value	323.72 (286), 0.062	$0.05 < p \leq 1.00$	Good fit
RMSEA (90% CI)	0.019 (0.000 – 0.028)	$0 \leq \text{RMSEA} \leq 0.05$	Good fit
SRMR	0.033	$0 \leq \text{SRMR} \leq 0.05$	Good fit
CFI	0.994	$0.97 \leq \text{CFI} \leq 1.00$	Good fit

TLI	0.991	$0.97 \leq \text{TLI} \leq 1.00$	Good fit
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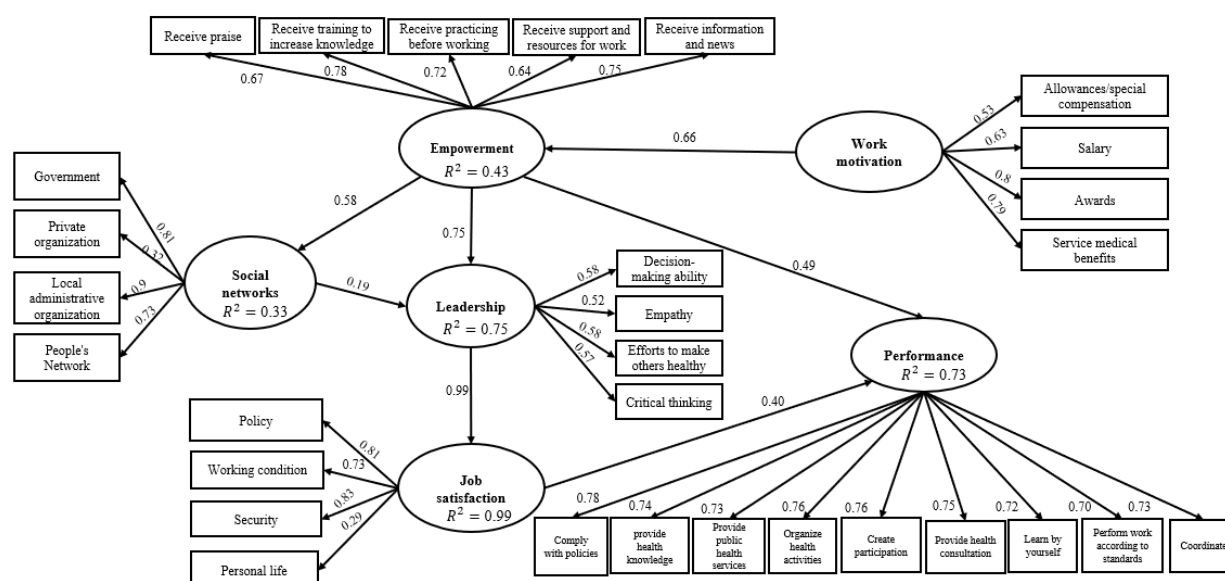


Figure 2. Covariance-based structural equation model of VHV performance in Kranuan District, Khon Kaen Province, Thailand. Model fit indices: $\chi^2 = 323.72$, $df = 286$, $p = 0.062$; RMSEA = 0.019, 90% CI: 0.000 – 0.028; SRMR = 0.033; CFI = 0.994; TLI = 0.991.

The CB-SEM analysis of VHV performance revealed significant causal relationships among empowerment, leadership, job satisfaction, social networks, and work motivation. Empowerment had the strongest total effect on performance ($\beta = 0.83$, $p < 0.01$), followed by motivation ($\beta = 0.55$, $p < 0.01$). The model explained 73% of the variance in VHV performance ($R^2 = 0.73$). Furthermore, Work motivation had a

significant direct impact on empowerment ($\beta = 0.66$, $p < 0.01$). Empowerment had a significant total effect on leadership ($\beta = 0.86$, $p < 0.01$) and a significant indirect effect on job satisfaction ($\beta = 0.85$, $p < 0.01$). Leadership had the strongest direct effect on job satisfaction ($\beta = 0.99$, $p < 0.01$). Moreover, empowerment had a significant positive direct effect on social networks ($\beta = 0.58$, $p < 0.01$), as shown in Table 5.

Table 5 Standardized coefficients (β) of direct, indirect, and total effects in the final CB-SEM

Variables		Standardized coefficients (β)				R^2
Dependent variables	Independent variable	DE	IE	95 % CI for IE	TE	
Performance						0.73
	Empowerment	0.49**	0.34**	0.100 – 0.409	0.83**	
	Leadership	–	0.40**	0.141 – 0.480	0.40**	
	Job satisfaction	0.40**	–	–	0.40**	
	Social networks	–	0.07*	0.001 – 0.134	0.07*	
Empowerment	Motivation	–	0.55**	0.192 – 0.454	0.55**	0.43
	Motivation	0.66**	–	–	0.66**	
	Leadership	0.75**	0.11**	0.022 – 0.308	0.86**	
	Social networks	0.19**	–	–	0.19**	
Job satisfaction	Motivation	–	0.56**	0.174 – 0.407	0.56**	0.99
	Empowerment	–	0.85**	0.500 – 0.968	0.85**	
	Leadership	0.99**	–	–	0.99**	
	Social networks	–	0.18*	0.011 – 0.350	0.18*	
	Motivation	–	0.56**	0.132 – 0.372	0.56**	
Social networks	Empowerment	0.58**	–	–	0.58**	0.33
	Motivation	–	0.38**	0.153 – 0.392	0.38**	

DE = Direct effect, IE = Indirect effect, TE = Total effect. Bootstrap resampling (2,000 iterations) was used to estimate 95% confidence intervals for indirect effects. * $p < 0.05$, ** $p < 0.01$.

DISCUSSION

This study examined factors associated with the performance of VHVs in Kranuan District, Khon Kaen Province, using a self-developed questionnaire and a proportional sample drawn from nine sub-districts. The final CB-SEM demonstrated good overall fit and substantial explanatory power for VHV performance ($R^2 = 0.73$), indicating that the proposed structural model adequately represented the observed data. In addition, CFA supported acceptable construct reliability and validity, providing confidence in the measurement model prior to interpreting the structural pathways. The characteristics of VHVs predominantly consisting of primary education, a median age of 56 years, long service duration, and modest income - reflect sustained voluntary commitment

despite financial and family constraints, a context that remains underrepresented in the existing literature.

Empowerment is a process through which individuals gain greater control over factors that affect their lives, encompassing both process and outcome-oriented dimensions.³⁹ In this study, empowerment showed the strongest total association with VHV performance, operating through both direct and mediated pathways ($\beta = 0.83$, $p < 0.01$), comprising both a significant direct effect (DE = 0.49) and an indirect effect mediated through leadership and job satisfaction (IE = 0.34). These findings are consistent with prior evidence indicating that empowerment through participatory decision-making and recognition mechanisms is associated with enhanced performance among health workers.⁴⁰ Previous studies in Thai community health

worker contexts similarly suggest that empowerment strengthens self-efficacy and task engagement, thereby supporting performance.^{17, 41}

Work motivation, including compensation, recognition, and intrinsic incentives, showed a strong direct association with empowerment ($DE=0.66$, $p<0.01$) and indirectly influenced performance through empowerment, social network, leadership, and job satisfaction pathways. Evidence from Suphan Buri Province indicates that compensation and social recognition are key motivational factors influencing VHV performance.⁴² The present findings suggest that motivation may function as an upstream mechanism that enables VHVs to benefit from empowerment-related processes, consistent with earlier research linking motivation, participation, and empowerment among health personnel.⁴³

Leadership encompasses decision-making ability, empathy, commitment to promoting community health, critical thinking, and emotional regulation. In this study, leadership functioned as both a predictor and a mediator within the structural model. Empowerment and social networks were positively associated with leadership, and leadership showed a strong direct association with job satisfaction. These relationships align with findings from Choi et al., who reported that leadership capacity among volunteers enhances coordination and team dynamics.¹⁵ Additionally, research conducted in Phayao Province, Thailand, found that the leadership of VHVs positively correlated with health literacy and participation in work-related activities.⁴⁴ The strong association between leadership and job satisfaction observed in this study supports the hypothesized pathway in the model and is consistent with the findings of SEM studies conducted in Nakhon Sawan Province, where higher job satisfaction among VHVs was associated with greater role effectiveness.⁴¹

Social networks were indirectly associated with performance through leadership ($IE = 0.07$, $p < 0.05$) and motivation pathways ($IE = 0.38$, $p < 0.01$). This finding is consistent with previous evidence suggesting that social networks promote leadership capacity and happiness at work.⁴⁵ In practice, VHVs operate within collaborative team structures and frequently coordinate with public health officials. During the COVID-19 pandemic, peer support was particularly important for sustaining VHV effectiveness, underscoring the relevance of social networks in this context.⁹

Job satisfaction showed both direct and indirect associations with performance, operating through empowerment and motivation pathways. While not the strongest determinant, satisfaction supports performance by strengthening psychological engagement and empowered behavior.²⁸ The direct association between job satisfaction and performance indicates a meaningful but moderate effect within the model. The strong direct association observed between leadership and job satisfaction reflects their close psychosocial linkage in the VHV context; however, CFA results demonstrated acceptable discriminant validity, suggesting that these constructions remain empirically distinguishable.

Taken together, the findings suggest that interventions aiming to enhance VHV performance may benefit from prioritizing empowerment-oriented strategies, including participatory decision-making, role recognition, and targeted training. Strengthening work motivation and fostering leadership capacity through supportive social networks may further support performance via mediated pathways. Initiatives such as community-based collaboration, mentorship programs, or peer support mechanisms may indirectly enhance leadership and job satisfaction, thereby supporting volunteer effectiveness.

This study has several limitations. First, the cross-sectional design does not allow causal inference; therefore, the observed relationships should be interpreted as associations rather than causal effects. Second, data were collected from a single district, which may limit the generalizability of the findings. Future research using longitudinal designs and multi-site samples is recommended to further validate the proposed structural pathways and temporal ordering of effects.

CONCLUSION

In summary, empowerment, work motivation, leadership, social networks, and job satisfaction were all associated with VHV performance through both direct and mediated pathways. The proposed CB-SEM explained 73% of the variance in VHV performance ($R^2 = 0.73$).

RECOMMENDATIONS

Recommendations for Practice

1. Prioritize empowerment-oriented interventions, as empowerment showed the strongest total association with performance, through participatory decision-making and role recognition. Monitoring indicators: empowerment scores, participation in decision-making.

2. Strengthen work motivation as an upstream mechanism, given its indirect contribution to performance via empowerment and leadership, using appropriate incentives and recognition. Monitoring indicators: motivation scores, engagement levels.

3. Develop leadership capacity, as leadership had strong indirect effects on performance and a direct effect on job satisfaction, by integrating leadership development within empowered and collaborative work environments.

Monitoring indicators: leadership competency and job satisfaction scores.

4. Promote social networks, which indirectly influenced performance through leadership and motivation, by facilitating teamwork and peer support. Monitoring indicators: peer interaction frequency, perceived social support.

5. Improve job satisfaction, a direct determinant of performance, by strengthening supportive leadership and work conditions. Monitoring indicators: job satisfaction scores, work engagement.

Recommendations for future research

1. Examine the generalizability of the structural relationships using larger, multi-site samples at provincial or national levels.

2. Apply longitudinal SEM designs to validate temporal ordering and mediation effects.

3. Extend the model by incorporating additional constructs, such as health literacy and self-care, to refine explanatory power.

AUTHORS' CONTRIBUTIONS

RK: Writing-original draft, Formal analysis, and Investigation. PK: Writing-review and editing, and Formal analysis. PD: Writing-review and editing, and Conceptualization. UP: Conceptualization, Methodology, and Writing-review and editing.

ETHICAL CONSIDERATION

This research was approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University (protocol number: 62/2024, Certificate of Approval number: MUPH-2024-059, approval date: 13 June 2024), in accordance with the Declaration of Helsinki.

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CONFLICTS OF INTEREST

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

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