Effectiveness of a mobile app-based intervention using local foods on maternal knowledge, attitude, practice, and toddlers' growth: A quasy experimental study

Daniel Akbar Wibowo[1,2], Yulia Lanti Retno Dewi[3], Nur Hafidha Hikmayani[4*], Sri Mulyani[5]

[1] Doctoral Program of Public Health, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
[2] Bachelor Nursing Program, Faculty of Health Science, Galuh University, Ciamis, West Java, Indonesia
[3] Department of Nutrition, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
[4] Department of Pharmacology, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
[5] Departement of Nursing Anesthesia, School of Vocation, Universitas Sebelas Maret, 57126, Surakarta, Central Java, Indonesia

OPEN ACCESS

Jurnal Keperawatan Padjadjaran (JKP)

Volume 14(2), 223-237

http://dx.doi.org/10.24198/jkp.v14i2.3088

Article Info

Received : April 06, 2026
Revised : June 30, 2026
Accepted : July 14, 2026
Published : August 27, 2026

Corresponding author

Nur Hafidha Hikmayani*
NDepartment of Pharmacology, Faculty of Medicine, Universitas Sebelas Maret,Indonesia; Address: Jl. Ir. Sutami No.36 A Kentingan, Surakarta, Central Java, Indonesia 57126; Phone: [+62271646994], E-mail: hafidha@staff.uns.ac.id

Citation

Wibowo, D.A., Dewi, Y.L.R., Hikmayani, N.H., & Mulyani, S. (2026). Effectiveness of a mobile app-based intervention using local foods on maternal knowledge, attitude, practice, and toddlers' growth: A quasy experimental study. *Jurnal Keperawatan Padjadjaran, 14*(2), 223-237. http://dx.doi.org/10.24198/jkp.v14i2.3088

Website

http://jkp.fkep.unpad.ac.id/index.php/jkp

E-ISSN: 2442-7276
P-ISSN: 2338-5324

Abstract

Background: Stunting remains a major public health concern in Indonesia. Mothers frequently face barriers in meeting children's nutritional needs due to lack of knowledge, insufficient support, and a non-enabling environment. Strengthening maternal behaviour through targeted education, access to local nutritious foods, and mobile-based interventions is essential.
Purpose: This study evaluated the effectiveness of a mobile application–based nutrition intervention on maternal knowledge, attitudes, and practices (KAP) and toddler growth outcomes.
Methods: Guided by the PRECEDE–PROCEED model, this quasi-experimental study involved 138 dyads of mother-toddler who were purposively selected and divided equally into intervention and control groups through simple random sampling within clusters. Primary outcomes included maternal KAP related to stunting, nutritional monitoring, and meal preparation using Nile tilapia fish. Data were collected through pre- and post-tests using the set of knowledge, attitude and behavior questionnaire and Developmental Pre-Screening Questionnaire. The data analyzed using descriptive statistics and non-parametric tests (Wilcoxon, Mann–Whitney).
Results: Baseline characteristics were comparable between groups. After the intervention, the intervention group showed significantly higher maternal knowledge (mean±SD: 18.72±1.87 and 17.20±1.08), attitudes (85.97±5.47 and 75.09±3.72), and practices (77.06±3.55 and 70.13±2.16) than the control group (all $p < 0.001$). Height-for-age (HFA) scores also improved (0.70±0.91 and −1.06±0.78; $p < 0.001$), whereas no significant changes were observed in child development (9.54±0.65 and 8.94±0.82).
Conclusion: Enhanced knowledge and attitudes, combined with access to local food sources and simple recipes, facilitated behavior adoption, while the mobile module helped sustain these improvements. Cross-sector collaboration may support standardized maternal education and strengthen integration of this intervention within national stunting prevention programs.

Keywords: mobile-app; maternal kap; nutritional intervention; stunting; toddlers

Introduction

Stunting remains a major health issue in Indonesia, affecting approximately 2.3 million children under five year across the country as of 2024 (Unicef, 2025). As the country with the third-highest stunting rate in Southeast Asia,

Indonesia continues to experience a slow decline in stunting prevalence, which currently only at 3% (Ministry of Health of the Republic of Indonesia., 2025; Ministry of Health of the Republic of Indonesia, 2018; World Health Organization (WHO), 2022) Stunting prevalence varies significantly across provinces, and depend on the characteristics of the provinces and sub districts (Mulyaningsih et al., 2021). The study also highlight other factors that associated with the prevalence of stunting in Indonesia such as socioeconomic status, maternal education, water, and sanitation infrastructure, and limited access to community health services (Mulyaningsih et al., 2021). The various contextual factors and characteristics of each region necessitate the suitable and context-specific strategies for stunting reduction (Eryando et al., 2022). For instance, Ciamis Regency, an area in West Java Province (Indonesia), has experienced a substantial increase in stunting prevalence, rising from 16% in 2021 to 25.4% in 2023 (Health Development Policy Agency of Health Ministry Indonesia, 2024). According to recent study on stunting determinants in Ciamis Regency, it is found that access and availability of food were not associated with stunting, whereas maternal educational status showed a significant association (Betaditya et al., 2022). These findings underscore the importance of providing adequate support and appropriate health education for mothers to ensure sufficient dietary intake for their children.

The UNICEF Conceptual Framework of Malnutrition 2020 identifies inadequate dietary intake and disease as the immediate causes of malnutrition, including stunting (UNICEF, 2020). These two factors directly interrelated causing the impairment of a child growth and development. Poor dietary intake compromises the immune system and increasing children's susceptibility to infections which can exacerbate further nutritional deficiencies by reducing nutrient absorption and appetite (Black et al., 2013). A study conducted using data from the Indonesian Basic Health Research, showed that limited dietary diversity significantly affected the nutritional status of children aged 6–23 months (Samosir et al., 2023). Similar study also found that many mothers are lack of knowledge about exclusive breastfeeding, complementary feeding, and balanced dietary requirements (Sahanggamu et al., 2017). Although parents have reportedly added animal-source foods (ASF) (e.g. meat, eggs, and dairy products) to their children's diet, these foods are consumed infrequently and in small quantities (Arini et al., 2022). This inadequate intake of animal-source of protein may contribute to the widespread deficiencies in iron, zinc, calcium, and vitamin among the children (Arini et al., 2022). Promoting mothers' positive behavioral changes to improve toddler dietary intake is essential for reducing stunting.

Mothers' feeding behaviors are shaped by multiple factors. According to the PRECEDE-PROCEED model, behavioral change is influenced by predisposing, enabling, and reinforcing factors, and modifying these factors is essential for achieving sustainable behavior changes (Porter, 2016). Previous studies have shown that maternal educational background is a major predisposing factor influencing maternal knowledge about child nutrition and related feeding practices (Laksono et al., 2022). For instance, higher maternal education has been associated with better nutrition knowledge and improved feeding practices. However, evidence from rural communities in West Java indicates that limited maternal education attainment is commonly linked to inadequate nutrition knowledge and suboptimal infant and young child feeding practices (Mauludyani & Khomsan, 2022). These challenges are further compounded by insufficient health education and nutrition promotion activities, contributing to the persistently high prevalence of stunting among children (Berutu et al., 2024; Haryanti et al., 2024a). A community-based study conducted in a village in Ciamis Regency similarly identify gaps in maternal feeding knowledge and caregiving practices contributing to persistent stunting in village samples (Suminar et al., 2025). Furthermore, low feeding practices also intensified by socioeconomic constraints and limited access to affordable nutritious foods even when they are aware of recommended feeding guidelines (Kolopaking et al., 2011).

Utilizing locally available and affordable food resources is a powerful strategy to overcome the socio-economic barriers. For instance, complementary feeding programs implemented in Southeast Sulawesi Province, eastern Indonesia, promoted diverse diets using locally available ingredients (e.g. seafood, eggs, and vegetables), and enhanced maternal nutrition knowledge through mini classes and home visits significantly improved dietary diversity and feeding practices (Effendy et al., 2020). Similarly, a community-based intervention in rural East Nusa Tenggara Province, one of Indonesia's most stunting-affected regions used locally produced supplementary foods, and promoted caregiver knowledge has succeeded in reducing stunting prevalence from 42.3% to 28.7% over 12 months (Dwianto, 2025). This evidence suggests that using local food resources combined with nutritional education is a promising strategy to reduce stunting prevalence.

Nile tilapia (Oreochromis niloticus), a freshwater fish species native to Africa, is widely cultivated in the West Java Province due to its rapid growth, ease of breeding, and affordability. From a nutritional perspective, Nile Tilapia provides high-quality protein and is a valuable source of essential micronutrients such as iron, zinc, calcium, and vitamin B. Given its wide availability and nutrient density, the Nile Tilapia is increasingly promoted as a locally sourced food to improve dietary intake (Wibowo et al., 2024). Unfortunately, despite the fact that the fish is nutritious, its consumption in West Java remains low at 38.48 kg per capita per year, and even lower in

Ciamis Regency at only 22.15 kg per capita (Baliwati & Saputra, 2014; Ministry of Marine Affairs and Fisheries Republic of Indonesia, 2023). Based on dietary recommendation, a minimum of 15-25 kg per capita per year is considered a baseline for adequate intake, while 40-50kg per capita per year reflects a more optimal intake associated with better health outcome (World Health Organization (WHO), 2011, 2020). However, many mothers lack knowledge and skills in processing fish into child-friendly meals. The mother more concerns on the danger of fish bones, taste preferences, or unfamiliarity with age-appropriate recipes can discourage fish inclusion in children's diets (Gibson et al., 2020). Furthermore, a recent mixed-methods study also added that common parental concerns included fears that the fish may cause allergies, digestive problems, or illness (Yigit et al., 2025). This misconception should be addressed through targeted nutritional education for parents, especially mothers who play a key role in managing children's dietary intake.

The mobile-based intervention has the potential to provide accessible nutrition education, facilitate behavior change, and support decision-making for parents. It allows the users to learn anytime and anywhere, making it especially beneficial for the busy caregivers or mothers. Unlike traditional methods, mobile-based intervention is not time-bound, more durable than printed materials, and offers greater accessibility, particularly in remote or underserved areas. A recent study suggests that a smartphone-based education program on complementary feeding significantly improved maternal nutritional literacy and led to better children's' growth outcomes (Seyyedi et al., 2020). Given the high smartphone uses in West Java Province (70.37%) and particularly in Ciamis Regency (79.38%), along with increased internet accessibility, mobile-based intervention emerge as a promising solution for expanding nutritional education (Regional Development Planning Agency of Ciamis Regency, 2022; Statistics Indonesia (BPS), 2021; West Java Provincial Office of Communication and Informatics, 2020). Considering the beneficial features of the mobile-based intervention, this study aimed to develop an application named "MENUMIS STUNTING" (*Menu Seputar Nutrisi Sehat untuk Anak Stunting [Healthy Nutrition Menu for Stunted Children*]) and examine its impact on maternal knowledge, attitudes, and practices (KAP), as well as toddler growth.

Materials and Methods

Study Design

The current study used quasi-experimental study adopts the PRECEDE-PROCEED in analyzing the influence of mobile-based health education programs in improving mothers' feeding knowledge, attitude, and practice. The PRECEDE-PROCEED framework provided a structured approach for identifying predisposing, enabling, and reinforcing factors and for supporting sustainable behaviour change.

Development of Mobile-App Intervention and Program Description

The program utilized a smartphone-based application titled MENUMIS STUNTING (Menu Seputar Nutrisi Sehat untuk Anak Stunting [Healthy Nutrition Menu for Stunted Children]) as an online platform for educational activities and interactive discussion, enabling users to access learning materials and participate in Q&A sessions. Several nutrition education themes were formulated into a 12-week program consisting of weekly 6-minute educational videos, downloadable supplementary materials, and an integrated Q&A feature that allowed participants to submit questions through the application (Appendix 1). During the intervention period, participants were required to access supplementary materials and health education videos at least once per week with flexible scheduling and were encouraged to use the application at a minimum frequency of three times per week. User engagement was enhanced through reminder notifications delivered via WhatsApp groups and by monitoring application usage, including frequency of access, duration of use, and completion of educational materials. The application also included a question-and-answer (Q&A) feature designed to facilitate interactive online discussion. The monitoring process was conducted online by surveyors via WhatsApp to assess whether participants had completed the weekly educational materials, identified risks of participant dropout, and addressed any technical issues encountered during application use. During the study period, the control group received standard care in the form of routine health and nutrition education delivered face-to-face during weekly Posyandu sessions by healthcare personnel or community health cadres using standard printed materials. No access to the mobile learning application was provided.

The intervention was conducted over 12 weeks (Appendix 2), with each session addressing a specific topic related to stunting prevention, toddler nutrition, and meal preparation using local source food. Weeks 1-4 covered understanding about stunting, the role of nutrition in toddler growth and development, nutritional status monitoring, and mothers' roles in meeting toddlers' nutritional needs. Weeks 5–7 introduced Nile tilapia as an animal protein source for stunting prevention, explained its nutritional benefits for toddler growth, and presented various tilapia-based recipes for toddlers. Weeks 8–12 focused on practical food preparation sessions, including steamed Nile tilapia, tilapia porridge, tilapia soup, tilapia nuggets, and tilapia rice porridge.

The intervention materials were developed through three stages: needs assessment, prototype development, and usability testing. The needs assessment was conducted using FGDs and semi-structured interviews with 18 key informants,

Table 1.Limited Trial Result

		Mean	N	Std. Dev	Std. Error Mean
Knowledge	Pre-test	12.53	36	1.404	0.234
	Post-test	18.17	36	1.207	0.201
Attitude	Pre-test	54.97	36	1.028	0.171
	Post-test	80.03	36	2.063	0.344
Practice	Pre-test	50.11	36	1.833	0.305
	Post-test	65.08	36	1.105	0.184

Notes:
*Chi-Square test with Significant at p<0.05.. **t-test with Significant at p<0.05.

Table 2. General characteristics of participants by group at baseline (n=138)

Characteristics	Category	Intervention (n=69)		Control (n=69)		Total (n=138)		p-value
		N	%	N	%	N	%	
Education	Primary Education	25	36.2	23	23	48	35	0.625
	Secondary Education	36	52.2	34	49.3	70	51	
	Tertiary Education	8	11.6	12	17.4	20	14	
	Total	69	100	69	100	138	100	
Income	Above District Minimum Wage	19	27.5	15	21.7	34	24.6	0.553
	Below District Minimum Wage	50	72.5	54	78.3	104	74.4	
	Total	69	100	69	100	138	100	
Occupation	Employed	26	37.7	21	30.4	47	34	0.475
	Unemployed	43	62.3	48	69.6	91	66	
	Total	69	100	69	100	138	100	
Birth Weight	Low	6	8.7	12	17.4	18	13	0.206
	Normal	63	91.3	57	82.6	120	87	
	Total	69	100	69	100	138	100	
Chronic Infection	Yes	24	34.8	20	29	44	32	0.584
	No	45	65.2	49	71	94	68	
	Total	69	100	69	100	138	100	

Notes:
Chi-Square test with Significant at p<0.05 and non-statistically significant at p>0.05

including local stakeholders, healthcare providers, and mother–toddler dyads. Findings indicated low participation in existing stunting education programs, limited access to information, low animal protein intake (particularly fish), and limitations of paper-based education; participants preferred interactive and audio-visual learning formats. Based on these findings, the application content and prototype were developed by the research team with IT and multimedia experts. Content validation was then conducted by nutrition, education, and fisheries experts, and revisions were made based on their feedback to improve content accuracy, clarity, and usability (Appendix 3). The application content and prototype were subsequently developed and validated by nutrition, education, and fisheries experts using the Content Validity Index (CVI). The validation demonstrated excellent content validity (I-CVI = 1.00; S-CVI/Ave = 1.00)"

The completed mobile learning prototype was subsequently tested on a limited scale of samples and revised prior to the full implementation phase (Figure 1). Functionality was assessed through black-box testing involving 36 users in Sukasenang and Wanasigra villages, with a 100% success rate—above the 80% usability threshold. Usability testing via the System Usability Scale (SUS) returned an average score of 74.8, exceeding the acceptable threshold of 68, signifying that the application is appropriate for use as a nutritional intervention tool. According to the limited trial results that were reported in Table 1, this application may positively improve knowledge, attitudes, and practice related to toddler nutrition.

Table 3. Comparison of the pre- and post- test results within intervention and control group (n=138)

Group	Dependent Variables	N	MeanSD	Min-Max	CI 95%
Knowledge					
Intervention	Pre-Test	69	13.071.834	9.00-18.0	12.63-13.51
	Post-Test	69	18.721.870	14.0-20.0	18.28-19.71
Control	Pre-Test	69	13.071.192	11.0-16.0	12.79-13.36
	Post-Test	69	17.031.150	14.0-19.0	16.75-17.31
Attitude					
Intervention	Pre-Test	69	60.125.279	43-69	58.85-61.38
	Post-Test	69	85.965.481	73-100	84.64-87.27
Control	Pre-Test	69	68.102.462	63-75	67.51-68.69
	Post-Test	69	75.103.7111	68-85	74.21-75.99
Practice					
Intervention	Pre-Test	69	55.254.710	44-65	54.11-56.38
	Post-Test	69	77.063.552	66-80	76.20-77.91
Control	Pre-Test	69	55.063.086	45-61	54.32-55.80
	Post-Test	69	70.092.092	64-74	69.58-70.59
Height-for-Age (HFA)					
Intervention	Pre-Test	69	-3.250.434	-4.00-(-3.00)	-3.35-(-3.14)
	Post-Test	69	0.700.912	-1.00-2.00	0.48-0.91
Control	Pre-Test	69	-1.001.043	-3.00-1.00	-1.25-(-0.75)
	Post-Test	69	1.770.926	0.00-3.00	1.55-1.99
Development					
Intervention	Pre-Test	69	6.670.834	6.00-8.00	6.47-6.87
	Post-Test	69	9.540.655	8.00-10.00	9.38-9.69
Control	Pre-Test	69	6.670.834	5.00-8.00	6.37-6.97
	Post-Test	69	9.540.657	8.00-10.00	9.38-9.49

Abbreviations:
HFA: Height-for-age. CI: Confidence Interval

Table 4. Comparison between intervention and control group results for the variables of interest (n=138)

Variable	Group	N	Mean±SD	Mean Difference	95% CI	df	p-value
Knowledge	Intervention	69	18.721.870	1.69	18.28-19.71	69	0.001*
	Control	69	17.031.150		16.75-17.31	69	
Attitude	Intervention	69	85.965.481	10.86	84.64-87.27	69	0.001*
	Control	69	75.103.7111		74.21-75.99	69	
Behaviour	Intervention	69	77.063.552	6.97	76.20-77.91	69	0.001*
	Control	69	70.092.092		69.58-70.59	69	
Height/Age	Intervention	69	0.700.912	1.07	0.48-0.91	69	0.001*
	Control	69	1.770.926		1.55-1.99	69	
Development	Intervention	69	9.540.655	0.00	9.38-9.69	69	0.001*
	Control	69	9.540.657		8.00-10.00	69	

Notes:
Chi-Square test with Significant at $p<0.05$ and non-statistically significant at $p>0.05$

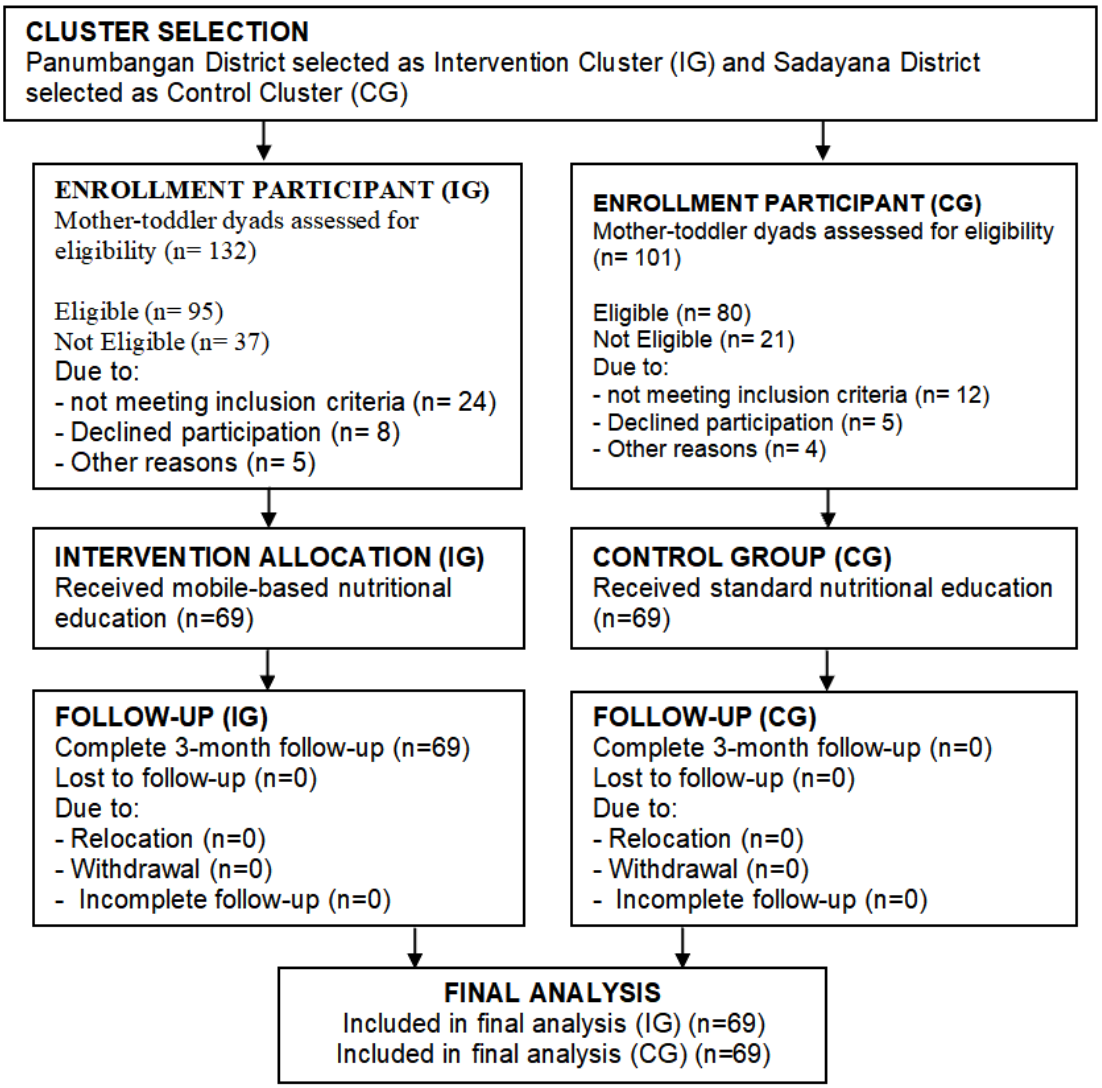

Figure 1. TREND Flow Diagram of Participant Selection, Allocation, Follow-up, and Analysis

Population, Sampling Technique, and Sample

A total of 138 mother–toddler dyads were recruited through a multistage sampling approach. Clusters were defined based on community health center service areas in Ciamis Regency, a predominantly agricultural region with moderate human development and ongoing socioeconomic challenges affecting household nutrition and child health (Central Statistics Agency of Ciamis Regency, 2025). Panumbangan District was assigned as the intervention group, while Sadananya District served as the control group. Both districts were selected through cluster sampling due to their high stunting prevalence in Ciamis Regency and comparable socioeconomic conditions and access to health services. Eligible participants within each cluster were then selected using simple random sampling and equally allocated to the intervention (n = 69) and control (n = 69) groups. Panumbangan was designated as the intervention cluster based on program implementation readiness, support from community health centers and cadres, and feasibility of monitoring the MENUMIS STUNTING application, whereas Sadananya was assigned as the control group to provide a comparable setting and minimize potential selection bias.

Sample size was determined using the Lemeshow formula at a 95% confidence level, resulting in 138 respondents (including a 20% buffer for dropout) (Appendix 4). The study had included mothers whose children had been identified as at risk of stunting through screening at local community health centers and who had demonstrated adequate literacy skills and the ability to operate a smartphone. Mothers of toddlers with congenital or chronic health conditions (e.g. tuberculosis, other chronic respiratory infections, congenital heart disease, chronic otitis media, metabolic disorders, and genetic abnormalities) had been excluded to ensure participant safety and to avoid potential confounding factors.

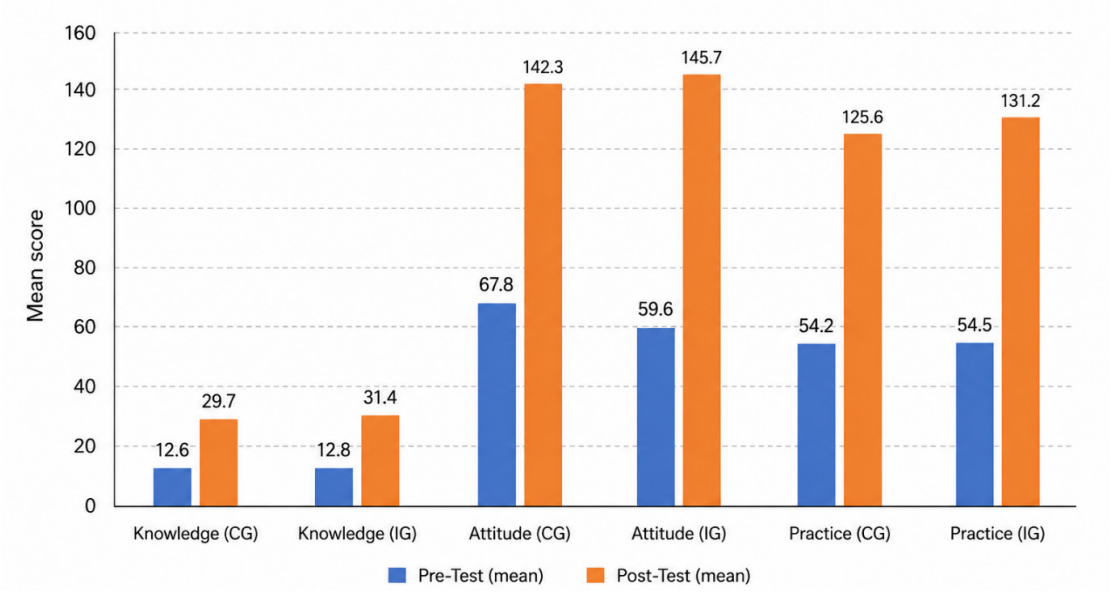

Figure 2. Comparison of Mean Pre- and Post-Test Scores Between Control Groups (CG) and Intervention Groups (IG)

Abbreviations:
IG: Intervention Group, CG: Control Group

Instrument

In this study, primary outcomes, including maternal knowledge, attitudes, and practice, were measured using a structured questionnaire consisting of three domains, each comprising 20 items. The knowledge questionnaire was developed by the researchers based on theories of stunting, toddler nutrition, and local food utilization and aligned with the study objectives. The knowledge, attitude, and behavior questionnaires employed in this study were developed by the researchers specifically for the study and were not adapted from previously published instruments. The development process was informed by relevant literature, theoretical frameworks, and indicators corresponding to each variable under investigation. Before data collection, the instrument underwent content validation to ensure its relevance, clarity, and adequacy in measuring the intended constructs. Before implementation, all instruments' items were re-tested for validity and reliability among 36 mothers of stunted toddlers from Sukamanah and Sukaraja villages in Ciamis Regency. The validity test showed that all items were valid (r calculated > r table = 0.329). Reliability testing demonstrated high internal consistency, with Cronbach's alpha values of 0.898 for knowledge, 0.946 for attitudes, and 0.947 for behavior. Meanwhile, toddler growth as a secondary outcome was measured using the Kuesioner Pra Skrining Perkembangan (KPSP; Developmental Pre-Screening Questionnaire), a national standardized tool for assessing child development in Indonesia. The KPSP evaluates four domains: gross motor, fine motor, language, and personal–social development. Each age-specific questionnaire contains 10 items scored as 1 ("yes") or 0 ("no"), with total scores interpreted as follows: 9–10 = age-appropriate development, 7–8 = questionable development, and ≤6 = suspected developmental delay requiring further assessment.

Data Collection and Analysis

The research data were collected through a self-reported questionnaire using pre-test and post-test design to quantitatively assess maternal knowledge, attitudes, and practices before and after the mobile-app intervention. This process was conducted by trained field enumerators. Prior to the study, the research team provided briefing and training sessions to standardize study procedures and ensure consistency in field implementation. Both mother and toddler assessments were conducted prior to the intervention and re-evaluated three months afterwards. This study applied a single-blind approach at the participant level, whereby mothers were not informed of their allocation to either the intervention or control group to reduce the risk of the Hawthorne effect. Full double-blinding was not feasible due to geographical constraints and the cluster sampling design. To minimize observer bias, separate enumerator teams were assigned to each district, and enumerators in the control area were not given access to the educational application materials used in the intervention group. Quantitative data from pre- and post-intervention questionnaires and toddler growth was analyzed using SPSS version 26. Descriptive statistics were applied to summarize respondent characteristics and outcome variables. For group comparisons, non-parametric tests (Wilcoxon signed-rank test for paired samples and Mann–Whitney U test for independent samples) were conducted due to the non-normal distribution

of data.

Ethical Considerations

This study obtained ethical clearance from The Research Ethics Committee of Faculty Medicine Universitas Sebelas Maret with registration number 192/UN27 06 11/KEP/EC/2024. Prior to data collection, participants were thoroughly informed about the study's objectives, procedures, potential risks, and anticipated benefits. Involvement in the study was voluntary, and participants were assured they could withdraw their participation at any point without any consequences. To protect participant privacy, all identifying information was anonymized and stored in a secured, password-protected database accessible solely to the research team. Given that the research involved stunted toddlers and their mothers—a vulnerable population, additional care was taken to ensure their safety. Pilot testing of the mobile learning application was conducted beforehand to ensure its usability, ease of access, security, and potential benefits for participants. Given that the intervention was educational in nature, it was categorized as minimal risk. Throughout the study period, no significant issues associated with the application or educational materials were observed. In accordance with the policy the ICMJE data sharing guidelines, the authors declare that individual deidentified participant data underlying the results reported in this study on nutrition and education interventions will be available upon reasonable request. The shared data will include participant demographic information, pre- and post-intervention measurements, and survey responses.

Results

Study Characteristics

The demographic profiles of participants in each group are reported in Table 2. Most respondents had secondary education, while fewer attained primary or higher education. The majority were unemployed and household incomes below the regional minimum wage. Most toddlers were born with normal birth weight and did not experience chronic infections. Baseline comparison of key demographic profiles between intervention and control groups showed no statistically significant differences (p>0 05), indicating that both groups were homogenous prior to the intervention (Table 2).

Implementation

The within-group comparisons of pre-test and post-test outcomes for both groups are presented in Table 3. Baseline values were comparable between the intervention and control groups, indicating similar initial conditions. Improvements were most pronounced in the primary outcomes—knowledge, attitude, and practice—suggesting favorable changes in maternal cognitive and behavioral domains following exposure to the intervention (Table 3). Toddler growth and developmental scores also increased over time in both groups.

Table 4 presents the between-group comparison of post-intervention outcomes. The intervention group demonstrated significantly higher mean scores for knowledge, attitude, and practice, with corresponding mean differences, 95% confidence intervals, and p-values indicating statistically significant effects (Table 4). These findings confirm that the observed improvements in maternal outcomes were attributable to the intervention rather than to time-related changes alone (Figure 2). Toddlers in the intervention group also exhibited significantly greater improvements in height-for-age (HFA), suggesting a beneficial effect of the intervention on linear growth. In contrast, there is no statistically significant difference that was observed in child developmental outcomes, as both groups showed comparable improvements.

Discussion

This quasi-experimental study evaluated the impact of mobile-app nutritional intervention program on maternal knowledge, attitude, practice (KAP) as primary outcomes, and toddler height-for-age (HFA), and toddler development score as secondary outcome. The adaptation of the PRECEDE-PROCEED framework in this study provides deeper contextual insights in formulating educational formats that suit mothers' needs and facilitates sustainable behavioral changes. An application called MENUMIS STUNTING (Menu Regarding Healthy Nutrition for Stunting Children), consisting of 12 weekly nutrition education modules on the processing and preparation of Nile tilapia–based meals, was successfully developed and demonstrated positive results both in limited trials and actual implementation.

Although most toddlers were born with normal birth weight and did not experience chronic infections (Table 2), the risk of stunting remains high. This is largely associated with the participants' sociodemographic characteristics, as most mothers had only moderate education, were unemployed, and lived below the regional minimum wage (Table 2). Mothers with low levels of education tend to have limited knowledge about health and nutrition, which impacts their ability to understand the importance of proper nutrition for child growth and development (Syah & Yuniarti, 2024). This phenomenon was supported by recent study in Ciamis Regency found that most of mothers have moderate knowledge of child nutrition (Rahayu et al., 2023). In addition, qualitative findings indicate that families with stunted toddlers often neglect fish consumption, even though fish is a primary source of protein for growth. Lower level of education often leads to a lack of information about healthy eating patterns, the importance of exclusive breastfeeding, and child growth and development, which can affect children's physical growth and cognitive development in the long term period (Laksono et al.,

2022). Current study suggest that mothers with only primary or secondary education have greater odds of having stunted children compared to those with tertiary education (Laksono et al., 2022; Yunitawati et al., 2025). In this case, health education efforts regarding maternal education can help reduce this risk, as previous study shows that maternal education negatively correlates with the incidence of stunting among toddlers (Rahayu & Khairiyati, 2014).

Apart from the education and support provided to mothers, socioeconomic factors also play an important role in stunting prevention efforts. According to prior study, the risk of stunting increases as household wealth decreases (Tamir et al., 2024). Compared to children from the wealthiest households, children from rich, middle, poor, and poorest households have a higher likelihood of being stunted. Similar study also reported that identifying low household income as a stunting risk factor (Kassaw et al., 2020). Low income is often associated with limited access to nutritious and sufficient food necessary for child growth (Ijaiya et al., 2024). In addition, maternal employment status also plays a significant role in stunting risk. While working mothers may contribute to household income, time constraints can compromise childcare and diet quality, thereby increasing vulnerability to stunting (Supadmi et al., 2024). Conversely, unemployed mothers often face financial barriers that limit access to nutritious food and health services (Supadmi et al., 2024). Therefore, interventions to address stunting cannot focus solely on providing nutrition, but also address obstacles related to sociodemographic aspects.

Effect of mobile-app intervention on Maternal Knowledge, Attitude, and Practice (KAP)

A mobile-based nutritional intervention utilizing locally available food resources (e.g., Nile tilapia) was reported to significantly improve maternal knowledge, attitudes, and practices (KAP) among mothers of toddlers. Although both groups demonstrated score improvement, the intervention group showed more consistent and pronounced improvements across all variables. These findings are consistent with previous studies reporting the effectiveness of mobile-app intervention in enhancing maternal KAP (Fitriami & Galaresa, 2022; Nurhidayah et al., 2024; Pantiawati et al., 2025). This improvement should be interpreted within the local context of existing community-based stunting management programs in Ciamis Regency, where routine health services, nutritional counseling, growth monitoring, and supplementary feeding are already implemented. Despite these ongoing programs, previous evidence from the same setting showed that maternal nutritional knowledge remained moderate and feeding practices were still constrained by socioeconomic barriers, food access limitations, and established dietary habits. Therefore, the greater improvement observed in the intervention group suggests that mobile-based education may complement existing services by providing more accessible, continuous, and engaging learning opportunities.

Repeated exposure to information through these medium supports knowledge retention and comprehension (Dissieka et al., 2019), while interactive and visual features enhance engagement and facilitate understanding of complex information (Ahmed et al., 2025). Despite some mixed evidence, tailoring delivery methods and content to audience needs can improve knowledge uptake among mothers of diverse educational backgrounds (Daly et al., 2018; Knop et al., 2024). Moreover, mothers of young children often face time constraints in attending health education programs due to caregiving and household duties (Acharya et al., 2022). In this context, mobile-app interventions offers flexibility, allowing mothers to learn at their own pace and schedule, access information anytime, and review unfamiliar materials without time pressure (Sisouvong & Pasanchay, 2024). The use of locally available food resources may also explain the observed behavioral improvement. Considering that socioeconomic conditions are recognized determinants of maternal feeding practices, the intervention intentionally promoted affordable and accessible local foods. In Ciamis Regency, Nile tilapia is widely available and represents a practical source of high-quality protein and essential micronutrients that support child growth. Integrating locally relevant nutritional recommendations may have reduced implementation barriers and increased the likelihood of adopting recommended feeding practices. Furthermore, these findings align with a recent systematic review which concluded that video and online counseling delivered via mobile applications positively impact maternal nutritional literacy (Hasan et al., 2024). In this study, once mothers better understood appropriate food combinations and preparation techniques, their feeding practices improved.

In contrast to knowledge, improvements in attitudes are shaped by complex factors, including beliefs, cultural norms, personal experiences, and socioeconomic conditions (Abdulahi et al., 2021; Bashir et al., 2023). As reported by several studies, greater knowledge does not necessarily translate into more positive attitudes (Abdulahi et al., 2021; Bashir et al., 2023). However, present study shows that utilization of mobile-based intervention in maternal education is effective in improving both knowledge and attitudes (Table 4). Discussion forums and nutrition chatbots features in the application enabling mothers to ask questions and receive immediate feedback, which proven effectively enhanced engagement in the learning process (I. Nurhidayah et al., 2018). Emotional engagement strengthens motivation for mother to adopt new behaviors in childcare and nutritional practices (Wu & Yu, 2022). User interaction within

discussion forums not only reinforces social norms but also enhances maternal confidence in applying acquired knowledge and strengthens their commitment to child development and well-being. Consequently, mothers feel more assured in implementing what they have learned. Through this mechanism, mobile application functions as an effective tool for changing mothers' attitudes and even practices regarding toddler nutrition and development.

Maternal behavior improvement in this study aligns with the PRECEDE-PROCEED model (Porter, 2016), where enhanced maternal knowledge, attitudes, and practices (KAP), practical nutritional guidance, and support from discussion forums acted as key drivers of positive behavioral change. Recognizing that behavioral changes are also influenced by socio-economic barriers, community support, and cultural context, the study not only provided mothers with flexible and engaging learning opportunities but also sought to mitigate socio-economic barriers by promoting the use of local food resources. As a commonly consumed freshwater fish in Sundanese communities and widely cultivated in household ponds (balong), Nile tilapia is affordable, accessible, and familiar to local households. Recipe modules were adapted to local cooking practices while modifying texture and nutritional content to suit the dietary needs of stunted toddlers, which may have supported greater maternal acceptance and implementation. Data from the Fisheries Department in Ciamis Regency indicates that Nile Tilapia is a widely cultivated freshwater fish in this area, offering considerable potential as an affordable and accessible source of animal protein. This fish is abundant in protein, essential fatty acids, iron, and other micronutrients vital for child development and growth, and its regular consumption may contribute to optimal growth, enhanced nutritional status, and a reduced risk of stunting (Wibowo et al., 2024). Recent evidence shows that providing local food-based food has a positive impact on nutritional status among toddlers aged 6–36 months in Indonesia, particularly in rural settings (Susanto et al., 2017), which also reflects the characteristics of most participants in the present study (Table 3) However, there is contrasting evidence that shows application-based education is not always sufficient to change behavior unless accompanied by direct interaction with healthcare professionals (Rufaindah & Patemah, 2021). Therefore, mobile-based learning interventions should be used as a complement rather than a replacement for direct interactions between mothers and healthcare providers.

Effect of mobile-app intervention on toddler nutritional outcomes

Assessing the sociodemographic profile of participants in this study indicates an elevated risk of stunting among children, underscoring the urgent need for targeted nutritional interventions. The main barriers identified were poor dietary habits, limited participation in health programs, and the absence of engaging, contextually appropriate educational materials for mothers. To address this, the present study evaluated the impact of a mobile-based learning intervention on toddler nutritional outcomes as part of stunting reduction efforts, focusing on Height-for-Age (HFA) and developmental indicators. The findings demonstrated that the intervention improved toddlers' HFA and developmental scores after participation (Table 3). However, cross-group comparisons revealed that while HFA significantly improved in the intervention group compared to controls, no significant effects were observed on developmental outcomes (Table 4).

This study supports evidence that technology-based nutrition education can improve children's anthropometric indicators, although significant changes in growth may not be observed due to insufficient intervention duration or the need for longer follow-up (Hojati & Farhangi, 2025; Mousavi Ezmareh et al., 2024; Seyyedi et al., 2020). In the first 3–6 months of an intervention, anthropometric measures such as weight and height (or length) are particularly responsive indicators of nutritional improvement (Garenne et al., 2013). This may explain why increases in HFA scores are observed earlier than developmental scores. In addition, toddler development is shaped by the interplay of biological, parenting, environmental, and socio-economic factors, which adds further complexity (Rocha et al., 2021). According to prior study, maternal education combined with stimulation sessions improved children's motor, cognitive, and language development (Muhoozi et al., 2018). Despite some evidence on the contrary, certain findings indicate that toddler development may also improve through adequate nutritional fulfilment, even in the absence of structured stimulation programs (M. M. Black et al., 2017). There is strong evidence that highlights the importance of stimulation in supporting toddler growth and development. Combining early stimulation with nutrition programs enhanced child development outcomes, underscoring the value of integrated interventions (Andrew et al., 2020). Early child stimulation was positively associated with linear growth and improvements in cognitive, motor, and language development even among low birth weight infants (Upadhyay et al., 2022). Therefore, it is important to include child stimulation in maternal education programs.

Nursing Implications

Nurses play a vital role in delivering health education, promoting preventive behaviors, and improving maternal caregiving practices in community settings (Kappi, 2026). However, nurses often face barriers such as limited time, heavy workload, inadequate educational resources, insufficient communication skills, and low community health literacy (Shadadi et al., 2018; Wang et al., 2024). These challenges may reduce the effectiveness and sustainability of maternal and child health education programs.

Mobile-based nutritional interventions provide an innovative approach to extending health education beyond conventional face-to-face methods through continuous support, flexible learning schedules, and wider outreach (Umeano, 2025). Community health nurses may utilize this platform to deliver education, monitor participant engagement, and facilitate interactive discussions efficiently. This intervention may also enables broader participation and expand the outreach coverage of community healthcare facilities. Therefore, the findings of this study offer practical implications for developing sustainable, accessible, and community-based nutritional education strategies, particularly in low-resource settings.

Limitations of This Study

This study has several methodological limitations. The non-randomized design may have reduced statistical precision and increased the risk of selection bias and residual confounding, potentially affecting the internal validity of the findings. The study was also conducted in selected community health center areas in Ciamis Regency, which may limit the generalizability of the findings to regions with different social and economic characteristics. In addition, the relatively short intervention and lack of long-term follow-up restricted the evaluation of sustained behavioral and nutritional changes. The intervention also focused on menu variations from a single local food source, which may not represent the broader range of affordable and culturally relevant foods. In addition, the application did not include a log-in system or user-monitoring features, limiting the assessment of participant engagement, intervention adherence, and usage patterns. Future studies should employ larger samples, stronger methodological designs, longer follow-up periods, multiple local food sources, and enhanced digital monitoring systems to strengthen the evidence base and improve generalizability.

Conclusions

This present study suggests the potential impact of mobile-app nutritional intervention and utilization of local food source on maternal knowledge, attitudes, and practices (KAP), as well as contributing to early improvements in height-for-age (HFA). Although the three-month intervention was relatively short to assess growth and developmental outcomes, it was sufficient to capture early behavioral changes and weight responses, supporting evidence that mobile-app interventions may positively influence toddler nutritional outcomes. This study underscores the importance of engaging diverse stakeholders including academic institutions, healthcare providers, community health cadres, and local fisheries department while leveraging local food resources to address nutritional needs in affordable and contextually relevant ways, particularly for low-income communities. Cross-sectoral collaboration may facilitate the development of standardized maternal health education formats, strengthen the training of community health cadres, and support the integration of this intervention within the national stunting prevention program. Further research with longer intervention periods and extended follow-up is necessary to evaluate the impact of mobile-app interventions on children's nutritional status and reductions in stunting.

Acknowledgement

The authors would like to express their sincere gratitude to the participating mothers and children, whose cooperation and involvement made this study possible. We also acknowledge the support of stakeholders in Ciamis Regency, including local authorities and community health cadres, for their valuable guidance during the development and implementation of the study.

Declaration of Conflicting Interests

The authors had no conflicts of interest in this research.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of AI Use in Assisted Technologies

The authors used artificial intelligence–assisted technologies (specifically ChatGPT by OpenAI) to improve the clarity and language of the manuscript. The authors reviewed and edited all AI-assisted content and took full responsibility for the accuracy, integrity, and originality of the final manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

Abdulahi, M., Fretheim, A., Argaw, A., & Magnus, J. H. (2021). Determinants of knowledge and attitude towards breastfeeding in rural pregnant women using validated instruments in Ethiopia. *International Journal of Environmental Research and Public Health, 18*(15), 7930. https://doi.org/10.3390/ijerph18157930

Acharya, A., Chang, C.-L., Chen, M., & Weissman, A. (2022). Facilitators and barriers to participation in health mothers' groups in improving maternal and child health and nutrition in Nepal: A mixed-methods study. *BMC Public Health, 22*(1), 1660. https://doi.org/10.1186/s12889-022-13859-6

Ahmed, H. M. M., El-Sabagh, H. A., & Elbourhamy, D. M. (2025). Effect of Gamified, Mobile, Cloud-Based Learning Management System

(GMCLMS) on student engagement and achievement. *International Journal of Educational Technology in Higher Education, 22*(1), 49. https://doi.org/10.1186/s41239-025-00541-1

Andrew, A., Attanasio, O., Augsburg, B., Day, M., Grantham-McGregor, S., Meghir, C., Mehrin, F., Pahwa, S., & Rubio-Codina, M. (2020). Effects of a scalable home-visiting intervention on child development in slums of urban India: evidence from a randomised controlled trial. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 61*(6), 644–652. https://doi.org/10.1111/jcpp.13171

Arini, H. R. B., Hadju, V., Thomas, P., & Ferguson, M. (2022). Nutrient and food intake of Indonesian children under 5 years of age: A systematic review. *Asia-Pacific Journal of Public Health, 34*(1), 25–35. https://doi.org/10.1177/10105395211041001

Baliwati, Y. F., & Saputra, I. M. (2014). The analysis of fish and other animal food self-sufficiency in 26 districts/citiesof West Java 2012. *Jurnal Pengolahan Hasil Perikanan Indonesia, 17*(3), 186–196.

Bashir, S., Ansari, A. H., & Sultana, A. (2023). Knowledge, attitude, and practice on antenatal care among pregnant women and its association with sociodemographic factors: A hospital-based study. *Journal of Patient Experience, 10.* https://doi.org/10.1177/23743735231183578

Berutu, R. E., Rosmiati, R., Emilia, E., Haryana, N. R., & Ingtyas, F. T. (2024). Maternal knowledge of balanced nutrition and maternal feeding practices associated with stunting in children aged 24-60 months in the Puskesmas Siempat Rube Working Area. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI), 7*(7), 1878–1883. https://doi.org/10.56338/mppki.v7i7.5288

Betaditya, D., Julia, M., & Nisa, F. Z. (2022). Food security as a determinant of stunting among children aged 2–3 years in Ciamis Regency, West Java. J*urnal Gizi Klinik Indonesia, 18*(4), 157–163. https://doi.org/10.22146/ijcn.37573

Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., McCoy, D. C., Fink, G., Shawar, Y. R., & Shiffman, J. (2017). Early childhood development coming of age: Science through the life course. *The Lancet, 389*(10064), 77–90. https://doi.org/10.1016/S0140-6736(16)31389-7

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., & Martorell, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet, 382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Central Statistics Agency of Ciamis Regency. (2025). Ciamis Regency in Figures 2025.

Daly, L. M., Horey, D., Middleton, P. F., Boyle, F. M., & Flenady, V. (2018). The effect of mobile app interventions on influencing healthy maternal behavior and improving perinatal health outcomes: Systematic review. *JMIR MHealth and UHealth, 6*(8), e10012. https://doi.org/10.2196/10012

Dissieka, R., Soohoo, M., Janmohamed, A., & Doledec, D. (2019). Providing mothers with mobile phone message reminders increases childhood immunization and vitamin A supplementation coverage in Côte d'Ivoire: A randomized controlled trial. *Journal of Public Health in Africa, 10*(1), 1032. https://doi.org/10.4081/jphia.2019.1032

Dwianto, P. (2025). Assessing the effectiveness of community-based nutritional programs on preventing stunting in rural children. *Journal of Nutrition in Child Development, 1*(1), 1–6.

Effendy, D. S., Prangthip, P., Soonthornworasiri, N., Winichagoon, P., & Kwanbunjan, K. (2020). Nutrition education in Southeast Sulawesi Province, Indonesia: A cluster randomized controlled study. *Maternal & Child Nutrition, 16*(4), e13030. https://doi.org/10.1111/mcn.13030

Eryando, T., Sipahutar, T., Budhiharsana, M. P., Siregar, K. N., Aidi, M. N., Utari, D. M., Rahmaniati, M., & Hendarwan, H. (2022). Spatial analysis of stunting determinants in 514 Indonesian districts/cities: Implications for intervention and setting of priority. *Geospatial Health, 17*(1). https://doi.org/10.4081/gh.2022.1055

Fitriami, E., & Galaresa, A. V. (2022). Android application-based stunting prevention education to improve mothers' knowledge and attitudes. *Citra Delima Scientific Journal of Citra Internasional Institute, 5*(2), 78–85. https://doi.org/10.33862/citradelima.v5i2.258

Garenne, M., Maire, B., Fontaine, O., & Briend, A. (2013). Adequacy of child anthropometric indicators for measuring nutritional stress at population level: a study from Niakhar, Senegal. *Public Health Nutrition, 16*(9), 1533–1539. https://doi.org/10.1017/S136898001200448X

Gibson, E., Stacey, N., Sunderland, T. C. H., & Adhuri, D. S. (2020). Dietary diversity and fish consumption of mothers and their children in fisher households in Komodo District, eastern Indonesia. *PloS One, 15*(4), e0230777. https://doi.org/10.1371/journal.pone.0230777

Haryanti, F., Hartini, S., Andarwati, F., Risnawati, H., Pratiwi, A. N., Kusumawati, A. S., Cahyani, R. D., & Lusmilasari, L. (2024a). Maternal knowledge on nutritional-focused nurturing care and associated factors among women with stunted children aged 6-23 months in Yogyakarta, Indonesia: A cross-sectional study. *Belitung Nursing Journal, 10*(4), 472. https://doi.org/10.33546/bnj.3481

Haryanti, F., Hartini, S., Andarwati, F., Risnawati,

H., Pratiwi, A. N., Kusumawati, A. S., Cahyani, R. D., & Lusmilasari, L. (2024b). Maternal knowledge on nutritional-focused nurturing care and associated factors among women with stunted children aged 6-23 months in Yogyakarta, Indonesia: A cross-sectional study. *Belitung Nursing Journal, 10*(4), 472. https://doi.org/10.33546/bnj.3481

Hasan, D. S., Arief, Y. S., & Krisnana, I. (2024). Mobile application intervention to improve nutritional literacy of mothers with stunting children: A systematic review. *Pediomaternal Nursing Journal, 10*(2), 70–75. https://doi.org/10.20473/pmnj.v10i2.47436

Health Development Policy Agency of Health Ministry Indonesia. (2024). Indonesian Health Survey (SKI) 2023: In Figures. Health Development Policy Agency, Ministry of Health, Republic of Indonesia.

Hojati, A., & Farhangi, M. A. (2025). MyKid'sNutrition mobile application: Effect on mothers' nutritional knowledge and nutritional status of preschool-aged children with undernutrition–a randomised controlled trial. *BMJ Nutrition, Prevention & Health, 8*(1). https://doi.org/10.1136/bmjnph-2024-001007

Ijaiya, M. A., Anjorin, S., & Uthman, O. A. (2024). Income and education disparities in childhood malnutrition: A multi-country decomposition analysis. *BMC Public Health, 24*(1), 2882. https://doi.org/10.1186/s12889-024-20378-z

Joseph, C., & Maluka, S. O. (2021). The influence of community factors in the implementation of community-based interventions to improve antenatal care: a qualitative study based on the IMCHA programme in Tanzania. *Reproductive Health, 18*(1), 188. https://doi.org/10.1186/s12978-021-01225-5

Kappi, A. A. (2026). Preventing childhood malnutrition: The collaborative impact of parental practices and community nursing. *Sage Open Nursing, 12*. https://doi.org/10.1177/23779608261447460

Kassaw, M. W., Bitew, A. A., Gebremariam, A. D., Fentahun, N., Açık, M., & Ayele, T. A. (2020). Low economic class might predispose children under five years of age to stunting in Ethiopia: Updates of systematic review and meta-analysis. *Journal of Nutrition and Metabolism, 2020*(1). https://doi.org/10.1155/2020/2169847

Knop, M. R., Nagashima-Hayashi, M., Lin, R., Saing, C. H., Ung, M., Oy, S., Yam, E. L. Y., Zahari, M., & Yi, S. (2024). Impact of mHealth interventions on maternal, newborn, and child health from conception to 24 months postpartum in low- and middle-income countries: A systematic review. *BMC Medicine, 22*(1), 196. https://doi.org/10.1186/s12916-024-03386-4

Kolopaking, R., Bardosono, S., & Fahmida, U. (2011). Maternal self-efficacy in the home food environment: A qualitative study among low-income mothers of nutritionally at-risk children in an urban area of Jakarta, Indonesia. *Journal of Nutrition Education and Behavior, 43*(3), 180–188. https://doi.org/10.1016/j.jneb.2009.10.010

Laksono, A. D., Wulandari, R. D., Amaliah, N., & Wisnuwardani, R. W. (2022b). Stunting among children under two years in Indonesia: Does maternal education matter? *Plos One, 17*(7), e0271509. https://doi.org/10.1371/journal.pone.0271509

Mauludyani, A. V. R., & Khomsan, A. (2022). Maternal nutritional knowledge as a determinant of stunting in West Java: Rural-urban disparities. *Amerta Nutrition, 6*. https://doi.org/10.20473/amnt.v6i1SP.2022.8-12

Ministry of Health of the Republic of Indonesia. (2025). Two focus areas of stunting reduction interventions to achieve the 14% target in 2024. https://www.badankebijakan.kemkes.go.id/en/dua-fokus-intervensi-penurunan-stunting-untuk-capai-target-14-di-tahun-2024/

Ministry of Health of the Republic of Indonesia. (2018). Indonesia health profile 2018. https://e-journal.unair.ac.id/BIOKULTUR/article/download/32242/21891/159621

Ministry of Marine Affairs and Fisheries Republic of Indonesia. (2023). Data Portal: Fish Consumption Statistics. https://statistik.kkp.go.id/

Mousavi Ezmareh, F., Bostani Khalesi, Z., Jafarzadeh Kenarsari, F., & Maroufizadeh, S. (2024). The impact of complementary feeding education for mothers using mobile phone applications on the anthropometric indices of Iranian infants. *Digital Health, 10*. https://doi.org/10.1177/20552076241272558

Muhoozi, G. K. M., Atukunda, P., Diep, L. M., Mwadime, R., Kaaya, A. N., Skaare, A. B., Willumsen, T., Westerberg, A. C., & Iversen, P. O. (2018). Nutrition, hygiene, and stimulation education to improve growth, cognitive, language, and motor development among infants in Uganda: A cluster-randomized trial. *Maternal & Child Nutrition, 14*(2), e12527. https://doi.org/10.1111/mcn.12527

Mulyaningsih, T., Mohanty, I., Widyaningsih, V., Gebremedhin, T. A., Miranti, R., & Wiyono, V. H. (2021). Beyond personal factors: Multilevel determinants of childhood stunting in Indonesia. *PloS One, 16*(11), https://doi.org/10.1371/journal.pone.0260265

Nurhidayah, I., Mediani, H. S., & Mardhiyah, A. (2018). Empowering school teachers for the early detection of tuberculosis in school-aged children. *Media Karya Kesehatan, 1*(2), 185–195. https://doi.org/10.24198/mkk.v1i2.17125

Nurhidayah, R., Sari, D. K., & Kusumawati, P. D. (2024). Nutritional rangers mobile application in improving child nutrition, feeding response and mother's knowledge in underprivileged families. *Journal Of Nursing Practice, 8*(1), 184–189. https://doi.org/10.30994/jnp.

v8i1.659

Pantiawati, I., Murwani, R., Kartini, A., & Afifah, D. N. (2025). WhatsApp-Based Nutrition Telemedicine to Improve Knowledge Attitude Practice (KAP) of mothers with stunted children in Indonesia. *Seejph, 26,* 3727–3743. https://doi.org/10.70135/seejph.vi.5867

Porter, C. M. (2016). Revisiting precede–proceed: A leading model for ecological and ethical health promotion. *Health Education Journal, 75*(6), 753–764. https://doi.org/10.1177/0017896915619645

Rahayu, A., & Khairiyati, L. (2014). The risk of maternal education regarding the incidence of stunting in children aged 6–23 months. *Penelitian Gizi Dan Makanan (The Journal of Nutrition and Food Research), 37*(2), 129–136.

Rahayu, Y., Sandriani, S., Ameliasari, N., & Hayati, E. T. (2023). The relationship between mother's knowledge about nutrition provision with an improvement of stunting children's weight. *Asy-Syifa: Journal of Science and Technology Nursing, 1*(1), 7–16. https://doi.org/10.52221/asy.v1i1.332

Regional Development Planning Agency of Ciamis Regency. (2022). Households Use of Cellular Phones in Ciamis Regency.

Rocha, H. A. L., Sudfeld, C. R., Leite, Á. J. M., Machado, M. M. T., Rocha, S. G. M. O., Campos, J. S., Silva, A. C. e, & Correia, L. L. (2021). Maternal and neonatal factors associated with child development in Ceará, Brazil: A population-based study. *BMC Pediatrics, 21*(1), 163. https://doi.org/10.1186/s12887-021-02623-w

Rufaindah, E., & Patemah, P. (2021). Application of "Stunting Prevention" android-based applications to mother knowledege and nutritional status of toddlers ages 0-36 months. *Jurnal Kebidanan, 11*(1), 41–46. https://doi.org/ 10.31983/jkb.v11i1.6393

Sahanggamu, P. D., Purnomosari, L., & Dillon, D. (2017). Information exposure and growth monitoring favour child nutrition in rural Indonesia. *Asia Pacific Journal of Clinical Nutrition, 26*(2), 313–316. https://doi.org/10.6133/apjcn.012016.09

Samosir, O. B., Radjiman, D. S., & Aninditya, F. (2023). Food consumption diversity and nutritional status among children aged 6-23 months in Indonesia: The analysis of the results of the 2018 Basic Health Research. *PloS One, 18*(3), e0281426. https://doi.org/10.1371/journal.pone.0281426

Seyyedi, N., Rahimi, B., Eslamlou, H. R. F., Afshar, H. L., Spreco, A., & Timpka, T. (2020). Smartphone-based maternal education for the complementary feeding of undernourished children under 3 years of age in food-secure communities: Randomised controlled trial in Urmia, Iran. *Nutrients, 12*(2). https://doi.org/10.3390/nu12020587

Shadadi, H., Sheyback, M., Balouchi, A., & Shoorvazi, M. (2018). The barriers of clinical education in nursing: A systematic review. *Biomedical Research, 29*(19), 3616–3623.

Sisouvong, V., & Pasanchay, K. (2024). Mobile learning: Enhancing self-directed education through technology, wireless networks, and the internet anytime, anywhere. *Journal of Education and Learning Reviews, 1*(2), 39–50. https://doi.org/ 10.60027/jelr.2024.711

Statistics Indonesia (BPS). (2021). Statistics of Telecommunication Indonesia 2021.

Suminar, R., Heryani, S., Heriyanti, S. W., & Ningrum, W. M. (2025). Increasing awareness among mothers of children under five using a stunting detection calculator in Kertaharja Village, Cijeungjing Community Health Center Working Area. *Abdimas Galuh, 7*(1), 706–710. https://doi.org/ 10.25157/ag.v7i1.17718

Supadmi, S., Laksono, A. D., Kusumawardani, H. D., Ashar, H., Nursafingi, A., Kusrini, I., & Musoddaq, M. A. (2024). Factor related to stunting of children under two years with working mothers in Indonesia. *Clinical Epidemiology and Global Health, 26,* 101538. https://doi.org/ 10.1016/j.cegh.2024.101538

Susanto, T., Sulistyorini, L., & Yudisianto, A. (2017). Local-food-based complementary feeding for the nutritional status of children ages 6–36 months in rural areas of Indonesia. *Korean Journal of Pediatrics, 60*(10), 320. https://doi.org/ 10.3345/kjp.2017.60.10.320

Syah, N., & Yuniarti, E. (2024). The relationship between maternal education level and stunting: literature review. *Jurnal Penelitian Pendidikan IPA, 10*(10), 704–710. https://doi.org/ 10.29303/jppipa.v10i10.9243

Tamir, T. T., Zegeye, A. F., Workneh, B. S., & Mekonen, E. G. (2024). Underweight and associated factors among children under age of five in low and lower-middle income African countries: hierarchical analysis of demographic and health survey data. *Frontiers in Public Health, 12*, 1423603. https://doi.org/10.3389/fpubh.2024.1423603

Umeano, A. (2025). Innovative nursing approaches integrating digital health and evidence-based practice to strengthen healthcare accessibility and patient satisfaction outcomes. *International Journal of Advance Research in Community Health Nursing, 7*(2), 82–94. https://doi.org/10.33545/26641658.2025.v7.i2b.247

Unicef. (2025). Indonesia Nutritional Status Survey (SSGI) 2024: Continued Progress in Tackling Child Malnutrition.

UNICEF. (2020). Conceptual framework on the determinants of maternal and child nutrition. A Framework for the Prevention of Malnutrition in All Its Forms.

Upadhyay, R. P., Taneja, S., Strand, T. A., Sommerfelt, H., Hysing, M., Mazumder, S., Bhandari, N., Martines, J., Dua, T., & Kariger,

P. (2022). Early child stimulation, linear growth and neurodevelopment in low birth weight infants. *BMC Pediatrics, 22(*1), 586. https://doi.org/ 10.1186/s12887-022-03624-5

Wang, S., Liu, K., Tang, S., Wang, G., Qi, Y., & Chen, Q. (2024). Barriers and facilitators to patient education provided by nurses: A mixed-method systematic review. *Journal of Clinical Nursing, 33*(7), 2427–2437. https://doi.org/10.1111/jocn.17026

West Java Provincial Office of Communication and Informatics. (2020). 80 Percent of Villages in West Java Already Have Internet Access.

Wibowo, D. A., Dewi, Y. L. R., Hikmayani, N. H., & Zen, D. N. (2024). The Influence of Tilapia on the Growth and Development of Stunted Toddlers. *International Journal of Religion, 5*(10), 1488–1500. https://doi.org/10.61707/57g5er95

World Health Organization (WHO). (2011). Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption.

World Health Organization (WHO). (2020). Healthy Diet Fact Sheet.

World Health Organization (WHO). (2022). Nutrition profiles: South-Eastern Asia. Global Nutrition Report. https://globalnutritionreport.org/resources/nutrition-profiles/asia/south-eastern-asia/

Wu, R., & Yu, Z. (2022). Exploring the effects of achievement emotions on online learning outcomes: A systematic review. *Frontiers in Psychology, 13,* 977931. https://doi.org/10.3389/fpsyg.2022.977931

Yigit, M., Santaflioglu, B., Kilic, E. K., Celebier, K., & Kalayci, F. (2025). From pregnancy to plate: understanding barriers and facilitators of fish consumption during complementary feeding. *BMC Pediatrics, 25*(1), 432. https://doi.org/10.1186/s12887-025-05789-0

Yunitawati, D., Laksono, A. D., Khairunnisa, M., Purwoko, S., Muis, E. W., Nursafingi, A., Riyanto, S., & Samsudin, M. (2025). Education role in stunting under two years among poor communities in Indonesia. *Jurnal Promosi Kesehatan Indonesia, 20*(1), 30–36. https://doi.org/ 10.14710/jpki.20.1.30-36