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MOBILE LEARNING APPLICATIONS AND CHANGES IN MATERNAL BEHAVIOR IN THE PROVISION OF FOOD FOR CHILDREN: SYSTEMATIC REVIEW

13 Daniel Akbar Wibowo[1], Yulia Lanti Retno Dewi[2], Nur Hafidha Hikmayani[3], Dini Nurbaeti Zen[4]

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ABSTRACT

Background: Nutritional problems among children, especially in developing countries, remain a significant concern. Stunting, underweight, and malnutrition are prevalent due to inadequate dietary intake and poor maternal education. Mobile learning (m-learning) applications have emerged as potential tools to enhance maternal knowledge and improve child nutrition. This 1 study systematically reviews existing literature to assess the impact of m-learning applications on changing maternal behavior in the provision of food for children.

Method: This systematic literature review follows the PRISMA guidelines. The review was conducted in August 2024, covering studies published from 2014 to 2024. Databases including 55 Scopus, PubMed, and Crossref were searched using relevant keywords. A total of 348 articles were identified, with 30 meeting the inclusion criteria for final analysis. The selected studies were analyzed to evaluate the effectiveness of m-learning applications in altering maternal behavior related to food provision.

Results: The review indicates that m-learning applications significantly enhance maternal knowledge and positively influence food provision behaviors. However, the effectiveness of 68 these applications is influenced by factors such as socio-economic status, cultural context, and the usability of the application. Personalized feedback, community support, and interactive features within the applications are crucial for achieving behavior change.

Conclusions: M-learning applications hold substantial potential for improving maternal behavior in food provision, thereby enhancing child nutrition. Future developments should focus on culturally relevant content, user-friendly interfaces, and integrating community support mechanisms to maximize the effectiveness of these interventions.

Keywords: Mobile learning, Maternal behavior, Child nutrition, Dietary practices, Systematic review

INTRODUCTION

Nutritional problems in children, particularly in developing countries, remain a major concern. One of the most critical aspects of child nutrition in developing countries is the prevalence of stunting, wasting, and underweight conditions. According to the World Health Organization, approximately 149 million children under five years of age were stunted globally in 2021, with 45 million suffering from wasting (Larsen et al., 2023). These conditions are often exacerbated by inadequate dietary intake, poor feeding practices, and high rates of infectious diseases, which are prevalent in many low- and middle-income countries (LMICs) (Ahmed et al., 2012).

In Indonesia, stunting reported around 30% among children under five years old in Indonesia (Khoe et al., 2022). This undernutrition is often exacerbated by inadequate dietary intake, poor maternal education, and limited access to healthcare services (Silva & Sumarto, 2018). The SEANUTS study indicated that a significant proportion of Indonesian children consume less than the recommended dietary allowances for energy and essential nutrients, leading to deficiencies that can have long-term health implications (Sandjaja et al., 2013). On the other hand, the prevalence of overweight and obesity among children has increased significantly, particularly in urban areas. Recent studies indicate that childhood obesity rates have risen from 5.1% in 1993 to 15.6% in 2014, with urban children being disproportionately affected (Khoe et al., 2022). Additionally, dietary patterns have shifted towards higher consumption of processed foods and sugary beverages, which are linked to obesity (Oddo et al., 2019). A study in rural Central Java found that nearly 40% of households experienced this double burden, indicating a significant increase from previous years (Lowe et al., 2021). This phenomenon is particularly concerning as it suggests that while some children may be overweight, others are simultaneously suffering from undernutrition, leading to adverse health outcomes. Mothers play a central role in food provision for their children, and their knowledge and behavior regarding nutrition significantly influence the quality of food provided.

In the digital age, mobile learning (m-learning) applications offer new opportunities to improve mothers' nutritional knowledge. A pilot randomized controlled trial in Uganda found that a mobile health app significantly enhanced maternal health knowledge, which is crucial for improving child nutrition and health outcomes (Musiimenta et al., 2022). Other study highlighted that nutrition-related mobile apps can lead to positive changes in dietary behaviors by increasing self-efficacy and autonomy among users (West et al., 2017). Mobile applications can provide accessible, interactive, and personalized nutritional information. Studies have demonstrated that nutrition-related apps can effectively enhance dietary quality, increase physical activity, and reduce body mass index (BMI) among children (Francis et al., 2023). The potential for mobile apps to provide personalized feedback and resources is particularly beneficial for parents seeking to navigate the complexities of child nutrition (Uribe et al., 2021). Moreover, the ability to access a wealth of information through mobile platforms can empower mothers, especially those from diverse backgrounds, to make informed dietary choices for their families (Hughson et al., 2018). However, it remains unclear how effective m-learning is in changing mothers' behavior regarding food provision for their children.

Although there is research on m-learning and nutrition, many studies only measure knowledge improvement, not actual behavior change. This research aims to identify and evaluate evidence from existing research on the influence of m-learning applications on changes in mothers' behavior in food provision for their children, assess the effectiveness of m-

learning in improving the quality of food provided by mothers to their children, identify factors that influence the effectiveness of m-learning in this context, and provide recommendations for the development and implementation of m-learning applications for mothers' nutrition education. By conducting this systematic literature review, it is hoped that this research can contribute to efforts to improve children's nutrition through the utilization of m-learning technology.

METHODS

The Review Protocol

The protocol was formulated considering the suggestions of the Cochrane Collaboration for systematic reviews and con-forming with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) Statement recommendations (Page et al., 2021).

Focus Question

The PICO framework was used to form the following focus question: "does mobile learning applications affects change in maternal behavior in the provision of food for children?"

- Population: mother as a user of mobile learning or mobile applications related to behavior change in the provision of food for children
- Intervention: Multiple interventions to mobile learning or mobile applications user related to the provision of food for children
- Comparison: This study compares the knowledge and behavior of users who use mobile learning or mobile applications related to behavior in the provision of food for children
- Outcome: Factors that affect the effectiveness the use of mobile learning or mobile applications related to behavior in the provision of food for children

Search Strategy

This study is a systematic literature review to determine the effect of mobile learning applications and changes in maternal behavior in the provision of food for children. A literature search was conducted in August 2024. The literature was obtained from reputable international journal articles from Scopus, PubMed, and Crossref databases. Keywords related to "mobile learning", "mobile application", "e-learning", "mother", "maternal", "behaviour" and obtained 129 documents. Articles included in the search were those published in English from 2014-2024. During the search process, researcher used Boolean operators and wildcard characters precisely to focus our search and detect the singular or plural form of the same term in all databases used.

Study Selection and Eligibility Criteria

The data collection approach for this systematic literature review commenced with an article search. In order to mitigate errors and potential bias in the article selection process, a minimum of two researchers independently assessed each paper. The researchers applied a filtering process based on the title and abstract of article, followed by a thorough evaluation of the entire text of possibly relevant articles. As a result, 30 articles were deemed suitable for inclusion in the study. Researchers collected and combined pertinent data from an additional 30 articles, including title, author and year, aims, samples, research methods, and research findings. Ultimately, a narrative synthesis was conducted to succinctly describe the results and discern recurring patterns and themes across the study. A systematic review is a rigorous research approach that can be employed to address these inquiries. Systematic reviews can amalgamate findings from multiple-research to offer more robust evidence regarding the effectiveness of different types of interventions on improving the utilization of health facilities for childbirth. The inclusion and exclusion criteria in this study can be seen in table 1.

Table 1 Inclusion and Exclusion Criteria

Inclusion	Exclusion
Article that discusses the effect of mobile learning applications and changes in maternal behavior in the provision of food for children	Articles that are not related to the effect of mobile learning applications and changes in maternal behavior in the provision of food for children
Research article	Non research article
English documents	Non-English documents
Published year 2014-2024	Published outside 2014-2024
Available in full text	Not available full text
Open access	Non-open access
Research conducted in different countries	
Quantitative, qualitative, experimental research methods	Systematic review method, literature review, non-research

RESULT

Based on search results using preset keywords and inclusion criteria, 348 potential papers were first obtained from three literature databases: Scopus (N = 142), PubMed (N = 49), and Crossref (N = 157). Following the title screening process, 201 articles with relevant titles were identified. After removing duplicate papers (N = 14), those not published between 2014 and 2024 (N = 4) and non-open access articles (N = 10). A subsequent screening of abstracts resulted in the review of 173 papers, with 143 abstracts failing to meet the set criteria. A subsequent full-text inspection was performed to determine eligibility, resulting in the inclusion of 30 papers in the study.

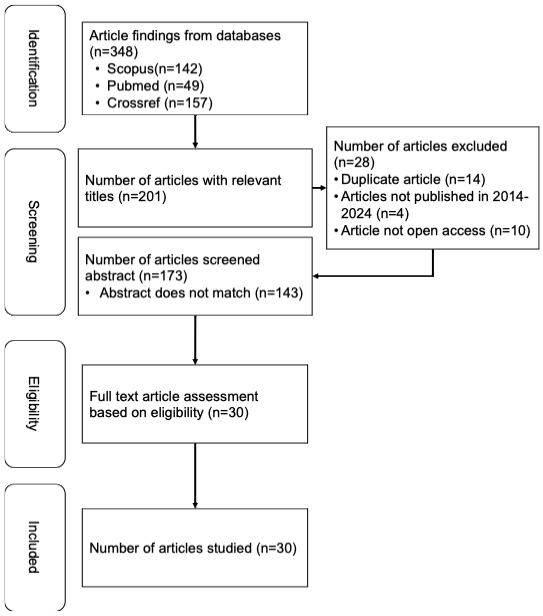

Figure 1 Article extraction process flowchart

Table 2 Article Extraction Result

Title, Author, Year	Aim	Sample	Method	Result
"In the Past, the Seeds I Planted Often Didn't Grow." a Mixed-Methods Feasibility Assessment of Integrating Agriculture and Nutrition Behaviour Change Interventions With Cash Transfers in Rural Bangladesh (Naveed et al., 2020)	The aims of the study were to assess the feasibility and acceptability of integrating agriculture and nutrition behavior change interventions with cash transfers to improve maternal and child nutrition among poor and nutrition-insecure households in rural Bangladesh	The study involved a total of 60 women from low-income families in rural Bangladesh, with data collected through in-depth interviews with 20 women and key-informant interviews with 6 project workers	The study employed a mixed-methods approach, combining qualitative and quantitative data collection. Qualitative data were gathered through in-depth interviews and focus groups, while quantitative data were collected via structured surveys to assess socio-demographic characteristics, participation in counseling, and cash transfer utilization	The results indicated that the integrated intervention of nutrition education, agriculture counseling, and cash transfers was feasible and acceptable. Participants reported increased awareness of nutritious food benefits, improved spending on food for their families, and enhanced decision-making power regarding cash use.
The Effectiveness of Using Mobile Learning Application on Undergraduates' Intrinsic Motivation and Their General Nutrition Knowledge (AlKasasbeh, 2023)	The aims of the study were to evaluate the effectiveness of a mobile learning application on enhancing undergraduates' intrinsic motivation and improving their general nutrition knowledge. The research sought to provide practical interventions tailored to individual needs and to explore the impact of mobile technology on educational outcomes among Jordanian university students	The study involved a total of 125 undergraduate students from a private university in Jordan, divided into two groups: a control group of 62 students and an experimental group of 63 students. Participants were enrolled in the 'Sports and Health' course during the first semester of the academic year 2022–2023	The study employed a quasi-experimental design with two groups. Both groups received nutrition lessons via Moodle, but the experimental group also participated in a one-hour online training using the Calorie Counter by Fat Secret app. Data on intrinsic motivation and nutrition knowledge were collected through pre-tests and post-tests administered to both groups	The results indicated that the experimental group, which used the mobile learning application, showed a significant improvement in nutrition knowledge compared to the control group. However, there were no statistically significant differences in intrinsic motivation between the two groups
Interactive Cause and Effect Comic-Book Storytelling for Improving Nutrition Outcomes in Children (Amresh et al., 2015)	The aims of the interactive cause and effect comic-book storytelling project are to improve nutrition outcomes in children by educating them about healthy eating and physical activity through engaging narratives. The approach seeks to enhance knowledge retention, encourage shared learning between parents and children, and promote positive behavior changes related to nutrition and exercise	The samples for the study included 150 parent/child dyads, with a focus on Hispanic families, particularly those with children in pediatric emergency settings and family learning centers. The research involved usability testing and feedback from 82 participants collected between December 2013 and March 2014	The methods involved conducting a bilingual needs assessment survey to assess dietary habits and exercise patterns among Latino parent-child dyads. This survey was implemented over 14 weeks and utilized touch screen tablets for data collection. Additionally, storyboard development for the interactive intervention was guided by a nutritional specialist to ensure cultural relevance and effectiveness	The results indicated successful usability testing and positive feedback from participants regarding the interactive storytelling intervention. The majority of parents recognized the importance of healthy eating and physical activity for their children, while barriers to healthy eating were identified, such as time constraints and lack of control over children's diets

Title, Author, Year	Aim	Sample	Method	Result
Association Between Maternal and Child Dietary Diversity: An Analysis of the Ghana Demographic and Health Survey (Amugsi et al., 2015)	The aim of the study was to investigate the relationship between maternal dietary diversity (DD) and child dietary diversity (DD) in Ghana, while accounting for various maternal and household factors. The research sought to understand how maternal nutrition influences child health and dietary practices, emphasizing the importance of feeding children a diverse range of foods during the critical early years of life	The study used data from the 2008 Ghana Demographic and Health Survey, focusing on a sample of 1,187 mother-child dyads, where mothers were aged 15-49 and their youngest children were aged 6-36 months. The dietary diversity scores for both mothers and children were based on their reported consumption of 15 food groups in the 24 hours prior to the survey	The study used data from the 2008 Ghana Demographic and Health Survey, focusing on a sample of 1,187 mother-child dyads, where mothers were aged 15-49 and their youngest children were aged 6-36 months. The dietary diversity scores for both mothers and children were based on their reported consumption of 15 food groups in the 24 hours prior to the survey	The results indicated a strong association between maternal dietary diversity and child dietary diversity, even after adjusting for various demographic and socio-economic factors. Mothers consumed a greater variety of food groups compared to their children, suggesting that not all foods consumed by mothers were provided to their children. The findings highlight the importance of improving maternal nutrition to enhance child dietary practices
A Web-Based Gamification Program to Improve Nutrition Literacy in Families of 3- To 5-Year-Old Children: The Nutriscience Project (Azevedo et al., 2019)	The aims were to improve nutrition literacy among families of 3- to 5-year-old children through a web-based gamification program. The project focused on enhancing knowledge about healthy food choices, promoting the consumption of fruits and vegetables, and reducing the intake of sugar and salt, while involving parents, children, and educators in the learning process	The study involved a convenience nonrandom sample of 37 kindergartens, which included 59 classrooms and 877 families. Out of these, 32 kindergartens were allocated to the intervention group and 5 to the control group. Ultimately, 106 families from the intervention group and 83 from the control group completed pre and post questionnaires assessing nutrition literacy	The methods used in the Nutriscience Project included a quasi-experimental design with a web-based platform for the intervention. Families participated in educational activities, uploaded content related to nutrition challenges, and completed self-reported surveys assessing nutrition literacy across four dimensions. The impact was analyzed using general linear models with repeated measures to evaluate changes in nutrition literacy scores before and after the intervention	The results of the Nutriscience Project indicated a significant improvement in nutrition literacy scores for the intervention group, with a final mean score of 78.8% compared to a baseline score of 72.7% ($P < .001$). In contrast, the control group showed no significant change in scores, highlighting the effectiveness of the web-based gamification program in enhancing nutrition literacy among participating families
Assessment of Maternal Nutritional Knowledge and Its Predictors Among Mothers Attending an Urban Primary Health Care Unit in Giza (Esmat et al., 2023)	The aim of the study was to assess the level of maternal nutritional knowledge and its predictors among mothers with children aged 0–42 months attending an urban primary health care unit in Giza, Egypt. The research sought to understand how maternal education, occupation, age, and number of children influence nutritional knowledge, which is	The study included a sample of 288 mothers who had children aged between 0 to 24 months, conveniently recruited from an urban primary health care center in Giza, Egypt	The study employed a cross-sectional design, using a specially designed close-ended Arabic questionnaire to assess maternal nutritional knowledge through face-to-face interviews. Statistical analyses, including Mann-Whitney, Kruskal-Wallis, and Spearman's correlation tests, were conducted to explore associations between	The results indicated that participating mothers had a fair to good level of nutritional knowledge, with a mean score of 13.31 out of 20. Significant associations were found between maternal nutritional knowledge and factors such as education level, occupation, and residence, while a negative correlation was observed with the number of children. Most

Title, Author, Year	Aim	Sample	Method	Result
	crucial for preventing malnutrition in children during their critical early years		various factors and the total knowledge score	infants in the study had normal weight-for-age growth rates
Increasing Access to Healthful Foods: A Qualitative Study With Residents of Low-Income Communities (Evans et al., 2015)	The aim of the study was to gather low-income community members' opinions about their food purchasing choices and their perceptions of effective ways to increase access to healthful foods in their communities	The study included a total of 148 participants from 13 focus groups, primarily consisting of low-income individuals living in food desert areas in central Texas. The majority were female and ethnically diverse, with 63% Hispanic, 17% African American, and 16% Caucasian	The study employed focus group discussions conducted in both English and Spanish, using a standardized protocol with open-ended questions. Participants completed socio-demographic and food behavior surveys, and thematic content analysis was performed on the qualitative data using the QSR NVivo software	The results indicated that participants had a high level of knowledge about healthful eating but faced significant barriers, including high prices, inadequate geographic access, and poor quality of available healthful foods. Suggested solutions included the establishment of new supermarkets and support for farmers' markets and community gardens
Nutrition Interventions for Improving Nutritional Status of Toddlers in Cirebon Regency Indonesia (Farisita, 2021)	The aims of the study were to analyze the differences in nutritional knowledge, attitudes, and practices of mothers of children under five before and after nutrition education interventions, as well as to assess the nutrient intakes and nutritional status of the toddlers before and after receiving supplementation with eggs and milk for 90 days	The study involved 58 mothers and their children under five years old, specifically targeting toddlers aged 6-59 months who lived with their mothers and met the inclusion criteria	The study employed a pre-experimental design with a one-group pre and posttest approach. It included nutrition education for mothers over three meetings and provided supplementary feeding of eggs and milk to toddlers for 90 days. Data collected encompassed socio-demographic information, nutritional knowledge, attitudes, practices, nutrient intakes, and nutritional status	The results indicated that nutrition education significantly improved mothers' nutritional knowledge and practices, with knowledge scores increasing from 59.9 to 69.4 (p=0.001) and practice scores from 76 to 83 (p=0.000). However, the nutritional status of toddlers showed no significant change post-intervention, with stunting rates remaining similar before and after the intervention
Additional Risk Factors for Malnutrition in Children Infected With HIV (Félicitée et al., 2018)	The aims of the study were to identify additional risk factors for malnutrition in children infected with HIV and to evaluate the dietary habits and nutritional status of these children, focusing on the impact of various sociodemographic and health-related factors on their nutrition	The study sampled children infected with HIV aged between 6 to 59 months who were followed up at the day unit of the mother and child center in Yaoundé, Cameroon. A total of 200 mothers/guardians were interviewed regarding their children's dietary practices and sociodemographic characteristics	The study employed a transversal design, utilizing semi-structured interviews with mothers/guardians to gather data on sociodemographic and economic characteristics, as well as dietary habits. A dietary recall method was used to assess food consumption over the previous three days, and the Individual Dietary Diversity Score (IDDS) was calculated based on the variety of food groups consumed	The study found a prevalence of malnutrition at 22% among the children infected with HIV, with the highest rates observed in those aged 12-35 months. Factors such as low maternal education, dietary restrictions, and inadequate dietary diversity were associated with higher malnutrition rates. Additionally, most mothers had knowledge of malnutrition, but many did not

Title, Author, Year	Aim	Sample	Method	Result
				diversify their children's diets adequately
Improving Child Nutrition and Development Through Community-Based Childcare Centres in Malawi – The NEEP-IE Study: Study Protocol for a Randomised Controlled Trial (Gelli et al., 2017)	The aims of the NEEP-IE study are to provide evidence on the effectiveness and costs of delivering an integrated agricultural and nutritional intervention through community-based childcare centres (CBCCs) and parenting groups. Specifically, the study seeks to evaluate the impact of this integration on the diets, nutrition, and development of children aged 36 to 72 months, as well as on CBCC meal provision, attendance, and enrolment, and to identify factors influencing these outcomes	The NEEP-IE study involves a sample of 60 community-based childcare centres (CBCCs) in rural communities around Zomba district, Malawi. These centres are randomized into a control group, which receives standard support from Save the Children's Early Childhood Development programme, and an intervention group, which receives additional nutritional and agricultural support activities. Each treatment arm is designed to include approximately 20 households per cluster for data collection	The NEEP-IE study employs a cluster randomized controlled trial design, where 60 community-based childcare centres (CBCCs) are randomly assigned to either a control group or an intervention group. The intervention includes integrated agricultural and nutritional support alongside the existing Early Childhood Development programme. Data collection involves mixed methods, including surveys, dietary assessments, anthropometry measurements, and caregiver interviews, to evaluate the impact on child nutrition and development.	As the NEEP-IE study is ongoing, specific results are not yet available. However, the study aims to assess the impact of integrated nutritional and agricultural interventions on children's diets, nutrition, and development, as well as on CBCC meal provision and attendance. The findings will provide evidence to inform the Government of Malawi and development partners about the effectiveness and feasibility of scaling up the intervention
Impact of Child Nutrition Training for Mothers on the Nutritional Status of Children: A Propensity Score Matching Approach (Hossain & Hossain, 2022)	The aim of the study is to evaluate the impact of child nutrition training for mothers on the nutritional status of their children, specifically assessing changes in height-for-age Z scores (HAZ), weight-for-height Z scores (WHZ), and weight-for-age Z scores (WAZ) compared to children whose mothers did not receive the training	The study sampled a total of 300 mothers, with 70 mothers from the Matikata Union who received child nutrition training (treatment group) and 230 mothers from the Gogram Union who had not received the training (control group)	The study employed an analytical cross-sectional household survey design, utilizing structured questionnaires to collect data from mother-child pairs. It applied propensity score matching to compare the nutritional status of children whose mothers participated in nutrition training with those whose mothers did not	The results indicated that children whose mothers received child nutrition training had significantly lower prevalence rates of stunting (0.357 SD), wasting (0.646 SD), and underweight (0.935 SD) compared to those in the control group, demonstrating the positive impact of the training on children's nutritional status
Mobile-Based Nutrition Counseling and Unconditional Cash Transfers for Improving Maternal and Child Nutrition in	The aims of the pilot study were to evaluate the effectiveness of mobile-based nutrition counseling and unconditional cash transfers in improving maternal and child nutrition in Bangladesh. Specifically, the study sought to enhance nutrition	The study recruited 340 participants, specifically pregnant or recently delivered, lactating women from rural Bangladesh. Out of these, 275 participants provided complete information for the analysis	The study employed a mixed-methods pilot design, combining quantitative and qualitative approaches. It included baseline and end-line surveys, focus group discussions, and in-depth interviews. Participants received	The results indicated that approximately 89% of participants could operate their mobile phones without difficulty, and 87% reported using the cash transfers primarily for food purchases. High satisfaction rates were noted, with 93% expressing

Title, Author, Year	Aim	Sample	Method	Result
Bangladesh: Pilot Study (Huda et al., 2018)	knowledge, promote appropriate dietary practices, and assess the impact of these interventions on child growth and nutritional outcomes		mobile-based nutrition counseling and unconditional cash transfers delivered via mobile banking	willingness to receive similar services in the future. However, the study could not conclusively determine the intervention's effectiveness due to its design
Assessment of a Nutrition Education Program Designed to Enhance Mothers' Attitudes on Infants and Young Children Feeding in Sudan (I. Mohammed et al., 2021)	The aim of the study was to assess the effect of a designed Nutrition Education Program (NEP) on enhancing mothers' attitudes towards the nutritional care of infants and young children under the age of two in Sennar Locality, Sudan	The study involved a total of 136 mothers of children under the age of two, who were randomly assigned to either the intervention group (Mayerno) or the comparison group (El Salaam) in Sennar Locality, Sudan	The study employed a quasi-experimental pre-and post-design, consisting of three phases: pre-evaluation (baseline data collection), implementation of the Nutrition Education Program (NEP), and post-evaluation (data collection on mothers' attitudes). Data were gathered through personal interviews using a validated questionnaire	The results indicated that the Nutrition Education Program (NEP) significantly improved mothers' attitudes towards nutritional care for children under two years old, with statistically significant differences observed between pre-test and post-test scores in the experimental group
SIMPATIK Website Nutrition Education on Mother's Knowledge and Diversity of Toddler Consumption in Jambi City (Junita et al., 2023)	The aim of the study was to determine the impact of the SIMPATIK website on increasing mothers' nutritional knowledge and enhancing the diversity of food consumption among toddlers in Jambi City, using a quasi-experimental design without a control group	The study involved 60 mothers of toddlers aged 6 to 59 months, selected through purposive sampling from the working area of the Tahtul Yaman Health Center in Jambi City	The study employed a quasi-experimental design with a pre-post test approach, utilizing questionnaires and interviews to collect data on mothers' nutritional knowledge and toddlers' food consumption diversity. Statistical analysis was conducted using the Wilcoxon test	The results indicated that the SIMPATIK website significantly improved mothers' nutritional knowledge ($p=0.000$; $D = 2.18$) and increased the diversity of toddlers' food consumption ($p=0.000$; $D = 0.99$) in Jambi City
Explaining the Impact of mHealth on Maternal and Child Health Care in Low- And Middle-Income Countries: A Realist Synthesis (Kabongo et al., 2021)	The aims of the study are to explore the impact of mHealth interventions on maternal and child health care in low- and middle-income countries, identify the mechanisms through which these interventions operate, and develop a conceptual framework to understand the factors influencing their effectiveness in improving health outcomes for pregnant women and mothers	The study included a total of 32 articles that were identified through an electronic search of five databases, focusing on peer-reviewed studies conducted in low- and middle-income countries targeting pregnant women, mothers with new babies, and healthcare providers, including community health workers	The study employed a realist synthesis approach, which involved a discursive and iterative consultation among researchers to develop an initial program theory. Data were extracted from selected articles, and thematic analysis was conducted to map the intervention-context-actors-mechanism-outcomes (ICAMO) configurations for healthcare providers and pregnant women	The results indicated that 32 studies were analyzed, with 20 contributing to a model for healthcare providers and 29 for pregnant women and mothers. Key findings highlighted that mHealth interventions improve communication, enhance healthcare performance, and ultimately increase the quality of maternal and child health care

Title, Author, Year	Aim	Sample	Method	Result
Effect of Nutrition Education on Knowledge, Complementary Feeding, and Hygiene Practices of Mothers With Moderate Acutely Malnourished Children in Uganda (Kajjura et al., 2019)	The aims of the study were to evaluate the effect of nutrition education on the knowledge, complementary feeding practices, and hygiene practices of mothers with moderately acutely malnourished children in Uganda, and to assess improvements in meal frequency, dietary diversity, and water quality as a result of the intervention	The study included 204 mother-infant pairs who were conveniently sampled across 24 randomly selected clusters in Uganda	The study employed a nutrition education intervention based on the Health Belief Model, which included weekly face-to-face group sessions conducted in the local language over three months. Data were collected through pretest and posttest semi-structured questionnaires to assess maternal knowledge and practices regarding complementary feeding and hygiene	The results indicated significant improvements in maternal knowledge and practices regarding dietary diversity and meal frequency ($P < .001$), while handwashing practices did not show significant improvement ($P = .183$). However, the practice of boiling water for safe consumption improved significantly ($P < .001$)
Determinants of Stunting, Underweight and Wasting Among Children ≪ 5 years of Age: Evidence From 2012-2013 Pakistan Demographic and Health Survey (Khan et al., 2019)	The aims of the study were to identify and analyze the determinants of stunting, underweight, and wasting among children under five years of age in Pakistan, focusing on both maternal and child-related factors to inform strategies for reducing malnutrition in this population	The study included a sample of 3,071 Pakistani children aged 0–59 months who had complete anthropometric measurements, drawn from the 2012-2013 Pakistan Demographic and Health Survey	The study utilized a cross-sectional design, analyzing data from the 2012-2013 Pakistan Demographic and Health Survey, which involved structured interviews and anthropometric measurements of children to assess malnutrition	The results indicated that stunting was the most prevalent nutritional issue, affecting 44.4% of children, followed by underweight at 29.4% and wasting at 10.7%. Various factors, including maternal education, wealth index, and rural residence, were significantly associated with these conditions
The Effectiveness of Nutrition Education for Overweight/Obese Mother With Stunted Children (NEO-MOM) in Reducing the Double Burden of Malnutrition (Mahmudiono et al., 2018)	The aim of the NEO-MOM study was to empower overweight or obese mothers to effectively address the double burden of malnutrition in their stunted children through nutrition education and behavioral intervention strategies based on Bandura's Social Cognitive Theory. The study sought to improve child growth outcomes and enhance maternal self-efficacy in providing adequate nutrition for their children	The study involved a total of 71 eligible participants, who were randomly allocated into two groups: 35 in the intervention group (NEO-MOM) and 36 in the comparison group (standard care with printed educational materials and government food supplementation)	The study employed a randomized controlled trial (RCT) design, utilizing behavioral intervention strategies based on Social Cognitive Theory. Participants received nutrition education and training over three months, focusing on self-efficacy, outcome expectations, and nutrition literacy. Data were analyzed using ANCOVA to assess changes in maternal and child outcomes, adjusting for baseline values and food insecurity	The results indicated a significant effect of time on child height and weight across both groups, but no significant differences between the intervention and comparison groups. The intervention group showed improved maternal self-efficacy and caloric intake, but there was no significant catch-up growth observed in child height-for-age z-scores
Effect of Mobile Based Educational	The main aim of the mobile-based educational program was to improve	The study involved a non-probability purposive sample	The study utilized a quasi-experimental design and involved	The results indicated a significant improvement in mothers' knowledge

Title, Author, Year	Aim	Sample	Method	Result
Program on Mother's Knowledge and Practice Regarding Care of Children With Helicobacter Pylori Infection (Mohamed Tork et al., 2022)	mothers' knowledge, practices, and medication adherence regarding the care of children affected by Helicobacter pylori infection. Specific objectives included enhancing understanding of H. pylori infection, its transmission, management, and the importance of hygiene practices and medication adherence	of 100 mothers who were responsible for the care of their children with Helicobacter pylori infection. Inclusion criteria required mothers to have a smartphone, be able to use the WhatsApp application, and possess reading and writing skills	three main tools for data collection: a structured interview questionnaire to assess mothers' knowledge, a self-reported practice questionnaire to evaluate their practices, and a medication adherence scale. The mobile-based educational program was implemented over six months, with assessments conducted before and after the program to measure its effectiveness	and practices regarding the care of children with Helicobacter pylori infection after the mobile-based educational program. Prior to the program, 89% of mothers had unsatisfactory knowledge, which increased to 98% post-program. Additionally, 96% of mothers reported inadequate practices before the program, while 93% reported adequate practices afterward. There was also a significant positive correlation between mothers' knowledge, practice, and medication adherence levels before and after the program
Developing Nutrition Leaflets and Pocketbook (N. Afifah et al., 2021)	The aim of the study was to increase the nutritional knowledge of mothers with children under five years of age through the development and use of socialization media, specifically leaflets and pocketbooks, to address nutritional problems and stunting effectively	The study involved 40 mothers of children under five years of age from Pagerngumbuk Village, Wonoayu District, Sidoarjo Regency, who were purposively selected due to the area's high incidence of stunted children	The study employed a development research method based on Plomp's educational development model, which included stages of investigation, design, realization, evaluation, and implementation. Data were collected through questionnaires and tests to assess media validity, effectiveness in improving nutritional knowledge, and mothers' responses to the media	The results indicated that the developed leaflets were effective in increasing mothers' nutritional knowledge, with a significant improvement in posttest scores. In contrast, the pocketbook did not show a significant increase in knowledge. Overall, both media received positive feedback from the mothers
"Food Is Something Everyone Should Participate In": A Positive Deviance Approach to Understanding the Use of a Food and Nutrition App in Low-Income, Latino Homes	The aims of the study were to investigate the impact of the VeggieBook app on cooking behaviors and family eating habits among mothers, particularly focusing on their experiences with meals and vegetable consumption before and after using the app. The study sought to understand how the app influenced cooking enjoyment, family	The study involved individual interviews with mothers who were frequent users of the VeggieBook app and had experienced beneficial food outcomes during their participation in a randomized controlled trial. The sample consisted of mothers from low-income Latino families who were engaged in the app's use	The study employed a positive deviance approach and utilized semi-structured interviews to gather qualitative data from mothers about their experiences using the VeggieBook app. The interviews were analyzed for themes using a framework analysis approach, allowing researchers to identify key behaviors and strategies that led to	The results revealed three main themes related to mothers' use of the VeggieBook app: (1) mothers invited their children to use the app, (2) they involved both sons and daughters in the kitchen, and (3) they cautiously stepped outside their culinary comfort zones. These behaviors contributed to increased vegetable consumption and healthier meal preparation within the family

Title, Author, Year	Aim	Sample	Method	Result
(Neffa-Creech et al., 2020)	involvement in meal preparation, and overall dietary changes	to improve their cooking and family eating behaviors	successful app usage and healthier meal preparation	
The Effect on Children's Attitudes Towards Food Associated With Their Non-Cognitive Skills, and With the Nutrition Knowledge of Their Parents (Osera et al., 2018)	The aims of the study were to explore the major factors influencing the development of children's food habits and to assess whether the level of nutrition knowledge of parents significantly impacts their children's attitudes and behaviors towards food and nutrition	The study involved a sample of 219 students aged 3 to 5 years and their parents from Osaka prefecture, Japan	The study employed a cross-sectional design, utilizing questionnaires to assess the lifestyle and food-related habits of children, as well as the nutrition knowledge of their mothers. Statistical analyses, including the Mann-Whitney U test and Chi-square tests, were used to evaluate associations between variables	The results indicated that children's non-cognitive skills towards food, such as concern and respect for food, significantly increased when they participated in cooking-related activities at home. However, the level of their mothers' nutrition knowledge was not significantly related to the children's food-related behaviors
Mobile Phone-Based Nutrition Education Targeting Pregnant and Nursing Mothers in Sri Lanka (Peiris et al., 2023)	The aims of the study were to develop and implement a mobile phone-based nutrition education intervention targeting pregnant and nursing mothers in Sri Lanka, to improve their knowledge, attitudes, and practices related to nutrition, and to enhance maternal and child health outcomes through effective communication strategies	The study sample consisted of 996 pregnant and nursing mothers who participated in the pre-assessment survey, with 720 completing the post-assessment. Most participants were nursing mothers, accounting for 84.2% in the pre-assessment and 78.9% in the post-assessment	The study employed a before-and-after within-subjects design, delivering 19 mobile phone messages over four weeks covering various nutrition themes. Data were collected through a structured interviewer-administered questionnaire and qualitative interviews to assess awareness, attitudes, and practices of the participants	The results indicated significant improvements in knowledge and practices related to nutrition among participants, with 59.9% finding the intervention very useful. Statistical analyses showed significant enhancements in breastfeeding practices and dietary diversity, with both smartphone and feature phone users demonstrating increased knowledge
Analysis of the Completeness of Specific Nutritional Interventions as an Effort to Prevent Stunting: An Observational Study (Setianingsih, 2023)	The aims of the study are to analyze the completeness of specific nutritional interventions targeting breastfeeding mothers and children aged 0-23 months, and to assess their effectiveness in preventing stunting in Indonesia. The study seeks to identify gaps in these interventions and provide recommendations for improving their implementation to achieve stunting reduction targets	The study sampled 128 breastfeeding mothers from a population of 193 nursing mothers, using a simple random sampling technique to ensure a representative selection for the analysis of specific nutritional interventions	The study employed a quantitative cross-sectional design, utilizing univariate and bivariate analyses, including Chi-square analysis, and multivariate analysis with logistic regression to assess factors influencing the completeness of specific nutritional interventions among breastfeeding mothers	The results indicated that only 55.5% of breastfeeding mothers received complete specific nutritional interventions, which is below the government's target of 100%. Key influencing factors identified included mother's education, knowledge, attitude, support from husbands and health workers, and parity, with significant associations found for each
A Repeat Cross-Sectional Study Examining the	The aims of the study were to evaluate the impact of the 2008 nutritional standards for school lunches in	The study included dietary intake data from 368 children in 2003-4 and 624 children in	The study employed a repeat cross-sectional design, using a validated four-day food diary (Food	The results indicated that between 2003-4 and 2008-9, there was a greater increase in non-starch

Title, Author, Year	Aim	Sample	Method	Result
Equitable Impact of Nutritional Standards for School Lunches in England in 2008 on the Diets of 4-7y Olds Across the Socio-Economic Spectrum (Spence et al., 2014)	England on the dietary intake of 4-7-year-olds and to analyze the differential effects of these standards across the socio-economic spectrum	2008-9, all aged 4-7 years, from 12 primary schools in Newcastle, North East England	Assessment in Schools Tool) to collect dietary intake data from children over three weekdays and one weekend day. The analysis compared nutrient intake before and after the implementation of the nutritional standards in 2008	polysaccharide (NSP), iron, and zinc intake at lunchtime among the least deprived children compared to the most deprived. Overall, school lunches in 2008-9 provided a healthier option, with lower energy from non-milk-extrinsic sugars and higher vitamin C intake compared to home-packed lunches
Consumption of Dietary Supplements by Chinese Women During Pregnancy and Postpartum: A Prospective Cohort Study (Tang et al., 2017)	The aims of the study were to investigate the consumption patterns of dietary supplements among Chinese women during pregnancy and the postpartum period, and to identify factors associated with their usage. The study sought to provide insights into maternal nutrition and inform future educational interventions targeting dietary supplementation among this population	The study involved a sample of 695 mothers who gave birth to singleton babies in Jiangyou, Sichuan Province, China. Participants were recruited from seven hospitals and were followed up at 1, 3, and 6 months postpartum to gather information on dietary supplement use	The study employed a prospective cohort design, collecting data through personal interviews at hospital discharge and follow-up telephone interviews at 1, 3, and 6 months postpartum. Statistical analyses, including logistic regression and generalized linear-mixed modeling, were used to determine factors associated with dietary supplementation during pregnancy and postpartum	The results indicated that 81.8% of women consumed dietary supplements during pregnancy, while 32.1% continued to do so postpartum. Calcium was the most commonly used supplement (63.9% during pregnancy and 28.1% postpartum), whereas folic acid intake was below recommended guidelines. Higher education levels and attendance at prenatal classes were associated with increased supplement use
Using Mobile Health to Strengthen the Communication Skills for Effective Delivery of Health Information in Nepal: A Qualitative Study of the Perspectives of Female Community Health Volunteers (Tuitui et al., 2022)	The aim of the study was to examine the changes in the interactions and communication skills of Female Community Health Volunteers (FCHVs) following the introduction of a mobile-based intervention called Mobile Chautari, and to assess its impact on the delivery of health information in their communities	The study involved a diverse sample of participants, including 48 FCHVs, 15 pregnant women and mothers with children under five, 15 health facility staff, and focus group discussions with 6 FCHVs and 6 mothers-in-law, along with observations of Health Mothers Group meetings	The study employed qualitative methods, including in-depth interviews, focus group discussions, and observations of Health Mothers Group meetings, to gather insights from FCHVs, pregnant women, mothers with children under five, mothers-in-law, and health facility staff regarding their experiences with the Mobile Chautari intervention	The results indicated that the Mobile Chautari intervention significantly improved FCHVs' communication skills, confidence, and engagement with community members. It enhanced the quality of health discussions in meetings, increased participation, and strengthened trust between FCHVs and beneficiaries, ultimately contributing to better health outcomes
Are Mothers Under Lunchbox Pressure? An Exploration of the Experiences of Victorian Mothers	The aims of the study were to explore the experiences of Victorian mothers in preparing lunchboxes for their children, focusing on the challenges they face, including time and financial	The study involved a sample of ten Victorian mothers of primary school students, who were recruited through primary schools, community	The study employed a Constructivist Grounded Theory methodology, utilizing semi-structured interviews to gather data from the participants. The interviews explored mothers'	The analysis identified four main themes: (1) non-nutritional barriers impacting food choices, (2) children's preferences influencing parental decisions, (3) perceived judgment

Title, Author, Year	Aim	Sample	Method	Result
Preparing Lunchboxes for Their Children (Watson-Mackie et al., 2022)	constraints, and to understand their motivations and strategies for ensuring their children's dietary needs are met	organizations, and social media. The participants varied in income levels, relationship status, and included mothers of children with special needs	views on lunchbox preparation and food choices, and the data were analyzed using an inductive, thematic approach	from others regarding food choices, and (4) a lack of support and information from schools about appropriate lunchbox contents
Mothers' Knowledge of Nutritional Programming Influences DHA Intake in Children – Analysis of Nutrition of Children Aged 13-36 Months in Poland (Woźniak et al., 2022)	The aim of the study was to assess mothers' knowledge of nutritional programming and its influence on the dietary intake of docosahexaenoic acid (DHA) in their children aged 13-36 months. The research sought to understand how maternal awareness impacts children's nutrition and overall health outcomes	The study included a sample of 363 mothers aged 20-43 years, with children under the age of 3, who participated in an online questionnaire conducted in Poland from 2019 to 2021. The mothers were categorized based on their knowledge of nutritional programming	The study employed an online questionnaire to assess mothers' knowledge of nutritional programming, their nutrition during pregnancy, and their children's dietary intake. Participants provided a three-day food diary of their children's meals, and the data were analyzed to identify correlations between maternal knowledge and children's DHA intake	The results indicated that 44% of mothers possessed accurate knowledge of nutritional programming, while 12% overestimated their knowledge. Mothers with proper nutritional knowledge breastfed longer and had children with higher DHA intake. The study found a significant correlation between maternal education level and children's nutritional intake, highlighting insufficient awareness among mothers regarding dietary recommendations
Child Nutrition Trends Over the Past Two Decades and Challenges for Achieving Nutrition SDGs and National Targets in China (Yang et al., 2020)	The aims of the study are to identify trends in child nutrition, assess gaps in achieving child nutrition-related goals, and provide implications for program and policy options for the Chinese government to improve child nutrition outcomes	The study utilized data from the Global Burden of Disease 2016 and the Chinese National Nutrition and Health Surveillance, focusing on eight child nutrition-related indicators over a span of 26 years	The study employed a quantitative analysis of child nutrition-related indicators using data from the Global Burden of Disease 2016 and the Chinese National Nutrition and Health Surveillance, examining trends and making projections to assess progress towards SDG targets and national nutrition goals	The results indicated a significant reduction in the prevalence of stunting (58.7%), wasting (53.4%), and underweight (69.2%) among children under five years. However, overweight increased by 88.9%, and exclusive breastfeeding rates remained stable at about 30%. Projections suggested that child wasting would be 3.0% lower than the target of 5.0% by 2025, while the number of stunted children would decrease by 39.7%

DISCUSSION

The Influence of M-Learning Applications on Changes in Mothers' Behavior in Food Provision for Children

Mobile applications have the potential to serve as effective tools for promoting healthier food choices and improving dietary habits among families. Mobile learning applications have emerged as a vital tool in enhancing maternal knowledge and behaviors related to food choices, which ultimately impacts children's dietary habits.

Mobile learning applications serve as an innovative platform for delivering nutritional education to mothers, which is crucial for improving food provision practices. Research indicates that mothers who possess a better understanding of nutrition are more likely to engage in healthy food-related behaviors for their children (Osera et al., 2018). The effectiveness of these applications lies not only in the quantity of information provided but also in the quality and applicability of that information. For instance, emphasize the importance of enhancing the quality of nutritional information available to parents, suggesting that mobile applications can be designed to present evidence-based guidelines that are easy to understand and implement (Osera et al., 2018). Furthermore, the integration of interactive features in these applications can enhance engagement and retention of nutritional knowledge, leading to more informed food choices.

The socio-economic context in which mothers operate also plays a significant role in shaping their food provision behaviors. Many mothers, particularly those from low-income backgrounds, face barriers such as limited access to healthy food options and financial constraints that influence their purchasing decisions (Evans et al., 2015). Mobile learning applications can be designed to include features that address these barriers, such as budgeting tools, meal planning resources, and local food sourcing information. For example, research by indicates that mothers with better dietary diversity are more likely to have children with comparable diets, suggesting that educational interventions that enhance mothers' dietary knowledge can lead to improved family nutrition (Amugsi et al., 2015). By equipping mothers with practical strategies to navigate food deserts and make healthier choices within their budget, mobile applications can significantly impact dietary behaviors.

In addition to educational content, mobile applications can also serve as platforms for community support and shared experiences among mothers. The sense of community can alleviate feelings of isolation that many mothers experience, especially those navigating food provision in challenging socio-economic environments. By facilitating connections among users, these applications can provide a space for mothers to share tips, recipes, and support, thereby enhancing their confidence in making healthier food choices. Research indicates that social support plays a critical role in influencing dietary behaviors, as mothers often seek validation and encouragement from peers (Watson-Mackie et al., 2022).

Furthermore, the design and usability of mobile learning applications are crucial for their effectiveness. Applications that are user-friendly and accessible can significantly enhance engagement and adherence to nutritional guidelines. For instance, features such as visual aids, step-by-step cooking instructions, and culturally relevant recipes can make the learning process more relatable and enjoyable for mothers (Arora et al., 2021). By considering the diverse backgrounds and preferences of users, developers can create applications that resonate with mothers and facilitate lasting behavioral changes.

In conclusion, mobile learning applications hold significant potential for influencing mothers' behaviors regarding food provision for their children. By enhancing nutritional knowledge, addressing identity conflicts, navigating socio-economic barriers, fostering community support, and respecting cultural contexts, these applications can empower mothers to make healthier food choices. The interplay between maternal identity, socio-economic

factors, and children's preferences underscores the complexity of food provision behaviors, highlighting the need for comprehensive and tailored approaches in mobile learning interventions. Future research should continue to explore the effectiveness of these applications in diverse populations and settings, ensuring that they meet the unique needs of mothers and their families.

Factors That Influence the Effectiveness of M-Learning Applications on Changes in Mothers' Behavior in Food Provision for Children

The effectiveness of mobile learning applications in influencing mothers' behavior regarding food provision for their children is contingent upon several interrelated factors. These factors encompass learning readiness, community support, and the socio-cultural context in which these applications are utilized. Understanding these elements is crucial for designing mobile learning interventions that can effectively alter maternal behaviors and improve children's dietary habits.

Learning readiness significantly impacts the effectiveness of mobile learning applications, particularly in the context of maternal education and child nutrition. Study highlighted the importance of experiential learning strategies in promoting healthy eating, suggesting that active family involvement in meal preparation can lead to more sustainable nutritional behaviors than passive knowledge transmission (Azevedo et al., 2019).

Community-based interventions have been shown to enhance the effectiveness of mobile health (mHealth) applications. emphasize that skilled community health volunteers, supported by well-designed mHealth tools, can significantly improve health outcomes for mothers and children, including increased uptake of essential health services and better nutrition practices (Tuitui et al., 2022). In addition, the findings from research indicate that mobile applications designed for food and nutrition education can significantly enhance mothers' confidence in preparing healthy meals, especially when these applications are integrated with community support initiatives (Neffa-Creech et al., 2020). This suggests that the effectiveness of mobile learning applications is not solely dependent on the technology itself but also on the surrounding community context that fosters engagement and application of learned behaviors.

The usability of mobile learning applications is critical, as it directly affects user engagement and the overall effectiveness of the learning experience. Studies have shown that mobile applications can significantly enhance nutrition education and improve knowledge among users, particularly mothers, who are pivotal in child nutrition (AlKasasbeh, 2023). For instance, the integration of mobile technology in nutrition education has been linked to increased understanding of dietary practices, which can lead to improved food provisioning behaviors (Alam et al., 2020).

The socio-cultural context in which mothers operate cannot be overlooked when assessing the effectiveness of mobile learning applications. Cultural beliefs and practices surrounding food can significantly influence mothers' perceptions of healthy eating and their willingness to adopt new dietary practices. Study found that culturally tailored content in mobile learning programs can lead to improved knowledge and practices among mothers (Mohamed Tork et al., 2022). By incorporating culturally relevant recipes and dietary guidelines, mobile applications can resonate more deeply with mothers, making the information more relatable and applicable to their daily lives. Furthermore, understanding the cultural significance of certain foods can help in framing educational content that respects and honors these traditions while promoting healthier choices.

The effectiveness of mobile learning applications aimed at changing mothers' behavior in food provision for children is significantly impacted by socio-economic barriers. These barriers can manifest in various forms, including limited access to technology, financial constraints, and educational disparities, which collectively hinder the successful adoption and utilization of mobile applications designed for nutritional education and food planning. Socio-economic

factors, including network infrastructure and awareness, significantly influence the uptake of mobile health (mHealth) interventions in low- and middle-income countries (Kabongo et al., 2021). Consequently, mothers from lower socio-economic backgrounds may find it challenging to access the resources necessary for effective food provision education through mobile applications. Socio-economic disparities also influence dietary habits among children, with schools in higher socio-economic areas showing greater improvements in nutritional standards compared to those in lower-income neighborhoods (Spence et al., 2014). This suggests that even when mobile applications provide valuable information, the socio-economic context can impede the practical application of that knowledge.

In conclusion, the effectiveness of mobile learning applications in influencing mothers' behavior regarding food provision for their children is influenced by a multitude of factors. Learning readiness, community support, usability, socio-cultural context, and socio-economic barriers all play critical roles in determining the success of these interventions. By addressing these factors, developers and educators can create mobile learning applications that not only enhance mothers' knowledge and practices but also foster lasting behavioral changes that promote healthier food choices for children.

The Effectiveness of m-Learning in Improving Maternal Behavior in the Provision of Food

The effectiveness of mobile learning in improving mothers' behavior in food provision for children is a multifaceted issue that intersects technology, nutrition education, and maternal empowerment. Mobile learning, defined as the use of mobile devices to facilitate educational experiences, has emerged as a promising tool in enhancing knowledge and behaviors related to child nutrition. The integration of mobile technology into nutrition education can significantly influence maternal behaviors, thereby improving food provision for children.

Research has shown that mobile-based interventions can effectively enhance maternal knowledge regarding nutrition. For instance, a study conducted in Bangladesh demonstrated that mobile-based nutrition counseling, combined with unconditional cash transfers, led to positive feedback from mothers regarding their food purchasing behaviors. Approximately 87% of the participants reported using the cash received to buy food for themselves and their children, indicating a direct impact on food provision behaviors (Huda et al., 2018). This aligns with findings from another study that emphasized the importance of integrating nutrition education with cash transfers to improve dietary diversity and food security among mothers in rural settings (Alam et al., 2020). Such interventions not only provide immediate financial support but also educate mothers on the nutritional needs of their children, fostering better food choices.

Furthermore, the role of maternal education in reducing childhood undernutrition cannot be overstated. Higher levels of maternal education have been associated with improved dietary intake among children, particularly in lower-income families (Yang et al., 2020). Mobile learning platforms can serve as effective vehicles for delivering educational content to mothers, thereby enhancing their understanding of nutritional practices. By utilizing mobile learning, mothers can gain knowledge that empowers them to make informed decisions about their children's diets.

The effectiveness of mobile learning interventions is further supported by evidence from various studies that have explored the use of mobile technology in health education. For instance, a study in Sri Lanka found that mobile phone-based nutrition education targeted at pregnant and nursing mothers improved their understanding of infant and young child feeding practices (Peiris et al., 2023). This suggests that mobile learning can bridge the gap between health information and practical application, leading to better food provision behaviors among mothers. Additionally, the use of interactive storytelling and gamification in mobile

applications has been shown to enhance engagement and knowledge retention, making learning about nutrition more accessible and enjoyable for mothers (Amresh et al., 2015).

Moreover, the integration of mobile learning with community-based initiatives can amplify its effectiveness. For example, community-based childcare centers in Malawi have implemented mobile learning strategies to improve child nutrition and development through integrated nutritional and agricultural interventions (Gelli et al., 2017). Such programs not only educate mothers but also create a supportive environment that encourages the application of learned behaviors in real-life contexts. This holistic approach is essential for fostering sustainable changes in maternal behaviors related to food provision.

In conclusion, mobile learning represents a powerful tool for improving mothers' behavior in food provision for children. By enhancing maternal knowledge and empowering women through education, mobile learning can lead to better nutritional practices and ultimately improve child health outcomes. The integration of mobile technology with community support and tailored educational content is essential for maximizing the effectiveness of these interventions. As research continues to evolve in this area, it is imperative to focus on developing scalable and sustainable mobile learning solutions that address the diverse needs of mothers and their children.

Recommendations for the Development and Implementation of m-Learning Applications for Mothers' Nutrition Education

The development and implementation of mobile learning applications for mothers' nutrition education is a critical area of focus, particularly in light of the significant impact maternal nutrition has on child health outcomes. Research indicates that maternal education plays a pivotal role in shaping dietary practices and nutritional knowledge, which in turn influences the health and nutritional status of children. For instance, studies have shown that mothers with higher educational levels tend to have better nutritional knowledge, which correlates with improved feeding practices and reduced rates of malnutrition among their children (Endris et al., 2017; Félicitée et al., 2018; Woźniak et al., 2022). This underscores the necessity for mobile applications that can effectively deliver nutritional education tailored to mothers, particularly those with varying levels of education.

Mobile learning applications can serve as a powerful tool to bridge the knowledge gap in nutrition among mothers. The integration of interactive features, such as quizzes, videos, and community forums, can enhance engagement and retention of nutritional information. Research has demonstrated that educational interventions, including mobile health (mHealth) technologies, can significantly improve maternal knowledge and attitudes towards nutrition (I. Mohammed et al., 2021; Kajjura et al., 2019). Therefore, the design of mobile applications should incorporate these interactive elements to maximize user engagement and learning outcomes.

Furthermore, the content of mobile learning applications must be culturally relevant and accessible to mothers from diverse backgrounds. Studies indicate that maternal nutritional knowledge is influenced by socio-demographic factors, including education level and cultural beliefs (Esmat et al., 2023; Khan et al., 2019). Thus, applications should be designed to accommodate different literacy levels and cultural contexts, ensuring that the information provided is understandable and applicable to the users' daily lives. For instance, the use of visual aids, such as infographics and videos, can be particularly effective in conveying complex nutritional concepts in a straightforward manner (Junita et al., 2023; N. Afifah et al., 2021). Additionally, incorporating local dietary practices and foods into the educational content can enhance relatability and encourage adherence to recommended practices.

To further enhance the effectiveness of mobile learning applications, it is essential to incorporate feedback mechanisms that allow users to ask questions and receive personalized advice. Research has shown that mothers who receive tailored nutritional guidance are more

likely to implement recommended practices, leading to improved dietary diversity and nutritional status among their children (Farajzadeh-Moghanjoughi et al., 2019; Hossain & Hossain, 2022). Features such as chatbots or direct messaging with nutritionists can provide mothers with immediate support and clarification on nutritional queries, thereby fostering a supportive learning environment.

Moreover, the implementation of mobile applications should be accompanied by community outreach and support initiatives. Evidence suggests that community-based interventions, such as home visits and peer support groups, can complement the educational content delivered through mobile platforms (I. Mohammed et al., 2021). By fostering a community of support, mothers can share experiences, challenges, and successes, which can enhance motivation and adherence to nutritional recommendations. Therefore, partnerships with local health organizations and community leaders can facilitate the successful rollout of mobile learning applications and ensure sustained engagement among users.

In addition to educational content, mobile applications should also provide resources for tracking dietary intake and nutritional status. Features that allow mothers to log their children's meals and monitor growth can empower them to make informed dietary choices and recognize the importance of nutrition in their children's development (Mahmudiono et al., 2018; Setianingsih, 2023). Research indicates that mothers who actively engage in monitoring their children's nutrition are more likely to adopt healthier feeding practices, thereby reducing the risk of malnutrition (Farisita, 2021; Tang et al., 2017). Consequently, incorporating tracking tools within mobile applications can enhance user engagement and promote accountability in dietary practices.

Furthermore, the evaluation of mobile learning applications is crucial to ensure their effectiveness and relevance. Continuous assessment through user feedback and outcome measurements can inform necessary adjustments to the content and features of the application. Studies have shown that regular evaluation of educational interventions leads to improved outcomes and user satisfaction (I. Mohammed et al., 2021; Kajjura et al., 2019). Therefore, implementing a robust evaluation framework will be essential in refining the application and ensuring it meets the evolving needs of mothers.

In conclusion, the development and implementation of mobile learning applications for mothers' nutrition education should prioritize user engagement, cultural relevance, and community support. By leveraging interactive features, personalized guidance, and tracking tools, these applications can significantly enhance maternal nutritional knowledge and practices. Furthermore, ongoing evaluation and community involvement will be critical in ensuring the sustainability and effectiveness of these educational interventions. Ultimately, such initiatives hold the potential to improve maternal and child health outcomes, particularly in underserved populations.

CONCLUSSION

Mobile learning applications can significantly improve maternal behavior in food provision for children by enhancing nutritional knowledge, addressing socio-economic barriers, fostering community support, and providing culturally relevant content. These applications effectively deliver nutritional education that leads to healthier food choices for children.

Interactive features, practical tools, and community support within these apps boost engagement, knowledge retention, and confidence in making better food decisions. Future efforts should focus on creating scalable, sustainable solutions that meet diverse needs and integrate with community and health initiatives for lasting impact on child nutrition and health outcomes.

REFERENCES