THE ASIA-PACIFIC SCHOLAR
MEDICAL AND HEALTH PROFESSIONS EDUCATION

ORIGINAL ARTICLE

Check for updates

Long-term implementation and clinical outcomes: Nutrition literacy programme for oral health promotion

Chollada Sorasak[1], Worayuth Nak-Ai[2], Choosak Yuennan[3] & Mansuang Wongsapai[1]

[1]Intercountry Centre for Oral Health, Department of Health, Thailand; [2]Sirindhorn College of Public Health Chonburi, Praboromarajchanok Institute, Thailand; [3]Boromarajonani College of Nursing Chiang Mai, Praboromarajchanok Institute, Thailand

Abstract

Introduction: Nutrition literacy represents a critical determinant of oral health outcomes. Guided by Social Cognitive Theory and the Nutrition Literacy Skills Framework, this study evaluated the implementation and effectiveness of a nutrition literacy programme for oral health promotion among village health volunteers (VHVs), key implementers in Thailand's healthcare system, during January to December 2024.

Methods: A convergent parallel mixed-methods design was employed to address existing methodological gaps in nutrition literacy research. The quantitative component comprised a cross-sectional survey (N=60 VHVs trained in January 2024) and clinical outcome monitoring via electronic health records. The qualitative strand involved a multi-case study approach with purposive sampling (n=20) through in-depth interviews. Data collection occurred at 6-month post-implementation (July 2024), with clinical monitoring through December 2024. Analysis integrated descriptive and inferential statistics with thematic analysis.

Results: Post-implementation analysis revealed significantly enhanced nutrition literacy skills (M=4.14, SD=0.414), with notable improvements in communication (M=4.74, SD=0.511) and implementation (M=4.21, SD=0.440). All six nutrition literacy domains showed strong correlations (r=0.712-0.868, p<.01), supporting the framework's interconnected nature. Clinical outcomes improved significantly: oral health check-up rates increased from 1.41% to 2.61% (p<.05), and functional teeth retention rose from 87.36% to 92.72% (p<.01). Qualitative findings revealed adaptive knowledge transfer methods and context-specific implementation strategies influenced by community readiness.

Conclusion: Through comprehensive mixed-methods evaluation, the 12-month implementation data demonstrated significant improvements in both VHVs' nutrition literacy skills and clinical oral health outcomes. Success factors included theoretically-grounded implementation strategies and stakeholder engagement in resource-limited settings.

Keywords: *Convergent Parallel, Health Literacy, Mixed Methods, Nutrition, Oral Health, Thailand, Village Health Volunteer*

Practice Highlights

- Nutrition literacy among VHVs significantly improved across all six key domains.
- Oral health check-up rates increased from 1.41% to 2.61% post-programme implementation.
- Functional teeth retention rose from 87.36% to 92.72% over the 12-month period.
- VHVs used context-specific strategies for community-based nutrition education.

I. INTRODUCTION

Oral health is fundamentally linked to nutrition and dietary behaviours, yet nutritional factors affecting oral health remain a significant public health challenge worldwide, particularly in low- and middle-income countries (Peres et al., 2019; Watt et al., 2019). In Thailand, the high prevalence of dental caries and periodontal diseases related to dietary habits (Chaianant et al., 2022), underscores the urgent need for effective nutrition education strategies for oral health promotion.

Understanding the relationship between nutrition literacy and oral health behaviours requires consideration of multiple theoretical perspectives. Social Cognitive Theory (Bandura, 2004) highlights how personal factors, dietary patterns, and environments interact to shape oral health behaviours, particularly relevant in Thailand's family-based eating culture. The nutrition literacy skills Framework (Squiers et al., 2012) outlines how individuals develop and apply nutrition literacy competencies through interactions between dietary knowledge and social environments. Additionally, Ecological Systems Theory (Bronfenbrenner, 1979) demonstrates how family and societal systems influence health behaviours and programme implementation.

Within this theoretical context, nutrition literacy for oral health emerges as a critical determinant of oral health outcomes. While health literacy encompasses capacities for accessing and using health information (Sørensen et al., 2012), nutrition literacy for oral health specifically focuses on these competencies in oral healthcare. Evidence consistently shows that individuals with low nutrition literacy tend to exhibit poor oral health behaviours and outcomes (Berkman et al., 2011; Kickbusch et al., 2013). This relationship is particularly significant in reducing oral health disparities (Horowitz & Kleinman, 2012), with higher nutrition literacy correlating with improved oral hygiene practices and health outcomes (Baskaradoss, 2018).

Recent advances in nutrition literacy programmes for oral health promotion have revealed that culturally tailored, context-specific interventions can significantly enhance service accessibility and oral healthcare engagement (Macek et al., 2016). Various programme modalities have emerged, encompassing educational initiatives, community-based activities, and digital media interventions (Dickson-Swift et al., 2014). These approaches align well with Thailand's dental public health policy, which emphasises proactive oral health promotion and community participation. Systematic review (Firmino et al., 2017) identified several critical gaps in existing research: the absence of mixed-methods studies examining both programme effectiveness and change processes, limited analysis of community-level behavioural change mechanisms, and insufficient research in resource-constrained developing countries where success factors may differ substantially from developed nations.

To address these research gaps, this study aims to evaluate the effectiveness of a nutrition literacy programme for oral health promotion in Thailand's context. Of particular interest is the role of VHVs as key implementation agents, given their established position in community health promotion (Kowitt et al., 2015). While previous research has demonstrated VHVs' capacity to utilise technology for expanding health service coverage (Jandee et al., 2015), empirical evidence regarding their role in promoting nutrition literacy for oral health remains limited.

Guided by our theoretical framework, we employed a Convergent Parallel Mixed Methods design (Creswell & Plano Clark, 2017), enabling comprehensive assessment of both quantitative programme effectiveness and qualitative change mechanisms. This approach examines how social modelling, nutrition literacy skill development related to oral health, and environmental factors interact to influence programme outcomes. Ultimately, this study's findings will contribute to developing contextually appropriate nutrition literacy strategies for oral health promotion in developing countries while aligning with Thailand's dental public health policies.

II. METHODS

A. Study Design

This study employed a convergent parallel mixed methods design (Creswell & Plano Clark, 2017) to comprehensively evaluate the implementation and effectiveness of a nutrition literacy programme for oral health promotion. The design integrated quantitative outcomes with qualitative insights to achieve deeper understanding than single-method approaches. The quantitative component utilised a cross-sectional survey to assess nutrition literacy skills and clinical outcomes, while the qualitative component employed a multi-case study approach (Yin, 2018) to explore implementation experiences and contextual factors.

B. Population and Sampling

The quantitative phase included all VHVs who completed nutrition literacy training (N=60) in January 2024, with data collection occurring in July 2024. For the qualitative component, 20 VHVs were purposively

selected using intensity sampling (Miles et al., 2013) based on four criteria: programme implementation experience exceeding six months, strong communication abilities, representation from varied performance areas, and voluntary informed consent. This sample size achieved theoretical saturation (Creswell, 2013; Guest et al., 2006). Gender distribution differed between samples (quantitative: 98.3% female; qualitative: 70% female) due to purposive sampling for diverse leadership perspectives. Sensitivity analysis confirmed no significant gender-based differences in primary outcomes ($p > .05$). The six-month assessment period aligned with established behaviour change evaluation timeframes (Glasgow et al., 2019), while monitoring through December 2024 captured seasonal variations and sustainability data.

C. Research Instruments

Two complementary instruments were developed and validated through pilot testing with 30 VHVs sharing similar characteristics with the target population, but excluded from the final sample. The questionnaire was designed according to Nutbeam's health literacy framework (Nutbeam, 2000), operationalizing three literacy levels into six nutrition literacy components relevant to oral health promotion. Items utilised a five-point Likert scale (1 = "not confident at all" to 5 = "very confident") for self-assessment of perceived competencies. A panel of five experts including community dentistry, nutrition, public health, health literacy, and health communication specialists assessed content validity, achieving a high IOC index of 0.96, while internal consistency demonstrated excellent reliability (Cronbach's alpha = 0.929).

The structured interview guide explored knowledge application, teaching methods, implementation challenges, outcomes, and recommendations following established qualitative research principles (Jacob & Furgerson, 2012). Qualitative trustworthiness was ensured through member checking at two stages: during interviews for immediate verification and after preliminary analysis with eight selected participants for validation and refinement.

D. Data Collection

Baseline data was collected prior to programme implementation in January 2024, establishing pre-intervention metrics through public health service records. Following six-month implementation, parallel quantitative and qualitative assessments were conducted in July 2024. Self-assessment questionnaires were administered to all VHVs, followed by in-depth interviews (45-60 minutes) with 20 purposively selected participants until data saturation was achieved (Guest et al., 2006). In accordance with Consolidated Criteria for Reporting Qualitative Studies (COREQ) guidelines (Zachariah et al., 2024), participant confidentiality was maintained throughout the study, with written informed consent obtained after comprehensive briefing on study objectives and participant rights. Monthly data extraction from the Health Data Centre continued through December 2024 to capture sustained programme effects, with systematic collection on the 5th of each month ensuring complete and timely data acquisition.

E. Data Analysis

The analytical approach integrated multiple complementary methods for comprehensive understanding. Quantitative analysis included descriptive statistics (frequencies, percentages, means, standard deviations) with Shapiro-Wilk normality testing. Inferential analyses comprised paired t-tests for pre-post comparisons ($\alpha = 0.05$), chi-square tests for categorical outcomes, and Pearson's correlation coefficients examining relationships between nutrition literacy domains. Effect sizes were reported using Cohen's d with bootstrap confidence intervals (1,000 resamples). Statistical analyses utilised IBM's Statistical Package for the Social Sciences (SPSS) Statistics software. Missing data patterns were examined using Little's Missing Completely at Random (MCAR) test, with multiple imputation (5 datasets) addressing missing values following Rubin's guidelines (2004). Sensitivity analyses compared complete-case and imputed datasets (van Buuren, 2018).

Qualitative data underwent thematic analysis following established frameworks (Braun & Clarke, 2006), involving verbatim transcription, independent coding by two researchers, and iterative thematic framework development through consensus meetings. ATLAS.ti software facilitated systematic organisation and analysis. Quality assurance included investigator triangulation, member checking with eight participants, audit trail documentation, and researcher reflexivity journals.

F. Data Integration

A comprehensive integration strategy synthesised quantitative and qualitative findings through three interconnected phases (Cano & Lomibao, 2023). Joint displays facilitated systematic comparison of results, enabling identification of convergent and divergent patterns. Meta-inferences were constructed through iterative cross-method analysis, with attention to complementary insights. Pattern matching techniques examined alignments between quantitative outcomes and qualitative themes, developing integrated theoretical

understandings. Conflicting findings were reconciled by contextualising quantitative results with qualitative explanations, while complementary data enriched overall interpretation, enhancing study rigor and validity.

III. RESULTS

All participants (N=60) completed quantitative assessments at baseline and a 6-month follow-up, with 20 VHVs participating in qualitative interviews. Clinical outcomes were monitored through December 2024 using complete Health Data Centre monthly data. Following convergent parallel design, quantitative and qualitative data streams were systematically merged to achieve comprehensive understanding of programme implementation and outcomes. The integrated analysis revealed that communication skills improvements were explained through qualitative evidence of adaptive teaching strategies, while regional outcome variations were illuminated by implementation challenges identified through qualitative inquiry. This systematic data merging approach provided richer insights than either quantitative or qualitative methods could offer independently.

A. Baseline Characteristics

1. Qualitative Sample (n = 20)

The qualitative sample achieved a full response rate (100%). Participants were predominantly female (70%), with males comprising 30%. The age distribution showed that 70% were between 50–60 years, while 15% each were aged 30–39 and 40–49 years. No participants were over 60. In terms of role, 65% served as Village Health Volunteers (VHVs), and 35% were Caregivers. None held dual roles.

2. Quantitative Sample (n = 60)

The quantitative sample also achieved a 100% response rate. Females constituted the vast majority (98.3%), with only one male respondent (1.7%). Most participants (70%) were aged 50–60 years, with smaller proportions aged 30–39 (11.7%), 40–49 (16.7%), and over 60 (1.7%). Regarding position, 85% were VHVs, 13.3% were Caregivers, and 1.7% held both roles.

B. Programme Implementation and Nutrition Literacy Skills for Oral Health

The intervention (Table 1) demonstrated significant improvements across all six nutrition literacy domains ($p < 0.001$) with large effect sizes. Communication skills showed the greatest improvement (d = 1.64, mean difference: 0.84 points, 95% CI: 0.66-1.02), followed by Decision Making (d = 0.90), Critical Inquiry (d = 0.88), Understanding (d = 0.85), Application (d = 0.77), and Access (d = 0.74). Other domains improved by 0.36-0.41 points.

C. Clinical Outcomes and Programme Effectiveness

Clinical outcomes significantly improved. Dental check-up rates increased from 1.41% to 2.61% (difference: 1.20 percentage points, 95% CI: 0.90-1.50, p=0.032). Participants with ≥20 functional teeth rose from 87.36% to 92.72% (difference: 5.36 percentage points, 95% CI: 3.38-7.34, $p < 0.001$), indicating substantial improvements in both knowledge and oral health behaviour.

Outcomes	Baseline (mean±SD)	6-month (mean±SD)	Mean difference (95% CI)	p-value
Nutrition Literacy Skills Related to Oral Health				
Access	3.80±0.50	4.16±0.47	0.36 (0.19, 0.53)	<0.001†
Understanding	3.75±0.48	4.15±0.46	0.40 (0.23, 0.57)	<0.001†
Critical Inquiry	3.70±0.47	4.11±0.46	0.41 (0.24, 0.58)	<0.001†
Decision Making	3.72±0.46	4.13±0.45	0.41 (0.25, 0.57)	<0.001†
Application	3.85±0.49	4.21±0.44	0.36 (0.19, 0.53)	<0.001†
Communication	3.90±0.52	4.74±0.51	0.84 (0.66, 1.02)	<0.001†
Clinical Outcomes				
Dental check-up rate (%)	1.41	2.61	1.20 (0.90, 1.50)	0.032‡
Functional teeth (%) *	87.36	92.72	5.36 (3.38, 7.34)	<0.001‡

Note: *Defined as having ≥20 functional natural teeth
†Statistically significant at $p < 0.001$, Paired t-test
‡Statistically significant at $p < .05$ for dental check-up rate and $p < 0.001$ for functional teeth, Chi-square test
Data were retrieved from the Health Data Centre database (Ministry of Public Health, 2024).
Table 1. Changes in Nutrition Literacy Skills Related to Oral Health and Clinical Outcomes After a 6-Month Training Programme (N=60)

Health Literacy Domain	1. Access	2. Understanding	3. Critical Inquiry	4. Decision Making	5. Application	6. Communication
1. Access	1					
2. Understanding	.858**	1				
3. Critical Inquiry	.753**	.712**	1			
4. Decision Making	.775**	.817**	.834**	1		
5. Application	.724**	.770**	.797**	.797**	1	
6. Communication	.812**	.820**	.822**	.868**	.799**	1

Note: N = 60; **p < .01 (2-tailed) Pearson correlation coefficients are shown.

Table 2. Correlation Analysis of Nutrition Literacy Domains Related to Oral Health

Regional variations in dental check-up rates were substantial, ranging from 0.07% to 38.18% (p < 0.001) across participating health centres, suggesting the need to investigate factors contributing to different implementation outcomes despite similar geographical and healthcare delivery contexts. The findings support overall programme effectiveness, though the cross-sectional design indicates the need for longitudinal research to confirm long-term impacts. Future nutrition literacy programmes for oral health promotion should emphasize communication skills and context-specific implementation approaches. The qualitative analysis of 20 VHV interviews yielded four main themes (Figure 1).
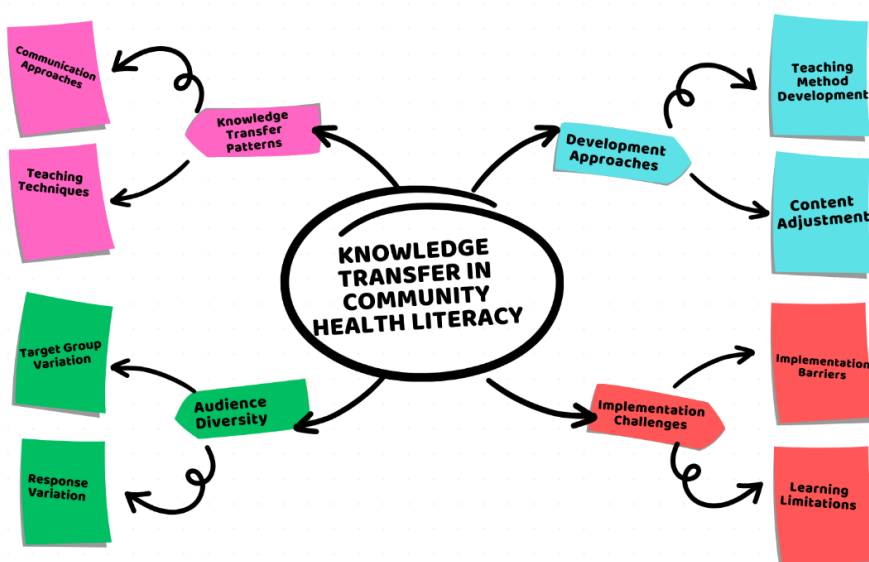

Figure 1. Qualitative final thematic map

D. Implementation Process and Contextual Factors

1. Knowledge Transfer Patterns

VHVs utilised multiple communication channels and diverse pedagogical approaches. Individual consultations involved direct problem assessment, with participants noting "Face-to-face, asking what problems they have, like sensitive teeth" (P15). Digital platforms expanded reach through "Online communication and inviting others to join our Line group" (P5). Teaching methods included demonstrations, mnemonics, and hands-on practice.

2. Audience Diversity

VHVs encountered heterogeneous learning populations with varying engagement levels. Successful interactions were characterised by high comprehension rates: "Everyone understood and could practice, no problems as they all understood well" (P19). However, engagement challenges persisted, with some noting "One person at home is not very interested" (P16).

3. Implementation Challenges

Communication barriers emerged as significant obstacles. VHVs identified hearing difficulties: "The listener's hearing, they can't hear well" (P1), language barriers: "Don't use too many English terms, some words are not understood" (P10), and content complexity issues: "Some content is difficult to understand, takes a long time and repeated study" (P14).

4. Development Approaches

VHVs suggested practical improvements emphasising "Should practice more than theory" (P1). They recommended age-appropriate strategies: "Elderly may have difficulty learning, but if we can make content easy to understand, they will gain knowledge too" (P15), and streamlined delivery: "Shorter courses might attract more participants" (P5).

E. Integrated Results

The convergent parallel design employed a merging data integration approach to synthesise quantitative and qualitative findings systematically, providing comprehensive understanding of programme effectiveness, as presented in Table 3.

Major Themes	Quantitative Results (n=60)	Qualitative Evidence (n=20)	Meta-inference
Nutrition Literacy Skills Performance Related to Oral Health	Overall implementation: M=4.14±0.41, p< 0.001; Highest in communication (M=4.74±0.51); Strong inter-skill correlations (r=.712-.868, p< 0.001)	Demonstrated multiple teaching approaches: individual counselling, memory techniques, continuous monitoring	Quantitative high scores validated by qualitative evidence of practical skill application
Clinical Outcome Changes	Dental check-up: 1.41% to 2.61% (p< .01); Functional teeth: 87.36% to 92.72% (p< .01); Regional variation: 0.07-38.18%	Implementation variations: successful behaviour adoption, mixed community readiness, diverse response levels	Outcome improvements linked to implementation quality and community readiness
Implementation Challenges	Highest in self-monitoring (M=4.25±0.44); Significant regional differences (p< .01)	Identified barriers: technical language, age-related learning, practice compliance	Statistical variations explained by specific implementation challenges identified qualitatively
Support Systems	Strong correlations between: decision-making and communication (r=.868); access and understanding (r=.858); all p< 0.001	Multiple support channels: digital platforms, family networks, community groups	Integrated support systems crucial for programme effectiveness

Table 3. Integrated Analysis of Mixed Methods Results

The systematic merging of quantitative and qualitative data through meta-inference analysis revealed four key dimensions of programme implementation and outcomes.

1. Nutrition Literacy Skills and Clinical Outcomes

Quantitative findings demonstrated high overall implementation levels (M=4.14±0.41, p< 0.001), with communication skills showing exceptional improvement (M=4.74±0.51). The strong correlation between communication and decision-making skills (r=.868, p< 0.001) was validated through qualitative evidence: "We adapted communication methods based on audience needs" (P15).

Dental check-up rates increased significantly from 1.41% to 2.61% (p< .01), while functional dentition improved from 87.36% to 92.72% (p< .01). Qualitative insights revealed implementation quality influences: "Regular follow-ups and practical demonstrations helped maintain behaviour changes" (P8). Regional outcome variations (0.07-38.18%) aligned with identified barriers and facilitators.

2. Implementation Dynamics and Support Systems

Strong correlations between access and understanding (r=.858, p< 0.001) were complemented by contextual adaptation findings. VHVs balanced cultural factors: "We needed to balance traditional beliefs with modern dental care practices" (P13). Statistical associations among nutrition literacy domains (r=.712-.868, all p< 0.001) were substantiated by interconnected support mechanisms: "The combination of in-person support and online reminders helped maintain engagement" (P5).

The meta-inference demonstrates programme effectiveness through synergy of enhanced nutrition literacy skills and context-sensitive implementation strategies, emerging through systematic integration of quantitative measurements with qualitative insights.

IV. DISCUSSION

A. Programme Effectiveness and Theoretical Framework

This study demonstrates the effectiveness of a Village Health Volunteers (VHVs)-led nutrition literacy programme for oral health promotion in significantly improving nutrition literacy skills and clinical outcomes. The findings align with established empirical evidence at regional and international levels regarding healthcare personnel capacity development and relationships between nutrition literacy for oral health, oral health behaviours, and preventive service utilisation (Baskaradoss, 2018; Nutbeam, 2008; Samarasekera et al., 2024; Batista et al., 2017; Baskaradoss, 2016).

The strong correlation between nutrition literacy components, particularly communication and decision-making (r = .868), reflects their interconnected nature and underscores comprehensive skill development importance (Kunathum, 2023). This finding aligns with Social Cognitive Theory (Bandura, 2004), emphasising behavioural, personal, and environmental factor interdependence in health promotion. Results support the Nutrition Literacy Skills Framework (Squiers et al.,

2012), positioning communication and decision-making as essential mediators between nutrition literacy and oral health behavioural outcomes in diverse cultural contexts.

B. Clinical Outcomes and Community Engagement

The increase in dental check-up rates from 1.41% to 2.61%, while statistically significant, represents modest absolute change. However, within rural communities where oral health service access is severely limited and baseline utilisation extremely low, even small improvements may represent important community health engagement shifts (Petersen, 2009). This suggests early evidence of improved health literacy and behaviour change among participants, particularly VHVs who played critical implementation roles.

Future interventions could incorporate community-based incentives, outreach dental services, and proactive VHV follow-up to reinforce preventive behaviours. Evidence demonstrates that community mobilisation and culturally tailored interventions effectively improve oral health behaviours in low-resource settings (Fisher-Owens et al., 2013; Watt, 2007).

C. Domain-Specific Performance and Regional Variations

Communication and skill application emerged as key behavioural change drivers in nutrition literacy for oral health (M = 4.74, SD = 0.51 and M = 4.21, SD = 0.44 respectively). The relatively lower scores in critical inquiry (M = 4.11, SD = 0.46) and decision-making (M = 4.13, SD = 0.45) skills align with identified community health worker limitations (Gall et al., 2023) and indicate the necessity of incorporating hybrid learning approaches to strengthen advanced nutrition literacy competencies (Lin et al., 2024).

Regional analysis revealed significant outcome variations across implementation areas (0.07% to 38.18%, p < .01) (Watt et al., 2019), with stronger outcomes in communities with higher social capital. This pattern aligns with systematic reviews from low- and middle-income countries (Haldane et al., 2019) and documented disparities in Thailand's healthcare systems (Chaianant et al., 2022). These findings support Asset-Based Community Development theory (Kretzmann & McKnight, 1993), emphasising the importance of leveraging existing community strengths for sustainable oral health improvements.

D. Social Support Systems and Cultural Context

Social support systems proved crucial for programme success, particularly in developing countries where social networks, family support systems, and community resources serve as primary health determinants (Kowitt et al., 2015). The strong correlation between communication and community participation (r = .799, p < .01) reflects these interconnections, aligning with Ecological Systems Theory (Bronfenbrenner, 1979), which emphasises how multiple environmental layers influence nutrition-related oral health behaviours in developing countries where community and cultural contexts play crucial roles.

E. Gender Considerations and Methodological Considerations

The quantitative sample exhibited significant gender imbalance (98.3% female participants), potentially influencing generalisability. In Northern Thailand, approximately 83% of VHVs are female, reflecting traditional social roles where women are often a group highly motivated to engage in volunteer work aimed at assisting others. Furthermore, women's volunteer roles frequently involve healthcare and activities related to building community resilience (Sukhampha et al., 2023). Women typically exhibit higher health awareness and more proactive health behaviours than men, which may partly explain observed positive outcomes (Tan et al., 2021).

The notably high correlations between nutrition literacy domains (r=0.712-0.868) reflect comprehensive skill development influenced by the holistic training programme and Thai VHVs' cultural context where integrated health communication is traditionally emphasised. This finding aligns with studies in Asian contexts (Leung et al., 2020; Oh et al., 2022) suggesting important cultural influences on health literacy skill development.

F. Study Strengths and Limitations

This study demonstrates methodological strengths through its convergent parallel mixed-methods design with systematic data integration, enhancing understanding through integrated quantitative and qualitative insights. The qualitative component achieved theoretical saturation (Guest et al., 2006), while community-based implementation aligned with established nutrition literacy research practices (Kowitt et al., 2015).

Key limitations include absence of factor analysis despite high internal consistency (Cronbach's α = 0.929), pronounced gender imbalance restricting applicability, six-month follow-up potentially inadequate for capturing long-term changes (Baskaradoss, 2018), self-reported data risks and social desirability bias (Althubaiti, 2016),

geographical specificity limiting generalisability given Thailand's varied healthcare systems (Chaianant et al., 2022), and resource constraints precluding randomised controlled design. While the dental check-up rate increase was statistically significant (p=0.032), the modest improvement suggests need for more intensive interventions.

V. CONCLUSION

The VHVs-led nutrition literacy programme for oral health promotion demonstrates clear effectiveness through significant behavioural and clinical changes. Key success factors include local context adaptation and community engagement. For broader implementation, three policy directions are suggested: (1) integration with national health promotion policies, (2) inclusion of nutrition literacy indicators related to oral health in monitoring systems, and (3) development of standardised guidelines allowing local adaptation. Long-term VHVs capacity development should incorporate continuous professional development through structured mentoring programmes, nutrition literacy skill enhancement workshops for oral health promotion, and recognition systems for advanced competencies. Digital health integration should focus on mobile learning platforms, telemedicine support, and electronic health records, while sustainable monitoring mechanisms should include automated data collection, regular feedback loops, and community-based evaluations.

Future studies should have follow-up periods of at least one year to confirm sustainability of nutrition-related oral health behaviour changes (Baskaradoss, 2018). Research priorities should analyse regional variations, conduct economic evaluations, and develop sustainability indicators while integrating diverse learning approaches to enhance effectiveness (Lin et al., 2024). This study confirms the programme's effectiveness and provides insights into change mechanisms and success factors for future nutrition literacy programmes focused on oral health promotion and public health policy. A phased scaling approach with diverse pilot programmes is recommended to optimise outcomes through cross-regional learning and experience sharing.

Notes on Contributors

Chollada Sorasak led the research design, developed methodology, conducted formal analysis and investigation. She was responsible for writing the original manuscript draft and managing the revision process.

Worayuth Nak-Ai provided expertise in validating the research design, research methodology and supervised the overall research implementation process. He was responsible for proof the original manuscript draft and managing the revision process.

Choosak Yuennan managed the data curation process and provided supervision for data collection and analysis procedures.

Mansuang Wongsapai coordinated resource allocation and managed project administration tasks throughout the study period.

Ethical Approval

This study was approved by the Human Research Ethics Committee of Sirindhorn College of Public Health, Chonburi (COA No. 2023/T07, dated 21 August 2023).

Data Availability

The data supporting the findings of this study, including four tables and one figure used in the analysis, are openly available in Figshare at http://dx.doi.org/10.6084/m9.figshare.28105718.

The dataset includes the complete quantitative and qualitative analysis results, tables, and figures used in this study and can be accessed without restrictions for research purposes.

Declaration of Interest

The authors declare no conflicts of interest, financial, consultant, institutional or other relationships that might lead to bias or a conflict of interest.

References

Althubaiti, A. (2016). Information bias in health research: Definition, pitfalls, and adjustment methods. *Journal of Multidisciplinary Healthcare, 9*, 211–217. https://doi.org/10.2147/JMDH.S104807

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behaviour, 31*(2), 143–164. https://doi.org/10.1177/1090198104263660

Baskaradoss, J. K. (2016). The association between oral health literacy and missed dental appointments. *Journal of the American Dental Association, 147*(11), 867–874. https://doi.org/10.1016/j.adaj.2016.05.011

Baskaradoss, J. K. (2018). Relationship between oral health literacy and oral health status. *BMC Oral Health, 18*(1), 172. https://doi.org/10.1186/s12903-018-0640-1

Batista, M. J., Lawrence, H. P., & Sousa, M. D. L. R. D. (2017). Oral health literacy and oral health outcomes in an adult population in Brazil. *BMC Public Health, 18*, 60. https://doi.org/10.1186/s12889-017-4443-0

Berkman, N. D., Sheridan, S. L., Donahue, K. E., Halpern, D. J., & Crotty, K. (2011). Low health literacy and health outcomes: An updated systematic review. *Annals of Internal Medicine, 155*(2), 97–107. https://doi.org/10.7326/0003-4819-155-2-201107190-00005

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Cano, J. C., & Lomibao, L. S. (2023). A mixed methods study of the influence of phenomenon-based learning videos on students' mathematics self-efficacy, problem-solving and reasoning skills, and mathematics achievement. *American Journal of Educational Research, 11*(3), 97–115.

Chaianant, N., Tussanapirom, T., Niyomsilp, K., & Gaewkhiew, P. (2022). Factors associated with oral health check-up in working adults: The 8th Thai National Oral Health Survey 2017. *Thai Dental Public Health Journal, 27*(2), 112–123.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). SAGE Publications, Inc.

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications, Inc.

Dickson-Swift, V., Kenny, A., Farmer, J., Gussy, M., & Larkins, S. (2014). Measuring oral health literacy: A scoping review of existing tools. *BMC Oral Health, 14*, Article 148. https://doi.org/10.1186/1472-6831-14-148

Duijster, D., Monse, B., Dimaisip-Nabuab, J., Djuharnoko, P., Heinrich-Weltzien, R., Hobdell, M., Kromeyer-Hauschild, K., Kunthearith, Y., Mijares-Majini, M. C., Siegmund, N., Soukhanouvong, P., & Benzian, H. (2017). "Fit for School" – A school-based water, sanitation and hygiene programme to improve child health: Results from a longitudinal study in Cambodia, Indonesia and Lao PDR. *BMC Public Health, 17*, Article 302. https://doi.org/10.1186/s12889-017-4203-1

Firmino, R. T., Ferreira, F. M., Paiva, S. M., Granville-Garcia, A. F., Fraiz, F. C., & Martins, C. C. (2017). Oral health literacy and associated oral conditions: A systematic review. *Journal of the American Dental Association, 148*(8), 604–613. https://doi.org/10.1016/j.adaj.2017.04.012

Fisher-Owens, S. A., Isong, I. A., Soobader, M. J., Gansky, S. A., Weintraub, J. A., Platt, L. J., & Newacheck, P. W. (2013). An examination of racial/ethnic disparities in children's oral health in the United States. *Journal of Public Health Dentistry, 73*(2), 166–174. https://doi.org/10.1111/j.1752-7325.2012.00367.x

Gall, M., Schroeder, F., & Heise, G. (2023). Community health worker use of smart devices for health promotion: Scoping review. *JMIR mHealth and uHealth, 11*(1), e42023. https://doi.org/10.2196/42023

Gholami, M., Pakdaman, A., Montazeri, A., Jafari, A., & Virtanen, J. I. (2014). Assessment of periodontal knowledge following a mass media oral health promotion campaign: A population-based study. *BMC Oral Health, 14*, Article 31. https://doi.org/10.1186/1472-6831-14-31

Glasgow, R. E., Harden, S. M., Gaglio, B., Rabin, B., Smith, M. L., Porter, G. C., Ory, M. G., & Estabrooks, P. A. (2019). RE-AIM planning and evaluation framework: Adapting to new science and practice with a 20-year review. *Frontiers in Public Health, 7*, 64. https://doi.org/10.3389/fpubh.2019.00064

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Haldane, V., Chuah, F. L. H., Srivastava, A., Singh, S. R., Koh, G. C. H., Seng, C. K., & Legido-Quigley, H. (2019). Community participation in health services development, implementation, and evaluation: A systematic review of empowerment, health, community, and process outcomes. *PLOS ONE, 14*(5), e0216112. https://doi.org/10.1371/journal.pone.0216112

Horowitz, A. M., & Kleinman, D. V. (2012). Oral health literacy: A pathway to reducing oral health disparities in Maryland. *Journal of Public Health Dentistry, 72*(s1), S26–S30. https://doi.org/10.1111/j.1752-7325.2012.00316.x

Jacob, S. A., & Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *The Qualitative Report, 17*, 1–10.

Jandee, K., Kaewkungwal, J., Khamsiriwatchara, A., Lawpoolsri, S., Wongwit, W., & Wansatid, P. (2015). Effectiveness of using mobile phone image capture for collecting secondary data: A case study on immunization history data among children in remote areas of Thailand. *JMIR mHealth and uHealth, 3*(3), e75. https://doi.org/10.2196/mhealth.4183

Kickbusch, I., Pelikan, J. M., Apfel, F., & Tsouros, A. D. (2013). *Health literacy: The solid facts*. World Health Organization Regional Office for Europe. https://apps.who.int/iris/handle/10665/128703

Kowitt, S. D., Emmerling, D., Fisher, E. B., & Tanasugarn, C. J. (2015). Community health workers as agents of health promotion: Analysing Thailand's Village Health Volunteer Programme. *Journal of Community Health, 40*(4), 780–788. https://doi.org/10.1007/s10900-015-9999-y

Kretzmann, J. P., & McKnight, J. L. (1993). *Building communities from the inside out: A path toward finding and mobilizing a community's assets*. ACTA Publications.

Kunathum, W. (2023). The relationship between health literacy and roles in chronic disease prevention among village health volunteers. *Public Health Policy and Laws Journal, 9*(3), 431–444.

Leung, A. Y. M., Chau, P. H., & Leung, I. S. H. (2020). Health literacy experiences of multi-ethnic patients and their health-care providers in the management of type 2 diabetes in Malaysia. *Health Expectations, 23*(6), 1442–1452. https://doi.org/10.1111/hex.13095

Lin, G. S. S., Tan, W. W., Ng, Y. S., & Afrashtehfar, K. I. (2024). Enhancing students' academic performance through hybrid team-based case-based learning. *The Asia Pacific Scholar, 9*(3), 67–69. https://doi.org/10.29060/TAPS.2024-9-3/CS3189

Macek, M. D., Atchison, K. A., Watson, M. R., Holtzman, J., Wells, W., Braun, B., ... Richards, J. (2016). Assessing health literacy and oral health: Preliminary results of a multi-site investigation. *Journal of Public Health Dentistry, 76*(4), 303–313. https://doi.org/10.1111/jphd.12156

McKinnon, M. A., Odoh, O., Taylor, P., Charlie, D., Morry, J., Mathu-Muju, K., & Donnelly, L. (2022). Developing a land-based oral health promotion project with an Indigenous community in northern British Columbia, Canada. *Canadian Journal of Dental Hygiene, 56*(3), 172–176.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications, Inc.

Ministry of Public Health. (2024). *Health Data Centre Service* [Dashboard].

Nutbeam, D. (2000). Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International, 15*(3), 259–267. https://doi.org/10.1093/heapro/15.3.259

Nutbeam, D. (2008). The evolving concept of health literacy. *Social Science & Medicine, 67*(12), 2072–2078. https://doi.org/10.1016/j.socscimed.2008.09.050

Oh, K. M., An, K., Lee, M., & Kreps, G. L. (2022). Cultural factors influencing health literacy, health care access, and health behaviours among Korean-Americans. *Health Literacy Research and Practice, 6*(2), e89–e97. https://doi.org/10.4324/9781003230243-2

Peres, M. A., Macpherson, L. M. D., Weyant, R. J., Daly, B., Venturelli, R., Mathur, M. R., Listl, S., Celeste, R. K., Guarnizo-Herreño, C. C., Kearns, C., Benzian, H., Allison, P., & Watt, R. G. (2019). Oral diseases: A global public health challenge. *The Lancet, 394*(10194), 249–260. https://doi.org/10.1016/S0140-6736(19)31146-8

Petersen, P. E. (2009). Global policy for improvement of oral health in the 21st century – Implications to oral health research of World Health Assembly 2007, World Health Organisation. *Community Dentistry and Oral Epidemiology, 37*(1), 1–8. https://doi.org/10.1111/j.1600-0528.2008.00448.x

Rubin, D. B. (2004). *Multiple imputation for nonresponse in surveys* (Vol. 81). Wiley.

Samarasekera, D. D., Lee, S. S., Yeo, S. P., Chen, J., Findyartini, A., Greviana, N., & Sherman, L. (2024). The state of continuing professional development in East and Southeast Asia among medical practitioners. *The Asia Pacific Scholar, 9*(3), 1–14. https://doi.org/10.29060/TAPS.2024-9-3/OA3045

Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., & Brand, H. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health, 12*, 80. https://doi.org/10.1186/1471-2458-12-80

Squiers, L., Peinado, S., Berkman, N., Boudewyns, V., & McCormack, L. (2012). The health literacy skills framework. *Journal of Health Communication, 17*(suppl 3), 30–54. https://doi.org/10.1080/10810730.2012.713442

Sukhampha, R., Khwanriang, P., & Vaisamruat, K. (2023). Women on the frontline of COVID-19: Understanding local women village health volunteers in the northern province of Thailand. *BMC Health Services Research, 23*, Article 9305. https://doi.org/10.1186/s12913-023-09305-x

Tan, J., Yoshida, Y., Ma, S.-K., & Mauvais-Jarvis, F. (2021). Gender differences in health protective behaviours during the COVID-19 pandemic in Taiwan: An empirical study. *medRxiv* [Preprint]. https://doi.org/10.1101/2021.04.14.21255448

Tay, R. S. C., Wegner, D. R., Lim, L. S., Ting, J., & Ong, S. T. (2024). Enhancing teaching and learning of evidence-based practice via game-based learning. *The Asia Pacific Scholar, 9*(3), 41–49. https://doi.org/10.29060/TAPS.2024-9-3/SC3111

van Buuren, S. (2018). *Flexible imputation of missing data* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9780429492259

Walker, D., Tynan, A., Tucker, T., Fisher, B., & Fisher, T. (2023). Engaging with a rural Aboriginal community to identify strategies to improve oral health within their community. *Australian Journal of Primary Health, 29*(1), 38–46. https://doi.org/10.1071/PY22215

Watt, R. G. (2007). From victim blaming to upstream action: Tackling the social determinants of oral health inequalities. *Community Dentistry and Oral Epidemiology, 35*(1), 1–11. https://doi.org/10.1111/j.1600-0528.2007.00348.x

Watt, R. G., Daly, B., Allison, P., Macpherson, L. M. D., Venturelli, R., & Benzian, H. (2019). Ending the neglect of global oral health: Time for radical action. *The Lancet, 394*(10194), 261–272. https://doi.org/10.1016/S0140-6736(19)31133-X

Yin, R. K. (2018). *Case study research and applications: Design and methods*. SAGE Publications, Inc.

Zachariah, R., Kumar, A. M. V., Isaakidis, P., Sreenivas, A., Bissell, K., Van den Bergh, R., Satyanarayana, S., Van Henten, S., & Reid, A. J. (2024). Reporting guideline for global health qualitative research methods. *Global Health Action, 17*(1), 2350585. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11353496/

*Worayuth Nak-Ai
Praboromarajchanok Institute, Thailand
668-3570-5859
worayuth@scphc.ac.th