Jurnal Bidan Cerdas
e-ISSN: 2654-9352 dan p-ISSN: 2715-9965
Volume 7 Issue 2, 2025, page 248-258
DOI: 10.33860/jbc.v7i2.4194
Website: https://ojs.polkespalupress.id/index.php/JBC
Publisher: Poltekkes Kemenkes Palu

Strengthening Application-Based Digital Health Literacy in The Prevention and Management of Stunting among Mothers with Children Under Five Years of Age

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ARTICLE INFO

Article History:

Received: 2025-04-22
Accepted: 2025-09-03
Published: 2025-09-16

Keywords:

Digital Literacy;
Child Nutritional Status;
Stunting.

ABSTRACT

Background: The rapid advancement of information technology has significantly transformed access to health information. However, the emergence of online media as a major information channel has also brought negative consequences, such as the widespread dissemination of misinformation, particularly when not accompanied by adequate digital literacy skills. This study aimed to analyze the effect of strengthening digital health literacy among mothers with children under five years of age in preventing and managing stunting. **Methods:** A quasi-experimental study with a two-group pre-posttest design was conducted involving 112 mothers of children under five with stunting, divided into control (n=56) and intervention (n=56) groups. Samples were selected using simple random sampling. A web-based application, *Cegating*, was developed and tested for usability using the System Usability Scale (SUS). Respondents' knowledge was measured using a structured questionnaire. Data were analyzed using univariate and bivariate approaches with SPSS software. **Results:** The usability test of *Cegating* yielded a SUS score of 89.8%. In the intervention group, the mean knowledge score increased from 62.52 (pre-test) to 64.79 (post-test) (p=0.001). In the control group, the mean score increased from 60.68 to 63.30 (p=0.029). **Conclusion:** Strengthening digital health literacy improved mothers' knowledge in preventing and managing stunting. The *Cegating* application is feasible and effective as an educational tool to enhance health education strategies for mothers with children under five to prevent and address stunting.

INTRODUCTION

The prevalence of stunting among children remains a serious public health concern that requires urgent attention. One of the primary causes of increasing health problems is inadequate nutrition. According to the World Health Organization (WHO) 2020 report, the global prevalence of stunting among children under five reached 150.8 million, or 22.2%. WHO identified five regions with a high prevalence of stunting, including Indonesia, which is part of the Southeast Asia region, with a prevalence rate of 36.4% (Ministry of Health of the Republic of Indonesia, 2022; Kirana et al., 2022). Based on the 2022 Indonesia Nutrition Status Survey, the prevalence of stunting in

Indonesia was 21.6%, while in the Special Region of Yogyakarta (DIY), it was recorded at 16.4% in the same year (Ministry of Health RI, 2022). This issue is linked to high morbidity and mortality, weakened immunity leading to greater vulnerability to diseases, and increased risk of both communicable and non-communicable diseases, such as diabetes, obesity, cardiovascular disease, cancer, and stroke later in life. Moreover, stunting contributes to impaired cognitive development, growth retardation, poor academic achievement, and reduced economic productivity.

Indonesia has undertaken various strategies to address stunting, including strengthening health services. Presidential Regulation No. 72 of 2021 on the Acceleration of Stunting Reduction mandates that efforts be carried out holistically, integratively, and with high quality through coordination, synergy, and synchronization among ministries/agencies, provincial and district/city governments, village administrations, and stakeholders. A key aspect of these efforts is community education, which aims to increase awareness among mothers and families about child nutrition. Providing parents with knowledge about proper nutrition and access to adequate health services is also essential to prevent and manage stunting. These outreach efforts, known as literacy strengthening, are designed to improve family understanding.

With the rapid growth of internet use, digital literacy has become increasingly important. The challenges of the Industrial Revolution 4.0 era have also shaped the needs of society, particularly in the health sector. Advances in information technology have facilitated easier access to various types of information. One of these developments is the widespread use of online media as a primary channel for disseminating information. The internet enables communities to access health-related information conveniently, including issues concerning child and family health. In this context, digital literacy becomes essential in educating mothers about stunting in the digital era. Mothers need to be equipped with the ability to access accurate and reliable information, critically evaluate and analyze digital health content, and disseminate credible information about stunting through digital media.

According to the Indonesian Internet Service Providers Association (APJII), internet users in Indonesia reached 171.17 million, representing 64.8% of the total population (APJII, 2019). Based on the 2024 Indonesian Internet Penetration Survey released by APJII, internet penetration in Indonesia had reached 79.5%, an increase from 73.7% in 2020, 77.01% in 2022, and 78.19% in 2023 (APJII, 2024). This growth has been accompanied by the expansion of online media providing information on health, child growth and development, parenting, and family-related issues. According to Anjani (2018) and the Population and Family Development Law No. 54/2009, all family members play a vital role in optimizing health; however, mothers and children are considered the most influential groups in achieving such goals (Gani & Rahayu, 2022).

Research shows that young parents often rely on information and communication technology due to changes in mobility and limited support from parents, relatives, and peers. As a result, they turn to the internet for information and interaction. A study of millennial parents in Indonesia, particularly mothers, revealed that 55.40% sought parenting information from the internet, 14% from books, 13.80% from seminars, 15.40% from family members, and 1.40% from neighbors. These parents accessed information through social media, parenting websites, blogs, and online articles and journals. The same study also indicated that 66.78% of millennial parents used social media (Setyastuti et al., 2019). In the present era, digital literacy holds significant potential in improving maternal and child health knowledge and awareness. According

to Jati (2021), at least 85–95% of individuals with broad access to information are women, most of whom are young mothers under 35 years of age and first-time parents from the millennial generation.

Along with the rapid development of information technology, information overload has also emerged, with not all available information being accurate. Misinformation and hoaxes can significantly affect communities, particularly in health-related contexts. Not all health information circulating on the internet originates from credible sources. This trend highlights the need for strong digital literacy skills to ensure the accuracy of information selection. According to the Ministry of Communication and Informatics' Press Release No. 02/HM/KOMINFO/01/2024, the number of hoaxes handled by the Directorate General of Informatics Applications' AIS Team in 2023 increased compared to the previous year, with health-related hoaxes being the most common (2,357 cases).

Digital health literacy (eHealth Literacy) refers to the ability to seek, find, understand, and evaluate health information from electronic sources and apply it to address health problems. Such skills are essential for mothers, as primary caregivers in families, particularly those with young children, to enable them to effectively select credible online information and ensure its reliability.

METHODS

This study employed a quasi-experimental design using a two-group pre-posttest approach. Samples were selected through simple random sampling. Respondents were randomly assigned to either the intervention or control group without considering specific characteristics. A total of 112 mothers of stunted children under five years old participated, with 56 allocated to the intervention group and 56 to the control group. The study was conducted in Bantul District, with participants recruited from Srandakan and Imogiri 2 Community Health Centers. Inclusion criteria were mothers of children under five diagnosed with stunting and residing in Bantul District, while exclusion criteria included children with specific diseases, aged over five years, lacking maternal and child health (MCH) books, or living outside Bantul District.

The research began with the development of the *Cegating* web-based application by the research team, which was then reviewed by nutritionists, pediatricians, and obstetricians. The application was piloted with 20 mothers of children under five and assessed using the System Usability Scale (SUS). Additionally, the Digital Literacy Manual Book and *Cegating* web application were further reviewed by information technology experts. Knowledge was measured using a validated and reliable instrument. The intervention was carried out in two stages: (1) an interactive seminar providing information on social media dynamics, identifying hoax-prone messaging applications, and simple techniques for verifying websites, followed by (2) training sessions on the use of the *Cegating* web application.

This study received ethical clearance from the Ethics Committee of Poltekkes Kemenkes Yogyakarta (Approval No. DP.04.03/e-KEPK.1/595/2024). Prior to data collection, researchers explained the objectives, procedures, and potential impacts of participation. Written informed consent was obtained from all respondents. Participant identity and information were kept confidential. Data analysis was performed using bivariate tests to examine the relationship between independent and dependent variables. Normality was assessed using the Kolmogorov–Smirnov test, and statistical analysis was conducted using the unpaired t-test.

RESULT

Based on the preliminary study, the prevalence of stunting in the Srandakan Health Center area was 10.72% and in the Imogiri II Health Center area was 15.49%, both higher than the prevalence in other health center areas in Bantul District (6.45%). The Srandakan Sub-district covers an area of 18.3 km², consisting mostly of dry land and rice fields. Geographically, this region is predominantly lowland, with a small portion in the southern area forming coastal zones. Meanwhile, the working area of Imogiri II Health Center consists partly of lowland regions, including Kebonagung, parts of Karangtengah, and Sriharjo, while mountainous and hilly areas are located in Selopamioro, as well as parts of Sriharjo and Karangtengah.

The *Cegating* application was tested to assess the feasibility and effectiveness of the product developed by the research team. The trial was conducted with 20 mothers of children under five in the working area of Yogyakarta City Health Center. The descriptive results of the trial are presented as follows:

Table 1. Frequency Distribution of Respondents in the Feasibility Test of the *Cegating* Application by Gender and Education Level

Variables	Category	n	%
Gender	Male	0	0.0
	Female	20	100.0
Education	Junior High School	4	20.0
	Senior High School	12	60.0
	Tertiary Education	4	20.0

Table 1 shows that among the respondents, 4 participants (20%) had completed junior high school, 12 participants (60%) senior high school, and 4 participants (20%) higher education.

Table 2. System Usability Scale (SUS) Items for the Cegating

No	Statement	SA	A	N	D	SD
1	I find this application easy to use	15	5	0	0	0
2	I find this application simple and visually appealing	12	8	0	0	0
3	I feel supported and satisfied when using this application	11	9	0	0	0
4	The application displays data consistently	8	12	0	0	0
5	The application is enjoyable to use	14	6	0	0	0
6	I find the system very easy to learn	10	10	0	0	0
7	I find the system is not complicated to use	7	13	0	0	0
8	I feel no technical assistance is needed to use the system	5	11	0	4	0
9	The system provides features with clear information	12	7	1	0	0
10	The application is well organized	7	12	1	0	0
11	I feel confident using this system	7	12	1	0	0
12	I find the system requires only a short time to master	12	8	0	3	0
13	I can obtain results quickly using this application	13	7	0	0	0
14	The system results are consistent with the anthropometric graphs and tables presented	11	9	0	0	0
15	I find no obstacles in using this application	8	12	0	0	0
	Total	**152**	**141**	**3**	**7**	**0**

Based on Table 2, the System Usability Scale (SUS) test yielded a total score of 1,347 out of a maximum possible score of 1,500. The percentage was calculated by dividing

the total score by the maximum score and multiplying by 100, resulting in 89.8%. This score indicates a very high level (>80), thereby meeting the usability criteria. In qualitative terms, the result falls into the “Acceptable” category, meaning that the system is considered usable.

Table 3. Characteristics of Mothers

Variables	Category	Control Group		Intervention Group	
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Age	< 20 Tahun	1	1.8	0	0
	20–35 Tahun	33	58.9	34	60.7
	> 35 Tahun	22	39.3	22	39.3
Education	Primary School	4	7.1	1	1.8
	Junior High School	16	28.6	6	10.7
	Senior High School	27	48.2	39	69.6
	Tertiary Education	9	16.1	10	17.9
Occupation	Employed	9	16.1	13	23.2
	Unemployed	47	83.9	43	76.8

Based on Table 3, it can be seen that the majority of mothers with children under five were aged between 20–35 years, with 33 respondents (59.9%) in the control group and 34 respondents (60.7%) in the intervention group. Most mothers had completed senior high school education, with 27 respondents (48.2%) in the control group and 39 respondents (69.6%) in the intervention group. Furthermore, the majority of mothers were unemployed (housewives), with 47 respondents (83.9%) in the control group and 43 respondents (76.8%) in the intervention group.

Table 4. Characteristics of Children Under Five

Variable	Control Group		Intervention Group	
	n	%	n	%
Gender				
Female	25	44.6	30	53.6
Male	31	55.4	26	46.4
Age				
24-36 Months	38	67.9	28	50.0
37-48 Months	18	32.1	28	50.0

Based on Table 4, it is evident that the majority of stunted children in the control group were male, with 31 respondents (55.4%), whereas in the intervention group, most were female, with 30 respondents (53.6%). In terms of age distribution, most stunted children in the control group were aged 24–36 months, totaling 38 respondents (67.9%). In contrast, in the intervention group, the age of stunted children was equally distributed between 24–36 months (50.0%) and 37–48 months (50.0%).

Table 5. Analysis of Stunting Knowledge (Pre-test and Post-test) in Control and Intervention Groups

	Control Group		Intervention Group	
	Pre-test	Post-test	Pre-test	Post-test
Maximum Score	88	88	88	94
Minimum Score	29	35	35	47
Average Value	63.82	68.84	68.09	78.09

	Control Group		Intervention Group	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Mean	65	71	71	76
Mode	71	59	71	76
Standard Deviation	13.116	14.580	11.594	11.306
Mean Difference	5.02		10	

Based on Table 5, the pre-test and post-test results in the control group showed the same maximum score (88), while in the intervention group, the maximum score increased to 94. The minimum score, mean, and median all demonstrated an increase from pre-test to post-test. The mode decreased in the control group but increased in the intervention group. The standard deviation increased in the control group, whereas it decreased in the intervention group. The mean difference was greater in the intervention group compared to the control group.

Table 6. Mean Score of the Effect of Digital Literacy

Mean Score	**Pre-Test**	**Post-Test**	***P-Value***
Control Group	60.68	63.30	0.029
Intervention Group	62.52	64.79	0.001

Based on Table 6, there was an increase in the mean score between the pre-test and post-test in both the control and intervention groups. The results of the statistical test showed a p-value of 0.029 in the control group and 0.001 in the intervention group ($p < 0.05$), indicating that digital health literacy had a significant effect in preventing and managing stunting.

DISCUSSIONS

The results of the System Usability Scale (SUS) test for the *Cegating* application showed a score of 89.8%. This indicates a very high level of usability, meeting the criteria for the *Acceptable* category after being converted into a qualitative scale. The SUS is a widely used method to measure the usability of a system through questionnaires, as it provides subjective perceptions from users.

In this study, respondents were divided into two groups through random sampling. The intervention group received seminars and training sessions on strengthening digital literacy using the *Cegating* application, while the control group was provided with a manual book and access to the application. The findings revealed that both groups experienced improvements in knowledge regarding the prevention and management of stunting in children under five. In the intervention group, the mean pre-test score of 62.52 increased to 64.79 (p-value: 0.001). In the control group, the mean pre-test score of 60.68 rose to 63.30 (p-value: 0.029). These results indicate that digital literacy can enhance maternal knowledge on preventing and managing stunting.

Digital literacy refers to the ability to read, write, and understand presented information. Individuals with strong digital literacy are independent and skilled in seeking information, selecting relevant content, and presenting it through appropriate media so that messages are easily understood by the audience (Lankshear & Knobel, 2006). Previous studies have also stated that Gilster identified four key competencies of digital literacy: knowledge gathering, content evaluation, internet searching, and hypertext navigation (Lanksher C, 2006).

The conceptual framework of digital literacy proposed in earlier research includes: (1) visual literacy (images or photos); (2) information reproduction literacy;

(3) information literacy; (4) branching literacy; and (5) socio-emotional literacy. The framework proposed by Eshet-Alkalai has been considered relevant and widely applied, particularly in the dissemination of health information via social media (Alkalai, 2004). According to prior studies, the duration of online media use is categorized into five levels: very long (more than 7 hours/day), long (5–6 hours/day), moderate (3–4 hours/day), short (1–2 hours/day), and very short (less than 1 hour/day). These categories help differentiate behavioral patterns among mothers. The research data indicated that most millennial mothers fell into the moderate category, while three respondents accessed the internet for more than seven hours daily, placing them in the very long category (W. , et al Syamsoedin, 2015).

The rapid advancement of digital technology has created a cultural shift, particularly in digital culture. Previously, information was primarily derived from traditional or mainstream media, which was neither instant nor real-time. With today's information overload through social media, many individuals become impulsive and less critical in selecting information, making them more vulnerable to misinformation and hoaxes. False information spreads rapidly through social media and messaging applications such as WhatsApp and Line, influencing public trust and decision-making, especially on health issues such as vaccination, among communities with limited health literacy.

An online survey conducted by the Indonesian Telematics Society (Mastel) on February 7, 2017, involving 1,116 respondents in just 48 hours, showed that health-related hoaxes ranked third (41.20%) after political/social and ethnic/religious hoaxes. This highlights health issues as a critical topic in Indonesia, given the lack of health and digital literacy to counter misinformation. The survey also explored public understanding of hoaxes, behaviors towards them, communication channels used for dissemination, societal impacts, and strategies to combat misinformation.

Through digital literacy, communities are expected to be capable of producing and selecting the information they need, as well as presenting it effectively. In this era of convergence, society is not only a recipient of information but also an active participant in communication, particularly in digital spaces. Anyone can be an active and selective user if they are able to utilize social media effectively in their daily lives. The findings of this study demonstrate that strengthening digital literacy had a significant impact on stunting prevention and mitigation in both the control and intervention groups ($p=0.001$, <0.05).

Stunting is caused by multiple factors, primarily inadequate nutrient intake and/or increased nutritional needs. It is often preceded by weight loss, which may begin during pregnancy and continue after birth. The indicator used to identify stunted children is height-for-age (HAZ) based on WHO Child Growth Standards, with stunting defined as a z-score < -2 standard deviations (SD). The first 0–24 months are considered a critical period, also known as the "golden window," during which inadequate nutrition can have irreversible consequences (Ministry of Health Republic of Indonesia, 2022).

Several factors contribute to the high incidence of stunting in children under five, including maternal height, premature birth, low birth length, maternal education, and low socioeconomic status. Other factors include paternal height, parental smoking habits, crowded living conditions, frequent febrile illnesses, and low immunization coverage. Moreover, communities often underestimate stunting, as children with short stature may appear physically active, unlike underweight children who raise more concern. Similarly, awareness of the importance of maternal nutrition during pregnancy remains low, despite its direct impact on infant nutritional status Ministry of Health

Republic of Indonesia, 2022; UNICEF Indonesia, 2013).

This study also found that most mothers in both intervention and control groups had at least secondary education. Maternal knowledge significantly influences stunting in children under five. Adequate knowledge contributes to improving children's nutritional status and achieving optimal growth. Conversely, insufficient knowledge, poor understanding of healthy eating habits, and limited awareness of stunting affect maternal behavior in providing appropriate food types and portions for their children. Therefore, there is a correlation between maternal knowledge and stunting among children aged 24–60 months in the working area of Suhaid Health Center (Aghadiati dkk., 2023). Wawan dan Dewi (2019) further emphasized that knowledge is influenced by education, which is closely linked to an individual's awareness. Higher education generally correlates with broader knowledge, although non-formal education may also enhance understanding. A mother with good self-capacity tends to possess adequate knowledge to support stunting prevention (Ministry of Health Republic of Indonesia, 2022). This aligns with Rahmawati et al. (2019), who reported that parents exposed to stunting information are able to comprehend, interpret, and recall messages, thus gaining better knowledge. Conversely, mothers not exposed to such information tend to have lower knowledge levels compared to those who learned through social media or public health education (Nurmaliza, 2018).

Education is a lifelong process to enhance competence inside and outside of school. It facilitates learning, and the higher one's education, the easier it is to absorb information from various sources. Rahmawati et al. (2019) described education as a determinant of parental knowledge about stunting. Nurmaliza and Herlina (2018) found that mothers with low education were three times more likely to have children with poor nutritional status compared to mothers with higher education. Parents serve as the primary environment influencing child development, providing love and protection as a foundation for their growth (Nurmaliza, 2018).

The results of this study are consistent with the findings of Wicaksono et al., who reported that low maternal education is strongly associated with the incidence of stunting in children, with an odds ratio (OR) of 2.64. This finding also aligns with Beal et al., who demonstrated that low caregiver education, particularly among mothers, is strongly related to stunting in several studies. However, this result differs from Manggala et al., who reported that low maternal education was not associated with stunting in children, as indicated by a p-value of 0.660.

This study also showed that the maternal age in both the intervention and control groups was within the range of 20–35 years. Mothers at this age are generally more capable of accessing information through social media platforms such as TikTok, Instagram, YouTube, and others, allowing them to verify the accuracy of reported news. This information can further be validated through fact-checking accounts or trusted platforms. According to Ar-Rasily and Dewi (2016), age influences cognitive development and comprehension. As age increases, an individual's psychological maturity typically develops as well (Khairiyah Ar-Rasily & Dewi, 2016). This is supported by Sarah et al., (2022), who found that age significantly correlates with maternal knowledge of stunting (p=0.043). Older mothers tend to have a better understanding of childcare and appropriate dietary intake for their children due to greater knowledge and maturity (Sharah Nursa'iidah & Rokhaidah, 2022). These findings are consistent with Andari et al., (2020), who reported maternal height as a significant predictor of stunting (OR 2,720; 95% CI: 1,050–7,049). Similarly, Beal et al. (2018) reported that maternal factors such as undernutrition prior to conception, during pregnancy and lactation, short maternal stature, and adolescent pregnancy were

associated with stunting in Indonesia (Beal T, 2018).

The findings of this study further revealed that the majority of respondents in both the intervention and control groups were unemployed. Maternal employment status significantly affects attitudes toward providing nutrition for children. Working mothers often have limited time to focus on their toddlers' diets, which may result in reduced attention to their children's nutritional status and overall development. Moreover, the impact of maternal employment varies depending on the type of work. Mothers engaged in physically demanding jobs are more likely to experience physical fatigue, prioritizing rest over childcare and thus neglecting their children's nutritional needs. In contrast, unemployed mothers, typically housewives, spend most of their time at home without external work commitments. On the other hand, working mothers are dynamic women with the capacity and skills to manage multiple responsibilities, such as being mothers, wives, teachers, and more (Bongga, 2019).

This finding is supported by previous research, which reported that the majority of respondents were unemployed mothers. Their study indicated that stunting was more prevalent among toddlers whose mothers were housewives. Although housewives may have more time for childcare, inadequate parenting practices such as insufficient attention to children's eating habits can still contribute to nutritional problems. Therefore, both employed and unemployed mothers must effectively manage their time to ensure proper nutrition and promote healthy child growth and development (Mentari & Hermansyah, 2018).

This study also demonstrated that maternal knowledge of stunting in toddlers at Oesapa Health Center had a significant influence on the incidence of stunting. This was evidenced by the chi-square test results, which yielded a p-value of 0.00 (<0.05), indicating a significant relationship between maternal knowledge of stunting and stunting incidence among toddlers at Oesapa Health Center. Thus, the alternative hypothesis (H1) was accepted, while the null hypothesis (H0) was rejected.

These findings are consistent with previous research on the relationship between maternal knowledge and stunting in the working area of Suhaid Health Center. That study reported that, among 62 mothers of toddlers, 42 had low knowledge levels and had children aged 24–60 months categorized as stunted or severely stunted (Aghadiati et al., 2023). These results indicate that maternal knowledge influences stunting in toddlers, as knowledge helps improve children's nutritional status and supports their growth maturity. Inadequate knowledge, poor understanding of healthy eating habits, and a lack of awareness about stunting can shape maternal behavior and attitudes in providing the type and quantity of food necessary to ensure optimal child growth and development.

Thus, a confirmed relationship exists between maternal knowledge and the incidence of stunting among toddlers aged 24–60 months in the working area of Suhaid Health Center. According to the researchers, the correlation between maternal knowledge and stunting incidence at Oesapa Health Center is largely due to the limited understanding of mothers regarding how to meet their children's nutritional needs, which may be influenced by the fact that the highest maternal education level in this study population was senior high school.

CONCLUSION

Strengthening digital health literacy among mothers with children under five years of age has a significant impact on the prevention and management of stunting. Both mothers and health workers can utilize the *Cegating* application by maximizing the available features to enhance knowledge and monitor child growth and

development at any time. Through this application, mothers and health workers can immediately access the nutritional status of children once the measurement data are entered, enabling faster and more accurate screening of stunted children and allowing for earlier follow-up interventions. The application also provides child growth charts and health information to further enrich knowledge. Future research should explore other aspects of stunting prevention and management in young children. In addition, the development of more diverse health education media is required, while ensuring that the information provided continues to come from credible and trustworthy sources.

Acknowledgements: The authors would like to express their sincere gratitude to the funding providers of the *Penelitian Kerja Sama Perguruan Tinggi* (PKPT, Inter-University Collaborative Research) scheme, to Poltekkes Kemenkes Yogyakarta, and to all parties who have facilitated and contributed to this community service activity.

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