Article

The Effect of Caring Strategies with Smart e-Books on Practice to Prevent Stunting during Pregnancy

Yuni Purwati* (Corresponding author)
https://orcid.org/0000-0003-3545-315X
Universitas Aisyiyah Yogyakarta, Yogyakarta, Indonesia
yunipurwati@unisayogya.ac.id

Febriana Renitasari
https://orcid.org/0009-0006-1438-9178
National Taipei University of Nursing and Health Sciences, Taiwan
febriana.reni18@gmail.com

Diah Nur Anisa
https://orcid.org/0000-0002-3168-6143
Universitas Aisyiyah Yogyakarta, Yogyakarta, Indonesia
diahnuranisa@unisayogya.ac.id

Abstract

Stunting is a health problem in Indonesia caused by malnutrition during the first 1 000 days of life, which includes 270 days in the womb and 730 days after birth. It affects cognitive development and increases the risk of infectious and chronic diseases. Caring strategies for stunting prevention are needed during pregnancy. This study examined the effect of caring strategies for preventing pregnancy stunting using smart e-books on stunting prevention practices during pregnancy. Post-intervention scores showed a higher proportion of participants in the "good" practice categories; in the intervention group. These findings support the integration of digital devices and caring strategies into prenatal care programmes to improve maternal education and early stunting prevention.

Keywords: stunting prevention; caring; pregnancy; practice smart e-books

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Introduction and Background

The critical period of child growth and development occurs in the first 1 000 days of life, which includes 270 days of pregnancy and the first 730 days of life which is called the golden period (Ministry of Health of the Republic Indonesia 2022). Malnutrition during the first 1 000 days of life causes disorders in brain development, metabolism and stunting (Mustakim et al. 2022; World Health Organization 2023). The short-term consequences of stunting in children are growth delays, cognitive and motor development problems and frequent illness. Stunting is a disorder of child growth and development which is known from height according to age under the World Health Organization (WHO) standard. The long-term consequences of stunting include decreased intellectual capacity, low academic achievement, increased risk of chronic diseases such as diabetes, cardiovascular disease, hypertension and obesity in adulthood (Wand et al. 2024; Meher and Zaluchu 2025).

In 2021, the global prevalence of stunting reached 22.0%, or around 149.2 million children. In Indonesia, although the national stunting rate decreased from 24.4% to 21.6% in 2022, this figure is still above the 2023 target of 16%. Efforts to achieve the 2024 national target of 14%, as outlined in the National Medium-term Development Plan, require strong multi-sectoral collaboration. In 2021, in the special region of Yogyakarta, it was reported that 8.50% of children under five years suffered from malnutrition and 9.83% experienced stunting. In Bantul Regency, 921 children (7.26%) were identified as having stunting, with cases reported in all primary health centres (Ministry of Health of the Republic Indonesia 2023; World Health Organization 2023; Yogyakarta Health Office 2022).

During the critical period of growth and development of 270 days of pregnancy, optimisation of stunting prevention efforts is needed as a priority programme for reducing stunting in Indonesia. One of the interventions focused on the 270 days of pregnancy is by optimising routine antenatal care, iron and folic acid supplementation, and providing additional nutrition (Presidential Regulation 2021). Knowledge and readiness of pregnant women affect the success of stunting prevention practices and reducing the incidence of child stunting. Pregnant women who have a poor understanding of stunting prevention efforts tend to be less regular in attending antenatal care, pay less attention to the nutritional value of the nutrients consumed and do not regularly take iron and folic acid tablets (Meher and Zaluchu 2025). Poor pregnancy care can affect fetal growth development, intra uterine fetal distress, prematurity, low birth weight and stunted children with accompanying child growth and development delays (Umar et al. 2023).

Various studies on stunting prevention have been conducted in support of the government's stunting reduction programme. Findings that maternal factors such as age, education, employment and parity have been associated with greater awareness of stunting risk prevention (Saleh et al. 2021; Meher and Zaluchu 2025). Support from healthcare providers also show result in better compliance with iron supplementation.

Support is provided through education for pregnant women with materials in maternal and child health books (Muhamad et al. 2023). Another finding is themed "Impact of Stunting on Development of Children" (Mustakim et al. 2022), to analyse the effectiveness of providing nutritional education to pregnant women to prevent gestational stunting. This is a quasi-experimental study that produces differences in knowledge, attitudes and actions of pregnant women regarding antenatal care services; the educational intervention provided focuses on nutritional education.

The gap between the government's stunting reduction programme and the results of previous studies that there is no special media effective stunting prevention caring strategy affects the readiness of stunting prevention during pregnancy. Based on this gap, the development of smart e-books has been produced as an effort to prevent stunting since pregnancy. Smart e-books have been tested for validity by graphic design media experts with an average result of 80.33% valid interpretation and content expert validity test with an average result of 82%; a valid interpretation. This smart e-book needs to be proven effective in the practice of preventing stunting in the subject group. The study aimed to prove the effectiveness of the smart e-book on caring strategies for preventing stunting during pregnancy.

Research Methods

Research Design

This study used a true experiment with a pre-test and post-test control group approach, a randomised trial. In the experimental group, participants underwent a pre-test on stunting prevention practices using a 20-item stunting prevention practice questionnaire. One week after the pre-test, the subjects received education through e-smart book media for 60 minutes. Four weeks after the intervention, a post-test on stunting prevention practices was conducted. In the control group, subjects completed the pre-test and post-test on stunting prevention practices at the same time as the experimental group. The control group continued to receive interventions according to the standard prenatal class programme provided at primary healthcare facilities.

Population and Sample

A total of 104 pregnant women in their first trimester were randomly assigned to the intervention group (n = 52), which received prenatal education using smart e-books, and the control group (n = 52), which received routine prenatal education. Stunting prevention practices were measured using a valid and reliable 20-item questionnaire administered before and four weeks after the intervention. Data were analysed using paired t-test and independent sample t-test. The intervention group showed a statistically significant increase in stunting prevention practice scores compared to the control group $t = 5.532 > t$ table 1.673 with a significance value < 0.001.

The sample was all pregnant women domiciled in Bantul Regency, Yogyakarta, Indonesia. It included pregnant women who checked their pregnancy at four selected health centres, namely Kasihan 2, Bantul II, Sedayu I and Sedayu II Bantul Yogyakarta, Indonesia. The inclusion criteria included productive maternal age, first trimester pregnancy (gestational age 1 to 14 weeks), single pregnancy and no pregnancy complications. Sampling was done by simple random sampling, sample size using the estimated sample size calculation for two paired groups (Levy and Lemeshow 2018). Calculation using sample size determination in the health studies programme, research power 90%, population group 1: 50% and group 2: 20% produced 52 subjects. The total of 104 subjects, including 52 experimental group subjects and 52 control subjects was selected using simple random sampling technique which was also applied to determine the experimental and control groups. Subjects were blinded (single blind) to reduce the risk of bias from the subject source. The subjects in the experimental group were recruited from Kasihan II and Bantul II Community Health Centres, Bantul, Yogyakarta, Indonesia, while the subjects in the control group were recruited from Sedayu I and Sedayu II Community Health Centers, Bantul, Yogyakarta, Indonesia.

Ethical Considerations

This research met the ethical research standards and received approval from the Health Research Ethics Commission of Universitas Aisyiyah Yogyakarta, Indonesia number: 4233/KEP-UNISA/II/2025, dated 15 February 2025. This research also received permission from the Health Office Bantul Yogyakarta, Indonesia to conduct research at the Basic Health Facilities at Kasihan II, Bantul II, Sedayu I and Sedayu II Health Centres.

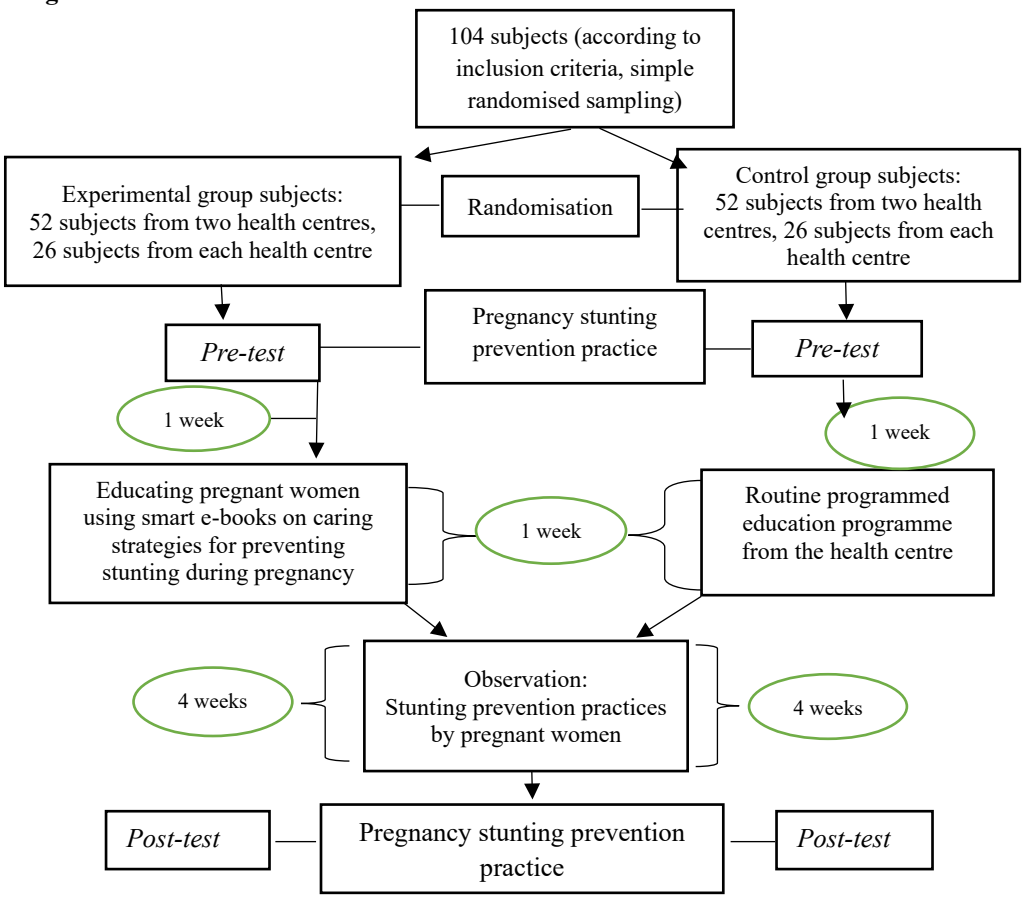
Data Collection

Data collection was conducted from February to April 2025. The questionnaire was used to collect data on stunting prevention practices during the pre-test and post-test pregnancy period of the experimental and control groups. The questionnaire was developed by researchers based on the WHO stunting prevention theory (WHO 2023; Nadhiroh et al. 2023; Traore et al. 2023). The questionnaire consisted of 20 statement items that had been tested for validity and reliability on 30 pregnant women subjects. The instrument was declared valid as evidenced by the results of the product moment test count > 0.0349 with significance < 0.05 and reliable proven by testing *Cronbach's Alpha*, result value > 0.80. The questionnaire was then used to measure stunting prevention practices pre-test and post-test of the intervention and control groups.

After the pre-test, the experimental group subjects in each health centre attended a class for pregnant women who were given education using smart e-books on strategies for preventing stunting during pregnancy. Education was carried out for 100 minutes for

each group with the following activities: delivering learning objectives, delivering materials and motivation based on smart e-books, questions and answers, monitoring maternal and child health books and motivation to use smart e-books as a guide to preventing stunting since pregnancy. Education was carried out by researchers and coordinating midwives who had followed the same perception. After the class for pregnant women, subjects were given a checklist to evaluate the implementation of antenatal care according to schedule, monitoring balanced nutrition, taking iron tablets, and physical activity during pregnancy. The control group was not taught using smart e-books, but still attended the programmed pregnant women's class. The post-test of the experimental and control groups was conducted four weeks after the implementation of the pregnant women class and the research process was stopped. The research protocol is explained in diagram 1 below.

Diagram 1: Research Protocol



Data Analysis

Data processing stages included editing, coding, data entry and data cleaning. A univariate analysis was used to determine the mean, minimum and maximum values, and 95% confident interval (CI) on the dependent variable and respondent characteristics. Data were tested for equality analysis with data normality. On normal data, a paired sample t-test is carried out to determine the difference in stunting prevention practices during pregnancy before and after the intervention. The pre-test and post-test scores of the intervention and control groups were made to get scores; then an independent t-test was carried out to determine the difference in influence on the experimental group.

Results

The results are presented as follows: 1) Characteristics of the respondents; 2) Data on stunting prevention practices during pregnancy; and 3) Results of a paired t-test and an independent sample t-test.

Table 1: Frequency Distribution of Respondent Characteristics

Variables	Intervention group		Control group	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Age of pregnant mother	Mean: 2.04; SD: 0.194 (2± 3)		Mean: 2.04;SD: 0.194 (2 ± 3)	
20 to 30 years	50	96.2	50	96.2
30 to 35 years	2	2.8	2	2.8
Total	**52**	**100**	**52**	**100**
Parity	Mean: 1.65; SD: 0.711(1 ± 3)		Mean: 1.63; SD: 0.627 (1 ± 3)	
First pregnancy	25	48.1	23	44.2
Second pregnancy	20	38.5	25	48.1
Third/more pregnancy	7	13.5	4	7.7
Total	**52**	**100**	**52**	**100**

Table 1 shows that respondent characteristics according to the age of pregnant women in the experimental and control groups, the majority were aged 20 to 30 years, namely 50 (96.2%) subjects, mean: 2.04, SD: 0.194 (2 ± 3). According to parity status in the experimental group, the majority were first pregnancies 25 (48.1%), mean: 1.65; SD: 0.711 (1± 3). In the control group, the majority were second pregnancies 25 (48.1%), mean: 1.63; SD: 0.627 (1 ± 3).

Figure 1. Data on stunting prevention practices during pregnancy

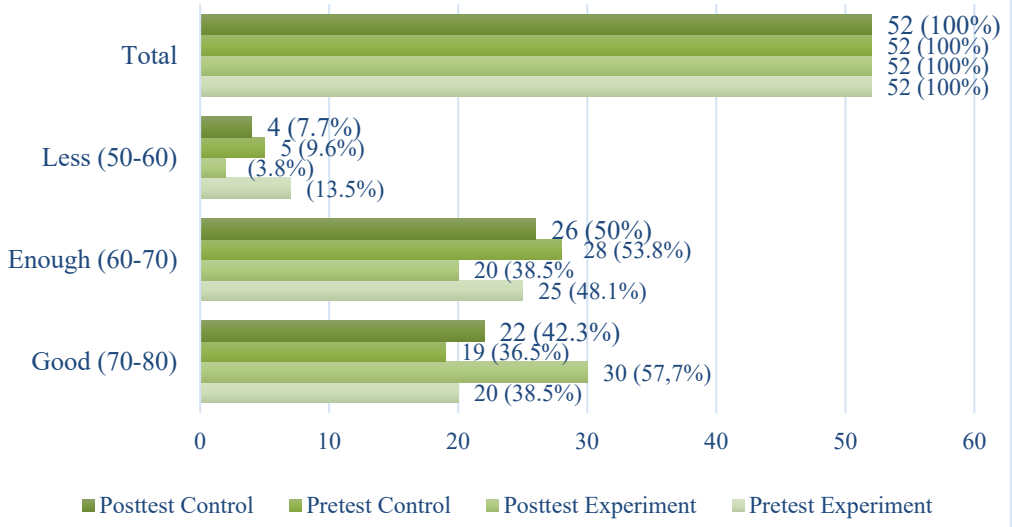


Figure 2 shows the results of the practice of preventing stunting during pregnancy in the experimental group through a questionnaire given before attending the pregnant mother class with smart e-book media and four weeks after attending the mother class. It shows an increase in the practice of preventing stunting during pregnancy in the good category, from 20 (38.5%) subjects to 30 (57.7%) subjects. The control group was lower than the experimental group, namely from 19 (36.5%) subjects to 22 (42.3%).

Table 2: Results of Paired T-test and Independent Sample T-test

	Paired differences							
	Mean	**St Dev**	**St error mean**	**95% CI of the difference**		**t**	**df**	**Sig. (2-tailed)**
				Lower	**Upper**			
Pre-test-post-test experiment group	-3.038	3.125	0.433	-3.908	-2.169	-7.012	51	0.000
Pre-test-post-test control group	-2.31	1.906	0.264	-0.761	0.300	-0.873	51	0.387
	Mean different		**St error mean**	**95% CI of the difference**		**t**	**df**	**Sig. (2-tailed)**
				Lower	Upper			
Independent sample t-test	2.808		0.508	1.798	3.789	5.532	84.3	0.000

Before the t-test statistical test, all pre-test and post-test data of the experimental and control groups, a normality test was performed with Kolmogorov-Smirnov and the overall significance figure that was obtained was > 0.05, so the data is normally distributed. The results of the paired t-test of the experimental group showed the results of t = -7.012, with the significance value of < 0.001, M (SD) = -3.038 (-3.908; -7.0120). The smart e-book of caring strategies for preventing stunting during pregnancy has an effect on improving the practice of preventing stunting during pregnancy. The results of the independent t-test samples obtained the results of t = 5.532 > t table 1.673 with a significance value of < 0.001, M (SD) = 2.808 (1.798; -3.789). The increase in the practice of preventing stunting during pregnancy in the experimental group that was given education using the smart e-book on preventing stunting during pregnancy was higher than the control group that received routine programmed education (see table 2).

Discussion

This study evaluated the effectiveness of smart e-books on caring strategies for preventing stunting during pregnancy. The results showed a significant increase in the practice scores of pregnant women who received intervention with smart e-book media (experimental group) compared to those who received routine antenatal education

(control group). These results show that the use of structured and interactive educational media presented in smart e-books can effectively influence maternal behaviour during pregnancy. These findings support the notion that targeted interactive educational strategies during pregnancy can significantly increase maternal awareness and behaviour related to stunting prevention (Jaacks et al. 2019).

The score of stunting prevention practices by pregnant women increased significantly in the intervention group after the education session, indicating that pregnant women responded positively to the structured and contextual information presented in the smart e-book format. This is in concert with previous studies that emphasise the importance of health education in influencing health-related behaviours during pregnancy (Meher and Zaluchu 2025; Hijrawati et al. 2021; Malhotra et al. 2021). The use of smart e-books is also in line with current trends in digital health promotion, especially improving access and retention of knowledge through portable and repeatable learning tools.

The intervention group's improved practices reflected a comprehensive understanding of stunting prevention, including iron supplementation, regular antenatal care visits and adequate nutritional intake. This is in line with WHO recommendations for maternal health and child development (WHO 2023). By focusing on the intervention during the first trimester, this study capitalised on a critical phase in pregnancy when health behaviours are more likely to be formed and maintained. Previous research has also shown that behavioural changes during pregnancy can be facilitated by increasing knowledge and motivation (Nadhiroh et al. 2023; Sabbily et al. 2025; Soofi et al. 2024). The results of this study are also in line with previous studies that highlight the importance of maternal education in preventing stunting in children. A study by Ireland et al. 2019 emphasised that early intervention during pregnancy, including nutrition education and behavioural counselling, is essential in reducing the risk of stunting. Similarly, Rahangmetan et al. 2024 reported that educational interventions significantly improved knowledge and adherence to prenatal care standards among pregnant women, especially regarding iron supplementation and balanced nutrition. The smart e-book programme on caring strategies for stunting prevention since pregnancy uniquely addresses stunting prevention through a caring approach, integrating empathy-driven communication and reinforcement strategies, which can contribute to increased participant engagement and outcomes.

In addition, the increased readiness of the intervention group reflects a comprehensive understanding of stunting prevention, including iron supplementation, regular antenatal care visits and adequate nutritional intake. This is in line with WHO recommendations for maternal health and child development (WHO 2023).

Conversely, the control group did not show significant changes in readiness, suggesting that routine prenatal education alone may not be sufficient to drive behavioural improvements in this context. These findings reinforce the need for more personalised and focused interventions that address specific public health challenges such as stunting,

as outlined in the Indonesian Presidential Regulation No. 72 of 2021 on stunting control (Presidential Regulation 2021). The study also confirmed prior studies that the critical period of the first 1 000 days of life as a determinant of child growth and development outcomes (Indrio et al. 2023; Hijrawati et al. 2021; Keats et al. 2021). Educating mothers during the first trimester, taking advantage of the golden period, may lead to long-term improvements in child health outcomes.

The findings of this study are pivotal for maternal and child health policy, as integrating smart e-books on pregnancy stunting prevention strategies into routine antenatal care can improve stunting prevention practices, especially in high-risk areas. Given the ongoing challenge of reducing stunting prevalence in Indonesia and meeting the national target of 14%, innovative approaches that support early behavioural change are essential. This study had several strengths, including its experimental design, adequate sample size, and use of a validated questionnaire. However, the study had its limitations, among them the relatively short follow-up period (four weeks), which created a need to assess the long-term sustainability of behaviour or actual health outcomes in infants. Future studies should consider longitudinal designs to examine whether improvements in stunting prevention practices result in actual reductions in stunting incidence. In addition, although this study used a randomised method in sample selection, several potential confounding factors such as household food security and paternal support need to be measured because they affect the effectiveness of the intervention.

Conclusion

In conclusion, the smart e-book on caring strategies for preventing stunting since pregnancy is effective in improving pregnant women's practices to prevent stunting. This supports the integration of digital-based and caring education interventions into routine prenatal care. Such strategies can be important tools in achieving national and global goals to reduce child stunting and improve maternal and child health outcomes. The study contributes to the evidence supporting the digital education and caring behaviour model in maternal and child health promotion. Future studies can explore the long-term impact of interventions using smart e-books and include broader socio-environmental factors that influence stunting prevention.

Conflict of Interest Statement

The authors declare that they have no competing interests. The authors also declare that the preparation of this article did not involve the use of AI assistance.

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