



Interactive Social Media-Based Nutrition Education to Improve Complementary Feeding Practices for Mothers with Underweight Children

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Abstract

Underweight in toddlers remains a serious nutritional problem that impacts long-term growth and development. Evidence from observational and intervention studies consistently indicates that complementary feeding practices do not meet recommendations. Social media has the potential to be an effective platform for nutrition education, but scientific evidence regarding interactive digital IEC interventions remains limited. This study aimed to analyze the effectiveness of social media-based interactive IEC in improving mothers' knowledge, attitudes, and practices (KAP) regarding the provision of complementary feeding to underweight toddlers. The study was conducted as a quasi-experimental, non-randomized controlled trial on 84 mothers (42 intervention; 42 control) in Semarang Regency from October to November 2025. The intervention group received educational videos on complementary feeding via TikTok/YouTube (two videos per day for 14 days) and 24-hour chatbot support. The control group received routine community health center services. Pre and post-measurements were conducted using a reliable KAP questionnaire. Analysis used the Wilcoxon and Mann-Whitney tests. Intergroup comparisons at post-test showed significant differences for all variables ($p < 0.001$), with a medium-to-large effect size in the intervention group. Social media-based interactive IEC combining educational videos and a chatbot effectively increased mothers' KAP on complementary feeding for underweight toddlers. Further research with a randomized design and longer duration is needed to evaluate its impact on children's nutritional status.

Introduction

In 2019, 4.8% (95% UI 3.9–6.0) of DALYs among children under 5 years of age were underweight. Globally, in 2019, 241,000 deaths (183,000–326,000) among children under 5 years of age were caused by underweight (Global Health Metrics, 2019). The prevalence of underweight in 2022 was 12.3%. In Indonesia, 1 in 10 children is underweight or too thin for their age. The results of the 2022 Indonesian Nutrition Status Survey (SSGI) showed that the prevalence of underweight or malnourished

toddlers in 2022 was 17.1%. An increase of 0.1 from the previous year. Data on the prevalence of malnutrition in children under two years of age in Indonesia is 11.4%, and children under five years of age are malnourished (17.7%) (Kementerian Kesehatan RI, 2018).

Malnutrition in toddlers (infants and children under 2 years), particularly underweight, remains a significant public health challenge in middle-income countries, including Indonesia; this condition affects growth, cognitive development, and the risk of

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long-term disease (Muluye *et al.*, 2020; Waqiyah *et al.*, 2023). National and global data indicate that the prevalence of underweight during the toddler period affects child development outcomes and requires specific nutritional interventions in the 0 to 24-month period to prevent long-term effects (Muluye *et al.*, 2020; Waqiyah *et al.*, 2023). One of the main determinants of nutritional status in toddlers is the practice of providing complementary foods (MP-ASI); providing MP-ASI that does not meet recommendations (time, frequency, quality, and quantity) is associated with an increased risk of malnutrition, including underweight and stunting (Waqiyah *et al.*, 2023).

National and global data show that the prevalence of underweight in children has serious consequences for linear growth, neurocognitive development, and long-term health risks. Globally, the prevalence of stunting and wasting remains high and is closely associated with undernutrition among children aged 0–59 months, which threatens their development and potential productivity in adulthood (Dewey *et al.*, 2021; Sanefuji *et al.*, 2021). Cohort studies and reviews have demonstrated associations between prenatal and postnatal nutritional deficiencies and stunted growth and brain development, providing a biological basis for the relationship between early nutritional status and subsequent neurodevelopmental outcomes (Rodrigues *et al.*, 2023; Sanefuji *et al.*, 2021).

Evidence from observational and interventional studies consistently indicates that complementary feeding practices that do not meet recommendations (e.g., early introduction before 6 months, low dietary diversity, and meal frequency below the minimum threshold) are predictors of poor nutritional status (underweight, wasting, and stunting) in children aged 6–24 months (Najib *et al.*, 2023; Suhermi *et al.*, 2017). For example, a cohort study in Moshi, Tanzania, reported a high prevalence of solid/semi-solid food introduction before 6 months of age, low meal frequency, and low dietary diversity; these factors were significantly associated with the risk of underweight and wasting (ARR for underweight = 2.6; 95% CI 1.3–5.1) and an increased risk of stunting if the minimum

meal frequency was not achieved (Masuke *et al.*, 2021). Similar findings in the South Asian context indicate that a carbohydrate-dominated diet for children aged 6–23 months with limited intake of animal-source foods, fruits, and vegetables contributes to stunted growth (Ariff *et al.*, 2020). In Indonesia, a literature review concluded that inappropriate complementary feeding practices affect child growth and development, underscoring the relevance of adequate complementary feeding practices in the 6–24-month age group.

Complementary feeding practices that do not meet recommendations reduce energy and essential micronutrient intake during critical growth periods, hindering body mass accumulation and organ or brain development; this cumulative effect is associated with decreased anthropometric indicators (W/A, H/A) and cognitive or neurobehavioral developmental outcomes (Rodrigues *et al.*, 2023; Sanefuji *et al.*, 2021). Furthermore, early introduction of complementary feeding before 6 months is associated with a higher risk of infection, which worsens nutritional status through more nutrient losses and decreased intake, as reported in local food-based interventions and studies of complementary feeding practices in developing countries (Marlina & Erowati, 2021; Suryana *et al.*, 2022).

Empirical evidence shows that maternal knowledge, attitudes, and practices regarding complementary feeding significantly influence the quality of children's intake and, therefore, their nutritional status (Kusumawati *et al.*, 2017; Simbolon *et al.*, 2022). Traditional nutrition education interventions have improved maternal knowledge of complementary feeding in various studies in middle- and low-income contexts, but changes in attitudes and practices are often more difficult to achieve without a sustained, interactive approach (Majidah *et al.*, 2021). RCTs and quasi-experimental studies have shown improvements in knowledge and sometimes feeding practices following structured education, but effectiveness in long-term behavior change still depends on the format, intensity, and participant engagement (Majidah *et al.*, 2021; Muluye *et al.*, 2020).

National nutrition education strategies generally rely on conventional approaches

(leaflets, face-to-face sessions at health facilities, group counseling), which, while beneficial, have limitations in coverage, sustainability, and equitable accessibility, including location, time, and resource constraints, thus reducing population impact, particularly for busy young mothers or those living in remote areas (Budiono *et al.*, 2024; Majidah *et al.*, 2021; Muluye *et al.*, 2020). Program implementation studies indicate that printed materials or one-off counseling sessions can increase knowledge but do not necessarily change practices without ongoing follow-up and personal involvement (Majidah *et al.*, 2021).

The use of social media and digital technology offers significant potential to expand reach, increase interactivity, and tailor messages to the preferences of young users (Asih *et al.*, 2024). Research Andriani *et al.* (2021) found that the majority of mothers (89.1%) use mobile devices. Mothers use mobile devices primarily to seek information on nutrition (82.7%) and diseases (70%). Research Maafs-Rodríguez *et al.* (2023) by a quantitative analysis revealed that social media is the most frequently used platform on a daily basis. Platforms such as TikTok and YouTube have been used in health communication to deliver accessible and engaging information, demonstrating their capacity to reach broad audiences and stimulate user engagement (Basch *et al.*, 2022; Boatman *et al.*, 2021; Douglass *et al.*, 2022). Systematic reviews and qualitative studies report that adolescents and parents increasingly rely on digital platforms for everyday health information, making these platforms representative for health behavior education interventions (Basch *et al.*, 2022; Douglass *et al.*, 2022). While there is evidence that digital media can improve knowledge and several behavioral indicators among young populations and mothers, there is limited scientific evidence specifically evaluating interactive digital IEC interventions that combine short social media-based educational videos and a 24/7 companion chatbot to improve feeding behaviors in mothers of underweight children.

Studies on other health topics (e.g., HPV vaccination) demonstrate the significant potential for delivering education through

TikTok but also highlight variations in content quality and the need for professional involvement for effective health messages (Basch *et al.*, 2022; Boatman *et al.*, 2021). Existing nutrition intervention studies often do not incorporate interactive components or chatbot-based personalization, so research evaluating the combination of multimedia and interactive support to achieve maternal behavior change is needed (Muluye *et al.*, 2020). This knowledge gap highlights the need for research that develops social media-based digital nutrition education interventions using a scientific approach, starting with a systematic literature review to identify the best evidence, and focus group discussions (FGDs) to understand the needs, barriers, and local preferences of target mothers. This approach then develops contextualized multimedia educational materials and pilot tests before larger-scale evaluation (Douglass *et al.*, 2022; Muluye *et al.*, 2020). This approach aligns with evidence-based intervention development practices that enhance cultural relevance, acceptability, and the likelihood of adoption in the field (Muluye *et al.*, 2020). This study offers novel value through the integration of two key elements: (1) short multimedia educational videos designed for popular platforms (TikTok and YouTube) to leverage the reach, engaging visual-audio format, and content consumption habits of young mothers; and (2) an interactive chatbot to provide personalized support, answer practical questions, and provide repeated reinforcement throughout the intervention period. The use of video as a medium for MP-ASI education has been shown to increase understanding and serve as a reference for mothers' practices (Aulia *et al.*, 2022), while preliminary evidence on AI/chatbot integration in health education suggests the potential to increase information availability and personalize support (May *et al.*, 2024).

One important contribution of this study is its focus on a specific population: mothers of underweight children. This group has received little attention in systematic digital interventions, despite being a high-risk group requiring a more intensive and personalized nutrition approach (Muluye *et al.*, 2020; Waqiyah *et al.*, 2023). Targeting the intervention

to mothers of underweight children allows for more focused messaging (e.g., portion sizes, meal frequency, and nutritious local recipes) and effective evaluation of relevant KSP changes for nutritional improvement. Therefore, this study was designed to evaluate the effectiveness of social media-based interactive IEC (TikTok/YouTube educational videos + chatbot) in improving mothers' knowledge, attitudes, and practices regarding complementary feeding for underweight toddlers. The study aimed to analyze the effectiveness of social media-based interactive IEC in improving mothers' knowledge, attitudes, and practices regarding complementary feeding for underweight toddlers. The research hypothesis was that the intervention group would show greater improvements in knowledge, attitudes, and practices of complementary feeding compared to the control group after the digital intervention.

Method

This study used a quasi-experimental non-randomized controlled trial design with two groups: the intervention group and the control group. The study was conducted in Semarang Regency from October to November 2025. The intervention group received an interactive social media-based Communication, Information, and Education (KIE) program regarding the provision of Complementary Breastfeeding Foods (MP-ASI), while the control group received routine community health center services without additional digital intervention. This study has obtained ethical approval from the Research Ethics Committee of Semarang State University (Approval Number 345/KEPK/FK/KLE/2024) on June 24, 2024. Participants in this study were mothers having children aged 6–24 months with an underweight status based on data from the Semarang District Health Office. Sample selection used a purposive sampling technique with the following inclusion criteria: (1) Willing to be respondents and sign informed consent, (2) Own an Android-based mobile phone and be able to operate it, (3) Participate in the entire series of research without dropping out, and (4) Do not have medical conditions or congenital abnormalities in children that can

affect nutritional status. The total sample was 84 people, 42 in the intervention group (5 health centers) and 42 in the control group (5 health centers). For 14 days, the intervention group got an interactive IEC program, while the control group got routine care. Pre- and post-tests were conducted before and after the intervention.

The social media-based interactive IEC consists of educational videos on TikTok and YouTube platforms with the topics of the need for complementary feeding, safety of complementary feeding, how to provide complementary feeding and the composition of complementary feeding, how to make complementary feeding easily, the adequacy of complementary feeding, including frequency of feeding and variety of foods, the adequacy of complementary feeding in terms of quantity and dosage, how to store complementary feeding, how to process complementary feeding, complementary feeding when a child is sick. The frequency of 2 videos per day for 14 days with a video duration on TikTok of 1-2.5 minutes was developed through an initial research process that included a Systematic Literature Review (SLR) to identify effective nutrition education components, as well as focus group discussions (FGDs) to adapt educational materials to the local context and video duration on YouTube of 6-9 minutes videos from Global Health Media which were dubbed and adjusted to the Indonesian local context and guidelines with the help of UNICEF nutrition experts in Indonesia. Participant compliance in watching educational videos was assessed by commenting on or liking educational videos on TikTok. An interactive chatbot was also provided, functioning as a 24-hour support service to answer mothers' questions regarding complementary feeding. It utilized the WhatsApp platform and an automated response mechanism, monitored daily to remind respondents to study the shared videos. Participants in the intervention group were added to a WhatsApp group and received educational videos daily for 14 consecutive days, from September 15 to September 29, 2025.

Data analysis was performed using SPSS version 22. Descriptive analysis was used to describe the characteristics of the respondents. The Shapiro–Wilk normality test was used to determine the distribution of the data, and

because most variables were not normally distributed, the analysis was performed using non-parametric methods. Comparison of baseline characteristics between groups used the chi-square test for categorical data and the Mann–Whitney test for continuous and specific data. Maternal age variables were tested using the independent t-test. Changes in knowledge, attitude, and practice scores within groups were analyzed using the Wilcoxon signed-rank test, while differences between groups in the pre-test and post-test were tested using the Mann–Whitney test.

Results and Discussions

Samples are 84 mothers with underweight children were selected as research samples (42 intervention groups and 42 control groups) by the Semarang District Health Office, with the criteria of being willing to participate as respondents, having an Android cellphone, participating in the research process, and

not dropping out during the research period. Basic Characteristics of Study Participants TABLE 1 shows the basic characteristics of study participants and differences between the intervention and control groups. The majority of study participants were mothers aged around 30-32 years, had secondary to higher education levels, and were unemployed. Most of the mothers in both groups attended classes for mothers of toddlers, though the proportion was higher in the intervention group. The number of toddlers in the family was generally only one, with the child's age around 19-21 months, and birth weight around 2800-2875 grams. The group of children was mostly male, with an age gap of more than 2 years. The basic characteristics of the groups were relatively comparable or homogeneous, as indicated by mostly p-values > 0.05. This indicates that there was no significant difference between the two groups before the intervention; a significant difference was only found in gender characteristics, with a p-value of $0.044 < 0.05$.

TABLE 1. Differences in Baseline Characteristics Between the Intervention and Control Groups

Characteristics	Intervention (n=42)	Control (n=42)	p-value
Mother's age (mean $\pm$ SD)	31.71 $\pm$ 5.936	30.86 $\pm$ 6.426	0.776
Child Birth Order Number (median $\pm$ SD)	2 $\pm$ 0.796	2 $\pm$ 0.861	0.644
Child Birth Weight (median $\pm$ SD)	2800 $\pm$ 456.301	2875 $\pm$ 497.897	0.628
Number of Toddlers in the Family (median $\pm$ SD)	1 $\pm$ 0.328	1 $\pm$ 0.497	0.148
Child Age (median $\pm$ SD)	21 $\pm$ 5.746	19.50 $\pm$ 5.134	0.978
Mother's education n (%)			
Elementary	9 (21.4%)	22 (52.4%)	0.460
Middle - High	33 (78.6%)	20 (47.6%)	
Mother's work status n (%)			
Doesn't work	30 (71.4%)	34 (81%)	1.000
Work	12 (28.6%)	8 (19%)	
Father's education n (%)			
Elementary	13 (31%)	20 (47.6%)	0.588
Middle – High	29 (69%)	22 (52.4%)	
Gender n (%)			
Male	26 (61.9%)	24 (57.1%)	.044
Female	16(38.1%)	18 (42.9%)	
Child Age Gap n (%)			

Less than 2 years	2 (4.8%)	6 (14.3%)	1.000
More than or 2 years	40 (95.2%)	36 (85.7%)	
Participation in the Mother and Toddler Class			
Doesn't participate	6 (14.3%)	18 (42.9%)	0.685
Participate	38 (85.7%)	24 (57.1%)	

The main results of TABLE 2 compare maternal knowledge, attitudes, and maternal practices regarding complementary feeding between the control and intervention groups. The results showed an increase in knowledge about complementary feeding that differed between groups. In the control group, the knowledge score increased from 17.14 ± 2.98 in the pre-test to 18.14 ± 3.14 in the post-test, with a significant difference ($p = 0.004$). Meanwhile, the intervention group showed a greater increase, namely from 18.36 ± 2.29 to 20.43 ± 1.66 , and the difference was very significant ($p = 0.000$). The results of the comparison test between groups showed that before the intervention, there was no significant difference between the intervention and control groups ($p = 0.061$). However, after the intervention, the difference in knowledge scores became significant ($p = 0.000$). So the intervention can improve mothers' knowledge about complementary feeding. The results showed that an interactive social media-based IEC intervention significantly improved mothers' knowledge, attitudes, and practices regarding complementary feeding (MP-ASI) for underweight toddlers. These findings strengthen the evidence that digital education approaches combining short videos and chatbots can produce meaningful behavior change, especially in vulnerable populations. This section critically examines the findings by integrating empirical evidence, behavioral theory, comparisons with global literature, and the study's methodological limitations.

The underlying theory supported by the literature is that improving maternal nutritional literacy can change complementary feeding practices, and digital educational interventions increase access to nutritional information, thus facilitating these changes (Handayani *et al.*, 2023; Wahyuni *et al.*, 2024). A scoping

review of the literature emphasized the need to improve access to nutritional information for mothers of toddlers 0–2 years, including on complementary feeding, and recommended the use of information media for this topic (Wahyuni *et al.*, 2024). Evaluations of health promotion programs also showed that the combination of educational counseling and complementary feeding materials results in better knowledge gains than controls. Chatbots, as interactive elements, have the potential to provide personalized responses, message repetition, and reminders that support behavioral adoption, in line with the principles of health education interventions, which are based on communication and learning theory, recommended for improving maternal nutritional literacy. Therefore, the most likely mechanisms explaining the findings are: (a) short videos convey easily digestible and visually engaging information, thereby increasing knowledge and attitudes; (b) chatbots provide continuous interaction, personalization, and reinforcement of practices that lead to changes in complementary feeding behavior (Aulia *et al.*, 2022; Wahyuni *et al.*, 2024).

A digital intervention in the form of a social media-based interactive IEC (short video + chatbot) resulted in a greater increase in maternal knowledge scores than routine community health center services, a pattern consistent with evidence that audiovisual education and media-based interventions improve understanding and retention of information about complementary feeding (MP-ASI). Field studies and reviews have shown a positive correlation between educational interventions and improvements in maternal knowledge about MP-ASI and feeding practices (Asmi, 2022). Specifically, local research has shown that educational interventions (education plus practice) increase

maternal knowledge about MP-ASI and that educational media (e.g., information cards, smart cards) improve child feeding knowledge and practices (Untari *et al.*, 2022), supporting the finding that dynamic, repeatable short video formats facilitate better understanding than conventional face-to-face education alone (Asmi, 2022; Untari *et al.*, 2022).

Mechanisms that explain increased knowledge include content accessibility, flexibility for re-watching, and audiovisual elements that make it easier to understand nutritional concepts. Research in the context of MP-ASI and nutrition education programs emphasizes that easy access to materials and the ability to repeat messages strengthen learning and retention of information (Untari *et al.*, 2022), while studies of the implementation of online programs among young mothers show that digital platforms facilitate participation and repetition of messages (e.g. online nutrition classes during the pandemic), thereby supporting increased knowledge and practice (Sitoayu *et al.*, 2022). In addition, literature examining the determinants of complementary feeding practices identifies maternal knowledge as an important factor in appropriate complementary feeding practices (Julianti *et al.*, 2023; Nurrizka *et al.*, 2021), so increasing knowledge through audiovisual formats can be understood as a possible causal pathway.

The control group experienced a decrease in scores from 66.36 ± 11.21 to 63.83 ± 13.51 . It was statistically significant ($p = 0.019$), but the intervention group showed a consistent and significant increase from 70.24 ± 10.82 on the pre-test to 76.43 ± 7.38 on the post-test ($p = 0.000$). Comparison of attitudes between groups also showed significant differences both before the intervention ($p = 0.016$) and after the intervention ($p = 0.000$). This indicates that the intervention not only improved maternal attitudes but also maintained a positive direction of change compared to the control group, which tended to experience a decrease in maternal attitudes about Complementary Feeding.

Digital interventions are also associated with increased positive attitudes toward complementary feeding practices. Empirical evidence suggests that increased knowledge is

often accompanied by shifts in attitudes when interventions provide persuasive and practical messages; local studies have found a relationship between knowledge levels, attitudes, and the appropriateness of complementary feeding, and comprehensive educational programs have improved feeding practices in families with stunted children (Julianti *et al.*, 2023; Setyawati *et al.*, 2024; Untari *et al.*, 2022). Therefore, visual-narrative content in short videos can foster more positive perceptions about the importance of appropriate complementary feeding, as supported by studies showing that evidence-based education can change mothers' beliefs and attitudes (Asmi, 2022; Untari *et al.*, 2022).

In contrast, the decline or stagnation in attitudes in the control group indicates that sporadic and less frequent health communication is insufficient to maintain or improve maternal attitudes toward complementary feeding. Literature highlighting the need for repeated counseling and ongoing support for practice change corroborates this interpretation: repeated counseling and education are associated with more appropriate initiation of complementary feeding and improved practices (Anduaem *et al.*, 2020); (Untari *et al.*, 2022). Therefore, the decline in attitudes in the control group supports the need for more consistent and multi-layered interventions. The role of chatbots as emotional and cognitive reinforcement is also theoretically and empirically justified. Interactive support (two-way feedback) allows personalized clarification of mothers' doubts, improving their confidence in adopting new practices. Research on online mentoring and complementary feeding consultations suggests that online support facilitates access to information and practice improvement for mothers (Sitoayu *et al.*, 2022). Thus, the chatbot's function as a personalized reinforcement mechanism is consistent with findings that ongoing support increases adoption of recommended behaviors.

The control group showed no change, with scores remaining at 12.88 ± 1.89 in both the pre- and post-tests ($p = 1.000$). However, the intervention group showed a significant increase from 13.83 ± 1.23 to 14.24 ± 1.10 ($p = 0.009$). The results of the inter-group

TABLE 2. Comparison of Outcome Variables After Social Media-Based Interactive IEC on Maternal Knowledge, Maternal Attitudes, and Maternal Practices regarding Complementary Feeding between the Control Group and the Intervention Group

Variables	Control Group (n=42)							Intervention Group (n=42)							Group Difference			
	Pre		Post		p ^a	Z		Pre		Post		p ^a	Z		Pre		Post	
	M	SD	M	SD				M	SD	M	SD				P ^b	Z	P ^b	Z
Mother's Knowledge	17.14	2.984	18.14	3.136	0.004	-2.880 ^b		18.36	2.293	20.43	1.655	0.000	-5.664 ^b		0.000	-1.875	0.000	-3.747
Mother's Attitude	66.36	11.207	63.83	13.510	0.019	2.347 ^b		70.24	10.817	76.43	7.382	0.000	-5.394 ^b		0.000	-2.411	0.000	-5.288
Mother's Practice	12.88	1.890	12.88	1.890	1.000	.000 ^b		13.83	1.228	14.24	1.100	0.009	-2.622 ^b		0.000	-2.593	0.000	-3.905

M, mean; SD, standard deviation

^a The difference between pre-test and post-test in each group was obtained from the Wilcoxon signed rank test.

^b The difference between the control group and the intervention group was obtained from the Mann Whitney test.

comparison test showed that although there was a slight difference in the pre-test ($p = 0.010$), the difference became highly significant in the post-test ($p = 0.000$). These findings confirm that the nutrition education intervention directly improves maternal practices in complementary feeding.

Significant changes in complementary feeding practices in the intervention group indicate that digital interventions successfully translate knowledge into concrete actions. These results support meta-analyses and systematic reviews that suggest educational interventions (without distribution of complementary foods) can still improve breastfeeding and complementary feeding practices in communities, both in hospitals and the community. Education extends the duration of exclusive breastfeeding, increases the adequacy of complementary feeding, and improves hygiene practices such as handwashing before feeding (Arikpo *et al.*, 2018). Nutrition intervention studies that incorporate practical demonstrations and education have shown improvements in child feeding practices. For example, a nursing nutrition intervention that included practical training on preparing complementary feeding improved feeding practices in families with children (Julianti *et al.*, 2023; Marlina & Erowati, 2021).

Furthermore, studies of educational media (such as cards or smart media) have

documented improvements in practices after exposure to easily replicated educational materials (Untari *et al.*, 2022). Therefore, demonstrative videos on how to prepare complementary feeding, including portion sizes and frequency, provide behavioral cues that mothers can readily imitate, a process consistent with behavior change theories that emphasize modeling and reinforcement (Julianti *et al.*, 2023; Untari *et al.*, 2022). Chatbots provide “just-in-time” support that facilitates the translation of knowledge into practice at the moment of need (e.g., when preparing complementary feeding), consistent with reports on the effectiveness of online mentoring supporting complementary feeding practices (Sitoayu *et al.*, 2022). Round-the-clock support can reduce practical confusion and increase consistency in implementing complementary feeding recommendations at home.

Not all studies demonstrate the superiority of video or digital media over static media when the intervention is a single channel without additional reinforcement. A cluster study in rural Benin found that short videos for nutrition education showed no significant advantage over posters/flyers in improving feeding practices (MDD and MMF indicators) after a 6-month program (Sam *et al.*, 2020). The combination of educational videos and chatbots creates a layered education model

(multimedia + interactivity) that is theoretically and empirically more effective than a single approach. Evidence from media and education interventions suggests that intervention packages combining informative content and practical support improve understanding and practice more strongly than a single channel alone (Julianti *et al.*, 2023; Untari *et al.*, 2022). One study that aligns with the findings of this study is a quasi-experimental study by Yildiz *et al.* (2025), which reported that an AI-based breastfeeding counseling application supported by a chatbot in a group of breastfeeding mothers showed significant improvements in breastfeeding self-efficacy scores and breastfeeding success compared to a control group that only received an educational booklet (Yildiz *et al.*, 2025). Furthermore, content design based on a systematic literature review (SLR) and focus group discussions (FGDs) ensured that the material was evidence-based and culturally relevant—an approach recommended in the nutrition intervention development literature to ensure local acceptance and scientific validity (Ainy *et al.*, 2021; Marlina & Erowati, 2021; Untari *et al.*, 2022).

The results of this study reinforce the finding that conventional education is limited when it is not accompanied by ongoing support or is limited to a single face-to-face counseling session. Reviews and field studies of educational programs indicate that increases in knowledge do not always lead to changes in practice without ongoing reinforcement and support (Mahumud *et al.*, 2021; Untari *et al.*, 2022). This research adds to the evidence that social media-based digital interventions not only increase knowledge but also drive changes in practice, aligning with studies that have found the effectiveness of social media channels (TikTok/YouTube) in public health education on topics such as immunization, nutrition, and maternal health (Sitoayu *et al.*, 2022) (Untari *et al.*, 2022). The mechanism of change is likely a combination of increased self-efficacy (belief in the ability to perform), behavioral modeling through demonstrative videos, repeated reinforcement through easy access and notifications, and flexible access that overcomes time and distance barriers. The literature on the determinants

of complementary feeding practices and educational intervention design emphasizes that these factors—repeated education, modeling, and social/technical support—are critical components for sustainable behavior change (Nurriszka *et al.*, 2021) (Julianti *et al.*, 2023) (Andualem *et al.*, 2020) (Sitoayu *et al.*, 2022). Thus, digital interventions can overcome operational constraints in community health centers regarding the reach and frequency of education.

From a program and policy perspective, the tested interventions have the potential to be integrated into national nutrition programs as a relatively low-cost and easily scalable approach. The experience of online assistance, the use of local media for processing MP-ASI, and effective educational media shows that a multimedia approach can be adopted by the Ministry of Health and primary care facilities, such as community health centers, to reach a wide population of mothers (Marlina & Erowati, 2021; Sitoayu *et al.*, 2022; Untari *et al.*, 2022). The flexibility of the format allows replication for other targets—stunting prevention, anemia, promotion of exclusive breastfeeding, and youth nutrition programs—as local nutrition education programs have been implemented for various nutrition issues (Marlina & Erowati, 2021). Strengths of the study include its two-group quasi-experimental design and the use of reliable instruments; this design provides empirical evidence of the intervention's effectiveness on knowledge, attitudes, and practices (KAP) outcomes, similar to other intervention studies using non-randomized, controlled designs (Julianti *et al.*, 2023; Untari *et al.*, 2022). However, limitations such as non-randomized sampling, potential response bias (social desirability), and the relatively short intervention duration reduce the inferential strength of long-term outcomes (such as children's nutritional status). Related literature also emphasizes the need for long-term impact evaluations to confirm changes in children's anthropometric status following educational interventions (Andualem *et al.*, 2020; Mahumud *et al.*, 2021), so findings should be interpreted with caution.

Further research with stronger methodology (e.g., randomized controlled

trials), longer duration, and measures of child nutritional outcomes (weight/age, height/age, and height-to-age ratio) is needed to assess whether observed changes in KAP contribute to improvements in the nutritional status of underweight or stunted children (Andualem *et al.*, 2020; Mahumud *et al.*, 2021). Furthermore, exploring the use of more sophisticated AI in chatbots (e.g., NLP tailored to local language/context) could improve the personalization of support and the effectiveness of behavior change, as literature recommends integrating technology for online mentoring and nutrition education (Sitoayu *et al.*, 2022) (Untari *et al.*, 2022). Cost-effectiveness evaluations and system-scale implementation studies (integration into community health centers/Ministry of Health) are also needed to translate evidence into national program policy (Marlina & Erowati, 2021; Sitoayu *et al.*, 2022; Untari *et al.*, 2022).

Conclusion

An interactive social media-based IEC intervention merging the short educational videos and a chatbot proved more effective than routine community health center services in improving mothers' knowledge, attitudes, and practices regarding complementary feeding for underweight toddlers. This improvement was made possible by flexible access, audiovisual repetition, behavioral demonstrations, and interactive support that strengthened mothers' learning and decision-making processes. These findings suggest that a digital education approach can be a feasible, affordable, and potentially integrated strategy into nutrition programs at the primary care level. However, further research with a more robust design, longer duration, and measurement of child nutrition outcomes is needed to assess the sustainability of behavior changes and their impact on long-term nutritional status.

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