Content and Features of Mobile Health (mHealth) For Mother and Child Nutrition in The First 1000 Days of Life (Family Based Intervention): A Systematic Review

ABSTRACT

Background: Improving mother and child nutrition during the first 1000 days of life (DoL) is one of the major areas where mHealth has demonstrated great promise. A lot of mHealth is already used in society. However, no study examines the content and features of mobile health. Aim: This study aims to examine the difference in content and features of mHealth intervention for maternal and child nutrition throughout the first 1000 days of life. Thus, new apps can be enhanced. Methods: The online journal databases that offer free papers from Scopus-indexed journals published in 2017–2022 served as the primary sources for the literature included in this study. Several keywords were used in the literature search, which used the databases Google Scholar, Science Direct, and PubMed. A total of 8 articles were included in the literature review. Results: Existing mHealth provides content and features to support and improve the health status of pregnant women, breastfeeding mothers, and children aged 0-24 months. mHealth interventions have the potential to improve maternal and child nutrition health in the first 1000 days of life by providing education, communication, support, data collection and analysis, cultural appropriateness, accessibility, and capacity building for health workers. However, it is crucial to address challenges such as evidence-based design, privacy and security, sustainability, and data management, and to ensure cultural appropriateness and accessibility for all populations. Conclusions: The more complete the content, features, and uses of mHealth, the greater the users' acceptance.

Keywords: Mobile Health. Mother and Child Health. Systematic Review. Nutrition

INTRODUCTION

Mobile Health (mHealth) has emerged as a powerful tool to deliver healthcare services in low- and middle-income countries (LMICs) (Braun et al., 2013; Tamrat & Kachnowski, 2012). The proliferation of mobile phones and wireless communication technologies has opened up new avenues for delivering maternal and child health services in remote and underserved areas (Benski et al., 2020; Paduano et al., 2022).

Mobile Health (mHealth) can be used effectively, practically, and widely in society, especially at the household level as a public health service (Pagliari et al., 2005; Shaw et al., 2018). Currently, many digital applications have developed, especially those related to family-based health in countries such as developing countries (Farrow et al., 2019; Meedya et al., 2021; Nourani et al., 2019; Reyes et al., 2018). Various mHealth applications have been developed by various parties, both the government, academia, and the private sector. Several mHealth applications specifically targeting mothers and children include Child Growth, Baby Growth, My Baby Today, Baby Growth Tracker, Baby Growth Chart, Newborn Baby Log, and Child Development Questions and Answers (Humphrey et al., 2021; Nikièma et al., 2017; Nyang'echi & Osero, 2021). The use of family-based mHealth can assist in providing health services and can be a behavior change intervention (Rich & Miah, 2014; Zhang et al., 2021). Several studies have noted that the use of health applications can assist in providing health services for families (Finucane et al., 2021; Olfert et al., 2019; Rinawan et al., 2021; Selem-Solís et al., 2018; Wunsch et al., 2020). For instance, two studies in Tanzania reported that providing the Pregnancy and Newborn Diagnostic Assessment (PANDA) app was able to enhance the quality of ANC and have a beneficial impact on the interaction between pregnant women and medical professionals (Benski et al., 2020; Paduano et al., 2022).

Furthermore, one of the key areas where mHealth has shown tremendous potential is in improving maternal and child nutrition during the first 1000 days of life (Sondaal et al., 2016). This period is critical for a child's growth and development, and malnutrition during this period can have long-term consequences on the child's physical and cognitive development (Victora et al., 2008). Nutrition education and counseling interventions delivered through mobile phones are effective in improving maternal knowledge and practices related to infant and young child feeding (IYCF) (Ruel et al., 2008). These interventions typically use interactive voice response (IVR) or

short message service (SMS) to deliver educational messages to mothers. Some interventions also incorporate behavior change communication (BCC) strategies to promote optimal infant and young child feeding practices (Midhet & Becker, 2010).

On the other hand, food-based interventions delivered through mobile phones include the provision of fortified foods, such as micronutrient powders (MNPs), and cash transfers to purchase nutritious food items. These interventions aim to improve dietary diversity and micronutrient intake among pregnant and lactating women and young children. Several studies have demonstrated the effectiveness of these interventions in improving maternal and child nutrition outcomes (Lee et al., 2016; Ruel et al., 2008). However, no study exists to review what content and features mobile health has and is already used by society. Therefore, this study proposes to review the different content and features of mHealth interventions for maternal and child nutrition during the first 1000 days of life.

Aims

This discussed the evidence base for these m-health interventions and identify contents and features in the apps. The findings of this review will have implications for policymakers and program implementers who are interested in using mHealth to improve maternal and child nutrition outcomes in low- and middle-income countries.

METHODS

Literature Searching

The analysis of this study was conducted according to PRISMA guidelines (Moher et al., 2015), without a previously published review protocol, by two independent reviewers. Literature sources in this systematic review were obtained from online journal databases that provide free articles from Scopus-indexed Journals, published in 2017-2022. Literature search used Google Scholar, Science Direct, and PubMed databases. To identify pertinent articles, we employed a combination of MeSH terms and free-text words, with keywords such as “eHealth”, “mHealth”, “Pregnant”, “Mother”, “Child”, “Stunting”, “health of both mother and child”, “Stunting”, “mHealth for first 1000 days of life”, “mHealth content”, “mHealth features”, “mHealth evaluation”.

From the results of the initial search, 2305 articles were found, and after going through a screening process, the remaining 8 pieces of articles were reviewed. A clear description of procedures in literature management can be seen in **Figure 1.** Studies were collected by three independent reviewers and then adjustments were made between reviewers through discussion.

Eligibility Criteria

Studies are eligible for inclusion in this review if they meet the following criteria: 1). study that assessed the content, features, and uses of mHealth to support the nutritional health of mothers and children in the first 1000 days of life. 2). family-based intervention. 3). publications from the last 5 years; 4). they were written in English. We excluded the articles if the full text was unavailable or if the descriptions of the content, features, and uses of mHealth to support the nutritional health of mothers and children in the first 1000 days of life were unclear.

Data Extraction

Three investigators individually reviewed the full-text articles and conducted data extraction for each study. Any inconsistencies or discrepancies in the data were resolved by referring to the original articles. A standardized data extraction method was employed, utilizing Microsoft Excel. Any conflicts in the selection of studies were thoroughly discussed until a consensus was reached.

RESULTS

In our initial literature search, we identified a total of 2305 articles. Selection of duplicate and title screening of articles, we had 504 articles remaining for the further abstract screening process. Subsequently, 297 articles were excluded due to duplication and aims. Only 207 studies had free access to the full text and met the inclusion criteria. Then, a total of 199 studies were

excluded during the eligibility review based on our inclusion and exclusion criteria. Finally, we included 8 articles in this review.

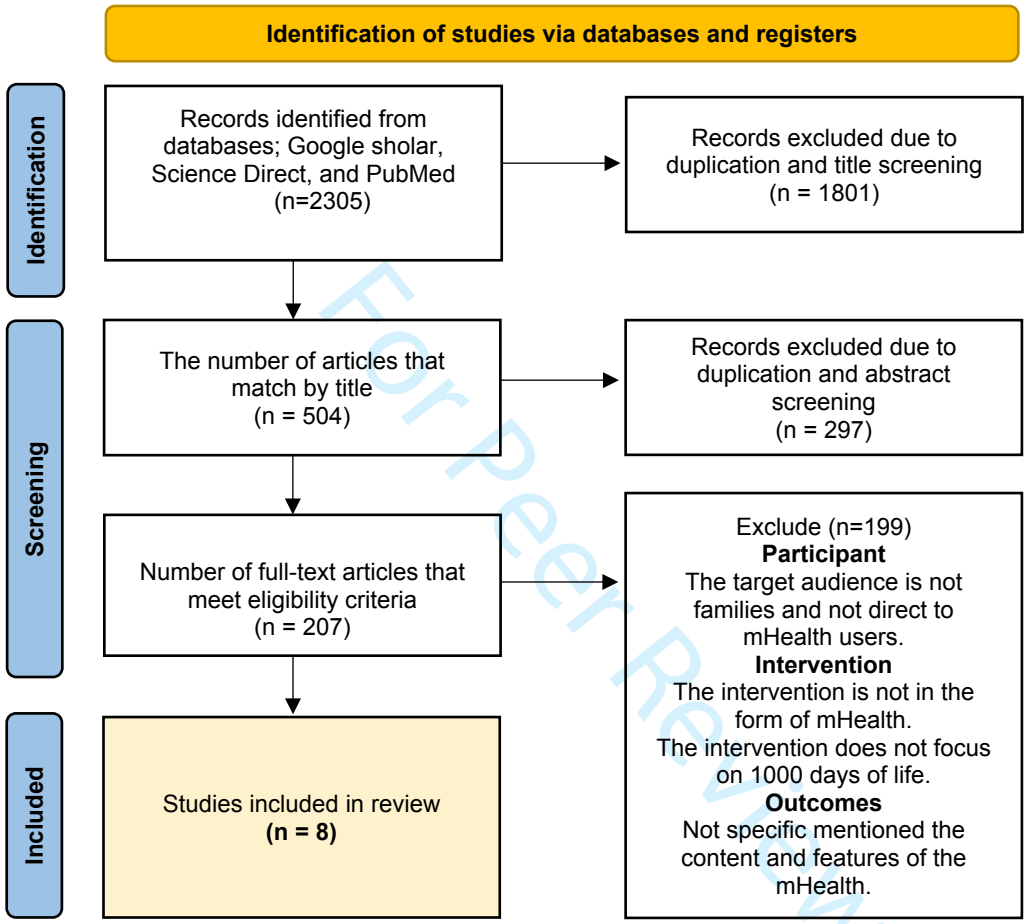

Figure 1. PRISMA flow chart of study selection

Content of the mHealth

There are several contents that we found from the mHealth studies which are included in this study. 1). All apps were specific and relevant to mHealth for maternal and child nutrition health at 1000 days of life. 2). All those apps also had appropriate content on the health of pregnant women or breastfeeding mothers, the health of children aged 0-24 months, early initiation of breastfeeding,

exclusive breastfeeding, complementary foods, immunization, measurement of nutritional status, and developmental measurement. 3). All apps reported reliable information that involves experts and is consistent with national guidelines. 4). All apps provided positive or affirmative content, not negative content. 5). All apps provided practical information that leads to real behavioral change such as how to overcome obstacles, motivation for behavioral change, how to improve a healthy lifestyle, and how to sustain the change of behavior). 5). Six apps were appropriate for societies with low health literacy, in which the apps using images or visual content. 6). A support function to assess personal health conditions, not only for physical problems but also for mental health. 7). All apps provide content that can start a conversation with a competent such as a doctor or other health worker. 8). Only one app had budget-friendly information. This means all the information can be read and accessed freely without any payment (Trude et al., 2021). 9). Six studies had content to self-monitoring. For example, to measure the body mass index of the mother or baby, hemoglobin status, etc. 10). Five apps using images or content that reflect cultural diversity.

Features of the mHealth

There are several features that we found from reviewed studies: 1). All apps had features involving the whole family and were specific features on the first 1000 days of life, such as breastfeeding assistance, playing with children, and cooking together. 2). Five apps using the apps that users can customize and personalize some features. For instance, an option to receive specific emails or texts; to select "yes" or "no" for certain application capabilities will be considered as personalization. 3). Four apps had features to send questions to healthcare professionals (via live face-to-face chat, video chat, and send messages). 4). Two apps had features to facilitate

community or ability to connect and interact with other users including social media discussion forums, achievement of ideas, achievements, and challenges, chat rooms. 5). Five apps had features with interesting and interactive components (videos, games, quizzes, image illustrations). 6). Three studies had tools and practical information and provided instructions on how to do the practice (a practical video of the easy exercise for pregnant women and the lactating process, exclusive breastfeeding, child growth monitor, BMI calculator, or content needed at the first 1000 days of life**.** 7). Four apps provided features of antenatal care, body mass index calculator, blood pressure, fundal height, tetanus immunization, Iron tablet consumption, and infectious diseases. 8). Two apps provide a nutritional status check feature for mothers. 9). One app that provided menus/recipes for complementary food for breastfeeding (easy to cook, cheap, child-friendly, and healthy). 9). Only one app provided information and reminders for immunization. 10). Two apps that provide nutritional status check features for children. 11). Two apps that provided child development assessment features. 12). Three apps provided an appointment/consultation reminder feature. 13). Five apps had a login feature for up to the first 1000 days of life (including parent and child login features). 14). Six apps had achievable and monitored goal setting, with feedback. 15). Five apps had map information on nearby health facilities.

Limitation of the mHealth

A research study by Rosawan Areemit in Thailand has a program called KhunLook App. Participants were parents that already well-educated and willing to try new technologies. However, the number of participants was too small to draw general conclusions (Areemit et al., 2020a). A study by Lisa Militello, in USA, has a program called SMILE Voice Mail (Self-Management Intervention-Life Essentials). In SMILE App technology for literacy measures was

not captured in this study. Another limitation is the basic functionality of the tested technology (voice-only interaction via mobile phone without multimodal and/or customized content). However, studies and interventions were conducted to discuss the feasibility of using sound in perinatal populations and to provide a starting point for future research. Thus, the effect of the application on Perinatal health education and health outcomes is not measured (Militello et al., 2021a).

In a study by Angela CB Trude in the USA, has a program called WhatsApp. First, no information was collected about Internet access and WhatsApp usage. Second, the control group was not considered because of the feasibility design to investigate the implementation of the intervention and acceptability, so causality could not be established (Trude et al., 2021). A study by Anne Caroline Benski, in the USA, has a program called Pregnancy and Newborn Diagnostic Assessment (PANDA). This study does not use control groups; no evaluation of mHealth use on maternal health status has been carried out (Benski et al., 2020). In a study by Victoria Lebrun, in USA, has a program called Mobile Alliance for Maternal Action (MAMA)/mHealth Voice mail and text messages. This study using only a single group, makes it difficult to attribute changes in knowledge, attitudes, and decision-making (Lebrun et al., 2020). Interestingly, no studies provide menus or recipes for pregnant and lactating women (fast, cheap, child-friendly, and healthy). This could be one of the features for creating an app.

Strength of the mHealth

The KhunLook Thailand app was created with the aim of child health surveillance, then developed and validated for growth assessment. The app was well received by parents as users (Areemit et al., 2020a). In a study by Lisa Militello in the USA, has a program called SMILE. This app's use of voice technology as a new strategy for collecting data and other ways to interact with

the pregnant population outside the clinic. Voice technology can help reduce barriers associated with literacy (e.g., spelling mistakes, mistyped words), support formative assessment, and involve social support beyond just the patient (Militello et al., 2021). In Australia introduce A Milk Man application is an acceptable source of information and breastfeeding support that is readily used by fathers and fathers-to-be during the perinatal period in assisting their partners. The application shows encouraging results by facilitating conversations between partners. The conversation forum is a success of the app, and the dads make suggestions for improvement. Gamification results vary but are a key motivator for some users (White et al., 2019). An app from Italy called hAPPyMamma contains information on health promotion and prevention and health services for pregnancy, childbirth, and postpartum, divided into thematic sections (Bonciani et al., 2021). mHealth has the potential to improve the quality of antenatal care and change patient behavior by increasing willingness to return at future visits and encouraging the early presence of antenatal care in pregnancy (Benski et al., 2020). In addition, in the USA mHealth can increase knowledge of maternal and child health; mHealth can involve all family members in decision-making and exchanging information/opinions (Lebrun et al., 2020). The mHealth from New Zealand is acceptable with minor modifications, potentially being an effective tool to support parents' understanding of assessing their child's growth and development (Humphrey et al., 2021).

DISCUSSION

Mobile technology offers unique opportunities to reach people with health promotion interventions. Several mHealth interventions have been developed to improve maternal and child nutrition outcomes (Areemit et al., 2020; Bonciani et al., 2021; Trude et al., 2021). Since these applications have considerable potential to improve maternal and child health, the quality of

mHealth must be monitored and managed by health professionals. From this perspective, the literature review conducted is very meaningful because it identifies content and features, to improve the applications that support pregnant women, breastfeeding mothers, or mothers of children aged 0-24 months. The results of this literature review can be used as material for consideration when application developers want to create similar applications, so they can carefully consider the technical aspects regarding the content, and features, of the existing applications before releasing the new apps.

Education is one of the key content areas of mHealth for mother and child nutrition health. Mobile applications can provide mothers with information on nutrition, breastfeeding, and complementary feeding, among other topics. These apps can also offer personalized recommendations based on the mother's location, cultural background, and the child's age and development. For example, the Alive & Thrive program in Vietnam developed a mobile application called NutriPhone, which provides mothers with information on breastfeeding and complementary feeding and a tool to track their child's growth (Doan et al., 2020).

In addition, another important content area is communication. Mobile technologies can facilitate communication between mothers and healthcare providers, allowing for remote consultations, follow-up appointments, and monitoring of health outcomes (Areemit et al., 2020; Bonciani et al., 2021; Militello et al., 2021). Another example, in rural India, a mHealth intervention called mDiabetes used mobile phone text messages to provide diabetes education and support to patients, resulting in improved glycemic control (Somannavar et al., 2008). Another study in Bangladesh found that a mobile phone-based counseling intervention increased exclusive breastfeeding rates and improved infant growth (Huda et al., 2020). Also a study conducted in

China found that a mobile phone-based platform for monitoring and reporting adverse events following immunization was effective in improving the timeliness and completeness of reporting. The platform allowed health workers to report adverse events in real-time, which enabled rapid response and intervention (Chen et al., 2018).

In addition to content, mHealth interventions for mother and child nutrition health should include several key features. First, they should be user-friendly and accessible, particularly for mothers who may have low levels of literacy, in low-resource settings or limited access to technology. Using multimedia, such as videos and graphics, can help overcome language barriers and improve engagement (Chacko et al., 2016). Second, mHealth interventions should be culturally appropriate and sensitive to the needs of the target population. This may include adapting content and language to local contexts, incorporating traditional practices and beliefs, and involving community members in the development and implementation process (Tomlinson et al., 2009). In addition, mHealth interventions should be designed to be sustainable and scalable. This may involve partnering with local organizations and government agencies to integrate mHealth into existing healthcare systems, and ensuring that the necessary infrastructure and resources are in place to support long-term implementation (Sant Fruchtman et al., 2021).

Another important feature of mHealth interventions for mother and child nutrition health is their ability to collect and analyze data, which can help identify patterns and trends in maternal and child health outcomes, as well as monitor the effectiveness of the interventions. This data can be used to inform decision-making and improve the quality of care. For example, a study conducted in Tanzania found that a mobile phone-based platform for monitoring maternal and child health outcomes was effective in improving the quality of care and reducing the incidence of adverse events (Tamrat & Kachnowski, 2012).

Moreover, mHealth interventions can also be used to improve maternal mental health, which is an important aspect of overall maternal and child health. A systematic review of mHealth interventions for maternal mental health found that these interventions can be effective in reducing symptoms of depression and anxiety, improving knowledge and attitudes about mental health, and increasing access to support services (Farrow et al., 2019).

Despite the potential benefits of mHealth, some several challenges and limitations need to be addressed. One challenge is ensuring that the interventions are accessible to all mothers, including those in low-resource settings and those who may not have access to mobile phones or other devices. Another challenge is ensuring that the interventions are evidence-based and tailored to the specific needs of the target population. Additionally, another challenge that needs to be addressed is ensuring the privacy and security of personal health information transmitted through mHealth interventions. This is particularly important given the sensitive nature of maternal and child health data. It is crucial to have appropriate security measures in place to protect the confidentiality of the data and to ensure compliance with data protection laws and regulations. The sustainability of mHealth interventions is a crucial aspect to consider. While many mHealth interventions have shown promising results in the short term, it is important to ensure that they can be sustained in the long term, both in terms of funding and technical support. Sustainability can be enhanced by involving local stakeholders in the design and implementation of interventions, building partnerships and collaborations, and incorporating mHealth into existing health systems (Tamrat & Kachnowski, 2012).

CONCLUSION

Existing mHealth provides content and features to support and improve the health status of pregnant women, breastfeeding mothers, and children aged 0-24 months. mHealth interventions have the potential to improve maternal and child nutrition health in the first 1000 days of life by providing education, communication, support, data collection and analysis, cultural appropriateness, accessibility, and capacity building for health workers. However, it is crucial to address challenges such as evidence-based design, privacy and security, sustainability, and data management, and to ensure cultural appropriateness and accessibility for all populations. The more complete the content, features, and uses of mHealth, the greater the users' acceptance.

REFERENCES

Areemit, R., Lumbiganon, P., Suphakunpinyo, C., Jetsrisuparb, A., Sutra, S., & Sripanidkulchai, K. (2020). A mobile app, KhunLook, to support Thai parents and caregivers with child health supervision: Development, validation, and acceptability study. *JMIR MHealth and UHealth*, *8*(10). https://doi.org/10.2196/15116

Benski, A. C., Schmidt, N. C., Viviano, M., Stancanelli, G., Soaroby, A., & Reich, M. R. (2020). Improving the quality of antenatal care using mobile health in madagascar: Five-year cross-sectional study. *JMIR MHealth and UHealth*, *8*(7). https://doi.org/10.2196/18543

Bonciani, M., de Rosis, S., & Vainieri, M. (2021a). Mobile health intervention in the maternal care pathway: Protocol for the impact evaluation of hAPPyMamma. *JMIR Research Protocols*, *10*(1). https://doi.org/10.2196/19073

Bonciani, M., de Rosis, S., & Vainieri, M. (2021b). Mobile health intervention in the maternal care pathway: Protocol for the impact evaluation of hAPPyMamma. *JMIR Research Protocols*, *10*(1), 1–14. https://doi.org/10.2196/19073

Braun, R., Catalani, C., Wimbush, J., & Israelski, D. (2013). Community Health Workers and Mobile Technology: A Systematic Review of the Literature. *PLoS ONE*, *8*(6). https://doi.org/10.1371/journal.pone.0065772

Chacko, A., Jensen, S. A., Lowry, L. S., Cornwell, M., Chimklis, A., Chan, E., Lee, D., & Pulgarin, B. (2016). Engagement in behavioral parent training: Review of the literature and implications for practice. *Clinical Child and Family Psychology Review*, *19*, 204–215.

Chen, S., Gong, E., Kazi, D. S., Gates, A. B., Bai, R., Fu, H., Peng, W., De La Cruz, G., Chen, L., & Liu, X. (2018). Using mobile health intervention to improve secondary prevention of coronary heart diseases in China: mixed-methods feasibility study. *JMIR MHealth and UHealth*, *6*(1), e7849.

Doan, T. T. D., Binns, C., Pham, N. M., Zhao, Y., Dinh, T. P. H., Bui, T. T. H., Tran, T. C., Nguyen, X. H., Giglia, R., & Xu, F. (2020). Improving breastfeeding by empowering mothers in Vietnam: A randomised controlled trial of a mobile app. *International Journal of Environmental Research and Public Health*, *17*(15), 5552.

Farrow, C., Belcher, E., Coulthard, H., Thomas, J. M., Lumsden, J., Hakobyan, L., & Haycraft, E. (2019a). Using repeated visual exposure, rewards and modelling in a mobile application to increase vegetable acceptance in children. *Appetite*, *141*, 104327.

Finucane, A. M., O'Donnell, H., Lugton, J., Gibson-Watt, T., Swenson, C., & Pagliari, C. (2021). Digital health interventions in palliative care: a systematic meta-review. *NPJ Digital Medicine*, *4*(1), 64.

Huda, T. M., Alam, A., Tahsina, T., Hasan, M. M., Iqbal, A., Khan, J., Ara, G., Ali, N. B., Al Amin, S. U., & Kirkwood, E. K. (2020). Shonjibon cash and counselling: a community-based cluster randomised controlled trial to measure the effectiveness of unconditional cash transfers and mobile behaviour change communications to reduce child undernutrition in rural Bangladesh. *BMC Public Health*, *20*(1), 1776.

Humphrey, G., Dobson, R., Parag, V., Hiemstra, M., Howie, S., Marsh, S., Morton, S., Mordaunt, D., Wadham, A., & Bullen, C. (2021). See How They Grow: Testing the feasibility of a mobile app to support parents' understanding of child growth charts. *Plos One*, *16*(2), e0246045.

Lebrun, V., Dulli, L., Alami, S. O., Sidiqi, A., Sultani, A. S., Rastagar, S. H., Halimzai, I., Ahmadzai, S., & Todd, C. S. (2020). Feasibility and acceptability of an adapted mobile phone message program and changes in maternal and newborn health knowledge in four provinces of Afghanistan: Single-group pre-post assessment study. *JMIR MHealth and UHealth*, *8*(7). https://doi.org/10.2196/17535

Lee, S. H., Nurmatov, U. B., Nwaru, B. I., Mukherjee, M., Grant, L., & Pagliari, C. (2016). Effectiveness of mHealth interventions for maternal, newborn and child health in low–and middle–income countries: Systematic review and meta–analysis. *Journal of Global Health*, *6*(1).

Meedya, S., Win, K., Yeatman, H., Fahy, K., Walton, K., Burgess, L., McGregor, D., Shojaei, P., Wheatley, E., & Halcomb, E. (2021). Developing and testing a mobile application for breastfeeding support: the Milky Way application. *Women and Birth*, *34*(2), e196–e203.

Midhet, F., & Becker, S. (2010). Impact of community-based interventions on maternal and neonatal health indicators: Results from a community randomized trial in rural Balochistan, Pakistan. *Reproductive Health*, *7*(1), 1–10.

Militello, L., Sezgin, E., Huang, Y., & Lin, S. (2021). Delivering perinatal health information via a voice interactive app (SMILE): Mixed methods feasibility study. *JMIR Formative Research*, *5*(3). https://doi.org/10.2196/18240

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., & Group, P.-P. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews*, *4*, 1–9.

Nikièma, L., Huybregts, L., Martin-Prevel, Y., Donnen, P., Lanou, H., Grosemans, J., Offoh, P., Dramaix-Wilmet, M., Sondo, B., & Roberfroid, D. (2017). Effectiveness of facility-based personalized maternal nutrition counseling in improving child growth and morbidity up to 18 months: A cluster-randomized controlled trial in rural Burkina Faso. *PloS One*, *12*(5), e0177839.

Nourani, A., Ayatollahi, H., & Mirnia, K. (2019). A smart phone application for the mothers of premature infants. *IRBM*, *40*(5), 263–269.

Nyang'echi, E., & Osero, J. (2021). Effects of mobile health technologies on uptake of routine growth monitoring among caregivers of children aged 9 to 18 months in Kenya. *Journal of Primary Care & Community Health*, *12*, 21501327211010996.

Olfert, M. D., Barr, M. L., Hagedorn, R. L., Long, D. M., Haggerty, T. S., Weimer, M., Golden, J., Maurer, M. A., Cochran, J. D., & Hendershot, T. (2019). Feasibility of a mhealth approach to nutrition counseling in an Appalachian state. *Journal of Personalized Medicine*, *9*(4), 50.

Paduano, S., Incerti, F., Borsari, L., Benski, A. C., Ernest, A., Mwampagatwa, I., Lilungulu, A., Masoi, T., Bargellini, A., Stornelli, F., Stancanelli, G., Borella, P., & Rweyemamu, M. A. (2022). Use of a mHealth System to Improve Antenatal Care in Low and Lower-Middle Income Countries: Report on Patients and Healthcare Workers' Acceptability in Tanzania. *International Journal of Environmental Research and Public Health*, *19*(22). https://doi.org/10.3390/ijerph192215342

Pagliari, C., Sloan, D., Gregor, P., Sullivan, F., Detmer, D., Kahan, J. P., Oortwijn, W., & MacGillivray, S. (2005). What is eHealth (4): a scoping exercise to map the field. *Journal of Medical Internet Research*, *7*(1), e391.

Reyes, J., Washio, Y., Stringer, M., & Teitelman, A. M. (2018). Usability and acceptability of everhealthier women, a mobile application to enhance informed health choices. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *47*(6), 853–861.

Rich, E., & Miah, A. (2014). Understanding digital health as public pedagogy: A critical framework. *Societies*, *4*(2), 296–315.

Rinawan, F. R., Susanti, A. I., Amelia, I., Ardisasmita, M. N., Dewi, R. K., Ferdian, D., Purnama, W. G., & Purbasari, A. (2021). Understanding mobile application development and implementation for monitoring Posyandu data in Indonesia: A 3-year hybrid action study to build "a bridge" from the community to the national scale. *BMC Public Health*, *21*, 1–17.

Ruel, M. T., Menon, P., Habicht, J.-P., Loechl, C., Bergeron, G., Pelto, G., Arimond, M., Maluccio, J., Michaud, L., & Hankebo, B. (2008). Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial. *The Lancet*, *371*(9612), 588–595.

Sant Fruchtman, C., Mbuyita, S., Mwanyika-Sando, M., Braun, M., de Savigny, D., & Cobos Muñoz, D. (2021). The complexity of scaling up an mHealth intervention: the case of SMS for Life in Tanzania from a health systems integration perspective. *BMC Health Services Research*, *21*(1), 1–11.

Selem-Solís, J. E., Alcocer-Gamboa, A., Hattori-Hara, M., Esteve-Lanao, J., & Larumbe-Zabala, E. (2018). Nutrimetry: BMI assessment as a function of development. *Endocrinología, Diabetes y Nutrición (English Ed.)*, *65*(2), 84–91.

Shaw, J., Jamieson, T., Agarwal, P., Griffin, B., Wong, I., & Bhatia, R. S. (2018). Virtual care policy recommendations for patient-centred primary care: findings of a consensus policy dialogue using a nominal group technique. *Journal of Telemedicine and Telecare*, *24*(9), 608–615.

Somannavar, S., Lanthorn, H., Pradeepa, R., Narayanan, V., Rema, M., & Mohan, V. (2008). Prevention awareness counselling and evaluation (PACE) diabetes project: a mega multi-pronged program for diabetes awareness and prevention in South India (PACE-5). *Journal of Association of Physicians of India*, *56*(6), 429–435.

Sondaal, S. F. V., Browne, J. L., Amoakoh-Coleman, M., Borgstein, A., Miltenburg, A. S., Verwijs, M., & Klipstein-Grobusch, K. (2016). Assessing the effect of mHealth interventions in improving maternal and neonatal care in low-and middle-income countries: a systematic review. *PloS One*, *11*(5), e0154664.

Tamrat, T., & Kachnowski, S. (2012). Special delivery: an analysis of mHealth in maternal and newborn health programs and their outcomes around the world. *Maternal and Child Health Journal*, *16*(5), 1092–1101.

Tomlinson, M., Solomon, W., Singh, Y., Doherty, T., Chopra, M., Ijumba, P., Tsai, A. C., & Jackson, D. (2009). The use of mobile phones as a data collection tool: a report from a household survey in South Africa. *BMC Medical Informatics and Decision Making*, *9*(1), 1–8.

Trude, A. C. B., Martins, R. C., Martins-Silva, T., Blumenberg, C., Carpena, M. X., Del-Ponte, B., & Loret de Mola, C. (2021a). A WhatsApp-Based Intervention to Improve Maternal Social Support and Maternal–Child Health in Southern Brazil: The Text-Message Intervention to Enhance Social Support (TIES) Feasibility Study. *Inquiry (United States)*, *58*, 1–11. https://doi.org/10.1177/00469580211048701

Trude, A. C. B., Martins, R. C., Martins-Silva, T., Blumenberg, C., Carpena, M. X., Del-Ponte, B., & Loret de Mola, C. (2021). A WhatsApp-Based Intervention to Improve Maternal Social Support and Maternal–Child Health in Southern Brazil: The Text-Message Intervention to Enhance Social Support (TIES) Feasibility Study. *Inquiry (United States)*, *58*. https://doi.org/10.1177/00469580211048701

Victora, C. G., Adair, L., & Fall, C. (2008). Maternal and child undernutrition: consequences for adult health and human capital (vol 371, pg 340, 2008). *Lancet*, *371*(9609), 302.

White, B., Giglia, R. C., White, J. A., Dhaliwal, S., Burns, S. K., & Scott, J. A. (2019a). Gamifying breastfeeding for fathers: Process evaluation of the milk man mobile app. *JMIR Pediatrics and Parenting*, *2*(1). https://doi.org/10.2196/12157

White, B., Giglia, R. C., White, J. A., Dhaliwal, S., Burns, S. K., & Scott, J. A. (2019b). Gamifying breastfeeding for fathers: Process evaluation of the milk man mobile app. *JMIR Pediatrics and Parenting*, *2*(1). https://doi.org/10.2196/12157

Wunsch, K., Eckert, T., Fiedler, J., Cleven, L., Niermann, C., Reiterer, H., Renner, B., & Woll, A. (2020). Effects of a collective family-based mobile health intervention called "SMARTFAMILY" on promoting physical activity and healthy eating: protocol for a randomized controlled trial. *JMIR Research Protocols*, *9*(11), e20534.

Zhang, Q., Zhang, J., Park, K., & Tang, C. (2021). App usage associated with full redemption of WIC food benefits: A propensity score approach. *Journal of Nutrition Education and Behavior*, *53*(9), 779–786.

Table 1. The content, features, and uses of mHealth to support maternal and child nutritional health in the first 1000 days of life.

Author/Year/ Location	***Rosawan Areemit, et al, 2020, Thailand*** (Areemit et al., 2020b)	***Lisa Militello, et al, 2021, United States***(Militello et al., 2021b)	***Becky White, et al, 2019, Australia*** (White et al., 2019b)	***Angela CB Trude , et al, 20 21, USA(***[1](Trude et al., 2021c)	***Manila Bonciani, 2021, Italy***(Bonciani et al., 2021b)	***Anne Caroline Benski, et al 2020, USA***(Benski et al., 2020c)	***Victoria Lebrun, et al, 2020, USA***(Lebrun et al., 2020b)	***Gayl Humphrey, et al, 2021, New Zealand***(Humphrey et al., 2021b)***ne Benski, et al 2020, USA***(Benski et al., 2020c)	***Victoria Lebrun, et al, 2020, USA***(Lebrun et al., 2020b)	***Gayl Humphrey, et al, 2021, New Zealand***(Humphrey et al., 2021b)
Program Name/ Forms of mHealth/ Service providers	KhunLook App (Can be accessed using Android or IOS)	SMILE Voice Mail (Self-Management Intervention–Life Essentials)/ Accessible using IOS system	mHealth Milk Man (Can be accessed using IOS and Android systems)	WhatsApp (Can be accessed using Android or IOS)	hAPPyMamma	Pregnancy and Newborn Diagnostic Assessment (PANDA)/ (Can be accessed using Android)	Mobile Alliance for Maternal Action (MAMA)/ mHealth Voice mail and text messages	mHeath See How They Grow		
Study Characteristics	**Study design**: Focus Group (FG) **Research Method**: Mix Method; Qualitative, Quasi-experimental; Surveys with structured questionnaires.	**Study design**: Feasibility Study Research **Methods**: Mixed Methods **Research Sample**: Pregnant women with a gestational age range of 17 to 36 weeks (n = 9	**Study design**: RCT Research **Methods**: Mixed Methods **Research Sample**:	**Study design**: Pre/Post without control group **Research Methods**: prospective cohort **Research Sample**:	**Study design**: Pre/Post with Research Methods control group: prospective cohort.	**Study design**: Cross Sectional Study **Research Methods**: observational study **Research Sample**:	**Study design**: single group **Research Methods**: Baseline/Follow-up Study **Research Sample**:	**Study design**: Focus Group (FG) **Research Methods**: Online-based surveys		

	Research Sample: Develop and expert (n = 12), parents (n = 8) ; Validity of growth assessment on an application using 2 groups, intervention group using application (n = 34), and control group given MCH book (n = 22) ; Parental evaluation of application eligibility and acceptance (n=356)		Spouses of pregnant women recruited from public and private hospitals and have downloaded the Milk Man app (n=586)	Mother (n=30)	**Research Sample**: Women who are planning a pregnancy or are already pregnant (<13 weeks of pregnancy) aged 18-45 years, and divided into 2 groups; Control group (n=109), intervention group (n=109)	Pregnant Women (n=1446)	Families with children under 12 months (Husband/ Wife) (n=729)	**Research Sample**: parents/caregivers (n=101)
Program Originator (Organization/ government agencies/ University/ Medical professional/ Founder or another organizer)	Faculty of Medicine, Khon Kaen University, Thailand	The SMILE app was developed in partnership with Duet Health	Not mentioned	Not mentioned	Government of Tuscany, and involving researchers Sant'Anna School, which facilitates the application design process and evaluates the results of these innovations	In cooperation with the Ministry of Health of Madagascar	Not mentioned	Not mentioned
CONTENT								

Specific and relevant for maternal and child nutrition health at the first 1000 day of life	✓	✓	✓	✓	✓	✓	✓	✓
Appropriate content/feedback (health of pregnant women/breastfeeding mothers, health of children aged 0-24 months, early initiation of breastfeeding, exclusive breastfeeding, complementary foods, immunization, measurement of nutritional status, developmental measurement, other health problems)	✓	✓	✓	✓	✓	✓	✓	✓
Reliable information (involving experts in their field, has passed the valid process of it, consistent with national guidelines)	✓	✓	✓	✓	✓	✓	✓	✓
Positive/affirmative content, not negative content	✓	✓	✓	✓	✓	✓	✓	✓
Practical information and leads to real change (overcoming obstacles, motivating change, improving business, and sustaining change)	✓	✓	✓	✓	✓	✓	✓	✓
Suitable for low literacy (apps using images/visual content)	✓		✓	✓	✓	✓		✓

There is a support function (Informational/Instrumental/Emotional/Assessment)	✓	✓	✓	✓	✓	✓	✓	✓
Content that can start a conversation with a competent doctor/health worker	✓			✓	✓			
Budget-friendly information				✓				
Need to monitor myself	✓		✓	✓	✓	✓		✓
Images/content that reflects cultural diversity	✓		✓		✓	✓		✓
FEATURES								
Features involving the whole family (with the first 1000 days of life content, such as breastfeeding assistance, playing with children, cooking together)	✓	✓	✓	✓	✓	✓	✓	✓
Have the ability to customize and personalize some features (e.g., opting in to receive specific emails or texts; To select "yes" or "no" for certain application capabilities will be considered as personalization)		✓	✓		✓	✓		✓
Ability to send questions to healthcare professionals (via live pr				✓	✓		✓	✓

face-to-face chat, video chat, send messages)						
Features facilitate community/ability to connect/interact with other users including social media discussion forums, achievement of ideas, achievements, and challenges, chat rooms			✓	✓		
Features with interesting and interactive components (videos, games, quizzes, image illustrations)	✓		✓	✓	✓	✓
Tools and practical information, and provide instructions on how to do the practice (Video demonstrating, health of pregnant and lactating women, exclusive breastfeeding, child growth monitor, BMI calculator, or content needed at the first 1000 DoL)	✓		✓	✓		
Provides features antenatal, BMI calculator, blood pressure, fundal height, Tetanus immunization, Fe tablet consumption, and infectious diseases		✓		✓	✓	✓

Provide menus/recipes for pregnant and lactating women (fast, cheap, child-friendly, and healthy)							
Provides nutritional status check feature for mothers			✓		✓		
Provide menus/recipes for MP-ASI (fast, cheap, child-friendly, and healthy)			✓				
Provides immunization reminder	✓						
Provide nutritional status check feature for children	✓						✓
Provide child development assessment features	✓						✓
Provides appointment/consultation reminder feature	✓		✓		✓		
Login feature up to the first 1000 days of life (including parent and child login feature)	✓		✓	✓	✓		✓
Achievable and monitored goal setting, with feedback	✓	✓	✓	✓	✓		✓
There are resources related to the area where it is located near	✓			✓	✓	✓	✓
LIMITATIONS							
	The results of this study are interpretations of a specific time and do not reflect current applications. The	Detailed assessment Sociodemographic data and health and technology literacy measures	First, no information was collected about Internet access and		Do not use control groups; no evaluation of mHealth use on	Using only a single group, making it difficult to attribute	

	development of "KhunLook" in phases 1 and 2 involved a sample of parents in a university hospital. Most parents were well educated and willing to try new technologies but the number of participants was too small to draw general conclusions	was not captured in this study. Another limitation is the basic functionality of the tested technology (voice-only interaction via mobile phone without multimodal and/or customized content). However, studies and interventions were conducted to discuss the feasibility of using sound in perinatal populations and to provide a starting point for future research. Thus, the effect of the application on Perinatal health education and health outcomes are not measured.		WhatsApp usage. Second, the control group was not considered because of the feasibility design to investigate the implementation of the intervention and acceptability, so causality could not be established		maternal health status has been carried out	changes in knowledge, attitudes, and decision-making
STRENGTH							
	The KhunLook Thailand app was created with the aim of child health surveillance, then developed and validated for growth assessment; The app was well received for by parents as users.	Voice technology is a new strategy for collect data and other ways to interact with the pregnant population outside the clinic. Voice technology can help reduce barriers associated with literacy (e.g., spelling mistakes, mistyped words), support formative assessment, and involve social	AMilk Man application is an acceptable source of information and breastfeeding support that is readily used by fathers and fathers-to-be during the perinatal period in		hAPPyMamma contains information on health promotion and prevention and health services on pregnancy, childbirth, and postpartum, divided into	mHealth has the potential to improve the quality of ANC, and change patient behavior by increasing willingness to return at future visits and encouraging	mHealth is able to increase knowledge of maternal and child health; mHealth can involve all family members in decision making and exchanging	The mHealth app is acceptable with minor modifications, potentially being an effective tool to support parents' understan

	support beyond just the patient.	assisting their partners. The application shows encouraging results by facilitating conversations between partners. The conversation forum is definitely a success of the app, and the dads make suggestions for improvement. Gamification results vary, but are a key motivator for some users	thematic sections	the presence of ANC early in pregnancy.	informatio n/opinions	ding of assessing their child's growth and developm ent.