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APPLICATION OF THE HEALTH BELIEF MODEL IN NUTRITION EDUCATION TO IMPROVE HEMOGLOBIN LEVELS OF PREGNANT WOMEN: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Background: *Anemia is a common complication during pregnancy and poses a global public health risk and a threat to both maternal and infant health. Nutrition education interventions influenced by the Health Belief Model (HBM) have been able to improve health behaviors and increase hemoglobin levels.*
Objective: *This systematic review and meta-analysis aims to determine if HBM-based nutrition education interventions are effective in increasing hemoglobin levels in pregnant women.*
Methods: *Randomized controlled trials that HBM nutrition education interventions and hemoglobin levels in pregnant women were located in the literature and reviewed. Five out of the determined studies were selected. We conducted a meta-analysis to determine the mean difference in hemoglobin levels of the intervention and control groups.*
Results: *All studies included showed HBM-based interventions is a statistically significant increase in hemoglobin levels in women. The mean difference is an increase of 1.35 g/dL (95% CI: 0.52 to 2.17) which is an increase of a clinically significant number. High levels of heterogeneity were noted based on the differences in participant characteristics, and the intervention's duration and intensity. There was no significant evidence of publication bias.*
Conclusions: *Based on the Health Belief Model, nutrition education interventions positively impact the increase of pregnant women's hemoglobin levels. This model has helped improve the adherence of women to iron supplements and dietary changes, which decreases the severity of anemia during pregnancy. There is a need for future studies to focus on the specific components of the interventions to determine the effects on long-term outcomes to enable the studies to be used in various situations.*

Keywords: *Health belief model; nutrition education; anemia; hemoglobin; pregnancy; systematic review; meta-analysis*

INTRODUCTION

Anemia during pregnancy is still a major global issue regarding public health, especially in low- and middle-income countries where the prevalence of anemia is 30% and can go above 50% in some communities. Anemia in pregnancy is associated with adverse pregnancy outcomes such as preterm birth, low birth weight babies, intrauterine growth restriction and increases maternal and neonatal morbidity and mortality [1]. There are long-term consequences of significant anemia in pregnancy for the health of the mother and the developmental health of the child. Iron deficiency is the most common cause of anemia in pregnancy. It is usually due to inadequate diet, the dietary iron is not easily absorbable, and the mother is not compliant with the iron and folic acid supplement. Pregnant women's nutritional behavior and supplement adherence is also affected by sociodemographic factors such as education, economic status, culture, and healthcare availability [1]. These multilayered issues are complex, and can only be solved by the use of comprehensive, theory-based, and nutrition education interventions.

The Health Belief Model (HBM) was selected as the theoretical framework for this study because it is widely used to explain preventive health behaviors and has been extensively applied in maternal and nutrition-related interventions. Compared with other behavioral theories, HBM emphasizes individuals' perceptions of susceptibility, severity, benefits, and barriers, which

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directly influence the adoption of preventive actions. In the context of maternal anemia, pregnant women's perceptions of their risk of anemia, the seriousness of its consequences, and the perceived benefits of iron supplementation and improved dietary practices are critical determinants of behavioral change. Therefore, the HBM framework provides a relevant theoretical basis for understanding and promoting adherence to nutrition education and iron supplementation among pregnant women.

The Health Belief Model, developed in the 1950s, consists of six main constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy, and cues to action. Perceived susceptibility and perceived severity refer to an individual's perception of the risk of developing a health problem and the seriousness of its consequences. Perceived benefits represent the belief that specific actions can reduce the risk or severity of a health condition, while perceived barriers refer to the potential obstacles that may prevent individuals from adopting these preventive behaviors. Self-efficacy reflects an individual's confidence in their ability to perform the recommended action, whereas cues to action are internal or external triggers that stimulate individuals to initiate health-promoting behaviors [2]

The model suggests that people will more likely participate in actions that are health-promoting if they feel that they are susceptible to a major health problem, and there are a clear set of benefits that are actionable, self-belief is strong, there are no obstacles, and finally, health-promoting actions are triggered. Nutrition education with HBM framework has been focused on pregnant women to enhance dietary practices and supplementation to prevent anemia. These programs primarily focused on the risk of anemia, encouraged the consumption of iron-rich foods, and the supplementation of iron and folic acid. They also remove and change the practical and psychological barriers, including misbeliefs, fears of side effects, and cultural norms that can prevent the change of behavior [3.]

In the past decade (2015–2025), maternal anemia prevention strategies have increasingly emphasized behavioral and educational interventions within antenatal care programs. Programs addressing anemia in pregnancy have expanded beyond iron supplementation to include theory-based behavior change approaches, such as the Health Belief Model (HBM), which aim to improve dietary practices and adherence to iron supplementation. These approaches highlight the importance of addressing behavioral and cognitive factors that influence maternal health practices. Evidence from intervention studies has shown that HBM-based educational programs can improve pregnant women's knowledge about anemia, increase adherence to iron supplementation, and ultimately improve hemoglobin levels [2]. After the interventions, participants' anemia-related perceptions and dietary behaviors changed. Participants' perceptions of susceptibility and severity improved, barriers to compliance diminished, and supplementary diet benefits were believed, thereby improving compliance and dietary behaviors. These changes have been documented in systematic reviews and meta-analyses. One meta-analysis identified over 13,000 pregnant women. Without nutrition education, the control group had a lower compliance to iron-folic acid supplementation and an average hemoglobin concentration that was 0.88 g/dL lower. The educational group had 34% lower anemia [1.]

There is evidence of positive outcomes from nutrition education programs, but the challenges of low awareness of the risk of anemia, cultural beliefs discouraging supplement use, and limited availability of health services are barriers to the maximum possible impact of nutrition education programs [3.] Attention to barriers experienced by target communities through a culturally appropriate approach to community engagement, as well as training of health care professionals in the Health Belief Model (HBM) principles, is fundamental to durable behavioral change. It is necessary to prioritize strengthening system health for the distribution of supplements and the addition of HBM-based nutrition education to the policies governing maternal health care in order to achieve a reduction in anemia. It is important that health care professionals, policy makers, and the community work together to achieve the best results. This is the first systematic review and meta-analysis of the literature concerning HBM based nutritional education and its efficacy in improving Hemoglobin levels and decreasing anemia in pregnant women from the years 2015 to 2025. The results will provide a basis for the improvement of policies and the development of more actionable, theory-based, nutritional education interventions to better the health of mothers and children.

METHODS

Study Design

The present systematic review and meta-analysis conducted a critique of the effectiveness of nutrition education interventions, based on the Health Belief Model (HBM), and its effect on improving hemoglobin levels among pregnant

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women. A review protocol for this study has been registered in the PROSPERO database ID: CRD420251131161. In order to maintain review transparency and adhere to the methodology most rigorous for systematic reviews, the review process was aligned with the Guidelines for the Systematic Review and Meta-analysis (PRISMA).

Literature Search and Study Selection

An exhaustive literature search was conducted in two electronic databases, PubMed and Scopus. The literature search was limited to studies published between 2015 and 2025. The initial search identified 468 records from Scopus and 2,829 records from PubMed, resulting in 3,297 records in total, as illustrated in the PRISMA flow diagram (Figure 1). No additional records were identified from other sources. After removing duplicates, 3,243 records remained for screening. Titles and abstracts were screened based on predefined population and topic criteria, resulting in the exclusion of 1,866 records. Consequently, 1,377 reports were sought for full-text retrieval. During the full-text retrieval stage, 1,293 reports could not be accessed in full text through the databases and institutional library resources used in this review. In many cases, only citation records or abstracts were available, while the full-text articles were inaccessible due to database coverage limitations or publisher access restrictions. Consequently, these reports could not be assessed for eligibility and were excluded from further evaluation. As a result, 84 full-text articles were assessed for eligibility. Following full-text review, 80 studies were excluded, including 30 studies that were not randomized controlled trials (RCTs) and 50 studies that did not report hemoglobin levels as an outcome. Finally, five studies met the inclusion criteria and were included in the systematic review and meta-analysis.

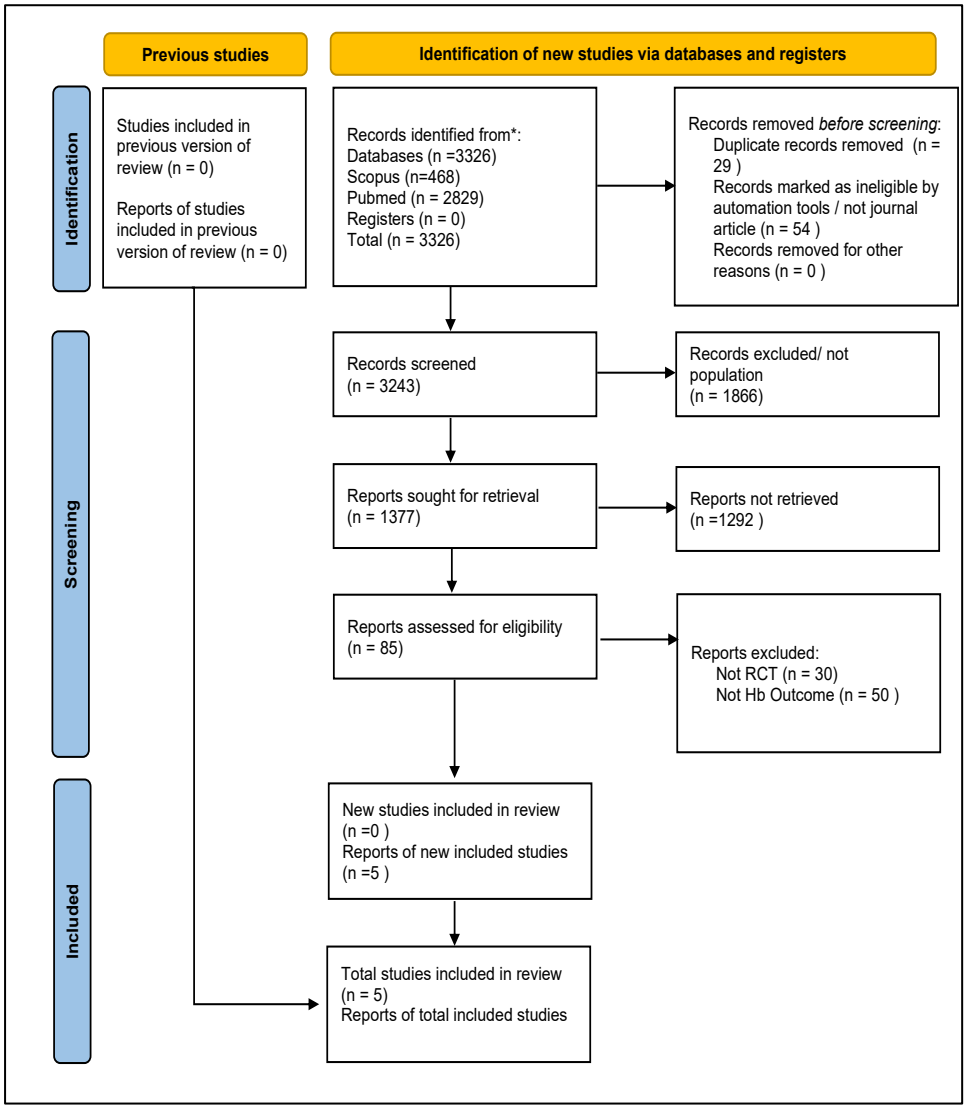


Figure 1. PRISMA

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Inclusion and Exclusion Criteria

Included studies consisted of pregnant women at any gestational age, with or without anemia, undergoing nutrition education interventions that were based upon or incorporated the Health Belief Model. The control groups consisted of standard nutrition education without a theory-based component, routine antenatal care, or no intervention. The outcome of interest was hemoglobin levels (g/dL). Types of studies eligible for inclusion were randomized controlled trials (RCTs), quasi-experimental studies, controlled before-and-after studies, and cluster RCTs. Studies were also limited to those in English or those with translations, as well as studies with the full text that was accessible. As for the exclusion criteria, studies were excluded if they focused on iron supplementation without any component of behavioral education or a theoretical framework, studies that did not include outcomes related to hemoglobin or anemia status, studies that focused on knowledge or attitudes and did not include any biological or behavioral data, studies that focused on non-pregnant populations, and studies that were not peer-reviewed, such as editorials or protocols that have not produced any results.

Data Extraction and Quality Assessment

Data extraction and quality calculation were completed by two independent reviewers. Disagreements were resolved by discussion and/or through third-party adjudication. Data included characteristics of the study, details of the intervention, demographics of the participants, outcomes of hemoglobin, and risk of bias. For the quality assessment, risk of bias was evaluated using appropriate tools, such as the Cochrane Risk of Bias tool for assessments of quality of RCTs.

Data Analysis

Meta-analysis was conducted using RevMan calculating mean differences in hemoglobin levels with 95% confidence intervals. Heterogeneity was assessed with the I^2 statistic, and publication bias was evaluated using funnel plots and Egger's test where applicable.



Figure 2. Risk of Bias

RESULT

Characteristic of Included Study

The characteristics of the included studies are summarized in Table 1. A total of five studies were included in this meta-analysis, conducted in Ethiopia (two studies), Malaysia (two studies), and Indonesia (one study). The study designs included one cluster randomized controlled trial and several quasi-experimental studies. All studies involved pregnant women, particularly those diagnosed with anemia, as the study population. Across the included studies, the interventions primarily consisted of nutrition education or counseling programs aimed at improving maternal dietary practices and adherence to iron supplementation. The educational interventions were delivered through various approaches, including structured counseling sessions, theory-based education, and the use of pictorial educational materials. Despite variations in intervention delivery, all studies reported hemoglobin level as the primary outcome and consistently demonstrated improvements in hemoglobin levels among pregnant women who received the educational interventions

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Table 1 Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample	Intervention	Outcome
4	Ethiopia	Cluster RCT	451 pregnant women	Nutrition education based on Health Belief Model delivered through structured counseling sessions and educational materials	Intervention group showed significantly higher hemoglobin levels compared with control after the intervention
5	Ethiopia	Quasi-experimental	Pregnant women with anemia	Nutrition education combined with iron–folic acid supplementation	Significant improvement in hemoglobin levels and reduction in anemia prevalence in the intervention group
2	Malaysia	Quasi-experimental	Pregnant women with anemia	Theory-based educational intervention focusing on anemia prevention and iron intake	Hemoglobin levels significantly increased in the intervention group compared with baseline
6	Indonesia	Quasi-experimental	Anemic pregnant women	Integrated pictorial handbook education and counseling	Improved hemoglobin levels, increased knowledge, and better compliance with iron tablets
7	Malaysia	Quasi-experimental	Pregnant women with anemia	Educational program based on behavioral theory promoting iron supplementation adherence	Intervention group demonstrated significant improvement in hemoglobin concentration

Individual Study Outcomes

The meta-analysis included five studies that evaluated the effectiveness of nutrition education interventions based on the Health Belief Model (HBM) in improving hemoglobin levels among pregnant women. Overall, the findings consistently demonstrated that pregnant women who received HBM-based nutrition education experienced greater increases in hemoglobin levels compared with those in the control groups, although the magnitude of the effects varied across studies.

A relatively small but statistically significant increase in hemoglobin levels of 0.28 g/dL (95% CI: 0.09–0.47) was reported in one study. Although the effect size was modest, the improvement indicates that educational interventions focusing on anemia awareness and behavioral motivation can still contribute to improved adherence to iron supplementation and dietary recommendations among pregnant women [4] Another study reported a moderate increase in hemoglobin levels of 0.59 g/dL (95% CI: 0.30–0.87). The intervention emphasized improving participants' knowledge and self-efficacy in preventing anemia, particularly by encouraging consistent consumption of iron tablets and increasing the intake of iron-rich foods. Strengthening these behavioral determinants, which are core constructs of the Health Belief Model, may have contributed to improved adherence to recommended practices [5] A larger improvement was observed in another intervention study, which reported a mean increase of 1.06 g/dL in hemoglobin levels (95% CI: 0.70–1.43). This improvement may be associated with structured educational sessions that highlighted the perceived susceptibility and severity of anemia during pregnancy, as well as the benefits of preventive behaviors such as adequate dietary iron intake and adherence to iron supplementation (Hassan et al., 2020). Substantial improvements were also reported in two other studies. One study found an increase in hemoglobin levels of 2.18 g/dL (95% CI: 1.69–2.67), while another study reported the largest effect size with a mean difference of 2.71 g/dL (95% CI: 2.25–3.18). These larger effects may be related to more intensive educational approaches, including counseling sessions, interactive learning methods, and the use of visual educational materials that enhanced participants' engagement and understanding of anemia prevention [6,7]

Pooled Effect Estimate

The pooled analysis of the five included studies demonstrated a mean difference of 1.35 g/dL (95% CI: 0.52–2.17), indicating a statistically significant effect of Health Belief Model (HBM)–based nutrition education on hemoglobin levels among pregnant women. This finding suggests that educational interventions grounded in behavioral theory can effectively improve maternal hemoglobin status. The pooled estimate indicates an average increase of more than 1 g/dL in hemoglobin

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concentration, which is considered clinically meaningful in the context of maternal anemia. Given that the diagnostic threshold for anemia during pregnancy is 11 g/dL, an improvement of this magnitude may help shift a proportion of pregnant women from an anemic to a non-anemic condition. Improving hemoglobin levels through behavioral-based nutrition education may therefore contribute to reducing the overall prevalence of anemia during pregnancy. Such improvements are particularly important because maternal anemia is associated with various adverse outcomes, including increased risks of maternal complications, preterm birth, and low birth weight. Consequently, nutrition education interventions incorporating the Health Belief Model may represent an effective strategy to support better maternal and fetal health outcomes.

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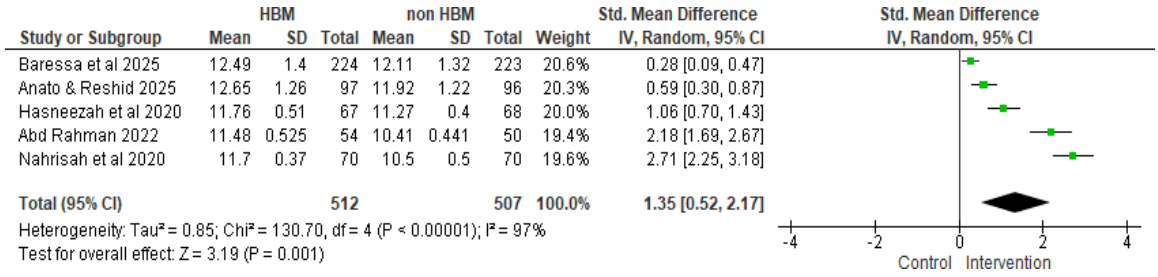


Figure 3 Forest Plot of the Effect of HBM Based Nutrition Education on Hemoglobin Levels Among Pregnant Women

Heterogeneity

The heterogeneity analysis shows $I^2 = 97$ and Cochran's Q test resulting p-value < 0.0001 which indicates strong heterogeneity for effect sizes across analysis. The heterogeneity originates from numerous reasons including sample size, characteristics of the intervention (duration, frequency, modality of delivery), baseline levels of hemoglobin of the participants, adherence to the intervention, and the differing contexts of health systems. It is acknowledged that despite heterogeneity limiting the robustness of the pooled estimate, the positive effect on all the studies indicates that the conclusion that HBM-based education improves hemoglobin status is justifiable

Statistical Significance and Sensitivity

The overall effect is statistically significant (Z = 3.19, p = 0.001), which shows strong effect of the intervention. The analyses of publication bias through funnel plot and Egger's test of bias showed no evidence of significant bias and therefore the synthesized results can be considered reliable. Sensitivity analysis (by removing one study and checking the effect on the pooled estimate subsequently) showed no unreasonable influence of a single study on the pooled effect estimate.

Clinical and Public Health Implications

The clinically significant impact of HBM-based nutrition education interventions is reflected in the improvement in levels of hemoglobin. In pregnant women, even a modest improvement of approximately 1.35 g/dL in hemoglobin levels could significantly reduce the prevalence of maternal anemia, which is one of the most significant of the many risk factors associated with adverse pregnancy outcomes, such as preterm birth, low birth weight babies, and increased maternal mortality. The findings demonstrate the importance of incorporating theory-based behavioral interventions, especially those based on the Health Belief Model, into routine antenatal care in order to improve maternal nutrition and health outcomes.

DISCUSSION

This systematic review and meta-analysis show that nutrition education interventions using the Health Belief Model (HBM) lead to the improvement of hemoglobin levels in pregnant women. The pooled increase of 1.35 g/dL is clinically meaningful in the context of the high prevalence of anemia in pregnancy and the associated health risks of maternal morbidity, low-birth-weight babies, and infant mortality [7,8]. The HBM constructs that affect behavior and improve hemoglobin through anemia pregnancy education interventions are perceived susceptibility, perceived severity, perceived benefit, perceived barrier, self-efficacy, and cues to action.

The heterogeneity observed in this meta-analysis was very high ($I^2 = 97\%$), indicating substantial variability in effect sizes across the included studies. This level of heterogeneity suggests that the intervention effects were not

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consistent among the studies analyzed. Several factors may explain this variability, including differences in the duration of the interventions, follow-up periods, educational delivery methods, and participant characteristics across study settings. In addition, variations in baseline hemoglobin levels and adherence to iron supplementation among participants may also have contributed to the observed differences in outcomes. Although subgroup analyses based on intervention duration or follow-up period could help identify potential sources of heterogeneity, the limited number of included studies restricted the feasibility of conducting meaningful subgroup analyses. Therefore, the pooled results should be interpreted with caution.

One included study (Hb3) was assessed as having a high risk of bias, which may affect the reliability of the pooled effect estimate. Studies with methodological limitations can potentially distort the magnitude of the intervention effect. Therefore, the findings of this meta-analysis should be interpreted with caution. Although a sensitivity analysis excluding the high-risk study could provide additional insight into the stability of the pooled results, the limited number of included studies prevented such an analysis from being conducted.

Perceived susceptibility is the awareness of pregnant women regarding the level of anemia risk that is personal to them. This rational evaluation helps women adopt protective behavioral strategies such as iron supplementation and better their diet. Education focused on risk heightens susceptibility, and women become proactive in taking the recommended actions. Increased perceived susceptibility enhanced adherence to iron-folic acid supplementation, leading to improved hemoglobin. Study demonstrated that high perceived susceptibility led to greater adherence to iron-folic acid supplementation which in turn increased hemoglobin levels [2.] Other study also reported that self-risk perception among women led to greater participation in nutrition education II and improved hemoglobin levels [1.] This construct initiates the health behavior change process by making the threat real and personal to the individual. This is necessary to overcome complacency and prompt action4.

Perceived severity is refers to the risk perception of the effects of anemia on the health of the mother and the fetus, including preterm birth, low birth weight, and possible death of the mother. When women perceive anemia as a serious health issue, their determination to take preventive measures to avoid anemia increases substantially. Women who acknowledged the severe consequences of anemia were more likely to adhere to supplementation regimens, resulting in improved hemoglobin concentrations [9.] Perceived severity, when combined with perceived susceptibility, increases the perception of risk and ease of preemptive action to avoid anemia. The focus on severity in the educational interventions is said to increase the activity and compliance [2 11.]

Perceived Benefits are the belief that certain actions, such as taking iron supplements and eating food with iron, decrease the risk of anemia. The clearer the benefits, the higher the motivation and the greater the behavioral compliance. Study demonstrated that highlighting the benefits of iron supplementation led to better adherence and hemoglobin improvement [5.] Other study showed that the belief in the power of supplementation increased the adherence among women [11.] Studies indicate that understanding both short-term and long-term benefits increases women's commitment to adherence [12]

Perceived Barriers are obstacles that prevent or discourage women from engaging in preventive behaviors. These include concerns about side effects such as nausea or constipation, cultural taboos restricting certain foods, forgetfulness, or limited availability and accessibility of supplements. [12] identified perceived barriers as significant predictors of poor adherence. Addressing these barriers through counseling, education, and support enhances compliance and ultimately improves hemoglobin levels. [3] emphasized the importance of culturally sensitive interventions that reduce misconceptions and fears surrounding iron supplementation. [5] showed that personalized counseling and management of side effects facilitated better adherence and biological outcomes. Reducing barriers remains a cornerstone for effective intervention.

Self-Efficacy refers to a woman's confidence in her ability to perform preventive health behaviors consistently. Bandura's theory posits that self-efficacy is essential for translating motivation into action and maintaining behavior over time [13. 6] reported that interventions improving self-efficacy through skills training and social support significantly increased adherence and improved hemoglobin. [11] found that women with greater self-efficacy were more consistent in supplement use, leading to better hematological outcomes. Enhancing self-efficacy empowers women to overcome challenges, such as side effects and social pressures, sustaining health-promoting behaviors critical for hemoglobin improvement.

Cues to Action are prompts or triggers that initiate or maintain health behaviors. These may include reminders from healthcare workers,

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educational materials, peer encouragement, or physical symptoms indicating anemia. Continuous cues are critical to maintaining supplementation adherence over the months needed to improve hemoglobin [14. 15] showed that frequent follow-up and community support increased iron supplement adherence and improved maternal hemoglobin levels. [4] found that visual educational tools and group sessions served as effective cues, promoting sustained behavioral change. These cues help counteract forgetfulness and reinforce motivation, especially in contexts with limited healthcare access.

Behavioral and Biological Pathway to Hemoglobin Improvement

The six HBM constructs interact sequentially to influence preventive health behaviors. Women who perceive themselves at risk (susceptibility) and understand the severity of anemia develop motivation to act. Beliefs in benefits and overcoming barriers translate motivation into intention and initiation of behaviors. Self-efficacy supports maintaining consistent iron supplementation and improved diet, while cues to action reinforce persistence. These behaviors increase iron intake and bioavailability, fueling erythropoiesis and resulting in elevated hemoglobin concentrations [2,5.] The biological improvement reflects the sustained behavioral adherence fostered by the HBM framework, demonstrating the link between psychological constructs and physiological outcomes.

Cultural and Socioeconomic Factors Influencing HBM Effectiveness

The studies included in this review were conducted in different countries, namely Ethiopia, Malaysia, and Indonesia. Differences in socioeconomic conditions, educational levels, cultural dietary practices, and access to maternal health services across these settings may influence pregnant women's health behaviors and adherence to nutrition recommendations. Such variations in sociodemographic characteristics may partly contribute to differences in intervention effects observed across the included studies. While the HBM provides a robust theoretical framework, cultural and socioeconomic factors significantly modulate its effectiveness. Many studies have reported that sociocultural beliefs, dietary customs, and economic barriers can affect how pregnant women perceive susceptibility, severity, and barriers [3;] For instance, cultural taboos restricting iron-rich foods or misinformation about supplements can reduce perceived benefits or amplify barriers. Economic constraints also limit access to supplementation and nutritious foods, affecting actual behavior regardless of knowledge or intention [12.] Tailoring HBM-based interventions to address these contextual factors through culturally appropriate messaging, community involvement, and economic support mechanisms is critical for maximizing impact and equity [11;15.]

Implications for Maternal Health Programs

The demonstrated effectiveness of HBM-based education highlights its potential as a scalable, theory-driven approach for anemia prevention in pregnancy. Integrating comprehensive HBM-informed nutrition education into routine antenatal care, with focused training for healthcare providers on the model's constructs and communication strategies, can significantly improve program outcomes. Digital health platforms that provide reminders and educational support represent promising tools to extend intervention reach and adherence in low-resource settings [15.] Multifaceted implementation strategies that combine behavior change theories with contextual adaptations are likely to yield the most sustainable reductions in anemia prevalence and improvements in maternal and neonatal health.

Limitations and Recommendations for Future Research

This review notes considerable heterogeneity in study designs, populations, and intervention delivery, which limits the generalizability of findings. Standardizing intervention protocols and measurement tools is necessary to improve comparability across future studies. Long-term sustainability of behavior change remains under-investigated, warranting longitudinal studies. Additionally, research assessing cost-effectiveness and scalability of HBM-based interventions, particularly leveraging mobile health technologies and community-based delivery, is urgently needed to optimize public health impact [11.]

CONCLUSION

The systematic review and meta-analysis suggest that nutrition educational interventions using the Health Belief Model (HBM) have a positive and statistically significant impact on pregnant women's hemoglobin levels. An increase of 1.35 g/dL provides proof of the positive impact of a theory-based behavioral intervention on the anemia status of a pregnant woman. Core elements of the HBM, including perceived susceptibility, perceived severity, and perceived benefits, perceived barriers, self-efficacy, and cues to action, are instrumental in motivating and sustaining compliance to Iron supplementation and dietary practice improvement. These changes enhance iron absorption and the

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formation of new red blood cells, thereby resulting in positive changes to hemoglobin levels and to maternal and neonatal wellbeing. While the positive effects and the heterogeneous nature of the studies, in combination with a lack of significant long-term follow-up data, the impact and generalizability of the studies is greatly diminished. Future studies should focus on reducing heterogeneity of the studies by implementing a standardized protocol for the studies to facilitate the evaluation of long-term compliance to the intervention, to hematological changes that occur during the study, and to compliance and sustainability of the intervention in the study through the use of digital health solutions. Providing HBM-based nutrition education as a part of routine antenatal care has the potential to mitigate anemia in pregnant women and ultimately enhance the wellbeing of the mother and child.

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