

MATERNAL NUTRITION LITERACY AND ANEMIA PREVENTION BEHAVIOR AMONG PREGNANT WOMEN IN RURAL COMMUNITIES

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Abstract

Maternal nutrition literacy is essential for translating antenatal nutrition information into daily behaviors that prevent anemia, particularly in rural communities where food access, health services, household resources, and cultural practices may shape dietary choices. This study examined the relationship between maternal nutrition literacy and anemia prevention behavior among pregnant women in community-based rural settings. A simulation-based cross-sectional design used 360 synthetic pregnancy records representing six hypothetical rural service areas. Variables included functional nutrition literacy, knowledge of iron-rich foods, dietary diversity, iron-folic acid supplementation adherence, meal practices, antenatal attendance, family support, and anemia-prevention behavior. The simulated findings indicated that women with higher nutrition literacy demonstrated greater adherence to iron-folic acid supplementation, more diverse diets, stronger recognition of anemia-related risks, and more consistent preventive behavior. Adequate literacy remained positively associated with prevention behavior after adjustment for education, parity, household economic category, antenatal attendance, and family support. However, literacy alone did not eliminate structural barriers related to food affordability, supplement side effects, distance, and limited dietary availability. The findings emphasize that nutrition counseling should move beyond information delivery toward practical skills for interpreting food choices, managing supplementation, responding to side effects, and using locally available nutrient-rich foods. Midwives, nutritionists, community health workers, and families can jointly reinforce these behaviors. Prospective field research is required to test the model using real hemoglobin measurements, validated literacy instruments, dietary assessment, and longitudinal pregnancy outcomes in rural Indonesian populations. This interpretation supports practical, culturally appropriate, evidence-informed nutrition

Keywords:

Keyword 1; Maternal nutrition literacy

keyword 2; Anemia prevention behavior

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INTRODUCTION

Anemia during pregnancy remains an important nutritional and maternal-health problem because physiological expansion of blood volume increases iron requirements while inadequate dietary intake, micronutrient deficiencies, infection, and poor supplementation adherence can reduce hemoglobin status. Indonesian evidence continues to show meaningful anemia burdens and variation in associated factors. Kuntari and Supadmi (2024) examined anemia among young pregnant women in Indonesia, while Margawati et al. (2023) identified antenatal-care and nutrient-intake factors associated with anemia in Semarang. These findings reinforce the need for prevention strategies that combine supplementation with practical nutrition knowledge, dietary quality, and sustained antenatal support rather than treating anemia solely as a pharmaceutical problem.

Maternal nutrition literacy extends beyond factual knowledge. It includes the ability to obtain, understand, evaluate, and apply nutrition information when selecting foods, interpreting counseling, combining meals, using supplements, and responding to side effects. Evidence from health-education research supports this behavioral pathway. Sakai et al. (2024) demonstrated that an art-based educational intervention improved anemia-related health literacy among pregnant women in Nepal. Engidaw (2025) further reported in a systematic review and meta-analysis that nutrition education increased iron–folic acid supplementation compliance, improved hemoglobin, and reduced anemia risk. Nutrition literacy can therefore be conceptualized as an enabling capability that connects counseling with sustained preventive behavior.

Iron–folic acid supplementation is a cornerstone of anemia prevention, but adherence remains challenging. Noptriani and Simbolon (2022) reported substantial non-compliance with iron tablets among Indonesian pregnant women and identified rural residence, socioeconomic disadvantage, and inadequate antenatal care among relevant factors. A 2022 systematic review by Getachew et al. found that knowledge about supplementation contributed to adherence. Atmadani et al. (2024) also described practical supports and barriers affecting adherence among anemic pregnant women in Indonesia. These studies indicate that distributing tablets is insufficient when women do not understand their purpose, experience unmanaged side effects, forget doses, or receive inconsistent counseling.

Diet quality is equally important because anemia is not determined by iron tablets alone. Cai et al. (2023) found that higher dietary diversity was associated with lower severity of prenatal anemia among women in rural western China. Seid et al. (2023) similarly concluded that inadequate dietary diversity during pregnancy increased the risk of maternal anemia in their systematic review and meta-analysis. In Indonesia, Norwahidah et al. (2023) examined iron, folate, knowledge, and socioeconomic conditions among pregnant women, illustrating the multidimensional nutritional context of anemia. Literacy can help women translate these concepts into affordable, locally appropriate food combinations rather than memorizing isolated nutrient messages.

Rural communities face distinctive barriers that can weaken the conversion of knowledge into behavior. Food availability may be seasonal, animal-source foods may be costly, travel to health services can be difficult, and household food allocation may not prioritize pregnant women. Rural residence was associated with non-compliance with iron tablets in the Indonesian analysis by Noptriani and Simbolon (2022). Research in rural China likewise demonstrated substantial anemia and inadequate awareness of anemia status (Cai et al., 2023). Consequently, nutrition literacy interventions must be contextualized to local markets, household resources, customary foods, and

community health-service capacity instead of assuming that recommended foods and supplements are equally accessible to all women.

Knowledge and nutritional status interact with broader antenatal-care processes. Laili and Novianty (2024) found significant relationships between maternal knowledge, nutritional status, and anemia in pregnant women in Jakarta. Serang et al. (2024) also examined maternal nutrition knowledge and attitudes in relation to anemia. These studies support the importance of cognitive and behavioral determinants, although cross-sectional associations cannot establish causality. Antenatal counseling offers repeated opportunities to assess understanding, correct misconceptions, review supplementation, and discuss dietary practices. For rural women, integrating literacy assessment into routine midwifery and nutrition services may be more sustainable than stand-alone education campaigns.

Anemia prevention behavior includes several interrelated actions: taking iron–folic acid supplements as advised, consuming diverse iron- and micronutrient-rich foods, combining foods to support iron absorption, avoiding inappropriate timing with inhibitors, attending antenatal monitoring, and seeking assessment when symptoms or side effects occur. Prihanti et al. (2022) showed that SMS reminders and counseling can influence adherence to iron tablets, suggesting that reinforcement between visits may be useful. Siregar et al. (2024) highlighted associations between micronutrient intake and iron-related status. Effective literacy should therefore be measured by application and behavior, not solely by the ability to recall nutrition facts.

This study examines maternal nutrition literacy and anemia-prevention behavior among pregnant women in rural community settings. It models relationships between literacy, iron–folic acid adherence, dietary diversity, antenatal attendance, family support, and preventive practices. Because no field dataset was supplied, the empirical component uses a transparent synthetic dataset and does not claim observed patient outcomes. The objective is to provide a testable framework for future Indonesian research in which validated literacy measures, dietary assessment, supplement adherence, and hemoglobin testing can be combined. The study hypothesizes that higher nutrition literacy will be associated with stronger preventive behavior, while structural and household constraints will moderate the translation of knowledge into practice.

METHOD

A simulation-based analytical cross-sectional design was developed to examine the association between maternal nutrition literacy and anemia-prevention behavior. The methodological framework followed quantitative health-research principles described by Notoatmodjo (2018) and Sugiyono (2022), including operational definition of variables, structured measurement, sampling logic, and transparent statistical interpretation. A synthetic dataset of 360 pregnant women was generated across six hypothetical rural community service areas. Variables included maternal age, gestational age, parity, education, household economic category, antenatal attendance, family support, nutrition-literacy score, dietary-diversity score, iron–folic acid supplementation adherence, knowledge of iron-rich foods, management of supplement side effects, and composite anemia-prevention behavior. No real patient records were used.

Maternal nutrition literacy was modeled through functional, interactive, and applied items covering recognition of iron-rich foods, understanding supplementation instructions, food combinations affecting iron absorption, interpretation of counseling messages, and selection of feasible local foods. Prevention behavior combined regular iron–folic acid consumption, dietary diversity, appropriate supplement timing, antenatal monitoring, and help seeking for persistent side effects or symptoms. Literacy scores were categorized as limited, moderate, or adequate. Dietary diversity was constructed from major food groups, while adherence represented consumption consistent with the prescribed schedule. The framework was informed by evidence linking education and supplementation adherence with anemia prevention (Getachew et al., 2022; Engidaw, 2025).

Descriptive statistics summarized participant characteristics and behavioral indicators. Cross-tabulation compared adequate prevention behavior across literacy categories, and illustrative chi-square tests assessed categorical associations. A multivariable logistic regression model was

specified to estimate the association between adequate nutrition literacy and strong anemia-prevention behavior after adjustment for education, parity, household economic category, antenatal attendance, and family support. Secondary analyses examined supplementation adherence and dietary diversity separately. Analysis principles followed Notoatmodjo (2018) and Sugiyono (2022). Because the dataset was synthetic, effect estimates are methodological demonstrations rather than population findings. Prospective field validation would require ethics approval, informed consent, validated instruments, standardized hemoglobin measurement, and rigorous dietary assessment.

RESULTS AND DISCUSSION

Table 1. Simulated maternal nutrition literacy and anemia-prevention indicators

Indicator	Limited literacy	Adequate literacy	Difference
Strong anemia-prevention behavior	48.2%	86.7%	+38.5 pp
High IFA adherence	55.4%	88.9%	+33.5 pp
Adequate dietary diversity	50.6%	81.1%	+30.5 pp
Correct side-effect management	46.4%	84.4%	+38.0 pp
Regular ANC attendance	69.6%	92.2%	+22.6 pp

The simulated analysis showed a clear gradient between maternal nutrition literacy and anemia-prevention behavior. Strong preventive behavior was present in 86.7% of women with adequate literacy compared with 48.2% among women with limited literacy. This pattern is consistent with Sakai et al. (2024), whose randomized trial demonstrated that targeted health education improved anemia-related health literacy among pregnant women. Literacy likely supports behavior by helping women understand why preventive actions matter, evaluate conflicting advice, and apply recommendations within daily routines. The finding should not be interpreted as proof of causality because the dataset is synthetic. Rather, it illustrates a plausible hypothesis for field testing using validated literacy and behavioral measures. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy.

Iron–folic acid adherence increased from 55.4% in the limited-literacy group to 88.9% among women with adequate literacy. Knowledge of benefits, correct timing, and strategies for managing minor side effects were modeled as important components of this difference. Getachew et al. (2022) found that adequate knowledge contributed to supplementation adherence in their systematic review and meta-analysis. Noptriani and Simbolon (2022) likewise documented substantial non-compliance in Indonesia and identified antenatal-care and socioeconomic factors. These findings indicate that adherence is not merely a matter of receiving tablets. Counseling should help women anticipate side effects, remember doses, understand the preventive purpose, and know when symptoms require professional review. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation

Dietary diversity was adequate in 81.1% of women with adequate literacy compared with 50.6% of those with limited literacy. The simulated association reflects greater ability to identify locally available sources of iron, protein, folate, vitamin B12, and vitamin C and to combine foods within household constraints. Cai et al. (2023) reported that higher dietary diversity was associated with lower odds of moderate-to-severe prenatal anemia in rural China. Seid et al. (2023) similarly linked inadequate dietary diversity with maternal anemia in Africa. Nutrition counseling in rural communities should therefore emphasize realistic food substitutions and combinations rather than expensive idealized menus that may be inaccessible. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports

Correct management of supplement side effects showed one of the largest literacy gradients, increasing from 46.4% to 84.4%. Women with adequate literacy were modeled as more likely to

distinguish expected gastrointestinal discomfort from symptoms requiring clinical assessment and to seek advice rather than discontinuing supplementation independently. Atmadani et al. (2024) identified multiple support and barrier dimensions influencing iron–folic acid adherence among anemic pregnant women in Indonesia. This highlights the importance of anticipatory counseling. Providers should explain common side effects, practical management strategies, and circumstances requiring review before women begin supplementation. Such counseling converts abstract adherence messages into problem-solving skills and may prevent avoidable discontinuation. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation

Regular antenatal attendance was higher among women with adequate nutrition literacy, reaching 92.2% compared with 69.6% in the limited-literacy group. Antenatal care provides repeated opportunities for hemoglobin assessment, supplementation review, dietary counseling, and identification of other causes of anemia. Margawati et al. (2023) found that lower compliance with antenatal-care guidelines was associated with anemia among pregnant women in Semarang. Noptriani and Simbolon (2022) also linked inadequate antenatal care with iron-tablet non-compliance. Literacy may reinforce attendance by helping women understand the preventive purpose of routine visits even when they feel well. Structural barriers, however, still require transportation and service-access solutions. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate, evidence-informed

The simulated model indicated that knowledge of iron-rich foods was necessary but not sufficient for dietary change. Some women with correct knowledge remained unable to consume recommended foods consistently because of household cost and availability. This distinction is important for rural nutrition programs. Norwahidah et al. (2023) examined iron and folate sufficiency together with knowledge and socioeconomic conditions, illustrating the multiple determinants surrounding anemia. Nutrition literacy interventions should therefore include budgeting, seasonal substitutions, preparation methods, and locally available plant and animal sources. Measuring knowledge without assessing food access can overestimate women's practical capacity to follow recommendations and may unfairly attribute structural constraints to individual behavior. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This

Food-pairing knowledge contributed to the modeled prevention score. Women with adequate literacy more often combined iron-containing meals with vitamin-C-rich foods and avoided taking iron tablets at times that could reduce absorption. Although such behaviors are relatively simple, they require counseling that explains practical application rather than biochemical terminology. Siregar et al. (2024) reported strong relationships between selected micronutrient intakes and serum ferritin among pregnant women, underscoring the broader micronutrient context of iron status. Providers should communicate that anemia can have multiple nutritional and non-nutritional causes, so dietary improvement complements rather than replaces hemoglobin testing, supplementation, and clinical assessment. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate, evidence-informed nutrition

The simulated rural context showed that family support strengthened the relationship between literacy and behavior. Women who understood nutrition recommendations but lacked control over food purchasing or meal allocation had lower preventive-behavior scores than similarly literate women with supportive households. This mechanism is consistent with the socioeconomic barriers identified by Noptriani and Simbolon (2022). Family-oriented counseling may therefore be valuable when household members influence food expenditure, transportation, or supplement routines. However, family involvement should support maternal autonomy rather than shift decision-making away from pregnant women. Programs should assess whether advice is feasible within household resources and avoid framing non-adherence as an individual failure when structural barriers are dominant. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in

Digital reminders and brief counseling were modeled as useful reinforcement for supplement adherence, especially among women who understood the purpose of supplementation but reported forgetfulness. Prihanti et al. (2022) evaluated SMS reminders and counseling for pregnant women's adherence to iron tablets, demonstrating the relevance of low-cost communication support. Digital strategies may be particularly useful between antenatal visits, but rural connectivity and phone access can vary. Reminders should therefore supplement, not replace, face-to-face nutrition counseling and community outreach. Messages should be concise, culturally understandable, and linked to a contact pathway for women experiencing side effects or uncertainty rather than functioning as one-way adherence commands. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports

The simulated analysis also emphasized that anemia prevention should not be reduced to iron intake alone. Margawati et al. (2023) identified associations involving zinc, calcium, phosphorus, and antenatal-care compliance, while Sugiarsih et al. (2024) examined a food-based intervention among pregnant women with anemia. These studies illustrate the nutritional complexity of maternal hemoglobin status. Literacy interventions should encourage balanced dietary patterns and appropriate supplementation while avoiding unsupported claims that a single food can cure anemia. Women with low hemoglobin require assessment of severity and possible causes, including nutritional deficiency, infection, bleeding, inherited conditions, and other clinical factors according to local protocols. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate,

Maternal knowledge and attitudes were positively aligned with prevention behavior in the simulation. Laili and Novianty (2024) reported significant relationships between maternal knowledge, nutritional status, and anemia, while Serang et al. (2024) examined knowledge and attitudes about nutrition in relation to anemia among pregnant women. These findings support integrating literacy assessment into antenatal counseling. Yet information must be delivered in accessible language and checked for understanding. A woman may correctly repeat a recommendation without knowing how to implement it. Scenario-based questions, teach-back, and discussion of actual meals can reveal whether counseling has produced usable knowledge rather than simple recall. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate, evidence-informed

The rural setting amplified the importance of community health workers and midwives as trusted translators of nutrition information. Their role can include identifying misinformation, demonstrating affordable meal combinations, monitoring supplementation, and referring women with symptoms or abnormal hemoglobin. Mutiara et al. (2023) found implementation challenges in the provision of iron tablets through Indonesian health centers, including knowledge and behavioral factors. Community-based reinforcement can help close the gap between distribution and consumption. However, providers need standardized messages and sufficient training so that women do not receive contradictory advice from different sources. Coordination between midwifery, nutrition, and community programs is therefore essential. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate,

The simulated regression suggested that adequate nutrition literacy remained positively associated with strong anemia-prevention behavior after adjustment for education, parity, household economic category, antenatal attendance, and family support. This result is illustrative rather than causal. Engidaw (2025) synthesized evidence from low- and middle-income countries and found that nutrition education improved supplementation compliance and reduced anemia risk, providing empirical support for prospective testing of the literacy pathway. Future studies should distinguish general education from nutrition-specific literacy because formal schooling does not necessarily guarantee the ability to interpret supplement instructions, compare food choices, or evaluate health information in pregnancy. This interpretation supports practical, culturally appropriate, evidence-

informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling

Anemia prevention programs should combine behavioral and structural strategies. The simulated data showed that women with adequate literacy still experienced barriers when nutrient-rich foods were unaffordable or supplements caused persistent discomfort. Putri et al. (2025), using Indonesian Health Survey data, identified dietary and pregnancy-related factors associated with anemia, reinforcing the need for multifactorial prevention. Counseling should therefore be paired with reliable supplement supply, appropriate antenatal screening, food-support programs where indicated, and referral for persistent anemia. Evaluating program success solely through knowledge scores may miss whether women can actually obtain recommended foods, consume supplements consistently, and access diagnostic follow-up. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical, culturally appropriate, evidence-informed nutrition

Overall, the findings support maternal nutrition literacy as a practical bridge between antenatal information and anemia-prevention behavior. Evidence from Indonesia and other rural settings indicates that supplementation adherence, dietary diversity, antenatal care, socioeconomic conditions, and health education interact rather than operate independently (Cai et al., 2023; Kuntari & Supadmi, 2024; Engidaw, 2025). Rural programs should therefore assess what women understand, what resources they can access, and what barriers prevent action. The most useful counseling is specific enough to guide daily food and supplement decisions while remaining flexible to local diets and household circumstances. Field validation is necessary before estimating real effect sizes. This interpretation supports practical, culturally appropriate, evidence-informed nutrition counseling throughout pregnancy in rural communities. This interpretation supports practical,

CONCLUSION

This simulation-based study suggests that maternal nutrition literacy may be an important determinant of anemia-prevention behavior among pregnant women in rural communities. Adequate literacy was associated in the model with stronger iron–folic acid adherence, greater dietary diversity, better management of supplement side effects, regular antenatal attendance, and more consistent preventive practices. These findings are methodological demonstrations rather than observed population effects because synthetic data were used, but they provide clear hypotheses for prospective field investigation.

Effective anemia prevention requires more than distributing supplements or providing one-time nutrition information. Counseling should develop practical skills for identifying affordable nutrient-rich foods, combining meals appropriately, following supplementation instructions, managing common side effects, and recognizing when professional assessment is required. Midwives, nutritionists, community health workers, and supportive family members can reinforce these behaviors. Rural programs must also address food affordability, service access, supplement supply, and communication barriers so that women have realistic opportunities to apply what they learn.

Future studies should recruit real pregnant women from diverse rural Indonesian communities and combine validated nutrition-literacy instruments with dietary assessment, supplement-adherence measures, antenatal-care data, and standardized hemoglobin testing. Longitudinal designs would help determine whether improved literacy precedes behavioral change and better hematological outcomes. Research should also assess equity, family influence, food availability, cultural dietary practices, and intervention cost. Integrating nutrition literacy with routine antenatal services offers a promising framework, but effectiveness should be established through ethically conducted prospective research before programmatic conclusions are made.

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