

Original Research Paper

## Effectiveness of the CAMPE module for preeclampsia prevention among high-risk pregnant women

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### Abstract

Preeclampsia remains one of the leading causes of maternal mortality in Indonesia. Prevention efforts through nutrition education based on local foods are considered effective in reducing the risk. This study aimed to develop, assess the feasibility of the module through expert validation and evaluate the effectiveness of the CAMPE (Cara Mencegah Preeklamsia-Prevent Preeclampsia through Nutritional Management) Module for high-risk pregnant women in Takalar Regency, South Sulawesi. This study employed a Research and Development (R&D) approach with a quasi-experimental effectiveness test using a pretest–posttest control group design, involving 140 pregnant women (70 in the intervention group and 70 in the control group). Data were analyzed using paired t-tests to assess within-group pretest–posttest differences and independent t-tests to compare outcomes between the intervention and control groups. Validation results indicated that the module was highly feasible (mean score: 4.64). After the intervention, knowledge increased from 60.75 to 85.60 and attitudes from 70.25 to 91.40 in the intervention group. Statistical tests showed a significant difference ( $p<0.000$ ) compared to the control group. In conclusion, the CAMPE Module proved to be effective and significantly improved the knowledge and attitudes of high-risk pregnant women regarding preeclampsia prevention. This module is appropriate for use as a local food-based nutrition education tool in primary healthcare services. Future multicenter randomized studies with longer follow-up periods are needed to evaluate long-term effectiveness and clinical outcomes.

**Keywords:** CAMPE Module; high-risk pregnancy; local food-based intervention; nutrition education; preeclampsia prevention

### 1. Introduction

High-risk pregnancies have adverse effects on delivery outcomes, with major implications including increased morbidity and mortality among mothers both before and after childbirth. Based on the national statistical data from the Long Form Population Census 2020, Indonesia's Maternal Mortality Ratio (MMR) has decreased to 189 deaths per 100,000 live births (Kementerian PPN/Bappenas, 2023). However, this achievement remains far from the 2030 Sustainable Development Goals (SDGs) target. Preeclampsia (PE) is responsible for 24% of maternal deaths in Indonesia (Kementerian Kesehatan RI, 2022), posing significant risks to maternal health but may also cause serious complications for the fetus, such as preterm birth and growth restriction. Factors including maternal age, parity, obesity, and a history of hypertension play important roles in the occurrence of PE (Lokeswara et al., 2021).

Management and quality of care for PE in Indonesia remain inconsistent across practitioners and facilities, partly due to the absence of a comprehensive pathophysiological framework and limited



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infrastructure in several regions. PE management follows three levels of prevention: primary prevention through early screening and risk-factor control; secondary prevention for high-risk women using low-dose aspirin (75 mg/day) and calcium supplementation (1 g/day); and tertiary prevention focused on managing PE-related complications (Kementerian Kesehatan RI, 2017).

Nutritional regulation during pregnancy plays an essential role in preventing PE complications by supporting placental function, blood pressure, and overall maternal and fetal health. Deficiencies in certain micronutrients such as calcium, magnesium, and vitamin D can increase PE risk (Esquivel, 2023; Kinshella et al., 2022; Perry et al., 2022). Nutritional intervention models designed for PE prevention include not only supplementation but also nutrition education, dietary management, and counseling for pregnant women. Effective nutritional models also account for cultural context, dietary habits, and local food availability. Evidence suggests that nutrition interventions that consider social, economic, cultural contexts and local food resources have a greater likelihood of being accepted by communities (Garcia-Larsen et al., 2018; Inna Noor Inayati & Anita Lontaan, 2025).

Despite national guidelines for preeclampsia prevention exist, their implementation at the primary healthcare level remains limited due to the lack of contextualized and user-friendly educational media. The general nature of these guidelines fails to accommodate sociocultural diversity and local food availability, reducing their practical relevance for high-risk pregnant women. Moreover, evidence on structured local food-based educational modules for preeclampsia prevention is scarce, particularly in South Sulawesi. Takalar Regency in South Sulawesi presents unique geographical, social, and economic characteristics that pose challenges to PE prevention efforts. In Takalar Regency, PE prevalence increased from 50 cases (2022) to 54 (2023), and 67 (2024), with hypertensive disorders in pregnancy and PE causing 60% of maternal deaths (Dinas Kesehatan Kabupaten Takalar, 2024). This highlights that PE remains a serious health challenge for pregnant women in this area.

Preeclampsia manifest as new-onset hypertension after 20 weeks of gestation accompanied by maternal organ dysfunction, as hypertension alone is insufficient for diagnosis. Most cases are identified through proteinuria and other organ-related complications (Ananth et al., 2021). Its multifactorial pathophysiology involves genetic, environmental factors, oxidative stress in placental, endothelial dysfunction (Li et al., 2021; Man et al., 2023; Poon et al., 2023; Vornic et al., 2024). Nutritional deficiencies may further alter placental membrane lipid composition, affecting transcellular transport and membrane-bound enzyme function, thereby influencing angiogenesis and vasculogenesis (Man et al., 2023; Dávila Ruiz et al., 2024; Zhang et al., 2022).

Optimizing maternal healthcare, including early detection and appropriate management of preeclampsia, is critical for improving maternal and neonatal outcomes. Early detection and timely intervention can prevent or reduce severe PE-related complications. Pregnant women play an important role through self-care practices supported by proper counseling, with evidence showing that improved self-care knowledge enhances disease control (Ranjbar et al., 2024). Continuity of care is also essential to monitor disease progression and ensure prompt intervention. This model has been shown to improve self-care practices and quality of life among women with PE (Desoky et al., 2023).

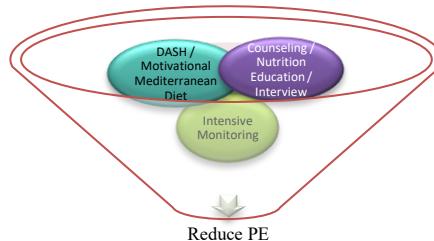
Medical-based strategies alone are often insufficient without structured non-medical interventions, particularly nutrition management and targeted health education. Adequate maternal nutrition is essential for blood pressure regulation, endothelial function, and placental development, all of which are closely associated with the pathophysiology of preeclampsia (Man et al., 2023). Therefore, integrating nutritional education into preventive care is critical to enhance maternal self-care capacity. A holistic strategy for early detection and management of PE requires not only medical interventions but also comprehensive individual care. Partner and family involvement, counseling for emotional and mental needs, and attention to the psychological impact of the disease are crucial for

the well-being of pregnant women (Asmanidar & Emilda, 2024). Effective PE management also relies on coordinated monitoring of maternal–fetal conditions, strict blood pressure control, and evaluation of organ function. Variations in holistic strategies among studies highlight the need for more comprehensive research to identify the most appropriate prevention model at both primary and secondary levels.

Several studies highlight the roles of calcium, vitamin D, saturated fats, and dietary fiber in the development or prevention of PE. Meanwhile, research focusing on other nutrients associated with PE risk suggests limited effects of vitamin C, vitamin E, omega-3 fatty acids, magnesium, salt, and zinc consumption (Xiaomang & Yanling, 2021). Calcium plays an important role in regulating blood pressure by increasing intracellular calcium concentrations. Inadequate calcium intake may stimulate renin and thyroid hormone production, thereby elevating blood pressure (Xiaomang & Yanling, 2021). Evidence supports high-dose calcium supplementation ( $>1000$  mg/day) as an effective method to reduce the risk of PE. However, the effectiveness of lower doses (500 mg/day) varies across studies, particularly regarding duration and timing of supplementation. Vitamin D is essential in modulating inflammatory processes, contributing to reduced PE risk. Vitamin D deficiency has been associated with endothelial dysfunction, which can worsen PE (Aguilar-Cordero et al., 2020). Evidence from previous study shown that vitamin D supplementation may help lower the risk of PE (Alamolhoda et al., 2020). Therefore, vitamin D status in pregnant women should be routinely monitored, and deficiencies should be corrected through supplementation of 400–1000 IU per day (Curtis et al., 2018).

Pregnant women with PE risk require comprehensive nutritional assessment, including anthropometric measurements (height, weight, weight gain), biochemical data (LDL-c, TAG), medical history (previous PE, medical conditions), and dietary history (food and supplement intake before and during pregnancy). Key signs and symptoms that should be monitored include early weight gain, diet adherence, intake of fruits, vegetables, dietary fiber, calcium, and vitamin D status. Interventions should include referral to a nutritionist when needed and efforts to increase healthy food intake while reducing processed food consumption (Aguilar-Cordero et al., 2020).

Based on the above evidence, three nutritional intervention strategies have been identified to reduce PE incidence: 1). Dietary Approaches to Stop Hypertension (DASH) and the Mediterranean Diet (MedDiet); 2). Counseling, nutrition education, and motivational support; and 3). Intensive nutrition monitoring supported by technology (see Figure 1).



**Figure 1.** Nutritional interventions framework to reduce preeclampsia incidence.

This study aimed to: 1) develop the CAMPE Module as a nutrition regulation– and local food–based educational medium for preeclampsia prevention; 2) assess the feasibility of the module through expert validation; and 3) evaluate the effectiveness of the CAMPE Module in improving the knowledge and attitudes of high-risk pregnant women toward PE prevention.

## 2. Research Methods

This study employed a Research and Development (R&D) approach aimed at developing an evidence-based nutrition regulation model for the prevention of preeclampsia that is appropriate to the local context. The study was conducted after completion of the qualitative exploratory phase, from April to September 2025 in Takalar Regency, South Sulawesi. It involved community health cadres and primary healthcare providers at the Puskesmas level to deliver education and monitoring based on the CAMPE module guidelines. The R&D process consisted of the following stages: (1) problem identification and exploration of local needs through in-depth interviews, surveys, and focus group discussions; (2) product development, in the form of a nutrition education module for pregnant women and healthcare providers; (3) model validation and revision through expert panel discussions involving academics and healthcare practitioners; and (4) limited field testing, involving 30 midwives and 30 pregnant women, to assess the feasibility and preliminary effectiveness of the module, followed by evaluation and refinement of the model.

The effectiveness of the model was evaluated using a quasi-experimental pretest–posttest control group design, involving 140 high-risk pregnant women, comprising 70 participants in the intervention group and 70 participants in the control group. Purposive sampling technique was used to select the participants.

The inclusion criteria were high-risk pregnant women for preeclampsia, including those aged  $<20$  years or  $>35$  years, with obesity ( $\text{BMI} \geq 30 \text{ kg/m}^2$ ), a history of chronic hypertension, a previous history of preeclampsia, or first-time pregnancy (nulliparous), who were able to read and write and willing to participate in the study. The exclusion criteria included pregnant women diagnosed with obstetric complications. The research instruments consisted of the CAMPE Module as well as knowledge and attitude questionnaires related to preeclampsia prevention through nutritional regulation, all of which had undergone validity and reliability testing prior to use. At baseline, participants in the intervention and control groups completed identical assessments. The intervention group received standard antenatal care, pregnancy classes, and the CAMPE Module, whereas the control group received standard antenatal care and pregnancy classes only. Post-intervention assessments were conducted using the same instruments. Within-group changes were analyzed using paired t-tests, and between-group differences were examined using independent t-tests. The research workflow is illustrated in **Figure 2**.

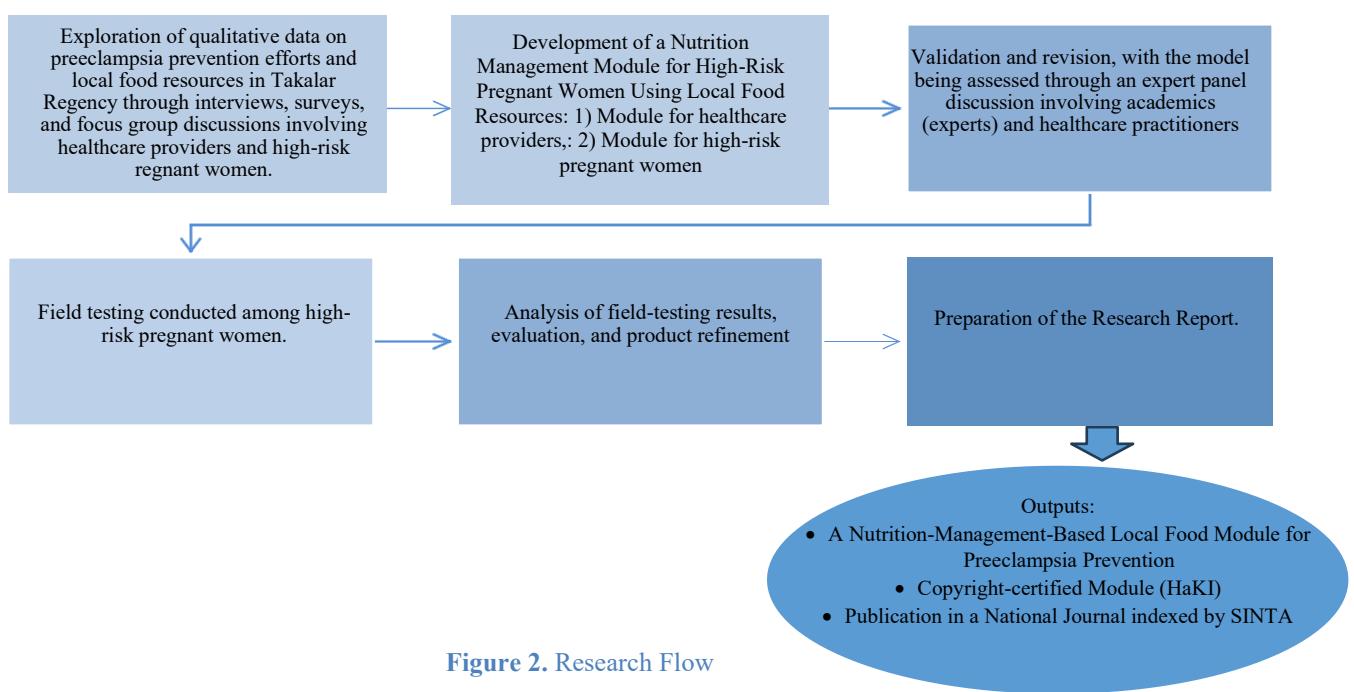


Figure 2. Research Flow

Ethical approval was obtained from the Health Research Ethics Committee (Approval No. 728/UN4.14.1/TP.01.02/2025, April 30, 2025), and all participants provided written informed consent.

### 3. Results and Discussion

#### 3.1. Result

In this study, the development focused on addressing the low knowledge and attitudes of high-risk pregnant women regarding preeclampsia prevention through the creation of a practical and contextually relevant nutrition education module based on local foods. The characteristics of R&D research are closely related to actual health problems or potentials that require innovative learning solutions. Any educational model, media, approach, or method developed must be effective and undergo several stages of testing and expert validation to ensure its scientific accountability.

##### 1) Research and Data Collection

A literature review on preeclampsia prevention, maternal nutrition, and health education media guided the scope and approach of the prevention model. Field studies, including focus group discussions with healthcare providers, relevant institutions, and high-risk pregnant women in Takalar District, revealed limited knowledge on balanced nutrition, local food utilization, and early detection of preeclampsia, informing model development.

##### 2) Planning

Based on preliminary findings, the planning phase defined the product's objectives, target users, components, and usage guidelines.

##### 3) Initial Product Development

The CAMPE Module draft was developed with input from experts in midwifery, nutrition, and instructional media. Expert validation scored 91.4 ("very good") for accuracy, clarity, layout, and usability. Revisions enhanced contextualization and readability.

##### 4) Initial Field Testing

A trial with 70 high-risk pregnant women at three primary healthcare centers assessed content clarity, appeal, and language comprehension. Participants showed strong interest, particularly in local food-based menus and clear visuals. Revisions added daily local menus and simplified language.

##### 5) Initial Product Revision

Qualitative refinement focused on readability, relevance, and practical usability, incorporating simplified text, infographics, and a reorganized daily menu section, resulting in a concise, engaging, and user-friendly module.

##### 6) Large-Scale Field Testing

The second trial involved 140 high-risk pregnant women (70 intervention, 70 control), all continuing routine ANC services. Effectiveness was evaluated by measuring pre- and post-intervention changes in knowledge and attitudes using validated questionnaires. Data were analyzed using paired t-tests to assess within-group pretest–posttest differences and independent t-tests to compare outcomes between the intervention and control groups.

The study consisted of three stages: module development, implementation, and evaluation. Before the trial, the module underwent expert validation for content validity, practicality, effectiveness, and overall quality.

###### 1) Expert Validation

The results of the assessment by two experts, indicating that the quality and feasibility of the material and the type of media to be developed fall into the "very good" category. This is

reflected in the average score of the seven module components, which is 4.64. The expert validation results are as summarized in **Table 1**.

**Table 1. Expert Validation Results**

NO	Aspects Being Assessed	Component	I	II	Average
1	Material Relevance	Is the content in the module relevant to preeclampsia prevention?	4	5	4.5
2	Clarity of Information	Is the information clearly presented and easy to understand?	5	5	5.0
3	Compliance with Nutrition Guidelines	Is the module aligned with current nutrition guidelines?	4	4	4.0
4	Practical Applicability	Does the module include practical steps that can be applied by pregnant women?	5	5	5.0
5	Visual Attractiveness	Is the module design appealing and easy to read?	5	4	4.5
6	Availability of Resources	Does the module include the necessary resources for implementation?	4	5	4.5
7	Potential Impact	Does the module have the potential to contribute positively to preeclampsia prevention?	5	5	5.0
<b>Average</b>					<b>4.64</b>

## 2) Implementation

The research activities were carried out in Takalar District from April to September 2025. The study subjects consisted of an intervention group (standard ANC, pregnancy class, and use of the CAMPE Module) comprising 70 high-risk pregnant women, and a control group (standard ANC and pregnancy class) comprising 70 high-risk pregnant women. Respondent characteristics are presented in **Table 2**.

**Table 2. Distribution of Respondents by Age and Educational Level**

No	Variable	Intervention Group		Control Group	
		n	%	n	%
1	<b>Age</b>				
	< 20 Years	22	31.4	20	28.6
	20-35 Years	26	37.2	30	42.8
	>35 Years	22	31.4	20	28.6
	<b>Total</b>	<b>70</b>	<b>100</b>	<b>70</b>	<b>100</b>
2	Educational Level				
	Elementary School	10	14.3	8	11.4
	Junior High School	16	22.9	14	20.0
	Senior High School	28	40.0	30	42.9
	Higher Education	16	22.8	18	25.7
	<b>Total</b>	<b>70</b>	<b>100</b>	<b>70</b>	<b>100</b>

The majority of respondents were in the 20–35 years age group, accounting for 37.2% in the intervention group and 42.8% in the control group. However, the proportion of pregnant women in the <20 years and >35 years age groups was also relatively high (approximately 30% each), indicating that most respondents belonged to the high-risk category for preeclampsia. This situation makes the implementation of education using the CAMPE Module both relevant and strategic for improving pregnant women's knowledge and attitudes toward the prevention of pregnancy complications. Most of the respondents had a high school education, accounting for 40.0% in the intervention group and 42.9% in the control group. Upper secondary and higher education levels are considered sufficient to receive and understand health information. Meanwhile, women with primary education (elementary

and junior high school) still require special visual education approaches and simplified language so that the messages in the CAMPE Module can be more easily understood and applied in daily life.

**Table 3.** Pregnant Women's Knowledge and Attitude Before and After the Intervention

Group	n	Rata-rata Pretest ± SD	Rata-rata Posttest ± SD	Δ (Selisih)	p-value Within Group	p-value Between Group
<b>Pregnant Women's Knowledge</b>						
Intervensi	70	60.75 ± 8.12	85.60 ± 6.90	+24.85	0.000	0.000
Kontrol	70	61.30 ± 7.95	69.80 ± 7.50	+8.50	0.041	
<b>Pregnant Women's Attitude</b>						
Intervensi	70	70.25 ± 9.10	91.40 ± 6.75	+21.15	0.000	0.000
Kontrol	70	71.00 ± 8.85	78.20 ± 7.80	+7.20	0.038	

Based on **Table 3**, intervention group of pregnant women had significantly increased knowledge scores with a mean of 60.75 at pretest and 85.60 at posttest, the change in the score was +24.85 points. On the other hand, the control group gained +8.50 points to obtain 69.80 at posttest. Both groups increased significantly ( $p < 0.05$ ) with those in the intervention group showing significantly better improvement between the tests ( $p = 0.000$ ). Similar trends were observed in the scores for attitude, in which the intervention group increased from 70.25 to 91.40 (+21.15 points) and the control group gained +7.20 (from 71.00 to 78.20). These improvements were also statistically significant ( $p < 0.05$ ), which signifies that the CAMPE Module was effective in improving the knowledge and attitude of preeclampsia prevention among pregnant women at high risk.

### 3.2. Discussion

The study findings demonstrate that the CAMPE Module effectively improved the knowledge and attitudes of high-risk pregnant women regarding preeclampsia prevention. The module was systematically developed based on preliminary study results and actual needs identified in the field, integrating essential content on balanced nutrition, early detection of pregnancy danger signs, and the utilization of locally available nutrient-rich foods such as moringa leaves, seafood, and legumes. These results highlight that a local food-based educational approach is not only culturally and socially appropriate but also enhances pregnant women's understanding and preventive behaviors toward reducing the risk of preeclampsia.

The intervention group's substantial knowledge gain (mean increase of 24.85 points) demonstrates the CAMPE Module's effectiveness in improving pregnant women's understanding of the links between dietary patterns, blood pressure, and preeclampsia risk. This finding is consistent with [Inna Noor Inayati & Anita Lontaan, \(2025\)](#) who showed that visually engaging and participatory educational media enhance pregnant women's knowledge of reproductive health and nutrition. The module's simple language, clear illustrations, and local food-based menus further supported comprehension and practical application. Similarly, [Kinshella et al. \(2022\)](#) reported that adequate intake of micronutrients such as calcium and vitamin D can reduce the risk of gestational hypertension and preeclampsia by up to 50%. [Li et al. \(2021\)](#) also emphasized the role of micronutrient- and antioxidant-rich diets in improving endothelial function and maternal circulation.

Theoretically, the increase in knowledge and behavioral change observed in this study can be interpreted through the Health Belief Model (HBM), which posits that knowledge shapes risk perception and motivates preventive actions. Greater understanding of preeclampsia risks and nutritional importance increases the likelihood that pregnant women will adopt healthy behaviors. Thus, the CAMPE Module functions not only as an informational tool but also as a catalyst for cognitive awareness and sustained internal motivation. In addition to knowledge improvement, the

study also demonstrated significant positive attitude changes in the intervention group, with an average increase of 21.15 points compared to only 7.20 points in the control group. Statistical analysis showed a p-value < 0.05, indicating that the CAMPE Module intervention had a significant effect on enhancing the attitudes of high-risk pregnant women toward preeclampsia prevention. This supports [Natoatmodjo, \(2020\)](#) assertion that effective knowledge improvement is typically followed by positive changes in attitude and health-related behavior. Through participatory educational processes such as discussions, question-and-answer sessions, and simulation of local food-based menu planning, pregnant women became actively engaged, understood the benefits of lifestyle changes, and were motivated to implement healthy behaviors.

These findings align with [Desoky et al. \(2023\)](#) who demonstrated that educational interventions grounded in the continuous care model enhance motivation and compliance in preeclampsia prevention. [Inna Noor Inayati & Anita Lontaan, \(2025\)](#) similarly noted that nutrition education incorporating social and emotional elements strengthens affective responses and fosters positive health behaviors. Accordingly, the CAMPE Module serves not only as an instructional resource but also as an empowerment strategy that enables pregnant women to make informed decisions for their own and their fetus's health.

The implementation of the module is consistent with national policy priorities, as outlined by [Kementerian PPN/Bappenas \(2023\)](#), which emphasize balanced nutrition education, the utilization of local food sources, and the strengthening of maternal class programs to reduce preeclampsia and other obstetric complications. The local food-based approach integrated into the CAMPE Module also aligns with principles of sustainability and community nutrition resilience. [Perry et al. \(2022\)](#) further note that the use of locally available foods enhances adherence to nutritional recommendations, reinforces household food security, and fosters healthier dietary practices within communities.

The involvement of multidisciplinary health care providers, including midwives, nutritionists, and community health volunteers, in implementing the module highlights the importance of collaborative practice in sustaining maternal education. This approach aligns with the Continuity of Care framework, which emphasizes integrated and coordinated midwifery services to improve maternal and neonatal outcomes. Thus, the CAMPE Module serves not only as an educational resource but also as a collaborative learning model that strengthens providers' capacity to deliver effective, culturally contextualized, and sustainable health education.

Despite its positive findings, this study has several limitations. The single-district setting with specific socio-cultural and dietary characteristics may limit generalizability. The quasi-experimental design also poses a risk of selection bias due to non-random group assignment. Additionally, the evaluation focused on short-term outcomes, assessing knowledge and attitudes without long-term follow-up to determine sustained behavioral changes or clinical outcomes such as preeclampsia incidence. Future research should adopt multicenter and randomized designs and incorporate longer follow-up periods to assess long-term effectiveness and health outcomes.

#### 4. Conclusion

In accordance with the study objectives, this research successfully developed the CAMPE Module as a nutrition regulation- and local food-based educational medium for preeclampsia prevention among high-risk pregnant women. The feasibility assessment through expert validation demonstrated that the module achieved a very high level of acceptability in terms of content accuracy, clarity of information, consistency with nutritional guidelines, practical applicability, and quality of media presentation, confirming its suitability for implementation in primary healthcare settings. Furthermore, the effectiveness evaluation revealed that the CAMPE Module significantly improved the knowledge and attitudes of high-risk pregnant women toward preeclampsia prevention compared to the control group. These findings indicate that the CAMPE Module is an effective educational

intervention and supports the use of a local food-based nutritional approach as a feasible strategy for preeclampsia prevention. This study was limited by its single-district setting, risk of selection bias due to non-random group assignment and short-term outcome assessment, highlighting the need for future multicenter randomized studies with longer follow-up to evaluate long-term effectiveness and clinical outcomes.

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