

# Improving Iron Deficiency Anemia (IDA) Prevention and Management Strategies in Indonesia: An Expert Opinion



Renno Raymond Okto Zulfikar<sup>1</sup>, Endang Mariani<sup>2,3</sup>, Catherine Gunawan<sup>4</sup>, Nova Lidia Sitorus<sup>5</sup>, Charisma Dilantika<sup>5</sup>, Tonny Sundjaya<sup>5,6</sup>, Bunga Pelangi<sup>7</sup> and Ray Wagiu Basrowi<sup>5,7,8,\*</sup>

<sup>1</sup>Universitas Mercu Buana, Jakarta, Indonesia

<sup>2</sup>Department of Anthropology, Faculty of Social and Political Science, Universitas Indonesia, Indonesia

<sup>3</sup>Department of Communication and Health, Laboratorium Political Psychology, Faculty of Psychology, Universitas Indonesia, Indonesia

<sup>4</sup>Department of Medicine, Awal Bros Batam Hospital, Gajah Mada Street No.Kav. 1, Baloi Indah, Lubuk Baja, Batam City, Riau Islands, Indonesia

<sup>5</sup>Department of Nutrition, Danone Specialized Nutrition Indonesia, Jakarta, Indonesia

<sup>6</sup>Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Jakarta, Indonesia

<sup>7</sup>Research Department, Health Collaborative Center (HCC), Jakarta, Indonesia

<sup>8</sup>Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia

## Abstract:

**Background:** Iron deficiency anemia (IDA) remains a significant public health challenge in Indonesia, particularly in pregnant women and female adolescents. The Indonesian government has implemented several prevention and management programs, such as providing iron-folic acid tablets to female adolescents and pregnant women, initiating early health promotion to infants and pregnant women, conducting nutritional education to pregnant women, and providing supplementary feeding to pregnant women. However, the prevalence of iron deficiency anemia (IDA) in these groups remains significant and some of the strategies haven't been successfully and effectively implemented. Stemming from this issue and gaps, qualitative insights and opinions from relevant experts are crucial for the improvement of iron deficiency anemia (IDA) prevention and management strategies in Indonesia.

**Objectives:** This qualitative study discussed the expert opinions regarding iron deficiency anemia (IDA) prevention and management strategies in Indonesia.

**Methods:** A qualitative study on expert opinions regarding iron deficiency anemia (IDA) involving 11 participants selected through purposive sampling among those who have expertise in women's and children's health, nutrition, clinical psychology, and education in a 90-minute online Focus Group Discussion (FGD) was done. The main themes identified were the importance and urgency of iron deficiency anemia (IDA) status assessment, behavior modification-oriented health education, and iron deficiency anemia (IDA) prevention in pregnant women and female adolescents. Data were transcribed and analyzed using NVIVO 12.

**Results:** The key recommendations from the experts' discussion for a holistic approach to prevent and manage iron deficiency anemia (IDA) in Indonesian pregnant women and female adolescents were: (1) By emphasizing iron deficiency anemia (IDA) status assessment prior to supplementation with ferritin test as indicators, hoping that the targets can be detected and receive interventions as early and accurately as possible. (2) Behavior modification-oriented health education by analyzing the target's level of knowledge and comprehension of iron deficiency anemia (IDA), potential challenges, and factors that can encourage preventive behavior against iron deficiency anemia (IDA), implementing preventive measures against iron deficiency anemia (IDA) and supportive social environments, and providing health education with the involvement of supportive social environments. (3) Iron deficiency anemia (IDA) prevention strategies in pregnant women and female adolescents by consumption of foods rich in iron and/or rich in iron enhancers, as well as avoiding foods that contain iron inhibitors and the iron-folic acid tablets consumption adherence.

**Conclusion:** Effective iron deficiency anemia (IDA) prevention and management strategies include ferritin-based iron status assessment prior to supplementation, behavior modification-oriented health education, dietary interventions, and iron supplementation adherence. Nevertheless, the government's commitment to support and fund the programs is also crucial in order to achieve the desired outcomes.

**Keywords:** Expert opinion, Iron deficiency anemia, Ferritin, HBM, Dietary interventions.

© 2025 The Author(s). Published by Bentham Open.

This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International Public License (CC-BY 4.0), a copy of which is available at: <https://creativecommons.org/licenses/by/4.0/legalcode>. This license permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



CrossMark

Received: October 21, 2024

Revised: November 24, 2024

Accepted: November 26, 2024

Published: June 11, 2025



Send Orders for Reprints to  
[reprints@benthamscience.net](mailto:reprints@benthamscience.net)

\*Department of Nutrition, Danone Specialized Nutrition In-donesia, Jakarta, Indonesia, Department of Epidemiology, Faculty of Public Health, Universitas Indonesia, Jakarta, Indonesia and Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia; E-mail: [ray.basrowi@gmail.com](mailto:ray.basrowi@gmail.com)

Cite as: Zulfikar R, Mariani E, Gunawan C, Sitorus N, Dilantika C, Sundjaya T, Pelangi B, Basrowi R. Improving Iron Deficiency Anemia (IDA) Prevention and Management Strategies in Indonesia: An Expert Opinion. Open Public Health J, 2025; 18: e18749445361508. <http://dx.doi.org/10.2174/0118749445361508250602094137>

## 1. INTRODUCTION

Iron deficiency anemia (IDA) remains a significant public health challenge in Indonesia, particularly in pregnant women, female adolescents, and children [1]. The Basic Health Research (Riskesdas) surveys conducted by the Ministry of Health of the Republic of Indonesia in 2018, revealed a notable number in the prevalence of anemia among pregnant women (48,9%), children under five years old (38,5%), individuals aged 15-24 years old (32%), and children aged 5-14 years old (26%) [2]. Most anemia cases are due to iron deficiency anemia (IDA), particularly in low-developing countries such as Indonesia [3, 4]. The prevalence of iron deficiency anemia (IDA) in Indonesian pregnant women ranged from 46.2% to 46.5% [5, 6] and 21.1% in female adolescents [7]. Anemia is associated with increased morbidity and mortality in pregnant women and their babies, poor birth outcomes, decreased physical and work performance in adolescents and adults, as well as impaired growth, cognition, and behavior in children and adolescents [7-9].

The Indonesian government has implemented population-level approach programs to prevent and manage iron deficiency anemia (IDA), such as providing iron-folic acid tablets to female adolescents and pregnant women, initiating early health promotion to infants and pregnant women, conducting nutritional education to pregnant women, and providing supplementary feeding to pregnant women [4]. However, the prevalence of iron deficiency anemia (IDA) in these groups remains significant and some of the strategies haven't been successfully and effectively implemented. This was shown by only 44.2% of pregnant women consumed iron-folic acid tablets as recommended ( $\geq 90$  tablets during their pregnancy) and only 3% - 4.3% of female adolescents consumed iron-folic acid tablets recommended as well ( $\geq 52$  tablets a year). It was also found that Indonesian pregnant women were still at risk of chronic malnutrition, with an increased prevalence from 10.6% in 2018 to 16.9% in 2023. Additionally, only 32.1% of pregnant women have received supplementary food, and 5.8%-25.7% of them did not finish their supplementary food [10].

Stemming from this issue and gaps, qualitative insights and opinions from relevant experts are crucial for the improvement of iron deficiency anemia (IDA) prevention and management strategies in Indonesia.

## 2. MATERIALS AND METHODS

This qualitative study discussed the opinions of experts regarding iron deficiency anemia (IDA) through a 90-minute online Focus Group Discussion (FGD) involving 11 participants selected through purposive sampling. All authors were involved in the interview. The experts were selected among those who have expertise in women's and children's health, nutrition, clinical psychology, and education. Contact details of these experts were obtained through various networks within the universities and professional associations. The experts were invited by telephone and e-mail to participate in a virtual meeting, which was audio-recorded. No expert was refusing to participate in the study. The 11 experts representing each field who participated in the expert review meeting consisted of 2 male experts and 9 female experts. There were two obstetrics and gynecology experts, two pediatricians specialized in nutrition and metabolic, one pediatrician specialized in growth and development, two specialists in clinical nutrition, one community nutrition expert, one clinical psychologist, one midwife, and one education expert.

No one was present besides the researcher and the experts during data collection. The researcher provided the questions. It has not been tested before. The FGD was performed one time only through the virtual meeting. The duration of the meeting was four hours. Data processing involved two processes, namely (1) verbatim transcription of focus group discussion recordings through Windows Media Player and Microsoft Word, and (2) categorization of the transcribed data using NVIVO 12 application with the assistance of codes/nodes features. The transcripts were returned to the experts for comment and correction before being processed further. Two people analyzed the data. The categorized data was then analyzed using a thematic content approach in NVIVO 12, which included the identification, analysis, and interpretation of themes within a qualitative data set. Specifically, data analysis was conducted using exploratory features such as word frequency (Word Cloud and Tree Map) and was conducted thematically. The results were presented to the experts for feedback.

## 3. RESULTS

The expert consensus agreed that it is crucial to conduct interventions based on life cycle, focusing on two key targets: pregnant women and female adolescents, who

have a high prevalence of anemia. Three thematic outcomes were found through content analysis based on the discussion topic. From these thematic outcomes, an inductive process was carried out by taking the perspective of a holistic approach to iron deficiency anemia (IDA) prevention and management through health promotion. According to the World Health Organization (WHO), health promotion is defined as a process that enables communities to increase their control over health and to improve their healthy lifestyle through developing health literacy and multisectoral actions. It extends beyond concentrating solely on individual actions, rather, it encompasses a broad spectrum of social and environ-

mental interventions. It can also be achieved by building healthy public policies, and supportive environments, strengthening community actions and individual health-related skills [11].

Regarding health promotion for iron deficiency anemia (IDA) prevention and management, experts consensus recommended three strategies: (1) the importance and urgency of iron deficiency anemia (IDA) status assessment, (2) health education based on behavior modification, and (3) prevention of iron deficiency anemia (IDA) in pregnant women and female adolescents.

Table 1 summarizes the main themes, subthemes, and examples of participants' quotes during the FGD:

**Table 1. Main themes, subthemes, and examples of participants' quotes.**

Main Themes	Subthemes	Examples of Participants' Quotes
The importance and urgency of iron deficiency anemia (IDA) status assessment	Provision of iron-folic acid tablets without conducting structured procedural examinations	<ul style="list-style-type: none"> <li>- Expert 1 (Pediatrician specialized in nutrition and metabolic): It is necessary to assess the iron status before iron supplementation or fortification in high-risk groups, particularly pregnant women and female adolescents.</li> <li>- Expert 2 (Obstetric and gynecology expert): It is crucial to assess the iron status.</li> </ul>
	The assessment of anemia status is done through a hemoglobin (Hb) test as part of the government's program	<ul style="list-style-type: none"> <li>- Expert 1 (Pediatrician specialized in nutrition and metabolic): Ferritin test is recommended to assess iron status. However, this test is expensive (around Rp 300,000).</li> <li>- Expert 3 (Obstetric and gynecology expert): Agree with the ferritin test recommendation, because relying solely on Hb test would result in missing the opportunity to detect individuals in stage (1) iron depletion and (2) iron deficiency erythropoiesis. This leads to delays in detection and supplementation interventions according to each stage. When providing iron supplementation at the low Hb level stage, it only acts as therapy, however, it does not interfere with the low ferritin or circulating iron level. If pregnant women who already have depleted iron reserves or circulated iron are only given iron supplementation, it will also affect the period of exclusive breastfeeding, as the iron content in the breast milk will decrease. Therefore, it is important to conduct iron deficiency anemia (IDA) status examination that is capable of detecting stages 1, 2, and 3 through ferritin test and appropriate interventions according to iron deficiency anemia (IDA) status.</li> </ul>
Behavior Modification-Oriented Health Education	(1) Analyzing the target's level of knowledge and comprehension of iron deficiency anemia (IDA), potential challenges, and factors that can encourage preventive behavior against iron deficiency anemia (IDA) (2) Implementing preventive measures against iron deficiency anemia (IDA) and supporting social environments (3) Providing health education with the involvement of supportive social environments	<ul style="list-style-type: none"> <li>- Expert 2 (Obstetric and gynecology expert): Not all target populations have been educated and comprehended regarding anemia and its effects. It is crucial to start intervening from the female adolescent group because they will become the main contributor to anemia in pregnant women.</li> <li>- Expert 4 (Community nutrition specialist): Nowadays, the health education method has to follow the technology trend, such as the impact of Instagram and WhatsApp group on the improvement of knowledge, attitude, and behavior of pregnant women and female adolescents.</li> <li>- Expert 5 (Clinical psychologist): It is crucial to improve the education and comprehension of pregnant women and female adolescents regarding anemia and its effects because one of the leading causes of maternal death is bleeding, and the bleeding is usually due to anemia.</li> <li>- Expert 8 (Pediatrician specialized in nutrition and metabolic): Many of the target population might have good knowledge but with no implementation and bad behavior, which is difficult to be modified. Additionally, many also believe in media social information more than doctor's advice. It is also recommended that early education regarding iron deficiency anemia (IDA) and its impacts be provided from a young age, such as since elementary school level.</li> <li>- Expert 7 (Midwife): It is crucial to improve the education regarding iron-folic acid tablets in schools to the female adolescent group. Additionally, it is also recommended to educate the bride and groom-to-be regarding reproductive health and pregnancy planning at the Civil Registry Office or the Office of Religious Affairs. Unplanned pregnancy is very common in Indonesia, which consequently results in suboptimal physical health and preparedness. Therefore, the involvement of other sectors is necessary, such as the Ministry of Education, economy, etc. to counter this issue.</li> <li>- Expert 6 (Specialist in clinical nutrition): It is crucial to educate at the population level, such as individuals, families, and communities.</li> <li>- Expert 8 (Education expert): Peer group counseling appeared to be more effective than individual counseling. It is also important to build relationships and be empathic with the person we give counseling.</li> <li>- Expert 9 (Specialist in clinical nutrition): Intervention should be implemented on population levels. For example, at the family level, the parents should be educated on how to practice authoritative or moderate parenting styles so that children can modify their behavior with parental support. At the school level, health education can be implemented into the curriculum and teachers can also provide examples and serve as role models for iron deficiency anemia (IDA) prevention behavior. At the peer level, peer pressure can lead to a particular lifestyle demand, therefore, it is important to empower peers regarding behaviors related to iron deficiency anemia (IDA) prevention.</li> </ul> <p>The attitude and intention towards a particular behavior are the main contributing factors for behavior modification. Additionally, subjective norms, perceived behavior control, and beliefs also contribute to behavior modification. Therefore, it is important to consider these factors as well rather than solely educate the target population.</p>

Main Themes	Subthemes	Examples of Participants' Quotes
Iron deficiency anemia (IDA) prevention in pregnant women and female adolescents	Dietary behavior	<ul style="list-style-type: none"> <li>- Expert 3 (Obstetrics and gynecology expert): A previous study showed many Indonesian pregnant women had a deficiency of iron, folic acid, vitamin B6, B12, and protein intake which subsequently affected their Hb. Therefore, it is important to provide repetitive nutritional education to this group rather than solely relying on iron-folic acid tablets and food fortification. Another factor to be considered is the appetite of the pregnant women which might affect their food choice.</li> <li>- Expert 2 (Obstetrics and gynecology expert): Pregnant women's dietary behavior with fast food intake through online commerce is a challenge because it provides more affordable foods effortlessly. However, these foods are dominated by high carbohydrate foods, instead of high protein foods.</li> <li>- Expert 4 (Community nutrition expert): Female adolescents' dietary behavior with coffee, tea, and boba milk tea intake in cafes or through online commerce is also a challenge, because these might inhibit iron absorption.</li> <li>- Expert 5 (Clinical psychologist): It is crucial to educate balanced diet to pregnant women.</li> <li>- Expert 1 (Pediatrician specialized in nutrition and metabolic): The variety of foods consumed during pregnancy affects children's eating behavior in the future, as the flavor of the maternal diet is transferred to the amniotic fluid to be perceived by the fetus. This process continues until the postnatal period, particularly when the baby starts to consume breast milk since the flavor is also transmitted through breast milk. The flavor experienced during the breastfeeding period then helps children to eat various foods more easily during the complementary feeding (CF) period. Thus, it is important to start eating various and highly nutritious foods since the pregnancy period.</li> <li>- Expert 6 (Specialist in clinical nutrition): It is crucial to consume iron-rich foods, both heme and non-heme iron-containing foods. Non-heme iron absorption is specifically enhanced by vitamin C; therefore consuming non-heme iron with vitamin C or food fortification with a combination of heme iron and vitamin C is recommended.</li> <li>- Expert 8 (Pediatrician specialized in nutrition and metabolic): Provision of specially formulated milk for female adolescents with appealing promotion is recommended.</li> </ul>
	Adherence of iron-folic acid tablets consumption	<ul style="list-style-type: none"> <li>- Expert 3 (Obstetrics and gynecology expert): The Indonesian government has implemented the provision of free iron-folic acid tablets for pregnant women as one of iron deficiency anemia (IDA) in pregnant women's prevention programs. However, only 44.2% consumed the tablets as recommended. Healthcare workers need to emphasize the benefit and importance of iron-folic acid tablets to pregnant women during education sessions in order to increase their compliance. It is also crucial for the women to continue consuming iron-folic acid tablets up to 3 months post-partum to prevent iron deficiency anemia (IDA) in the infant receiving exclusive breastfeeding.</li> <li>- Expert 2 (Obstetrics and gynecology expert): Regardless of the type of iron preparation given, adherence to iron-folic acid tablets is the most crucial. Because it was proven that the Indonesian government's iron supplementation program failed to show the target population's adherence, vitamin C can also be combined into the preparation to enhance iron absorption.</li> <li>- Expert 4 (Community nutrition specialist): Ferrous sulphate is the iron preparation used in the Indonesian government program due to being the least expensive. However, it causes more gastrointestinal intolerance compared to the more expensive preparation.</li> <li>- Expert 5 (Clinical psychologist): It is crucial to educate pregnant women on how and when to consume iron tablets to increase their adherence and effectiveness.</li> <li>- Expert 1 (Pediatrician specialized in nutrition and metabolic): One of the alternatives for iron tablet's bad odor problem is to substitute it with microencapsulated iron preparation, which nonetheless is more expensive.</li> <li>- Expert 7 (Midwife): Innovation is needed to solve the non-adherence to iron tablet problem due to its discomfort effects.</li> <li>- Expert 8 (Pediatrician specialized in nutrition and metabolic): Provision of appealing promotion regarding iron supplementation to female adolescents is recommended to increase their adherence.</li> </ul>

## 4. DISCUSSION

### 4.1. The Importance and Urgency of Iron Deficiency Anemia (IDA) Status Assessment

In the implemented Indonesian government program, the provision of iron-folic acid tablets was done without conducting structured procedural examinations. However, experts argued that it is necessary to assess the iron status before iron supplementation or fortification in high-risk groups, particularly pregnant women and female adolescents.

Generally in Indonesia, the assessment of anemia status is conducted through a hemoglobin (Hb) test as part of the government's program to assess the severity of the anemia problem. Hemoglobin is the primary component of red blood cells that serves as a facilitator for oxygen transfer from the lungs to the rest of the body for cell use, exchanges oxygen with carbon dioxide, and then trans-

ports carbon dioxide back to the lungs to exchange it for oxygen [12, 13]. Hemoglobin consists of four protein molecules known as globulin chains, with each chain containing a crucial structure called heme. This heme molecule contains iron, which is essential for oxygen and carbon dioxide transportation and contributes to the red coloration of blood [11]. Hemoglobin test is also a standard screening in midwifery assessment for pregnant women with a minimum of two times examination, typically in the first and third trimester. Additionally, hemoglobin level was also used as a measuring method of the anemia prevalence among high-risk groups, including pregnant women and female adolescents (aged 10 - 19 years) in the Basic Health Research (Riskesdas) [2].

In this study, experts agreed that ferritin test is a better indicator than hemoglobin test in detecting iron deficiency anemia (IDA). Ferritin is a globular protein molecule which responsible for oxidizing, storing, and binding iron [14, 15]. One ferritin molecule can bind up to



4.500 iron atoms or almost one-third of the body's iron is bound to ferritin, resulting in a strong correlation between serum ferritin and body iron storage level [14]. Discussion of the experts mainly focused on the pathophysiology of iron deficiency anemia (IDA) using the keywords “cadangan” or storage and “ferritin” to mention the importance and urgency of the ferritin test, particularly in pregnant women prior to iron-folic acid tablet consumption [14, 15].

There are three stages of iron deficiency according to the process: (1) Stage 1 - iron depletion, (2) Stage 2 - iron deficiency erythropoiesis, and (3) Stage 3 - iron deficiency anemia. The first stage or iron depletion occurs when there is a continuous lack of iron intake that causes a decrease in the body's iron reserves, reflected by the low serum ferritin, however, there are no erythropoietic consequences yet. The iron supplied by the iron transport compartment primarily supports the production of red blood cells (RBCs), since the need for iron in erythropoiesis is significantly greater than in other tissues. If the supply becomes insufficient, it is followed by the next stage known as iron-deficient erythropoiesis, which occurs even though there may not be a significant drop in hemoglobin concentration [16, 17]. Erythropoiesis is a process of RBCs production by the proliferation and differentiation of hematopoietic cells in the bone marrow [18, 19]. Thus, if the number of RBCs in the circulation decreases, the hemoglobin level will also decrease [12, 18].

Experts pointed out that relying solely on hemoglobin test would result in missing the opportunity to detect individuals in stage (1) iron depletion and (2) iron deficiency erythropoiesis. This leads to delays in detection and interventions according to each stage. When providing iron supplementation at the low hemoglobin level stage, it only acts as therapy, however, it does not interfere with the low ferritin or circulating iron level. Therefore, it is important to conduct an iron deficiency anemia (IDA) status assessment that is capable of detecting stages 1, 2, and 3 through ferritin test. Low serum ferritin is the most sensitive and specific method to identify isolated iron deficiency as it reflects iron reserve [19]. If the test becomes the standard for iron deficiency anemia (IDA) examination, experts hope that the targets will be detected and receive interventions as early and accurately as possible.

However, there are challenges in ferritin test implementation, notably the cost, which is higher than the hemoglobin test. Experts explained that healthcare financing planner needs to consider this perspective to manage iron deficiency anemia (IDA) and the potential losses incurred from iron deficiency anemia (IDA) occurrence.

Experts recommended the Government to conduct ferritin tests periodically, with pregnant women being the main priority and targeting female adolescents gradually. Based on the expert consensus discussions, iron deficiency anemia (IDA) status examinations are primarily directed at pregnant women, as they are a high-risk group for iron

deficiency anemia (IDA). Pregnancy increases blood plasma volume, leading to hemodilution and subsequently decreases the hemoglobin level [20, 21], which supports that ferritin will be a more valid test for anemia during pregnancy. If pregnant women who already have depleted iron reserve or circulated iron are only given iron supplementation, it will also affect the period of Exclusive Breastfeeding (EB), as the iron content in the breast milk will decrease. Therefore, in order to manage and reduce the risk of deleterious effects of iron deficiency anemia (IDA) during pregnancy and the postpartum period, appropriate interventions according to iron deficiency anemia (IDA) status in pregnant women are crucial.

#### 4.2. Behavior Modification-Oriented Health Education

For iron deficiency anemia (IDA) prevention, educational intervention is required to enhance the effectiveness of dietary intervention since it promotes both behavioral and knowledge-oriented modifications [22]. Behavior modification can be done through three main stages: (1) analyzing the target's level of knowledge and comprehension of iron deficiency anemia (IDA), potential challenges, and factors that can encourage preventive behavior against iron deficiency anemia (IDA), (2) implementing preventive measures against iron deficiency anemia (IDA) and supportive social environments, (3) providing health education with the involvement of supportive social environments [23, 24].

According to expert consensus discussions, the education topic is predominantly focused on recommendations for improvement on the existing practices and experiences, which the outcomes were not as expected. Thus, reflecting on these experiences, experts agreed that to achieve different outcomes, health education should focus on behavioral change rather than solely on knowledge. Repetitive education targeted to female adolescents and pregnant women is also necessary. Expert consensus also emphasized the need for quality improvement of information provided during education, including the content of the information, as well as communication methods and styles.

Sometimes the content of information was not fully disseminated and did not engage with the local community. The community, particularly the key target audience must receive information and comprehension regarding the impact of iron deficiency anemia (IDA) and the importance of its examinations. The Health Belief Model (HBM), which is defined as a model that predicts a specific health behavior is more or less likely based on an individual's perceptions of disease severity and personal susceptibility to the disease combined with perceived benefits and barriers to that behavior. This concept is known as perceived severity or vulnerability. It encourages people to increase their comprehension regarding iron deficiency anemia (IDA) prevention and take necessary actions by making them realize the magnitude of the negative consequences of a condition [18, 25]. Previous studies also showed that pregnant

women who received education based on the health belief model, particularly the perceived severity concept, have higher scores of knowledge and good dietary practices than those who did not [26, 27].

The key message of behavioral modification also needs to be designed according to the communication style, way of communication preferences, and acceptance level of the key targeted audience. To effectively modify the behavior, specific strategies need to be implemented for each level of the target audience, whether at the individual, family, or community level. Each level requires a different approach and method in message composition, communication style, and message delivery strategy. The message delivery strategy should be carried out through structural actions within educational institutions and can be internalized through social acceptance to achieve the expected behavior as a lifestyle [22].

Based on the expert discussion, the focus of education innovation or improvement is on how to enhance actions by using the term "improved" or "lebih baik." Strategic discourse with the terms "how" or "bagaimana" is used to shift from the current condition or intervention. Subsequently, education is expected to be able to promote behavioral modification from the stage of reluctance to the desired behavior.

The closest social groups and surroundings that have the greatest influence on the key target's decision-making must be involved in behavior modification, as well as obtaining their engagement and support in order to achieve the desired outcome. Experts suggested that three social groups contribute to iron deficiency anemia (IDA) prevention in female adolescents, including family, peer groups, and school/educational environment.

In the family environment, parental involvement can be achieved through interventions in the parenting styles. For a balanced diet and iron supplementation, experts recommended the implementation of an authoritative or moderate parenting style. Parents can be educated on how to practice these parenting styles so that children can modify their behavior with parental support. The period of providing education and habituation of behavior at the family level can also begin early to facilitate behavior formation more effectively. This opinion is supported by findings implying that children raised in an authoritative parenting style have higher mealtime structure and dietary quality than those raised in a permissive style [28].

Meanwhile, in the peer group, it is important to consider the applicable subjective norms regarding behaviors related to iron deficiency anemia (IDA) prevention. Experts suggested that for the female adolescent group, the recommended approach for communication is peer group counseling. This approach focuses on building relationships between female adolescents and their peer groups. It is also necessary to understand how much the adolescents understand about iron deficiency anemia (IDA), so that the communication can be based on the empathic understanding principle. Studies found that female adolescents who have peer

group support have higher adherence to iron-folic acid tablet consumption due to they tend to have a strong desire to be accepted and liked by their peers or social circle [29].

Furthermore, in the school environment, support and supervision from teachers are crucial. Schools, as formal education institutions, can play a role by providing education and internalizing health content into the curriculum. This aligns with government programs in iron-folic acid tablets provision in schools, which will fully involve the school community. Teachers, as educators, can also provide examples and serve as role models for iron deficiency anemia (IDA) prevention behavior [22].

There are social context-related factors that need to be taken into account in the pregnant women group. Experts pointed out the issue of unplanned pregnancies, which are related to the physical and health condition of the women who are not ready for pregnancy. However, it is not easy either to intervene and educate them regarding pregnancy planning due to the social pressure from both family and society on married couples to have children immediately [22]. Experts believe that prior to marriage, potential brides and grooms must receive education regarding reproductive health and contraception. If this is implemented in a structured manner, it will encourage potential brides and grooms to discuss pregnancy planning better.

Additionally, a previous study showed that compared to children with full formula feeding, the hospital admission rate was 12% lower in those with partial breastfeeding and 15% lower in those with exclusive breastfeeding for at least 6 months. The protective effect of breastfeeding on hospitalization was reduced with age. These decreased risks of subsequent hospital admission were found to remain significant until the child was 3–4 years old for non-infection respiratory, oral cavity, and non-infection genitourinary tract, and 10 years for infection and non-infection gastrointestinal tract. Several mechanisms might explain this, first, breastfed infants have better gut microbiome maturation, which leads to better immunity in later life and lower consequent hospitalization rate. Second, breastfeeding-induced inhibition of Th2 immune responses helps to prevent asthma and other allergic disease that result from an inappropriate Th2 response to environmental antigens. Third, there is a protective synergistic effect of soluble CD14 levels and breastfeeding on the risk of asthma. Fourth, maternal pathogen-specific IgAs in breast milk are crucial in preventing respiratory and gut infections in breastfed children. Therefore, encouraging breastfeeding for at least the first 6 months until 2 years and beyond is an important public health strategy to improve overall child health and lower hospital admission, as well as the government's financial burden. However, there are challenges for breastfeeding mothers such as medical, cultural, psychological, physical discomfort, and inconvenience, especially for working mothers who have maternal leave of less than 6 months. These issues might affect breastfeeding rates and the consequent health and

quality of the country's generations. Therefore, it is crucial for the government to increase the breastfeeding rate by providing education on the benefits of breastfeeding and establishing regulations that support every breastfeeding woman [30].

The timing of complementary food (CF) introduction is also closely related to childhood health. Children with CF introduction at  $\geq 7$  months were associated with low height-for-age z-score (HAZ) and frequent ( $\geq 6$  events) hospitalizations compared to those with CF introduction at 4–7 months. Although exclusive breastfeeding offers clear benefits, the appropriate introduction of CF provides better growth and health for children. Delaying the introduction of CF until seven months in exclusively breastfed infants was associated with frequent hospitalization events and lower heights [31]. This might be explained by the fact that from the age of 6 months, an infant's need for energy and nutrients, including iron, starts to exceed what is provided by breast milk due to rapid growth and progressive perinatal iron storage depletion. Therefore, highly nutritious and rich in iron complementary feeding is essential to meet this gap. If complementary foods are introduced late or given inappropriately, an infant's growth and immunity might be disturbed due to nutritional deficiency [32]. According to the Scientific Report of the 2020 Dietary Guidelines Advisory Committee, CF should not be started before the age of four months, and beginning CF at 4 to 5 months of age does not offer long-term benefits or drawbacks compared with starting at 6 months of age [33]. Therefore, the government must emphasize the optimal timing and appropriate CF by providing education and establishing regulations that support CF practice.

Food labeling on food packages is crucial for providing nutritional information and helps healthy diet promotion. Increased food labeling awareness, comprehension, and usage are associated with increased interest of people towards maintaining a healthy diet. However, previous study showed that older age, male, obesity, residing in rural area, lower household income, lower educational level, smoking, and increased alcohol consumption were associated with lower food labeling awareness, comprehension, and usage. Therefore, it is recommended to personalized nutrition strategies, such as educating on the importance of a balanced diet and improving food labeling awareness, comprehension, and usage, particularly among the target population [34]. Policymakers should also ensure that citizens are provided with the right information on the labels of food packages.

Previous studies showed a significant association between higher physical activity levels and reduced risk of depression and anxiety. This might be explained by the fact that physical activity helps alleviate symptoms of depression and anxiety, improves mood, and improves cognitive function [35]. While physical activity levels do not directly correlate with iron deficiency anemia (IDA), depression and anxiety are associated with iron deficiency anemia (IDA). Persons who are depressed frequently have a poor appetite and malnutrition, which can cause

nutritional deficits and potentially lead to anemia and iron deficiency anemia (IDA) [36]. Psychological stress also activates the hypothalamic-pituitary-adrenocortical (HPA) axis and increases proinflammatory cytokines, which consequently disrupt iron absorption and utilization, mediated by the IL-6 activation of hepcidin [37]. On the other hand, persons with iron deficiency anemia (IDA) may also present with psychiatric manifestations such as depression and anxiety [38]. Therefore, encouraging regular physical activity can also be one of the iron deficiency anemia (IDA) prevention strategies. However, it is also important to consider the individual's preferences and capabilities when recommending physical activity to ensure that it is enjoyable and sustainable.

#### 4.3. Iron Deficiency Anemia (IDA) Prevention in Pregnant Women and Female Adolescents

Expert consensus targeted iron deficiency anemia (IDA) prevention at high-risk groups, namely pregnant women and female adolescents. Prevention of iron deficiency anemia (IDA) is reviewed through two main behavior categories: dietary behavior with high-protein foods and adherence to iron-folic acid tablet consumption.

Based on the expert discussion, the topic related to dietary behavior referred to the existing reality as a less-than-ideal condition, characterized by the use of terms “not” or “tidak” and “insufficient” or “kurang”. The entire discussion also revolved around the subject of the term “food” or “makanan” as the main topic. As a sub-theme, the food is also reviewed in accordance with the dietary requirements of female adolescents and pregnant women.

Dietary behavior with high-protein foods poses a challenge for both pregnant women and female adolescents due to imbalanced dietary habits or patterns. Additionally, access to fast food through online commerce is also a challenge because it provides more affordable foods with many promos or discounts and consumers can get them effortlessly. However, these foods are dominated by high carbohydrate foods instead of high protein foods [39, 40]. Surveys showed that around 90% of food merchants in online commerce sell junk food or empty-calorie foods, such as burgers, pasta, fried rice, and many more. Only 10% offer healthy foods, but still, most are not ideal for the balanced diet principle. For instance, they tend to sell fruit salad, but it is mixed with mayonnaise and cheese for topping [41].

Experts agree that female adolescents need to understand the importance of being mindful of their dietary choices, particularly foods with high iron content, as well as foods that enhance and inhibit iron absorption. Iron sources in foods are categorized into two types: heme iron, which is bound to protein, and non-heme iron, which is a complex organic iron compound. Heme iron is found in animal-based foods such as meat, fish, liver, eggs, and dairy products. On the other hand, non-heme iron is derived from plant-based foods like legumes, green leafy vegetables, fruits, and cereals [42]. Iron absorption enhancers can be obtained through consuming foods that are rich in protein and vitamin C. Protein plays an



important role in transporting iron in the body, especially protein from animal sources [43]. Vitamin C helps iron absorption through the reduction process of iron from the ferric form to the ferrous form in the small intestine. Vitamin C also enhances the absorption of non-heme iron. Vitamin C can be found in vegetables and fruits, such as orange, pineapple, papaya, tomato, and guava [43, 44]. Studies have shown that pregnant women with inadequate iron, protein, and vitamin C intake are most likely to suffer iron deficiency anemia (IDA) [44, 45]. Meanwhile, iron inhibitors can be found in foods that contain caffeine, tannins, oxalates, and phytates, such as soy products, tea, and coffee [46].

Dietary habits tend to form rigid patterns that are difficult to modify; therefore, adolescents with poor dietary habits are at risk and might manifest in their health condition. Education regarding a balanced and rich-in-iron diet is a crucial part of iron deficiency anemia (IDA) prevention programs in female adolescents. Therefore, female adolescents can empower themselves to choose food preferences they enjoy while fulfilling their nutritional needs, especially those with high iron content.

It is crucial to intervene in the dietary intake of pregnant women as it affects both the mother and the fetus. If a pregnant woman does not consume a balanced diet, both the mother and the fetus are at risk of anemia due to inadequate iron. Consequently, it is associated with increased maternal infection, pre-eclampsia, and bleeding, as well as several negative impacts related to fetal growth, neurological development, low birth weight, mother and child immune system, and fetal mortality [47-49]. On the other hand, pregnant women face various challenges related to appetite changes and other pregnancy symptoms. Therefore, experts agree that it is necessary to provide counseling regarding foods that are nutritious, rich in iron, yet appetizing for them. Healthcare providers need to take a more personalized approach to understand the obstacles and challenges faced by pregnant women to meet their daily dietary requirements and provide dietary advice regarding these issues. Pregnant women can thus adopt a high-iron dietary habit to prevent iron deficiency anemia (IDA).

Additionally, the variety of foods consumed during pregnancy affects children's eating behavior in the future, as the flavor of the maternal diet is transferred to the amniotic fluid to be perceived by the fetus. This process continues until the postnatal period, particularly when the baby starts to consume breast milk since the flavor is also transmitted through breast milk [50, 51]. The flavor experienced during the breastfeeding period then helps children to eat various foods during the transition to complementary feeding (CF) [50]. This is supported by studies that showed that infants who had early exposure to fruits and vegetables during the prenatal and/or breastfeeding period showed greater receptiveness to their flavor [52, 53]. Early exposure to flavor during the breastfeeding period may also encourage children to try novel foods and grow up to be less picky about foods [54, 55]. Thus, it is important to start eating highly nutritious

foods since the pregnancy period, especially those that are rich in iron.

The second preventive behavior of pregnant women and female adolescents is to consume iron supplements in the form of iron-folic acid tablets. This intervention is a part of the Indonesian government's program in managing iron deficiency anemia (IDA). For female adolescents (10 - 19 years old), this is implemented in schools by providing one iron-folic acid tablet per week throughout the year or 52 tablets in total. Meanwhile, for pregnant women, iron-folic acid tablets are provided during pregnancy, or 90 tablets at minimum.

In the expert consensus discussion, the topic related to iron-folic acid tablets revolves around reluctance/non-adherence to consuming them as recommended, as shown by the use of the term "not" or "tidak". The experts in the discussion then analyzed this condition by examining the implemented interventions, such as the provision of education and iron-folic acid tablets, and how they were received and consumed by the female adolescents and pregnant women. Through this analysis, it was identified that the provision of iron-folic acid tablets alone is not enough to solve the iron deficiency anemia (IDA) problem, as Indonesia's Basic Health Research survey in 2018 revealed that not all female adolescents and pregnant women completed their iron-folic acid tablets consumption as recommended.

Furthermore, the expert consensus got into deeper discussions regarding the failure of iron supplementation in adolescent intervention, which subsequently resulted in a high prevalence of anemia among female adolescents and also aligns with the prevalence of anemia among pregnant women. Female adolescents may experience discomforts such as an unpleasant taste, strong metallic odor, and side effects like nausea after consuming iron-folic acid tablets, which subsequently causes them to stop consuming the iron-folic acid tablets [56]. In addition, there is no monitoring process to ensure adherence to iron-folic acid tablet consumption as recommended in female adolescents, which is also a challenge in the program. However, since iron deficiency or iron deficiency anemia (IDA) during pregnancy is more challenging and takes more time to overcome, iron-folic acid tablet consumption is more significant if it begins in adolescence period. Experts suggested that to optimize iron-folic acid tablet consumption adherence among female adolescents, it is necessary to create compelling messages and tempting rewards for them to voluntarily adopt behavior modifications that promote iron deficiency anemia (IDA) prevention.

Pregnant women also face the same obstacles in consuming iron-folic acid tablets; they find it unappealing and have an unpleasant odor and taste that causes discomfort and consequently results in non-adherence as recommended [57]. Therefore, experts suggested that intensive education from healthcare providers to pregnant women emphasizing the importance of iron-folic acid tablets to improve their adherence is necessary. By using a "perceived benefits" approach for pregnant women,



highlighting the prevention of anemia and the maintenance of iron levels in the body, which will impact fetal development, particularly brain development and intellectual capacity, pregnant women may be more motivated to adhere to iron-folic acid tablet consumption. Studies showed that the same approach can also be implemented for female adolescents as it also increases the adherence to iron-folic acid tablet consumption [58].

## CONCLUSION

Within the public health framework, iron deficiency anemia (IDA) prevention and management remain priority programs. Three strategies were proposed by the expert consensus for the program to be effective: (1) iron deficiency anemia (IDA) status assessment with ferritin test, (2) Behavior modification-oriented health education using the health belief model, (3) prevention of iron deficiency anemia (IDA) in pregnant women and female adolescents through consuming foods rich in iron and/or rich in iron enhancer, as well as avoiding foods that contain iron inhibitors, and the adherence to iron-folic acid tablet consumption. Nevertheless, the government's commitment to support and fund the programs is crucial in order to achieve the desired outcomes.

## AUTHORS' CONTRIBUTIONS

The authors confirm their contribution to the paper as follows: Conceptualization, R.R.O.Z., E.M., N.L.S., C.D., R.W.B.; Data Analysis or Interpretation, B.P.; writing—original draft preparation, C.G., N.L.S., C.D., T.S.; writing—review and editing, C.G., N.L.S., C.D., T.S., R.W.B. All authors have read and agreed to the published version of the manuscript.

## LIST OF ABBREVIATIONS

HBM	=	Health Belief Model
Hb	=	hemoglobin
WHO	=	World Health Organization
FGD	=	Focus Group Discussion
IDA	=	Iron deficiency anemia

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

## HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

## CONSENT FOR PUBLICATION

Not applicable.

## STANDARDS OF REPORTING

COREQ guidelines were followed.

## AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

## FUNDING

The meeting and APC were supported by Danone Specialized Nutrition Indonesia.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

## ACKNOWLEDGEMENTS

We thank TransMedical Institute for the assistance in language editing and formatting the manuscript.

## REFERENCES

- [1] Manikam NRM. Known facts: iron deficiency in Indonesia. *World Nutr J* 2021; 5(1-1): 1-9.  
<http://dx.doi.org/10.25220/WNJ.V05.S1.0001>
- [2] Tim RKD. (Riskesdas) Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan Republik Indonesia Laporan nasional Riskesdas 2018. Jakarta: Badan Penelitian & Pengembangan Kesehatan Kemenkes RI 2018.
- [3] Sungkar A, Bardosono S, Irwinda R, *et al.* A life course approach to the prevention of iron deficiency anemia in Indonesia. *Nutrients* 2022; 14(2): 277.  
<http://dx.doi.org/10.3390/nu14020277> PMID: 35057458
- [4] Sekartini R, Aisyah Widjaja N, Ratna Mutu Manikam N, Jo J, Wagiu Basrowi R, Dilantika C. Iron-deficiency anemia: Indonesia's striving. *Asia Pac J Paediatr Child Health* 2022; 5: 3-16.
- [5] Suega K, Dharmayuda TG, Sutarga IM, Bakta IM. Iron-deficiency anemia in pregnant women in Bali, Indonesia: A profile of risk factors and epidemiology. *Southeast Asian J Trop Med Public Health* 2002; 33(3): 604-7.  
PMID: 12693598
- [6] Anggraeni MD, Fatoni A, Setiyani R. Food consumption as a risk factor of anemia among Indonesian pregnant women: A cross-sectional study among Javanese ethnic group. *Open Access Maced J Med Sci* 2021; 9(E): 552-8.  
<http://dx.doi.org/10.3889/oamjms.2021.6066>
- [7] Sari P, Judistiani RTD, Herawati DMD, Dhamayanti M, Hilmanto D. Iron deficiency anemia and associated factors among adolescent girls and women in a rural area of Jatinangor, Indonesia. *Int J Womens Health* 2022; 14: 1137-47.  
<http://dx.doi.org/10.2147/IJWH.S376023> PMID: 36039326
- [8] Vaira R, Merlin Karinda, Muflihah. Factors related of anemia in adolescence girl. *Science Midwifery* 2022; 10(4): 2490-5.  
<http://dx.doi.org/10.35335/midwifery.v10i4.696>
- [9] Chaparro CM, Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. *Ann N Y Acad Sci* 2019; 1450(1): 15-31.  
<http://dx.doi.org/10.1111/nyas.14092> PMID: 31008520
- [10] Survei Kesehatan Indonesia Tahun 2023. Jakarta: Kementerian Kesehatan Republik Indonesia 2024.
- [11] Health Promotion. 2022. Available from: [https://www.who.int/health-topics/health-promotion#tab=tab\\_1](https://www.who.int/health-topics/health-promotion#tab=tab_1)
- [12] Rochmanto RA, Zakaria H, Alviana RD, Shahib N. Non-invasive hemoglobin measurement for Anemia diagnosis. 2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI). Yogyakarta, Indonesia, 19-21 September 2017, pp. 1-5.  
<http://dx.doi.org/10.1109/EECSI.2017.8239096>
- [13] Diana AL, Krishnan V, Pooja S, Manikandan V. Evaluation of the colorimetric cyanmethemoglobin method and the automatic analyser for hemoglobin estimation. *SALT J Sci Res Health Care*

- 2021; 17-27.  
<http://dx.doi.org/10.56735/saltysrh.ms2101011727>
- [14] Soppi E. Iron deficiency without anemia – Common, important, neglected. *Clin Case Rep Rev* 2019; 5(2)  
<http://dx.doi.org/10.15761/CCRR.1000456>
- [15] Sudarev VV, Dolotova SM, Bukhalovich SM, et al. Ferritin self-assembly, structure, function, and biotechnological applications. *Int J Biol Macromol* 2023; 224: 319-43.  
<http://dx.doi.org/10.1016/j.ijbiomac.2022.10.126> PMID: 36280176
- [16] Pfeiffer CM, Looker AC. Laboratory methodologies for indicators of iron status: Strengths, limitations, and analytical challenges. *Am J Clin Nutr* 2017; 106 (Suppl. 6): 1606S-14S.  
<http://dx.doi.org/10.3945/ajcn.117.155887> PMID: 29070545
- [17] Ferdi J, Bardosono S, Medise BE. Iron intake and its correlation to ferritin and hemoglobin level among children aged 24–36 months in Jakarta in 2020. *World Nutrition Journal* 2021; 5(1): 106-12.  
<http://dx.doi.org/10.25220/WNJ.V05.i1.0014>
- [18] Koury MJ. Abnormal erythropoiesis and the pathophysiology of chronic anemia. *Blood Rev* 2014; 28(2): 49-66.  
<http://dx.doi.org/10.1016/j.blre.2014.01.002> PMID: 24560123
- [19] Camaschella C. Iron deficiency: New insights into diagnosis and treatment. *Hematology* 2015; 2015(1): 8-13.  
<http://dx.doi.org/10.1182/asheducation-2015.1.8> PMID: 26637694
- [20] Daru J, Allotey J, Peña-Rosas JP, Khan KS. Serum ferritin thresholds for the diagnosis of iron deficiency in pregnancy: A systematic review. *Transfus Med* 2017; 27(3): 167-74.  
<http://dx.doi.org/10.1111/tme.12408> PMID: 28425182
- [21] Pramita LS, Fatmaningrum W, Utomo MT, Akbar MIA. Low-hemoglobin levels during pregnancy with low-birth weight: A systematic review and meta-analysis. *Pedimaternurs J* 2021; 7(1): 55-64.  
<http://dx.doi.org/10.20473/pmnj.v7i1.24184>
- [22] Guidelines for the Prevention and Management of Anemia in Adolescent Girls and Women of Childbearing Age (WUS). Jakarta: Kementerian Kesehatan Republik Indonesia 2018.
- [23] Purwanta E. Development of an integrated behavior modification model learning program for children with behavioral problems. *J Educ Horizon* 2014; 2(2)  
<http://dx.doi.org/10.21831/cp.v2i2.2147>
- [24] Michie S, Atkins L, West R. The Behaviour Change Wheel: A Guide to Designing Interventions. (1st ed.), Surrey: Silverback Publishing 2014.
- [25] Tarkang EE, Zotor FB. Application of the health belief model (HBM) in HIV prevention: A literature review. *Cent Afr J Public Health* 2015; 1(1): 1-8.
- [26] Baharzadeh K, Marashi T, Saki A, Javid AZ, Araban M. Using of health belief model to promote preventive behaviors against iron deficiency anemia among pregnant women. *J Research & Health* 2017; 7(2): 754-62.
- [27] Diddana TZ, Kelkay GN, Dola AN, Sadore AA. Effect of nutrition education based on health belief model on nutritional knowledge and dietary practice of pregnant women in dessie town, northeast Ethiopia: A cluster randomized control trial. *J Nutr Metab* 2018; 2018: 1-10.  
<http://dx.doi.org/10.1155/2018/6731815> PMID: 30034866
- [28] Lopez NV, Schembre S, Belcher BR, et al. Parenting styles, food-related parenting practices, and children's healthy eating: A mediation analysis to examine relationships between parenting and child diet. *Appetite* 2018; 128: 205-13.  
<http://dx.doi.org/10.1016/j.appet.2018.06.021> PMID: 29920321
- [29] Utomo ETR, Rochmawati N. Knowledge, family support and peer support are associated with consumption of iron supplements in adolescent girls. *Scientific J Lecturers* 2020.
- [30] Lee JS, Shin JI, Kim S, et al. Breastfeeding and impact on childhood hospital admissions: A nationwide birth cohort in South Korea. *Nat Commun* 2023; 14(1): 5819.  
<http://dx.doi.org/10.1038/s41467-023-41516-y> PMID: 37730734
- [31] Jonsdottir OH, Thorsdottir I, Hibberd PL, et al. Timing of the introduction of complementary foods in infancy: A randomized controlled trial. *Pediatrics* 2012; 130(6): 1038-45.  
<http://dx.doi.org/10.1542/peds.2011-3838> PMID: 23147979
- [32] Infant and young child feeding: Model chapter for textbooks for medical students and allied health professionals. The importance of infant and young child feeding and recommended practices 2009.
- [33] Miniello VL, Verga MC, Miniello A, Di Mauro C, Diaferio L, Francavilla R. Complementary feeding and iron status: "The unbearable lightness of being" infants. *Nutrients* 2021; 13(12): 4201.  
<http://dx.doi.org/10.3390/nu13124201> PMID: 34959753
- [34] Choi Y, Kim HJ, Park J, et al. National prevalence and trends in food labeling awareness, comprehension, usage, and COVID-19 pandemic-related factors in South Korea, 2014–2022. *Sci Rep* 2024; 14(1): 2617.  
<http://dx.doi.org/10.1038/s41598-024-51948-1> PMID: 38297021
- [35] Rahmati M, Lee S, Yon DK, et al. Physical activity and prevention of mental health complications: An umbrella review. *Neurosci Biobehav Rev* 2024; 160: 105641.  
<http://dx.doi.org/10.1016/j.neubiorev.2024.105641> PMID: 38527637
- [36] Liu C, Zhou R, Peng X, Zhu T, Wei W, Hao X. Relationship between depressive symptoms and anemia among the middle-aged and elderly: A cohort study over 4-year period. *BMC Psychiatry* 2023; 23(1): 572.  
<http://dx.doi.org/10.1186/s12888-023-05047-6> PMID: 37553590
- [37] Reid BM, Georgieff MK. The interaction between psychological stress and iron status on early-life neurodevelopmental outcomes. *Nutrients* 2023; 15(17): 3798.  
<http://dx.doi.org/10.3390/nu15173798> PMID: 37686831
- [38] Lee HS, Chao HH, Huang WT, Chen SCC, Yang HY. Psychiatric disorders risk in patients with iron deficiency anemia and association with iron supplementation medications: A nationwide database analysis. *BMC Psychiatry* 2020; 20(1): 216.  
<http://dx.doi.org/10.1186/s12888-020-02621-0> PMID: 32393355
- [39] Puspita M, Aprilia A. Faktor-faktor pendorong konsumen Surabaya membeli makanan dan minuman melalui aplikasi gofood dan grabfood. *J Hosp Manag* 2020; 6(2): 88-98.  
<http://dx.doi.org/10.9744/jmp.6.2.88-98>
- [40] Maraya GP. Analysis of the Relationship between the Use of Online food delivery services and changes in generation z's eating patterns in Jakarta during the covid-19 pandemic. Thesis Jakarta: Binawan University 2022.
- [41] Jannah M. The relationship between the use of social media and online food delivery services with the quality of students' diets. Thesis Semarang: State Islamic University 2022.
- [42] Fuada N, Setyawati B, Salimar S, Purwandari R. Relationship between knowledge of food sources of iron and anemia status in pregnant women. *Media Gizi Mikro Indonesia* 2019; 11(1): 49-60.  
<http://dx.doi.org/10.22435/mgmi.v11i1.2324>
- [43] Almatier S. Prinsip Dasar Ilmu Gizi. Jakarta: Gramedia Pustaka Utama 2016.
- [44] Yuspitra TD. The Relationship Between Nutrition Knowledge and Nutrient Intake (Iron, Vitamin C, and Protein) with Anemia Status in Pregnant Women in Nagarejo Village, Galang District, Deli Serdang Scientific Paper. Medan: Politeknik Kesehatan Medan 2019.
- [45] Tarigan N, Sitompul L, Zahra S. Energy, protein, iron, folic acid intake and anemia status of pregnant women in the petumbukan health center working area. *Wahana Inovasi* 2021; 10(1): 117-27.
- [46] Masthalina H, Laraeni Y, Dahlia YP. Consumption patterns (fe inhibitor and enhancer factors) on anemia status of adolescent girls. *J Public Health* 2015; 11(1)
- [47] Abu-Ouf NM, Jan MM. The impact of maternal iron deficiency and iron deficiency anemia on child's health. *Saudi Med J* 2015; 36(2): 146-9.  
<http://dx.doi.org/10.15537/smj.2015.2.10289> PMID: 25719576
- [48] Means RT. Iron deficiency and iron deficiency anemia: Implications and impact in pregnancy, fetal development, and early childhood parameters. *Nutrients* 2020; 12(2): 447.  
<http://dx.doi.org/10.3390/nu12020447> PMID: 32053933

- [49] Cerami C. Iron nutriture of the fetus, neonate, infant, and child. *Ann Nutr Metab* 2017; 71(Suppl 3) (Suppl. 3): 8-14. <http://dx.doi.org/10.1159/000481447> PMID: 29268254
- [50] Forestell CA. Flavor perception and preference development in human infants. *Ann Nutr Metab* 2017; 70(3) (Suppl. 3): 17-25. <http://dx.doi.org/10.1159/000478759> PMID: 28903110
- [51] Rohlfs Dominguez P. A minireview of effects of maternal diet during pregnancy on postnatal vegetable consumption: Implications for future research (a new hypothesis) and recommendations. *Crit Rev Food Sci Nutr* 2018; 58(13): 2229-38. <http://dx.doi.org/10.1080/10408398.2017.1313810> PMID: 28562066
- [52] Mennella JA, Jagnow CP, Beauchamp GK. Prenatal and postnatal flavor learning by human infants. *Pediatrics* 2001; 107(6): e88. <http://dx.doi.org/10.1542/peds.107.6.e88> PMID: 11389286
- [53] Forestell CA, Mennella JA. Early determinants of fruit and vegetable acceptance. *Pediatrics* 2007; 120(6): 1247-54. <http://dx.doi.org/10.1542/peds.2007-0858> PMID: 18055673
- [54] Hausner H, Nicklaus S, Issanchou S, Mølgaard C, Møller P. Breastfeeding facilitates acceptance of a novel dietary flavour compound. *Eur J Clin Nutr Metab* 2009; 4(5): e231-8. <http://dx.doi.org/10.1016/j.eclnm.2009.06.024> PMID: 19962799
- [55] Maier-Nöth A, Schaal B, Leathwood P, Issanchou S. The lasting influences of early food-related variety experience: A longitudinal study of vegetable acceptance from 5 months to 6 years in two populations. *PLoS One* 2016; 11(3): e0151356. <http://dx.doi.org/10.1371/journal.pone.0151356> PMID: 26968029
- [56] Pujianto T, Kharismawati E, Anggraini E. Description of knowledge and compliance of adolescent girls in consuming iron supplement tablets. *Nat Health Sci Publ Semin* 2023; 2(2): 569-74.
- [57] Rifai A, Wardawati W, Rismawati R. Factors related to the level of compliance of consumption of iron supplement tablets in pregnant women in totoli village, majene regency. *J Health Educ Technol* 2023; 6(2): 105-15.
- [58] Nasichah A, Sulistyowati M. The relationship between adolescent girls' beliefs and compliance with consuming iron supplement tablets based on HBM Theory: Literature review. *Ambusai Health J* 2023; 4(2): 459-69.

**DISCLAIMER:** The above article has been published, as is, ahead-of-print, to provide early visibility but is not the final version. Major publication processes like copyediting, proofing, typesetting and further review are still to be done and may lead to changes in the final published version, if it is eventually published. All legal disclaimers that apply to the final published article also apply to this ahead-of-print version.