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Feasibility Study of a Web-Based Application in Enhancing Breastfeeding Promotion and Early Childhood Health in Primary Care Settings

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Abstract

This study developed and evaluated a web-based application to support breastfeeding promotion and early childhood health care in a district within Health Region 5, Thailand. Following a Software Development Life Cycle (SDLC) framework, the project progressed through four phases: requirement analysis, design, testing, and evaluation. Requirement analysis included a survey of existing data system, assessments of budget feasibility, safety, applicability, data scope, and maintenance, stakeholder interviews. The design captured maternal and infant health data, home visit records, and developmental milestones Thailand's Developmental Surveillance and Promotion Manual (DSPM). Testing occurred in a primary care settings in Song Phi Nong district, Suphan Buri Province, within Health Region 5. The same personnel participated in testing (May 2–6, 2022) and evaluation (June 1–30, 2022): 30 randomly selected primary health care providers from the 141 in the district. Evaluation of functionality, usability, and security used an 11-item questionnaire with a 5-point Likert scale to assess user satisfaction. Results indicated that the application was successfully designed and tested, receiving positive feedback from providers, who found it more convenient than traditional paper-based recording during home visits and appreciated its ability to facilitate data transfer to the Ministry of Health's database.

Introduction

Breastfeeding is fundamental to early childhood health, providing essential nutrition and protection against disease. The World Health Organization (2023) recommends exclusive breastfeeding for the first six months, followed by continued breastfeeding alongside complementary foods up to two years or beyond—a guideline widely endorsed for supporting optimal development. Although global exclusive breastfeeding rates rose to 48% in 2023 (Couto et al., 2020), disparities remain, particularly in Thailand. In response, Thailand's Ministry of Public Health has implemented national policies supporting postpartum home visits at key intervals to monitor breastfeeding practices and child development. Evidence suggests these visits strengthen trust between families and healthcare providers, thereby enhancing breastfeeding outcomes and promoting both maternal and infant health (Carvalho et al., 2022; Gadeberg et al., 2024).

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Breastfeeding provides complete nutrition for infants, supplying essential proteins, fats, carbohydrates, and micronutrients necessary for optimal growth and development (Miolski, 2023). It strengthens the infant's immune system through the presence of immunoglobulins, oligosaccharides, and fatty acids, thereby reducing susceptibility to common infections and chronic diseases (Wang et al., 2024). Evidence also links breastfeeding to improved cognitive development, a reduced risk of autism spectrum disorders (Kofler-Eshet et al., 2023) and enhanced emotional bonding between mother and infant (Coo et al., 2024).

For mothers, breastfeeding supports postpartum recovery and reduces the risk of conditions such as breast cancer, ovarian cancer, cardiovascular diseases, and type 2 diabetes (Krupa et al., 2025). It also promotes mental well-being by potentially lowering the incidence of postpartum depression (Lubis et al., 2024).

From a societal perspective, breastfeeding offers public health and environmental advantages by decreasing healthcare expenditures and minimizing the ecological footprint associated with formula production and packaging (Mohapatra, & Samantaray, 2023).

In terms of child development, multiple determinants must be considered during postnatal care visits, including genetic predispositions, nutritional status, parental education, household income, caregiving practices, environmental conditions, and access to healthcare services (Cousminer, & Freathy, 2020; Jansson et al., 2022; Wang, 2023). Comprehensive and timely data collection is essential for monitoring these variables and guiding appropriate interventions.

Despite these well-documented benefits, Thailand's exclusive breastfeeding rates for infants under six months were reported as 23.1% in 2015, 14% in 2019, and 28.6% in 2022 (National Statistical Office & United Nations Children's Fund, 2016; World Health Organization, 2018; National Statistical Office of Thailand, 2023), falling short of the Department of Health's 2025 target of 50%.

A range of challenges continues to hinder breastfeeding practices globally and locally. These include limited access to accurate breastfeeding information, prevailing social and cultural norms, aggressive marketing of breast milk substitutes, lack of family and workplace support, and socioeconomic disparities (Cetthakrikul et al., 2022; Cetthakrikul et al., 2024; Miranda et al., 2025). In Thailand, additional barriers include inadequate maternal leave policies, insufficient community support systems, and regional disparities in healthcare accessibility.

Factors such as maternal education, income level, exposure to infant formula marketing, social support networks, and workplace accommodations significantly influence breastfeeding practices (Tomori et al., 2022; Yang et al., 2024; Sezer et al., 2024). Moreover, maternal physical and mental health conditions—including smoking, obesity, and depression—are associated with early breastfeeding cessation (Braithwaite et al., 2025; Kurui et al., 2023).

To support child development, the Thai government introduced the Developmental Surveillance and Promotion Manual (DSPM), which provides structured guidelines for monitoring children at specified ages: 9, 18, 30, 42, and 60 months. Despite widespread training efforts and national implementation, recent statistics suggest that developmental delays persist. The Thailand Multiple Indicator Cluster Survey reported that in 2018, 22% of children aged 0–2 years and 34% of children aged 3–5 years experienced developmental delays, with the rate declining to 22.2% in 2022 (National Statistical Office of Thailand, 2023).

Evidence from international and local studies underscores the effectiveness of home-based interventions in enhancing exclusive breastfeeding rates and reducing neonatal morbidity (Kahraman & Havlioğlu, 2024; Tiruneh et al., 2019). Within Health Region 5, the overall performance according to the Department of Health's health indicators in Song Phi Nong District exceeded the provincial, regional, and national targets (Department of Health, Ministry of Public Health, 2021). Notably, the proportion of postpartum women receiving the full three home visits was 94.82% in 2021 and 94.22% in 2022, while the percentage of children aged 0–5 years demonstrating age-appropriate development was 91.27% in 2021 and 96.40% in 2022. However, specific statistics on exclusively breastfed infants under six months of age at the district level were not available for either 2021 or 2022 in the Information System for Health Promotion and Environmental Health database.

Data from primary care unit staff in the study area revealed that home visit records are manually documented and entered solely into the HOSxP program, which restricts data retrieval beyond what is stored in the platform (Kamonratananun et al., 2024). Consequently, primary health care providers—who play a vital role in postpartum support and infant monitoring—currently

rely on a predominantly paper-based documentation system. This approach involves delayed, fragmented, and labor-intensive reporting to the Health Data Center (HDC), thereby limiting the effectiveness of health monitoring and decision-making processes. Although the HDC database aggregates standard health indicators, it lacks other essential determinants that influence breastfeeding practices and early childhood development.

Aligned with the WHO's health systems framework, which emphasizes accurate and accessible data for evidence-based decision-making (World Health Organization, 2023), there is a clear need for digital solutions. Mobile health (mHealth) platforms, including web-based applications, offer a promising strategy for real-time data collection, sharing, and analysis (Qian et al., 2021). These applications can facilitate accurate, inclusive, and timely data management, providing a robust foundation for health system decision-making (Alamri et al., 2024).

When developed within a structured Software Development Life Cycle (SDLC), mHealth tools ensure enhanced usability, data security, and system scalability (Nigussie et al., 2021). Incorporating privacy protections, user engagement, and clinician input during development further supports the effectiveness and sustainability of these platforms (Davie et al., 2023). Web-based applications, in particular, offer significant advantages in primary healthcare settings. They are accessible across multiple devices without requiring installation, support real-time updates, and allow multiple users to access standardized data simultaneously. These attributes not only reduce development costs but also enhance healthcare service delivery by streamlining workflows, improving communication, and ensuring timely interventions (Ameyaw et al., 2024; Romm et al., 2025).

Within the context of breastfeeding promotion and early childhood health monitoring, web applications provide a promising avenue for improving service efficiency, caregiver satisfaction, and health outcomes. Given the public health importance of breastfeeding and early child development, and the evolving capabilities of digital technologies, this study proposes the development of a web-based application database designed to enhance postpartum care delivery in a primary care setting in Song Phi Nong district. The application aims to serve as a practical tool for primary healthcare providers, enabling them to monitor, document, and support breastfeeding practices and child development with greater accuracy and accessibility.

The university affiliated with this study is designated as a community-based institution committed to local development, as categorized by the Ministry of Higher Education, Science, Research and Innovation of Thailand (2022). Its Faculty of Nursing is particularly dedicated to addressing societal health concerns, with specific initiatives focusing on early childhood and elderly care. Guided by these institutional priorities, this area falls within the university's designated academic service zone, enabling the institution to leverage its academic resources for community health improvement.

However, a significant gap remains in the absence of a readily accessible, comprehensive data system for primary healthcare providers to efficiently monitor, document, and support breastfeeding practices and child development. Therefore, a new instrument—specifically a web-based application tailored to the needs of primary healthcare in Health Region 5—is needed.

This study has two primary objectives. First, it aims to develop a web-based application for primary healthcare providers in a selected district within Health Region 5, designed to streamline data management related to breastfeeding promotion and early childhood health. The application incorporates a back-end database to facilitate efficient data storage and retrieval. Second, the study seeks to evaluate the application's usability, functionality, and user satisfaction, ensuring that the platform effectively supports healthcare providers' workflows and aligns with their practical needs and expectations.

Materials and methods

1. Study design

This study employed a structured Software Development Life Cycle (SDLC) framework, a well-established method widely applied in software development and acquisition within health information technology (Elliott & Strachan, 2004; Endang et al., 2022; McMurtrey, 2013). The objective was to develop a web-based application to enhance breastfeeding promotion and early childhood healthcare services in a designated district within Health Region 5, Thailand. The study was conducted from June 2022 to September 2022, systematically progressing through four distinct phases: requirement analysis, design, testing, and evaluation.

1.1 Requirement analysis

This phase began with a comprehensive survey of the existing data management system utilized by primary healthcare providers in the targeted district. The study involved a database development process that included a basic needs assessment with a sample of 30 participants, as well as semi-structured, in-depth interviews from three staff members responsible for maternal and infant health promotion and child development, along with the director of sub-district health-promoting hospitals.

The collected data were analyzed to assess the current state of the database, with particular attention to budgetary feasibility, project sustainability, and strategic planning and design considerations. These considerations encompassed system safety, practical applicability in real-world field settings, a clearly defined scope and structure for data collection, and protocols for ongoing system maintenance. Notably, the 30 healthcare professionals who participated in this initial user-requirements analysis were distinct from those involved in the subsequent pilot implementation phase.

1.2 Design

The application was designed to incorporate a robust, user-friendly data recording system that captures critical information related to maternal and infant health, home visit records, and developmental milestones. To assess child development in accordance with national healthcare standards, the Developmental Surveillance and Promotion Manual (DSPM)—a standardized tool issued by Thailand's Ministry of Public Health—was adopted.

System design was guided by the requirement analysis and articulated through flowcharts and diagrams. The database architecture was developed using the Entity-Relationship Model (E-R) Model and the Unified Modeling Language (UML) Use Case Model. A Use Case Diagram, created with UML, illustrated the system's functionalities and user interactions, thereby facilitating effective communication between developers and end users (see Fig. 1). User roles were clearly delineated, including staff responsible for data entry and conducting home visits, managers overseeing data accuracy and generating reports, and system administrators managing user and database operations.

Additionally, an Entity-Relationship (ER) diagram was constructed to visually represent data entities and their relationships, including postpartum mothers, children, birth records, risk factors, visit activities, healthcare personnel, and recommended actions during visits (see Fig. 2). The database was implemented using PHP programming language and

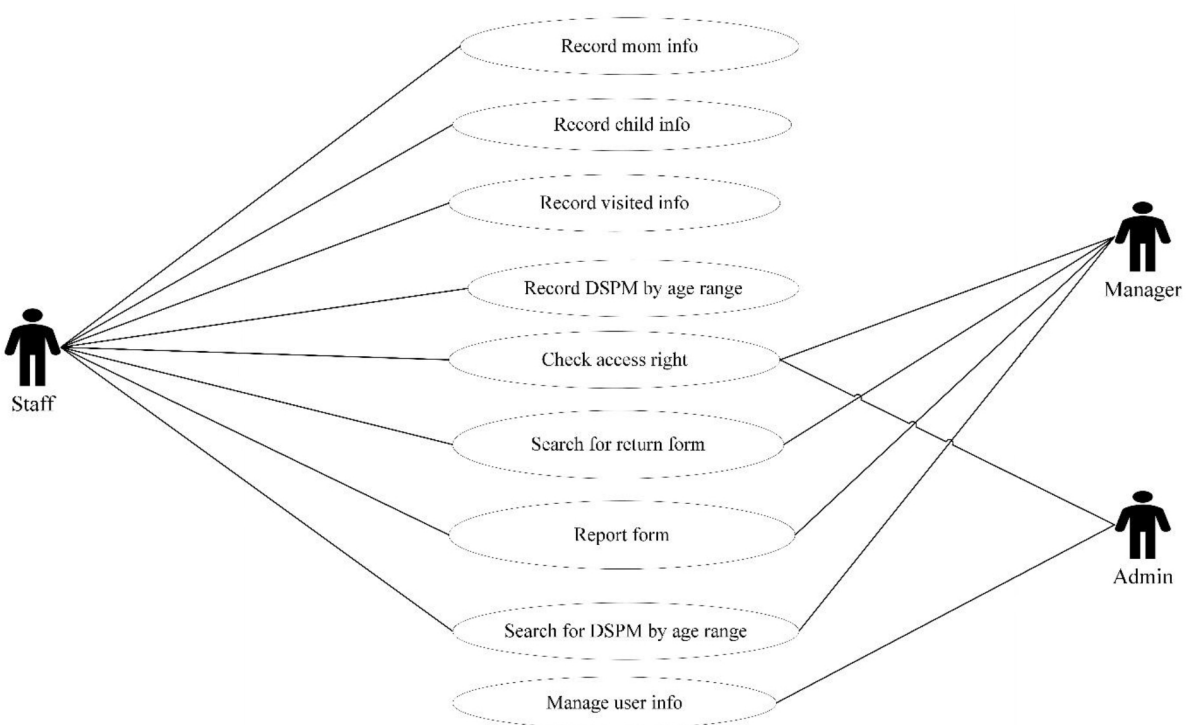

Fig. 1 Use case diagram illustrating system interactions

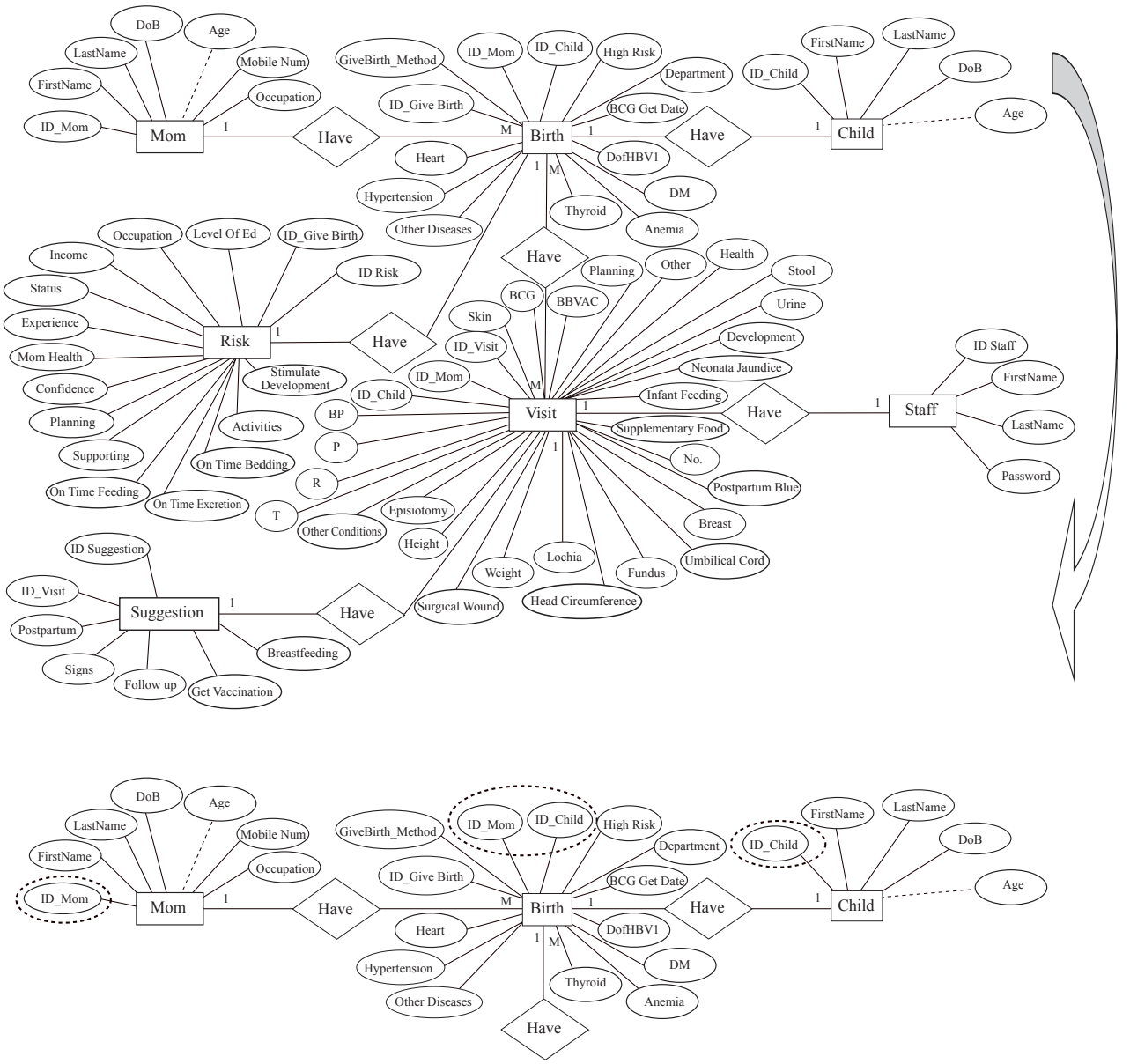

Fig. 2 Entity-relationship (ER) diagram illustrating database structure

MySQL server, with shared attributes enabling efficient data linkage and automated alerts for breastfeeding cessation risks and developmental delays.

1.3 Testing

Rigorous testing protocols were employed to identify and rectify functional errors, usability issues, and security vulnerabilities. This process included extensive data entry, data retrieval, and system security assessments to ensure the application's robustness and reliability.

The testing phase was conducted within primary care units in a selected district of Health Region 5, Thailand. The participants involved in both the testing and formal evaluation phases were the same: a team of 30 randomly selected primary health care providers from a total of 141. These individuals represented the target user group who would potentially use the web-based application in their daily practice.

The initial testing phase took place from June 1 to June 14, 2022, followed by the formal evaluation phase which was conducted from June 16 to June 30, 2022. During testing, participants were asked to perform a series of pre-defined tasks that mirrored typical workflows in their daily practice. These tasks included entering data for various categories, such as new postpartum mothers, infant weight measurements, and developmental milestones. Participants also retrieved records of existing patients to review medical histories and monitor progress. In addition, they were guided through system security assessments, which involved attempting to access restricted data or bypass login protocols to evaluate the system's protective features.

1.4 Evaluation

Evaluation of the developed web-based application was conducted using a structured 11-item questionnaire based on a 5-point Likert scale. The survey was administered to a sample of 30 randomly selected primary healthcare providers from a total of 141 potential users in the district, ensuring a representative assessment of user experience and satisfaction. The results provided valuable insights that informed subsequent refinements to improve the system's practicality and overall effectiveness.

2. Statistical analysis

The collected data were analyzed using descriptive statistical methods, including frequency distributions, percentages, and mean scores. These techniques provided clear and interpretable insights into user feedback and perceptions of system functionality.

3. Ethical considerations

Ethical approval for this study was granted by the Ethical Review Committee for Human Research, Research and Development Institute, Suan Dusit University (Approval Number: SDU-RDI-HS 2022-016).

Results and discussion

1. Results of the user-requirements analysis

1.1 Understanding the legacy system through a survey of the existing database

1.1.1 Demographics of the respondents

Thirty health-care professionals from health-promoting hospitals or primary care units participated in the survey. The majority were women (n = 22, 73.33%). Most held a bachelor's degree (n = 24, 80%), while six respondents (20%) possessed a master's degree or higher. The mean age was M = 38.39 years (SD = 8.59), and their average professional experience in breastfeeding or early-childhood services was M = 6.10 years (SD = 4.14).

1.1.2 The current status of the database

The breastfeeding promotion and early-childhood care service data are currently recorded in the HOSxP PCU platform. To assess this database, a survey was conducted among 30 healthcare professionals from health-promoting hospitals or primary care units within the study district as part of the user-requirements analysis. A quantitative appraisal of the database across seven dimensions, using a five-point Likert scale, revealed uniformly high ratings ($\bar{x}$ = 3.79–3.91).

The survey instrument evaluated data accuracy ($\bar{x}$ = 3.91, SD = 0.43), data currency ($\bar{x}$ = 3.91, SD = 0.37), data completeness for analysis and problem monitoring ($\bar{x}$ = 3.91, SD = 0.43), clarity of data storage and presentation ($\bar{x}$ = 3.79, SD = 0.56), utility of stored data for reporting key performance indicators ($\bar{x}$ = 3.79, SD = 0.56), data consistency ($\bar{x}$ = 3.85, SD = 0.61), and ease of verification ($\bar{x}$ = 3.82, SD = 0.57). These findings, detailed in Table 1, indicate that the current information infrastructure is perceived as reliable, up-to-date, and sufficiently comprehensive to support program monitoring and reporting. However, no information was found regarding factors indicating the risk of premature weaning or developmental delays in early childhood. These gaps will be further explored in the subsequent qualitative data analysis.

Table 1 Current condition of the breastfeeding and early childhood care promotion database

Items	$\bar{x}$	SD	Quality level
1. Accuracy of recorded data	3.91	0.43	high
2. Clarity of data storage and presentation	3.79	0.56	high
3. Consistency of the data	3.85	0.61	high
4. Ease of data verification	3.82	0.57	high
5. Currency of the data (up-to-date)	3.91	0.37	high
6. Completeness of stored data for analysis and issue monitoring	3.91	0.43	high
7. Utility of stored data for reporting key performance indicators	3.79	0.56	high

Remark: n = 30

1.1.3 Narrative summary of the in-depth interview findings

A qualitative requirement analysis was conducted through in-depth interviews with frontline staff of health-promoting hospitals and primary-care units as well as their managers. The discussion focused on two legacy information systems—one supporting breastfeeding services and the other dedicated to early childhood developmental surveillance. The interviews revealed several structural and operational deficiencies that limit effective data utilization and hinder service integration.

1) Breastfeeding information system

Postpartum home-visit activities are recorded using paper-based forms that replicate templates employed for other domiciliary services (e.g., bedridden patients, newly diagnosed diabetes, stroke cases). Due to the absence of digitization, these records cannot be systematically extracted for analysis or program monitoring. Consequently, staff are required to manually re-enter identical information into both the HOSxP PCU platform and the local health station database. Despite this duplication, the resulting electronic records remain inaccessible for retrieval or reporting purposes.

This inefficiency is exacerbated by constrained human resources:each facility typically designates a single focal officer for breastfeeding services and another for early childhood health, both of whom are responsible for multiple additional tasks. Facility managers underscored the need for an integrated database that could link breastfeeding, child health, and related service domains. Such a system, they argued, would significantly enhance efficiency and improve the utility of collected data.

2) Early childhood development database

Developmental status data are primarily embedded within outpatient medical records, yet the current database neither ingests these data nor supports query functionality. Information gathered during home visits—documented via the Developmental Surveillance and Promotion Manual (DSPM) forms and handwritten entries in caregivers' handbooks—remains fragmented and unaggregated. The system also fails to capture contextual variables known to influence developmental outcomes (e.g., socio-environmental factors), thereby limiting both clinical follow-up and broader population-level analysis.

Key informant interviews highlighted the operational burdens and systemic limitations. One staff member (Staff no.1) described the repetitive nature of data entry: "We use the same recording system as the home visit system for bedridden patients, new DM cases, stroke, some PP cases, or Thai COC. We enter data into the hospital system 2 times, the HOSxP system 3 times, visit the child 3 times, visit the mother 3 times, and enter home visit forms into the HOSxP system 3 times, which are 7, 14, and 45 days postpartum. However, the data entered into the system cannot be retrieved at all…" The same informant also emphasized the absence of critical variables: "There was no recording of factors influencing continuous breastfeeding and early childhood development."

1.2 Specification of additional system requirements

The user-needs assessment reveals two critical limitations. First, data recorded in the Ministry of Public Health's HOSxP database cannot be exported in a machine-readable file format, thereby hindering secondary analysis and data reuse. Second, home-visit activities continue to be documented on paper forms rather than captured electronically at the point of care. This reliance on manual records prevents the integrations of valuable information into the digital system and limits availability for evidence-based service enhancement.

2. Results from the design and development of a database to promote breastfeeding and early childhood care

The requirement analysis revealed critical bottlenecks in the existing information flow: data entered in the Ministry of Public Health's HOSxP platform could not be exported for secondary use, and home-visit encounters were still recorded on paper, leaving essential observations outside the digital record. These insights shaped the design brief for a custom-built database system. Guided by an integrative conceptual framework, the development team incorporated best-practice models of breastfeeding promotion, early-childhood developmental care

protocols, and contextual determinants that shape both behaviors. From this synthesis, a minimum data set was developed to support home-visit services—capturing maternal factors (e.g., lactation status, support networks), child-level indicators (e.g., weight, developmental milestones), and environmental variables known to influence outcomes.

The resulting web-based application, accessible at http://bf-dspm.com, enables authorized personnel to record visit details in real time and retrieve longitudinal records through a role-based interface. Data entered once are instantly available for clinical review, program monitoring, and analytics—eliminating duplicate entry and facilitating evidence-driven service improvements. Prototype screens illustrating the user workflow and dashboard functionality are shown in Fig. 3 to 5.

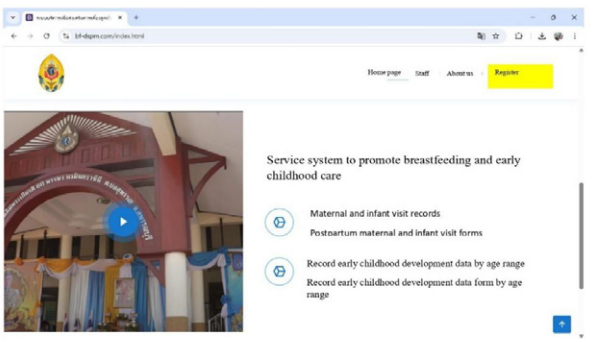

Fig. 3 System interface screenshot

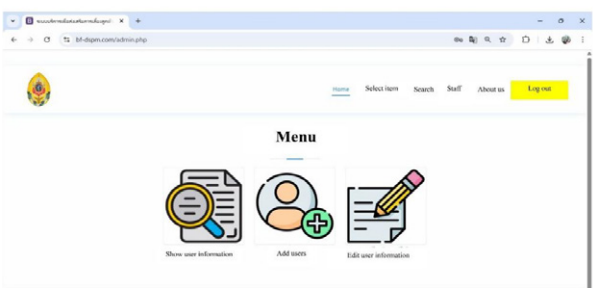

Fig. 4 Administrator workflow screen

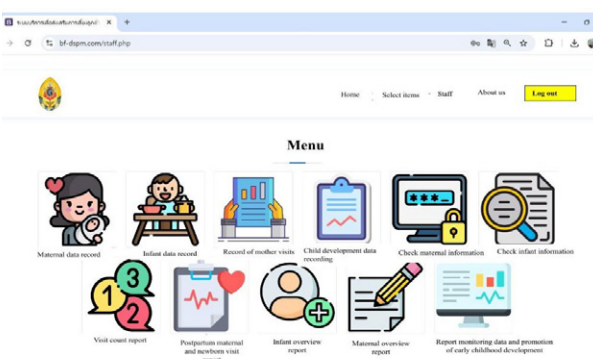

Fig. 5 User interface for data entry staff at login

Together, these design outcomes translate user-identified needs into a scalable digital infrastructure that enhances both breastfeeding support and early childhood developmental surveillance.

3. Results of the pilot implementation of the breastfeeding and early childhood care database

A field trial was conducted with 30 health care professionals to evaluate (i) the functional efficiency of the newly developed database and (ii) user satisfaction with its interface and outputs. The aggregate findings indicate consistently high levels of performance and user approval across all evaluation criteria (overall mean ≥ 3.79), as presented in Table 2.

Table 2 The evaluation results of the usage of the database for promoting breastfeeding and early childhood care

Item	$\bar{X}$	SD	Interpretation
Database efficiency			
1. On-screen prompts for data entry are clear and easily understood	3.91	0.43	Satisfactory
2. Data entry functions are user-friendly and responsive	3.79	0.56	Satisfactory
3. Information generated by the database is comprehensive and complete	3.85	0.61	Satisfactory
4. Information generated by the database can be readily verified for accuracy	3.82	0.57	Satisfactory
5. Database utilization ensures consistent, continuous, and up-to-date data storage	3.91	0.37	Satisfactory
6. The database can be employed for problem analysis and monitoring	4.24	0.75	Satisfactory
7. The database supports reporting against key performance indicators	4.09	0.83	Satisfactory
8. The system provides a high level of data access security	4.09	0.85	Satisfactory
User satisfaction			
9. The web page design is aesthetically pleasing and appropriate	4.09	0.63	Satisfactory
10. Use of the database saves working time	4.15	0.72	Satisfactory
11. Overall, the database is beneficial to users' work	4.10	0.60	Satisfactory
Overall	4.07	0.72	Satisfactory

Remark: n = 30

4. Implementation and maintenance

Implementation and maintenance were performed following updates to the database based on satisfaction evaluations from the pilot trial. Users were provided with a manual and informed that the system would be monitored and maintained for two years following the completion of the research project. During this period, users could request assistance or support from the system administrator.

The pilot implementation of the Unified Modeling Language (UML)-based database for breastfeeding promotion and early childhood care yielded consistently

positive quantitative and qualitative results. All eight technical performance items and three user satisfaction items were rated in the "satisfactory" range on a five-point scale. Regarding database efficiency, the highest mean score was recorded for the database's capacity to support problem analysis and monitoring ($\bar{x}$ = 4.24, SD = 0.75), while the lowest score within this category pertained to the user-friendliness and responsiveness of data entry functions ($\bar{x}$ = 3.79, SD = 0.56). For user satisfaction, the most notable attribute was the time saved through use of the database ($\bar{x}$ = 4.15, SD = 0.72). These outcomes demonstrate that the system not only meets functional specifications but also delivers tangible efficiency gains to frontline personnel.

The application's features are designed to directly promote breastfeeding and improve early child health through several key mechanisms. The real-time data access function enables healthcare providers to record home visit data and immediately view alerts related to factors affecting breastfeeding and child development. This instant access translates into clinical benefits by facilitating timely interventions. For instance, if the system detects a risk factor for premature weaning—such as inadequate maternal support or exposure to formula marketing, as highlighted by Cetthakrikul et al. (2022) and Cetthakrikul et al. (2024)—the healthcare provider can offer tailored counselling and support during the same visit. Drawing from the findings of Tomori et al. (2022) and Yang et al. (2024), the system facilitates the delivery of evidence-based support, which is essential for promoting and sustaining breastfeeding practices. Similarly, automated alerts for developmental delays, as identified through the Developmental Surveillance and Promotion Manual (DSPM) and supported by national policies (Department of Health, Ministry of Public Health, 2021), prompt early screening and intervention, ensuring that children receive timely support to achieve developmental milestones. The ability to retrieve data in PDF or Excel format enables seamless data sharing and collaboration among healthcare providers, enhancing the continuity of care.

Moreover, the web-based application strengthens data collection, analysis, and decision-making, aligning with the WHO's emphasis on accurate and accessible data for evidence-based decisions (World Health Organization, 2023). As Qian et al. (2021) suggest, mHealth platforms—including web-based applications—offer a promising strategy for real-time data collection, sharing, and analysis. By enabling efficient data management related to breastfeeding promotion and early childhood health, the application supports healthcare providers' workflows and meets practical needs. Factors such as maternal education, income level, exposure to infant formula marketing, social support systems, and workplace accommodations significantly influence breastfeeding practices (Tomori et al., 2022; Yang et al., 2024; Sezer et al., 2024). In addition, maternal physical and mental health conditions—including smoking, obesity, and depression—are associated with early breastfeeding cessation (Braithwaite et al., 2025; Kurui et al., 2023).

International evidence further corroborates the present findings. Østervang et al. (2024) reported "near excellent" usability (System Usability Scale = 83.6) for a newly deployed emergency department information system, highlighting real time save-state feedback as a critical determinant of user trust—an area flagged by our participants for refinement. Likewise, meta-analytic data indicate that digital interventions can double the odds of exclusive breastfeeding at 6 months in low- and middle-income countries (Thepha et al., 2024). While this study did not directly assess such outcomes, the developed platform provides an operational vehicle for scaling evidence based interventions by enabling real-time monitoring and tailored counselling. Comparable benefits have been documented in HIV care (Demir et al., 2024) and pandemic decision support (Komenda et al., 2022), underscoring the broader public health value of well-designed web-based applications.

This study aligns with prevailing research priorities in Thailand, which emphasize the essential role of structured health information systems in strengthening national healthcare under the Universal Coverage Scheme. The Ministry of Public Health demonstrated that well-designed informatics platforms enable evidence-based policymaking and efficient resource allocation—both critical to improving care quality (Ministry of Public Health, 2021). Further evidence shows that bespoke digital systems can markedly enhance service delivery in managing noncommunicable diseases such as chronic kidney disease. For example, Grechuta et al. (2024) found that clinical decision support systems (CDSSs), a key component of health informatics, offer support for monitoring noncommunicable diseases by providing personalized recommendations derived from comparing individual patient data to evidence-based guidelines. Extending these insights to maternal and child health (MCH), this study illustrates how a UML-driven software architecture can optimize clinical workflows

and improve the usability of collected data. A standout feature of the resulting system is its ability to generate Key Performance Indicator (KPI) reports automatically, supporting Thailand's shift toward performance-based budgeting. Reliable, consistently gathered data are the foundation of such budgeting reforms, enabling transparent monitoring and data-driven planning. Ultimately, this study confirms that intelligent information management can reduce administrative burdens and enhance care quality—echoing Mehta and Pandit's (2018) finding that big data analytics and decision support tools are pivotal for cost-efficient, high-quality healthcare delivery.

Methodologically, the mixedmethods design strengthens internal validity by triangulating Likertscale metrics with openended feedback. Nevertheless, two limitations temper generalizability: the sample was restricted to 30 health station staff in a single province, and the sixweek observation window may not capture longterm system reliability or cost trajectories. Selfreported time savings were not verified against objective workflow logs. Future research should therefore adopt multisite, longitudinal designs, integrate economic evaluations, and incorporate automated log file analysis to substantiate efficiency claims.

Practical implications follow logically from the data. First, the UML artefacts constitute a reusable blueprint for other MCH modules (e.g., immunization tracking), facilitating modular scalability. Second, mapping database entities to HL7 FHIR resources would enable bidirectional exchange with the national HOSxP platform, overcoming the current export barrier and enhancing interoperability. Third, adding offline functionality would extend the system's reach to remote areas with intermittent connectivity—an approach recommended in recent digital breastfeeding trials (Thepha et al., 2024). Finally, high ratings for access security must be safeguarded through continuous penetration testing and rolebased access controls as the user base expands.

Conclusion

This study presents credible evidence that a UMLbased, usercentered design approach can yield a highperforming and widely accepted information system for breastfeeding promotion and early childhood care. The convergence of robust quantitative ratings, affirmative qualitative feedback, and alignment with established information systems theory reinforces the study's validity. Considered alongside corroborating international and domestic literature, the findings indicate that the platform is both technically sound and practically advantageous. Addressing residual issues—such as savestate feedback and field label clarity—and conducting broader, longterm evaluations will further strengthen the system's value for MCH service delivery and policy planning.

References

Alamri, R.H., Alamri, M.H., Alamri, S.H., Mohammedkhalil, R.H., Alotaibi, S.S., Albalawi, A.O., … Alqarni, W.H. (2024). Comprehensive analysis of digital health technology: Assessing mobile health applications for managing chronic diseases and promoting patient engagement. *Journal of Ecohumanism, 3*(8), 6847–6858.

Ameyaw, E.K., Amoah, P.A., & Ezezika, O. (2024). Effectiveness of mHealth apps for maternal health care delivery: Systematic review of systematic reviews. *Journal of Medical Internet Research, 26,* e49510.

Braithwaite, E., Haftorn, K.L., Oftedal, A., Ayorech, Z., Kaasen, A., Murgatroyd, C., ... Bekkhus, M. (2025). *Associations between lifetime history of depression, OXTR DNA methylation and breastfeeding outcomes.* Retrieved from https://doi.org/10.31219/osf.io/6fxje

Carvalho, M.J.L.D.N., Carvalho, M.F., Santos, C.R.D., & Santos, P.T.D.F. (2022). First postpartum home visit: a protective strategy for exclusive breastfeeding. *Revista Paulista de Pediatria, 36,* 66-73.

Cetthakrikul, N., Kelly, M., Baker, P., Banwell, C., & Smith, J. (2022). Effect of baby food marketing exposure on infant and young child feeding regimes in Bangkok, Thailand. *International Breastfeeding Journal, 17*(1), 64.

Cetthakrikul, N., Voramongkol, N., Siritanaratkul, S., & Hangchaovanich, Y. (2024). Mothers' needs and wishes for breastfeeding support in workplaces in Thailand: A qualitative study. *International Breastfeeding Journal, 19*(1), 67.

Coo, S., García, M.I., & Prieto, F. (2024). Quality of mother-infant interaction, breastfeeding, and perinatal mental health. *Infant Behavior and Development, 75,* 101946. https://doi.org/10.1016/j.infbeh.2024.101946

Couto, G.R., Dias, V., & de Jesus Oliveira, I. (2020). Benefits of exclusive breastfeeding: An integrative review. *Nursing Practice Today, 7*(4), 245–254.

Cousminer, D.L., & Freathy, R.M. (2020). Genetics of early growth traits. *Human Molecular Genetics, 29,*(R1). R66–R72. https://doi.org/10.1093/hmg/ddaa149

Davie, J., Iannuccilli, K., Constantinescu, G., & Rieger, J. (2023). Clinician perspectives on the development of a web portal for remote monitoring of mHealth-facilitated dysphagia home exercise: A qualitative study. *International Journal of SpeechLanguage Pathology, 25*(6), 830–840.

Demir, E., Yakutcan, U., Adeoti, A.O., Isichei, C., & Adeyemi, S. (2024). Evaluating mobile health interventions for HIV patients in Nigeria: Healthcare policy implications from a simulation study. *Health Policy and Technology, 13*(6), 100937. https://doi.org/10.1016/j.hlpt.2024.100937

Department of Health, Ministry of Public Health, (2021). *Operation manual: Data collection and submission according to the Ministry of public health's standard health data structure, Version 2.4, Fiscal Year 2021.* Retrieved from https://dohdatacenter.anamai.moph.go.th/coverpage/ 7eb1b3118015b6b 3020 98 313b6b c2ac9.pdf

Elliott, G. & Strachan, J. (2004). *Global business information technology.* Retrieved from https://www.researchgate.net/publication/290179000Information_System_and_System_Development_Life_Cycle.

Endang, A.H., Riana, M.A., Jannah, M., & Malik, K. (2022). Home service information system design for health workers. *International Journal of Advanced Engineering Research and Science, 9*(7), 263–267.

Gadeberg, A.K., Nilsson, I., Christensen, U., Jacobsen, M.H., Rossau, H.K., & Villadsen, S.F. (2024). *How do home visits during pregnancy strengthen breastfeeding support postpartum? A realist evaluation of a large Danish breastfeeding intervention.* Retrieved from https://www.researchsquare.com/article/rs-4538634/latest

Grechuta, K., Shokouh, P., Alhussein, A., Müller-Wieland, D., Meyerhoff, J., Gilbert, J., ... Rolland, C. (2024). Benefits of clinical decision support systems for the management of noncommunicable chronic diseases: targeted literature review. *Interactive Journal of Medical Research, 13*(1), e58036.

Jansson, M., Herbert, E., Zalar, A., & Johansson, M. (2022). Childfriendly environments—What, how and by whom? *Sustainability, 14*(8), 4852. https://doi.org/10.3390/su14084852

Kahraman, S., & Havlioğlu, S. (2024). The effect of home nurse visits on infant weight and breastfeeding: Systematic review and meta-analysis. *International Journal of Nursing Practice, 30*(1), e13150. https://doi.org/10.1111/ijn.13150

Kamonratananun, N., Techamaitrechit, A., Saiboonsri, U., & Rattanaselanon, P. (2024). Health service system of breastfeeding promotion and early childhood care in primary care unit. *Suan Dusit Graduate School Academic Journal, 20*(2), 125–139. https://so19.tci-thaijo.org/index.php/SDUGSAJ/article/view/466

Kofler-Eshet, I., Stolar, O., Dichtiar, R., Dor, C., Eytan, D., & Sinai, T. (2023). Association between breastfeeding and autism spectrum disorders in toddlers–a case-control study. *Clinical Nutrition ESPEN, 54,* 673.

Komenda, M., Černý, V., Šnajdárek, P., Karolyi, M., & Mašek, J. (2022). Control centre for intensive care as a tool for effective management of ICU capacities in the Czech Republic during the COVID19 pandemic: Development and deployment study. *Journal of Medical Internet Research, 24*(2), e33149. https://doi.org/10.2196/33149

Krupa, O., Rybak, D., Kamińska-Omasta, K., Omasta, B., Romańczuk, K.B., Czerska, M.A., ... Furtak, K. (2025). A systematic review on the impact of breastfeeding on cancer risk, weight loss, cardiovascular disease, type 2 diabetes mellitus in mothers, and the role of fathers, medical personnel and training in breastfeeding. *Quality in Sport, 37,* 57660–57660. https://doi.org/10.12775/QS.2025.37.57660

Kurui, R., Bor, W., & Mituki, D. (2023). Evaluating the relationship between maternal postpartum depression, infant feeding practices, and infant nutritional status at a maternity hospital in Uasin Gishu County, Kenya. *African Journal of Nutrition and Dietetics, 1*(1), 49. https://doi.org/10.58460/ajnd.v1i1.49

Lubis, P.N., Saputra, M., & Rabbani, M.W. (2024). A systematic review of the benefits of breastfeeding against postpartum depression in low-middle-income countries. *Journal of Mental Health, 34*(3), 305–317. https://doi.org/10.1080/09638237.2024.2361232

McMurtrey, M.E. (2013). A case study of the application of the systems development life cycle (SDLC) in 21stcentury health care: Something old, something new? *Journal of the Southern Association for Information Systems, 1*(1), 14–25.

Mehta, N., & Pandit, A. (2018). Concurrence of big data analytics and healthcare: A systematic review. *International Journal of Medical Informatics, 114,* 57–65. https://doi.org/10.1016/j.ijmedinf.2018.03.013

Ministry of Higher Education, Science, Research and Innovation of Thailand. (2022). *Notification of the ministry of higher education, science, research and innovation re: Classification of institutions of higher education in the fiscal year 2564.* Retrieved from http://plan.tru.ac.th/download/2564/ประกาศจัดกลุ่มมหาวิทยาลัย%202564.pdf

Ministry of Public Health. (2021). *Digital health strategy, ministry of public health (2021 – 2025).* Retrieved from https://ict.moph.go.th/upload_file/files/97c2287c8f04e13f81fec13e431e7a5e.pdf

Miolski, J. (2023). Benefits of breastfeeding for mother and child. *Sanamed, 18*(1), 59–63.

Miranda, A.R., Barral, P.E., Scotta, A.V., Cortez, M.V., & Soria, E.A. (2025). An overview of reviews of breastfeeding barriers and facilitators: Analyzing global research trends and hotspots. *Global Epidemiology,* 100192. https://doi.org/10.1016/j.gloepi.2025.100192

Mohapatra, I., & Samantaray, S.R. (2023). Breastfeeding and environmental consciousness: A narrative review of environmental implications and potential contributions to reduce waste and energy consumption. *Cureus 15*(9), e45878. https://doi.org/10.7759/cureus.45878

National statistical office of Thailand. (2023). *Thailand multiple indicator cluster survey 2022: Survey findings report.* Retrieved from https://www.unicef.org/thailand/media/11046/file/Annual%20Report%202022_EN.pdf

National statistical office & United nations children's fund. (2016). *Thailand multiple indicator cluster survey 2015–2016: Final report.* Retrieved from https://mics-surveys-prod.s3.amazonaws.com/MICS5/East%20Asia%20and%20the%20Pacific/Thailand/2015-2016/Survey%20findings/Thailand%202015-16%20MICS_National%20(English).pdf

Nigussie, Z.Y., Zemicheal, N.F., Tiruneh, G.T., Bayou, Y.T., Teklu, G.A., Kibret, E.S., ... Betemariam, W.A. (2021). Using mHealth to improve timeliness and quality of maternal and newborn health in the primary health care system in Ethiopia. *Global Health: Science and Practice, 9*(3), 668-681. https://doi.org/10.9745/GHSP-D-20-00408

Østervang, C., Jensen, C.M., Coyne, E., Dieperink, K.B., & Lassen, A. (2024). Usability and evaluation of a health information system in the emergency department: Mixedmethods study. *JMIR Human Factors, 11*(1), e48445. https://doi.org/10.2196/48445

Qian, J., Wu, T., Lv, M., Fang, Z., Chen, M., Zeng, Z., ... Zhang, J. (2021). The value of mobile health in improving breastfeeding outcomes among perinatal or postpartum women: systematic review and meta-analysis of randomized controlled trials. *JMIR mHealth and uHealth, 9*(7), e26098. https://doi.org/10.2196/26098

Romm, K.L., Skoge, M., Barrett, E.A., Berentzen, L.C., Bergsager, D., Fugelli, P., ... Aminoff, S.R. (2025). A mobile health intervention to support collaborative decision making in mental health care: Development and usability. *JMIR Formative Research, 9*(1), e57614. https://doi.org/10.2196/57614

Sezer, H.K., Ceran, M.A., Demirsoz, M., & Kucukoglu, S. (2024). Development and psychometric evaluation of the paternal support scale of breastfeeding. *Journal of Pediatric Nursing, 75,* 149–157. https://doi.org/10.1016/j.pedn.2023.10.004

Thepha, T., Carr, G., Marais, D., Kuasri, J., Klangphaow, K., & Tangpukdee, J. (2024). The effectiveness of digital health versus standard care on exclusive breastfeeding duration among postpartum mothers in LMIC: Systematic review and meta-analysis. *Digital Health, 10,* 20552076241309520. https://doi.org/10.1177/20552076241309520

Tiruneh, G.T., Shiferaw, C.B., & Worku, A. (2019). Effectiveness and cost-effectiveness of home-based postpartum care on neonatal mortality and exclusive breastfeeding practice in low-and-middle-income countries: a systematic review and meta-analysis. *BMC Pregnancy and Childbirth, 19*(1), 1-19. https://doi.org/10.1186/s12884-019-2651-6

Tomori, C., HernándezCordero, S., Busath, N., Menon, P., & PérezEscamilla, R. (2022). What works to protect, promote and support breastfeeding on a large scale: A review of reviews. *Maternal & Child Nutrition, 18,* e13344. https://doi.org/10.1111/mcn.13344

Wang, W., An, Q., Huang, K., Dai, Y., Meng, Q., & Zhang, Y. (2024). Unlocking the power of Lactoferrin: Exploring its role in early life and its preventive potential for adult chronic diseases. *Food Research International, 182,* 114143. https://doi.org/10.1016/j.foodres.2024.114143

Wang, Z. (2023). Research on the influence of family factors on children's psychological health. *Lecture Notes in Education Psychology and Public Media, 23,* p.155. https://doi.org/10.54254/2753-7048/23/20230427

World health organization. (2023). *Infant and young child feeding.* Retrieved from https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding -10665/258734/9789241564052-eng.pdf

World health organization. (2018). *WHO and UNICEF issue new guidance to promote breastfeeding in health facilities globally.* Retrieved from https://www.who.int/news/item/11-04-2018-who-and-unicef-issue-new-guidance-to-promote-breastfeeding-in-health-facilities-globally

Yang, Y., Liu, H., Cui, X., & Meng, J. (2024). Mothers' experiences and perceptions of breastfeeding peer support: A qualitative systematic review. *International Breastfeeding Journal, 19*(1), 7. https://doi.org/10.1186/s13006-024-00620-y