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RESEARCH ARTICLE

Development of Antenatal Educational Module on Anemia in Pregnancy Using the Sidek Module Development Model

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ABSTRACT

Introduction: Anaemia in pregnancy is common worldwide and remains a significant maternal health concern in Malaysia. While antenatal education is essential for promoting healthy pregnancy outcomes, education about anaemia is often delivered inconsistently and lacks a structured framework. This study aimed to develop and validate an antenatal educational module on anaemia in pregnancy using the Sidek Module Development Model.

Methods: This methodological study employed the Sidek Module Development Model to guide the development and validation of the educational module. The process comprised two phases. The first phase included identifying educational needs, establishing learning objectives, selecting and organising content, and determining suitable instructional strategies and learning materials. The second phase involved content validation by experts using the Content Validity Index. Expert evaluations were conducted in two rounds to assess the relevance, clarity, simplicity, and comprehensibility of the module content.

Results: The first round of validation demonstrated high content validity, with a Scale-Level Content Validity Index of 0.977 for relevance, clarity, and simplicity. After revisions based on expert recommendations, a second round of validation was conducted. The revised module achieved S-CVI values ranging from 0.98 to 1.00 across all evaluation domains, indicating strong expert agreement regarding the assessed content domains.

Conclusion: The antenatal educational module on anaemia in pregnancy demonstrated excellent expert-rated content validity across two rounds of expert evaluation. The findings support the module's readiness for subsequent pilot testing and user evaluation to assess its usability, acceptability, and effectiveness among pregnant women.

Keywords: Anaemia in Pregnancy; Antenatal Education; Module Development; Content Validity; Sidek Module Development Model

INTRODUCTION

Anaemia is a common health problem for pregnant women and a major concern in maternal health worldwide. Anaemia in pregnancy, characterised by low haemoglobin concentrations, has been associated with adverse maternal and infant health outcomes, with lower haemoglobin levels associated with a higher risk of maternal mortality (1). A WHO fact sheet estimates that anaemia affects 30% of women aged 15-49 years and 37% of pregnant women worldwide. Anaemia in pregnancy is commonly defined as a haemoglobin level below 11 g/dL and has been linked to adverse maternal and neonatal outcomes, including preterm birth, low birth weight, postpartum haemorrhage and maternal mortality (2). The burden is higher in low- and middle-income countries. In these regions, nutritional deficiencies, limited access to healthcare, and inadequate health education are persistent challenges (2).

Substantial efforts have been made globally and nationally to improve maternal health outcomes. Yet, anaemia during pregnancy remains highly prevalent (3). Although largely preventable, anaemia continues to occur, pointing to gaps in health literacy, early detection, and preventive practices among pregnant women (3). In many healthcare settings, antenatal care focuses mainly on monitoring and nutritional supplementation. Educational interventions often receive less attention (3,4). Antenatal care offers valuable opportunities for health education. However, differences in service delivery and quality of care can affect the effectiveness of the information for pregnant women (3,5).

Structured antenatal education may strengthen maternal knowledge and awareness of pregnancy-related risks (6). Community-based antenatal health education has been associated Zwith improved knowledge about pregnancy care (7). A published study protocol from Sepang, Malaysia, described a planned quasi-experimental evaluation of health education for pregnant women with anaemia (8). Additionally, studies have demonstrated that knowledge regarding anaemia and adherence to preventive measures remain unsatisfactory among pregnant women (9). In Malaysia, the prevalence of anaemia among pregnant women has been reported to range from 19.3% to 57.4% (10). Contributing factors include inadequate dietary iron intake, poor adherence to iron supplementation, short interpregnancy intervals, and insufficient awareness of anaemia prevention (11). Despite this high burden, there is a lack of consistent, standardised, and evidence-based educational modules specifically addressing anaemia in pregnancy in Malaysia.

The Malaysian Perinatal Care Manual includes anaemia as one of the topics in antenatal health education and provides guidance on its management and nutritional care (12). Similarly, the Maternal Health Record provides health education records and information on anaemia, including guidance on iron-deficiency anaemia and dietary practices (13). However, these national materials do not provide a dedicated, structured antenatal education module on anaemia, with organised learning content for systematic delivery, comparable to the structured, topic-based education provided for breastfeeding. In contrast, the module developed in the present study consolidates evidence-based information on anaemia in pregnancy into a structured educational format and provides the content in four languages to support accessibility among Malaysia's linguistically diverse pregnant population.

METHODS

A methodological research design was used to develop and validate an antenatal educational module on anaemia in pregnancy. The Sidek Module Development Model (SMDM) (14) guided the development process, which consisted of two main phases: Phase One, module development, and Phase Two, module evaluation and refinement. The module development process was conducted at the Faculty of Health Sciences, UiTM Puncak Alam campus from January 2025 to June 2025. Phase One involved data and information derived from a review of relevant literature, national clinical guidelines, health authority reports, professional observations, and expert input, which informed the identification of educational needs, the formulation of learning objectives, the selection and organisation of module content, and the selection of instructional strategies and materials. Phase Two involved two rounds of expert content validation. The first validation round was conducted face-to-face at Bilik Mesyuarat 3, Faculty of Health Sciences, UiTM Puncak Alam campus, while the second validation round was conducted electronically, with the module and validation documents sent to the experts by email. The first validation round was conducted in July 2025 and involved four experts evaluating 11 items, while the second validation round was conducted in December 2025 with four experts evaluating 13 items. Following the first-round expert evaluation, the module content was revised and reorganised based on the experts' feedback. Lengthy text was simplified to improve readability and visual clarity, including revising the "Pathophysiology" section to "How Anemia in Pregnancy Occurs." The "Management" section was also reorganised into three sections covering management during antenatal care, delivery, and after delivery. As a result, the number of content items increased from 11 items in Round 1 to 13 items in Round 2. Data generated during the validation process comprised expert ratings of module content using the Content Validity Index (CVI) and qualitative feedback used to guide module refinement.

Phase One: Module Development

The first phase involved developing an antenatal educational module on anaemia in pregnancy, guided by SMDM (15). Key activities included setting the module goal, identifying key issues, conducting a needs analysis, formulating learning objectives, selecting and organising content, and determining appropriate teaching methods and materials.

Step One: Determination of Module Goal

The development process began by defining the module's overall goal: to provide pregnant women with comprehensive, evidence-based information about anaemia in pregnancy. This goal addresses the high prevalence of anaemia among pregnant women in Malaysia and its link to adverse maternal and neonatal outcomes. National reports from the Ministry of Health Malaysia consistently identify anaemia as the most common medical disorder during pregnancy (16). Establishing a clear goal guided subsequent stages of development and aligned the module with national maternal health priorities.

Step Two: Identification of Key Issues

To identify issues related to anaemia in pregnancy, published literature, national clinical guidelines, reports from health authorities such as the Ministry of Health Malaysia and the World Health Organization (WHO), and peer-reviewed studies were comprehensively reviewed. These sources highlighted anaemia as a significant contributor to adverse maternal outcomes, particularly due to its association with postpartum haemorrhage, reduced maternal reserves, and increased morbidity risk (16). The literature also emphasised the need to improve maternal awareness, early detection, and individual care practices for anaemia in pregnancy (3).

Step Three: Needs Analysis

Educational needs were preliminarily identified using the literature, practice-based observations, informal questioning during routine antenatal care and input from healthcare professionals. The literature consistently identified gaps in pregnant women's knowledge of anaemia, including its causes, symptoms, complications, and prevention (2,16,17). The primary researcher had six years of clinical experience as a Clinical Matron in a public health clinic. In addition, participation as a nurse auditor in the National Nursing Audit provided opportunities to observe nursing practices across various health clinics. Through these professional experiences, the primary researcher observed that some pregnant women had limited knowledge of anaemia in pregnancy, particularly regarding its causes, potential complications, appropriate dietary practices, and the importance of iron supplementation in anaemia prevention. A structured educational module was therefore considered necessary to support nurses in delivering complete, clear, consistent, and evidence-based information about anaemia prevention and management. Expert input from health professionals either directly or indirectly involved in antenatal care, such as midwives, family medicine specialists, nursing lecturers, and nutritionists, further informed the identification of relevant educational needs and the development of structured educational resources focused on anaemia in pregnancy. These observations were based on the primary researcher's professional experience and were not obtained through a formal needs assessment or systematic data collection. Pregnant women were not involved in a structured needs assessment or co-design exercise; therefore, learner needs and cultural appropriateness were informed by the literature, practice-based observations, informal patient questioning, and professional input rather than by formal end-user assessment. The informal clinical observations and patient questioning were not structured research interviews. No patient responses were formally recorded, coded or analysed as research data.

Step Four: Formulation of Learning Objectives

Following the needs analysis, the research team formulated the learning objectives for the anaemia educational module using the SMART framework (specific, measurable, achievable, relevant, and time-bound). The objectives were specific to the educational needs of pregnant women regarding anaemia in pregnancy. Measurability was considered in relation to the assessment of maternal knowledge and understanding of anaemia, including its causes, symptoms, complications, prevention, and management. The objectives were considered achievable within the scope of the module development project and relevant to the educational needs of pregnant women. The module-development phase was planned to take approximately six months (January–June 2025); separate expert content-validation rounds were subsequently conducted in July and December 2025. However, as the module was designed for self-paced learning, no specific timeframe was imposed on pregnant women to complete the learning activities. Therefore, the time-bound element referred to the planned module development process rather than the learners' completion of the module.

Step Five: Selection of Module Content

The module content was developed using evidence from authoritative Malaysian sources, including the Ministry of Health Malaysia Perinatal Care Manual, information contained in the Maternal Health Record, and the Maternal Dietary Guidelines for Malaysia (12,13,18). These sources were prioritised for clinical management, antenatal care, and dietary recommendations to ensure the module content was consistent with Malaysian healthcare practice and suitable for the planned educational intervention. WHO resources were used to support general information on anaemia in pregnancy (2), while standard obstetrics textbooks were consulted to supplement foundational information on anaemia, including its pathophysiology, causes, signs and symptoms (19,20). Relevant articles identified through Scopus were also used to supplement specific educational content, particularly definitions, pathophysiology, signs and symptoms, and other anaemia-related information (11,21,22,23). The selected evidence was reviewed for relevance to anaemia in pregnancy and its applicability to the intended target population. Where discrepancies occurred among international references, textbooks, and Malaysian Ministry of Health guidance, the latter was prioritised for clinical management and recommendations intended for the Malaysian antenatal care setting (16,17). The content was further reviewed by healthcare professionals to assess its appropriateness, clarity, and relevance for providing health education to pregnant women.

Step Six: Organisation of Module Content

The selected content was organised into a logical sequence to facilitate learning and comprehension. The module starts with fundamental concepts of anaemia in pregnancy, then progresses to detailed discussions on causes, symptoms, screening, management, complications, and prevention. This structure supports gradual learning and is intended to support information retention among pregnant women.

Step Seven: Selection of Teaching and Learning Strategies

Teaching and learning strategies were selected to support pregnant women's engagement and understanding of anaemia in pregnancy. The module was designed for self-directed, self-paced learning through a digital platform. It incorporated interactive learning activities, including infographics, educational videos, and quizzes to present key information on anaemia in pregnancy. Upon completing the quizzes, learners could review their answers to assess their understanding of the content. These activities were intended to reinforce learning, encourage active participation, and support learners in assessing their knowledge as they progressed through the module. The present study focused on module development and content validation rather than evaluating the actual delivery process, participant engagement, adherence to educational activities, or module effectiveness. These aspects will be evaluated in a subsequent randomised controlled trial (RCT).

Step Eight: Selection of Media and Materials

An electronic platform, the eHealth Mummy Baby Application (eHMBA), was selected as the proposed medium for delivering the anaemia educational module. The platform was designed to be accessible through smartphones, tablets, and other commonly used digital devices. The selected educational materials included infographics, educational videos, interactive quizzes, and supporting written content. These materials were prepared to present health information in a clear and accessible format. In addition, the module content was prepared in four languages (Malay, English, Mandarin, and Tamil) to accommodate the language needs of pregnant women. Figures 1–5 illustrate examples of the printed module cover and content pages.

Step Nine: Drafting the Module

The final stage of module development involved compiling all educational content, visual materials, videos, and learning activities into a complete module. The module development process took approximately six months and involved reviewing relevant literature and clinical guidelines, developing and organising the educational content, creating infographics and videos, and integrating these components into the digital application. Attention was given to language clarity, cultural considerations, and user-friendliness throughout the development process. English was used as the primary language for module development and expert content validation. The English version underwent two rounds of expert content validation, and all revisions arising from the validation process were completed before translation into other languages. Following completion of the second validation round and finalisation of the English version, the module was translated from English into Bahasa Melayu, Mandarin, and Tamil by a certified professional translation service provider. The translated versions were prepared to improve accessibility for pregnant women from different language backgrounds. As content validation was conducted using the English version only, the reported content validity results refer specifically to the validated English version and do not represent separate content-validity assessments of the translated versions. Figures 1 to 5 show example pages and covers of the four language versions; these images do not depict the interactive digital interface. Figure 6 shows an illustrative mock-up of the eHealth Mummy Baby Application (eHMBA) interface.

How Anemia in Pregnancy Occurs

- During pregnancy, your body needs to make more blood to support your baby.
- The liquid part of your blood (plasma) increases by almost 50% by the end of pregnancy.
- Red blood cells also increase, but only about 25%.
- Because the liquid part increases more than the red blood cells, your blood becomes "diluted."
- This is a normal change in pregnancy and helps your baby grow.
- However, if your hemoglobin (the part of red blood cells that carries oxygen) becomes too low, your body may not be able to give enough oxygen and nutrients to your baby.
- Figure 2 below shows how anemia in pregnancy occurs.

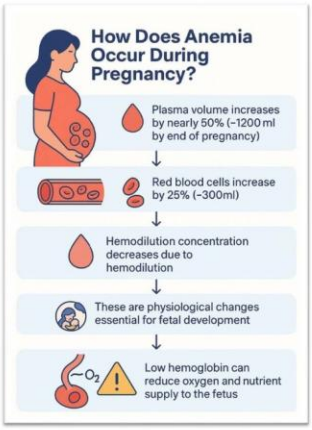

Figure 2: Pathophysiology of anemia in pregnancy

2

Classification of Anemia in Pregnancy

- Anemia in pregnancy can be classified into three categories:

1. **Mild anemia**
   - ✓ Hemoglobin level between 10 g/dL to 10.9 g/dL.
   - ✓ Normally, a pregnant woman with this type of anemia will be assigned a green tag for antenatal coding.
   - ✓ You will be managed by a midwife in the community health clinic.
   - ✓ Your antenatal follow-up is according to normal schedule.

2. **Moderate anemia**
   - ✓ Hemoglobin level between 7 g/dL to 9.9 g/dL.
   - ✓ Pregnant woman with this type of anemia will be coding as yellow tag for antenatal coding.
   - ✓ You will be managed by Family Medicine Specialist (FMS) in the community health clinic.
   - ✓ Your antenatal follow-up will be every two weeks as considered high-risk pregnancy.

3. **Severe anemia**
   - ✓ Hemoglobin level less than 7 g/dL.
   - ✓ The antenatal coding will be red tag means very high-risk pregnancy.
   - ✓ Pregnant women with this type of anemia will be managed in the hospital under the supervision of Obstetrician and Gynaecologist (O&G) specialist.

Causes of Anemia Among Pregnant Women

- Not getting enough essential nutrients like iron, folic acid, vitamin B12, and vitamin C.
- Getting pregnant again too soon (less than 2 years after the last birth).
- Having specific health problems such as malaria, thalassemia, leukemia, sickle cell disease, or frequent bleeding (hemorrhoids or vaginal bleeding).
- Having worm or parasite infections.
- Often drinking beverages that block iron absorption, such as tea, coffee, chocolate drinks, or soft drinks (carbonated beverages).

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Figure 1. Module developed in the English language

Bagaimana Anemia Semasa Kehamilan Berlaku?

- Semasa kehamilan, badan anda perlu menghasilkan lebih banyak darah untuk menyokong pertumbuhan bayi.
- Komponen cecair dalam darah anda (plasma) akan meningkat hampir 50% menjelang akhir kehamilan.
- Sel darah merah juga meningkat, tetapi hanya sekitar 25%.
- Oleh sebab peningkatan bahagian cecair lebih banyak daripada sel darah merah menyebabkan darah anda menjadi "cair."
- Ini adalah perubahan normal semasa kehamilan dan ianya untuk membantu pertumbuhan bayi anda.
- Walau bagaimanapun, jika paras hemoglobin (bahagian dalam sel darah merah yang membawa oksigen) menjadi terlalu rendah, badan anda mungkin tidak dapat membekalkan oksigen dan nutrien yang mencukupi kepada bayi.
- Rajah 2 di bawah menunjukkan bagaimana anemia semasa kehamilan berlaku.



Rajah 2: Patofisiologi kejadian anemia semas kehamilan

Klasifikasi Anemia Semasa Kehamilan

- Anemia semasa kehamilan dapat diklasifikasi kepada tiga iaitu:

1. **Anemia ringan**
   - ✓ Paras hemoglobin di antara 10 g/dL hingga 10.9 g/dL.
   - ✓ Secara amnya, wanita hamil dengan jenis anemia ini akan diberikan kod warna hijau bagi tujuan pengkodan antenatal.
   - ✓ Wanita hamil akan dipantau oleh jururawat di klinik kesihatan komuniti.
   - ✓ Pemeriksaan antenatal akan dijalankan mengikut jadual biasa.

2. **Anemia sederhana**
   - ✓ Paras hemoglobin di antara 7 g/dL hingga 9.9 g/dL.
   - ✓ Wanita hamil dengan jenis anemia ini akan diberikan kod warna kuning bagi pengkodan antenatal.
   - ✓ Wanita hamil akan dipantau oleh Pakar Perubatan Keluarga (FMS) di klinik kesihatan komuniti.
   - ✓ Pemeriksaan antenatal akan dijalankan setiap dua minggu kerana dikategorikan sebagai kehamilan berisiko tinggi.

3. **Anemia teruk**
   - ✓ Paras hemoglobin kurang daripada 7 g/dL.
   - ✓ Pengkodan antenatal akan diberikan kod warna merah, bermaksud kehamilan sangat berisiko tinggi.
   - ✓ Wanita hamil dengan jenis anemia ini akan dirawat di hospital di bawah penyeliaan Pakar Obstetrik dan Ginekologi (O&G).

Punca Anemia Semasa Kehamilan

- Kekurangan mikronutrien penting terutamanya zat besi, asid folik, vitamin B12, dan vitamin C.
- Kekerapan hamil semula dalam tempoh yang terlalu singkat (kurang daripada 2 tahun selepas kelahiran sebelumnya).
- Menghidap masalah perubatan tertentu seperti malaria, talasemia, leukemia, penyakit sel sabit (*sickle cell disease*), atau mengalami pendarahan yang kerap (seperti buasir atau pendarahan faraj).
- Mengalami jangkitan cacing atau parasit.

Figure 2. Module developed in the Malay language

- 由于血浆增加的比例大于红细胞，导致血液变得“稀释”。
- 这是怀孕期间的正常变化，有助于胎儿的生长。
- 然而，如果血红蛋白（红细胞中携带氧气的部分）水平过低，您的身体可能无法向胎儿提供足够的氧气和营养。
- 下图（图 2）显示了妊娠期贫血是如何发生的。

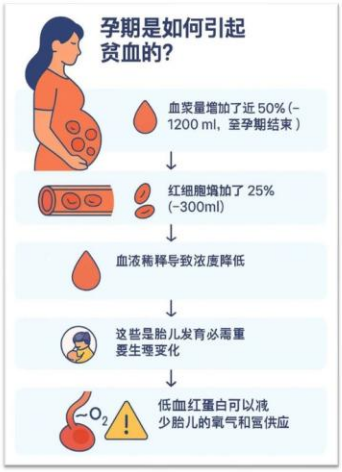


图 2：妊娠期贫血发生的病理生理学

2

妊娠期贫血的分类

✓ 妊娠期贫血可分为三类：

1. **轻度贫血**

- 血红蛋白水平在 10 g/dL 至 10.9 g/dL 之间。
- 一般来说，这类孕妇在产前编码中会标记为绿色。
- 孕妇将在社区卫生诊所由护士进行监测。
- 产前检查将按常规时间表进行。

2. **中度贫血**

- 血红蛋白水平在 7 g/dL 至 9.9 g/dL 之间。
- 这类孕妇在产前编码中会标记为黄色。
- 孕妇将在社区卫生诊所由家庭医学专科医生（FMS）进行监测。
- 由于属于高风险妊娠，产前检查每两周进行一次。

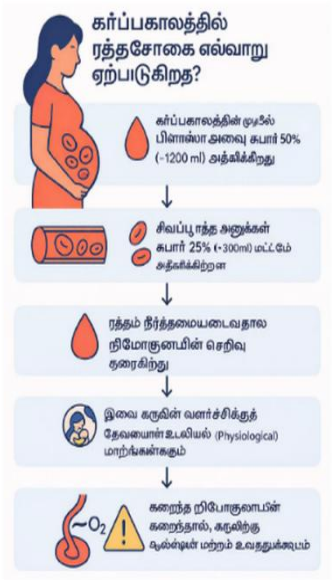
3. **重度贫血**

- 血红蛋白水平低于 7 g/dL。
- 产前编码为红色，表示妊娠非常高风险
- 这类孕妇将在医院由产科与妇科（O&G）专家监督下进行治疗。

妊娠期贫血的原因

- 缺乏重要微量营养素，尤其是铁、叶酸、维生素 B_{12} 和维生素 c。
- 短时间内再次怀孕（距上次分娩不足 2 年）。
- 患有某些疾病，如疟疾、地中海贫血、白血病、镰状细胞病，或经常出血（如痔疮或阴道出血）。
- 感染蠕虫或寄生虫。
- 经常摄入阻碍铁吸收的食物或饮料，如茶、咖啡、可可饮料或碳酸饮料。

3



படம் 2: கர்ப்ப காலத்தில் இரத்தக்குறைவு ஏற்படும் பாதோபிஸியாலஜி

கர்ப்ப கால இரத்தக்குறைவின் வகைப்பாடு

✓ கர்ப்ப கால இரத்தக்குறைவு மூன்று வகைகளாக வகைப்படுத்தப்படுகிறது:

1. **மிதமான இரத்தக்குறைவு**

- ஹீமோகுளோபின் அளவு 10 g/dL முதல் 10.9 g/dL வரை.
- பொதுவாக, இந்த வகை இரத்தக்குறைவு உள்ள கர்ப்ப பெண்களுக்கு கண்காணிப்பு குறியீட்டில் பச்சை நிறம் கொடுக்கப்படும்.
- கர்ப்ப பெண்கள் சமூக சுகாதார கிளினிக் நர்சின் கண்காணிப்பில் இருக்குவர்.
- கண்காணிப்பு பரிசோதனைகள் வழக்கமான அட்டவணையின் படி நடைபெறும்.

2. **நடுத்தர இரத்தக்குறைவு**

- ஹீமோகுளோபின் அளவு 7 g/dL முதல் 9.9 g/dL வரை.
- இந்த வகை இரத்தக்குறைவு உள்ள கர்ப்ப பெண்களுக்கு கண்காணிப்பு குறியீட்டில் மஞ்சள் நிறம் கொடுக்கப்படும்.
- கர்ப்ப பெண்கள் சமூக சுகாதார கிளினிக் குடும்ப மருத்துவ நிபுணரால் (FMS) கண்காணிக்கப்படுவர்.
- இது உயர் அபாயக் கர்ப்பமாக வகைப்படுத்தப்படுவதால், கண்காணிப்பு பரிசோதனைகள் இரு வாரங்களுக்கு ஒருமுறை நடக்கின்றன.

3. **கடுமையான இரத்தக்குறைவு**

- ஹீமோகுளோபின் அளவு 7 g/dL க்குக் குறைவாக இருக்கும்போது.
- கண்காணிப்பு குறியீட்டில் சிவப்பு நிறம் கொடுக்கப்படும், இதன் பொருள் கர்ப்பம் மிகவும் உயர் அபாயத்துடன் உள்ளது.
- இந்த வகை இரத்தக்குறைவு உள்ள கர்ப்ப பெண்கள் மருத்துவமனையில் மற்றும் (O&G) நிபுணர்களின் மேற்பார்வையில் சிகிச்சை பெறுவர்.

கர்ப்ப கால இரத்தக்குறைவின் காரணங்கள்

- முக்கியமான சிறு ஊட்டச்சத்துக்கள் (மிக்ரோ நியூட்ரியன்கள்) குறைவாக இருப்பது, குறிப்பாக இரும்பு, ஃபோலிக் அமிலம், வைட்டமின் B12 மற்றும் வைட்டமின் C.
- குறுகிய கால இடைவெளியில் மீண்டும் கர்ப்பமாகி பிறப்பது (முந்தையப் பிறப்புக்கு 2 ஆண்டுகளுக்கு குறைவாக).
- சில மருத்துவச் சிக்கல்கள், எடுத்துக்காட்டாக மழலை நோய் (மலேரியா), தலாசிமியா, லூக்கிமியா, சிக்கிள் செல் நோய், அல்லது அடிக்கடி இரத்தக்கசிவு (பழகுகள் அல்லது யோனி இரத்தம்).
- சுறுகிய அல்லது பராசைட் தொற்று.
- இரும்பு உறிஞ்சுவதற்கு தடையாகும் உணவு அல்லது பானங்களை அதிகம் எடுத்தல், உதாரணமாக தேநீர், காபி, சாக்லேட் பானம், கார்போனேட்டெட் பானங்கள்.

Figure 4. Module developed in the Tamil language



Figure 5. Module completed in four languages

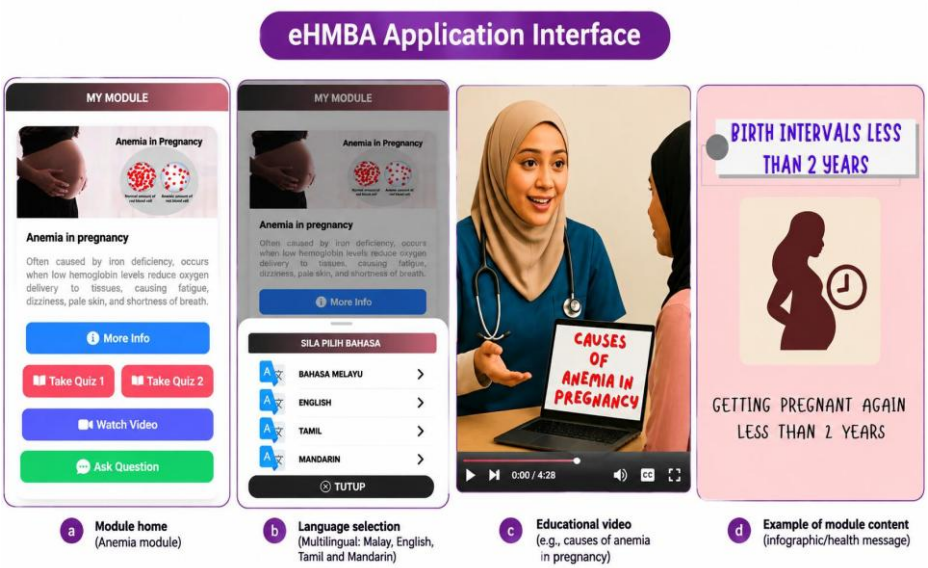


Figure 6. Illustrative mock-up of the eHealth Mummy Baby Application (eHMBA) interface showing the anaemia module, language selection, educational video, and example of educational content.

Phase Two: Module Evaluation and Refinement

In the second phase, the draft module underwent expert evaluation to assess its content for pregnant women, with particular attention to relevance, clarity, simplicity, and overall comprehensibility. Content validation was conducted in two rounds using the Content Validity Index (CVI), a widely accepted quantitative measure of expert agreement on educational materials (24). Four experts participated in each validation round, with the same professional composition in both rounds: one public health nurse, one nurse lecturer, one dietitian, and one family medicine specialist (FMS). The experts were purposively selected for their professional expertise and experience working with pregnant women. All experts had more than 10 years of experience working with pregnant women, either directly through clinical practice or indirectly through nursing education. The experts were recruited through professional contacts established during the researcher's previous work in the healthcare sector and were invited by email to participate in the validation process. The first-round panel and second-round panel consisted of different experts, except for one FMS who participated in both rounds. The change in panel composition was primarily due to the experts' work commitments, including difficulties obtaining release from their duties and attending training or other professional activities. For the second validation round, the module and validation documents were sent to the experts by email, and they were given two weeks to complete the evaluation. None of the experts involved in either validation round participated in the module development or initial drafting. The module was developed by the researcher, the research supervisor, and a Master's student before being submitted for expert evaluation. Prior to participation, all experts were informed of the study purpose and provided written informed consent. Ethical approval was obtained before commencement of the study from the Universiti Teknologi MARA (UiTM) Research Ethics Committee [REC/12/2024 (ST/MR/255)] and the Medical Research & Ethics Committee, Ministry of Health Malaysia [NMRR ID-25-01170-L4S].

Two rounds of expert validation were conducted to evaluate and refine the module content. Feedback from the first validation round was used to revise and refine the module prior to the second validation round, which aimed to confirm the improvements and further strengthen content accuracy, clarity, and appropriateness. Experts assessed each module content item using a four-point rating scale for relevance, clarity, and simplicity. For these criteria, the ratings were: 1 = not acceptable; 2 = below expectations and required major modifications; 3 = met expectations but required minor modifications; and 4 = excellence with no modifications needed. In the second validation round, ambiguity was also assessed using a four-point scale with a reversed scoring direction: 1 = excellence with no modifications needed; 2 = met expectations but required minor modifications; 3 = below expectations and required major modifications; and 4 = not acceptable. Therefore, ratings of 3 or 4 were considered acceptable for relevance, clarity, and simplicity, whereas ratings of 1 or 2 were considered acceptable for ambiguity. The Item-Level Content Validity Index (I-CVI) was calculated by dividing the number of experts who provided an acceptable rating for each item by the total number of experts. The Scale-Level Content Validity Index based on the average method (S-CVI/Ave) was calculated as the average of the I-CVI values across all items. With four experts, an I-CVI of 1.00 indicated agreement among all four experts, while an I-CVI of 0.75 indicated that three of four experts provided an acceptable rating. The interpretation of CVI values followed published content-validation guidance (24,25,26), with an S-CVI/Ave ≥ 0.90 indicating excellent content validity (26).

RESULTS

First Phase of Content Validation

In the first validation round, four experts evaluated 11 module content items across the criteria of relevance, clarity, and simplicity. The validation was conducted face-to-face, allowing the experts to review the module and provide written comments and suggestions directly on the draft. For relevance, 10 of the 11 items achieved an I-CVI of 1.00, while one item, "Prevention method," achieved an I-CVI of 0.75, indicating that three of the four experts provided an acceptable rating. The same pattern was observed for clarity and simplicity: 10 items achieved an I-CVI of 1.00, and the "Prevention method" item achieved an I-CVI of 0.75 for both criteria. The S-CVI/Ave was 0.977 for relevance, clarity, and simplicity, indicating excellent overall content validity. The item-level expert ratings and I-CVI values for all 11 items are presented in Supplementary Table S1. The written comments and suggestions provided by the experts during the first validation round were reviewed and used to refine the module before the second validation round, including revisions to wording, visual presentation, and content organisation.

Second Phase of Content Validation

Following module refinement, the second validation phase was conducted with a different panel of experts, except for one family medicine specialist (FMS) who participated in both rounds. Four individual experts participated in each validation round, comprising one public health nurse, one nurse lecturer, one dietitian, and one FMS. The change in panel composition was primarily due to the experts' work commitments, including difficulties obtaining release from their duties and attendance at training and other professional activities. In the second validation round, 13 module content items were evaluated across four criteria: relevance, clarity, simplicity, and ambiguity. The increase from 11 items in the first validation round to 13 in the second round resulted from revisions based on first-round expert feedback. The "Pathophysiology" item was revised and renamed "How Anemia in Pregnancy Occurs", while the original "Management" item was reorganised into three sections: "Management During Antenatal", "Management During Delivery", and "Management After Delivery". Thus, the increase in the number of items resulted from reorganizing the module content rather than from adding two unrelated items. Detailed second-round expert ratings and item-level I-CVI values are provided in Supplementary Table S2.

Summary of Content Validation Outcomes and Expert Consensus

Overall, the Anemia in Pregnancy Antenatal Educational Module demonstrated excellent expert-rated content validity in both validation rounds. In the first validation round, the S-CVI/Ave was 0.977 across the three assessed criteria: relevance, clarity, and simplicity. In the second validation round, the domain-specific S-CVI/Ave values were 0.98 for relevance and 1.00 for clarity, simplicity, and ambiguity. The overall S-CVI/Ave of 0.995 for the second validation round was calculated by averaging the four domain-specific S-CVI/Ave values [(0.98 + 1.00 + 1.00 + 1.00)/4]. As the two validation rounds differed in the number of items evaluated and the assessment criteria used, the S-CVI/Ave values were not interpreted as a direct measure of improvement between rounds. Instead, each value was interpreted as evidence of excellent content validity for its respective validation round. The findings indicate strong expert agreement that the module content was relevant, clear, simple, and unambiguous. Following the first validation round, minor revisions were made based on expert feedback to improve the wording, visual presentation, content organisation, and alignment with current clinical practices. The revised module was subsequently subjected to a second validation round to confirm the refinements and further assess its content validity. These findings support the module's readiness for subsequent pilot testing and user evaluation. Table 1 summarizes the findings for the first and second validation processes.

Table 1. Findings of the first and second content validation

Criteria	First validation (11 items)		Second validation (13 items)	
	I-CVI	S-CVI	I-CVI	S-CVI
Relevance	10 items = 1.00 1 item = 0.75	0.977	12 items = 1.00 1 item = 0.75	0.98
Clarity	10 items = 1.00 1 item = 0.75	0.977	13 items = 1.00	1.00
Simplicity	10 items = 1.00 1 item = 0.75	0.977	13 items = 1.00	1.00
Ambiguity	Not assessed	-	13 items = 1.00	1.00
Overall S-CVI		**0.977**		**0.995**

Overall S-CVI/Ave for the second validation round = (0.98 + 1.00 + 1.00 + 1.00) / 4 = 0.995

DISCUSSION

Anaemia remains the most frequently reported medical disorder during pregnancy in Malaysia and continues to contribute to adverse maternal outcomes, such as postpartum haemorrhage and increased morbidity (2). Structured health-education modules have also been developed for other populations, including nursing students (27), while research in low- and middle-income countries has documented adverse birth outcomes associated with maternal anaemia (28). A mixed-methods study in Ghana and Uganda identified gaps in community understanding and facility readiness for anaemia prevention and management (29). In the Malaysian antenatal care context, existing national resources support the management and information provision related to anaemia in pregnancy. The Malaysian Perinatal Care Manual serves as a clinical guideline for the management of pregnant women with normal and high-risk conditions, including anaemia in pregnancy (12). The Maternal Health Record, on the other hand, is routinely used by nurses and doctors to document antenatal care during clinic visits and contains selected information on anaemia, including its complications, dietary guidance for pregnant women with anaemia, and instructions for iron tablet intake (13). However, the anaemia-related information in the Maternal Health Record is not comprehensive and is primarily presented in text.

The module developed in the present study was therefore designed to provide more comprehensive information on anaemia in pregnancy in a structured and accessible format. The module covers the definition, causes, signs and symptoms, screening and diagnosis, management, complications, and prevention of anaemia. To facilitate understanding and make the educational content more engaging, visual infographics and videos were incorporated into the digital application, together with interactive quizzes that allow learners to assess their understanding. The module was also developed in four languages: English, Malay, Mandarin, and Tamil, to support accessibility among linguistically diverse pregnant women. Thus, the module is intended to complement, rather than replace, the Perinatal Care Manual, Maternal Health Record, and routine antenatal counselling by providing an additional structured and engaging educational resource on anaemia in pregnancy. Whether these features improve comprehension, engagement, usability, acceptability, or learning outcomes among pregnant women requires further evaluation through pilot testing and subsequent user studies. In a different preventive-health context, a randomised trial evaluated face-to-face and mobile-based education to increase cervical-screening acceptance (30); these findings cannot be assumed to apply to this module.

This study also illustrates the use of the SMDM as a structured framework for developing an antenatal educational module. The SMDM provided a systematic approach for aligning the identified educational needs, learning objectives, educational content, instructional strategies, and evaluation processes (15). Through its structured phases, the model facilitated the identification of educational needs, the formulation of learning objectives, the selection of relevant content, and the systematic evaluation of the module by experts. Such a structured development process is particularly important in antenatal education, where the accuracy, relevance, and clarity of educational information are important considerations. However, learner engagement and comprehension among pregnant women were not evaluated in the present study. Therefore, the contribution of the SMDM in supporting these outcomes remains to be established through subsequent user testing and evaluation.

The findings demonstrated excellent expert-rated content validity across two phases of expert evaluation, with S-CVI values ranging from 0.977 to 1.00, exceeding the recommended threshold (25,26). The structured development process is consistent with the SMDM framework and with published guidance on content validation (15,24). Both the SMDM framework and CVI guidance support a structured approach to content development and expert review (15,24). For example, a previous study reported excellent content validity (S-CVI/Ave = 0.985), high educational quality ratings, and excellent internal consistency in a multi-component lifestyle intervention module developed using the SMDM (27). These findings support the value of systematic module development, multidisciplinary expert evaluation, and evidence-based educational design in establishing content validity prior to subsequent user testing.

Another important feature of this study is the incorporation of multilingual and visually supported educational content to enhance accessibility. Previous research has highlighted the importance of accessible antenatal education and the influence of language preference and health literacy on health information-seeking experiences (31,32). The use of infographics has also been identified as a useful health knowledge translation approach, while picture-based health education has been associated with improvements in knowledge and adherence in specific educational contexts (33,34). In the present study, the module was developed in four of Malaysia's most widely used languages and incorporated infographics and videos to present information on anaemia in pregnancy. However, cultural acceptability, readability, comprehension, usability, and effectiveness of these features were not directly assessed with pregnant women. Therefore, the multilingual and visually supported format should be considered a design feature intended to support accessibility and information presentation, rather than evidence of established cultural appropriateness or effectiveness.

The systematic refinement process, implemented through two phases of expert validation, provided a structured basis for refining the module. Integrating expert feedback led to improvements in wording, visual presentation, and content organisation, with the aim of improving quality and clarity. Comparable iterative validation methods are advocated in nursing education to ensure that interventions remain evidence-based, clinically relevant, and responsive to learners' needs. This process is especially significant in antenatal education, where efficient communication and accurate understanding influence maternal self-care and pregnancy outcomes. The refinement process may have contributed to the excellent content validity observed in this study. Using a systematic, theory-driven approach supported the development of a high-quality educational module on anaemia in pregnancy.

Despite the findings, several limitations should be acknowledged when interpreting this study. First, the study focused on the development and expert content validation of the antenatal educational module and did not evaluate its effectiveness in improving pregnant women's knowledge, attitudes, health behaviours, or anaemia-related outcomes. Consequently, the module's actual impact on learning, behavioural change, and anaemia-related outcomes remains undetermined. Second, the module's readability, comprehension, usability, acceptability, and feasibility were not assessed directly with pregnant women in the present study. Therefore, the expert-rated content validity findings should not be interpreted as evidence of the module's suitability for routine use or its effectiveness in improving learning or behavioural outcomes. Third, content validation was conducted with four experts in each validation round. With a four-expert panel, the I-CVI values were necessarily discrete, with an I-CVI of 1.00 representing agreement among all four experts and 0.75 representing agreement among three of four experts. The relatively small panel size may limit the precision and certainty of agreement estimates and may also affect the breadth of perspectives represented in the content validation process. However, the multidisciplinary composition of the expert panel, comprising professionals from nursing, dietetics, and family medicine, provided varied professional perspectives on the module content. These limitations should be considered when interpreting the content validity findings. Subsequent pilot testing with pregnant women from diverse backgrounds is needed to assess readability, comprehension, usability, acceptability, feasibility, and learning outcomes before wider implementation and to determine the module's effectiveness in antenatal care settings.

CONCLUSION

This study successfully developed an antenatal educational module on anaemia in pregnancy using the Sidek Module Development Model (SMDM) and established its expert-rated content validity through two rounds of expert evaluation. The module demonstrated excellent expert-rated content validity, with strong agreement on its relevance, clarity, simplicity, and lack of ambiguity. The systematic development process and iterative expert review provide a structured foundation for subsequent user testing.

The module is therefore considered ready for subsequent pilot testing to assess its readability, comprehension, usability, acceptability, feasibility, and learning outcomes among pregnant women. Further studies are also needed to determine its effectiveness in improving knowledge, health behaviors, adherence to iron supplementation, dietary practices, and anaemia-related outcomes before wider implementation in routine antenatal care.

DECLARATIONS

Author contributions: Norazlina Md Jazli: Conceptualisation, Methodology, Writing – original draft, and development of the educational module. Sharifah Shafinaz Sh. Abdullah: Methodology, Supervision, and Writing – review and editing. Nor Sufaradila Maizura Badrun Sufian @ Ahmad Zaki and Aminath Rinzy: Data curation, including data entry and organisation of expert content-validation ratings in Microsoft Excel. Jiaqi Zhao: Writing – original draft and translation support. Chong Mei Chan: Writing – review and editing. All authors read and approved the final version of the manuscript.

The independent expert panel members evaluated the educational module during the content-validation process. They were not involved in the development or drafting of the module.

Conflicts of interest: The authors declare no conflicts of interest.

Declaration of Generative AI And AI-Assisted Technologies in the Writing Process: ChatGPT (OpenAI, GPT-6) and Grammarly for Windows (version 1.2.234.1829) were used for language refinement, grammar checking and readability. ChatGPT also provided guidance on statistical procedures and analytical approaches; all data analyses were independently performed by the researcher. ChatGPT and Canva AI (web-based platform; specific AI feature and release version not reported) were used as AI-assisted design tools to generate illustrations incorporated into the anaemia educational module (Figures 1–5) and to prepare the illustrative eHealth Mummy Baby Application (eHMBA) interface mock-up in Figure 6. The mock-up depicts a proposed interface and does not constitute evidence of a tested application. No generative AI tool was used to generate or alter the study data, statistical results or scientific findings. The authors report that they reviewed and verified the AI-assisted materials and accept responsibility for the accuracy and integrity of the manuscript.

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Data Availability Statement: Aggregate content-validation results are presented in Table 1, and item-level expert ratings for both validation rounds are provided in Supplementary Tables S1 and S2. The authors state that the underlying anonymised expert-rating data and supporting materials may be obtained from the corresponding author upon reasonable request, subject to confidentiality requirements. Personally identifiable information about expert-panel members will not be disclosed.

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Informed Consent and Confidentiality: The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all expert panel members prior to their participation in the content validation process. Participation was voluntary, and all expert panel members were informed of their right to withdraw from the study at any stage without any consequences. To ensure confidentiality, all information provided by the expert panel members was anonymized, securely stored, and used solely for research purposes, with access restricted to the research team.

Ethical Approval: Ethical approval was obtained prior to the commencement of this study from the Universiti Teknologi MARA (UiTM) Research Ethics Committee on 30 December 2024 (REC/12/2024 [ST/MR/255]) and the Medical Research & Ethics Committee, Ministry of Health Malaysia (NMRR ID-25-01170-L4S).

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