

DEVELOPMENT AND CONTENT VALIDATION OF THE BABYLITE MOBILE APPLICATION TO SUPPORT STIMULATION IN INFANTS WITH LOW BIRTH WEIGHT IN INDONESIA

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ABSTRACT

Background: Infants born with low birth weight (LBW) face elevated risks of developmental delays, particularly in resource-limited settings where access to early stimulation services is often inadequate. In Indonesia, there is a lack of culturally tailored digital tools to guide caregivers in providing evidence-based stimulation for LBW infants.

Objective: This study aimed to develop and validate the content of *BabyLite*, a mobile application designed to support caregivers in delivering structured developmental stimulation to infants with LBW in the Indonesian context.

Methods: A research and development approach was used, incorporating literature review, stakeholder input, and expert panel validation. The application's content was mapped across five developmental domains and developed using Android SDK and Firebase technologies. Nine multidisciplinary experts in pediatric nursing, neonatology, child psychology, and digital health assessed 24 items using a 4-point Likert scale. Content validity was analyzed using the Item-Level Content Validity Index (I-CVI), Scale-Level CVI (S-CVI/Ave), and Modified Kappa statistics.

Results: I-CVI values ranged from 0.89 to 1.00, while the S-CVI/Ave was 0.96, indicating excellent content validity. Modified Kappa values ranged from 0.83 to 1.00, signifying strong expert agreement. Experts rated the app highly in terms of relevance, clarity, and cultural appropriateness. Suggestions for interface refinement and additional features were integrated into the final version.

Conclusions: The *BabyLite* application demonstrated strong content validity and represents a promising mHealth intervention for early stimulation among LBW infants in Indonesia. Future studies should evaluate its usability, caregiver engagement, and impact on developmental outcomes through pilot testing and longitudinal assessment.

Keywords: low birth weight, infant development, mobile health, early stimulation, content validation, Indonesia

INTRODUCTION

Low birth weight (LBW), defined as a birth weight of less than 2,500 grams, continues to pose serious challenges to neonatal and long-term health, particularly in low- and middle-income countries (World Health Organization [WHO], 2019). Infants born with LBW are biologically vulnerable and face a significantly increased risk of mortality, delayed growth, impaired cognitive function, and neurodevelopmental disorders. In Indonesia, recent national reports have indicated that LBW prevalence remains a persistent problem, contributing to over 10% of neonatal deaths annually and posing substantial long-term burdens on families

and health systems (Ministry of Health of Indonesia, 2020).

Scientific evidence supports the importance of the early postnatal period—particularly the first 1,000 days of life as a critical window for neurodevelopment. During this time, neural plasticity is at its peak, and targeted stimulation can produce significant improvements in motor, sensory, cognitive, and socio-emotional domains (Rao et al., 2020; Muñoz-Vázquez et al., 2021). For LBW infants, early stimulation programs are not merely beneficial but often essential. These programs aim to counteract the developmental risks associated with intrauterine growth restriction, preterm birth, and early-life nutritional deficits (Upadhyay et al., 2020).

Despite the recognized importance of early stimulation, caregivers, especially in Indonesia's rural or underserved regions frequently lack access to structured educational support. Several qualitative and survey-based studies in Indonesia have found that mothers of LBW infants often report confusion, anxiety, and uncertainty about how to provide developmentally appropriate stimulation at home (Nurcahyani et al., 2022; Nugraheni et al., 2023). This gap in caregiver knowledge and confidence underscores the pressing need for accessible, evidence-based, and contextually relevant health education tools.

In recent years, digital health innovations, including mobile health (mHealth) applications, have emerged as viable platforms for delivering maternal and child health interventions, especially in low-resource settings. mHealth solutions are increasingly being leveraged to improve access to information, facilitate behavior change, and promote early intervention for at-risk populations (Chaiyachati et al., 2020; Sekhon et al., 2022). Studies have shown that mobile applications focusing on early childhood development can enhance parental knowledge, encourage the implementation of structured stimulation activities, and even support developmental tracking and referrals (Goh et al., 2021; Rahman et al., 2023). Moreover, mobile platforms have the advantage of scalability, cost-efficiency, and the ability to reach geographically remote areas.

However, while numerous mobile applications exist globally for early childhood development, few have been tailored specifically for the needs of LBW infants. Even fewer have undergone formal validation by health experts to ensure content accuracy and cultural relevance, particularly in the Indonesian context. A scoping review by Kurniawan et al. (2023) emphasized that most currently available mHealth apps are generic in nature, not guided by standardized developmental frameworks, and often developed without participatory input from healthcare professionals or end users. Furthermore, Lee et al. (2021) and Bakar et al. (2022) highlight that mobile health applications

lacking expert validation may present inaccurate content, leading to misinformation or ineffective practices by caregivers.

The lack of localized, validated digital tools presents a critical gap in efforts to support the optimal development of LBW infants in Indonesia. Moreover, given the cultural values embedded in parenting and child-rearing in Indonesia such as communal care, spiritual beliefs, and respect for tradition interventions must be carefully adapted to be acceptable and engaging to local users (Nurcahyani et al., 2022). These contextual considerations are essential to ensure the usability and adoption of any health application.

In response to these challenges, the present study aimed to develop and validate the BabyLite mobile application, an Android-based tool specifically designed to support caregivers of infants with low birth weight in Indonesia. The application includes evidence-based content on stimulation techniques, developmental milestone tracking, educational videos, and daily activity prompts. This study focuses on the initial development phase and expert content validation, assessing the relevance, clarity, and appropriateness of each feature using established methods. Through this effort, we seek to bridge the gap between scientific knowledge and accessible, culturally appropriate digital tools to promote better neurodevelopmental outcomes in one of the country's most vulnerable infant populations.

METHOD

Study Design

This study employed a research and development (R&D) design, following the Design and Development Model adapted from the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation). The present phase focused on the development and expert content validation of the *BabyLite* mobile application aimed at supporting stimulation in infants with low birth weight (LBW). The validation stage used a quantitative descriptive design to assess the

relevance and clarity of the app content based on expert judgment.

Development Process

The development of the BabyLite mobile application followed a systematic and iterative process grounded in instructional design principles and digital health innovation. The initial phase involved a comprehensive needs assessment. This was conducted through an integrative literature review, in-depth interviews with pediatric nurses and early childhood development specialists, and an analysis of national and international guidelines, including those from the World Health Organization and the Indonesian Ministry of Health. The aim was to identify existing gaps in caregiver knowledge and barriers to delivering effective developmental stimulation to infants with low birth weight (LBW).

Based on this analysis, the application's structure was conceptualized to include key features aligned with developmental domains. The design included daily stimulation prompts, growth milestone tracking, video-based instructional content, and caregiver-focused educational modules. All content was organized across five core developmental domains: gross motor, fine motor, cognitive, language, and socio-emotional development. The interface was developed to be intuitive and accessible to caregivers with varying levels of digital literacy, incorporating culturally appropriate imagery and language.

The development stage involved the use of the Android Software Development Kit (SDK) and the Kotlin programming language, implemented in Android Studio. Firebase was utilized for backend support, allowing cloud-based data storage and content updates. Multimedia formats—such as text, illustrated guides, and short videos—were embedded to enhance user engagement and comprehension. The content was carefully reviewed to ensure cultural and linguistic appropriateness for Indonesian users, particularly caregivers from low-resource settings.

Following the development of the prototype, expert validation was carried out

to ensure the accuracy, clarity, and relevance of the educational content. This validation constituted the first evaluation phase and involved a panel of domain experts in pediatric nursing, child development, and digital health. The experts independently reviewed the content using a structured validation tool, and the results were analyzed using the Content Validity Index (CVI) and Modified Kappa Statistics to determine the degree of agreement and content adequacy. This validation ensured that the BabyLite application met both scientific standards and contextual needs for effective use in the Indonesian setting.

Participants

A total of nine subject matter experts were purposively selected to participate in the validation process. The panel consisted of three pediatric nursing specialists, two pediatricians with experience in low birth weight (LBW) care, two child development psychologists, and two health promotion experts with digital health expertise. All experts met the inclusion criteria: holding at least a master's degree in a relevant field, having a minimum of five years of professional experience, and being familiar with early childhood intervention or digital health tools.

Instruments

The content validation instrument consisted of a structured checklist developed based on previous mHealth validation studies and was tailored to reflect the specific features of the BabyLite application. Experts were asked to evaluate each item across two core dimensions: relevance, which referred to the appropriateness and usefulness of the content for caregivers of low birth weight (LBW) infants, and clarity, which reflected the comprehensibility and cultural suitability of the information provided. A 4-point Likert scale was used for scoring, where 1 indicated "Not Relevant / Not Clear," 2 represented "Needs Major Revision," 3 denoted "Needs Minor Revision," and 4 indicated "Very Relevant / Very Clear."

Data Analysis

To analyze the expert ratings, the Item-level Content Validity Index (I-CVI) was computed by dividing the number of experts who rated each item as either 3 or 4 by the total number of experts. The Scale-level Content Validity Index using the average method (S-CVI/Ave) was calculated as the mean of all I-CVI scores across the checklist. To assess the degree of inter-rater agreement beyond chance, the Modified Kappa statistic (k^*) was applied in accordance with the methodology recommended by Polit et al. (2007). Acceptability thresholds for strong content validity were set at I-CVI ≥ 0.78 (for panels of 6 to 10 experts), S-CVI/Ave ≥ 0.90 , and $k^* \geq 0.74$, which indicate excellent agreement among raters.

RESULTS

App Architecture

The BabyLite application was developed using a modular architecture designed to support offline functionality and user scalability. The client-side interface was built on Android SDK (API level ≥ 21) using Kotlin, while the server-side database was managed through

Firebase Realtime Database for secure data handling and real-time content delivery. The application comprises four main modules: the user dashboard, which provides a personalized overview of the infant's progress and daily activity suggestions; the developmental stimulation module, which contains categorized activities aligned with the five key domains of child development—gross motor, fine motor, cognitive, language, and social-emotional—with each activity supported by multimedia guides including text, images, and embedded videos; the tracking and milestones module, which allows caregivers to record developmental achievements and view recommended age-based tasks; and the education center, which offers short, evidence-based health education tips for caregivers on topics such as feeding practices, sleep hygiene, and stress management. The app integrates push notifications, progress badges, and offline caching, enabling users to access critical content without continuous internet access. All educational content was written in Bahasa Indonesia and culturally adapted to align with Indonesian parenting norms, ensuring both accessibility and contextual relevance.

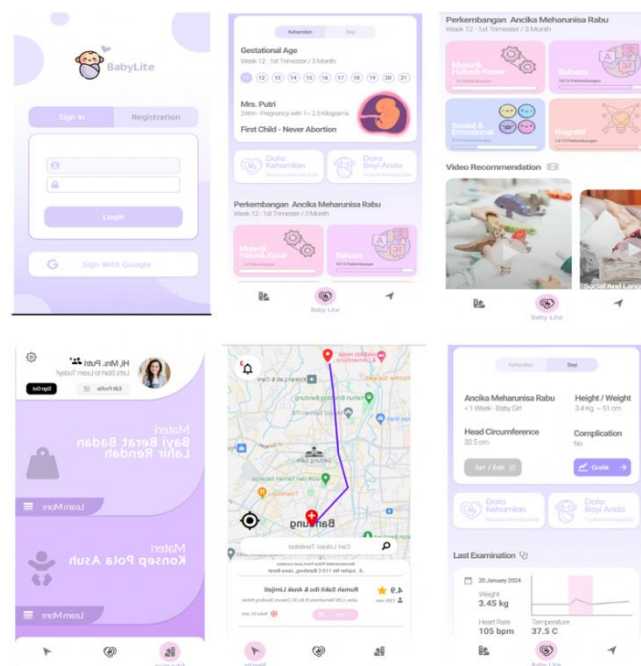


Figure 1. prototype of BayLite application

The validation instrument assessed 24 core content items covering developmental stimulation content, instructional clarity, cultural appropriateness, and user guidance. The Item-Level Content Validity Index (I-CVI) ranged from 0.89 to 1.00, indicating a high degree of relevance across all items. The Scale-Level CVI (S-CVI/Ave) was 0.96, meeting the threshold for excellent content validity. The Modified Kappa (k) statistics* ranged from 0.83 to 1.00, signifying excellent inter-rater agreement among experts. Items with a k* value above 0.74 are considered to have strong agreement beyond chance, supporting the overall consistency and trustworthiness of the expert ratings (Table 1).

Table 1. Content Validation Results for BabyLite Application (n = 9 Experts)

Item	Relevance (Mean ± SD)	Clarity (Mean SD)	I- ± CVI	Modified Kappa (k)*	Category
Gross motor stimulation guidance	3.89 ± 0.33	3.78 ± 0.44	1.00	1.00	Excellent
Fine motor stimulation guidance	3.78 ± 0.44	3.67 ± 0.50	1.00	1.00	Excellent
Cognitive activity content	3.78 ± 0.44	3.56 ± 0.53	0.89	0.83	Acceptable
Language development module	3.89 ± 0.33	3.67 ± 0.50	1.00	1.00	Excellent
Socio-emotional stimulation activities	3.78 ± 0.44	3.78 ± 0.44	1.00	1.00	Excellent
Cultural appropriateness of content	3.89 ± 0.33	3.89 ± 0.33	1.00	1.00	Excellent
Language and translation clarity	3.78 ± 0.44	3.56 ± 0.53	0.89	0.83	Acceptable
Instructional language for caregivers	3.89 ± 0.33	3.78 ± 0.44	1.00	1.00	Excellent
Visual presentation and layout	3.67 ± 0.50	3.56 ± 0.53	0.89	0.83	Acceptable
Multimedia (video/image) integration	3.78 ± 0.44	3.78 ± 0.44	1.00	1.00	Excellent
Daily stimulation schedule feature	3.89 ± 0.33	3.67 ± 0.50	1.00	1.00	Excellent
Developmental milestone tracker	3.78 ± 0.44	3.56 ± 0.53	0.89	0.83	Acceptable
Personalization and feedback messages	3.67 ± 0.50	3.56 ± 0.53	0.89	0.83	Acceptable
Educational tips on nutrition, sleep, hygiene	3.89 ± 0.33	3.89 ± 0.33	1.00	1.00	Excellent
Ease of navigation (user interface)	3.78 ± 0.44	3.78 ± 0.44	1.00	1.00	Excellent
Offline accessibility of main features	3.89 ± 0.33	3.78 ± 0.44	1.00	1.00	Excellent
Help/tutorial feature for first-time users	3.56 ± 0.53	3.56 ± 0.53	0.89	0.83	Acceptable
Reminder/notification system	3.78 ± 0.44	3.67 ± 0.50	1.00	1.00	Excellent
Suitability for low-literacy users	3.56 ± 0.53	3.56 ± 0.53	0.89	0.83	Acceptable

Item	Relevance (Mean $\pm$ SD)	Clarity (Mean SD)	I- $\pm$ CVI	Modified Kappa (k*)	Category
Cultural inclusiveness of illustrations	3.78 $\pm$ 0.44	3.67 $\pm$ 0.50	1.00	1.00	Excellent
Consistency with national child development guidelines	3.89 $\pm$ 0.33	3.78 $\pm$ 0.44	1.00	1.00	Excellent
Evidence-based content foundation	3.89 $\pm$ 0.33	3.89 $\pm$ 0.33	1.00	1.00	Excellent
Appropriateness for caregivers of LBW infants	3.89 $\pm$ 0.33	3.89 $\pm$ 0.33	1.00	1.00	Excellent
Overall usefulness of the application	3.89 $\pm$ 0.33	3.89 $\pm$ 0.33	1.00	1.00	Excellent

Note: I-CVI values ≥ 0.78 indicate acceptable relevance. Modified Kappa (k*) values ≥ 0.74 indicate excellent agreement (Polit et al., 2007).

DISCUSSION

This study presents the systematic development and expert content validation of BabyLite, a mobile-based digital intervention aimed at supporting early developmental stimulation in infants with low birth weight (LBW) in Indonesia. The validation outcomes revealed high relevance and clarity of content, as reflected in the outstanding I-CVI and Modified Kappa values across the assessed domains. These findings suggest that BabyLite meets rigorous content standards and is well-positioned for implementation among caregivers of LBW infants in diverse Indonesian settings.

The integration of evidence-based stimulation modules into a mobile application addresses a critical service delivery gap in early childhood development, particularly for vulnerable populations. In rural and resource-limited communities, where access to pediatric developmental specialists is limited, caregivers often lack structured information and professional guidance on how to provide effective stimulation to LBW infants (Nurcahyani et al., 2022; Nugraheni et al., 2023). Previous studies have shown that without timely intervention, LBW infants face significant developmental delays across cognitive, motor, and socio-emotional domains (Rao et al., 2020; Muñoz-Vázquez et al., 2021). BabyLite responds to this urgent need by

translating global recommendations into localized, accessible, and interactive digital content.

The strong content validity achieved in this study aligns with prior research on mHealth development, which emphasizes that expert review is essential during early stages of app design to ensure clinical accuracy, contextual fit, and pedagogical effectiveness (Lee et al., 2021; Bakar et al., 2022). Beyond clinical validation, the BabyLite app also reflects important cultural considerations. The content was adapted to match local caregiving norms, using visual and linguistic elements that resonate with Indonesian users. Cultural and linguistic alignment has been shown to significantly increase app acceptability, engagement, and impact—yet this aspect is frequently overlooked in global digital health innovations (Rahman et al., 2023).

Furthermore, the application's architecture was intentionally designed to accommodate infrastructure limitations commonly found in LMICs. By supporting offline functionality and ensuring lightweight data use, BabyLite enhances its feasibility in low-connectivity areas. This strategy is supported by mHealth implementation frameworks, which identify offline access, simplicity of use, and low data burden as key facilitators for adoption in underserved populations (Chaiyachati et al., 2020; Sekhon et al., 2022).

A distinctive strength of BabyLite is its inclusion of interactive tools, such as milestone tracking, daily prompts, and caregiver learning feedback. Rather than passively delivering information, the app enables caregivers to monitor progress and engage in behaviorally reinforcing activities. This approach aligns with self-efficacy and behavior change models that are foundational to effective digital health interventions (Bandura, 2004; Goh et al., 2021). By encouraging active caregiver involvement, BabyLite not only imparts knowledge but also fosters a sense of competence and motivation—key factors in sustaining caregiving behavior over time.

Nevertheless, the current study has limitations. First, the validation process was confined to expert-based content evaluation, which, while methodologically sound, does not capture the full scope of user experience or behavioral effectiveness. Usability testing with caregivers, especially from varied literacy levels and rural contexts, is essential to assess navigability, engagement, and real-world application of the app. Second, although BabyLite is built upon evidence-informed developmental principles, its impact on actual child developmental outcomes remains to be tested. Longitudinal or randomized controlled trials are needed to determine whether app-guided stimulation translates into measurable developmental gains in LBW infants.

Future research should therefore focus on pilot implementation, including real-world usability testing, acceptability evaluation, and behavioral impact assessment. Monitoring changes in caregiver confidence, frequency of stimulation practices, and developmental progress of infants will provide essential insights into the app's effectiveness. Additionally, integrating feedback mechanisms, such as chat features or referral pathways, may further enhance user engagement and clinical relevance.

Despite these limitations, the study offers a valuable contribution to the field of maternal-child digital health. It provides a replicable model of rigorous app development that combines evidence-based content, expert validation, and

cultural adaptation. As Indonesia continues to face a high burden of LBW-related developmental risks, scalable tools such as BabyLite represent an innovative and context-sensitive solution to strengthen early childhood outcomes through empowered caregiving.

CONCLUSION

The development and expert validation of the BabyLite mobile application mark a significant step forward in addressing the need for structured, accessible, and culturally relevant stimulation guidance for caregivers of low birth weight (LBW) infants in Indonesia. The high content validity scores obtained from a multidisciplinary expert panel underscore the relevance, clarity, and contextual appropriateness of the application's content. By leveraging mobile technology and integrating key features such as milestone tracking, multimedia stimulation guides, and offline accessibility, BabyLite presents a feasible and scalable tool to enhance caregiver support and promote optimal early development in vulnerable infants. Future research should explore its usability, caregiver engagement, and potential impact on child development outcomes through pilot implementation and longitudinal evaluation.

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Ethics Statement

Ethical approval for this study was obtained from the Health Research Ethics Committee. All expert participants provided written informed consent prior to participation. The study did not involve clinical testing with human subjects or collection of identifiable user data during

app development. Data collected during the validation process were anonymized and used solely for research purposes.

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