



Design and Implementation of Web-Based Nutrition Database for Early Childhood Teachers in Ethnic Minority Schools in Northern Thailand

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Abstract

The objective of this study was to design and implement an innovative web-based nutrition database system for early childhood teachers in ethnic minority schools in northern Thailand. This study employed a research and development (R&D) design using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, which consists of five phases: Phase 1: qualitative analysis of the situation and needs among early childhood ethnic minority school teachers and caretakers under the Therd Thai Subdistrict Administrative Organization, Mae Fah Luang District, Chiang Rai Province. Phase 2: designed the system structure and interface prototypes using the information from Phase 1 and the literature review. Phase 3: developed the system, conducted CVI validation, and pilot testing. Phase 4: Provided a one-day training and implemented the system for 8 weeks. Phase 5: evaluation satisfaction through post-implementation evaluation. Data were collected from March 2023 to September 2024. The results showed that the innovative web-based nutrition database system consists of 5 functions, including: (1) Child health profile management system, (2) Nutrition data management and surveillance System, (3) Nutrition education and promotion module, (4) Individual child nutritional assessment, (5) Area-based nutritional status surveillance dashboard. Moreover, post-implementation satisfaction evaluation yielded a total score of 4.67 (SD = 0.46), indicating a high level of satisfaction. In conclusion, encouraging the adoption of this innovative web-based

nutrition database system for sustainable use and expansion to other child care centres is recommended.

Keywords: Early childhood nutrition, Web-based database system, Ethnic minority schools, Northern Thailand

What was Known

- Nutrition records in ethnic minority schools were mostly paper-based.
- Early childhood nutrition data was often inconsistent and hard to access.
- Teachers had limited tools to monitor nutrition in remote community settings.

What's New and Next

- A new web-based system improves how teachers manage early childhood nutrition data.
- The system supports better planning for nutrition in ethnic minority schools.
- Future research should test long term use and expand the system to more centers.

Introduction

Early childhood is a critical development period during which adequate nutrition is essential for physical growth, cognitive development, and long-term health. Global estimates indicate that in 2022 approximately 148.1 million children under five were stunted, 45 million wasted, and 37 million overweights reflecting the persistent burden of undernutrition and the emerging problem of overnutrition^(1,2). Malnutrition remains one of the most serious yet under-addressed global development challenges, exacting high human and economic costs and disproportionately affecting poor, rural, and marginalized populations⁽³⁾. In Thailand, ethnic minority children living in remote, mountainous areas especially in northern provinces face compounded risks of malnutrition due to geographic isolation, socioeconomic disadvantage, limited healthcare access, and cultural dietary practices^(4,5). Previous studies among hill-tribe preschoolers have documented high prevalence of stunting, underweight, and micronutrient deficiencies^(5,6,7). Moreover, institutional feeding programs in remote rural preschools have reported lunch menus deficient in energy, macronutrients, and vital micronutrients such as iron, calcium, and vitamin B1 raising concerns about adequacy of nutritional support in these settings⁽⁶⁾.

Teachers and caretakers in early childhood centers play a crucial role in monitoring growth, planning menus, and supporting healthy eating behaviors; yet they often lack access to updated

nutrition data, structured monitoring tools, and user-friendly documentation systems, particularly in resource-limited ethnic-minority school contexts^(3,4). Manual, paper-based record-keeping remains common in remote schools, leading to fragmented data, delayed reporting, and limited capacity for longitudinal monitoring⁽³⁾.

Globally, web-based nutrition and health information systems have been proposed and used to improve data management, enhance accessibility, standardize data, and support decision-making by non-specialist personnel⁽³⁾. The digitalization of nutrition data enables multi-user collaboration, real-time updates, and longitudinal tracking of child nutrition status features that are particularly useful in low-resource, geographically dispersed educational settings^(3,8). However, there is limited evidence from Thailand of a tailored, context-sensitive web-based nutrition database system designed specifically for early childhood teachers in ethnic minority schools. Current nutrition services in these settings typically rely on manual, paper-based data collection, and routine health screenings. These traditional systems are often fragmented, leading to delayed nutritional status assessment and limited real-time monitoring. Furthermore, there is a lack of integrated digital platforms that connect community-level data to broader public health surveillance, making it difficult to provide timely interventions. Given the documented malnutrition burden among ethnic minority preschool children in northern Thailand^(5,6) and the nutritional inadequacies observed in institutional feeding programs, there is a clear need for an accessible, culturally appropriate, user-friendly web-based system to support teachers and caretakers in nutrition data management and menu planning⁽³⁾.

The use of a structured development framework, such as the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, can ensure that such a system is grounded in local needs, evidence-based nutrition guidelines, and user feedback to maximize usability and sustainability^(9,10). The ADDIE framework was selected for this research due to its systematic, iterative nature, which is essential for translating end-users' authentic needs into functional digital features. This approach facilitates continuous refinement based on direct feedback from teachers and caregivers, ensuring the final platform is highly responsive to the unique sociocultural and operational constraints of ethnic minority school settings^(9,10). Furthermore, this theory has been widely applied to develop innovations in public health and healthcare, with numerous studies supporting its effectiveness⁽¹¹⁻¹⁴⁾.

In response to this gap, the present study aimed to design and implement an innovative web-based nutrition database system for early childhood teachers in ethnic minority schools in

northern Thailand. Using a research and development (R&D) design guided by the ADDIE model, the study involves qualitative needs assessment, prototype development, pilot testing, deployment, and evaluation of user satisfaction. This initiative addresses a critical need for strengthening nutritional data infrastructure in underserved educational settings and contributes to efforts aimed at reducing nutrition inequities among vulnerable children in ethnic minority communities.

Materials and Methods

This study employed a Research and Development (R&D) design using the ADDIE model, which consists of five phases: Analysis, Design, Development, Implementation, and Evaluation^(9,10). The details of each phase are summarized in Table 1. The research was conducted from March 2023 to September 2024 under the approval of the Human Research Ethics Committee of the Chiang Rai Provincial Public Health Office, Thailand (protocol number CRPPHO 14/2566). Written informed consent was obtained from all participants, and data confidentiality was strictly maintained.

Table 1 Definition and key activities of each phase in the ADDIE model^(9,10)

Phase	ADDIE model	Definition	Key Activities
1	Analysis	This phase focuses on identifying the existing problems and needs in nutrition data management among users.	Conducted a qualitative study using in-depth interviews among early childhood school teachers and caretakers.
2	Design	This phase involves planning the structure and features of the system based on identified needs.	Designed the system structure, database framework, and user interface based on the results from Phase 1 and a literature review.
3	Development	This phase focuses on building and refining the system prototype	Developed the system, conducted CVI validation, and pilot testing.
4	Implementation	This phase involves deploying the system and applying it in real settings.	Provided training and implemented the system for 8 weeks
5	Evaluation	This phase assesses the performance and user satisfaction of the system.	Measured user satisfaction using questionnaires (quantitative) and open-ended feedback (qualitative), analyzed using descriptive statistics and content analysis.

Study site

The study site comprises early childhood ethnic minority schools in the Therd Thai Subdistrict, Mae Fah Luang District, Chiang Rai Province. There are nine such schools under the Therd Thai Subdistrict Administrative Organization. This sub-district was selected as the study site because it is a remote mountainous area with a high concentration of ethnic minority populations who face persistent nutritional challenges.

Phase 1: Analysis of the situation and needs

A qualitative study was conducted to explore the situation and needs of early childhood teachers and caretakers regarding a nutrition data-based system in ethnic minority schools. A total of 30 participants were recruited using purposive sampling.

The study population comprised early childhood school teachers and caretakers in the Therd Thai Subdistrict, Mae Fah Luang District, Chiang Rai Province, who were selected purposively. The inclusion criteria for early childhood school teachers and caretakers were: i) both male and female, ii) aged 18 years and older, iii) with at least one year of experience in working with preschool children and being responsible for their care, teaching, or supervision under the Therd Thai Subdistrict Administrative Organization, Mae Fah Luang District, Chiang Rai Province, Thailand, and iv) willing to participate in this study. Individuals with less experience or without direct caregiving/teaching roles were excluded.

Data were collected through in-depth interviews using semi-structured interview guides developed from a literature review. Each interview lasted approximately 30–60 minutes and was conducted in a private setting to ensure confidentiality. All interviews were audio-recorded with participants' consent and subsequently transcribed verbatim.

To ensure the credibility and trustworthiness of the qualitative findings, several strategies were employed. Data triangulation was achieved by including participants from multiple child development centers. Peer debriefing was conducted among the research team to review emerging themes and interpretations. In addition, member checking was performed with selected participants to confirm the accuracy of the findings. The data were analyzed using thematic analysis, following an inductive approach to identify key themes and patterns.

Phase 2: Design

In Phase 2, the database structure and interface prototypes were developed based on the Phase 1 findings and a literature review. A needs-to-function mapping approach was used to

ensure that the core functions directly addressed all identified user requirements and operational challenges.

Phase 3: Development

In this phase, the web-based nutrition database system was developed based on the technical specifications and prototypes from phase 2. To ensure the quality of the system, the content and functional prototypes were evaluated for content validity using the Content Validity Index (CVI) by three experts in nutrition, information technology, and public health. The researchers then refined the system in line with the experts' recommendations. Based on the three experts, all items achieved an I-CVI of 1.00, and the S-CVI was also 1.00, indicating excellent content validity. Subsequently, a pilot test was conducted with three early childhood teachers and caretakers to assess practical functionality. Final adjustments were made based on their feedback to optimize the system's usability before full-scale implementation.

Furthermore, the development phase focused on translating the functional requirements into a technical system. The technical specification to develop the web-based nutrition platform is divided into two parts: 1) the front-end web application developed by NodeJS Express and the back-end web application developed by React framework. The database system is MySQL 5.7. that are running on Ubuntu 20.04 web server environment. The user of this platform consists of 5 user access levels that are general user or guest, public health officer, early childhood teacher, subdistrict administrative organization officer (SAO officer), and system administrator. The web-based nutrition database system features are illustrated in Figure 1. To ensure the confidentiality of sensitive child health records, the system architecture incorporated with the user authentication, personal data privacy protection, cybersecurity standard and a three-tier data flow.

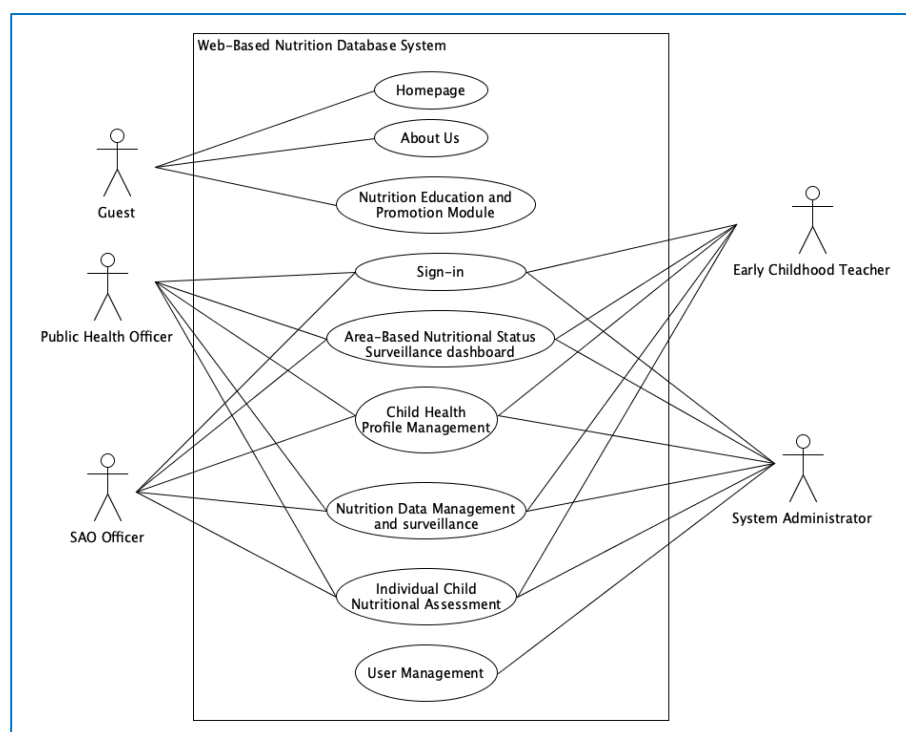


Figure 1 The web-based nutrition database system features.

The system architecture and data flow of the web-based nutrition database shown in Figure 2 was designed based on a three-tier model, comprising the presentation layer (user interface), the application logic layer (for automated nutritional assessment), and the data layer (MySQL database system). The data flow originates from user input of child health profiles and anthropometric measurements, which are then processed through the system's logic to generate real-time nutritional status and aggregate area-level trends on the dashboard.

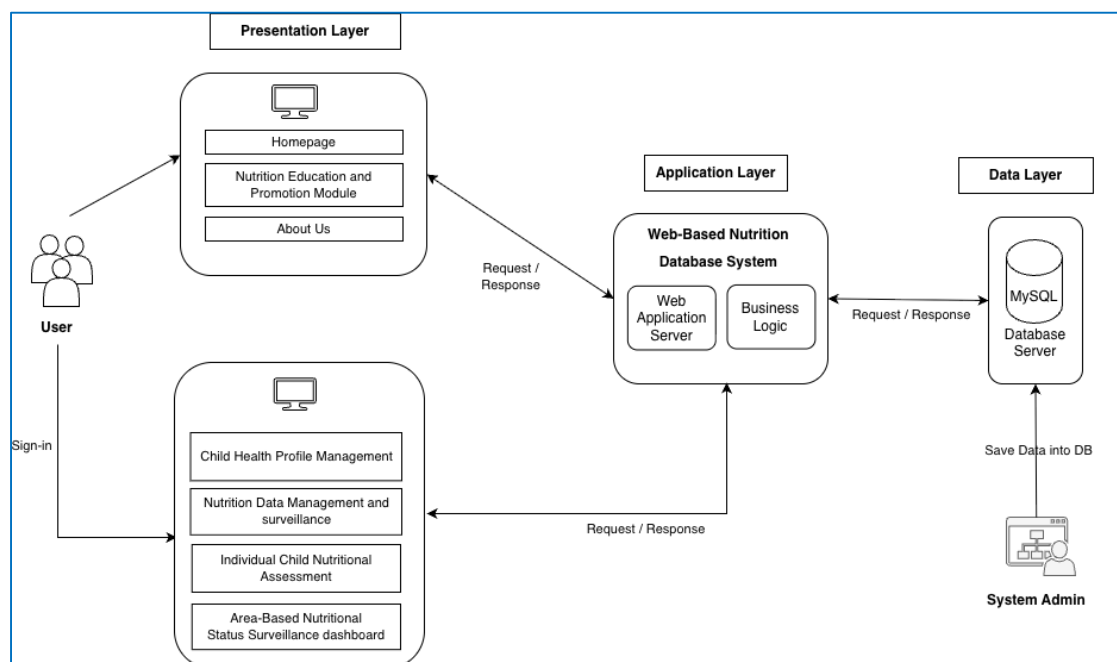


Figure 2 The system architecture and data flow of the web-based nutrition database.

Phase 4: Implementation

The finalized web-based nutrition database system was deployed for real-world application. The sample size was determined using G*Power 3.1.9.7⁽¹⁵⁾. Based on a one-sample t-test to evaluate user satisfaction against a predefined threshold, the calculation used a medium effect size of 0.50⁽¹⁶⁾, a significance level (α) of 0.05. This value was selected based on Cohen's benchmarks, in which 0.50 represents a medium effect size, which is considered appropriate for a pilot evaluation of a new digital innovation when specific prior data are limited. With a significance level (α) of 0.05 and 0.80 power, the required minimum was 27 participants. To account for a 10% non-response rate, the final sample was increased to 30 participants to ensure sufficient data for analysis⁽¹⁷⁾.

These participants were early childhood teachers and caretakers who met the same inclusion and exclusion criteria as in phase 1. A one-day consecutive training session was provided to participants prior to implementing and using the system continuously for 8 weeks in their respective centres.

Phase 5: Evaluation

A post-implementation satisfaction survey was conducted after 8 weeks of implementation. Data were collected via a validated self-administered questionnaire consisting of

two sections: Section 1: Satisfaction level – 10 items: five on functionality, and five on usability and web accessibility. Responses were rated on a 5-point Likert scale, ranging from 1 (very unsatisfied) to 5 (very satisfied)⁽¹⁸⁾. The satisfaction of each item was classified into three groups: high (4.50–5.00 points), moderate (3.00–4.49 points), and low (1.00–2.99 points). The CVI in the present study was 1, and the overall Cronbach's alpha was 0.96. High reliability was also observed for the functionality ($\alpha = 0.93$) and usability and web accessibility ($\alpha = 0.92$) subscales.

Section 2: Suggestions and recommendations – A single question open-ended was asked for feedback on the innovative web-based nutrition database system. The feedback was gathered to identify areas for further improvement, ensuring that the system effectively supports nutritional management in practice.

The quantitative data were analyzed using descriptive statistical methods, including frequencies, percentages, means, and standard deviations. No inferential statistical analysis or pre-post comparison was conducted, as the evaluation focused solely on post-implementation user satisfaction. Moreover, qualitative data from open-ended responses were analyzed using content analysis.

Result

Phase 1: Situation and needs assessment results

The situation analysis identified four key themes reflecting key challenges in nutrition data management. These include fragmented and inconsistent child health records, limited digital tools for nutrition tracking, difficulties in accessing real-time nutritional information, and teachers overloaded with administrative tasks. These findings, along with representative qualitative insights, are summarized in Table 2.

Table 2 Situation analysis

Themes	Illustrative quotations
Fragmented and inconsistent child health records	<i>“Everything is scattered; some centers use paper, some use notebooks. It’s hard to keep track.” (P4)</i>
Limited digital tools for nutrition tracking	<i>“We still don’t have an online system. Everything is handwritten.” (P11)</i>
Difficulty accessing real-time nutritional information	<i>“Looking back at old data is hard because nothing is stored in one place.” (P23)</i>
Teachers overloaded with administrative tasks	<i>“There’s a lot of paperwork, so we barely have time to summarize the kids’ nutrition.” (P29)</i>

Note: P followed by a number (e.g., P1, P2) represents the identity code of the participants who provided the information during the in-depth interviews.

The needs assessment indicated two major themes and seven sub-themes. The first theme, (1) web-based nutrition database requirements, encompassed a simple and user-friendly digital system, organized and accessible child health records, systematic nutrition data collection, individualized nutritional status assessment, and area-based nutrition dashboards. The second theme focused on (2) training and ongoing support, emphasizing the need for hands-on practice and data-entry skills (Table 3).

Table 3 Need assessments

Themes	Sub-themes	Illustrative quotations
Web-Based Nutrition Database	Need for child health profile management system	<i>"We want to record each child's information in one place, including weight, height, and health history. Right now, it's all separate."</i> (P6)
	Need for nutrition data management and surveillance system	<i>"It would be helpful if the system could store and organize nutrition data so we can track children's status over time."</i> (P12)
	Need for nutrition education and promotion module	<i>"We also want some guidance or information about nutrition so we can plan better meals for the children."</i> (P18)
	Need for Individual child nutritional assessment	<i>"If the system can tell us whether a child is underweight or overweight, it would make our work easier."</i> (P22)
	Need for area-based nutritional status surveillance dashboard	<i>"If the system could show graphs or charts, it would help us see the overall situation right away."</i> (P21)
Training and ongoing support	Need for hands-on practice and data entry skills	<i>"We need proper training because many of us have never used a database system before."</i> (P25)

Note: P followed by a number (e.g., P1, P2) represents the identity code of the participants who provided the information during the in-depth interviews.

Phase 2: System design and architecture

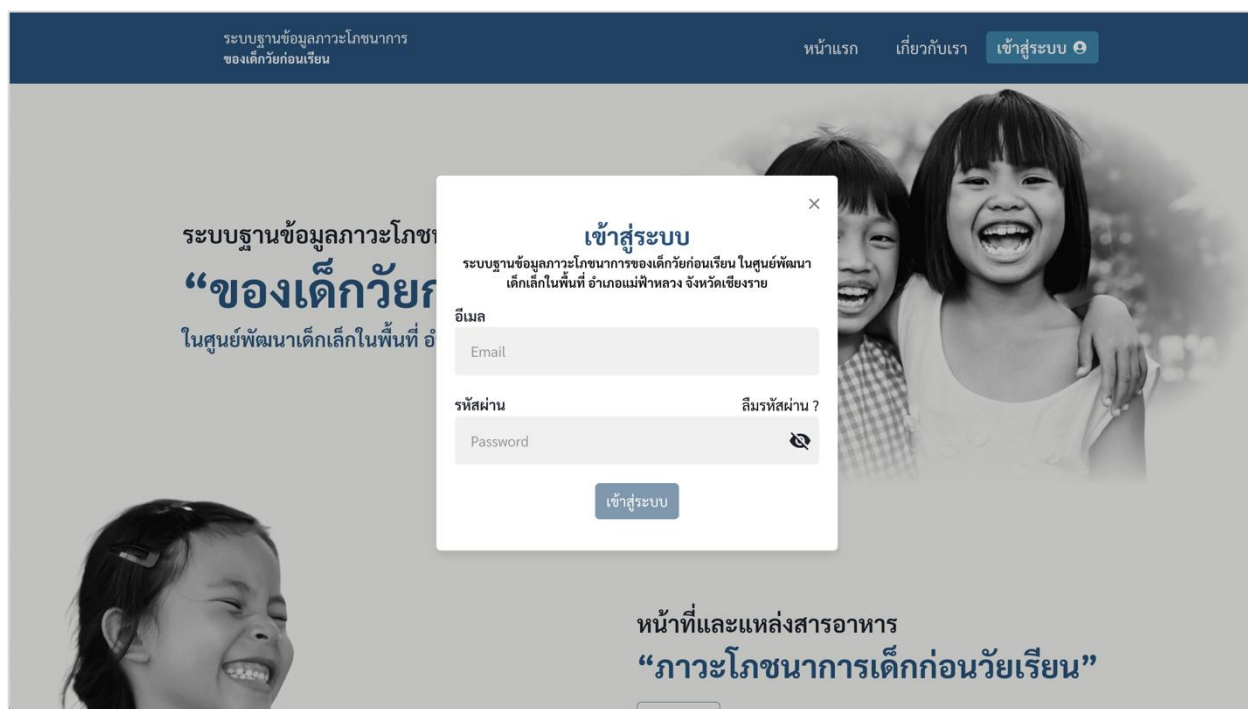
Qualitative findings and user requirements from Phase 1, along with the literature review, were translated into technical specifications, focusing on system architecture, database structure, and user interface⁽¹⁹⁻²⁷⁾. A needs-to-function mapping linked these requirements to specific system functions, leading to the design of five core modules aimed at enhancing nutrition monitoring in ethnic minority preschool centers (Table 4).

Table 4 Needs-to-function mapping of user requirements and system responses

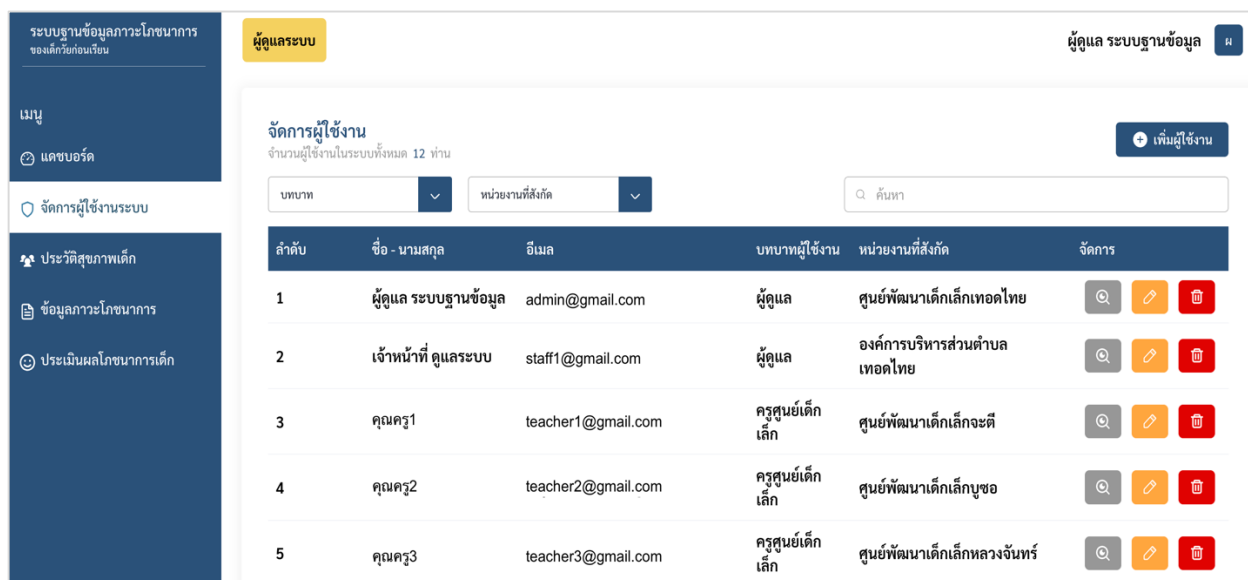
Identified needs (Sub-theme)	System response
Need for child health profile management system	Registers and manages comprehensive health profiles, including demographics, health history, and growth milestones for longitudinal tracking.
Need for nutrition data management and surveillance system	Standardizes the collection of anthropometric and dietary data, incorporating context-specific food items to reflect local ethnic patterns.
Need for nutrition education and promotion module	Provides age-appropriate nutrition education and dietary guidance for children aged 2–6 years, covering nutrient sources, functions, and specific recommendations.
Need for Individual child nutritional assessment	Automates nutritional status calculation based on dietary intake and anthropometric indicators for immediate feedback
Need for area-based nutritional status surveillance dashboard	Aggregates and visualizes multi-center data into interactive dashboards for trend monitoring and data-driven decision-making.

Phase 3: Development system and validation

The web-based nutrition database system was developed using software engineering and a Database Management System (DBMS). It integrates functional modules for recording, monitoring, and reporting nutrition data, supporting effective management of child nutrition information in practice. The system also demonstrated usability and readiness for implementation in real-world early childhood settings. The system comprises five major functional components, including: (1) Child health profile management system, (2) Nutrition data management and surveillance System, (3) Nutrition education and promotion module, (4) Individual child nutritional assessment, (5) Area-based nutritional status surveillance dashboard (Figure 3-8).



System login



User management

Figure 3 Overview of the web-based nutrition database system

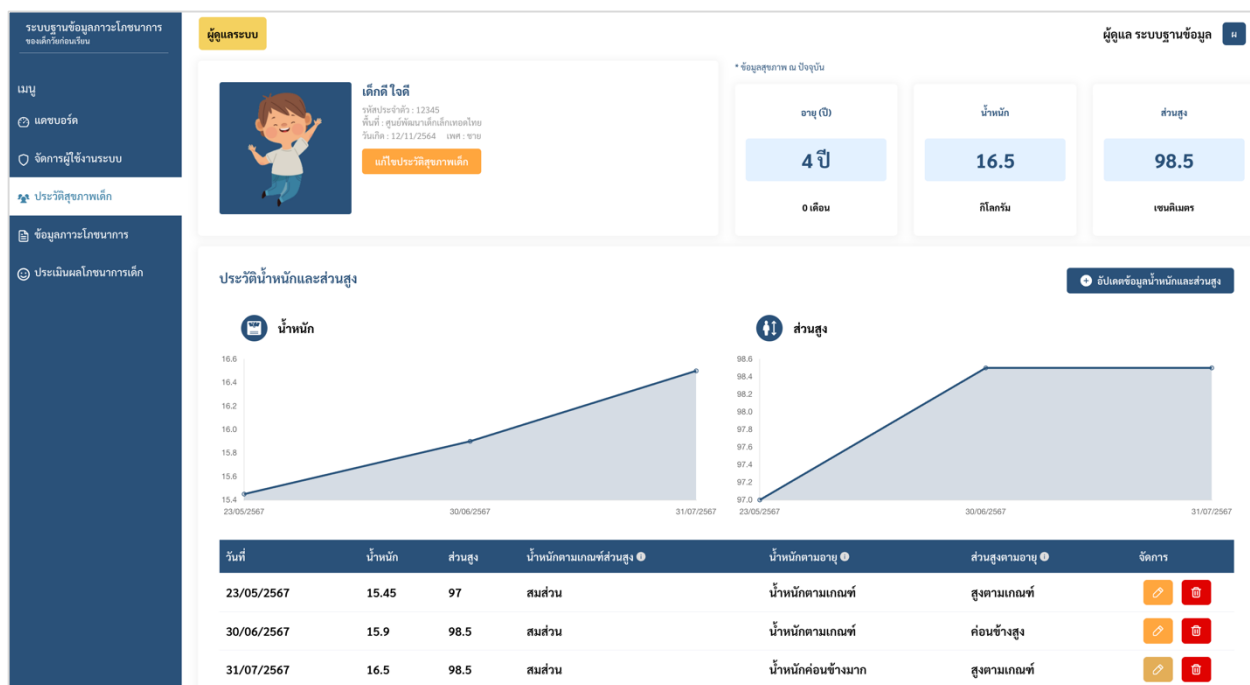


Figure 4 Child health profile management system

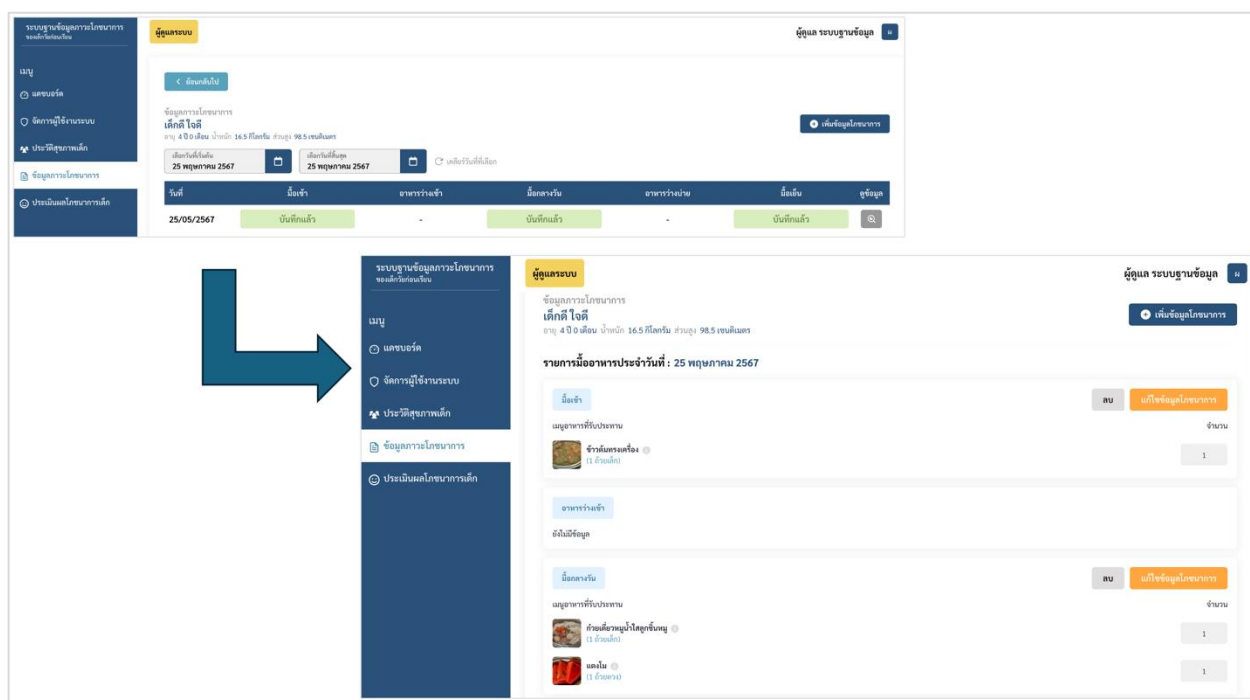


Figure 5 Nutrition data management and surveillance system



Figure 6 Nutrition education and promotion module

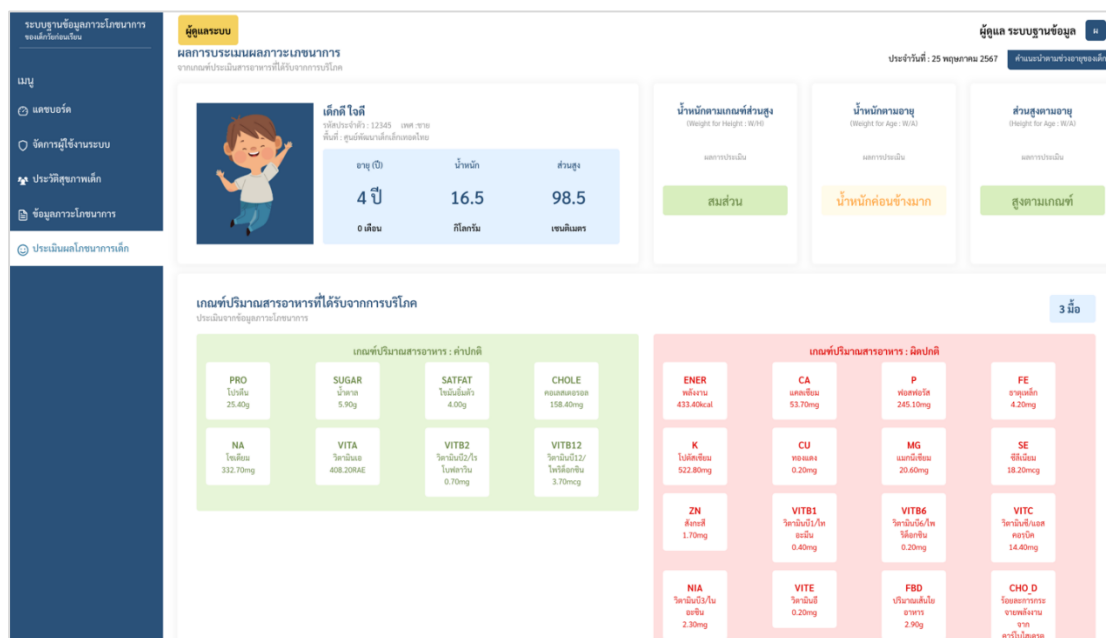


Figure 7 Individual child nutritional assessment

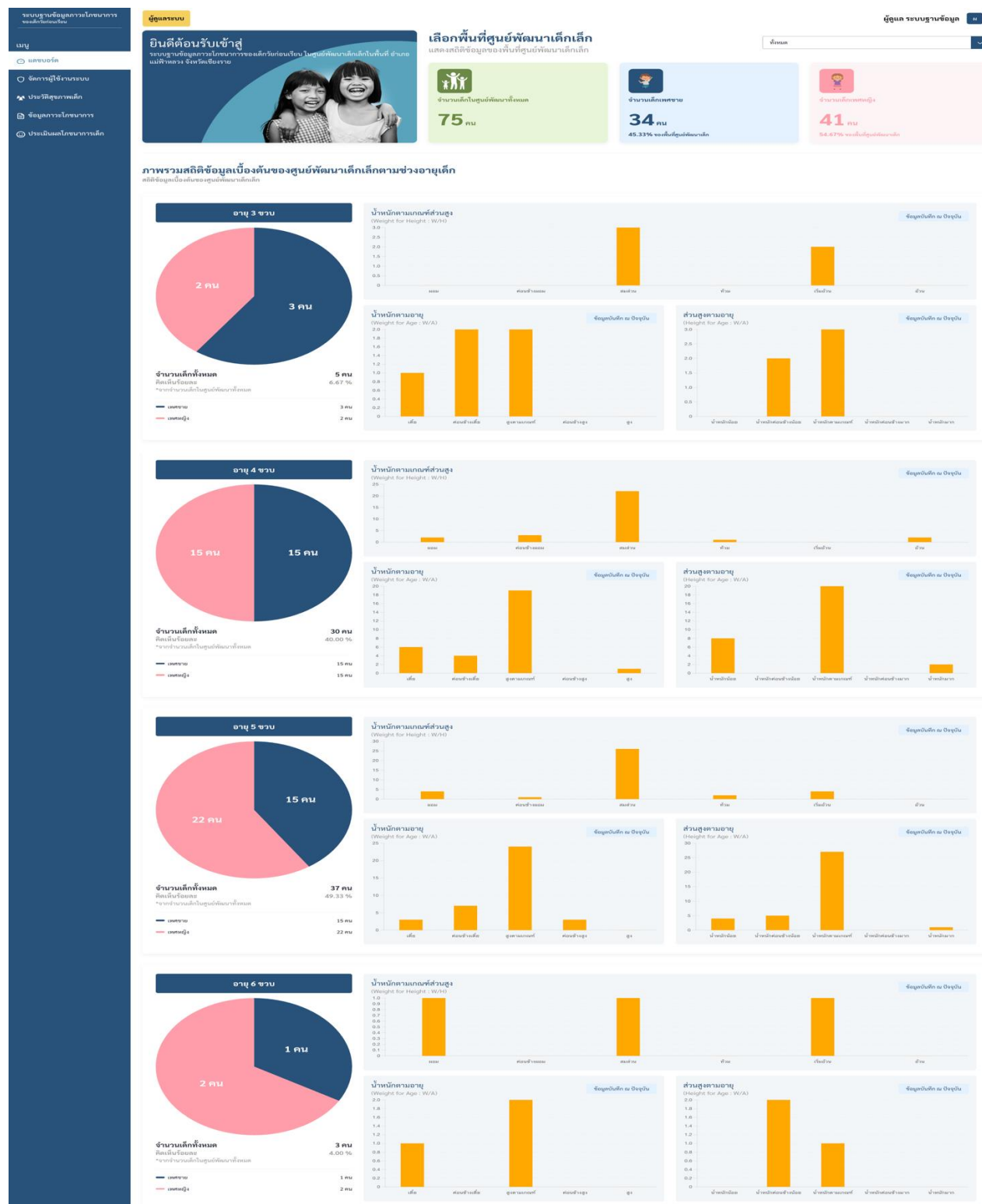


Figure 8 Area-based nutritional status surveillance dashboard

Phase 4: Implementation outcome

The web-based nutrition database system was successfully implemented across the targeted centers. Following initial training, all 30 participants (100%) demonstrated competency in operating the system. Over the 8 weeks, all five system functions were consistently utilized to record and monitor children's nutritional status. The transition to the digital platform was smooth, with the system demonstrating stable performance and maintaining data integrity across varying hardware and internet conditions.

Regarding the participant profiles, a total of 30 participants were recruited, nearly all of whom were female (96.7%), with a mean age of 34.4 ± 4.5 years. Half of the participants were Christian (50.0%). Eighteen participants (60%) held a bachelor's degree, 80% were teachers, and 53.4% had more than 10 years of work experience. All participants belonged to ethnic minority groups, as detailed in Table 5.

Table 5 General information of the participants (n=30)

Characteristics	n	%
Gender		
Female	29	96.7
Male	1	3.3
Age (years)		
> 40	5	16.7
31-40	16	53.3
20-30	9	30.0
<i>Mean = 34.4, SD=4.5, Minimum =24, Maximum=42</i>		
Marital status		
Married	30	100.0
Religion		
Buddhist	15	50.0
Christian	15	50.0
Education level		
High school	12	40.0
Bachelor's degree	18	60.0

Table 5 General information of the participants (n=30) (Cont.)

Characteristics	n	%
Occupation		
Teacher	18	60.0
Caretaker	12	40.0
Work experience (years)		
>10	16	53.4
5 -10	10	33.3
< 5	4	13.3
Ethnic group		
Yes	30	100.0
No	0	0.0

Phase 5: Evaluation of user satisfaction

Following the 8-week implementation, the post-implementation satisfaction evaluation yielded a total score of 4.67 (SD = 0.46), indicating a high level of satisfaction. Additionally, when considering each domain, it was also demonstrated that both the functionality domain and the usability and web accessibility domain had a high level (Mean=4.66, SD=0.50), (Mean=4.67, SD=0.43), respectively (Table 6). These findings, while potentially indicating a ceiling effect, suggest that the system effectively addressed user needs and was perceived as user-friendly by ethnic minority school staff, with consistently high scores observed across both functionality and usability domains.

Furthermore, qualitative feedback suggested the need for further enhancements in mobile accessibility and system flexibility. Participants reported that although the system was effective when accessed via computers, mobile-friendly features would improve usability in real-world settings. For example, one participant stated, *"It would be more convenient if we could use the system on our phones, especially when we are working outside the office or in the classroom."* (P17). Another participant highlighted that *"Sometimes we don't have access to a computer, so being able to enter data through a mobile device would make our work faster and easier."* (P26). These findings indicate that future system development should consider integrating mobile-compatible functions or a dedicated application to enhance accessibility and support continuous use in diverse educational settings. These findings are consistent with the needs identified in

Phase 1, particularly the demand for flexible and accessible digital tools in resource-limited settings.

Table 6 Satisfaction with the Innovative Web-Based Nutrition Database System (n=30)

Questions	Mean	SD	Interpretation
Section 1: Functionality (5 items)			
1.The system's features meet the needs of my tasks.	4.77	0.43	High
2.The system allows easy access to all the necessary data.	4.70	0.53	High
3. The system functions without errors or crashes	4.66	0.61	High
4.The system updates data quickly.	4.60	0.62	High
5. The system provides accurate and reliable information.	4.56	0.63	High
Subtotal: Functionality	4.66	0.50	High
Section 2: Usability and Web Accessibility (5 items)			
6. The system's interface is easy to understand.	4.63	0.49	High
7.The design of the system is visually appealing.	4.83	0.38	High
8. Navigating the system is intuitive and easy.	4.70	0.53	High
9. The system is easy to use	4.67	0.48	High
10.The response time of the system is fast enough for my needs.	4.53	0.63	High
Subtotal: Usability and web accessibility	4.67	0.43	High
Total satisfaction score	4.67	0.46	High

Note: Interpretation criteria based on mean scores: 4.50–5.00 = High, 3.00–4.49 = Moderate, and 1.00–2.99 = Low.

SD=Standard Deviation

Discussion

The study designed and implemented a web-based nutrition database system for early childhood teachers in ethnic minority schools in northern Thailand. The findings identified five key functions, and most participants reported high satisfaction, reflecting the system's ability to address key challenges in nutrition data management in resource-limited settings.

The high satisfaction observed in this study may be explained by the alignment between system design and user needs identified in Phase 1, informed by the initial situation analysis. Key challenges, including fragmented record-keeping, limited access to real-time data, and a high administrative workload, led to the need for a simple, user-friendly system, real-time data access, standardised data management for health and nutrition, and accessible visualisation. These needs were addressed through a centralised database and an integrated dashboard, enabling real-time data entry and retrieval. Training and technical support further facilitated use, particularly among participants with limited digital experience. This alignment likely contributed to the consistently high scores across both functionality and usability domains.

The findings are consistent with previous studies conducted in Malaysia^(13,14), Indonesia⁽²⁷⁻²⁹⁾ and Thailand⁽³⁰⁻³²⁾, which have reported high levels of usability and user satisfaction following the implementation of digital health and nutrition-related systems developed using the ADDIE framework. Prior research has shown that systems designed using ADDIE are generally perceived as user-friendly and useful in supporting learning and nutrition-related activities^(33,34). However, much of the existing literature has focused primarily on system development processes, educational outcomes, or usability testing in controlled or academic environments. In contrast, the present study extends existing evidence by demonstrating the feasibility and user acceptance of implementing such a system in real-world, low-resource ethnic minority preschool settings. It might be because the study that applied the ADDIE framework ensured the system was developed in line with both local needs identified in Phase 1, where users highlighted key needs such as simplified data entry, locally relevant content, and practical functions for child growth monitoring, which were directly incorporated into the system design. This alignment with user needs, together with evidence-based nutritional guidelines^(8,9), may have contributed to the high level of satisfaction observed.

One of the key strengths of this study is its innovative approach, which introduced a context-based web-based nutrition database system tailored to meet the unique needs of early childhood teachers and caretakers in ethnic minority schools. The platform was designed with a user-friendly system, integrating a qualitative needs assessment into its design to ensure it reflected actual user needs. Moreover, the content was designed for its local context and to address nutritional challenges, highlighting its development in a remote ethnic minority context. The study also demonstrates real-world implementation in early childhood education settings, supporting its practical applicability. The potential to scale up to the level of another school offers

a practical solution for enhancing public health nutrition in underserved educational settings. It indicates its potential contribution to public health nutrition surveillance.

Despite these strengths, several limitations in this study should be addressed. First, as this was a post-implementation evaluation, it lacks pre-intervention baseline data for comparison, and the absence of a control group may limit the ability to account for external confounding factors. Second, the findings relied on self-reported satisfaction, which may be subject to response bias. Third, the short duration of system use may not adequately reflect its long-term effectiveness and sustainability. Fourth, the sample size in this study was relatively small, and the participants were drawn from a small and context-specific sample, which may limit generalizability to other settings or populations. In addition, the innovative web-based nutrition data system requires an internet connection for use, which may affect implementation in areas with limited connectivity. Finally, some functions, such as the management of preschool children's health profiles, also require manual data entry. Future studies should consider incorporating objective outcome measures and evaluating system effectiveness using more rigorous designs, such as randomized controlled trials or comparative studies, to further assess its impact.

The findings have important public health implications. A standardized digital platform for recording and monitoring children's nutrition information can enhance the continuity and accuracy of nutrition monitoring, enabling more systematic tracking of child growth over time. The system also supports early detection of malnutrition by enabling teachers and caretakers to identify children at risk earlier and facilitate timely referral or intervention. In addition, such improvements may help reduce inequities among ethnic minority preschool children, particularly in communities where structural barriers often limit access to timely and reliable nutrition information. Further research should evaluate the long-term effectiveness and scalability of the system. Studies with larger and more diverse populations, longer follow-up periods, and comparative designs are recommended to determine the system's broader applicability. Future development may also include integrating mobile functions or linking the system with existing public health information systems to increase utility and strengthen its contribution to child nutrition surveillance.

Conclusion

This study developed and implemented a web-based nutrition database system designed for early childhood teachers in ethnic minority schools in northern Thailand. Using the ADDIE model, the system was developed to address identified gaps in existing nutrition data practices and refined through expert review and user feedback. The final system, comprising five functional

components, demonstrated high user satisfaction and was deemed appropriate for use in resource-limited school settings.

Ethical Approval Statement

This study was approved by the Human Research Ethics Committee of the Chiang Rai Provincial Public Health Office, Thailand (protocol number CRPPHO 14/2566; approval date: 1 March 2023).

Author Contributions

SK, TR, KK, and CS designed the study and formulated the content of the data-based platform and questionnaire. SK, TR, and KK implement the project and data collection. SK and TR analyze the data, interpreting data and wrote the manuscript, and KK and CS helped to revise it. All authors read and approved the manuscript prior to submission for publication.

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Conflicts of Interest

The authors declare no conflict of interest in this study.

References

1. World Health Organization. Malnutrition: Key facts. Available from: <https://www.who.int/news-room/fact-sheets/detail/malnutrition>, accessed 28 March, 2024.
2. UNICEF, WHO, World Bank Group. Joint Child Malnutrition Estimates (JME): levels and trends in child malnutrition. Key findings of the 2023 Edition. Available from: <https://www.who.int/publications/i/item/9789240073791>, accessed 26 March, 2024.
3. Roesler A, Smith M, Schultz J, Somphong C. Local perspectives and context in relation to feeding practices in ethnic minority communities in northern Thailand. BMC Public Health. 2023; 23(1): 1185. DOI: 10.1186/s12889-023-16233-2

4. Sroywong D, Wungrath J, Thongprachum A. Factors associated with stunting among hill-tribe preschool children in Mae Chaem District, Chiang Mai Province, Thailand. *J Med Health Sci.* 2021; 28(3): 104–12.
5. Janpeang J, Suwannapoom C, Anukunwathaka N. Nutritional status and related factors among ethnic preschool children in Northern Thailand: a cross-sectional study. *Child Health Nurs Res.* 2022; 28(3): 176–86. DOI: 10.4094/chnr.2022.28.3.176
6. Wungrath J, Yutabootr S, Limvilai T, Kapheak K. Nutritional value of lunches served in the remote rural area child-care centers in Chiang Mai, Thailand. *Open Public Health J.* 2022; 15(1): 1–6. DOI: 10.2174/18749445-v15-e2208182
7. Kitchanapaibul S, Singhan C, Ruanjai T. Factors associated with a double burden of malnutrition among preschool-aged ethnic minority children in northern Thailand: a community-based cross-sectional study. *BMC Public Health.* 2026; 26(1): 1082. DOI: 10.1186/s12889-026-26777-8
8. World Bank. Nutrition Overview: The challenge of malnutrition and its economic and human costs. Available from: <https://www.worldbank.org/en/topic/nutrition/overview>, accessed 28 March, 2024.
9. Branch RM. *Instructional design: The ADDIE approach*: Springer; 2009.
10. Peterson C. Bringing ADDIE to life: Instructional design at its best. *J Educ Multimed Hypermedia.* 2003; 12(3): 227–41.
11. Suknark N, Chootrakool H, Siripitayakulkit A, Kitidumrongsuk P, Pensiri F, Treewai P. Developing an application for nursing practice with hypertension. *Thai J Public Health.* 2024; 54(3): 1028–51.
12. Das S, Vinayagamoorthy V, Malik A, Kundu S, Kumar T, Varshney S, et al. Development and implementation of childhood obesity module for medical undergraduate using ADDIE model: A mixed method design. *J Educ Health Promot.* 2025;14(1):231. DOI: 10.4103/jehp.jehp_1459_24
13. Rashid AFA, Syed Saadun Tarek Wafa SWW, Talib RA, Bakar NMA. Development and validation of a web-based module for preschool child-parent dyads: the weight-related behaviour intervention programme. *Malays J Med Health Sci.* 2024; 20(6): 137–48. DOI:10.47836/mjmhs20.6.19
14. Mohd C, Shahbodin F, CKNCK S. Design and development of a multimedia courseware using personalized learning environment approach for nutrition topic. *ARNP J Eng Appl Sci.* 2016; 11(18): 10714–20.

15. Faul F, Erdfelder E, Lang A-G, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007; 39(2): 175-91. DOI: 10.3758/bf03193146
16. Cohen J. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
17. Whitley E, Ball J. Statistics review 4: Sample size calculations. *Crit Care*. 2002; 6(4): 335-341. DOI: 10.1186/cc1521.
18. Kongpan S, Soontornpipit P, Sillabutra J, Kitidamrongsuk P, Satitvipawee P, Sresumatchai V. Development of web application to support dengue investigation team of communicable disease control operations unit in Phang Nga Province. *Thai J Public Health*. 2025; 55(1): 1086-116.
19. World Health Organization. Training course on child growth assessment. Available from: <https://www.who.int/publications/i/item/9789241595070>, accessed 20 September 2025.
20. World Health Organization. *Physical status: the use and interpretation of anthropometry*. Report of a WHO Expert Committee. Geneva: WHO; 1995. (Technical Report Series No. 854).
21. World Health Organization. *WHO Anthro* (version 3.2.2, January 2011). Geneva: WHO; 2011.
22. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Dietary Reference Intake for Thais 2020*. Bangkok: Department of Health; 2020. (In Thai)
23. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Manual on the use of WHO Child Growth Standards 2006 for children aged 0–5 years*. Bangkok: Department of Health; 2015. (In Thai)
24. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Manual on growth reference criteria for children aged 6–19 years*. Bangkok: Department of Health; 2021. (In Thai)
25. Nutrition Association of Thailand. *Manual for assessment and monitoring of nutrition and development in early childhood*. Bangkok: Nutrition Association of Thailand; 2021. (In Thai)
26. Bureau of Nutrition, Department of Health, Ministry of Public Health. *Manual for the management and prevention of early childhood malnutrition (revised edition)*. Available from:

- <https://nutrition2.anamai.moph.go.th/th/book/download/?did=225422&id=136549&reload=>, accessed 15 April 2025. (In Thai)
27. Suiraoka IP, Nursanyoto H, Fritalia I. Development of stunting prevention education videos through balanced nutrition arrangements for adolescents. *Poltekita J Ilmu Kesehatan*. 2024; 18(2): 163-71. DOI: 10.33860/jik.v18i2.3923
 28. Dinatha NM, Sariyani MD, Natal YR, Maa MFS. Interactive multimedia nutrition education: strategies to strengthen the free nutritious meal program for junior high school students based on Ngada local culture. *Vasc Endovascular Rev*. 2025; 8(11s): 375-84.
 29. Putri SS, Widodo A, Wihardi Y. The Development of Foodivity interactive as an interactive multimedia to improve students' understanding of food nutrition topic. *J Sci Learn*. 2022; 5(3): 488-99. DOI: 10.17509/jsl.v5i3.38032
 30. Bunkhong P, Ketren P, Chainongpan C. Development of an e-learning course for healthcare workers studying the developmental surveillance and promotion manual (DSPM). *Thai J Health Promot Environ Health*. 2021; 44(4): 68-80. (In Thai)
 31. Tongnuang P, Binsa F, Jaisomkom A, Dereh N, Adisaisakda S, Adisaisakda K. Development of PNU SALT TALKING Application for Adults with Hypertension. *Netw J Nurs Public Health*. 2023; 10(1): 94-103. (In Thai)
 32. Suntep W, Kaewtem Y. Model development using “Healthier Choice” nutrition symbol for promoting health of noodle consumers in Mueang Lampang district. *J Health Syst Res*. 2022; 16(3): 302-18. (In Thai)
 33. Javeedullah M. Role of health informatics in public health surveillance and response. *Am J Artif Intell Comput*. 2025; 1(1): 70-86.
 34. de Camargo JTF, de Camargo EAF, Veraszto EV, Barreto G, Aceti PAZ, Junior AS. Information technology and public health: Possibilities for innovation through interdisciplinary actions. *Procedia Computer Science*. 2017; 104:294-301. DOI: 10.1016/j.procs.2017.01.138