Review Article

Nutritional anemia: Limitations and consequences of Indonesian intervention policy restricted to iron and folic acid

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Background and Objective: Currently, anemia is a severe public health issue in Indonesia. The aim of this review was to examine policy measures and program implementation to reduce anemia attributed to iron deficiency in Indonesia. **Methods and Study Design**: A literature search was conducted using Google Search, Sciencedirect.com, and PubMed to retrieve relevant studies in the last three decades. Qualitative data were also obtained from service providers. The search yielded 141 articles, of which 32 were excluded, and further screening was conducted based on the type and scale of the intervention program. **Results**: In the iron–folic acid (IFA) supplementation programs studied, antenatal care and health personnel capacity information were limited. Implementation often did not correspond to standard operating procedures. Analysis, follow-up, and feedback on IFA tablet programs were lacking. Moreover, the IFA tablet supply was inadequate, facilities and infrastructure were insufficient, and counseling guidance, relevant material, and information media were lacking. In the national fortification program, wheat flour was used as a vehicle for anemia prevention. However, evidence from the Total Diet Study indicated that wheat noodles have limited value across the Indonesian archipelago. **Conclusion**: Programs to reduce the likelihood of anemia will be more successful if they are less dependent on nutrient-specific strategies and focus more on the pathogenetic complexity arising from personal behavior, sociocultural factors, dietary and health patterns, local community, and ecology. Partnerships between the community and government reflected in evidence-based policy will always be of value, but continued research is required to examine the factors contributing to the successful outcomes of such programs.

Key Words: iron deficiency anemia, Indonesia, program policy, supplementation, fortification

INTRODUCTION

In patients with anemia, the number and size of red blood cells or the hemoglobin concentration is below the established cut-off value, consequently impairing blood's oxygen-transporting capacity.[1-4] Anemia is an indicator of both poor nutrition and poor health.[5] Anemia, especially that due to iron deficiency (IDA), is the most common micronutrient deficiency, especially among children under 5 years and women of reproductive age.[6,7] It leads to a higher risk of infections as well as impaired cognitive function and physical work capacity. Moreover, maternal anemia is associated with intrauterine growth restrictions.[6] If treated early, anemia due to acute blood loss has a favorable prognosis. Iron supplementation is a relatively inexpensive intervention for treating and preventing anemia related to iron deficiency.[6,8,9]

According to the 2018 Global Nutrition Report, globally, the incidence of anemia has increased slightly to 32.8%.[10] In 2016, Indonesia had the highest anemia prevalence (42%) among pregnant women compared with that in neighboring countries such as Malaysia (37%), Singapore (32%), Brunei Darussalam (27%), Vietnam (37%), the Philippines (30%), and Thailand (40%).[11]

Anemia is considered a public health concern when the national anemia prevalence among women of reproductive age (15–49 years) is ≥20%. Public health concern related to anemia is categorized as mild, moderate, and severe when the prevalence is 5%–19%, 20%–39%, and >40%, respectively.[12] On the basis of the 2018 Basic Health Research project, the anemia prevalence among pregnant women in Indonesia increased from 37.1% in 2013 to 48.9% in 2018, and currently, it is a severe public health issue.[13]

In 2012, the World Health Assembly Resolution endorsed the implementation of a comprehensive plan for maternal, infant (younger than 1 year), and young-child nutrition;[14] a 50% reduction of anemia in reproductive-age women was specified as one of six global nutrition targets for 2025.[15] There has been an increase in the number and breadth of national nutrition policies and nutrition

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Manuscript received and accepted 19 December 2020.
doi: 10.6133/apjcn.202012_29(S1).06

targets, and their financing and implementation are outstanding challenges. More countries are prioritizing nutrition by establishing national nutrition policies and action plans: 164 countries have such plans, 61% of which are multisectoral.[10] Public health strategies for anemia prevention and control include improvements to dietary diversity; food fortification with iron, folic acid, and other micronutrients; distribution of iron-containing supplements; and control of infections and malaria.[5]

For more than three decades, Indonesia has implemented an iron intervention program. Since the 2000s, iron has been added to wheat flour as mandatory fortification. This food-based approach has been promoted. However, currently, anemia is a severe public health and nutrition issue. This paper aims to review policy measures and program implementation to reduce anemia attributed to iron deficiency in Indonesia.

IRON DEFICIENCY ANEMIA IN INDONESIA

Anemia was listed as a public health burden worldwide in 2011; the World Health Organization (WHO) reported that the prevalence of anemia is the highest in children (42.6%) and the lowest in nonpregnant women (29.0%).[16] Anemia is currently among the most common and intractable nutritional problems globally. It is a global public health problem affecting both developing and developed countries, with major consequences for human health and social and economic development. WHO estimates the number of anemic people worldwide to be 2 billion in which 50% of all anemia cases attributable to iron deficiency. Iron deficiency anemia occurs at all stages of life but is more prevalent in pregnant women and young children. Adolescents, particularly girls, are vulnerable to iron deficiency. The 2002 World Health Report identified iron deficiency as one of the 10 most severe risks in countries with high infant and adult mortality.[17] A previous study also reported that addressing iron deficiency anemia is one of the most cost-effective public health interventions.[18]

The 2013 Basic Health Research in Indonesia showed that the prevalence of anemia in children aged 1–4, 5–14, and 15–24 years was 28.1%, 26.4%, and 18.4%, respectively.[19] The prevalence of anemia increased compared with that in the previous survey conducted in 2007, which was 27.7%, 9.4%, and 6.9% in children aged 1–4, 5–14, and 15–24 years, respectively.[20] In particular, the prevalence of anemia in school-age children and adolescents almost tripled. The Basic Health Research project also showed that the anemia prevalence was higher in the suburbs than in urban areas.[19]

Compared with anemia prevalence estimates in 1997, anemia prevalence estimates were lower in 2008 for all groups, with the greatest decline occurring in children aged 5 to 11 years (25.4%). The highest prevalence of anemia was observed in children aged 0–5 years, those aged 12–15 years, and nonpregnant and pregnant women in 2000. However, a chi-squared trend analysis revealed that the anemia prevalence declined significantly in all groups over the survey years (p=0.005 for pregnant women, p<0.0001 for all other groups). From this first-ever trend analysis of anemia in different populations in Indonesia, we concluded that the prevalence of anemia has decreased from 1997 to 2008 in all age and sex groups studied. Despite this progress, anemia remains a moderate public health problem in children aged <12 years and >15 years and in nonpregnant and pregnant women.[21]

In 1996, Muhilal reported that the prevalence of anemia among pregnant women in various parts of Indonesia ranged between 38.0% and 71.5%, and the average prevalence for the general population of Indonesia was approximately 63.5% (Table 1).

Unexpectedly, Java, the most developed part of Indonesia, was among the areas with the highest anemia prevalence of 57.8%–71.5%. Irian Jaya, one of the less developed areas, had the lowest prevalence (38%).[22] Moreover, the 1992 Household Health Survey showed that 63.5% of pregnant women and 55% of children under five had iron deficiency anemia. Similarly, the 1995 Household Health Survey showed that 50% of pregnant women had anemia. Pregnant women are the most at-risk population, and the prevalence of anemia (defined as hemoglobin <11 g/L) among this population is approximately 60% in Indonesia.[23] Among reproductive-age women, the prevalence of anemia in Indonesia is 30%–40%.[24]

In 1996, the prevalence of anemia in preschool children in various parts of Indonesia ranged between 35.8% and 60.6%, and the average prevalence at the national level was 55.5%. Similar to the situation for pregnant women, the lowest prevalence in preschool children was observed in Irian Jaya (35.8%). In Central Java, the prevalence in school children (44.9%) was the lowest, whereas the prevalence in pregnant women (62.5%) was the highest.[22] Nationally, the prevalence of anemia in children under 5 years was 28.1% and in children aged 5–14 years it was 26.4%.[19] Thus, with a cut off of anemia prevalence ≥40%, anemia has become a severe public health problem in Indonesia.

CURRENT POLICY AND IMPLEMENTATION

Iron Supplementation

Research on gardeners in Indonesia showed that the ad-

Table 1. Anemia prevalence in children, women, and men measured during the second, third, and fourth waves of the Indonesia Family Life Surveys (IFLS)

Group	Year	Anemia (%)
Children 0–4 y	1997/8	46.0
	2000	54.6
	2007/8	31.4
Children 5–11 y	1997/8	46.0
	2000	36.4
	2007/8	20.6
Children 12–15 y	1997/8	27.5
	2000	28.2
	2007/8	15.8
Women >15 y (nonpregnant)	1997/8	36.0
	2000	38.8
	2007/8	26.6
Women >15 y (pregnant)	1997/8	45.1
	2000	46.5
	2007/8	37.3
Men >15 y	1997/8	29.0
	2000	22.8
	2007/8	15.4

Source: Barkley, 2015 [21]

ministration of 100 mg iron for 60 days resulted in a significant improvement in hematological status, performance, work output, and morbidity among anemic workers.[25] This result endorses the WHO recommendation of an iron supplementation program for pregnant mothers.

Supplementation with daily oral iron and folic acid is recommended by WHO as a part of antenatal care to reduce the risks of low birth weight, maternal anemia, and iron deficiency (strong recommendation). Management of major nutrition deficiency in Indonesia, including nutritional anemia, is an important part of the effort to reduce infant and toddler mortality. Hence, since 1985 several activities related to Family Nutrition Improvement Efforts (*Upaya Perbaikan Gizi Keluarga-UPGK),* such as toddler weight measurement, mother and child nutrition counseling, vitamin A supplementation, iron tablets, and oral rehydration salt administration, were conducted in *Posyandu* (Integrated Healthcare Center) as an integrated service. In the first 3 years of REPELITA (Five-Year Development Plan) IV, more than 2 million pregnant mothers had received iron tablets: 150,000 individuals in 1984/85; 660,000 individuals in 1985/86; and more than a million individuals in 1986/87.[26]

Jus'at demonstrated that the iron folic acid supplementation program (iron–folic acid [IFA] tablets) implemented in collaboration with the Religious Office (*Kantor Urusan Agama-KUA*), accompanied by the provision of education (KIE) on the importance of IFA tablets and their early consumption prior to pregnancy, reduced anemia prevalence from 23.8% to 14.0% during the program.[27] The research findings caused the release of PERMENKES RI (The Minister of Health of Republic of Indonesia Regulation) Number 97 of 2014 on Health Services Prior to Pregnancy, which aims to eradicate anemia problems.

The Regulation of Minister of Health Number 97 of 2014 on Health Service During Pregnancy states that every pregnant mother should receive a minimum of 90 IFA tablets during pregnancy from the first contact and must also be provided counseling and education on the benefits, side effects, storing instruction, and methods of consuming IFA tablets. Moreover, PERMENKES RI Number 88 of 2014 on Iron Folic Acid Tablets Standard for Reproductive Women and Pregnant Mothers and PERMENKES RI Number 51 of 2016 on Standard Nutritional Supplementation Product were established.

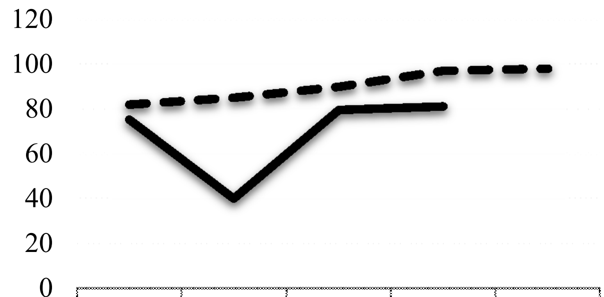
The Ministry of Health (MoH) through PERMENKES RI Number 88 of 2014 released the new technical specification for IFA tablets, which was valid from 2016. This new technical specification regulates the composition, dosage, and packaging of IFA tablets with the aim of increasing the effectiveness of IFA tablet administration. Each IFA tablet consists of ferrous fumarate iron equal to 60 mg elemental iron and 0.400 mg folic acid. The dosage specification is in accordance with the WHO recommendation.[28]

PERMENKES RI Number 51 of 2016 on Standard Nutritional Supplementation Products mentioned that for iron and folic acid tablets, iron is added in the form of a ferrous fumarate compound to increase the effectiveness of IFA tablet administration. However, Toto Sudargo, Dewanti, and Vista Ari Rahmawati showed that Fe-fumarate IFA tablets had reduced compliance among pregnant mothers in Yogyakarta, whereas commercial IFA tablets had higher compliance rates because of their preferable flavor, smaller tablet size, and fewer side effects.[29] Fitriana evaluated IFA tablet program adherence in female adolescents in East Sempaja, Palu, in which Kimia Farma IFA tablets were replaced with Hemafort Pharos; female adolescents preferred Hemafort Pharos IFA tablets.[30] Both types of IFA tablets are Fe-fumarate, but Hemafort Pharos tablets contain multinutrients, whereas Kimia Farma IFA tablets contain only iron and folic acid. IFA tablets with multinutrients tend to be more favored and could have higher compliance (in terms of IFA tablet consumption) than IFA tablets, which contain only folic acid and iron (regardless of whether it is Fe-Fumarate or not).

According to the 2018 Basic Health Research project, the proportion of female adolescents receiving IFA tablets was as low as 22.9%, whereas the proportion was 48.5% in the Performance Report of the Directorate of Community Nutrition of the MoH. This discrepancy is caused by the data collection methods. The percentage of girls who receive IFA tablets (TTD) was determined as the percentage of girls aged 12–18 years in junior high/high school or equivalent who receive regular iron tablets every week. Each teenage girl is expected to receive 52 iron tablets for 1 year.[31] On the basis of the survey results, the main reasons why female adolescents did not consume IFA tablets were the bad taste and smell of IFA tablets and because they believed that it was unnecessary to consume the tablets.[13]

The 2018 Basic Health Research project revealed that the percentage of pregnant women who received IFA tablets was 73.2%, which is slightly lower than the percentage of pregnant women who received IFA tablets in the 2018 Performance Report of the Directorate of Community Nutrition, MoH (81.2%). A positive trend was found for the percentage of pregnant women who received 90 IFA tablets during pregnancy from 2015 to 2018, even though it was still below the target (Figure 1). Moreover, the level of compliance of pregnant women in consuming ≥90 iron tablets during pregnancy only reached 38.1%.[13,32] Generally, the main reasons for noncompliance with IFA consumption by pregnant women were dislike, boredom, forgetfulness, feeling nauseous, and/or vomiting due to pregnancy.[13]

Tablet consumption was defined as the taking of IFA tablets containing iron and folic acid, both from the program and independently, by adolescent girls or pregnant women. This definition does not accurately describe the government's capacity to cover the requirements of IFA tablets in the supplementation program. On the basis of information related to the realization of iron supplement availability from the Directorate of Public Medicines and Health Supplies, the Directorate General of Pharmacy and Health Equipment, MoH, the iron supplement supply in 2017 was only 75% due to budget efficiency measures. Starting from 2019 to 2020, each region in Indonesia outside the stunting locus (priority area of stunting) was required to procure IFA tablets using Health Special Allocation Funds (DAK). IFA tablets for regions in the stunting locus were procured using the central budget. For 2021, the procurement of all iron supplements (in regions both in the stunting locus and outside the stunting locus) will be conducted by the center.



	2015	2016	2017	2018	2019
Target	82	85	90	97	98
old OD realization	75.4	40.2	79.6	81.2	
revised OD realization				97	

Figure 1. Percentage of pregnant women who received 90 IFA tablets during pregnancy (2015–2018). Source: Directorate of Community Nutrition of the MoH, 2018.[32]

Table 2 provides a summary of IFA tablet supplementation program evaluation in various areas in Indonesia. In general, the quality of antenatal care was low; the capacity of health personnel was low; IFA tablet program implementation did not correspond to the SOP; analyses, follow-up, and feedback were lacking in IFA tablet program reports; facilities and infrastructure were insufficient; counseling guidance was lacking; and counseling material, information media, and IFA tablet supply were insufficient.

On the basis of the Directorate of Community Nutrition's 2018 Budget Realization Report, the available budget for procuring IFA tablets for pregnant women was Rp 6,283,713,000, and Rp 5,810,354,524 of this amount has been spent (amounting to 92.47% of the total budget).[32] According to the results of an inspection, the Audit Board of the Republic of Indonesia (BPK-RI) concluded that the MoH of the Republic of Indonesia was not effective in managing funds for goods in 2018. Rp 6.13 billion of state money was wasteful spending; IFA tablets remained undistributed throughout 2018 until the expiration date in 2019. The MoH has not conducted adequate planning for delivering goods to local governments. The calculation for planning the need of goods was not carried out with the adequate basic variables for the central and regional governments. The variables used in the calculation at the provincial health office differ between the program implementing division and the pharmaceutical installation division. This has resulted in an inconsistency in the planning calculations for IFA tablet (TTD) procurement by provincial health offices; these calculations are used in the joint preparation of the drug given nationally. An examination of the dropping realization due to this inappropriate planning showed that a proportion of vitamin A tablets and IFA tablets for pregnant women and teenage girls was not used by the expiration date, resulting in a loss of IDR 6.13 billion.[33]

Supplementation is generally effective on a small scale. However, when it is implemented on a larger or national scale, its effectiveness is influenced by four aspects: appropriate planning for procurement and distribution, preparation of health service providers and communication with mothers, quality control and effective product traceability, and intensive monitoring and supervision.[34] WHO guidance for iron and folic acid supplementation has already emphasized the following:

"The implementation of a behavior change communication strategy to communicate the benefits of the intervention and management of side effects is vital to improving the acceptability of and adherence to recommended supplementation schemes".[6]

Iron fortification

For reducing anemia, the fortification program is considered cheaper and more effective than the supplementation program. WHO recommends iron fortification in various compound categories, including water-soluble, poorly water-soluble but soluble in dilute acid, water-insoluble, and poorly soluble in dilute acid, and encapsulated forms. The selection of the iron fortificant depends on the type of food vehicle targeted for fortification because it influences the effectiveness of iron fortification in terms of iron availability.[35] The iron compounds recommended by WHO to fortify cereals are ferrous sulfate, ferrous fumarate, ferric pyrophosphate, and electrolytic iron.[36]

In 1993, the New Order Government established the State Ministry of Food Affair and initiated a policy on food fortification and strengthened it in REPELITA III in one of the chapters of Food Law of 1996 Article 27. Chapter III on Food Quality and Nutrition in Article 27 of the Law states the following: "In terms of deficiency or decrease in society's nutritional status, the government can set requirements for improvement and enrichment of certain circulated food nutrient." The term nutrient enrichment means fortification. In response to the effectuation of this food law, the MoH issued a ministerial decree dated

Table 2. Evaluation studies of the iron supplementation program for adolescent girls and pregnant women in various regions of Indonesia

No	Authors (year)	Title	Location	Method	Result	Suggestion
1	Siekmans et al. (2018)[79]	Barriers and enablers of IFA supplementation for pregnant women	Afghanistan, Bangladesh, Indonesia, Ethiopia, Kenya, Nigeria, Senegal	Formative research was conducted using mixed qualitative and quantitative methods. Indonesia: FGD: PW or PPW (n=6 groups), influential persons (n=6 groups); IDI: PW or PPW (n=24), key influencers (n=24), village health workers—midwives or nurses (n=6), facility health workers (n=12), TBA (n=8), cadres or CHWs (n=8), community leaders (n=12), district and provincial level (n=18)	Opportunity: All pregnant mothers and health care workers understand the description of anemia symptoms. Hindrance: - Pregnant mothers do not think that they are at risk. - The low access and quality of ANC services reduce the scope of and compliance with IFA tablet consumption: a. Inadequacy of IFA tablet provision b. Insufficiency of counseling to encourage compliance with IFA tablet consumption	- Community-based delivery and counseling of IFA and referral to ANC - Improve ANC access and quality - Renewed investment in training for service providers - Ensure effective behavioral changes
2	Natalia et al. (2017)[80]	The scope of ANC and Fe tablets, their relationship with anemia prevalence in East Java	21 Regencies/ Cities in East Java	Quantitative study using secondary data from a regency/city on anemia prevalence in pregnant mothers with Hb level of <11 g/dL registered in the Nutrition and Family Health Section of East Java Province Health Services. Data analysis was through Pearson correlation.	- There was no correlation between ANC coverage and Fe tablets and anemia prevalence (p>0.05). - The coverage of Fe tablet administration to pregnant mothers through ANC services did not describe high or low anemia prevalence in pregnant mothers.	
3	Toto Sudargo, Dewanti, Vista Ari Rahmawati (2020)[29]	Comparing the efficiency between commercial and governmental iron-folic acid (IFA) supplement among pregnant women in Yogyakarta and Sleman	Yogyakarta City and Sleman Regency within the Yogyakarta Province	Using the mixed-method approach, the study evaluated and compared the efficiency between commercial IFA and IFA provided free by the government to pregnant women across all community health centers (Puskesmas). Hemoglobin was measured using a rapid test kit to determine anemia status. An interview was conducted to qualitatively evaluate participants' perception toward both types of supplementation.	- Yogyakarta had the highest prevalence of anemia (35.49%), whereas the prevalence was 8.90% in Sleman. - Yogyakarta City has preferably been using commercial IFA, replacing supplements provided by the government, since 2006, whereas in Sleman Regency, a similar change was noted between 2015 and 2018. However, in 2019, modified IFA was introduced in Sleman with Fe-Fumarate as the iron compound, replacing Fe-Sulfate. This has caused a decrease in compliance, leading to a return to the use of commercial IFA. - In Yogyakarta City, total coverage (100%) was achieved with commercial IFA in Puskesmas Danurejan 2, whereas the lowest coverage (66.9%) was found in Puskesmas Mantrijeron. In Sleman Regency, the highest and lowest coverage was 99.14% (Puskesmas Depok 2) and 77.68% (Puskesmas Pakem), respectively. - The use of commercial IFA has resulted in higher compliance as it has a more preferable taste and flavor, smaller size, and fewer side effects.	The use of commercial IFA in the government supplementation program to improve compliance and acceptance among pregnant women.

PPW: postpartum women; PW: pregnant women; CHW: community health worker; FGD: focus group discussion; IDI: in-depth interview; IFA: iron–folic acid; TBA: traditional birth attendant; ANC: antenatal care; IDA: iron deficiency anemia; IFE: internal factor evaluation; EFE: external factor evaluation; SWOT: strengths, weaknesses, opportunities, and threats; AHP: analytical hierarchy process; SOP: standard operating procedure; Hb: Hemoglobin.

Table 2. Evaluation studies of the iron supplementation program for adolescent girls and pregnant women in various regions of Indonesia (cont.)

No	Authors (year)	Title	Location	Method	Result	Suggestion
4	Rahmiati et al. (2018)[81]	Qualitative study about factors and strategy improvement of iron supplementation on pregnant woman in Tasikmalaya District	Tasikmalaya Regency	Cross sectional study and in-depth interview with the head of the IDA tablet program stakeholder. IFE and EFE analyses were used to reveal the situation of IDA supplementation. A SWOT analysis was used to provide an alternative strategy, and the AHP was used to determine the priority of strategies.	- An IFE score of 2.14 demonstrates that internally, the program did not optimize the strengths and did not improve the weaknesses. - EFE score of 2.10 indicates that the program did not optimize opportunities and did not improved the weakness.	- The alternative strategy involved the improvement of commitment, roles, and partnerships among stakeholders; the improvement of the action program; the improvement of facilities and infrastructure; and the improvement of health worker capacity.
5	Permatasari et al. (2018)[82]	The effectiveness of an iron supplementation program among adolescent girls in Bogor City	Bogor City, West Java Province	Quasi-experiment, pre–post intervention, effectiveness study. This study was performed parallel to the Prevention and Management Program of IDA on Junior High School and High School Adolescent Girls that was conducted by the Health Service of Bogor City (by administering iron supplement tablets; 60 mg of elemental iron and 0.25 mg of folic acid) for 16 weeks, with weekly supplementation and 10 tablets during the menstrual period. Tablets that must be consumed were 52 in total.	- The anemia prevalence among adolescent girls decreased after the intervention. The most influential factor for the increase in the Hb level in this study was the initial status of Hb. - The IDA Prevention Program was considered as ineffective, though there was a decrease in prevalence. The level of IFA tablet consumption compliance was still low.	- The IFA tablet administration program should be conducted by ensuring that participants consume the tablets together on the appointed day to increase compliance and place their compliance card on the shelf in their classroom. - The popularization of IFA tablet consumption for parents should be conducted so that students can obtain support and parents can understand the importance of consuming IFA tablets and provide food that is rich in iron, particularly animal-derived food, which is rarely consumed by participants (meat, chicken, liver, and fish).

PPW: postpartum women; PW: pregnant women; CHW: community health worker; FGD: focus group discussion; IDI: in-depth interview; IFA: iron–folic acid; TBA: traditional birth attendant; ANC: antenatal care; IDA: iron deficiency anemia; IFE: internal factor evaluation; EFE: external factor evaluation; SWOT: strengths, weaknesses, opportunities, and threats; AHP: analytical hierarchy process; SOP: standard operating procedure; Hb: Hemoglobin.

Table 2. Evaluation studies of the iron supplementation program for adolescent girls and pregnant women in various regions of Indonesia(cont.)

No	Authors (year)	Title	Location	Method	Result	Suggestion
6	Briawan et al. (2009)[83]	The determinant of success iron supplementation program for school students	Bekasi	The intended success of the program is determined based on a change in anemia status and increase in hemoglobin level. The brand of the capsules provided for the IDA Prevention Program by Bekasi Health Service was Diabion. The analyzed variables were capsule consumption compliance, health status, and initial status of anemia, age, nutritional status, and hand-washing habits as well as animal food consumption frequency.	- Overall, anemia prevalence was reduced, but a difference was noted between the change pattern of anemia prevalence of high school girls, which was increasing, and that of junior high school girls, which was also increasing. - The average compliance level of capsule consumption was 84.9% (good) presumably due to the absence of side effects - A relationship was found between initial anemia status, menstruation status, hand-washing habit, animal food consumption frequency, and increase in hemoglobin level. - The determinants of the iron supplementation program (the anemia status change and the increase in the hemoglobin level) were hand-washing habits and initial status of anemia.	The frequency of students' consumption of animal food was very low; this should be of concern to parents.
7	Dahlia et al. (2013)[84]	The evaluation of iron tablet administration program for pregnant mothers at Binamu Community Health Center, Binamu Subdistrict, Jeneponto Regency	The area of Binamu Community Health Center, Binamu Subdistrict, Jeneponto Regency.	This was a descriptive survey study describing the IFA tablet program implementation for pregnant mothers in terms of input, process, and output through interviews and observations.	- The availability of IFA tablets was not sufficient. - No technical guidance was available. - In the planning process (Health Office Work Unit Budget Plan), planning for IFA tablet accessibility based on the target/beneficiary was not conducted.	
8	Tuju et al. (2013)[85]	The analysis of IFA administration program implementation by midwife in community health center in the area of South Minahasa Regency Community Health Center	17 subdistricts of South Minahasa Regency	The type of research was observational descriptive analytic and cross-sectional.	- The variable affecting the implementation of the IFA tablet program was bureaucracy - The implementation of the IFA tablet program did not follow the existing SOP.	- Provision of education for midwives regarding the benefits in complying with the SOP of IFA tablet administration. - Give incentives to midwives who must implement the program in accordance with standards that fulfill coverage requirements.

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Table 2. Evaluation studies of the iron supplementation program for adolescent girls and pregnant women in various regions of Indonesia (cont.)

No	Authors (year)	Title	Location	Method	Result	Suggestion
9	Secapramana (2015)[86]	Fe tablet administration at Klari Subdistrict Community Health Center, Karawang Regency, West Java.	Klari Subdistrict Community Health Center, Karawang Regency, West Java	An evaluation was conducted by comparing the coverage of the Fe tablet administration program for pregnant mothers in Klari Subdistrict Community Health Center, Karawang Regency, West Java, from January to December 2015 using the standard system approach.	- The need for Fe tablets in Klari Community Health Center, Kawarang Regency, was 277,200 Fe tablets. The provision of Fe tablets was conducted by the government and a private party. - Leaflets and posters for education were absent. - Transportation was available, but there were some areas that could be reached by car. - The majority of the population in Klari subdistrict, Karawang Regency, have low education, and many pregnant mothers had not checked their pregnancy status regularly, and some of them were purposely not taking the Fe tablet or not consuming them. - In the planning of the program, no written data were available. - Planning for the designated service for Fe distribution does not exist. - No recording or reporting was performed.	NA
10	Maitri et al. (2017)[87]	The Evaluation of iron folic acid (IDA) tablet administration as the preventive and curative effort for anemia among pregnant women at Kraton Community Health Center in Yogyakarta City.	Kraton Community Health Center in Yogyakarta City	Data were obtained from secondary data and an in-depth interview with the chief of the Community Health Center, KIA staff, nutrition staff, pharmaceutical personnel, the cadre of pregnant mothers' companions, and pregnant mothers; also, interviews were conducted using questionnaire to determine the knowledge level of pregnant mothers.	- The level of IFA tablet consumption compliance was good. Education related to IFA tablets from midwives was good, and there were high levels of knowledge, self-motivation, and family support, with an absence of side effects from consuming IFA tablets. The high prevalence of anemia in pregnant women in 2016 (33%), was caused by the following: - The lack of IFA tablet distribution. - The consumption of various IFA tablets from the market with an IFA content that did not meet the standard - IFA tablet administration was not performed from the beginning of the pregnancy. - The consumption pattern of pregnant mothers was not appropriate.	NA
11	Fitriana and Dwi Pramardika (2019)[30]	Evaluation of iron folic acid tablet program for female adolescents	Bengkuring Community Health Center, East Sempaja, Palu	Evaluation research using the qualitative research method in the form of in-depth interviews followed by content analysis. The quantitative method was performed to examine Hb level.	- As many as 3 of 10 female adolescents in the Integrated Service Unit Community Health Center of Bengkuring had anemia. - The replacement of IFA tablet Kimia Farma (2018) with Hemafort Pharos (2019) increased compliance among female adolescents in the IFA tablet program. - Facilities and infrastructure were lacking in the anemia and IFA tablet program. - There was a discrepancy in distribution, which was performed once a month at Bengkuring Community Health Center. - Monitoring of IFA tablet consumption compliance and hemoglobin levels in female adolescents was not performed.	NA

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No	Authors (year)	Title	Location	Method	Result	Suggestion
11	Fitriana and Dwi Pramardika (2019)[30]	Evaluation of iron folic acid tablet program for female adolescents	Bengkuring Community Health Center, East Sempaja, Palu	Evaluation research using the qualitative research method in the form of IDI followed by content analysis. The quantitative method was performed to examine Hb level.	- The data on IFA tablet program were not recorded in the report book by the school. - No analysis or follow-up was conducted, and feedback was not available in the IFA tablet program report from schools, community health centers, or Samarinda Health Services. - There was an inconsistency between the aim and objective of the IFA tablet program of the community health center.	NA
12	Triana Mutmainah et al. (2014)[88]	Analysis of the differences between the implementation of and iron tablet supplementation program for pregnant mothers by the nutrition officer of a high-coverage community health center and by the nutrition officer of a low-coverage community health center in Kendal Regency Area.		Qualitative design presented in a descriptive, exploratory manner with the type of case study through IDI and observations.	- A specific bureaucratic structure does not exist - No SOP was available. - The coverage was still much lower than the minimum service standard. - The implementer was not aware that IFA tablet supplementation is important. - The delivery of information and education to pregnant mothers was not considered as an important part of the program because the program had been running for a long time. - The specific promotional material and information media for the IFA tablet supplementation program for pregnant mothers were not available. - All of the community health centers do not have counseling guidance and implementation instructions for the IFA tablet supplementation program.	NA

PPW: postpartum women; PW: pregnant women; CHW: community health worker; FGD: focus group discussion; IDI: in-depth interview; IFA: iron–folic acid; TBA: traditional birth attendant; ANC: antenatal care; IDA: iron deficiency anemia; IFE: internal factor evaluation; EFE: external factor evaluation; SWOT: strengths, weaknesses, opportunities, and threats; AHP: analytical hierarchy process; SOP: standard operating procedure; Hb: Hemoglobin.

Table 3. Average levels of nutrients to be added to fortified wheat flour based on extraction, fortificant compound, and estimated per capita flour availability

Nutrient	Flour extraction rate	Compound	Level of nutrient to be added in parts per million (ppm) by estimated average per capita wheat flour availability (g/day)†			
			<75‡	75–149	150–300	>300
Iron	Low	NaFeEDTA	40	40	20	15
		Ferrous sulfate	60	60	30	20
		Ferrous fumarate	60	60	30	20
		Electrolytic iron	NR§	NR§	60	40
	High	NaFeEDTA	40	40	20	15
Folic acid	Low or high	Folic acid	5	2.6	1.3	1
Vitamin B-12	Low or high	Cyanocobalamin	0.04	0.02	0.01	0.008
Vitamin A	Low or high	Vitamin A palmitate	5.9	3	1.5	1
Zinc¶	Low	Zinc oxide	95	55	40	30
	High	Zinc oxide	100	100	80	70

†These estimated levels account for only wheat flour as the main fortification vehicle in a public health program. If other mass-fortification programs with other food vehicles are implemented effectively, these suggested fortification levels may need to be adjusted downwards as required.
‡Estimated per capita consumption of <75 g/day does not allow for the addition of a sufficient level of fortificant to cover the micronutrient needs of women of childbearing age. Fortification of additional food vehicles and other interventions should be considered.
§NR: Not recommended because very high levels of electrolytic iron could negatively affect the sensory properties of fortified flour.
¶For these zinc fortification levels, 5-mg zinc intake and no additional phytate intake from other dietary sources are assumed.
Source: WHO, 2009.[40]

June 16th, 1996 regarding Wheat Flour Fortification.

The State Ministry of Food Affair formed the cross-sector Fortification Commission with active support from UNICEF. A national-level discussion, namely National Workshop on Food and Nutrition (Widyakarya Nasional Pangan dan Gizi) VI, was held in 1998. Since then, various experiments on wheat flour fortification started, and the implementation of wheat flour fortification began in 1998 in a wheat flour factory in Jakarta. Finally, on January 14, 1999, the wheat flour fortification program was officially launched by the government.

Two years later, wheat flour fortification with iron, zinc, folic acid, vitamin B-1, and B-2 became mandatory after the release of Decree of the Minister of Industry Trade number 153 in 2001 (Indonesian National Standard; Standar Nasional Indonesia [SNI]) for wheat flour. In February 2008, the mandatory wheat flour fortification program by SNI was once withdrawn by the government because wheat flour fortification was thought to be one of the causes of a dramatic increase in staple food prices, including the price of wheat flour. After several interministerial consultations, SNI wheat flour fortification was re-implemented in 2009. Twenty-six rules have been established for the food fortification policy in Indonesia. There are 10 general rules and 16 specific rules for mandatory fortification, among which 10 are specific fortification rules for wheat flour.[37]

The requirements for fortificant addition to wheat flour products as food vehicles in SNI 3751-2009 are described in the Decree of the Minister of Health, Republic of Indonesia No. 1452/Menkes/SK/X/2003. It is mentioned that produced, imported, or circulated wheat flour in Indonesia should be fortified to contain iron at a minimum of 50 mg/kg, zinc at a minimum of 30 mg/kg, vitamin B-1 (thiamine) at a minimum of 2.5 mg/kg, vitamin B-2 (riboflavin) at a minimum of 4 mg/kg, and folic acid at a minimum of 2 mg/kg.

From January to December 2011, the Laboratory of Balai Besar Industri Agro (Center for Agro-based Industry) analyzed 583 samples of wheat flour from various wheat flour companies considering that the period from January to December 2011 was the transition period for the application of mandatory SNI 3751-2009 in accordance with the Regulation of the Minister of Industry of Republic of Indonesia Number 35/M-IND/PER/3/2011, which was valid from March 22, 2012. According to the test results of 583 samples, the majority (95.85%) of samples complied with the requirements of SNI 3751-2009, whereas the remaining 4.15% did not fulfill the requirements of SNI 3751-2009. It can be assumed that in 2011, wheat flour products as food commodities that were circulated and marketed in Indonesia already met the SNI requirements according to the applied regulation.[38]

The National Standardization Agency of Indonesia requires fortification with iron of a minimum concentration of 50 ppm without any iron compound specified.[39] For iron fortification, manufacturers in Indonesia use elemental iron because it costs less and causes few, if any, sensory changes.

In 2004, a Center for Disease Control and Prevention (CDC) expert group in Cuernavaca, Mexico, made global recommendations for the type and level of different iron compounds (Table 3) to be added to wheat flour.[40] WHO recommended the same iron compounds but suggested that each country should estimate the level of fortification that would provide the required iron lacking in the traditional diet.[35]

Because elemental iron powders are organoleptically inert, they are widely used for wheat flour fortification. In 2002, a SUSTAIN task force evaluated the usefulness of the different elemental iron powders commonly employed in wheat flour fortification.[41] On the basis of in vitro, rat, and human studies, the task force recommended that electrolytic iron should be the only elemental iron powder used and that its amount added should be twice the iron level of ferrous sulfate, as its absorption capacity is approximately half of that of iron. They also recommended that carbon monoxide–reduced iron should not be used because of unacceptably low absorption. Furthermore, they indicated that more studies of carbonyl- and hydrogen-reduced iron powders are required before a recommendation can be made. It was subsequently found that another form of reduced iron (i.e., atomized iron powder) is widely used for wheat flour fortification because of its low cost. However, because of its low solubility in dilute acid under standardized conditions and its low absorption in rat hemoglobin repletion studies and human iron tolerance tests, atomized, reduced iron powder is not recommended for wheat flour fortification.[42]

The analysis results of the 2014 Indonesian Total Diet Study showed that among cereal groups, rice was the most consumed product by the majority of the Indonesian population (97.7%), with a consumption of 201.3 g per capita per day, followed by wheat and its products consumed by approximately 30.2% of the population (51.6 g per capita per day). A similar consumption pattern for cereal groups was found based on age, with rice consumption and its products as the highest consumed product followed by wheat and its products. The 51.6-g consumption of wheat and its products comprised wheat flour (9.4 g), wheat flour products (9.6 g), and noodles (32.6 g). Noodles were the third most consumed (by 23.4% of the population) cereal food commodity, with an average consumption of 32.6 g per capita per day.[43]

We compiled a list of wheat flour-based food products. Table 4 provides the estimates of iron content (mg) in wheat flour and its derivative products. Given that the average consumption of wheat flour and its derivative products in Indonesia is only 51.6 g per person per day and the estimated iron content is 8.8 mg (in 100 g per serving), the additional iron obtained from average wheat flour consumption is estimated to be 4.5 mg per capita per day. For noodles, as one of the most common wheat products consumed, the estimated iron content is as high as 5.5 mg per instant noodle serving (Table 4); thus, the iron content acquired from noodles is approximately 2.6 mg iron per capita per day.

The average amount of additional iron from fortified wheat flour is 4.5 mg per capita per day. The lowest dose of electrolytic iron with a significant impact on iron status is 10 mg. However, in a trial, electrolytic iron was shown to be less efficacious than ferrous sulfate in reducing iron deficiency, and no reduction was demonstrated in the percentage of participants with anemia.[44] Moreover, iron deficiency anemia remained in 60% of children in China after a 6-month trial using more than twice this 10-mg dose.[45] Because of the uncertainty regarding the lowest effective dose of electrolytic iron, the recommendation from the Cuernavaca Workshop should not be changed; this groups recommends that electrolytic iron twice the concentration of ferrous sulfate should be added.[35]

However, the wheat consumption range in Indonesia is below 75 g/day; as per the WHO recommendation (2009), electrolytic iron is not recommended when the average consumption of wheat flour is below 75 g/day because high levels of electrolytic iron could negatively affect the sensory properties of fortified flour.

The iron compounds that are recommended when wheat consumption is below 75 g/day are Na Fe-EDTA, ferrous sulfate, and ferrous fumarate. The results of experimental studies in animal and human models demonstrated that regardless of how beneficial the iron fortificant may be, its intake in combination with enhancers and inhibitors determines the final effect.[36] All the fortified condiments have been used in cereal-based diets high in phytic acid; therefore, Na Fe-EDTA is more preferable than ferrous sulfate and ferrous fumarate, and the enhanced iron absorption through EDTA in the presence of phytate is expected to reduce the variability in iron status responses caused by differences in overall meal bioavailability.[42]

Fe fortification using Fe-sulfate, Fe-fumarate, and Na Fe-EDTA in wheat flour does not significantly affect the sensory properties of breads and baozi. Na Fe-EDTA slightly affects the texture (slightly harder) of cookies. For noodles and macaroni, Fe-sulfate and Na-Fe-EDTA affect the color of products (darker color). Fe-fumarate is recommended for the iron fortification of wheat flour, with the lowest effect on the sensory properties of wheat products.[39]

The national wheat flour fortification program appears to use fortification levels that are too low in relation to the wheat flour consumption pattern, or the coverage of the program is limited. No study has investigated the effectiveness of iron compounds used in fortification in Indonesia, except for the Family Life Survey analysis series on anemia by Kendrick et al.[46] Kendrick et al concluded that wheat flour fortification has not significantly reduced the anemia prevalence among reproductive-age women in Indonesia.[47] Therefore, it seems unlikely that a meaningful reduction in the national prevalence of iron deficiency would be achieved through wheat flour fortification unless current practices are changed. The nine countries that can expect a positive impact from wheat flour fortification programs use ferrous sulfate: Argentina, Chile, Egypt, Iran, Jordan, Lebanon, Syria, Turkmenistan, and Uruguay. They could provide an average of 5.4–9.6 mg of additional iron per day through fortified flour, with optimal coverage.[42]

Quality monitoring for the wheat flour fortification program is lacking; quality monitoring is crucial because there are still reports of falsified fortification labels and the existence of low-quality, unfortified wheat flour in market circulation. Some local governments do not realize the importance of fortification; thus, the regional regulations that have been issued are ineffective.

Regarding the fortification of wheat flour, the government must immediately conduct an effectiveness test to determine its impact on reducing the prevalence of anemia. The replacement of supplementation with fortification results in savings in the state budget because the fortification program is cheaper and more effective than supplementation.

An effective and continuous food fortification program could enhance the nutrition status of vulnerable groups when the fortified food is consumed regularly, and the micronutrient substances added to the food vehicle are based on the daily average food intake per capita. The adequately fortified food must be consumed consistently by the majority of the population (approximately >80%).

Table 4. Iron content in flour and its products on the market

No.	Category	Brand Name	RDA† (%)	Iron content‡ (mg)
1	Flour	Bogasari Kunci Biru (Untuk Kue Kering, Cake, dan Biskuit)	40	8.8
2	Flour	Bogasari Segitiga Biru (Untuk Aneka Makanan)	50	11
4	Flour	Bogasari Cakra Kembar (Untuk Roti & Mie)	60	13.2
5	Flour	MILA Serbaguna	25	5.5
6	Flour	Golden Eagle	25	5.5
7	Flour	Hana Emas	60	13.2
8	Instant noodles	Indomie Rasa Soto Mie	25	5.5
9	Instant noodles	Indomie Goreng Rasa Rendang	20	4.4
10	Instant noodles	Indomie Mie Goreng Jumbo	35	7.7
11	Instant noodles	Indomie Rasa Ayam Bawang	15	3.3
12	Instant noodles	Indomie Mie Goreng	25	5.5
13	Instant noodles	Indomie Mie Goreng Iga Penyet	15	3.3
14	Instant noodles	Indomie Mie Goreng Sambal Rica-Rica	35	7.7
15	Instant noodles	Indomie Mie Goreng Pedas	45	9.9
16	Instant noodles	Indomie Mie Keriting Goreng Spesial	15	3.3
17	Instant noodles	Indomie Mie Keriting Rasa Ayam Panggang	20	4.4
18	Instant noodles	Indomie Mi Goreng Aceh	20	4.4
19	Instant noodles	Indomie Mi Goreng Rasa Ayam Geprek	30	6.6
20	Instant noodles	Indomie Rasa Seblak Hot Jeletot	30	6.6
21	Instant noodles	Mie Sedaap Rasa Ayam Spesial	10	2.2
22	Instant noodles	Mie Sedaap Rasa White Curry	15	3.3
23	Instant noodles	Mie Sedaap Rasa Kari Ayam	10	2.2
24	Instant noodles	Mie Sedaap Rasa Ayam Bawang	10	2.2
25	Instant noodles	Mie Sedaap Rasa Baso Spesial	10	2.2
26	Instant noodles	Mie Sedaap Rasa Soto	25	5.5
27	Instant noodles	Mie Sedaap Rasa Kari Spesial	10	2.2
28	Instant noodles	Mie Sedaap Goreng Ayam Krispi	10	2.2
29	Instant noodles	Mie Sedaap Mi Goreng	10	2.2
30	Instant noodles	Mie Sedaap Korean Spicy Chicken	10	2.2
31	Instant noodles	Mie Sedaap Cup Rasa Baso Spesial	10	2.2
32	Instant noodles	Mie Sedaap Cup Rasa Ayam Bawang Telur	10	2.2
33	Instant noodles	Mie Sedaap Cup Rasa Soto	10	2.2
34	Instant noodles	Mie Sedaap Cup Mi Goreng	10	2.2
35	White bread	Sari Roti Double Soft	10	2.2
36	White bread	Sari Roti Tawar Kupas	20	4.4
37	Biscuit	Lucky Stick Strawberry	10	2.2
38	Biscuit	Hello Panda Rasa Susu	6	1.32
39	Biscuit	Hello Panda Cookies & Cream	8	1.76
40	Biscuit	Biskuat Original	4	0.88
41	Biscuit	Belvita Breakfast Rasa Pisang & Sereal	20	4.4

†BPOM (National Agency of Drug and Food Control) RDA label reference: 2150 calories with 22 mg iron.
‡Estimated value
Weight per service for the flour category is generally 100 g and for instant noodles it is 70 g.
Source: Market survey compilation by author, 2020.

Therefore, the latest data on the target of food consumption to be fortified are crucial for determining the national standard.

Iron fortification of rice should be considered, which is a food commodity widely (97.7%) consumed by the Indonesian population, with an average consumption as high as 201.3 g per capita per day, which is much higher than the consumption level of wheat flour and its products. In a previous study, biofortified high-iron rice provided benefits for iron-deficient populations by increasing iron stores; this food also maintained the iron stores in populations without deficiency. From this feeding trial, it can be concluded that biofortified rice has the potential to improve the diets of the low-income population in developing countries.[48]

In the 1940s, the Philippines government started to fortify rice with thiamin, niacin, and iron and succeeded in decreasing the beriberi incidence, which, at that time, was a severe health problem caused by a lack of thiamine. In 1952, the Philippines government established laws on rice fortification that required all rice mills and wholesalers to fortify the rice milled and sold.

In the last decade, significant developments have been made in low-cost rice fortification technology, which have contributed to the reduction of micronutrient deficiency. The technology can affordably generate fortified rice having the same shape, smell, and taste as unfortified rice.

According to WFP (2018), nine studies have shown that fortifying rice with iron (alone or in combined with other micronutrients) can increase iron status (evidence of moderate certainty), other studies have shown small effect on iron status. One study demonstrated that fortified rice can increase the hookworm infection risk (evidence with low certainty).[8]

In Indonesia, to overcome the problem of anemia, a pilot project of fortification with iron and other substances in *Raskin* (rice for low-income individuals) was conducted in

2011. The feasibility of rice fortification was also examined in terms of cost and its impact on iron deficiency anemia (IDA). The fortification project was executed in 80 villages in Karawang and 15 villages in Bekasi using 14000 tons of *Raskin*. The monthly production amount of 1167 tons of *Raskin* was fortified for 3 years (2010–2012), costing US$2,220,440, with a possible time extension until 2013. The existing technology was assumed to be able to produce premix (artificial rice with a high iron content) with an identical shape and color as actual rice. At that time, no funding was available to conduct a premix trial and other necessary tests; thus, the cheapest premix was imported from India. The best and the most expensive premix was from the Philippines.[49]

In 2014, *BULOG* (Indonesian Bureau of Logistics) was involved in the development of the Rice Fortification for Poor Families pilot project in collaboration with the government and the Asian Development Bank using the Japan Fund for Poverty Reduction. The Indonesian Bureau of Logistics was actively involved, particularly in fortified *Raskin* production and distribution. The Southeast Asian Food and Agricultural Science and Technology Center of Bogor Agricultural University/IPB University conducted a fortified rice acceptance trial; the results showed that fortified rice was well accepted by the consumer because the fortification did not alter the color, taste, and smell of the rice. Moreover, 100 g of *Raskin* in 2014 comprised iron (8 mg), folic acid (20 µg), vitamin B-1 (0.64 mg), vitamin B-12 (1.0 µg), niacin (6 mg), and zinc (3 mg).

In 2015, a rice fortification program was conducted by the private producer AMARTA with the aim of fulfilling society's daily nutritional requirements. The nutritional components in 100 g of rice were folic acid (125 mcg), vitamin A (200 mcg), vitamin B-1 (thiamine; 0.4 mg), vitamin B-2 (riboflavin; 0.5 mg), vitamin B-3 (niacin; 6 mg), vitamin B-6 (pyridoxine; 0.6 mg), vitamin B-12 (cobalamin; 2 mcg), vitamin D (cholecalciferol; 1.5 mcg), vitamin E (tocopherol; 3 mg), vitamin K; 25 mcg), iron (5 mg), magnesium (30 mg), calcium (100 mg), iodine (50 mcg), zinc (5 mg). The rice cost was approximately Rp 20,000 per kg, and the rice was available in 5-, 10-, and 25-kg packs.[50]

In 2019, *BULOG* introduced rice containing vitamins (fortified) under the brand Fortivit, which does not require rinsing. The rice was enriched with vitamins and minerals. Specifically, 100 g of rice contained 195 µg of vitamin A, 0.65 mg of vitamin B-1 (thiamine), 9.1 mg of vitamin B-3 (niacin), 0.78 mg of vitamin B-6, 169 µg of vitamin B-9 (folic acid), 4 mg of iron (Fe), and 6 mg of zinc (Zn). This rice was developed in collaboration with the Kernel fortificant provider company, and it would be sold for IDR 20,000 per kg under the premium category and IDR 12,000 under the medium category.[51]

The consumption of micronutrient powder containing iron has some potential side effects in babies and children. In a recent study of children in Kenya, the administration of micronutrient powder containing iron (12.5 mg iron as ferrous fumarate) caused the development of intestinal inflammation (the increase of fecal calprotectin concentration) and an increase in the number of enteropathogens (including *Shigella*, *Escherichia coli*, and *Clostridium*) compared with micronutrient powder without iron.[52,53]

The adverse effects of micronutrient iron on intestinal microbiota can be reduced through the addition of prebiotic galacto-oligosaccharides to micronutrient powder, although further studies are required to confirm this. Thus, compared with iron interventions such as oral iron supplementation or fortification with micronutrient powder containing iron, rice fortification is preferred, as it is associated with a lower risk of infectious diseases in individuals with high or adequate iron intake. The daily iron dosage from the consumption of iron fortificant in the amount of rice is commonly lower and limited per person. In addition, iron fortificant is added to the food matrix thus reduces the potency of transferrin-bound iron accumulation in blood.

Therefore, the success of rice fortification interventions depends on the population and context as well as the prevalence of anemia. This is because iron deficiency can have other causes. The potential damage of fortified rice is low considering the low daily iron dosage and the limit on how much rice an individual can consume. More studies should be conducted to examine the possible biological and clinical adverse effects of iron-fortified rice from excess iron intake.

A study found that the fortification of cooking oil may be an alternative method of increasing vitamin A intake in mothers and children, especially in rural communities.[54] Mean oil consumption ranges from 2.4 mL/capita per day for infants aged 6–11 months to 31.5 mL/capita per day for lactating mothers. Moreover, the Recommended Nutrient Intake (daily) of vitamin A from fortified oil ranged from 26% in children aged 12–23 months to 35%–40% in older children and nonlactating women.[55] The increased intake of vitamin A is also attributed to the consumption of various foods that improve serum retinol in preschool children.[56]

Food-based approach

The International Conference on Nutrition was convened in 1992 for the development of food-based dietary guidelines (FBDGs) to promote appropriate diets and healthy lifestyles. In total, 159 heads of state committed to a plan of action on nutrition.[57] The popularization of nutrition messages started in the 1950s when a highly regarded nutrition expert in Indonesia, Prof. Poerwo Soedarmo MD, developed the slogan "Four Healthy Five Perfect" (locally known as Empat Sehat Lima Sempurna [ESLS] to educate people about the importance of nutrition. The message is a modification of the United States slogan "Basic seven and basic four."[58,59] This slogan is presented in a circlular form, with staple (carbohydrate source), side dish (protein and fat sources), vegetables, and fruits (vitamin and mineral sources) on the outside and milk in the middle. In the subsequent 25 years, ESLS became preferred in nutrition education and is widely known, especially among school-age children. It is well-known by the public even today.[60]

ESLS, which unintentionally provided a higher value for milk, produced a problematic situation for the governments of developing nations because of the unavailability of milk locally and its high price.[61] The government of Indonesia introduced the Guide to a Balanced Diet in 1993 (locally known as Pedoman Umum Gizi Seimbang [PUGS]). This was a result of the commitment of countries to the International Conference on Nutrition in 1992. In

1995, the guide was launched by the MoH and formally incorporated in the nutrition policy and program of REPELITA VI (1994–1998).[62] The guidelines were developed based on the results of research by the Nutrition Center for Research and Development, MoH. The guide has 13 messages: (1) food biodiversity, (2) eat food with sufficient energy, (3) consume complex carbohydrates for energy, (4) energy from fat and oil should only provide 25% of total energy, (5) use only iodized salt, (6) eat iron-rich foods, (7) exclusively give breast milk to infants 0–4 months (now 0–6 months), (8) eat breakfast daily, (9) drink sufficient clean and safe water, (10) do physical activity and exercise regularly, (11) avoid alcoholic drinks, (12) eat clean and safe food, and (13) always read food labels.[61]

The illustrative representation (as a cone) of the guidelines is a pyramid with three layers: (1) bottom layer: energy sources, (2) middle layer: fruit and vegetables, (3) top layer: foods that are sources of animal and plant protein. In 2002, the cone was altered to four layers, with energy source foods, vegetables and fruit, animal and plant protein, and sugar and salt from the bottom to top layers separately. Additionally, the following revisions were made: (1) separation between animal and plant proteins, in which milk is incorporated into the animal protein group, (2) addition of sugar and salt, (3) insertion of the recommended amount for consumption (servings), (4) fats and oils were excluded in the guide, and (5) message no. 7 was revised to "provide only breast milk for the baby until 4 months old, after which breast milk should be supplemented with complementary foods." In the next 8 years, no attempt was to modify the guidelines or popularize healthy eating and physical well-being.[63]

For children younger than 5 years, in addition to iron intake, the intake of zinc and calcium was consistently found to be limited in young children's diets, especially during the complementary feeding period.[64,65] However, the current FBDG messages do not specifically address the need to increase the density of these nutrients or to incorporate foods fortified with these nutrients. The anemia prevalence over the last 10 years has indicated that balanced nutrition has not yet been applied by the majority of individuals. Research on iron-rich food in Indonesia is lacking. An analysis of iron-rich food intake has been conducted by evaluating the consumption of animal protein source food, which is recognized as a good source of highly available iron.

Effect of optimal nutrition promotion and education on anemia status

The protein intake of the Indonesian population is still dominated by plant foods. For the prevention of anemia, protein and iron from animal foods are much more effective. Animal protein has high available iron, partly through the hem iron content of animals, and iron content is mostly unaffected by interactions with other food components.[36] The Deputy for Food and Agriculture of the Coordinating Ministry for Economic Affairs revealed that the consumption of animal protein in the country is only 8%, which is far below that in Malaysia (28%), the Philippines (21%), and Thailand (20%).[66]

On the basis of the Total Diet Study,[43] the meat most consumed by the population of Indonesia is poultry, with a consumption rate of 21.5% for all ages, followed by processed beef and buffalo, which are consumed by approximately 8.1% of the population. The 19–55 and 5–12 year age groups have the highest consumption of chicken (22.5%) and processed beef (13.8%), respectively.

Based on data from the Central Bureau of Statistics of Indonesia, the average daily per capita protein consumption decreased slightly from 47.25% in early 2011 to 45.21% in 2012 and continued to decline until it increased again at the end of 2015 (45.32%), reaching the highest at the end of 2016 (48.56%) and then stabilizing at 47.8% at the end of 2018.[67] This same pattern was identified for the consumption of processed foods.

The Executive Summary of Indonesian Population Expenditure and Consumption[67] revealed that the lower protein consumption may be the result of the low income level of the Indonesian population. Another problem is the quality of protein consumed because quality protein sources, such as livestock products, are expensive compared with vegetable protein sources.

In September 2018, the average daily protein consumption of every Indonesian citizen was 64.64 g, which is sufficient (in terms of quantity) based on the protein adequacy rate (2018 Indonesian protein adequacy rate is 57 g/capita/day). However, the largest contributor to protein consumption is grains (19.51 g), which makes up approximately 30% of total protein consumption. Consumption of protein in the form of fish, meat, egg, and milk is 16.67 g, or approximately one-quarter of total protein consumption. This amount is still less than the consumption of protein from whole grains. This finding in is in line with the conclusions of Harper, who researched the proportion of food ingredients commonly consumed in Indonesia and in other Asian countries.[68] According to Harper, most residents consume protein derived from plants. He also suggested increasing the consumption of animal protein if the income level of the population increases.[69]

According to Sediaoetama, the recommendation for animal protein consumption in the daily diet is 30% of total protein consumption.[70] Even if the quantity of protein consumed is sufficient in the Indonesian diet, its composition is still dominated by vegetable protein, whereas the proportion of animal protein consumed is still below the recommended level.

In terms of each group of animal protein, the maximum protein consumption is from fish compared with meat, eggs, and milk. On average, each Indonesian resident consumes 8.78 g of protein a day from fish. Protein consumption from meat is 4.46 g, half of the protein consumption from fish. Moreover, protein consumption from eggs and milk is only 3.43 g per capita a day.[67]

In the first quintile, protein consumption from eggs and milk (20.32%) is higher than that from meat (17.48%; Figure 2). This indicates that eggs and milk are more popular and affordable for low-income individuals. However, milk and eggs are not good sources of iron. Iron in egg yolk is poorly absorbed because of the presence of phosvitin.[71]

The emphasis on protein for evaluating nutritional quality has become counter-productive, as food product development is encouraged on this basis alone, without regard to the wider spectrum of food characteristics necessary for

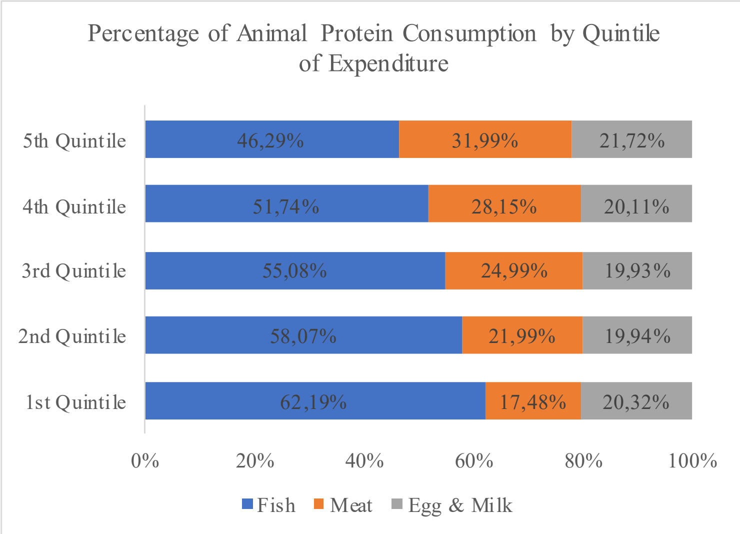

Figure 2. Proportion of animal protein consumption by quintile of expenditure. Source: BPS, 2018.[67]

optimal nutrition. Food intake biodiversity is a preferable measure of dietary quality and a basis of the prevention of nutritional anemia. It is now recommended by FAO as an index of food security[72,73] and in health outcome evaluation[74] and costs.[75,76]

Food production, supply, and distribution

The supply, availability, and distribution of animal protein sources is still uneven in all regions of Indonesia. The livestock sector in each region should be increased through local wisdom. According to the National Socioeconomic Survey, the consumption of animal protein at the provincial level varies between 11 and 27 g per capita a day.[77] The province with the highest average consumption of animal protein is the Riau Islands (27.12 g). More than 50% of the total consumption of animal protein in the Riau Islands is from fish (52.75%). By contrast, East Nusa Tenggara has the lowest protein consumption, which is 11.11 g per capita a day or less than half the protein consumption of the Riau Islands.

In general, in all provinces, the consumption of protein from fish is greater than that from meat, egg, and milk, except in the province of DI Yogyakarta. The consumption of protein from meat in Yogyakarta is 5.70 g per capita a day, the consumption of protein from eggs and milk is 3.89 g, and that from fish is 3.58 g. In addition, in terms of the proportion of the total animal protein consumption of each province, DI Yogyakarta has the highest proportion of protein consumption from meat (43.27%).[77]

CONCLUSION

Small-scale iron supplementation interventions are occasionally effective; however, regarding iron supplementation interventions on a larger scale, many regions in Indonesia had inadequate IFA tablet supply and ineffective implementation. Fortification should provide budgetary savings, but this concept may be ill-conceived or misplaced. Indonesian manufacturers add electrolytic iron to wheat flour, but wheat consumption is below the required 75 g/day in Indonesia, negating its effectiveness. The average amount of additional iron in fortified wheat flour is below the lowest dose of electrolytic iron necessary for a significant impact on iron status. WHO recommends that electrolytic iron should not be used when the average wheat flour consumption is below 75 g/day. Iron fortification of rice, a staple more widely consumed by Indonesians (rather than wheat flour), is a preferable alternative.

A feasibility study on iron-fortified cooking oil is recommended since its consumption level is relatively stable across life stages. The mean oil consumption ranges from 2.4 mL/capita per day for infants aged 6–11 months to 31.5 mL/capita per day for lactating mothers. However, no evaluation of its benefit and risk has been conducted, so the widespread use in this industry, where unintended consequences such as increased consumption of energy-dense fried foods would be encouraged, among other risks and costs.[78]

Although iron and folic acid supplementation has been implemented since the 1980s, iron fortification has been mandatory for two decades as a national intervention in Indonesia, and dietary modification has been promoted by the government. On the basis of the anemia prevalence among pregnant women, anemia is still a severe public health problem. Poor-quality diets, lack of food biodiversity, and compromised optimal nutrition and nutrient bioavailability, with adverse consequences for food security and health including nutritional anemia, are causes of iron deficiency and have an effect on its complex pathogenesis. Vulnerable life stages, such as the reproductive life span of women, childhood, and later life, and adverse socioeconomic circumstances are associated with the high prevalence of nutritional anemia, including that attributed to iron deficiency. Programs to reduce the likelihood of anemia in these settings will be more successful if they are less dependent on nutrient-specific strategies and focus more on the pathogenetic complexity arising from personal behavior, sociocultural factors, dietary and health patterns, local community, and ecology. Partnerships between the community and government reflected in evidence-based policy will always be of value, but continued research is required to examine the factors contributing to the successful outcomes of such programs.

ACKNOWLEDGMENT

We express our gratitude to the Danone Institute Indonesia (DII) for its research grant in 2020, which fully supported the writing of this manuscript. We also thank the officers of the Directorate of Community Nutrition Ministry of Health of the Republic of Indonesia, Community Health Centers, and National Institute of Health Research and Development for their assistance with the data collection.

AUTHOR DISCLOSURES

The authors have no conflicts of interest to declare. The study reported in this publication was supported by Danone Institute International (DII).

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