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SCOPING REVIEW: THE ROLE OF MICRONUTRIENTS (FE, ZN, IODINE, RETINOL, FOLATE) DURING PREGNANCY

Agus Hendra Al Rahmad[1,2] ✉

[1]Department of Nutrition, Health Polytechnic of Aceh, Ministry of Health, Aceh, Indonesia.
[2]Doctoral Program in Medical Science, Faculty of Medicine, Universitas Syiah Kuala, Aceh, Indonesia

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ABSTRACT

Pregnant women are highly vulnerable to nutritional problems such as Chronic Energy Deficiency (CHD), deficiency of micronutrient intake (iron, zinc, and vitamin A intake), anemia, and Iodine Deficiency Disorder (IDD). Micronutrient deficiencies in pregnant women must be specifically prevented. A healthy and nutritionally balanced diet is essential for maternal and fetal health. The review study aimed to identify the role of micronutrients (Fe, Zn, Iodine, Vitamin A, and Folate) during pregnancy. The literature review used a scoping review technique referring to the Arksey and O'Malley framework. The literature review (2012-2022) used the online databases PubMed, Science Direct, Willey Online Library, ProQuest, and Springer. The search used Medical Subject Headings (MeSH), including the variables "role of nutrients," "pregnant women," "micronutrients (Fe, Zn, Iodine, Vitamin A, Folate)," and "during pregnancy." The selection of articles using the PRISMA Flowchart starts with identification, screening, eligibility, and selected articles. Results, this literature study has found 18 articles that are feasible and meet the criteria. This study identified that women preparing for pregnancy and pregnant women must pay attention to nutrient intake at conception, nutritional status in trimesters I to III, and the role and intake of micronutrients during pregnancy both for maternal health and optimal health fetal growth. Obtaining adequate and balanced micronutrient intake is very important to maintain the health of pregnant women and fetuses during pregnancy. In conclusion, the role of micronutrients is significant for pregnant women and fetuses. One of the most important for pregnant women and fetuses is vitamin B9), which helps form red blood cells, maintain a healthy nervous system, and help in iron metabolism. Folic acid also helps in fetal growth and development, and iron helps produce red blood cells and maintains adequate oxygen levels in the body.

Kata Kunci:

Kehamilan;
NTD;
Peran nutrisi;
Selama kehamilan;
Zat gizi mikro;

ABSTRAK

Ibu hamil sangat rentan terhadap masalah gizi seperti Kekurangan Energi Kronis (KEK), kurangnya asupan mikronutrien (asupan zat besi, seng, dan vitamin A), anemia, Gangguan Akibat Kekurangan Yodium (GAKY). Defisiensi mikronutrien pada ibu hamil harus dicegah secara spesifik. Makanan yang sehat dan bergizi seimbang sangat penting bagi kesehatan ibu hamil dan janin. Tujuan studi review untuk mengidentifikasi peran mikronutrien (Fe, Zn, yodium, Vitamin A, folat) selama kehamilan. Literatur review menggunakan teknik scoping review merujuk framework Arksey dan O'Malley. Tinjauan kepustakaan (2012-2022) menggunakan database online PubMed, Science Direct, Willey Online Library, dan ProQuest, serta Springer. Pencarian menggunakan Medical Subject Headings (MeSH) mencakup variabel "role of nutrients", "pregnant women", "micronutrients (Fe, Zn, Iodine, Vitamin A, Folate)" dan "during pregnancy". Seleksi artikel menggunakan PRISMA Flowchart secara bertahap mulai dari identifikasi, skrining, kelayakan, artikel terpilih. Hasil, studi literatur ini telah menemukan 18 artikel yang layak dan memenuhi kriteria. Penelitian ini mengidentifikasi bahwa wanita yang sedang mempersiapkan kehamilan dan atau wanita hamil penting memperhatikan asupan zat gizi saat konsepsi, status gizi pada trimester I sampai III, dan peran serta asupan zat gizi mikro selama kehamilan baik bagi kesehatan ibu maupun pertumbuhan janin yang optimal. Memperoleh asupan zat gizi mikro yang cukup dan seimbang sangat penting untuk menjaga kesehatan ibu hamil dan janin selama masa kehamilan. Kesimpulan, peran zat gizi mikro sangat penting bagi ibu hamil dan janin. Salah satu yang sangat penting bagi ibu hamil dan janin adalah vitamin B9 (asam folat), yang membantu dalam pembentukan sel darah merah, menjaga sistem saraf yang sehat, dan membantu dalam metabolisme zat besi; asam folat, juga membantu pertumbuhan dan perkembangan janin; dan zat besi, membantu dalam produksi sel darah merah dan menjaga kadar oksigen yang cukup di dalam tubuh.

✉ ***Corresponding Author:***

Agus Hendra Al Rahmad
Department of Nutrition, Health Polytechnic of Aceh, Ministry of Health, Lampeunerut, Aceh Besar, Aceh, Indonesia
Telp. 065146126.
Email: 4605.ah@gmail.com

INTRODUCTION

In addition to under-five children, nutrition problems in Indonesia also occur in pregnant women (Emiroglu et al., 2019). Pregnant women are very vulnerable to nutritional problems such as chronic energy deficiency (CED), deficiency of micronutrient intake (iron, zinc, vitamin A), anemia, Iodine Deficiency Disorders (IDD) (Nahrisah et al., 2020). These problems are direct causes of increased morbidity and even maternal and child mortality rates (Arbie & Labatjo, 2019). In pregnant women, it is essential to consider micronutrient deficiencies (iron, zinc, and vitamin A intake), as they severely impact the fetus (Ritchie & Roser, 2017). The role of micronutrients such as vitamin A is vast in the body's process of iron metabolism, and zinc intake correlates with the incidence of anemia in pregnant women. Iyengar et al. (2009) reported that the role of zinc reaches more than 200 enzymes in the body, including enzymes that help the metabolism of iron nutrients. Intake of micronutrients (zinc and iron) is essential concerning the growth and development of children; when intake is deficient in the womb, children can be born short (Nugraheni et al., 2021).

According to data from the World Health Organization (WHO, 2021), the prevalence of anemia in pregnant women increased by 36.5%, and the prevalence in Southeast Asia reached 47.8%. Likewise, in Indonesia, the prevalence of anemia has reached 44.2%, with the highest rate at the age of 15-24 years (84.6%). Likewise, with data on CED, National Health Survey (NHS) in Indonesia report in 2018 suggests that pregnant women's deficiency of micronutrients (vitamins and minerals, iron, zinc, potassium, and magnesium) relatively high (Kemenkes RI, 2018). The prevalence of CED in women of childbearing age in Indonesia is 17.3% compared to 14.5% in women of childbearing age who are not pregnant. The indicator of CED is the upper arm circumference in women of childbearing age.

The vulnerability of nutritional problems in pregnant women can affect the fetus's growth and development. Several studies have reported the importance of mothers in fulfilling nutritional intake both in macro and micronutrients, improving nutritional status, and health service support to be able to improve the optimal health status of pregnant women (Lipoeto et al., 2020; Mousa et al., 2019; Zgliczynska & Kosinska-Kaczynska, 2021). The health and nutritional status of the mother during pregnancy is an excellent opportunity for quality conception and safe fetal existence, and ensuring the health and safety of the mother during childbirth (Cetin et al., 2019). Nutritional disorders in pregnant women not only weaken physically and risk danger to the mother's life but certainly have a severe impact on the safety of the fetus. According to (Arisman, 2010), a woman who wishes to become pregnant when her nutritional status is poor will face the risk of giving birth to a baby with Low Birth Weight (LBW) which is 2-3 times greater than a mother with good nutritional status, and the possibility of death in infants is 1.5 times.

It has been empirically proven that pregnant women need macro and micronutrients during conception for optimal maternal health and fetal growth and development (Cusick & Georgieff, 2016). It is fundamental to the importance of alleviating nutritional problems in pregnant women. Based on the physiological process, it is necessary to prepare for a mother's pregnancy which takes place during the process of fetal growth and development. The intake of nutrients, especially micronutrients such as iron, zinc, Iodine, vitamin A or Retinol, and folic acid, and the nutritional status of pregnant women will significantly affect their capacity to support success during pregnancy. Thus, the review study aimed to identify the role of micronutrients (Fe, Zn, Iodine, Vitamin A, and Folate) during pregnancy.

METHODS

The method used in this study is a scoping review related to the role of micronutrients during pregnancy. The design refers to the Arskey and O'Malley framework through five procedures: identifying questions, using relevant articles, selecting articles, data charting, and preparing a report on the results (Westphaln et al., 2021).

Step 1: Identify the Question

Table 1. Framework research question

P (Population and problems)	E (Exposure)	O (Outcomes)	S (Search strings)
Nutrition of pregnant women during their pregnancy	Role of micronutrients (Fe, Zn, Iodine, Vitamin A, Folate) during pregnancy	Intake, Micronutrients, Nutritional status, Fetus	All research designs relevant to the purpose of this study, such as Crossectional, Case-Control, Randomized Controlled Trial (RCT), and Literature Review or Systematic Reviews.

Based on the PEOs framework in table 1, the scoping review question is the role of micronutrients (Fe, Zn, Iodine, Vitamin A, Folate) during pregnancy?

Step 2: Identification of Relevant Articles

After identifying the questions, the next step was to identify relevant articles. It was done by determining the key parameters, which consisted of inclusion and exclusion criteria for the inclusion criteria, namely original articles and literature reviews (for the last ten years), English articles from 2012 - 2022, total text reviews, and articles that discuss the role of micronutrients (Fe, Zn, Iodine, Vitamin A, Folate) in pregnant women during their pregnancy. The exclusion criteria consisted of opinion articles, letters, and book reviews.

Identifying relevant articles uses several databases such as PubMed, ScienceDirect, Willey, ProQuest, and Springer. These databases were used to search for articles that fit the topic objectives and research questions. The search strategy and keywords used in the search process using Medical Subject Headings (MeSH) included the variables "role of nutrients," "pregnant women," "micronutrients (Fe, Zn, Iodine, Vitamin A, Folate)," and "during pregnancy." The exact and specific keywords differed based on the database used according to the research objectives. The use of boolean algorithms, namely AND, OR, and NOT are as follows: ((((role of nutrients) AND (pregnant women)) AND (micronutrients)) OR (Fe, Zn, Iodine, Vitamin A, Folate)) AND (during pregnancy).

Step 3: Article Selection Process

This stage is to select further articles using the PRISMA Flowchart. PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA), which was developed to assist researchers in improving the reporting of systematic reviews to be included in the meta-analysis (Hutton et al., 2015). The stages of screening articles are as follows:

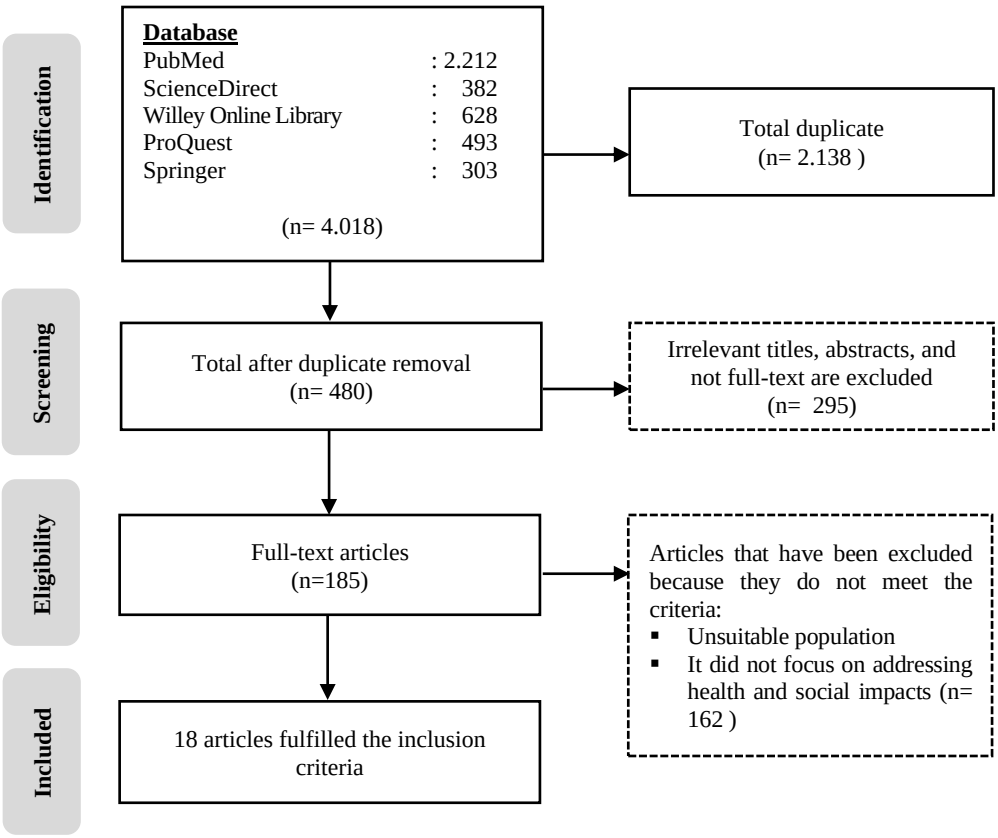

Figure 1. PRISMA Flow Chart

Article selection was performed by two authors with the initials AHA, AM, and two reviewers, IK and AH. In case of disagreement between the authors and reviewers, it was done through critical analysis of all available literature sources: The reviewing authors should consider all perspectives and arguments provided by other authors and conduct a critical analysis to ensure they understand the arguments correctly. In addition, they can find additional references. In this case, the authors and reviewers ensure the article selection process is conducted independently. The software used to organize notes during the literature review process uses the Reference Manager, Mendeley.

Step 4: Data Charting

Next, step 4 is to perform data charting on the 23 articles that have been selected based on the screening conducted. This process includes vital criteria such as research location, population, objectives, methodology, and significant findings or recommendations. The authors independently recorded the information and compared the charted data. Only two authors share the same conceptual view, so there is little risk of displeasure.

Step 5: Summarizing, Reporting Results, and Discussion

The fifth step in conducting a scoping review is summarising the articles that have gone through the charting process. This part includes grouping themes in articles that have been analyzed evidence-based or evidence-based, based on the context of the problem/homogeneity, and then reviewing the implications of the findings concerning future research, practice, and policies. This fifth step is expected to be a solid fundamental in supporting the reduction of stunting problems, namely through adequate consumption through micronutrient intake. In addition, it is also the basis for program policy-making both in health promotion and other regulations.

RESULTS

Eighteen articles relevant to the theme or topic of the study were found. The selected articles were from quantitative and qualitative studies comprising cross-sectional, RCT, cohort, and case-control designs. The quality was excellent, as they were from reputable journals.

Table 2. Results of Article Topic Mapping

Topic	Sub-Topic
Nutrients during conception	a. Maternal anthropometry in early pregnancy b. Folic acid supplementation c. Folic acid recommendations d. Folic acid modification
Nutritional status of pregnant women based on anthropometric parameters and pregnancy preparation recommendations or at the time of conception	a. Nutritional status of pregnant women b. Weight gain based on BMI before pregnancy, second and third trimesters in pregnant women c. Recommendations for women planning a pregnancy or at the time of conception
The role of micronutrients during pregnancy	a. Role and requirement of iron (Fe) b. Role and requirement of zinc (Zn) c. Role and requirement of iodine d. Role and requirement of vitamin A e. Role and requirement of folate

Nutrients at Conception

Maternal anthropometry in early pregnancy

Body weight affects fertility. Women who are overweight or obese are very likely to experience Polycystic Ovary Syndrome (PCOS), a polycystic ovary syndrome that results in ovulation failure (Barasi, 2013; Incedal Irgat & Bakirhan, 2021). Ideal weight is essential for women who are infertile in order to conceive and have offspring.

Folic acid supplementation

Women who may experience pregnancy are strongly encouraged to consume folic acid according to nutritional recommendations of 400 µg/day, starting from 3 months before conception until 12 weeks of gestation (de Seymour et al., 2019). This intake can be fulfilled not only through supplements but also through nutritious foods.

Folic acid recommendations

It is highly recommended to consume foods containing folic acid in their raw state, such as in the form or type of salad (Argyridis, 2019; Petersen et al., 2019).

Folic acid modification

Adding folic acid to flour minimizes NTD cases and significantly impacts increasing conception (Hamner & Tinker, 2014). Fortifying flour with folic acid aims to reduce the effects of NTDs (Kehoe et al., 2020).

Nutritional Status and Recommendations for Preparing for Pregnancy or at Conception

Nutritional status of pregnant women

Maternal nutritional status at conception is influenced by socioeconomics, maternal health and nutrition, birth spacing and parity, and age at first pregnancy (Symington et al., 2018).

Weight gain before pregnancy, second and third trimesters

Weight gain during pregnancy generally reaches 11-16 kg, but this figure will undoubtedly vary based on the mother's BMI before pregnancy (Aoyama et al., 2022). Knowing the pre-pregnancy weight for prognosis is essential as deciding whether or not intensive nutritional therapy is required.

Advice on planning a pregnancy or at conception

Women planning pregnancy or conception or in the first trimester must limit food (balanced nutrition) and not smoke and drink alcohol (Goossens et al., 2018; Mínguez-Alarcón et al., 2018).

The Role of Micronutrients During Pregnancy

The role and requirement of iron (Fe)

The role of micronutrients such as vitamin A is vast in the process of iron (Fe) metabolism in the body, as well as zinc intake correlates with the incidence of anemia in pregnant women (Georgieff, 2020). The link with zinc is essential because it has an enzyme role, which helps metabolize iron nutrients (Mahdi & Mohammed, 2022).

The role and requirement of Zinc (Zn)

Zinc (Zn) plays an essential role in fetal growth and development. According to Gibson (2022), zinc deficiency can cause fetal growth failure, premature and LBW, and is closely related to stunting.

The role and requirement of iodine

Iodine is one of the essential minerals for producing thyroid hormones, which are involved in brain and organ development, child growth, digestion and metabolism of food, regulation of body temperature, and control of muscle contraction (Kiely et al., 2021).

The role and requirement of vitamin A

The role of vitamin A during pregnancy is closely related to the increase of iron in the blood. Vitamin A supplementation from food is highly recommended as it can reduce mortality in pregnant women. Vitamin A deficiency severely impacts prematurity incidence and is likely to cause growth retardation and LBW (Bastos Maia et al., 2019; Emiroglu et al., 2019).

The role and requirement of folic acid

Folic acid or vitamin B9 fulfillment must be optimal during the periconceptional period to minimize the risk of Neural Tube Defects (NTDs) and their recurrence (Bibbins-Domingo et al., 2017; Haggarty, 2021). The results of a study conducted by De-Regil et al. (2015) also recommend that all women planning a pregnancy or pregnant women be able to meet the ideal folic acid needs.

DISCUSSION

Nutrients at Conception

Mothers who experience conception have critical anthropometric conditions, especially at the beginning of fetal development. Several studies have reported that body weight affects fertility. Therefore, it is necessary to achieve the optimal anthropometric ability of the mother (nutritional status based on BMI values is normal) in the range of 20 kg/m^2 to 25 kg/m^2. Women with BMI <18 kg/m2 may experience amenorrhea and ovulation failure (Zain & Norman, 2008). Meanwhile, women who are overweight or obese are very likely to experience Polycystic Ovary Syndrome (PCOS), a polycystic ovary syndrome that results in ovulation failure (Barasi, 2013; Incedal Irgat & Bakirhan, 2021). Achieving a typical and ideal body weight is an important thing that is needed to help infertile women become pregnant and have offspring.

Women who may become pregnant are strongly encouraged to consume folic acid according to nutritional recommendations of 400 µg/day, starting from 3 months before conception until 12 weeks of gestation (de Seymour et al., 2019). Of course, this intake can only be fulfilled through supplements. Folic acid fulfillment from foods with high composition (as much as 400 µg/day) can also be fulfilled from the consumption of vegetables and fruits and nut sources. Folic acid sources from fruit are found in bananas, tomatoes, beets, oranges, and others. In vegetables, folic acid is high in spinach and kale vegetables, broccoli, potatoes, and leeks. While legumes are found in almost all types, such as beans and pods, peanuts have a lot of folic acid content (Merrell & McMurry, 2021).

Notably, folic acid is a compassionate light, oxygen, and heat vitamin. Therefore, it is highly recommended to consume foods containing folic acid in natural conditions, such as in the form or type

of salad. If processed through cooking, the cooking process should not be too long so that the folic acid levels can decompose (Field & Stover, 2018).

In developed countries, the availability of folic acid has been modified/substituted into food by adding folic acid to flour to minimize NTD cases, and the impact is significant in increasing conception (Hamner & Tinker, 2014; Tulchinsky, 2010). One country, the UK, has proposed to fortify flour with folic acid to reduce the effects of NTDs. In the first weeks of pregnancy, adequate nutrient reserves are needed to support implantation and fetal organ formation. These reserves will be needed because the placenta is not yet fully functional for fetal nutrition, and this will occur until the gestational age reaches three months (Haggarty, 2021).

Nutritional Status and Recommendations for Preparing for Pregnancy or at Conception

The nutritional condition of the fetus determines its birth weight and the mother's nutritional status from conception, during pregnancy, to childbirth. The mother's nutritional status at conception is influenced by socioeconomics, maternal health and nutrition, birth spacing and parity, and the age of the first pregnancy (Symington et al., 2018). When pregnant women give birth, it is undoubtedly influenced by health conditions and nutritional status during conception (past), besides other factors, namely nutritional intake, infectious diseases, and the level of physical work.

Nutritional adequacy during pregnancy can be monitored through anthropometric parameters on the health condition of pregnant women and fetal weight. The examination can be done by weighing, measuring height, and determining the ideal weight of pregnant women and weight gain patterns. Weight gain during pregnancy generally reaches 11-16 kg, but this figure will undoubtedly vary based on the mother's BMI before pregnancy (Aoyama et al., 2022).

Pre-pregnancy weight is significant to know as a prognosis and decide whether intensive nutritional therapy is needed. If the mother's pre-pregnancy weight is below 10% or above 20% of the ideal weight, it reflects a nutritional status problem. Many techniques can be used in calculating ideal body weight. Broca's calculation is most recommended, modified by Katsura (Barasi, 2013). Based on the count of weeks of pregnancy, the average weight gain in the second and third trimesters should reach an average of 0.4 kg/week in women who have normal weight; in overweight women, the addition is 0.3 kg/week, and in underweight women weight gain should be above 0.5 kg/week. Excessive weight gain is strongly associated with large babies and is likely to risk labor complications. Conversely, low weight gain may pose a risk of LBW, with possible long-term health implications (Sato & Fujimori, 2012).

Some advice to women planning pregnancy or conception or in the first trimester to be able to (Goossens et al., 2018; Mínguez-Alarcón et al., 2018):

a. Limit excessive consumption of foods containing Vitamin A (retinol), such as liver and liver products, as these may have potential teratogenic effects.
b. Do not smoke and or avoid excessive drinking of alcohol.
c. Limit excessive amounts of caffeine (>300 mg/day).
d. Avoid foods that contain microorganisms (such as unpasteurized milk and cheese).

A balanced and healthy nutritional diet is required. It includes fruit and vegetable consumption, adequate iron intake, and fish consumption to provide Polyunsaturated Fatty Acids (PUFA).

The Role of Micronutrients During Pregnancy

The role and requirement of iron (Fe)

Iron or Fe nutrients in pregnant women are needed to increase the number of red blood cells and the formation of blood cells in the fetus and placenta. In young pregnant women (under 20 years old), the need for iron is essential for the growth of the mother (Nugraheni et al., 2021).

Avoiding iron deficiency during pregnancy requires sizable iron reserves and consuming bioavailable iron-rich foods (Lynch et al., 2018). Unfortunately, these conditions cannot always be met. A European study found that the average serum ferritin concentration of women of reproductive age ranged from 26- 38 g/l, meaning that women before pregnancy had an iron reserve of 40-50% (Milman et al., 2017). Behavioral patterns exacerbate iron intake in women, such as low compliance and inadequate iron intake. As much as 60-100% of women during pregnancy have iron intake below the

recommended intake or Recommended Dietary Allowance (RDA) as recommended in Indonesia, which is between 15-18 mg/day, and in second and third-trimester pregnant women, an additional 9 mg. Thus, it is necessary to increase additional iron in pregnant women, which can be obtained from iron supplements, menstrual cycles, and, most importantly, nutritious food intake.

Giving iron supplements to pregnant women may cause constipation in some women. This condition can be alleviated by drinking more and eating especially iron-containing foods (bread, cereals, and jelly). Supplemental iron should be sourced from nutritious foodstuffs.

The role and requirement of Zinc (Zn)

In low- and middle-income countries such as Indonesia, many women have poor diets and are deficient in crucial micronutrients needed by the body. Its particularly concerning for women during pregnancy, when energy and nutrient requirements are high for both the mother and fetus (Carducci et al., 2021). The intake of micronutrients such as zinc (Zn) or zinc plays an essential role in growth and development. According to Gibson (2022), zinc deficiency can cause fetal growth failure, premature, and LBW and is even closely related to stunting. A pregnant woman's body experiences a zinc deficiency when the level of Zn in the placenta is below 0.7 mg/L. While the recommended adequacy in women aged 18-49 years is around 8-9 mg/day, pregnant women in in the first trimester need an additional 2 mg and the second and third trimesters add 4 mg.

Sources of zinc can come from foods or foodstuffs such as red meat, chicken, shellfish, nuts, and cereals. Some of the benefits of zinc for the needs of pregnant women (Berdanier & Berdanier, 2015; Gibson, 2022; Tripathi et al., 2011):

a. DNA forming. For pregnant women, the main benefit of zinc is to help form new DNA that will carry genetic information from the mother to the fetus so that it can grow optimally. The formation of new cells by protein is the contribution of zinc. These cells function in fetal growth and development.
b. Eases Body Metabolism. Zinc can prevent various infectious diseases and accelerate pregnant women's and fetuses' metabolic processes to avoid disease. Pregnant women are strongly advised to consume zinc regularly (zinc content is very good for the health of pregnant women and fetuses).
c. Avoiding Pregnancy Problems. Several health problems during pregnancy, such as low birth weight babies, premature birth, and defect problems (fetal defects) that cause babies to be born with defects can be prevented if zinc intake is met as recommended. Pregnant women need zinc around 11 mg/day or reach a maximum of 40 mg/day.
d. Hormonal Stabilization. Pregnant women's hormones are known to have poor stabilization. To stabilize hormones in the body, an ideal Zn is needed. Pregnant women need to consume high zinc. It positively impacts the baby's brain and vision growth, development, and intelligence. Zinc supplements still pay attention or follow the doctor's recommendations. Pregnant women are significant in managing their diet because the intake of nutrients, in this case, zinc, dramatically affects the fetus. Pregnant women should prioritize consuming nutritious foods such as fruits and vegetables and balanced nutrition to give the fetus optimal nutritional intake.

The role and requirement of iodine

Iodine is one of the essential minerals that help produce thyroid hormones, which play an important role in brain and organ development, child growth, digestion and metabolism of food, regulation of body temperature, and control of muscle contractions (Kiely et al., 2021).

Iodine deficiency during pregnancy is a significant global public health problem and is a leading cause of neurodevelopmental disorders, and prevention is possible. The effects of severe iodine deficiency during pregnancy are detrimental to the mother and baby, including the birth process and decreased child intelligence (Chittimoju & Pearce, 2019). The impact of lack of iodine intake in pregnant women can make the fetus imperfect in growth and development, so it is possible to experience congenital disabilities and LBW, experience miscarriages, and stillbirths (Bath, 2019; Farias et al., 2020). According to Pearce (2012), a deficiency in iodine intake can disrupt thyroid hormone metabolism. Therefore, adequate iodine sufficiency before and during pregnancy is very important. During pregnancy, iodine requirements will increase to 50%. Pregnant and lactating women have higher

iodine requirements than other adults. Iodine intake is 220 - 250 µg/day during pregnancy and 250 - 290 µg/day during lactation (Chittimoju & Pearce, 2019). Likewise, in Indonesia, referring to the recommended RDA, pregnant women need 220 µg/day of iodine (Kemenkes RI, 2019).

Through the IDD prevention program, the government has conducted iodine fortification in table salt consumed by the Indonesian people. The program's goal is clear: to reduce the incidence of IDD and not experience iodine deficiency. However, this does not mean we should increase its use in food preparations. It is not good (done excessively) because it will harm pregnant women and babies in the womb (Hidayat, 2019).

An ideal source of iodine is a nutritious food. Some food sources high in iodine content and very good for pregnant women are seafood such as tuna, salmon, shrimp, shellfish, and seaweed. Then foods from dairy products and their preparations, namely cow's milk, cheese, and yogurt. In addition, iodine is also high in chicken eggs, meat, beef, and nuts (Gibson, 2022).

The role and requirement of vitamin A

As previously reported, nutritional deficiencies are prevalent among pregnant women, and one of them results in anemia. According to West et al. (2007), anemia in pregnant women is not only caused by a lack of iron (zinc) but also due to a deficiency of one of the micronutrients, Vitamin A or Retinol. It occurs because of the presence of erythropoiesis, which is where the production and maturation of erythrocyte cells occurs. In addition, according to Underwood (1994) hat blood vitamin A concentration can decrease gradually in each pregnancy due to hemodilution. This condition proves that inadequate vitamin A intake can also reduce blood concentration, so anemia in pregnant women.

Although vitamin A deficiency in pregnant women is less significant than other micronutrient deficiencies, it will still affect the pregnant woman and her baby. Generally, Vitamin A deficiency in pregnant women often occurs in the second and third trimesters because there is an increase in the need for blood and a rapidly developing fetus. Some possible effects of vitamin A deficiency in pregnant women are an increased risk of miscarriage, xerophthalmia, blindness, and iron anemia (Underwood, 1994; West et al., 2007).

Vitamin A intake in pregnant women is strongly associated with increased iron in the blood. Vitamin A deficiency has been shown to increase the risk of maternal mortality. Therefore, Vitamin A supplementation from food is highly recommended because it can reduce mortality in pregnant women. Not only in mothers or pregnant women, but vitamin A deficiency also impacts premature births and growth retardation, and LBW in infants (Bastos Maia et al., 2019; Emiroglu et al., 2019; West Jr et al., 1999). Thus, it becomes clear that the role of vitamin A during pregnancy in women is significant, both for the mother's and child's health conditions.

The adequacy of vitamin A consumption in pregnant women must be optimal in each trimester. Indonesia has provided particular recommendations for pregnant women to meet their vitamin A needs based on the 2019 RDA of 900 mcg/day (Kemenkes RI, 2019). Vitamin A can be obtained from various types of food or food, such as red meat, chicken or beef liver (it is highly recommended to limit liver consumption to no more than 200 grams/week), eggs, fish, cheese, milk, and its processing, and fruits. In addition, vitamin A is also high in vegetables, namely spinach, sweet potato, pumpkin, melon, broccoli, and tomatoes (Gibson, 2022; West et al., 2007).

The role and requirement of folic acid

Folic acid, or vitamin B9, is one of the vitamins included in the B vitamins and is an essential element in synthesizing Deoxyribonucleic Acid (DNA). This element is needed for coenzymes in the process of pyrimidine synthesis. Folic acid is the form that results from the synthesis of folate from one part of vitamin B, B9, so it is also called vitamin B9. Although folate and folic acid are often used interchangeably, folate is a water-soluble B vitamin (B9) that occurs naturally in foods (Goetzl et al., 2020; Tangkilisan & Rumbajan, 2016).

Optimal folic acid supplementation in the periconceptional period can reduce the incidence of Neural Tube Defects (NTDs) and their recurrence (Bibbins-Domingo et al., 2017; Haggarty, 2021). Folic acid administration is highly recommended for all women planning a pregnancy or pregnant women, as it can avoid or minimize the chance of NTDs (De-Regil et al., 2015). Education of preconception patients about the need for folic acid should be prioritized, as well as the importance of

prophylaxis during check-ups or healthcare visits for pregnant women (Mills, 2017). As many women are unaware of these recommendations, it is highly recommended that women planning a pregnancy and newly pregnant women and their partners attend such education, which can be obtained from specialist prenatal care services or obstetricians. Very important to implement to optimize the health of the womb and fetus.

The role of folic acid or Vitamin B9 is significant in women who will become pregnant and during pregnancy, so the need for folic acid must be fulfilled. Folic acid consumption must follow nutritional recommendations (RDA in 2019), 400 µg/day, starting at least three months before conception until 12 weeks of gestation. During pregnancy or trimester I to trimester III, the need for folic acid in mothers will increase, so it is recommended to be 600 µg / day (Kemenkes RI, 2019). An increased need for folic acid in pregnant women (first trimester) because folic acid deficiency is prevalent in the first week of life. If the needs are met, the body will store about 50-100 µg / day; almost half of it is stored in the liver. These reserves are sufficient for up to 3-6 months without folate intake from food (Castellanos-Sinco et al., 2015).

Folate sources are found in various animal and plant tissues, mainly in methyl or reduced formyl polyglutamate forms. Food sources or foods rich in folic acid are beef liver, chicken liver, kidneys, eggs, yeast, green vegetables (spinach, cauliflower, broccoli, lettuce, and potatoes), and legumes (peas and kidney beans). In adequate amounts, folic acid is found in dairy foods, fortified cereals, fish and meat, and in small amounts in fruits such as citrus, avocado, and papaya (Gibson, 2022; Goetzl et al., 2020; McNulty, 2022). Women who do not take folate supplements can still be fulfilled from natural components found in various foods or foods and can be sourced from grain products. If the diet is not good or lacks balanced nutrition, it is highly recommended to take folate supplements. In some countries, folic acid fortification has been carried out into food or ingredients. Folic acid fortification and supplementation are intended to prevent the risk of NTDs optimally (Bibbins-Domingo et al., 2017).

CONCLUSION AND RECOMMENDATION

The mother's nutritional status in early pregnancy is essential because weight can affect fertility. The average weight gain in the second and third trimesters should reach an average of 0.4 kg/week; in overweight women, the addition is 0.3 kg/week, and in underweight women, weight gain should be above 0.5 kg/week.

Some essential micronutrients during pregnancy are iron (Fe) and vitamin A, which are needed to increase the number of red blood cells and the formation of blood cells in the fetus and placenta, as well as anticipate the incidence of anemia in pregnant women and prevent miscarriages. The role of zinc (Zn) for pregnant women is the formation of DNA from mother to fetus, accelerating the body's metabolism in the mother and fetus. In addition, it prevents health problems during pregnancy, such as low birth weight babies, premature births, and fetal defects that cause congenital disabilities. However, it also acts as a hormone stabilizer in pregnant women. The role of iodine is essential in brain and organ development, child growth, digestion and metabolism of food, regulation of body temperature, and control of muscle contractions. Folic acid (vitamin B9) is an essential micronutrient during pregnancy, which can avoid or minimize the possibility of Neural Tube Defects (NTDs) in the periconceptional period.

It is recommended that women planning a pregnancy or who may become pregnant should be able to maintain an ideal body weight (BMI between 20 kg/m^2 and 25 kg/m^2). Women should pay attention to weight gain, as it risks complications during labor. Intake of micronutrients such as iron, zinc, vitamin A, and iodine should be met by consuming a nutritious and balanced diet. The need for folic acid is essential, and if it is not met from nutritious food intake, special supplements should be given to meet the need, which is 400 µg/day. In addition, it is necessary to educate preconception patients about the need for folic acid and the importance of prophylaxis during examination visits or health services for pregnant women.

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