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Effectiveness of E-Booklets on Pregnant Women's Knowledge of Balanced Nutrition

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ABSTRACT

Low nutritional intake and knowledge among mothers during pregnancy are important factors that influence the occurrence of KEK and the risk of stunting. Efforts to increase knowledge are usually carried out through posyandu counseling or information media. This study aims to determine the effectiveness of e-booklets on pregnant women's knowledge of balanced nutrition. The research method included a pre-experimental pre-test and post-test (single-group pretest-posttest design) with 21 pregnant women selected via incidental sampling from a population of 31. The measurement tool used a questionnaire consisting of 35 questions, with a calculated r value of 0.369-0.784 and a Cronbach's Alpha of 0.91. The data were analyzed using the Wilcoxon test because they were not normally distributed. The test results showed a p-value of 0.001, indicating that the e-booklet was effective in improving pregnant women's knowledge of balanced nutrition. Future researchers should conduct further randomized controlled trials (RCTs) to test the effectiveness of e-booklets, using a control group and a larger sample size, or to evaluate their impact on nutritional behavior/practices.

INTRODUCTION

Chronic energy deficiency (CED) is a condition in which a person has been lacking food for a long time, leading to a body mass index (BMI) below 23.5. Eating patterns influence the nutritional status of pregnant women by affecting nutrient intake, the foods consumed, and the frequency, amount, and portion sizes of meals (Rahayu & Sagita, 2019). Pregnant women with CED are a fundamental problem that needs to be addressed well, as they are at risk of prolonged labor and postpartum hemorrhage (Ernawati, 2018). The risks for the fetus include miscarriage, premature birth, congenital disabilities, low birth weight (LBW), and even infant death (Diningsih et al., 2021).

According to Indonesian Nutrition Status Survey (SSGI) data for 2024, the national prevalence of stunting was 19.8%. Central Java Province recorded a stunting prevalence of 17.1% among toddlers in 2024, according to the 2024 SSGI results (Ministry of Health Republic Indonesia, 2025). In 2023, according to statistics from the Semarang Regency Health Office, 3,190 of 70,380 toddlers in Semarang Regency were categorized as short or very short due to stunting. Pregnant women with Chronic Energy Deficiency (CED) have a greater risk of giving birth to stunted toddlers (Semarang Regency Health Office, 2023).

Several factors can influence the occurrence of chronic energy deficiency in pregnant women, including eating patterns and low nutritional knowledge. In Indonesia, there are still many cases of CED, mainly due to an imbalance in nutrient intake (energy and protein), leading to unmet nutritional needs (Prasetyawati, 2012). Low knowledge and practice of balanced

nutrition during pregnancy play an important role in a pregnant woman's nutritional intake, as good knowledge of balanced nutrition leads to a better menu for her.

Low knowledge can be influenced by the mother's age, education, and occupation, which may cause her to still believe in inaccurate myths and traditional teachings about balanced nutrition and affect her attitude toward receiving new information about balanced nutrition during pregnancy. Pregnant women can get the health information they need in various ways, including through posyandu counseling and media (Zahra et al., 2021). Nutritional deficiencies in pregnant women, such as Chronic Energy Deficiency (CED), are health problems that can adversely affect maternal health and increase the risk of fetal growth disorders, including stunting in children (Aini et al., 2023). Low knowledge among pregnant women about nutritional needs during pregnancy is often a factor contributing to the high risk of these nutritional problems (Akbarini & Siswina, 2022). One effective health education medium is a booklet, because it is easy for students to store, carry, and understand (Permadi et al., 2021). According to Pratiwi and Puspitasari (2017), another benefit of a booklet is that it helps learners learn faster and makes it easier for them to find information. In the current digital era, the use of electronic media has become increasingly popular and essential, enabling information to be disseminated without limits. Most e-booklets are static, similar to PDFs, with displays that are not very adaptive to small smartphone screens, making them difficult to read without zooming in or scrolling (Nuraenah et al., 2025). Pregnant women can access materials independently, anytime and anywhere, without relying on face-to-face sessions or health facilities. This is especially important for busy mothers or those with limited time. According to findings, digital media increases the accessibility of pregnancy education in the modern era (Febriani et al., 2022). Many digital media used in previous studies remain in static file formats with designs not optimized for smartphones, making them less suitable for the habits of modern pregnant women (Nuraenah et al., 2025).

The e-booklet was created to adapt to the current situation, where almost everyone, especially pregnant women, has a smartphone, so that all pregnant women can learn about balanced nutrition through it. Therefore, there is a need for pregnancy education media that is not only digital but also responsive, interactive, and user-friendly, namely in the form of an e-booklet, a modern adaptation of conventional brochures. This e-booklet offers flexible access on smartphones, can be read repeatedly without installation, and is better suited to the lifestyles and preferences of today's pregnant women. Thus, this research fills an important gap in maternal health literature by offering a more relevant, efficient, and accessible educational medium. This study aims to analyze the effectiveness of e-booklet media in improving pregnant women's knowledge of balanced nutrition.

METHOD

Based on the objective of this research, which is to determine the knowledge of pregnant women after being given education about balanced nutrition using an e-booklet. This study is a pre-experimental, pre-test and post-test study (Single-Group Pretest-Posttest Design). This research falls under the category of a Health/Medical Device Product, specifically a basic principle report, which provides analytical and experimental evidence of the concept's function and/or key characteristics.

The research tool used an e-booklet and knowledge measurement using a questionnaire that had previously undergone validity and reliability testing. The validity test results for 35 questions showed a calculated r value ranging from 0.369 to 0.784 and a Cronbach's Alpha of 0.91. The researcher applied the principles of research ethics in human subjects, particularly respect for respondent autonomy, protection of data confidentiality, and provision of clear information prior to participation. Before data collection, the researcher explained in detail the objectives, benefits, procedures, and the time required for the research process. Furthermore, the researcher provided an informed consent form that included a brief description of the research, the rights and obligations of respondents, and a guarantee that participation was voluntary and free of coercion. Respondents were allowed to read, ask questions about anything they did not understand, and discuss before expressing their willingness to participate. If

respondents agreed to participate, they were asked to sign the consent form. In addition, the researcher guarantees that all respondents' personal information will be kept confidential. The identities of the respondents are not included in the research report, and all data are used solely for academic purposes. The researchers guarantee that all respondents' personal information will be kept confidential. Respondents' identities are not included in the research report, and all data is used solely for academic purposes. Respondents also have the full right to withdraw from participation at any time without any consequences. The entire research process has been assessed and approved by the Ngudi Waluyo University Research Ethics Committee with number 400/KEP/EC/UNW/2025.

Table 1. Operational definition

Variable	Operational definition	Measurement tool	Measurement results	Scale
Knowledge	Respondents' ability to answer questions about balanced nutrition	Questionnaire on balanced nutrition knowledge consisting of 35 questions	1. Good if 76 - 100% 2. Fair if 75 – 56 % 3. Poor ≤55%	Ordinal
E-booklet	Digital educational material in the form of an electronic booklet presented in a mobile-friendly format, containing brief, structured information accompanied by illustrations about balanced nutrition for pregnant women	Provided in the form of a digital file (PDF), read by respondents during the intervention period.	1. Given 2. Not given	Nominal

The implementation of the research consisted of three stages:

1. Stage 1: A study was conducted to assess pregnant women's knowledge of balanced nutrition.
2. Stage 2: The intervention was administered by providing information via the e-booklet.
3. Stage 3: The effectiveness of the e-booklet medium in increasing pregnant women's knowledge of balanced nutrition was analyzed.

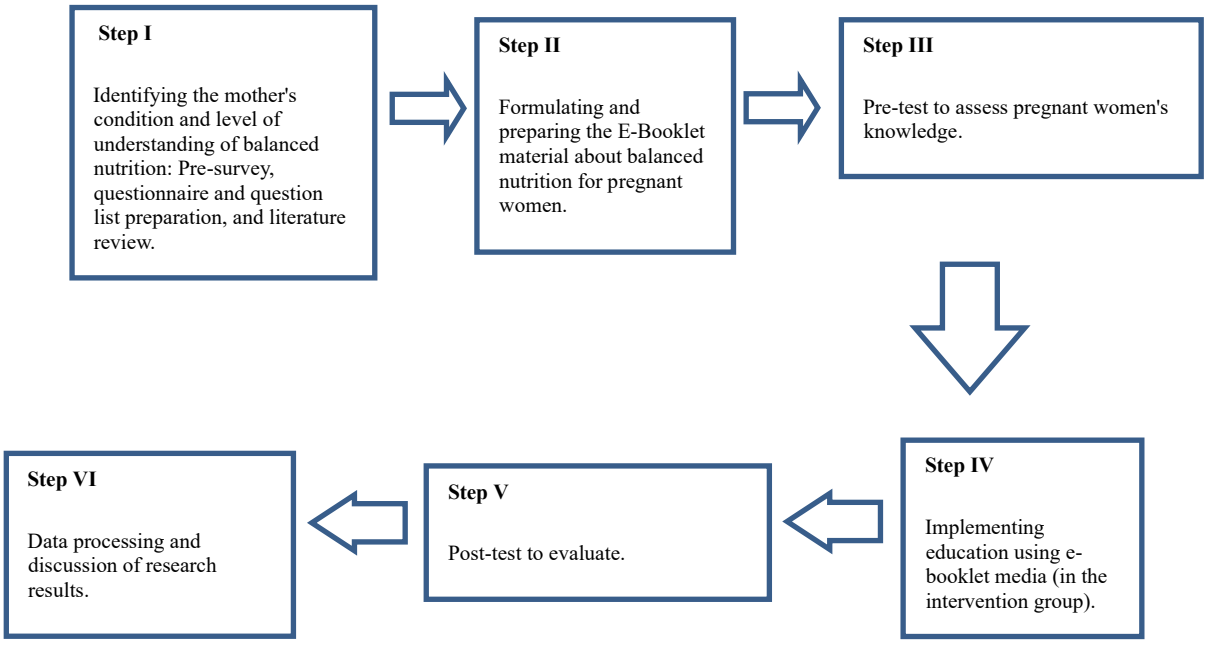

Diagram 1. Model and research method

The research sample consisted of 21 pregnant women who attended prenatal classes, selected by accidental sampling from a population of 31 pregnant women in May 2025 in Bergas Kidul. A Shapiro-Wilk normality test was performed beforehand, yielding pre-test and post-test p-values of 0.007 and 0.002, respectively, indicating that the data were not normally distributed. The Wilcoxon test yielded a p-value of 0.001, indicating that the e-booklet was effective in increasing pregnant women's knowledge of balanced nutrition.

RESULTS

Table 2. Characteristics of respondents

Variable	n	%
Age		
Healthy reproduction	16	76.2
Unhealthy reproduction	5	23.8
Gravida		
Primigravida	6	28.6
Multigravida	13	61.9
Grandemultigravida	2	9.5
Occupation		
Working	6	8.6
Not Working	15	71.4
Education		
Basic	7	33.3
Intermediate	10	47.6
University	4	19.0

Table 3. Frequency distribution of knowledge before and after e-booklet education

Knowledge	n	%
Before		
Good	7	33.3
Sufficient	10	47.6
Poor	4	19.0
After		
Good	7	33.3
Sufficient	14	66.7
Poor	0	0.0

Table 4. Bivariate analysis using the Wilcoxon

Average Knowledge	Min	Max	Mean	Std. deviation	p-value
Before	51	100	71	15.695	0.001
After	71	100	87	11.637	

The research results show that most respondents were classified as having healthy reproduction (76.2%); their pregnancies were multigravida (61.9%); many mothers were not working (71.4%); and they had a secondary education level (47.6%). The average knowledge of pregnant women about balanced nutrition increased from 71 to 87 after receiving the e-booklet (p-value = 0.001).

DISCUSSION

The research indicates that the e-booklet can effectively improve pregnant women's knowledge of balanced nutrition. This increase in knowledge will help reduce the incidence of stunting. Pregnant women require balanced nutrition to support the growth and development of their babies. An e-booklet (or electronic booklet) is a digital adaptation of a printed booklet that effectively conveys educational material in a concise, clear manner, complete with illustrations,

making it easy for the target audience to understand (Prasetyanti et al., 2023). The advantage of e-booklets lies in their accessibility on widely used digital devices, such as smartphones, allowing pregnant women to access information anytime, anywhere (Setyawati & Herlambang, 2015). The use of digital media in health promotion is also relevant, as many pregnant women today seek information from various sources, including the internet, despite varying levels of reliability (Olloqui-Mundet et al., 2024; Setyawati & Herlambang, 2015).

Several studies have shown that nutrition education interventions using booklets, including e-booklets, are effective in increasing the knowledge of pregnant women and other target groups (Aini et al., 2023; Siregar & Sukartini, 2022; Yanti et al., 2022). Nutrition education interventions using booklets have been shown to significantly improve pregnant women's nutrition knowledge scores, with substantial average increases from pre-test to post-test (Akbarini & Siswina, 2022; Siregar & Sukartini, 2022). This increase in knowledge is significant because adequate understanding is a prerequisite for changing proper nutrition practices. Several studies show that e-booklets are superior or have a greater impact on increasing knowledge levels compared to other media, such as e-leaflets or non-media counseling methods (Yanti et al., 2022). Some studies conclude that e-booklets are as effective as printed booklets in increasing knowledge (Nuraenah et al., 2025). In addition to knowledge, e-booklet-based education can also improve dietary practices and the consumption of essential nutrients, such as energy and protein, especially among pregnant women with conditions such as Chronic Energy Deficiency (Teweldemedhin et al., 2021; Yanti et al., 2022). These positive impacts indicate that well-designed educational media can support healthier behavioral changes (Teweldemedhin et al., 2021).

Digital learning media are sophisticated, innovative tools that can present stories and knowledge in text, graphics, animations, audio, and video. The use of digital learning media can make learning more engaging and stimulate learners' curiosity. As technology advances, it becomes easier for students to find any information or knowledge they want. State that learning media are educational tools that can be used to assist the teaching and learning process and foster learning motivation in students (Ramadani et al., 2023).

The choice of learning media should be oriented toward the audience's needs and presented in an attractive way to function as intended. There are many types of learning media, such as print media, audio media, audio-visual media, interactive multimedia, and e-learning. Therefore, e-learning is one of the alternative media that can be used in the learning process.

E-learning is a learning method that uses information and communication technology, especially the internet, to deliver learning materials and facilitate teaching and learning. E-learning allows flexible learning anytime, anywhere, and is accessible to anyone. Horton (2001), as cited by Sari & Werdiharini (2020), states that "e-learning is the use of electronic technology to create a learning experience. E-learning is designed to make learning more open by formulating, organizing, and creating freer learning experiences. It aims for learning success by combining elements of information, interaction, and educational communication. The e-booklet is a form of electronic learning or e-learning.

This media has a distinctive, attractive, and flexible physical form. It is distinctive for its small size and use of various colors to attract attention. It is flexible because its small size makes it easy to carry and use anytime, anywhere (Hanifah et al., 2020).

E-booklets have several advantages:

1) They are digital, so the cost is lower.
2) The creation process can be done at any time.
3) The content can be adjusted to the existing conditions.
4) They are easy to carry and use anywhere, as long as you have a smartphone, laptop, or computer connected to the internet.
5) The display is more varied with attractive colors, images, photos, and graphics.
6) Links and videos can be embedded.
7) The content is more detailed and precise.

Electronic media have attractive, concise material properties and are equipped with images, recordings, and/or sound. Research by Sari & Werdiharini (2020) on the development of e-learning based on Problem-Based Learning (PBL) showed that e-learning was very effective and could improve students' mathematical critical thinking skills. Research by Nofrianda et al.

(2023) and Fatimah (2015) stated that e-learning media can improve student learning outcomes. This study also found that e-booklets are suitable learning resources because they are accessible, support independent learning, and present information concisely and clearly.

According to Sugianto et al. (2017), a digital booklet is a form of information presentation systematically arranged into smaller learning units to achieve specific learning goals. It includes animations, sound, and navigation, making it more interactive for users. The information is easy to understand because it includes audio-visual displays, sound, and video. Fauziyah (cited in Violla et al et al., 2021) states that an e-booklet is a medium that presents summarized material with interesting pictures, making it a good source of information for understanding learning materials. In other words, an e-booklet is a digital booklet containing visual elements such as letters, photos, images, and lines, presented in a clear, easy-to-understand, firm, and attractive PDF format. According to Prananta & Safitri (2023), e-booklets are used as a media for providing information on tourist attractions.

Research on balanced nutrition to help prevent stunting is also in line with the study by Prananta & Safitri (2023), which showed that participants with poor knowledge decreased, while those with sufficient and very good knowledge increased. The fetus grows by taking nutrients from the mother's diet and from her body's nutrient stores. During pregnancy or breastfeeding, a mother must increase the variety and amount of foods she eats to meet her baby's growth needs and her own. If the mother's diet does not provide enough nutrients, the fetus or baby will draw on the mother's stores, such as fat cells for calories and iron.

The effectiveness of e-booklets in improving balanced nutrition knowledge among pregnant women may depend on accessibility and availability, attractive visuals, and engagement and motivation. E-booklets, as a digital medium, provide pregnant women with the flexibility to read and review the material at their own pace and according to their needs, even after the counseling session has ended, a limitation of verbal communication alone (Teweldemedhin et al., 2021). E-booklets combine text, images, and attractive illustrations, thereby helping to simplify the understanding of complex nutritional concepts and stimulate memory (French, 2013; Teweldemedhin et al., 2021). Pregnancy is a time when women are highly motivated to adopt healthy habits for their fetuses' sake (Olloqui-Mundet et al., 2024). E-booklets are a powerful tool for health workers to provide clear and structured nutritional guidance, which ultimately improves pregnant women's satisfaction with health services (Omer et al., 2020). This increase in knowledge is a fundamental step toward encouraging better dietary practices, thereby contributing to the prevention of nutritional problems such as Chronic Energy Deficiency and stunting (Yanti et al., 2022).

Improving nutritional knowledge among pregnant women can directly influence food consumption behavior, as knowledge is a significant factor shaping attitudes and choices of daily foods (Notoatmodjo, 2012). Good knowledge enables mothers to recognize the importance of nutrients such as energy, protein, iron, folic acid, and calcium according to their pregnancy needs (Ministry of Health Republic Indonesia, 2025). Understanding the functions of nutrients, such as the role of protein in tissue growth, iron in hemoglobin formation, and folic acid in fetal nervous system development, helps mothers recognize the risks of malnutrition during pregnancy (Allen, 2005). This increased understanding encourages pregnant women to choose healthier foods, increase dietary variety, and comply with recommendations for supplementation, such as iron and folic acid, as recommended in nutritional guidelines for pregnant women (Wolfe, 2015). This change in consumption behavior has been shown to improve the adequacy of daily macro- and micronutrient intake (Rosen & Slimings, 2016). Adequate nutritional intake will improve maternal nutritional status by providing sufficient energy and protein, which can prevent Chronic Energy Deficiency (CED).

In contrast, sufficient iron can prevent anemia, which is often experienced by pregnant women (Black et al., 2013). Good maternal nutritional status directly affects nutrient supply to the fetus via placental blood flow, thereby influencing fetal growth and the risk of low birth weight (Allen, 2005). Adequate energy and protein support fetal tissue development, while adequate micronutrients, such as iron and folic acid, are essential for cell formation, brain growth, and the prevention of fetal growth disorders (Ministry of Health Republic Indonesia, 2025). Thus, improving nutritional knowledge not only enhances cognitive understanding but also has a significant physiological impact on fetal growth and development through increased

maternal intake and nutritional status (Rosen & Slimings, 2016).

CONCLUSION

This study concludes that the e-booklet is effective in increasing pregnant women's knowledge of balanced nutrition. Based on the results, it is recommended that pregnant women store the e-booklet on their smartphones so they can easily access the balanced nutrition material wherever they are.

Recommendations for future researchers to conduct further research using a randomized controlled trial (RCT) design to test the effectiveness of e-booklets with a control group and a larger sample size, or to review their effectiveness in changing nutritional behavior/practices. Cadres are expected to adopt e-booklets as a medium for nutritional counseling for pregnant women, especially those with limited time or mobility.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

WW: Formulated the research problem, designed the research framework, collected data, processed the data, reviewed the results; **HW:** Formulated the research problem, designed the research framework, collected data and discussion; **LD, WK:** Reviewed the discussion and references; reviewed the results, discussion, and checked the grammar.

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Availability of data and materials

All data are available from the authors.

Competing interests

The authors declare no competing interests.

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