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Health Belief Model of Pregnant Women in Samarinda's Free Nutritious Meal Program: The Role of Predisposing, Reinforcing, and Enabling Factors in Self-Efficacy

Tri Sunarsih[1*], Rosdiana Rosdiana[2], Nendhi Wahyunia Utami[1], Endah Puji Astuti[1], Elvika Fit Ari Shanti[1]
[1]Universitas Jenderal Achmad Yani, Yogyakarta, Indonesia
[2]Universitas Widya Gama Mahakam, Samarinda, Indonesia

***Corresponding Author:** E-mail: are_she79@yahoo.com

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ABSTRACT

Introduction: Stunting remains a national health priority in Indonesia due to its long-term impact on human capital. One flagship government intervention under the National Strategy for Stunting Reduction 2018–2024 is the provision of free nutritious meals for pregnant women to improve maternal nutritional status and prevent stunting. However, adherence to this program varies widely, and previous studies have rarely examined psychosocial determinants based on behavioural health theories.

Objective: This study aimed to analyse factors within the Health Belief Model (HBM), including perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, alongside predisposing, reinforcing, and enabling factors that influence the self-efficacy of pregnant women participating in the free nutritious meal program in Samarinda City.

Methods: A quantitative cross-sectional design was applied to 203 pregnant women enrolled in the free nutritious meal program between March and August 2024. Participants were selected purposively to ensure representation of diverse educational backgrounds, parity, and gestational ages according to predefined inclusion criteria. Data were collected using a structured questionnaire based on HBM dimensions, perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, that had been validated and tested for reliability. Partial Least Squares–Structural Equation Modeling (PLS-SEM) was employed due to its suitability for analyzing complex latent constructs and small-to-moderate sample sizes, enabling simultaneous estimation of measurement and structural models.

Results: Predisposing factors showed a strong effect on the HBM construct ($\beta = 0.556$). Reinforcing factors exerted a greater influence on self-efficacy ($\beta = 0.228$) compared with enabling factors ($\beta = 0.142$). The HBM construct itself contributed positively to the enhancement of self-efficacy ($\beta = 0.244$). The model demonstrated an SRMR of 0.074 (< 0.08), indicating acceptable model fit.

Conclusion: Predisposing factors (knowledge, attitudes, and motivation) form the foundation of maternal health perceptions, while social support (reinforcing factors) plays a more dominant role than enabling factors in improving pregnant women's self-efficacy. This first comprehensive application of the HBM to a free nutritious meal program in Samarinda provides new empirical evidence to guide the design of theory-based maternal nutrition interventions and supports Indonesia's national stunting reduction efforts. Theoretically, the findings extend the HBM by demonstrating how contextual predisposing and reinforcing factors interact to strengthen self-efficacy within community-based nutrition programs. Practically, policymakers should integrate behavioral counseling and family involvement components into the free meal program to enhance motivation and sustained adherence among pregnant women. Future research should use longitudinal designs to assess long-term program effects and explore contextual factors influencing self-efficacy.

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INTRODUCTION

In Indonesia, stunting remains one of the most pressing public health problems due to its long-term consequences for human resource quality. The 2018 Basic Health Research (Riskesdas) report recorded a national stunting prevalence of 30.8%, while the 2024 national target of 14%, set under the National Strategy for Stunting Reduction 2018–2024, has yet to be achieved (1). Stunting is a predictor of poor human resource quality that subsequently undermines national development potential and delays the realization of the Generasi Emas (Golden Generation) 2045. If left unaddressed, stunting is estimated to cost the Indonesian economy up to IDR 300 trillion annually (1,2).

One of the key determinants of stunting is inadequate nutrient intake during pregnancy. Chronic energy deficiency (CED) among pregnant women remains high in Indonesia, with 17.3% of pregnant women experiencing CED and 48.9% suffering from anemia in 2018 (3,4). Unmanaged CED increases the risk of low birth weight (LBW), prematurity, neonatal mortality, miscarriage, intrapartum asphyxia, congenital anomalies, and contributes to 20% of children being stunted in the first two years of life (5–11). Supplementary feeding for pregnant women with CED has been shown to increase mid-upper arm circumference and maternal weight (12,13). One of the government's flagship strategies to optimize maternal nutrient intake is the provision of free nutritious meals for pregnant women under local and national programs (14,15).

Recent international evidence reinforces the importance of maternal nutrition interventions and behavior change education during pregnancy. A cluster randomized controlled trial in Ethiopia demonstrated that nutrition education integrating the Health Belief Model (HBM) and Theory of Planned Behavior significantly improved dietary diversity among pregnant women (16)(17–19). Similarly, a semi-experimental study among Afghan immigrant women in Iran revealed that nutrition education based on the HBM increased intake of key nutrients such as iron, calcium, and vitamins (9). Moreover, studies in Korea and China reported that higher maternal diet quality, assessed using validated dietary indices, was strongly associated with reduced risks of small-for-gestational-age infants and improved fetal growth outcomes (20,21). These findings suggest that maternal nutrition behavior is shaped not only by resource availability but also by psychosocial factors such as beliefs, motivations, and self-efficacy. Thus, behavioral models like the HBM provide a useful theoretical lens for understanding and improving adherence to nutrition interventions during pregnancy.

The free nutritious meal program has been implemented in several regions to improve maternal and fetal nutritional status. However, its success depends largely on the active participation of pregnant women, and low participation and adherence remain challenges. As the capital of East Kalimantan Province, Samarinda faces difficulties in reducing stunting rates, especially among pregnant women with limited access to nutritious food. According to the 2023 East Kalimantan Health Office report, stunting prevalence in the area remains above the national target, indicating the need for evidence-based interventions to enhance the effectiveness of the free nutritious meal program for pregnant women (22). Recent national studies have highlighted that pregnant women's nutritional behaviors remain a critical gap in stunting prevention (23) and that empowerment-based interventions show promise (24). These findings underscore the importance of examining behavioural determinants (e.g., perceptions, beliefs, motivation) beyond structural barriers to improve program effectiveness.

Pregnant women's adherence to such programs is influenced not only by structural factors such as facility availability but also by psychosocial and individual perceptions. The Health Belief Model (HBM) is a widely used health behaviour theory that explains how individual beliefs influence decisions to adopt healthy behaviours. The model encompasses perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. In the context of maternal nutrition, the HBM posits that women's perceptions of risk (susceptibility and severity) and perceived benefits of healthy eating, weighed against barriers such as food access and taste preference, shape their motivation and self-efficacy to adhere to dietary recommendations. Despite its extensive use in other health contexts, previous studies in Indonesia have rarely examined psychosocial factors within the HBM framework in the context of free nutritious meal programs, leaving a critical knowledge gap in understanding maternal adherence.

The novelty of this study lies in its theoretical integration of the Health Belief Model with predisposing, reinforcing, and enabling constructs to predict maternal self-efficacy in a nutrition-program context, rather than merely focusing on geographic location. This conceptual innovation contributes to extending the explanatory capacity

of the HBM in community-based maternal nutrition programmes and provides an evidence-based framework for improving program adherence and behavioural outcomes.

Based on this rationale, the present study aims to analyse HBM factors influencing pregnant women's participation in the free nutritious meal program in Samarinda City.

METHODS

Research Type

This study employed an analytical quantitative design with a cross-sectional approach to provide a comprehensive overview of the Health Belief Model (HBM) factors influencing pregnant women's self-efficacy to participate in the free nutritious meal program. The cross-sectional design was chosen for its efficiency in examining the relationships among variables at a single point in time (25,26).

Research Location

The research was conducted in Samarinda City, East Kalimantan Province, one of the regions implementing the free nutritious meal program for pregnant women. The site was selected due to its high stunting prevalence and the absence of comprehensive studies applying the HBM to this program. Data collection took place from March to August 2024.

Population and Sample

The study population comprised all pregnant women enrolled in the free nutritious meal program in Samarinda. A purposive sampling strategy was applied with inclusion criteria of being an active program participant, able to read and write, and willing to participate. The minimum sample size was determined using a model-based approach recommended for Partial Least Squares–Structural Equation Modeling (PLS-SEM), considering the number of indicators and structural paths. According to Hair et al. (27), a sample size of 10–20 times the largest number of structural paths pointing to a construct is adequate to ensure statistical power. Based on this criterion, a minimum of 180 participants was required, and the final sample of 203 respondents met this requirement. This sample size was adequate for the structural analysis using Partial Least Squares–Structural Equation Modeling (PLS-SEM) selected for data analysis (27,28).

Variables

The study variables included predisposing factors (knowledge, attitudes, motivation), reinforcing factors (family support, support from health workers), enabling factors (access to and availability of nutritious food), HBM constructs (perceived susceptibility, severity, benefits, barriers, and cues to action), and pregnant women's self-efficacy to participate in the free nutritious meal program.

Instrumentation or Tools

Data were collected using a structured questionnaire developed based on HBM dimensions and the identified predisposing, reinforcing, and enabling factors. The constructs and items were adapted from previously validated instruments developed by Champion & Skinner (28) and Rosenstock et al. (27) for HBM dimensions, as well as from locally validated maternal health behavior studies in Indonesia (29–31).

The instrument underwent a systematic translation and cultural adaptation process following WHO guidelines, including forward–backward translation, expert panel review, and pretesting for clarity and cultural relevance.

Each construct was measured using a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Representative items included "I believe that poor nutrition during pregnancy can harm my baby" (perceived severity) and "My family supports me to attend the free nutritious meal program regularly" (reinforcing factor).

The questionnaire underwent content validation by experts and was pilot-tested among 30 pregnant women, yielding Cronbach's alpha values greater than 0.70 for all subscales (7–9,12). This instrument enabled a more comprehensive assessment of psychosocial factors than previous studies that examined only one or two aspects of the HBM.

Data Collection Procedures

Data were gathered by trained enumerators under the supervision of midwives at local health centres. Respondents completed the questionnaire after receiving an explanation of the study objectives and signing informed consent. This procedure ensured adherence to research ethics and improved data quality.

Data Analysis

Data were analysed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS software. This methods was selected for its ability to test complex latent variable relationships in relatively small samples and to assess model fit through indices such as SRMR, R-square, and Q-square (29–31). This approach is rarely used in similar studies in Indonesia and thus constitutes one of the novelties of this research.

Ethical Approval

Ethical approval was obtained from the Health Research Ethics Committee of Universitas Jenderal Achmad, Yogyakarta (Skep/068a/KEP/III/2025). All respondents were informed of the purpose of the study, data confidentiality, and their right to withdraw at any time.

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RESULTS

A total of 203 pregnant women participated in this study. The majority were aged 26–35 years (72.41 %), had at least secondary education (senior high school 61.08 %, higher education 24.63 %), and almost half were housewives (49.75 %). More than half had received nutrition information from health workers (61.08 %) and routinely attended the free nutritious meal program (65.02 %) (Table 1).

Table 1. Distribution of Respondent Characteristics (n = 203)

Characteristics	n	%
Age (years)		
17–25	17	8.37
26–35	147	72.41
≥ 36	39	19.21
Education (level of formal education)		
Junior high school	29	14.29
Senior high school	124	61.08
Higher education (college/university)	50	24.63
Occupation		
Housewife	101	49.75
Private sector/self-employed	67	33.00
Civil servant/professional	35	17.24
Received nutrition information from health workers	124	61.08
Regularly attended the free nutritious meal program	132	65.02

(Source: Primary Data, 2024)

Measurement Model (Outer Model)

Validity and reliability of the constructs were assessed using factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's alpha. All indicator loadings exceeded 0.70, AVE values were above 0.50, and CR and Cronbach's alpha were greater than 0.70, confirming convergent validity and internal consistency. Discriminant validity was established using the Fornell–Larcker criterion.

Structural Model (Inner Model)

The Partial Least Squares–Structural Equation Modeling (PLS-SEM) analysis with bootstrapping of 5,000 resamples revealed that predisposing factors had a strong effect on the HBM construct (β = 0.556; p = 0.000). Reinforcing factors exerted a greater influence on self-efficacy (β = 0.228; p = 0.002) than enabling factors (β = 0.142; p = 0.031). The HBM construct itself contributed positively to enhancing pregnant women's self-efficacy (β = 0.244; p = 0.000).

The coefficient of determination (R^2) indicated that 30.9% of the variance in the HBM construct was explained by predisposing factors, while 26.6% of the variance in self-efficacy was explained by reinforcing factors, enabling factors, and the HBM construct. Both values represent moderate explanatory power.

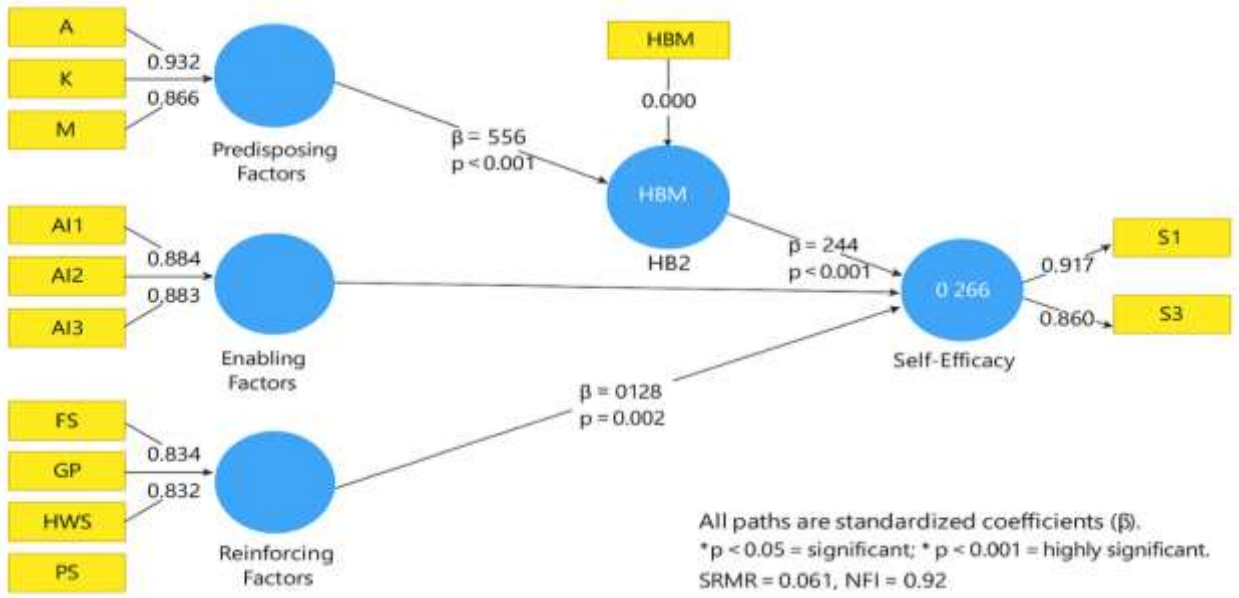

Figure 1. Structural Model of PLS-SEM Analysis with Standardized Path Coefficients, Significance Levels, and R^2 Values

The model shows the relationships among predisposing, enabling, and reinforcing factors, the Health Belief Model (HBM) construct, and self-efficacy. All path coefficients (β) are standardized, with significance levels indicated ($p < 0.05$ or $p < 0.001$). R^2 values denote the variance explained for endogenous constructs. Model fit indices: SRMR = 0.061, NFI = 0.92.

Table 2. Measurement and Structural Model Summary (PLS-SEM Analysis)

Construct	Indicator	Loading (λ)	Cronbach's α	CR	AVE	HTMT
Predisposing Factors	Knowledge	0.812	0.843	0.887	0.663	—
	Attitude	0.804				
	Motivation	0.823				
Reinforcing Factors	Family support	0.821	0.801	0.874	0.637	0.68
	Peer influence	0.782				
	Health worker encouragement	0.792				
Enabling Factors	Accessibility	0.745	0.782	0.853	0.592	0.71
	Availability	0.784				
	Program convenience	0.769				

Construct	Indicator	Loading (λ)	Cronbach's α	CR	AVE	HTMT
HBM Construct	Perceived susceptibility	0.803	0.851	0.896	0.683	0.74
	Perceived benefits	0.825				
	Perceived barriers (reverse)**	0.781				
	Cues to action	0.829				
Self-efficacy	Confidence to attend	0.861	0.874	0.911	0.721	0.76
	Ability to maintain participation	0.847				
	Overcoming barriers	0.833				

Note: All loadings are significant at $p < 0.001$. AVE > 0.5 and CR > 0.7 indicate good convergent validity; HTMT < 0.90 supports discriminant validity.
(Source: Primary Data, 2024)

Table 3. Structural Model (Path Coefficients)

Path Tested	Path Coefficient (β)	p-value	Interpretation
Predisposing → HBM Construct	0.556	0.000	Significant
Reinforcing → Self-efficacy	0.228	0.002	Significant
Enabling → Self-efficacy	0.142	0.031	Significant
HBM Construct → Self-efficacy	0.244	0.000	Significant

(Source: Primary Data, 2024)

Goodness-of-Fit of the Model

The standardized root mean square residual (SRMR) value of 0.074 (<0.08) indicated an acceptable fit. Additional model fit indices are presented in Table 4. To ensure the model's robustness, variance inflation factor (VIF), cross-validated redundancy (Q^2), and out-of-sample predictive power (PLSpredict) were also assessed. All inner VIF values were below 3.0, indicating no multicollinearity issues among predictor constructs. Q^2 values obtained through the blindfolding procedure were greater than 0 (Q^2_HBM = 0.182; Q^2_Self-efficacy = 0.207), confirming acceptable predictive relevance. The PLSpredict results further showed that the model's root mean square error (RMSE) values were lower than those of the linear regression benchmark, signifying strong out-of-sample predictive validity.

Table 4. Model Fit and Predictive Validity Indices of PLS-SEM Analysis

Fit Index	Saturated Model	Estimated Model	Cut-off Criteria	Interpretation
SRMR	0.074	0.082	< 0.08	Acceptable fit
d_ULS	0.500	0.605	Closer to 0	Moderate fit
d_G	0.332	0.344	Closer to 0	Stable model
Chi-Square	373.835	379.268	–	Large, not critical in PLS
NFI	0.749	0.745	≥ 0.90	Moderate fit
Inner VIF (range)	1.25–2.73	–	< 3.0	No collinearity issues
Q^2_HBM / Q^2_Self-efficacy	0.182 / 0.207	> 0	Predictive relevance confirmed	
PLSpredict RMSE (vs. LM benchmark)	Lower	–	–	Strong predictive validity

(Source: Primary Data, 2024; Hair, J.F., Hult, G.T.M., Ringle, C.M., & Sarstedt, M. (2022). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (3rd ed.). SAGE.)

These findings demonstrate that psychosocial factors integrated through the HBM can explain pregnant women's adherence behaviour to the free nutritious meal program more comprehensively than previous models. As illustrated in Figure 1, reinforcing factors (social support) showed a stronger path coefficient than enabling factors in influencing self-efficacy. Figure 2 and Table 3 confirm that the overall model achieved acceptable fit indices (SRMR <0.08), despite NFI values being in the moderate range. This study provides the first empirical evidence from Samarinda on the application of the HBM to a maternal nutrition program, which has not previously been reported in Indonesia.

DISCUSSION

These findings are particularly relevant to Indonesia's National Strategy for Stunting Reduction 2018–2024 and the East Kalimantan Health Office's 2023 stunting action plan, both of which prioritise family- and community-based nutrition interventions to achieve the national target of reducing stunting prevalence to 14% by 2024. The results demonstrate that predisposing, reinforcing, and enabling factors play crucial roles in shaping pregnant women's health perceptions through the Health Belief Model (HBM), thereby enhancing their self-efficacy to participate in the free nutritious meal program in Samarinda. The PLS-SEM analysis showed that predisposing factors exerted a strong influence on the HBM construct ($\beta = 0.556$), while reinforcing factors had a greater impact on self-efficacy than enabling factors ($\beta = 0.228$ vs $\beta = 0.142$). The explanatory power of the model was moderate, with R^2 values of 0.309 for the HBM construct and 0.266 for self-efficacy, indicating that while the model is informative, additional cultural and socioeconomic determinants may further explain maternal adherence behaviours. According to Hair et al. (27), R^2 values around 0.25 are considered moderate in behavioural health studies, underscoring the robustness yet openness of this model to further enrichment.

From a theoretical perspective, the findings align with the six core dimensions of the HBM, a model first introduced by Rosenstock (32) and later refined by Champion & Skinner (33). Predisposing factors such as knowledge, attitudes, and motivation reflect perceived susceptibility (awareness of stunting risks), perceived severity (understanding the consequences of poor maternal nutrition), and perceived benefits (belief in the program's health impact). Enabling factors are closely related to perceived barriers, where limitations in access or facilities may hinder participation. Reinforcing factors function as cues to action, with support from husbands, families, and community health workers serving as external triggers that activate maternal self-efficacy. This mapping confirms the theoretical robustness of the model and underscores how psychosocial determinants are embedded within HBM constructs.

The role of predisposing factors is consistent with previous studies. Bayked et al. (7) reported that maternal nutrition knowledge was associated with healthy eating practices, while Olloqui-Mundet et al. (8) emphasised the role of nutrition education in improving dietary habits. Recent Indonesian evidence also shows that all HBM constructs—including perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, are significantly associated with nutritional fulfilment behaviour among pregnant women (34), and Rahmawati et al. (35) highlighted health workers as major sources of maternal nutrition information. Similarly, Triharini et al. (36) showed that nutrition education interventions based on behaviour change theories improved knowledge and practices among expectant mothers, reinforcing the importance of predisposing elements in program design.

The observation that reinforcing factors were more influential than enabling factors in improving self-efficacy aligns with evidence from other settings. Riazi et al. (9) reported that social support enhanced the effectiveness of nutrition education among Afghan immigrants, and Hatamzadeh et al. (12) showed that support from health workers and family improved self-efficacy during the COVID-19 pandemic. In the Indonesian context, Maringka et al. (10) found that husbands' involvement increased adherence to maternal health programs, while Arifah et al. (37) noted that peer and family engagement strengthened compliance in antenatal care. Reinforcing factors can therefore be seen as cues to action that not only trigger behaviour but also sustain maternal participation in nutrition programs. This interpretation is further supported by Riyadi et al. (38), who demonstrated that social capital, a broader form of reinforcing support, was a significant predictor of adolescent health behaviours under the Theory of Planned Behavior framework. Their findings suggest that reinforcing factors in HBM may be enriched by integrating social capital perspectives, particularly in collectivist cultures such as Indonesia.

When compared internationally, the current findings converge with studies in Ethiopia (16) and Iran (9), where HBM-based nutrition education significantly improved dietary diversity and self-efficacy among pregnant

women. However, divergence is noted in contexts such as Korea and China, where structural determinants, such as healthcare access and economic stability, played a more dominant role than individual perceptions (13,20). These variations highlight how sociocultural environments influence the relative weight of HBM constructs, underscoring the importance of contextual adaptation when applying behavioural models across settings.

The novelty of this research lies in the contextual refinement and integrative application of predisposing, reinforcing, and enabling factors within the Health Belief Model (HBM) framework, combined with PLS-SEM analysis, to predict pregnant women's self-efficacy in a free nutritious meal program. This study does not merely replicate existing HBM models but adapts its constructs, such as perceived benefits, cues to action, and reinforcing support, to the sociocultural and programmatic context of maternal nutrition interventions in Indonesia. To the best of our knowledge, no prior study has comprehensively examined how these adapted constructs interact to shape women's behavioral self-efficacy in this setting. By linking psychosocial determinants with program adherence outcomes, this research advances theoretical understanding of how HBM operates in collectivist and resource-limited environments, and resonates with the emerging Food Is Medicine approach in high-income countries, where nutrition interventions are also shaped by social support and education (14,39,40). It therefore contributes to filling a critical evidence gap for designing contextually grounded and theory-driven maternal nutrition programs in Indonesia.

Policy implications are significant. In line with the national stunting reduction target of 14% by 2024 and the "Golden Generation" 2045 goal, these findings suggest that interventions should prioritise strengthening knowledge, motivation, and social support rather than focusing solely on facilities. Strategies may include developing tailored HBM-based educational modules delivered by midwives and community health workers, organising family-focused counselling to enhance spousal and household support, and integrating digital reminders via maternal health platforms. Programs should go beyond providing meals to empowering health workers, families, and communities as reinforcing agents. Such a theory-based approach ensures that interventions target specific HBM constructs, thereby increasing pregnant women's self-efficacy and program compliance.

Although this study provides new insights, several limitations should be noted. Its cross-sectional design precludes causal inference, and reliance on self-reported data introduces potential bias. The purposive sampling method limits generalisability to all pregnant women in Samarinda. Although the questionnaire underwent validity and reliability testing, measurement error cannot be fully ruled out. Furthermore, contextual influences such as cultural norms and household economic conditions, which were not directly assessed, may also shape self-efficacy. Future studies should employ longitudinal or intervention designs to test causal relationships and examine broader cultural and socioeconomic variables that may enhance the explanatory power of HBM-based models.

Despite these limitations, the present findings fulfil the study's aim of analysing HBM constructs, particularly predisposing, reinforcing, and enabling factors, that influence pregnant women's self-efficacy to participate in the free nutritious meal program. This reinforces the importance of theory-based nutrition interventions as a strategic component of Indonesia's stunting reduction agenda.

CONCLUSION

This study demonstrates that predisposing, reinforcing, and enabling factors play a critical role in shaping pregnant women's health perceptions through the Health Belief Model (HBM), thereby enhancing their self-efficacy to participate in the free nutritious meal program in Samarinda. Among these, reinforcing factors exerted a stronger influence than enabling factors, while predisposing factors formed the foundation of health perceptions. Specifically, perceived benefits and cues to action, such as social encouragement and midwives' motivation, were identified as key reinforcing drivers of women's participation, whereas perceived barriers related to access and program understanding limited engagement. The novelty of this research lies in its integrative approach to these three dimensions within the HBM framework using Partial Least Squares–Structural Equation Modeling (PLS-SEM), providing the first empirical evidence of HBM application in a maternal nutrition program in Samarinda and broadening the HBM literature in Indonesia.

In line with Indonesia's National Strategy for Stunting Reduction 2018–2024, these findings highlight the need for policymakers to strengthen pregnant women's knowledge, motivation, and social support through structured education, family involvement, and the empowerment of midwives or community health workers to improve program effectiveness. Interventions should explicitly address perceived barriers and enhance perceived benefits through

HBM-based education and consistent cues to action. Health professionals are encouraged to design HBM-based educational messages and activities to enhance pregnant women's self-efficacy. Future research should employ longitudinal designs to evaluate the long-term effects of HBM-based interventions on maternal adherence and infant health outcomes, thereby supporting national efforts to reduce stunting to 14% by 2024 and achieve the "Golden Generation" 2045 goal.

AUTHOR'S CONTRIBUTION STATEMENT

TS conceptualized and designed the study. R was responsible for data collection and initial data processing. NWU & EPA conducted the literature review and contributed to the theoretical framework. EFAS drafted the initial manuscript and led the revision process. All authors critically reviewed the manuscript and approved the final version for submission.

CONFLICTS OF INTEREST

The authors declare that there are no known conflicts of interest financial, professional, or personal that could have appeared to influence the work reported in this paper. This statement affirms the objectivity and integrity of the research.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used only standard language-editing tools (e.g., spelling and grammar checkers) and informal idea discussions. No substantive parts of the study design, data analysis, interpretation, or conclusions were generated by artificial intelligence technologies. All scientific content, interpretation, and writing were carried out independently by the authors.

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