BKM Public Health & Community Medicine
Berita Kedokteran Masyarakat

Volume 41 **Number** 11, 2025, **Pages** e24855
DOI: 10.22146/bkm.v41i11.24855

Effectiveness of netboard-based learning management system (LMS) nutrition education on nutritional intake of pregnant women

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Submitted:
September 25th, 2025
Accepted:
November 5th, 2025
Published:
November 27th, 2025

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Abstract

Purpose: Analyzing the effect of nutrition education through a Netboard-based Learning Management System (LMS) on the nutritional intake of pregnant women in the working area of the Kota Tengah Community Health Center, Gorontalo Province. **Methods:** This study employed a quasi-experimental design with pre-test and post-test measures. This study was conducted with two groups: an experimental group that received nutrition education through a Netboard-based LMS, and a control group that received education through conventional methods. The sample consisted of 40 second-trimester pregnant women in the catchment area of the Kota Tengah Community Health Center, assigned to the experimental group (n=20) and the control group (n=20). Data were collected using a 3 × 24-hour food recall form that covered indicators of macronutrient and micronutrient intake, as well as dietary patterns. The data were analyzed using an Independent Samples t-test. **Results:** The results showed that Netboard-based LMS nutrition education had a significant effect on pregnant women's dietary intake. The analysis yielded a significance value of 0.000 (< 0.05), with the experimental group demonstrating higher mean scores than the control group. **Conclusion:** Netboard-based LMS nutrition education effectively enhances the nutritional intake of pregnant women. Notably, 95% of participants in the experimental group achieved a 'good' intake classification post-intervention, compared to only 5% in the control group. This suggests that the digital platform is a promising tool for nutrition education in maternal health settings.

Keywords: digital health education; Netboard LMS; nutritional intake; pregnant women; quasi-experimental study

INTRODUCTION

Adequate nutritional intake during pregnancy is a key factor for maternal health and optimal fetal development. Sufficient nutrient intake increases the likelihood of delivering a healthy baby with normal birth weight and optimal neurological development [1]. Indicators used to assess maternal nutritional status include weight gain appropriate to gestational age, Chronic Energy Deficiency (CED) measured by mid-upper arm circumference (MUAC) <23.5 cm, and hemoglobin (Hb) levels with anemia threshold <11 g/dL [2,3]. Nutrient deficiencies in pregnant women are associated with adverse maternal outcomes such as anemia, miscarriage, preterm delivery, and postpartum hemorrhage. For infants, consequences include low

birth weight, recurrent infections, and increased risk of chronic diseases later in life [4].

Globally, inadequate nutrient intake significantly contributes to maternal mortality in developing countries [5]. In Indonesia, maternal undernutrition remains a pressing issue, especially in rural and remote areas [6]. In Gorontalo Province, Riskesdas (2018) reported that 17.3% of pregnant women experienced CED and around 50% suffered from anemia [7]. Preliminary data from Kota Tengah Public Health Center in 2025 indicated similar concerns, with 7% of 209 pregnant women diagnosed with CED and 30% with anemia. These figures emphasize the urgency of implementing practical, accessible, and scalable nutrition interventions within primary healthcare settings.

Previous studies have confirmed the critical role of nutrition during pregnancy in improving maternal and infant health outcomes [1]. Observational evidence from Indonesia highlights high deficits of both macro- and micronutrients in pregnant women, particularly in eastern regions [3]. Studies on mineral and dietary intake further demonstrate considerable variation in maternal micronutrient adequacy, underscoring the need for strategic intervention [4]. Knowledge and dietary practices play pivotal roles: nutrition education by health professionals has been shown to significantly impact nutrition-specific knowledge and healthy eating behaviors during pregnancy [8]. Traditional one-way media delivery, such as printed materials, often fails to induce sustained behavioral change.

In contrast, exclusively digital interventions among pregnant women have demonstrated improvements in dietary intake and food choices [9] and have strengthened nutrition counseling services at the maternal health level [10]. Furthermore, risk-based modeling approaches highlight the predictive importance of iron intake and MUAC as critical variables for identifying anemia risk among pregnant women [11]. Collectively, these findings imply the need for interactive, traceable, and scalable nutrition education strategies that align with modern health communication paradigms.

Despite these insights, key research gaps remain. First, empirical evidence on the effectiveness of brief, interactive, and accessible digital nutrition media, particularly lightweight platforms like Netboard LMS, remains limited, especially in decentralized public health systems outside Java. Second, many existing studies emphasize changes in knowledge and attitudes without sufficiently linking them to objective nutritional indicators, such as trimester-based weight gain, MUAC, and Hb levels [6,8,11]. Third, although Gorontalo shows a high prevalence of CED and anemia, digital interventions for maternal nutrition education that are replicable across health centers have yet to be adequately documented. Accordingly, the development and evaluation of Netboard-based LMS interventions that emphasize user engagement, real-time feedback, and learning traceability represent a promising strategy to bridge methodological gaps and address pressing public health program needs [9,12].

In response to these challenges, the present study aims to evaluate the effectiveness of a nutrition education intervention using a Netboard-based LMS platform to improve maternal dietary intake in the service area of Kota Tengah Public Health Center. Netboard was selected for its multimedia flexibility, ease of content curation, and bi-directional interactivity, supported by previous findings showing that web-based applications can positively influence dietary behavior and gestational weight management among pregnant women [9,12]. The main hypothesis is that Netboard-based nutrition education can enhance dietary intake among pregnant women and reduce their risk of anemia and CED by improving knowledge and food choices [6,8,9,11,12].

METHODS

Study design

The research design used was a quasi-experimental design with two groups and a pretest-posttest approach. This study examined two variables: the independent variable, the nutrition education provided in two forms—a Netboard-based Learning Management System (LMS) for the experimental group and conventional face-to-face education using printed materials for the control group—and the dependent variable, the nutritional intake of pregnant women. To minimize bias, enumerators were trained and blinded to group assignments, and nutritional intake was measured using a standardized 3×24-hour food recall form.

Study setting and participants

The study was conducted from August 2 to September 13, 2025. Participant recruitment was carried out during the first week of August 2025. The nutrition education intervention was implemented over three consecutive weeks. Pretest data collection was conducted before the start of the intervention, and posttest data were collected in the fourth week after all educational sessions had been completed. The educational intervention lasted three weeks and consisted of three sessions held once a week via the Netboard platform. Each session included materials such as infographics, short videos, and quizzes.

Comment features and discussion forums were utilized to facilitate two-way interaction between participants and facilitators.

The study population comprised all pregnant women within the working area of the Kota Tengah Community Health Center, Gorontalo City, totaling 209 individuals as of May 19, 2025. Among them, 77 pregnant women were identified as having inadequate nutritional intake, and this group served as the study's focus population. The sample was determined using a purposive sampling technique, in which respondents were intentionally selected based on specific inclusion criteria relevant to the study objectives. A total of 40 participants were included: 20 in the control group and 20 in the experimental group. Pregnant women in their second trimester were selected because this stage represents a critical period characterized by increased energy and nutrient requirements due to physiological changes and fetal growth.

The inclusion criteria were willingness to participate, age between 19 and 40 years, inadequate nutritional intake, being in the second trimester of pregnancy, and ownership of a mobile phone with internet access. The exclusion criteria included absence during data collection, refusal to participate, or having a history of illness. The assessment method for nutritional intake was identical for both the experimental and control groups, using a standardized and validated 3×24-hour food recall form. The same trained enumerators conducted data collection to ensure methodological consistency and minimize potential measurement bias between groups.

Outcome and data collection

The primary outcome of the study was the classification of nutritional intake adequacy based on the percentage of the Recommended Dietary Allowance (RDA), categorized as very poor, poor, sufficient, or good. The exposure was defined as the type of education received (Netboard-based vs. conventional), and the predictors included participants' level of engagement in the educational activities. Potential confounders such as age, parity, education, and access to technology were controlled for through inclusion criteria, and participants' level of engagement was considered an effect modifier influencing intervention outcomes.

The collected data consisted of nutritional intake data for pregnant women. The technique for collecting nutritional intake data from pregnant women involved administering a pretest and a posttest. The pretest and posttest on nutritional intake for pregnant women were administered to both the experimental group and the control group. The instrument used to measure nutritional intake was a 3x24-hour food recall form. The 3x24-hour food recall form was developed based on indicators of nutritional intake for pregnant women, which included macronutrients, micronutrients, and eating patterns. Nutritional intake classifications were determined based on the percentage adequacy of nutrient intake compared to the Indonesian Recommended Dietary Allowance (RDA) for pregnant women. The thresholds were as follows: "Very Poor" (<70% of RDA); "Poor" (70–<85% of RDA); "Sufficient" (85–<100% of RDA); and "Good" (≥100% of RDA).

These classification criteria refer to the Regulation of the Indonesian Ministry of Health No. 28 of 2019 on Recommended Dietary Allowance. They are supported by previous literature that applied similar nutrient intake categorization based on diet quality index and nutritional adequacy standards [13–15].

Statistical analysis

The data analysis technique used in this study was parametric inferential statistics. Before hypothesis testing, prerequisite tests were conducted to assess the assumptions of normality and homogeneity. The Shapiro–Wilk test was used to examine the normality of the data distribution, while the Levene's test was employed to assess the homogeneity of variances between groups. Following confirmation of these assumptions, an independent-samples t-test in SPSS version 25 was conducted to determine whether there were significant differences between the experimental and control groups. The significance level was set at 0.05. This study has been registered and ethically approved by the Health Ethics Committee of Gorontalo State University, with approval number letter 136/UN47.B7/KE/2025.

RESULTS

Table 1 presents the characteristics of pregnant women in the experimental and control groups. Variables include age, education level, occupation, and parity. These baseline characteristics are essential to assess comparability between the groups before the intervention.

Based on Table 1, the age distribution of participants was balanced across groups, with 55% aged 19–29 years and 45% aged 30–49 years in both study arms. Educational levels were also nearly comparable, with most participants having completed secondary education—65% in the experimental group and 75% in the control group. The proportion of participants with higher education was likewise similar, at 25% in the experimental group and 20% in the control group. Most respondents were housewives, accounting for 90% in

the experimental group and 80% in the control group, while the remaining participants were employed outside the home, at 10% and 20%, respectively.

Parity also showed similarity: primigravida (first pregnancy) comprised 40% of the experimental group and 35% of the control group, whereas multigravida (two or more pregnancies) accounted for 60% and 65%, respectively (Table 1). Overall, these patterns indicate no fundamental imbalance that could influence the intervention's effect on dietary intake.

Table 1. Characteristics of respondents (n=40)

Characteristics	Experimental group (n=20)		Control group (n=20)	
	n	%	n	%
Age (years)				
19-29	11	55	11	55
30-49	9	45	9	45
Education level				
Junior high school	2	10	1	5
Senior high school	13	65	15	75
Higher education	5	25	4	20
Occupation				
Housewife	18	90	16	80
Employed	2	10	4	20
Parity				
Primigravida	8	40	7	35
Multigravida	12	60	13	65

Data on the pre-test results of nutritional intake among pregnant women in the experimental group are presented. Data were collected before pregnant women received nutritional education through a Netboard-based LMS. Pre-test data on nutritional intake among pregnant women in the experimental and control groups can be shown in Table 2.

Table 2. Frequency distribution of pre-test data on nutritional intake (n=40)

Classification	Group			
	Experimental (n=20)		Control (n=20)	
	n	%	n	%
Good	0	0	1	5
Sufficient	2	10	2	10
Poor	5	25	8	40
Very poor	13	65	9	45

Table 2 shows the pre-test results, indicating that, before the nutrition education intervention through the Netboar-based LMS, most pregnant women in both groups had low nutritional intake. In the experimental group, most were classified as very poor (65%), poor (25%), and sufficient (10%), and none were classified as good. In the control group, the pattern was similar: 45% were classified as very poor, 40% as poor, 10% as sufficient, and 5% as good. These findings confirm that the initial nutritional intake in both groups was low, with the experimental group showing lower intake levels. Posttest data on the nutritional intake of pregnant women in the experimental and control groups. Data were collected after pregnant women received nutritional education through a Netboard-based LMS. Posttest data on the nutritional intake of pregnant women in the experimental and control groups can be shown in Table 3.

Table 3. Frequency distribution of post-test data on nutritional intake (n=40)

Classification	Group			
	Experimental (n=20)		Control (n=20)	
	n	%	n	%
Good	19	95	1	5
Sufficient	1	5	1	5
Poor	0	0	7	35
Very poor	0	0	11	55

Table 3 shows the posttest results, indicating that after the intervention with nutrition education through the Netboar-based LMS in both groups, the experimental group showed an increase in nutritional intake, with 95% classified as good and 5% as sufficient, and none classified as poor or very poor. In contrast, the control group, which did not receive nutritional education intervention through the Netboar-based LMS, mainly remained at a low level of nutritional intake.

The classification of very poor was 55% and the classification of poor was 35%, while the classifications of Sufficient and good were only 5% each. Overall, these findings confirm that a nutritional education intervention through a Netboar-based LMS increased nutritional intake in the experimental group. In contrast, the control group did not show a significant increase and tended to remain low.

Table 4. Results of the independent sample t-test

Variables	Mean	Std. Deviation	Min	Max	p-value
Pre-test					
Experiment	50	12	33	78	0.290
Control	52	16	25	101	
Post-test					
Experiment	102	11	83	125	0.009
Control	60	12	36	86	

The analysis of nutritional intake differences between groups was conducted using an independent sample t-test. The experimental group received nutritional education intervention through Netboard-based LMS, while the control group used conventional learning methods. The significance level was set at $\alpha = 0.05$, with decision criteria: if the Sig. (2-tailed) value ≤ 0.05, then there was a significant difference between

the two groups, whereas if the Sig. (2-tailed) value > 0.05 indicates no significant difference. Table 4 shows that there was no statistically significant difference in nutritional intake between the experimental and control groups before the intervention (p = 0.290). This indicates that both groups were comparable at baseline, allowing for a fair assessment of the intervention's effect. The p-value of 0.000 indicates a significant difference, suggesting that nutrition education via the Netboard LMS is more effective than conventional methods in improving pregnant women's nutritional intake.

DISCUSSION

This study demonstrates that nutrition education delivered through the Netboard-based Learning Management System (LMS) is an effective and practical approach to improving dietary behavior among pregnant women in primary care settings. Its interactive design facilitates adaptive self-learning and enhances access to nutrition information, particularly for populations with limited literacy or digital infrastructure. Netboard offers several advantages: it requires no installation, supports real-time content updates, and includes feedback mechanisms that promote user engagement. These features make it highly applicable in community health centers, especially those in resource-limited settings.

The Netboard-based LMS used in this study featured a range of curated nutrition education materials designed to facilitate interactive learning. The platform included modular infographics summarizing key nutritional messages, short instructional videos explaining specific dietary practices, and interactive quizzes that reinforced understanding. Additionally, a comment section allowed participants to ask questions or provide feedback, enabling two-way communication between learners and facilitators. This combination of visual content, interactivity, and communication tools provided a dynamic learning experience, offering significant advantages over traditional one-way media such as printed leaflets or posters.

Based on these findings, health programs can consider integrating Netboard-based modules to complement or replace traditional printed materials and face-to-face counseling. Implementing this approach requires minimal technological infrastructure, short training sessions for health personnel, and basic monitoring tools to track participant engagement. Digital kiosks or tablets can serve as access points in health facilities to support program scalability.

From a public health perspective, the Netboard platform presents a strategic opportunity to expand the reach of nutrition education while addressing inequities in health communication. It can be adapted for various topics such as stunting prevention, anemia reduction, or household nutrition. Policymakers at the local and national levels can support adoption by ensuring infrastructure readiness and fostering intersectoral collaboration, aligning with national digital health transformation agendas.

The effectiveness of this digital intervention aligns with a growing body of literature supporting technology-based maternal health education. Prior studies have shown that e-learning improves nutritional knowledge, dietary behavior, and adherence to anemia prevention guidelines among pregnant women [8,16,17]. Research across Southeast Asia also highlights that challenges such as limited internet access, unequal digital literacy, and socioeconomic disparities can constrain the effectiveness of conventional interventions. Therefore, when digital education is supported by mentoring and localized implementation strategies, it can effectively close these gaps [18–20].

This study also identifies areas for future research. Broader evaluations with larger, more diverse populations and more extended follow-up periods are needed to assess sustained impacts on anemia status, fetal growth, and postpartum dietary practices. Future studies should explore factors that influence engagement, such as participant parity, household workload, and prior technology use, and test strategies to enhance adherence, such as personalized reminders, incentives, or group-based mentoring. Additionally, integrating behavior change theories and community-based learning models into LMS design could further improve its contextual relevance and long-term effectiveness [9,17,20].

Despite its strengths, this study has several limitations. The focus on second-trimester pregnant women restricts the generalizability of findings across all stages of pregnancy, where nutritional needs and behaviors may vary [6]. The intervention lasted only one month, which may reflect only short-term improvements. Participant engagement also emerged as a critical factor, influenced by digital access, literacy, and competing domestic responsibilities. Lastly, although the 24-hour food recall method is validated, it is subject to recall bias. Future studies should consider longer interventions, stratified participant groups, and alternative intake assessment tools to enhance robustness and external validity [9,21].

CONCLUSION

This study demonstrates that Netboard-based LMS is an effective digital tool for delivering nutrition education to pregnant women in community healthcare settings. The intervention significantly improved nutritional intake, as reflected in the shift from low to adequate intake categories among participants in the experimental group.

These findings highlight the potential of interactive and accessible e-learning platforms to enhance dietary behaviors and support maternal health, especially in regions with limited access to conventional counseling. Integrating such digital approaches into primary healthcare programs could strengthen the impact of nutrition interventions, improve service outreach, and contribute to national efforts to reduce maternal undernutrition. Further research is needed to evaluate long-term outcomes and optimize implementation strategies for broader populations.

Funding

This research was funded by the Directorate of Research and Community Service (DPPM) of the Ministry of Higher Education, Science, and Technology, Postgraduate Research Scheme-Master's Thesis Research (PPS-PTM) 2025.

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