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Original Article

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Empowering cadres: the impact of KEPITING, a web-based application on stunting knowledge and attitudes

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ABSTRACT

Introduction: Stunting, an indicator of chronic malnutrition, affects children under five. Cadres hold strategic positions to enhance this. Despite the launch of digital applications designed to address stunting by enhancing knowledge and attitudes, their lasting impacts and usability have not been thoroughly evaluated, especially among cadres.

Methods: We conducted a longitudinal study to evaluate the long-term impact and usability of our web-based app KEPITING (Kader Peduli Stunting) to enhance knowledge and attitudes towards stunting detection among cadres covering two Districts in Jambi. We obtained 152 cadres as participants using purposive sampling, separated into two groups based on their respective districts—one using KEPITING and the other traditional training materials. Data were collected at pre-intervention, post-intervention, and nine months post- intervention using validated questionnaires to assess knowledge and attitude changes. A generalized Linear Model with Repeated Measures ANOVA and Mann-Whitney U tests was employed to examine the effects and interactions.

Results: KEPITING significantly improved knowledge of practical procedures ($p < 0.001$) and nutritional interventions ($p < 0.001$). Overall attitude improved significantly ($p = 0.008$, $\eta = 0.033$). Knowledge retention showed no significant time effect, whereas attitudes improved over time and were better retained in the intervention group. The System Usability Scale scored below an average of 58.7, indicating that usability improvements were needed.

Conclusions: KEPITING enhances cadre knowledge and attitudes but requires usability enhancements for optimal impact. This study highlights the importance of digital tools in stunting interventions and suggests areas for future research focusing on usability and long-term efficacy.

Keywords: attitude; knowledge; retention; stunting; web-based intervention

Introduction

Stunting is a manifestation of chronic malnutrition and serves as a critical indicator of children's health and wellbeing. It remains a significant public health concern globally, particularly in children under five years of age. In Indonesia, the prevalence of stunting is notably high, reported at 31.8% as of the latest data from 2022(WHO, 2024). This represents a substantial challenge, highlighting the country's ongoing struggle to reduce childhood malnutrition.

Globally, efforts to combat stunting have led to a decrease in its prevalence from 40.2% in 1990 to 22.3% in 2022, indicating significant progress (WHO, 2024). However, the persistently high rates in Indonesia underscore the urgent need for targeted interventions to address regional disparities and improve child-health outcomes. Stunting is not merely a marker of dietary insufficiency but is associated with a spectrum of adverse health effects, including impaired physical growth, cognitive developmental delays, and increased susceptibility to illness(Mutapi *et al.*, 2021; Lestari *et al.*, 2024). Early detection and intervention are essential to mitigate these adverse outcomes. In response to this need, the KEPITING ("Kader Peduli Stunting") platform was developed to assist health cadres in identifying at-risk children efficiently and effectively.

Local health cadres play a crucial role in Indonesia's public health strategy, serving as the frontline workforce for the early detection and prevention of stunting (Ahmad, Alwi and Hadi, 2023; Hamdy *et al.*, 2023). Community-based workers are tasked with identifying at-risk children, promoting nutritional education, and facilitating access to health services. Given their community presence and influence, cadres are well positioned to drive significant improvements in child health outcomes (Tampake *et al.*, 2021; Julianti and Elni, 2023). To maximize their effectiveness, cadres require adequate training and tools to identify stunting in children, such as cadre empowerment conducted by Handayani, Laksono and Wulandari (2020).

The classic approach to managing stunting begins with a physical examination and body measurements, usually performed by cadres, which are then documented on a growth chart within the Maternal and Child Health Book (KIA) and in a designated book at each *Posyandu* (Integrated Service Post) (Erwin and Hasana, 2022). These procedures typically occurred on a monthly basis, coinciding with the *Posyandu* event (Patungo, 2023). Following assessment and documentation, the cadre typically instructs parents on methods to prevent or address stunting, considering the findings from their own children's cases. Parents and cadres could also read the educational content within the KIA book and modify their nutrition based on the guidelines, which is important for stunting management (Amaliyah and Mulyati, 2020). However, these processes are subject to several challenges. The most prominent challenge faced by cadres is returning the KIA book to their parents, thus concealing the fluctuations in each child's nutritional status from the cadres. The risk of loss of KIA books is caused by accidents or force majeures, such as floods, fires, and earthquakes. The traditional intervention's dependence on individual visits to *Posyandu* could also potentially hinder a stunting prevention program.

Integration with digital systems could address these challenges by providing real-time alerts on which children require close monitoring, as shown in a study conducted by Irache and colleagues (2019), thereby enabling cadres to take proactive measures to support children at a high risk of stunting. There could also be more up-to-date information regarding stunting beyond what it has already covered in the KIA book Santoso et al. (2023). This could be easily integrated into digital ecosystems, such as web-based applications providing access to updated and curated content relevant to users' needs (Irache, Murachpersad and Caleyachetty, 2019; Santoso *et al.*, 2023). Digital storage solutions can effectively counter the risk of data loss associated with traditional methods by offering enhanced security and expedited access to specialized healthcare systems for prompt referral purposes(Neal et al., 2022).

Several digital applications have been launched to combat stunting, covering general frameworks, such as early detection, body and nutritional monitoring, health education, and social empowerment (Ponum *et al.*, 2020; Hildamayanti and Dhani Ariatmanto, 2023; Syamsir *et al.*, 2023). Examples of these digital applications include ELSIMIL and NutriCare for marriage preparation and pregnancy planning (Septiyani *et al.*, 2023; Puan and Budhisantosa, 2025), Si Centing for early detection and nutritional guidance (Rachmawati *et al.*, 2022), SI CENTIL RISTI for high-risk pregnant mothers (FIK UI, 2025), E-STARE for public health service access (Eka, 2022), and Nutrimo for stunting detection(Permana *et al.*, 2021). However, stunting research on most digital apps, including those mentioned above, has concentrated on the advantages they offer in raising awareness of stunting. The gap regarding this topic primarily lies in how individuals utilize and disseminate these apps and how they are practically applied in real life for extended time, as found in a scoping review by Nur Aini *et al* (2023).

Our distinctive contribution stems from our endeavor to uncover the long-term effects of our web-based applications designed for cadres, KEPITING, over the course of three key time points. First, before app deployment, the second point was at the end of the intervention, approximately 3 months after the initial deployment, and the third point, 9 months after the intervention period ended. We also offer insights into which aspects of said apps should be improved for the next development of stunting-related applications using the System Usability Scale (SUS).

This study sought to evaluate the impact of the KEPITING platform on cadres' knowledge retention and attitudes towards early stunting detection, comparing the effectiveness of web-based app training versus traditional module-based methods, with two questions in mind: (1) What is the impact of the KEPITING web-based platform on improving knowledge and attitudes towards stunting detection among health cadres compared to traditional training methods? (2) How does the retention of knowledge and attitudes differ over time between health cadres using the KEPITING platform and those using the traditional method?

Addressing these questions contributes to a deeper understanding of how technological tools such as KEPITING can be optimized to improve public health outcomes, particularly in resource-limited settings. By examining usability scores alongside knowledge and attitude shifts, this study provides valuable insights for refining digital health interventions to ensure their long-term success and sustainability, particularly for strategic partners such as health cadres.

Materials and Methods

Study Design Sampling Calculation and Recruitment

The study employed a longitudinal analysis approach to evaluate the impact of the KEPITING platform on cadres' knowledge and attitudes towards early stunting detection, with data collected at three key time points in a one-year span: pre-intervention (0), post-intervention, approximately three months after application deployment (1), and nine months post-intervention (2). Participants were 152 health cadres directly recruited through a local community health center in Pakuan Baru District and Kebun Handil District, Jambi City, who were equally divided into two groups. The criteria for inclusion were as follows: cadres who had an official appointment letter issued by the local authorities, being able to operate a computer or mobile phone with internet access, and willing to participate in the research.

We calculated the sample size using a comparative numerical analysis between two unpaired groups with purposive sampling, with the aim of reaching a 95% Confidence Interval. We also used G-Power software (Faul *et al.*, 2007), setting the power of the a priori t-test to 0.8, and medium effect size at 0.5, then adding a 10% attrition rate (Cohen, 2013). This resulted in 152 participants being divided into two distinct groups: the intervention group, which engaged with the KEPITING platform, a web-based learning resource akin to a Learning Management System (LMS), and the control group, which relied solely on traditional methods utilizing hardcopy materials. We differentiated the intervention and control groups based on community health center regions to minimize the risk of information exchange. This design facilitated a comprehensive comparison between the digital and conventional training methods. The outcome assessment was performed by one of the researchers who had no prior involvement with the participants.

Data Analysis

Prior to our study, we ensured the validity and reliability of the questionnaire through content and construct validity testing. Content validity was verified by consulting supervisors, based on the guidelines of the Indonesian Ministry of Health. Construct validity involved piloting the questionnaire with 30 *Posyandu* cadres in Pakuan Baru and Kebun Handil Districts and calculating validity using a product-moment correlation test. All the questionnaires were valid, with a Cronbach's alpha of 0.897 for the knowledge questions and 0.928 for the attitude questions. These questionnaires were administered at each time point for the real study, assessing knowledge through a 20-question dichotomous format and attitudes using a 10-item Likert scale**.** The System Usability Scale (SUS) was utilized to measure the platform's usability, aiming to identify areas for enhancement and ensure that it meets user expectations.

The statistical analysis was designed to accommodate the repeated-measures nature of the study. Descriptive statistics were first used to summarize the demographic data, providing a foundational understanding of the characteristics of the sample. We used a generalized linear model through repeated measures ANOVA to analyze changes in knowledge and attitude scores across the three time points. This method allowed for the assessment of within-subject variability and identification of statistically significant differences over time. Following this, post hoc tests were conducted to pinpoint specific differences between paired time points, offering detailed insights into where significant changes occurred. To address non-normally distributed data, the Mann-Whitney test was applied to compare the results between the intervention and control groups at each time point. Additionally, correlation and regression analyses were performed to explore the relationships between

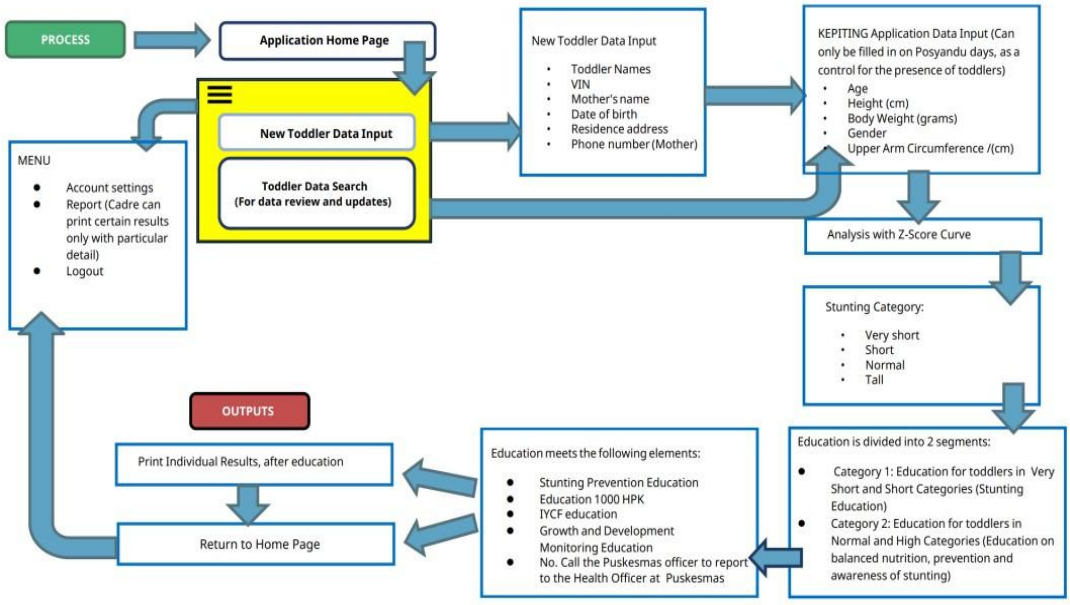

Figure 1. KEPITING Application Design Plan

demographic variables, such as age, education, and years of service, and the primary outcomes, to assess how these factors might predict changes in knowledge and attitudes. There were no dropouts in our study; therefore, the data were analyzed directly.

The Web-Application Used in This Study

KEPITING is a web-based app built using the waterfall method through System Development Life Cycle (SDLC) stages. It was designed to monitor and prevent stunting in children under 5 through systematic data collection and intervention. It provides a login page to ensure the security of data access within the system. Then, the system begins with the basic registration of children's information (children's name, citizen identification number, mother's name) and includes regular growth monitoring during *Posyandu* days, where measurements such as height, weight, and arm circumference were recorded. The system analyzes the data using Z-score curves to categorize children into four growth status groups: Very Short, Short, Normal, or Tall. Based on this classification, the system provides targeted educational interventions - stunting education for those categorized as short or very short, and balanced nutrition/prevention education for those in the normal/tall categories. The educational content covers key topics such as stunting prevention, the first 1,000 days of life, complementary feeding, and growth monitoring. Cadres can print individual results and access reports as needed, making them an efficient tool for community-level stunting prevention and monitoring. The entire design of this web app is shown in Figure 1.

The study was conducted in compliance with ethical guidelines and approved by the Ethics Commission of the Faculty of Nursing, University of Indonesia (Approval Number: KET- 082/UN2. F12.DI.2.1/PPM.00.02/2023). By implementing this comprehensive longitudinal analysis, this study provides valuable insights into the sustained impact of the KEPITING platform on cadres' knowledge and attitudes. This underscores the potential of digital tools to enhance public health outcomes, particularly when comparing them with traditional training methods in resource-limited settings. This approach not only assesses the immediate effectiveness of the intervention, but also evaluates its lasting impact, offering a robust evaluation of the program's effectiveness.

Results

This section describes the demographics of participants and results related to the impact of the KEPITING web-based app on the acquisition and retention of knowledge and attitude within three measurements. As desribed in Table 3, the average age of respondents in the Intervention Group is 44.57 years (SD = 9.369), and in the Control Group, it is 43.13 years (SD = 10.282). The intervention Group cadres had an average service length of 7.39 years (SD = 7.379), while the Control Group cadres average 6.66 years (SD = 4.084). Table 2 shows that a significant proportion of the intervention group (68.4%) and the control group (72.4%) had secondary education (SMA/SMK/MAN). Most respondents in both groups were unemployed, with 93.4% in the intervention group and 80.3% in the control group.

Effect of Web-Based App on Knowledge Across Different Components

Analysis using the General Linear Model (GLM) with Greenhouse-Geisser adjustment revealed varying impacts of the web-based application across knowledge domains regarding stunting detection between pre- and post-intervention (Table 3). The analysis of knowledge gains across different components revealed the varying impacts of web-based interventions. The intervention showed significant effects on stunting identification ($p = 0.007$, $\eta = 0.034$), practical procedures ($p < 0.001$, $\eta = 0.105$, CI 95%), and nutrition interventions ($p < 0.001$, $\eta = .111$). Contextual knowledge showed no significant improvement ($p = 0.051$, $\eta = 0.020$, CI 95%), while overall knowledge improvement was not statistically significant ($p = 0.060$, $\eta = 0.019$, CI 95%). Demographic factors also influenced the knowledge components differently. Age emerged as a significant factor for both stunting identification ($p = 0.022$, $\eta = 0.026$, CI 95%) and practical procedures ($p = 0.036$, $\eta = 0.030$, CI 95%). Education level significantly affected only contextual knowledge ($p = 0.011$, $\eta = 0.031$, CI 95%). Employment status did not significantly influence any knowledge component (all $p > 0.05$, CI 95%). Similarly, tenure duration had no significant impact across all knowledge domains (all $p > 0.05$, CI 95%).

Effect of Web-Based App on Attitude Across Different Components

The analysis of attitudinal components revealed varying impacts of the web-based intervention across the different components between pre- and post-intervention (Table 4). The intervention demonstrated significant effects on overall attitude ($p = 0.008$, $\eta = 0.033$, CI 95%) and appraising capabilities ($p = 0.001$, $\eta = 0.050$, CI 95%), while showing non-significant effects on doing ($p = 0.080$, $\eta = 0.017$, CI 95%) and telling components ($p = 0.095$, $\eta = 0.016$, CI 95%).

Demographic factors showed notable influences on the attitudinal components. Tenure duration significantly influenced overall attitude ($p = 0.001$, $\eta = 0.047$) and attitudes ($p = 0.006$, $\eta = 0.035$), as well as telling behaviors ($p = 0.003$, $\eta = 0.038$, 95% CI). Education level showed significant effects on the overall attitude ($p = 0.013$, $\eta = 0.042$, CI 95%), doing ($p = 0.047$, $\eta = 0.027$), and telling components ($p = 0.002$, $\eta = 0.061$). Age emerged as a significant factor for overall attitude (p

Table 1. Characteristics of Respondents based on Age and Length of Service as Cadres in the Intervention Group and Control Group (n=152)

Variable	Mean	SD	Min-Max	95%CI	n
Age					
Intervention	44.57	9.37	17-62	42.42-46.71	76
Control	43.13	10.28	25-65	40.78-45.48	76
Work Experience (in years)					
Intervention	8.05	8.82	0-33	5.71-9.08	76
Control	6.66	4.08	1-15	5.72-7.59	76

= 0.001, η = 0.045, CI 95%), telling (p = 0.006, η =.035, CI 95%), and appraisal (p = 0.001, η = 0.048, CI 95%). Employment status did not significantly influence any attitudinal component (all p > .05).

Retention of Knowledge and Attitude Between Post-Test and Follow-ups

We calculated the retention rates by dividing the scores from the follow-up period by those from the post-test period. Using the Mann-Whitney test, we analyzed which group demonstrated superior retention rates and in which specific aspects of these differences were evident. The analysis revealed that in the nutrition category, the intervention group had a significantly higher retention rate (p= 0.038, CI 95%). This indicates that the intervention was particularly effective in sustaining nutritional knowledge over time. Similarly, attitudinal retention was notably higher in the intervention group than in the control group (p = 0.016, CI 95%), highlighting the intervention's strong impact on improving attitudes during the follow-up phase. While the intervention group excelled in these areas, other categories, such as knowledge, understanding, practical skills, contextual knowledge, doing, telling, and appraising, did not display statistically significant differences between the groups, suggesting comparable retention levels across the intervention and control groups for these aspects.

We also analyzed the interaction variables that affect the retention rate across groups. For contextual knowledge, interactions between Group and Education (p = 0.016, η^2 = 0.087), Group and Tenure Duration (p = 0.024, η^2 = 0.098), and Age and Education (p = 0.001, η^2 = 0.209) were noteworthy, emphasizing the importance of these factors in supporting contextual understanding. Moreover, the combined effects of Group, Education, and Tenure Duration emerged significantly (p = 0.002, η^2 = 0.101) in contextual knowledge retention. Nutritional knowledge benefitted from an overall model fit (p = 0.008, η^2 = 0.536) and a strong baseline effect (p = 0.000, η^2 = 0.972), with Group and Education interaction (p = 0.015, η^2 = 0.088) playing a crucial role. For technical knowledge, a significant baseline was observed (p = 0.000, η^2 = 0.913), while overall knowledge retention was influenced by interactions between Group and Education (p = 0.034, η^2 = 0.072) and the combined factors of Group, Education, and Tenure Duration (p = 0.035, η^2 = 0.048).

The analysis of attitudes uncovered significant interactions and effects across various subcategories, highlighting how factors such as Age, Education, Employment Status, and Group membership influence overall attitudes, as well as specific aspects such as doing, telling, and appraising. In the "Doing" category, the interaction between Age and Education (p = 0.018, η^2 = 0.151) underscores the crucial role these factors play in shaping attitudes towards taking action, suggesting that age and educational level impact how individuals approach responsibilities. The "Telling" subcategory reveals significant effects of Age (p = 0.002, η^2 = 0.165) and interactions such as Age & Education (p = 0.015, η^2 = 0.157), Age & Employment Status (p = 0.000, η^2 = 0.170), and Employment Status & Tenure Duration (p = 0.003, η^2 = 0.096), indicating a collective influence on communication styles and information dissemination. For "Appraising," significant effects of Group and Age (p-values of 0.036 and 0.042, η^2 values of 0.047 and 0.102, respectively), alongside Age & Education interaction (p = 0.050, η^2 = 0.127), suggest that these factors critically impact evaluation and judgment processes. The table is presented in the Supplementary Materials.

System Usability Score (SUS) of the KEPITING Web-Application

At the third time point, or nine months post-intervention, 76 participants from the intervention group completed the SUS questionnaires. This study reports a mean SUS of 58.717, which falls below the widely accepted benchmark of 68 (Hyzy *et al.*, 2022), suggesting room for improvement in the usability of the system.

Table 2. Distribution of Respondent Characteristics based on Education Level and Employment Status in Intervention and Control Groups (n=152)

Variable	Intervention (n =76)		Control (n =76)	
	n	%	n	%
Education Level				
Basic Education (Elementary/Junior High)	15	19.7	15	19.7
Secondary Education (High School)	52	68.4	55	72.4
Higher Education (Diploma/Bachelor)	9	11.8	6	7.9
Employment Status				
Unemployed	71	93.4	61	80.3
Employed	5	6.6	15	19.7

Table 3. General Linear Model Analysis of Factors Influencing Knowledge and Attitudes Following Web-Based Intervention Between Pre and Post Intervention

Category	Tenure Duration	Education Level	Age	Employment Status	Intervention
Overall Knowledge	p = 0.716	p = 0.274	p = 0.709	p = 0.338	p = 0.060
	η^2 = 0.002	η^2 = 0.008	η^2 = 0.002	η^2 = 0.007	η^2 = 0.019
Stunting Identification	p = 0.574	p = 0.997	**p = 0.022**	p = 0.107	**p = 0.007**
	η^2 = 0.004	η^2 = <0.001	η^2 = 0.026	η^2 = 0.015	η^2 = 0.034
Practical Procedure	p = 0.636	p = 0.413	p = 0.036	p = 0.791	**p = <0.001**
	η^2 = 0.003	η^2 = 0.006	η^2 = 0.030	η^2 = 0.002	η^2 = 0.105
Contextual Knowledge	p = 0.624	**p = 0.011**	p = 0.224	p = 0.998	p = 0.051
	η^2 = 0.003	η^2 = 0.031	η^2 = 0.010	η^2 = <0.001	η^2 = 0.020
Nutrition and Interventions	p = 0.633	p = 0.180	p = 0.949	p = 0.408	**p = <0.001**
	η^2 = 0.003	η^2 = 0.012	η^2 = <0.001	η^2 = 0.006	η^2 = 0.111
Overall Attitude	**p = 0.001**	**p = 0.013**	**p = 0.001**	p = 0.108	p = 0.008
	η^2 = 0.047	η^2 = 0.042	η^2 = 0.045	η^2 = 0.018	η^2 = 0.033
Doing	**p = 0.006**	**p = 0.047**	p = 0.112	p = 0.582	p = 0.080
	η^2 = 0.035	η^2 = 0.027	η^2 = 0.015	η^2 = 0.004	η^2 = 0.017
Telling	**p = 0.003**	**p = 0.002**	**p = 0.006**	p = 0.806	p = 0.095
	η^2 = 0.038	η^2 = 0.061	η^2 = 0.035	η^2 = 0.001	η^2 = 0.016
Appraising	p = 0.072	p = 0.493	**p = 0.001**	p = 0.937	**p = 0.001**
	η^2 = 0.018	η^2 = 0.003	η^2 = 0.048	η^2 = < 0.001	η^2 = 0.050

Table 5 provides an insightful analysis of user perceptions and experiences regarding the KEPITING application, with a distinctive pattern in odd- and even-numbered questions reflecting positive and negative evaluations, respectively.

Odd-numbered questions (i.e., 1, 3, 5, 7, and 9) generally indicate positive feedback about the application. The high mean scores for these questions suggest that users perceive the application as desirable and effective. Specifically, users expressed a strong intention to use the application routinely (Mean = 4.21) and found it easy to use (Mean = 4.36), with an appreciation for well-integrated functions (Mean = 4.46). This cohort also believes that most people can quickly learn to use the application (mean = 3.57) and feel confident when using it (mean = 3.29).

Conversely, even-numbered questions (i.e., 2, 4, 6, 8, and 10) reflect potential areas of concern or dissatisfaction. Lower mean scores for questions about the application's complexity (mean = 3.33), reliance on technical support (mean = 3.30), perceived inconsistency (mean = 2.86), inconvenience (mean = 2.39), and the need for learning before usage (mean = 4.51) highlight specific areas where improvements could enhance the user experience. Notably, respondents largely disagreed with the notion that the application is too cumbersome or inconsistent.

Correlation between Usability Score and Knowledge and Attitude Gain between Pre and Post Intervention

Spearman's rank-order correlation was used to investigate the association between SUS and variations in knowledge and attitudes in a sample of 76 participants. At a 95% confidence level, neither the correlation between SUS scores and knowledge change nor between SUS scores and attitude change proved statistically significant; the respective correlation coefficients were (ρ = 0.048) and (p = 0.682) for knowledge change, and (ρ = -0.064) and (p = 0.584) for attitude change. Furthermore, the correlation between knowledge and attitude changes was weak and non-significant (p = 0.357). These results imply that usability perceptions, knowledge changes, and attitude changes are not significantly correlated. The findings of the study indicate no significant correlation between SUS scores and knowledge gains, which might be influenced by factors beyond technical usability. This observation aligns with the existing literature suggesting that content quality and pedagogical methods may play more critical roles in knowledge acquisition than usability alone. Conversely, there was a significant improvement in attitudes post-intervention, which

Table 4. General Linear Model Analysis of Test of Between-Subjects, showing sources that might contribute to retention in knowledge and attitude between intervention and control groups (df=1, n= 152)

Variable	Source	F-value	p-value	Partial Eta Squared
Knowledge	Intercept	1.016.779	<0.001	0.874
	Age	0.933	0.336	0.006
	Education Level	0.025	0.875	0.000
	Employment Status	1.169	0.281	0.008
	Tenure Duration	0.020	0.888	0.000
	Intervention	40.535	**<0.001**	**0.217**
Attitude	Intercept	1.087.644	<0.001	0.882
	Age	4.082	0.045	0.027
	Education Level	7.991	**0.005**	**0.052**
	Employment Status	1.184	0.278	0.008
	Tenure Duration	0.327	0.568	0.002
	Intervention	20.705	**<0.001**	**0.124**

Table 5. System Usability Score Questionnaire in Indonesian Language and its corresponding score related to KEPITING

No	Question	Mean	Median	Std. Deviation
1	Saya rasa saya ingin menggunakan aplikasi KEPITING secara rutin *I think I want to use the KEPITING app regularly.*	4.21	4.00	.573
2	Saya merasa aplikasi KEPITING terlalu rumit tanpa alasan *I find the KEPITING app unnecessarily complicated*	3.33	3.00	.641
3	Saya merasa aplikasi KEPITING mudah digunakan *I feel the KEPITING app is easy to use.*	4.36	4.00	.706
4	Saya pikir saya akan membutuhkan bantuan orang teknis (mis.: IT) untuk dapat menggunakan aplikasi KEPITING *I think I will need technical support (e.g., IT) to be able to use the KEPITING app.*	3.30	3.00	.712
5	Saya menemukan berbagai fungsi di aplikasi KEPITING terintegrasi dengan baik *I find the various functions in the KEPITING app to be well integrated.*	4.46	4.00	.552
6	Saya rasa ada terlalu banyak ketidak-konsistenan pada aplikasi KEPITING *I feel there is too much inconsistency in the KEPITING app.*	2.86	3.00	.559
7	Saya membayangkan kebanyakan orang akan belajar menggunakan aplikasi KEPITING ini dengan sangat cepat *I imagine most people will learn to use this KEPITING app very quickly*	3.57	4.00	.499
8	Saya merasa aplikasi KEPITING sangat merepotkan untuk digunakan *I find the KEPITING app very cumbersome to use.*	2.39	2.00	.492
9	Saya merasa sangat yakin saat menggunakan aplikasi KEPITING *I feel very confident when using the KEPITING app.*	3.29	3.00	.585
10	Saya perlu mempelajari banyak hal sebelum saya menggunakan aplikasi KEPITING *I need to learn a lot of things before I can use the KEPITING app*	4.51	**5.00**	.577
	Total Score	**58.72**	**57.50**	**4.839**

might be attributed to factors outside the scope of traditional usability metrics. These may include social interaction elements or the learning context, as noted in similar studies that explore the broad impact of educational interventions. This highlights the complexity of interactions between usability and attitudinal changes, suggesting that other non-measured factors may contribute significantly to these shifts.

Discussions

Indonesia has developed a suite of digital applications addressing stunting, each with unique features tailored to a specific target audience and stages of intervention. ELSIMIL caters to prospective brides and pregnant women, emphasizing pre-marriage and pregnancy planning to mitigate stunting risks through lifestyle and nutritional guidance (Septiyani *et al.*, 2023). lacking a targeted stunting focus in KEPITING. Si Centing aids families with toddlers by offering simplified growth tracking and stunting prevention guidance, making it user friendly for immediate family use. The SI CENTIL RISTI targets high-risk pregnant mothers with materials focused on stunting prevention and family empowerment (FIK UI, 2025), while E-STARE provides broader access to public health services with a component of stunting prevention (Eka, 2022). Finally, Nutrimo integrated health monitoring for stunting detection with general stunting prevention guidance (Permana *et al.*, 2021). Overall, KEPITING stands out for its structured approach to community involvement and emphasis on long-term monitoring and educational interventions based on growth status. This distinct feature addresses a crucial gap identified in research concerning the practical, long-term application of digital health tools in combating stunting, thus complementing the functionalities offered by other apps, such as ELSIMIL, Si Centing, and SI CENTIL RISTI.

In terms of effectiveness, KEPITING has shown particularly strong effects in practical and application-oriented areas such as nutrition interventions and procedural tasks, affirming the findings of Côté *et al.* (2020). These results suggest that web-based methods are particularly effective in imparting practical healthcare skills, which resonates with educational theories that emphasize experiential learning. Future interventions could benefit from incorporating additional interactive components to enhance engagement and skill acquisition. On the other hand, theoretical components such as contextual knowledge exhibited only marginal improvement, reflecting the observations of Wysocki *et al.* (2018) regarding the potential gaps in e-learning's contextual relevance.

The impact of age and educational background on the effectiveness of the intervention was apparent, particularly in stunting recognition and procedural implementation, where age had a significant effect. This may be attributed to the differences in digital literacy and cognitive processing capabilities, as discussed by Fazrina and Cahyaningrum (2022) and McDonough *et al.* (2020). Implementing digital health interventions relies heavily on digital literacy, which affects the performance of health-based apps by influencing users' capacity to comprehend and interact with the app's content (del Pilar Arias López *et al.*, 2023). The impact of educational background on contextual knowledge aligns with the findings of Korkmaz et al., Toraman, (2021) and Côté *et al.* (2020) underscoring formal education's role in theoretical understanding. Adaptive learning pathways that accommodate these demographic differences can enhance the accessibility and effectiveness of learners.

Interestingly, the lack of significant effects of employment status and tenure duration across

knowledge components suggests the broad applicability of the intervention across professional backgrounds. This aligns with Wysocki *et al.* (2018) and Côté *et al.* (2020), who noted minimal correlation between work experience and e-learning outcomes.

Attitudinal impacts were the most significant in enhancing evaluative skills and overall attitudinal improvement, as supported by Ristkari *et al.* (2019) and Wysocki *et al.* (2018). Kelders *et al* (2024) showed how dynamic and routine usage of apps fosters behavioral engagement, emphasizing the importance of the quality of fit between the user and technology. These components collectively contribute to a richer user experience and improve health outcomes. This suggests that embedding behavioral interventions within apps, such as role-playing and practice drills, might be effective in bridging this gap.

Demographic influences on attitudes reveal complex dynamics, with tenure duration affecting overall attitudes and specific behavioral components, suggesting that professional experience can inform and enhance attitude-focused interventions. The strong influence of education on communication-related attitudes (Korkmaz & Toraman, 2021; Côté *et al.*, 2020) and age-related impacts on evaluative skills underscores the importance of life experience in shaping attitudes, resonating with observations by Fazrina and Cahyaningrum (2022) and McDonough *et al.*(2020). The studies conducted by Braddock *et al.* (2024) and Guo *et al.*, who (2023) showed that age influences health app outcomes through differentiation in motivations. While young individuals may be more influenced by financial or competitive factors(Braddock *et al.*, 2024), older adults tend to be motivated by social comparison (Guo *et al.*, 2023). Thus, stunting apps, which are often targeted at older users, should encourage and incentivize collective awareness within the community, particularly cadres.

Retention analysis provides compelling evidence of the intervention's long-term effectiveness with stable knowledge and attitudinal gains across diverse demographic groups. This underscores the intervention's universal applicability, which is consistent with the findings of Côté *et al.*(2020), indicating that web-based learning can offer lasting benefits. The challenges in sustaining knowledge retention noted by Korkmaz and Toraman (2021) appear to be addressed by this robust intervention design, setting a successful precedent for future implementation.

Overall, the analysis revealed a general positive reception of the KEPITING application among users, with higher scores on questions related to usefulness and integration. However, there are clear indicators from the even-numbered questions that point to areas where the application could be improved to reduce complexity, increase user independence from technical support, and streamline the initial learning process. This duality in feedback suggests that while the core functionalities of the application are strong, the user experience can be enhanced by addressing the highlighted areas of concern. The demographic analysis revealed that the participants, predominantly those with middle-school-level education and minimal employment, may have influenced these perceptions.

Hyzy et al. (2022) identified that usability scores can be significantly shaped by user demographics and prior experiences. While the current SUS score indicates an acceptable level of usability, it underscores the necessity of targeted enhancements to better meet user expectations. It would also be helpful to use different methods while designing a digital health system, such as Lukmana and Al-Husaini (2024) using the Design Thinking approach to achieve an SUS score of 75. This aligns with other studies demonstrating that improvements in usability can lead to increased user satisfaction and engagement. These findings suggest that addressing specific usability issues could elevate the system to meet or exceed the average SUS benchmark, thereby enhancing the overall user experience.

In the context of this study, the SUS score indicates that the system's usability does not meet the established benchmark; however, there is significant improvement and consistency in users' knowledge and attitudes. This discrepancy could be attributed to several factors. First, positive attitudes towards e-learning platforms are influenced by digital literacy skills. Hamutoğlu *et al.* (2019) suggested that it may enhance users' learning experiences, regardless of usability scores. Furthermore, cognitive gains in digital foreign language learning, especially when paired with traditional methods, underline the importance of the learning method's effectiveness (Klímová & Pikhart, 2023) This indicates that even with usability challenges, the educational content's quality and the pedagogical strategies utilized can play a pivotal role in learning outcomes. Similarly, self-regulation is a key predictor of academic success in digital learning contexts, which has implications for knowledge retention, and underscores the importance of learner autonomy. (Kharaman-nia *et al.*, 2023)

Another factor that might have contributed to the low score was the design of the app itself. Moreover, mobile learning apps can suffer from user disengagement due to navigation difficulties or a lack of engagement, leading to negative attitudes (Balaman and Ataman, 2022). Generic e-learning platforms often face challenges with personalization, potentially resulting in disengagement and poor information retention(Begantsova, Akutina and Shchelina, 2020). These findings emphasize that the effectiveness of e-learning is not automatically ensured by usability; rather, it is significantly influenced by the content quality and pedagogical approaches. Thus, while the system in this study may require usability improvements to reach benchmark levels, the quality of

content and teaching methods employed have ensured cognitive and attitudinal gains, illustrating the multifaceted nature of e-learning effectiveness.

The moderate effect sizes suggest that, while the web-based application is a valuable tool, it should be integrated into a comprehensive training program rather than used as a standalone solution for capacity building in stunting detection and management. Future iterations of the application might benefit from incorporating more interactive elements to enhance or maintain engagement with action-oriented tasks and to strengthen communication skills. This might include conducting periodic updates, adding more features and incentives related to educational content, on-time monitoring check-ups, completing personal targets, filling out quizzes, and following new courses.

The findings from the analysis of web-based interventions for stunting detection provide several key implications for healthcare practices and research. First, the success of the intervention in enhancing practical procedures and nutrition intervention knowledge underscores the importance of incorporating interactive and hands-on learning experiences into healthcare training programs. This aligns with modern educational strategies that emphasize experiential learning to improve skill acquisition, as experiential learning might allow users to gain new insights and derive pleasure from their progress, thereby reflecting affective engagement (Kelders *et al.*, 2024). The modest gains in contextual knowledge suggest that theoretical content may require more structured and engaging delivery methods. Healthcare education programs could benefit from integrating scenario-based learning or problem-solving activities to convey abstract concepts better.

Demographic factors, particularly age and professional experience, emerged as significant factors in this study. This is well supported by an umbrella study conducted by Abdelmalak *et al* (2024) stated that sex, age, and education are major factors influencing the outcomes of mHealth applications. Age and professional experience are likely to affect familiarity with technology, comfort with digital interfaces, and thus, the extent of engagement with mHealth applications. Younger individuals or those with more tech-savvy professional backgrounds may find it easier to navigate and utilize health apps effectively, which aligns with the findings of broader research.

Age-specific considerations are crucial as different age groups process and retain information in distinct ways. Liu *et al.* (2022) stated that younger users performed better in tasks related to self-monitoring results than their older counterparts when comprehending digital health information. While younger individuals might easily assimilate and recall new information, older adults could face challenges with short-term memory, requiring repeated exposure and reinforcement to effectively retain new information. Interventions can be tailored to accommodate varying levels of digital literacy and cognitive processing capabilities, ensuring inclusivity and effectiveness across demographics. The influence of tenure duration on attitudes indicates that professional experience significantly affects how healthcare workers integrate new attitudinal approaches. Training programs may leverage existing professional experiences by incorporating mentorship or peer-led workshops. Moreover, the observed gap between attitudinal change and behavior highlights the need for future interventions that include stronger behavioral training elements. Role-playing, simulations, or real-world applications can help ensure that attitudinal shifts translate into practical behavioral changes.

It is crucial to investigate methods that promote the long-term retention of knowledge and attitudes among health professionals to effectively implement the KEPITING web-based application in real-world settings, where it can be used for stunting detection, monitoring, and education. Sustaining the achieved gains over a longer duration can be facilitated by incorporating periodic reinforcement sessions or follow-up interventions via apps. Determining the impact of educational background on learning outcomes and the incorporation of new information is of paramount importance to bridge the disparity in digital literacy among cadres. Tailoring the app's training modules to accommodate different educational backgrounds can lead to the development of more personalized and effective interventions to prevent stunting. The broad usability of KEPITING apps across various demographic groups implies the possibility of creating universally effective antistunting programs. Understanding the key components that enable broad applicability can inform the refinement of an app's features to guarantee versatility and efficiency. Incorporating behavioral change theories into an app's design can help translate knowledge and attitude improvements into lasting behavioral changes, ultimately increasing the app's educational impact.

The government can provide substantial support for the rollout of the KEPITING app or similar digital health apps by offering financial support and resource allocation to enhance and expand its features. Government officials can facilitate collaboration among app developers, educational establishments, and healthcare providers to guarantee consistency with national health objectives and regulations. Implementing policies that require the adoption of such apps in community health environments, and encouraging participation among health professionals, can increase engagement and efficiency. The government can enhance the success and accessibility of apps by establishing a supportive environment with favorable policies and infrastructure,

thereby ultimately advancing stunting detection, monitoring, and education initiatives across Indonesia.

This study's findings are subject to several limitations. The sample size of 152 respondents, split evenly between the control and intervention groups, may lack sufficient power to detect small effect sizes, which could impact the generalizability and precision of the results. There are no data regarding participants' familiarity with technology and digital literacy that might influence the perceived usability and effectiveness of the apps themselves. Self-reported questionnaires may introduce response bias, and the construction of each component is also subject to caveat, as it relies solely on a heuristic approach, which may compromise the accuracy of the reported changes in knowledge and attitudes. While the study allocates respondents into control and intervention groups based on geographic region, this method might inadvertently introduce sampling bias. Since allocation was not random, there is potential for pre-existing differences between the groups that could influence the outcomes, such as differing levels of baseline technology use or cultural factors. Lastly, the study may not have accounted for contextual factors, such as cultural influences and organizational support, that could affect intervention outcomes.

Future research might benefit from investigating the specific mechanisms contributing to the observed improvement in attitudes over time as well as examining whether these positive trends continue beyond the current follow-up period. Improving the design and content of the questionnaires could lead to a more comprehensive assessment of critical topics related to stunting prevention, ensuring that the questions accurately capture the intended constructs. Additionally, given successful retention patterns, it would be valuable to explore whether similar interventions could be adapted for other contexts while maintaining their effectiveness, sustainability, and user-friendliness across diverse populations.

Conclusion

This study examined the effectiveness of a web-based application compared with traditional training for health cadres in Indonesia, focusing on child health monitoring. The analysis showed that the web-based application significantly enhanced knowledge of practical procedures and nutrition interventions, with notable gains observed in stunting identification knowledge. Overall, attitudinal improvements were significant, especially in appraisal capabilities, although changes in action-oriented and communication attitudes were not significant. Despite these successes, the study found that demographic factors, such as age, service duration, and education level, did not significantly impact the effectiveness of the interventions, suggesting equal receptivity across different cadre profiles. The System Usability Scale score highlighted areas for improvement in the usability of the application, despite its educational impact. Limitations include a small sample size, potential response bias from self-reported data, region-based allocation between groups, and the lack of consideration of digital literacy, cultural, and organizational influences. Addressing these issues in future research could enhance the understanding and effectiveness of educational intervention. The web-based application is effective for certain knowledge and attitudinal improvements, advocating its integration into broader training strategies to enhance health cadre capabilities in stunting prevention. Ultimately, incorporating this technology into nursing care across Asia could facilitate continuous learning and improve practical skills, ultimately enhancing health outcomes, particularly in community settings.

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Declaration of Interest

We declare that there are no competing interests in this research.

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