

Original Paper

Human-Centered Baby Massage Mobile App for Low Birth Weight Infants: Usability Testing and a Pre-Post Pilot Intervention Study in Indonesia

Supriatin Supriatin¹, M.Kep; Regidor III Dioso², PhD; Hafizah Che Hassan², PhD

¹STIKes Cirebon, Cirebon, Jawa Barat, Indonesia

²Lincoln University College, Petaling Jaya, Malaysia

Corresponding Author:

Supriatin Supriatin, M.Kep

STIKes Cirebon

Jl. Brigjend Dharsono No.12b, Kertawinangun

Kec. Kedawung

Cirebon, Jawa Barat, 45153

Indonesia

Phone: 62 877 8877 77

Email: supriatinsupriatinstikes@gmail.com

Abstract

Background: Low birth weight (LBW) is associated with increased risks of neonatal morbidity, developmental delays, and long-term health problems. Although baby massages have been shown to improve growth and neurodevelopmental outcomes in LBW infants, access to suitable training and adherence to massage protocols remain challenging, particularly in low-resource settings. Mobile health interventions may help address these gaps by providing scalable and standardized education on infant massage.

Objective: This study aimed to design and evaluate a human-centered baby massage mobile app to support the growth and development of LBW infants in Indonesia.

Methods: A human-centered iterative design approach was used to develop the mobile app. Usability was assessed using the System Usability Scale among 42 caregivers of LBW infants. Qualitative data were collected through semistructured interviews and analyzed thematically to understand user experience. A pilot pre-post intervention study was conducted to evaluate the impact of the app on caregivers' knowledge, confidence, adherence to baby massage practices, and infant growth outcomes. Pre- and postintervention measures were compared.

Results: The app demonstrated high usability, with a mean System Usability Scale score of 78.6 (SD 8.2), indicating good usability (≥ 68). Most participants rated the app as "excellent" or "good." Qualitative findings highlighted improved caregiver confidence and ease of learning massage techniques. Statistically significant improvements were observed in caregiver knowledge (mean difference 20.5 points; $P=.002$), confidence (21.6 points; $P=.001$), and adherence to recommended massage practices (20.3 points; $P=.02$). Infant outcomes also improved, including weight gain (mean increase 330 g; $P=.003$) and head circumference (mean increase 1.3 cm; $P=.004$).

Conclusions: The human-centered baby massage mobile app showed promising feasibility and effectiveness in improving caregiver knowledge, confidence, and adherence to infant massage practices. The app provides a culturally appropriate and user-friendly tool to support early interventions for LBW infants in resource-limited settings.

(JMIR Pediatr Parent 2026;9:e73153) doi: [10.2196/73153](https://doi.org/10.2196/73153)

KEYWORDS

low birth weight; baby massage; mobile health; human-centered design; infant growth

Introduction

Low birth weight (LBW), defined by the World Health Organization as a birthweight less than 2500 g, remains a substantial global public health challenge [1]. LBW is a critical indicator of neonatal morbidity and mortality, with an estimated 15% to 20% of all births worldwide classified as LBW, representing more than 20 million births annually [2]. The burden of LBW is prevalent in South Asia and sub-Saharan Africa, with 44% and 28% of LBW cases globally, respectively [3]. In Indonesia, the prevalence of LBW ranges from approximately 6% to 10% of all live births, according to national health surveys and global estimates [4,5]. LBW can pose several health risks for infants, such as stunted growth, neurodevelopmental delays, and an increased risk of infections and chronic diseases [6,7]. Such challenges underscore the urgent need for effective interventions to mitigate the long-term sequelae associated with LBW.

Existing interventions for LBW infants can be divided into methods such as kangaroo mother care (KMC) [8,9] and those that use modern technology [10-12]. KMC refers to holding the infant in skin-to-skin contact with the caregiver and has been widely adopted in low- and middle-income countries because of its practicality and effectiveness [8]. However, its reliance on continuous physical contact can be impractical for caregivers, especially in resource-limited settings. Complementary nonpharmacological techniques, including baby massages, have potential benefits, but this procedure usually necessitates training and routine practice, which often remain inaccessible [13].

Baby massages, a form of touch intervention, have shown promise in promoting health outcomes for LBW infants. Research indicates that massage can enhance weight gain, support neurodevelopment, and strengthen the emotional bond between infants and caregivers [14-18]. Randomized controlled trials and systematic reviews further suggest that infant massage significantly improves weight gain and neurobehavioral development in LBW infants [19-22]. Despite these benefits, barriers such as a lack of trained health care providers and inconsistent app by caregivers limit its widespread adoption.

The therapeutic benefits of baby massages in neonatal care are well documented. As a nonpharmacological approach, it promotes vagal nerve stimulation and facilitates improved digestion and increased weight gain [23]. Moreover, it promotes neurodevelopment through enhanced sensory integration and modulation of stress hormones [18,20,24]. Baby massages promote emotional bonding, which is crucial for the psychological development of the infant [22]. Studies have demonstrated that it enhances digestive and immune functions and reduces levels of stress hormones in infants and parents alike [23,24]. It is also involved in critical motor and sensory development, especially in premature and term infants [16]. However, in low- and middle-income countries, structural challenges make it difficult to find and use baby massages, including health care infrastructure and sociocultural obstacles [25]. The diversity of massage techniques and cultural practices also creates challenges in its implementation, highlighting the importance of standardized training and evidence-based

guidelines [26,27]. In Indonesia, the limited availability of relevant and culturally sensitive educational materials has been a major obstacle to its adoption.

The rise of mobile health (mHealth) has shown promise in improving parental knowledge and compliance with neonatal care practices [28,29]. Parents have been encouraged to practice KMC and monitor infant growth through some mobile apps [11,12]. Such tools have also been shown to support prenatal care, breastfeeding, and early childhood development, and to improve parental confidence, adherence to health recommendations, and child health outcomes [29-31]. Studies show that mobile apps with interactive and user-centered features can be associated with higher user satisfaction and improved maternal health behaviors [32]. However, despite the increasing use of mHealth technologies, there is a significant lack of literature describing mHealth for baby massage education, particularly in multiculturally diverse contexts [33].

In many cases, existing mHealth apps are unable to implement human-centered design principles vital for usability and engagement, particularly in the Indonesian context [34]. Additionally, few evidence-based, culturally appropriate interventions exist to address the specific needs of LBW infants and their caregivers [35,36]. Little is currently known about the factors influencing the digital classroom experience in this field, including opportunities for bias against visual assets, as most research around baby massage education and experience continues to rely on face-to-face instructional culture. This creates a major gap in knowledge concerning how effective mHealth apps can be in increasing the knowledge, skills, and confidence of parents to perform baby massages [33]. Evidence is limited regarding infant health outcomes or how usability features may influence user engagement, satisfaction, and long-term adherence [34].

Filling these gaps is essential for informing scalable, accessible, and effective interventions targeting diverse populations. To ensure the development of such clinically meaningful mobile apps, we need a user-centered design process, complemented with a solid evaluation framework [34]. This study aims to address these gaps by developing and evaluating a human-centered baby massage mobile app designed to enhance growth and development in LBW infants in Indonesia.

Methods

Study Design

This study used a mixed methods design consisting of (1) usability testing and (2) a single-arm pilot pre-post intervention study conducted over 4 weeks.

The usability phase evaluated user experience (UX) and system performance using the System Usability Scale (SUS) and qualitative interviews.

The pilot phase used a 1-group pretest-posttest design to assess changes in caregiver knowledge, confidence, adherence to baby massage practices, and infant growth parameters following exposure to the mobile app.

No control group was included in this pilot study, as the primary objective was to assess the feasibility, usability, and preliminary effectiveness.

Participant Recruitment and Sample Size Rationale

Participants were recruited between January and March 2025 through community health centers, pediatric outpatient clinics, and online announcements distributed via maternal health networks in West Java, Indonesia.

Eligibility criteria included the following: being a primary caregiver (mother or father) of an infant with documented LBW (<2500 g), infant age between 0 and 12 months, ownership of an Android smartphone, and ability to read Bahasa Indonesia.

Caregivers of infants with congenital abnormalities or severe medical instability were excluded.

The sample size (N=42) was determined based on recommendations for pilot feasibility studies, which suggest 30 to 50 participants to estimate preliminary effect sizes and usability metrics. The sample was also considered adequate for detecting moderate pre-post effects using paired statistical testing.

Overview

A human-centered iterative design framework guided the development and evaluation of a mobile app designed to optimize growth and development in LBW infants through baby massages. The app design and development process was broken down into 6 clear steps, each contributing to the app definition and validation process.

Stages of App Design and Development

Overview

The development of the baby massage mobile app followed a systematic, human-centered design framework, resulting in a functional and user-friendly tool. The process was iterative, consisting of six development cycles that produced six progressively refined versions of the app. Each iteration incorporated user feedback to improve usability, content, and functionality. A brief description of each stage is presented in the subsections below.

Stage 1: Establishing the Study Team

A multidisciplinary team was established, comprising neonatologists, pediatricians, child development experts, mobile app developers, and UX designers. The team also included pediatric nurse specialists, nursing researchers, and software engineers.

Regular meetings were conducted to ensure alignment among team members, foster interdisciplinary collaboration, and integrate clinical insights with technical perspectives. These meetings also facilitated knowledge exchange across disciplines and supported systems thinking, which helped define the project's scope, objectives, and technical approach.

Stage 2: Defining a Set of App Design Requirements

The app design requirements were informed by a comprehensive literature review and expert consultations. Academic databases

were systematically searched for peer-reviewed articles, systematic reviews, and clinical guidelines related to LBW infants, baby massages, and mHealth apps (PubMed and Google Scholar; publications up to October 2023). Records published since 2019 were emphasized to ensure relevance and alignment with current best practices. We extracted findings on effective interventions, user preferences, and technological features and identified gaps in the literature, specifically for culturally tailored digital solutions for LBW infants in low-resource settings. These efforts were further complemented by consultations with neonatologists, pediatricians, child development specialists, and UX designers to inform screen design requirements. Several key features emerged: step-by-step tutorials for baby massages, progress tracking, reminders, and culturally relevant content. These requirements were based on evidence-based practices and adapted to the specific needs of LBW infants and their caregivers [37].

Stage 3: Defining User Requirements

Focus group discussions (FGDs) were conducted with caregivers of LBW infants and health care providers to identify user requirements. The discussions explored users' preferences, challenges, and expectations regarding a baby massage app.

Participants emphasized the need for a simple and intuitive interface, clear visual guidance, and offline functionality, particularly to accommodate limited internet access in rural settings [38].

Stage 4: Creating the App Prototype

In addition to instructional videos, interactive guides were incorporated to enhance user engagement. These guides allowed caregivers to access additional information, such as diagrams and animations, to better understand massage techniques and their benefits. The design emphasized intuitive navigation and responsive feedback to support ease of use.

A growth tracker feature was also included to enable caregivers to monitor infants' development. The dashboard displayed key indicators such as weight and head circumference in an easy-to-read format, allowing users to visualize progress over time.

The prototype was developed as a set of wireframes representing the app's layout and structure. Design tools such as Figma (Figma, Inc), Adobe XD (Adobe Inc), and Sketch (Sketch BV) were used to visualize the interface, typography, and icons through semi-interactive mock-ups.

Stage 5: Expert UX Review

A panel of experts in neonatal care, digital health, and UX design conducted a comprehensive review of the prototype. The panel included neonatologists with expertise in LBW infant care, clinicians experienced in mHealth apps in low-resource settings, and UX designers specializing in usability and user engagement.

The review process was structured and began with an initial briefing session, during which the prototype's features, design principles, and intended user journey were presented. Experts then evaluated the prototype based on predefined criteria,

including usability, functionality, visual design, sustainability, and cultural relevance.

Feedback from the experts led to refinements in several areas, including navigation clarity, instructional content, feature integration (eg, instructional videos and dashboard), and cultural appropriateness for the target Indonesian users.

Stage 6: Testing the Prototype

Usability testing and pilot testing were conducted to assess the refined prototype in real-world conditions.

Usability Testing

We conducted usability testing with 42 caregivers of LBW infants recruited from a tertiary care hospital in Indonesia. Respondents who were willing to download and evaluate the app were included in the study sample. To evaluate the app's usability, we used the SUS, which produces scores from 0 to 100. A higher score indicates improved usability. Furthermore, qualitative feedback on UX was collected via semistructured interviews [39]. We provided participants the app prototype and asked them to perform tasks such as finding a tutorial, setting reminders, and tracking their progress. Observations of users' interactions with the app, along with feedback collected through the SUS and interviews, were analyzed. Quantitative data from the SUS were analyzed using descriptive statistics, and thematic analysis was applied to the qualitative data.

Pilot Testing Phase

The pilot study used a single-arm pre-post design and was conducted among 42 caregivers of LBW infants from various socioeconomic backgrounds in Indonesia.

Knowledge, confidence, and adherence to baby massage practices were assessed using preintervention and postintervention questionnaires. The instrument, known as the Caregiver Baby Massage Knowledge, Confidence, and Adherence Questionnaire, was developed by the research team, comprising neonatologists, pediatricians, child development specialists, and nursing researchers.

The questionnaire development followed an iterative process, including a literature review on baby massage practices and caregiver self-efficacy, as well as expert consultation in neonatal care and digital health. The final instrument consisted of 30 items across three domains:

1. Knowledge (10 items)—assessing caregivers' understanding of baby massage techniques, benefits, and precautions
2. Confidence (10 items)—measuring caregivers' perceived ability to correctly and consistently perform baby massages
3. Adherence (10 items)—evaluating compliance with recommended baby massage routines

Items in the confidence and adherence domains were scored on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Knowledge items were scored as 1 (incorrect) or 5 (correct). Domain scores were calculated by summing item scores, with higher scores indicating better knowledge, confidence, or adherence.

The questionnaire was translated into Bahasa Indonesia and validated in a preliminary study involving 30 caregivers. Reliability testing demonstrated good internal consistency, with Cronbach α values of 0.88 (knowledge), 0.90 (confidence), and 0.86 (adherence).

Intervention Procedure

During the 4-week intervention period, caregivers were instructed to use the mobile app as their primary guidance tool for baby massage practice. Specifically, caregivers were asked to perform the following tasks:

- Watch instructional baby massage videos within the app at least 3 times per week
- Perform baby massage sessions at home at least once daily (minimum 5 sessions per week)
- Log massage completion in the app after each session
- Record infant weight weekly using digital baby scales available at community health centers
- Enter infant growth measurements, including weight and head circumference, into the in-app growth tracking feature

The app provided automated daily reminders to encourage adherence. All instructional materials were accessible offline after initial download.

No biochemical or laboratory biomarkers were assessed. Infant outcomes were limited to anthropometric measurements, specifically weight and head circumference.

Information regarding caregiver responses, app use patterns, and infant growth parameters was collected at baseline and after completion of the 4-week intervention. The mobile app for baby massages was developed as a functional prototype (Figure 1).

Figure 1. Mobile app for baby massages.



Statistical Analysis

Paired *t* tests (2-tailed) were conducted to compare preintervention and postintervention outcomes for caregiver knowledge, confidence, adherence scores, and infant growth parameters. Statistical significance was set at $P < .05$.

Ethical Considerations

This study was approved by the institutional review board of STIKep PPNJ Jawa Barat (III/045/KEPK/STIKep/PPNI/Jabar/XI/2024). All participants provided written informed consent prior to participation. Participants did not receive financial compensation for their participation in the study. Caregivers were informed of their

right to withdraw at any time without consequences. All collected data were anonymized and stored securely in password-protected databases.

Results

Demographic Characteristics of Participants

The study included 42 caregivers of infants aged 0 to 12 months. The demographic characteristics of the participants are presented in Table 1. Most of the participants ($n=35$, 83.3%) were mothers with an average age of 29.5 (SD 5.2) years. Most participants had a university-level education ($n=31$, 73.8%) and were first-time caregivers ($n=25$, 59.5%). Nearly all participants ($n=40$, 95.2%) had no prior experience with baby massage.

Table 1. Demographic characteristics of participants (N=42).

Characteristic	Values, n (%)
Gender	
Female	35 (83.3)
Male	7 (16.7)
Age (years)	
<25	10 (23.8)
25-34	27 (64.3)
≥35	5 (11.9)
Education level	
High School	8 (19)
University	31 (73.8)
Postgraduate	3 (7.1)
First-time caregiver	25 (59.5)
Prior baby massage experience	
Yes	2 (4.8)
No	40 (95.2)

Usability Testing Results

[Table 2](#) presents the descriptive statistics for the SUS scores. The mean SUS score was 78.6 (SD 8.2), indicating a high level of usability. Most participants (85%) rated the app as “excellent”

or “good” for ease of use and navigation. The highest-rated aspect was “ease of learning” (mean score 4.5; 5-point scale), while the lowest-rated aspect was “visual design appeal” (mean score 3.9; 5-point scale; [Table 2](#)).

Table 2. Descriptive statistics for usability testing using the System Usability Scale.

Usability metric	Value
Overall System Usability Scale score, mean (SD)	78.6 (8.2)
Ease of navigation, mean (SD)	4.3 (0.7)
Ease of learning, mean (SD)	4.5 (0.6)
Visual design appeal, mean (SD)	3.9 (0.8)
Task completion rate (%)	92
Error rate (%)	5.2

Qualitative Feedback From Users

Thematic analysis identified key themes related to usability, functionality, aesthetic design, user satisfaction, and cultural

relevance. [Table 3](#) summarizes the themes, categories, and example quotes.

Table 3. Thematic analysis of user feedback.

Theme and category	Example quote
Usability	
Ease of use	“I found the app very easy to navigate, and I didn’t need much time to learn how to use it.”
Clarity of features	“The app’s instructions are clear, but some icons could be more intuitive.”
Intuitive navigation	“The app is very easy to use. I found the tutorials and reminders without any difficulty.”
Functionality	
Reminder system	“The reminder feature is very helpful in ensuring I don’t forget my baby’s checkups.”
Tracking progress	“I like how I can track my baby’s weight and feeding schedule in one place.”
Informative content	“The videos and interactive guides taught me how to massage my baby properly. I feel more confident now.”
Aesthetic design	
Visual appeal	“The design is good, but a more colorful interface would make it more engaging.”
User satisfaction	
Overall experience	“I would recommend this app to other parents; it makes managing my baby’s health much easier.”
Cultural relevance	
Local language support	“I appreciate that the app is in Bahasa Indonesia. It makes it easier for me to understand.”
Culturally appropriate	“The massage techniques shown in the app are similar to what my mother taught me. It feels familiar and comfortable.”

Pilot Testing

Caregivers demonstrated a significant increase in knowledge about baby massage techniques and their benefits, with a mean improvement of 20.5 points ($P=.002$). Confidence levels among caregivers improved significantly, with a mean increase of 21.6 points ($P=.001$). Caregivers reported feeling more capable of performing baby massage correctly and consistently. Adherence

to baby massage practices improved by 20.3 points ($P=.02$), indicating that caregivers were more likely to follow the recommended massage routines after using the app. Infants showed significant improvements in weight (mean increase of 330 g; $P=.003$) and head circumference (mean increase of 1.3 cm; $P=.004$), suggesting positive effects of the intervention on infant growth and development (Table 4).

Table 4. Preintervention and postintervention outcomes for caregivers and infants.

Outcome measure	Preintervention, mean (SD)	Postintervention, mean (SD)	Mean difference (SD)	<i>P</i> value
Caregiver knowledge	65.2 (8.5)	85.7 (6.3)	20.5 (7.1)	.002
Caregiver confidence	60.8 (9.2)	82.4 (7.8)	21.6 (8.3)	.001
Adherence to practices	55.3 (10.1)	75.6 (8.9)	20.3 (9.5)	.02
Infant weight (grams)	2200 (150)	2530 (140)	330 (120)	.003
Infant head circumference (cm)	32.5 (1.2)	33.8 (1.1)	1.3 (0.9)	.004

Discussion

Principal Findings

This study assessed the effectiveness of a human-centered mobile app designed to support the growth and development of LBW infants in Indonesia through baby massages. The app achieved a high usability rating, reflecting its user-friendly design and ease of navigation.

Postintervention evaluations showed significant improvements in caregivers’ knowledge ($P=.002$), confidence ($P=.001$), and adherence to baby massage practices ($P=.02$). Importantly, infants whose caregivers used the app demonstrated significant increases in weight ($P=.003$) and head circumference ($P=.004$), indicating positive effects on their growth.

The app’s high usability and positive user feedback highlight its success in addressing the needs of its target audience. Caregivers praised its intuitive interface, clear instructions, and culturally relevant content, which were designed to reduce cognitive load and enhance engagement. Features such as the reminder system and progress tracking were particularly valued, as they supported consistent massage routines and enabled caregivers to monitor infant growth. These findings align with human-centered design principles, which emphasize tailoring digital health solutions to users’ needs and contexts [33,34,40,41].

While the app’s usability was generally high, minor concerns regarding visual design and icon intuitiveness suggest areas for future improvement. This study builds on these insights by introducing a culturally tailored, human-centered app

specifically designed for Indonesian caregivers, addressing a gap in the literature.

The findings corroborate prior research on the benefits of baby massages and mHealth interventions for LBW infants. For instance, Vickers et al [16] reported that baby massages enhance weight gain and neurodevelopment in LBW infants, while Knop et al [28] highlighted the role of mHealth interventions in improving parental education and adherence to neonatal care practices. Similarly, Bangor et al [42] found that high usability scores in health apps are associated with increased user satisfaction and adherence to health recommendations.

Additionally, the app incorporates traditional massage techniques that align with local practices, making it more acceptable and practical for Indonesian caregivers, thus enhancing its relevance and effectiveness [36]. Furthermore, the app's offline functionality addresses the challenge of limited internet access in rural areas, where nearly 80% of the population lacks reliable connectivity. This approach aligns with global health strategies advocating for digital tools to improve maternal and child health outcomes, especially in resource-constrained settings.

This study, while demonstrating promising outcomes, is not without limitations. One notable constraint is the relatively small sample size, which may restrict the generalizability of the findings. Additionally, the research was conducted within a specific cultural and regional context in Indonesia, potentially limiting its applicability to other settings with different cultural norms and health care environments. To address these limitations, future studies should aim to include larger and more diverse participant groups, as well as evaluate the app's usability and effectiveness across varied cultural contexts. Another limitation is the short duration of the intervention, which prevents conclusions about the long-term impact of the app on infant growth and development. Extending the study period and

incorporating follow-up assessments would provide deeper insights into the sustained benefits of the app. Furthermore, while qualitative feedback offered valuable perspectives on UXs, a more structured and comprehensive qualitative analysis could uncover additional insights into caregiver preferences and areas for improvement.

This pilot study used a single-arm pre-post design without a control group; therefore, causal inference cannot be established. Improvements in infant growth may have been influenced by natural growth progression or other unmeasured factors. Future randomized controlled trials are needed to confirm effectiveness.

Conclusions

This study highlights the effectiveness of a culturally tailored, human-centered baby massage mobile app in improving caregiver knowledge, confidence, and adherence to infant massage practices, while also positively influencing the growth and development of LBW infants in Indonesia. The app's high usability reflects its user-friendly design and intuitive navigation. The integration of such digital health tools into routine postnatal care offers a promising strategy for addressing the challenges faced by caregivers of LBW infants, particularly in low-resource settings. The app's culturally relevant content, local language support, and offline functionality make it accessible and practical for users in diverse contexts, including rural areas with limited internet access. Positive feedback from participants further emphasizes the app's value, with caregivers appreciating features such as step-by-step tutorials, progress tracking, and reminders. While minor usability concerns, such as the need for a more visually engaging interface, were noted, overall satisfaction with the app was high, indicating its potential as a reliable tool for supporting infant care. Looking ahead, future research should focus on scaling up the app, conducting longer-term evaluations to assess its sustained impact, and exploring its integration into existing neonatal care programs.

Acknowledgments

The authors would like to thank all participants for their involvement in this study. No generative artificial intelligence tools were used in the design, data collection, analysis, or scientific writing of this manuscript.

Funding

This study received no external funding.

Authors' Contributions

Conceptualization: SS, RIIID, HCH

Methodology: SS, RIIID, HCH

Investigation: SS

Data curation: SS

Formal analysis: HCH

Project administration: SS

Supervision: RIIID, HCH

Validation: RIIID, HCH

Resources: HCH

Writing – original draft: SS

Writing – review & editing: RIIID, HCH

All authors reviewed and approved the final manuscript.

Conflicts of Interest

None declared.

References

1. Low birthweight (prevalence). World Health Organization. URL: <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/76> [accessed 2026-04-09]
2. Low birthweight. UNICEF. Jul 2023. URL: <https://data.unicef.org/topic/nutrition/low-birthweight/> [accessed 2026-04-09]
3. Low birthweight: country, regional and global estimates. World Health Organization. Dec 13, 2004. URL: <https://www.who.int/publications/i/item/9280638327> [accessed 2026-04-09]
4. Ministry OHROI. National report on infant mortality and low birth weight. Jakarta. Ministry of Health; 2026.
5. Wulandari F, Mahmudiono T, Rifqi MA, Helmyati S, Dewi M, Yuniar CT. Maternal characteristics and socio-economic factors as determinants of low birth weight in Indonesia: analysis of 2017 Indonesian Demographic and Health Survey (IDHS). *Int J Environ Res Public Health*. Oct 26, 2022;19(21):13892. [FREE Full text] [doi: [10.3390/ijerph192113892](https://doi.org/10.3390/ijerph192113892)] [Medline: [36360771](https://pubmed.ncbi.nlm.nih.gov/36360771/)]
6. Wulandari RD, Laksono AD, Matahari R. Policy to decrease low birth weight in Indonesia: who should be the target? *Nutrients*. Jan 16, 2023;15(2):465. [FREE Full text] [doi: [10.3390/nu15020465](https://doi.org/10.3390/nu15020465)] [Medline: [36678335](https://pubmed.ncbi.nlm.nih.gov/36678335/)]
7. Jańczewska I, Wierzbą J, Jańczewska A, Szczurek-Gierczak M, Domżańska-Popadiuk I. Prematurity and low birth weight and their impact on childhood growth patterns and the risk of long-term cardiovascular sequelae. *Children (Basel)*. Sep 25, 2023;10(10):1599. [FREE Full text] [doi: [10.3390/children10101599](https://doi.org/10.3390/children10101599)] [Medline: [37892262](https://pubmed.ncbi.nlm.nih.gov/37892262/)]
8. Sivanandan S, Sankar MJ. Kangaroo mother care for preterm or low birth weight infants: a systematic review and meta-analysis. *BMJ Glob Health*. Jun 2023;8(6):e010728. [FREE Full text] [doi: [10.1136/bmjgh-2022-010728](https://doi.org/10.1136/bmjgh-2022-010728)] [Medline: [37277198](https://pubmed.ncbi.nlm.nih.gov/37277198/)]
9. Narciso LM, Beleza LO, Imoto AM. The effectiveness of Kangaroo Mother Care in hospitalization period of preterm and low birth weight infants: systematic review and meta-analysis. *J Pediatr (Rio J)*. 2022;98(2):117-125. [FREE Full text] [doi: [10.1016/j.jped.2021.06.004](https://doi.org/10.1016/j.jped.2021.06.004)] [Medline: [34274324](https://pubmed.ncbi.nlm.nih.gov/34274324/)]
10. Greene MM, Patra K, Czyzewski P, Gonring K, Breitenstein S. Adaptation and acceptability of a digitally delivered intervention for parents of very low birth weight infants. *Nurs Res*. 2020;69(5S Suppl 1):S47-S56. [doi: [10.1097/NNR.0000000000000445](https://doi.org/10.1097/NNR.0000000000000445)] [Medline: [32496399](https://pubmed.ncbi.nlm.nih.gov/32496399/)]
11. Spittle AJ, Olsen J, Kwong A, Doyle LW, Marschik PB, Einspieler C, et al. The Baby Moves prospective cohort study protocol: using a smartphone application with the General Movements Assessment to predict neurodevelopmental outcomes at age 2 years for extremely preterm or extremely low birthweight infants. *BMJ Open*. Oct 03, 2016;6(10):e013446. [FREE Full text] [doi: [10.1136/bmjopen-2016-013446](https://doi.org/10.1136/bmjopen-2016-013446)] [Medline: [27697883](https://pubmed.ncbi.nlm.nih.gov/27697883/)]
12. Bucher SL, Young A, Dolan M, Padmanaban GP, Chandnani K, Purkayastha S. The NeoRoo mobile app: initial design and prototyping of an Android-based digital health tool to support Kangaroo Mother Care in low/middle-income countries (LMICs). *PLOS Digit Health*. Oct 25, 2023;2(10):e0000216. [FREE Full text] [doi: [10.1371/journal.pdig.0000216](https://doi.org/10.1371/journal.pdig.0000216)] [Medline: [37878575](https://pubmed.ncbi.nlm.nih.gov/37878575/)]
13. Lestari KP, Nurbadlina FR, Wagiyo W, Jauhar M. The effectiveness of baby massage in increasing infant's body weight. *J Public Health Res*. May 31, 2021;10(s1):jphr.2021.2332. [FREE Full text] [doi: [10.4081/jphr.2021.2332](https://doi.org/10.4081/jphr.2021.2332)] [Medline: [34060735](https://pubmed.ncbi.nlm.nih.gov/34060735/)]
14. Field T. Massage therapy research review. *Complement Ther Clin Pract*. Aug 2016;24:19-31. [FREE Full text] [doi: [10.1016/j.ctcp.2016.04.005](https://doi.org/10.1016/j.ctcp.2016.04.005)] [Medline: [27502797](https://pubmed.ncbi.nlm.nih.gov/27502797/)]
15. Kobosko J, Fludra M, Śliwa L, Ganc M, Jedrzejczak WW, Skoczylas A, et al. Self-perceived stress and the personality of mothers of children with central auditory processing disorders – Differences from mothers of typically developing children. *Journal of Pediatric Nursing*. Mar 2022;63:e58-e63. [doi: [10.1016/j.pedn.2021.10.012](https://doi.org/10.1016/j.pedn.2021.10.012)]
16. Vickers A, Ohlsson A, Lacy JB, Horsley A. Massage for promoting growth and development of preterm and/or low birth-weight infants. *Cochrane Database Syst Rev*. 2004;2004(2):CD000390. [FREE Full text] [doi: [10.1002/14651858.CD000390.pub2](https://doi.org/10.1002/14651858.CD000390.pub2)] [Medline: [15106151](https://pubmed.ncbi.nlm.nih.gov/15106151/)]
17. Silveira RC, Mendes EW, Fuentesfria RN, Valentini NC, Procianny RS. Early intervention program for very low birth weight preterm infants and their parents: a study protocol. *BMC Pediatr*. Aug 09, 2018;18(1):268. [FREE Full text] [doi: [10.1186/s12887-018-1240-6](https://doi.org/10.1186/s12887-018-1240-6)] [Medline: [30092772](https://pubmed.ncbi.nlm.nih.gov/30092772/)]
18. Priyadarshi M, Kumar V, Balachander B, Gupta S, Sankar MJ. Effect of whole-body massage on growth and neurodevelopment in term healthy newborns: a systematic review. *J Glob Health*. Oct 18, 2022;12:12005. [FREE Full text] [doi: [10.7189/jogh.12.12005](https://doi.org/10.7189/jogh.12.12005)] [Medline: [36254378](https://pubmed.ncbi.nlm.nih.gov/36254378/)]
19. Lu LC, Lan SH, Hsieh YP, Lin LY, Chen JC, Lan SJ. Massage therapy for weight gain in preterm neonates: a systematic review and meta-analysis of randomized controlled trials. *Complement Ther Clin Pract*. May 2020;39:101168. [doi: [10.1016/j.ctcp.2020.101168](https://doi.org/10.1016/j.ctcp.2020.101168)] [Medline: [32379694](https://pubmed.ncbi.nlm.nih.gov/32379694/)]

20. Ho YB, Lee RS, Chow CB, Pang MY. Impact of massage therapy on motor outcomes in very low-birthweight infants: randomized controlled pilot study. *Pediatr Int*. Jun 2010;52(3):378-385. [doi: [10.1111/j.1442-200X.2009.02964.x](https://doi.org/10.1111/j.1442-200X.2009.02964.x)] [Medline: [19761514](https://pubmed.ncbi.nlm.nih.gov/19761514/)]
21. McCarty D, Silver R, Quinn L, Dusing S, O'Shea TM. Infant massage as a stress management technique for parents of hospitalized extremely preterm infants. *Infant Ment Health J*. Jan 2024;45(1):11-21. [FREE Full text] [doi: [10.1002/imhj.22095](https://doi.org/10.1002/imhj.22095)] [Medline: [38140832](https://pubmed.ncbi.nlm.nih.gov/38140832/)]
22. Hwu LJ, Tzeng YL, Teng YK, Liu SJ. Effects of massage intervention on discharged premature infants' weight, parental stress, and parent-child attachment: a randomized controlled trial. *Infant Behav Dev*. Aug 2023;72:101867. [doi: [10.1016/j.infbeh.2023.101867](https://doi.org/10.1016/j.infbeh.2023.101867)] [Medline: [37515904](https://pubmed.ncbi.nlm.nih.gov/37515904/)]
23. Field T, Diego M. Vagal activity, early growth and emotional development. *Infant Behav Dev*. Sep 2008;31(3):361-373. [FREE Full text] [doi: [10.1016/j.infbeh.2007.12.008](https://doi.org/10.1016/j.infbeh.2007.12.008)] [Medline: [18295898](https://pubmed.ncbi.nlm.nih.gov/18295898/)]
24. Dumuids-Vernet MV, Forma V, Provasi J, Anderson DI, Hinnekens E, Soye E, et al. Stimulating the motor development of very premature infants: effects of early crawling training on a mini-skateboard. *Front Pediatr*. Jun 6, 2023;11:1198016. [FREE Full text] [doi: [10.3389/fped.2023.1198016](https://doi.org/10.3389/fped.2023.1198016)] [Medline: [37346892](https://pubmed.ncbi.nlm.nih.gov/37346892/)]
25. Kawi J, Fudolig M, Serafica R, Reyes AT, Sy F, Leyva EW, et al. Health information sources and health-seeking behaviours of Filipinos living in medically underserved communities: empirical quantitative research. *Nurs Open*. Mar 2024;11(3):e2140. [FREE Full text] [doi: [10.1002/nop2.2140](https://doi.org/10.1002/nop2.2140)] [Medline: [38488390](https://pubmed.ncbi.nlm.nih.gov/38488390/)]
26. Brennan MK, Healey D, Tague C, Rosenthal B. Hospital based massage therapy specific competencies. *J Bodyw Mov Ther*. Apr 2019;23(2):291-294. [doi: [10.1016/j.jbmt.2019.01.009](https://doi.org/10.1016/j.jbmt.2019.01.009)] [Medline: [31103110](https://pubmed.ncbi.nlm.nih.gov/31103110/)]
27. Salvo SG. The therapeutic relationship: ethics, cultural competencies, and boundaries. In: *Massage Therapy E-Book*, 7th Edition. Amsterdam, The Netherlands. Elsevier; 2022.
28. Knop MR, Nagashima-Hayashi M, Lin R, Saing CH, Ung M, Oy S, et al. Impact of mHealth interventions on maternal, newborn, and child health from conception to 24 months postpartum in low- and middle-income countries: a systematic review. *BMC Med*. May 15, 2024;22(1):196. [FREE Full text] [doi: [10.1186/s12916-024-03417-9](https://doi.org/10.1186/s12916-024-03417-9)] [Medline: [38750486](https://pubmed.ncbi.nlm.nih.gov/38750486/)]
29. Gebremariam KT, Mulugeta A, Gallegos D. Theory-based mHealth targeting fathers and mothers to improve exclusive breastfeeding: a quasi-experimental study. *Int Breastfeed J*. Jan 06, 2023;18(1):2. [FREE Full text] [doi: [10.1186/s13006-022-00537-x](https://doi.org/10.1186/s13006-022-00537-x)] [Medline: [36604757](https://pubmed.ncbi.nlm.nih.gov/36604757/)]
30. Dienelt K, Moores CJ, Miller J, Mehta K. An investigation into the use of infant feeding tracker apps by breastfeeding mothers. *Health Informatics J*. Sep 2020;26(3):1672-1683. [FREE Full text] [doi: [10.1177/1460458219888402](https://doi.org/10.1177/1460458219888402)] [Medline: [31793799](https://pubmed.ncbi.nlm.nih.gov/31793799/)]
31. DeWitt A, Kientz J, Coker TR, Liljenquist K. mHealth technology design and evaluation for early childhood health promotion: systematic literature review. *JMIR Pediatr Parent*. Oct 06, 2022;5(4):e37718. [FREE Full text] [doi: [10.2196/37718](https://doi.org/10.2196/37718)] [Medline: [36201391](https://pubmed.ncbi.nlm.nih.gov/36201391/)]
32. Liu Y, Wang X. Application of smart mobile medical services in maternal health care management. *Contrast Media Mol Imaging*. Dec 8, 2021;2021:6249736-6249736. [FREE Full text] [doi: [10.1155/2021/6249736](https://doi.org/10.1155/2021/6249736)] [Medline: [34949971](https://pubmed.ncbi.nlm.nih.gov/34949971/)]
33. Harun A, Salmah AU, Hidayanty H, Suriah, Syafar M, Hadju V, et al. Do parents need application-based learning media to learn baby massage? A qualitative study. *J Educ Health Promot*. Mar 31, 2023;12:94. [FREE Full text] [doi: [10.4103/jehp.jehp_1308_22](https://doi.org/10.4103/jehp.jehp_1308_22)] [Medline: [37288396](https://pubmed.ncbi.nlm.nih.gov/37288396/)]
34. Göttgens I, Oertelt-Prigione S. The application of human-centered design approaches in health research and innovation: a narrative review of current practices. *JMIR Mhealth Uhealth*. Dec 06, 2021;9(12):e28102. [FREE Full text] [doi: [10.2196/28102](https://doi.org/10.2196/28102)] [Medline: [34874893](https://pubmed.ncbi.nlm.nih.gov/34874893/)]
35. Breneol S, Curran JA, Marten R, Minocha K, Johnson C, Wong H, et al. Strategies to adapt and implement health system guidelines and recommendations: a scoping review. *Health Res Policy Syst*. Jun 15, 2022;20(1):64. [FREE Full text] [doi: [10.1186/s12961-022-00865-8](https://doi.org/10.1186/s12961-022-00865-8)] [Medline: [35706039](https://pubmed.ncbi.nlm.nih.gov/35706039/)]
36. Rahayuningsih SI, Rustina Y, Afianti Y, Eryando T. The culture of caring for low birth weight infants at home after treatment: an ethnographic study from Indonesia. *J Keperawatan Padjadjaran*. Apr 30, 2024;12(1):74-84. [doi: [10.24198/JKP.v12i1.2380](https://doi.org/10.24198/JKP.v12i1.2380)]
37. Graves JM, Abshire DA, Amiri S, Mackelprang JL. Disparities in technology and broadband internet access across rurality: implications for health and education. *Fam Community Health*. 2021;44(4):257-265. [FREE Full text] [doi: [10.1097/FCH.0000000000000306](https://doi.org/10.1097/FCH.0000000000000306)] [Medline: [34269696](https://pubmed.ncbi.nlm.nih.gov/34269696/)]
38. Brooke J. SUS: a 'quick and dirty' usability scale. In: *Usability Evaluation in Industry*. London, UK. CRC Press; 1996.
39. Maramba I, Chatterjee A, Newman C. Methods of usability testing in the development of eHealth applications: a scoping review. *Int J Med Inform*. Jun 2019;126:95-104. [doi: [10.1016/j.ijmedinf.2019.03.018](https://doi.org/10.1016/j.ijmedinf.2019.03.018)] [Medline: [31029270](https://pubmed.ncbi.nlm.nih.gov/31029270/)]
40. Harte R, Glynn L, Rodríguez-Molinero A, Baker PM, Scharf T, Quinlan LR, et al. A human-centered design methodology to enhance the usability, human factors, and user experience of connected health systems: a three-phase methodology. *JMIR Hum Factors*. Mar 16, 2017;4(1):e8. [FREE Full text] [doi: [10.2196/humanfactors.5443](https://doi.org/10.2196/humanfactors.5443)] [Medline: [28302594](https://pubmed.ncbi.nlm.nih.gov/28302594/)]
41. Care of Preterm or Low Birthweight Infants Group. New World Health Organization recommendations for care of preterm or low birth weight infants: health policy. *EClinicalMedicine*. Aug 16, 2023;63:102155. [FREE Full text] [doi: [10.1016/j.eclinm.2023.102155](https://doi.org/10.1016/j.eclinm.2023.102155)] [Medline: [37753445](https://pubmed.ncbi.nlm.nih.gov/37753445/)]

42. Bangor A, Kortum PT, Miller JT. An empirical evaluation of the system usability scale. *Int J Hum Comput Interact*. Jul 30, 2008;24(6):574-594. [doi: [10.1080/10447310802205776](https://doi.org/10.1080/10447310802205776)]

Abbreviations

KMC: kangaroo mother care

LBW: low birth weight

mHealth: mobile health

SUS: System Usability Scale

UX: user experience

Edited by M Balcarras; submitted 26.Feb.2025; peer-reviewed by R Pryss, P Ghosh; comments to author 05.Dec.2025; revised version received 19.Feb.2026; accepted 19.Mar.2026; published 30.Sep.2026

Please cite as:

Supriatin S, Dioso RIII, Hassan HC

Human-Centered Baby Massage Mobile App for Low Birth Weight Infants: Usability Testing and a Pre-Post Pilot Intervention Study in Indonesia

JMIR Pediatr Parent 2026;9:e73153

URL: <https://pediatrics.jmir.org/2026/1/e73153>

doi: [10.2196/73153](https://doi.org/10.2196/73153)

PMID:

©Supriatin Supriatin, Regidor III Dioso, Hafizah Che Hassan. Originally published in JMIR Pediatrics and Parenting (<https://pediatrics.jmir.org>), 30.Sep.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Pediatrics and Parenting, is properly cited. The complete bibliographic information, a link to the original publication on <https://pediatrics.jmir.org>, as well as this copyright and license information must be included.