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Seafood Consumption and Anemia Risk Among Pregnant Women in Indonesian Coastal Areas

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ABSTRACT

In coastal areas, a less diverse diet is one of the main causes of anemia in pregnant women. This study aims to analyze the correlation between marine resource consumption patterns and the incidence of anemia in pregnant women in coastal areas of Indonesia in the period January 2025, focusing on food intake. This study uses a cross-sectional study design. The population in this study is pregnant women living in coastal areas, totaling 369 pregnant women; the sampling technique used in this study is Simple Random Sampling, totaling 189 respondents. Data collection was conducted using a Food Frequency Questionnaire, which was employed to identify the types and frequency of marine resource consumption over the past month, while the three-day 24-hour dietary recall was used to estimate daily nutrient intake, including iron and other relevant micronutrients. Anemia status was assessed by measuring hemoglobin levels through the Cyanmethemoglobin method. In data analysis, the Spearman test will be used to identify the relationship between marine resource consumption patterns and the incidence of anemia. Based on the results of the Spearman test on pregnant women, the value of Sig. (2-tailed) = 0.033 was obtained, which showed that there was a significant relationship between seafood consumption patterns and the incidence of anemia in pregnant women in coastal areas. study found a significant relationship between seafood consumption patterns and anemia in pregnant women in coastal areas. The presence of non-heme iron and inhibitory compounds in seafood, along with low intake of red meat and liver, increases the risk of anemia.

Key Messages:

- The dietary habits of coastal communities, which rely on low-iron seafood and have limited access to heme iron sources like red meat and liver, contribute to high anemia rates among pregnant women. Low vitamin C intake further hinders iron absorption.
- Anemia in pregnancy develops gradually and can cause serious complications like preterm labor, low birth weight, and delayed postpartum recovery. Babies of anemic mothers are also at risk of early iron deficiency, affecting their growth and cognitive development.
- Increasing intake of iron-rich seafood like shellfish, oysters, small fish, and seaweed can help reduce anemia in pregnant women in coastal areas. Community education on seafood variety and vitamin C intake can further improve iron absorption and maternal health.

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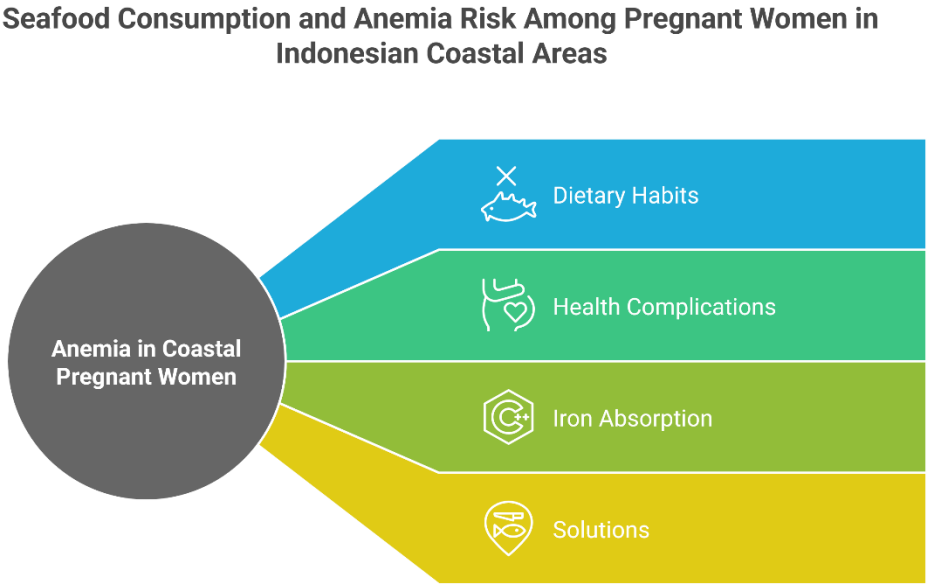
GRAPHICAL ABSTRACT



INTRODUCTION

Anemia is a global health problem that affects about 25% of the world's population, especially children and women of childbearing age. WHO noted that in 2021, anemia was experienced by 40% of children under five, 37% of pregnant women, and 30% of women aged 15–49 years. The main cause is iron deficiency, as well as other factors such as vitamin deficiency and chronic diseases. Anemia has an impact on the health, productivity, and safety of mothers and children (1). Regions with high prevalence, such as Sub-Saharan Africa and South Asia, demonstrate the need for more intensive global efforts in the prevention and control of anemia, including through nutrition interventions, education, and improved access to health services (2).

In coastal areas, anemia in pregnant women is greatly influenced by a less diverse diet. People tend to rely on fish as a source of iron, while consumption of red meat, liver, green vegetables, and vitamin C-rich fruits is still low. In fact, vitamin C plays an important role in increasing the absorption of non-heme iron which is dominant in coastal seafood (3). Economic factors, limited access to food, and preference for certain types of fish also narrow the intake of heme iron which is easier for the body to absorb. Consumption of shellfish and oysters that are actually rich in iron is also limited due to seasonal availability, high prices, and food safety concerns such as heavy metal contamination (4). In addition, hereditary eating habits and lack of nutrition education reinforce unbalanced consumption patterns (5). This condition shows the need for integrated nutrition interventions that consider accessibility, education, local food sustainability, and policy support to improve the food security of pregnant women in the region (6).

In 2024, the prevalence of anemia in pregnant women around the world is still quite high. Based on data from WHO, the prevalence of anemia in pregnant women globally is estimated to reach 43.9%. This figure varies across different regions, with the highest prevalence in Africa (59.1%), followed by Asia (49.4%), the Americas (28.2%), and Europe (26.1%). Anemia in pregnant women in Indonesia in 2018 was obtained on average from 497 cities or regencies that experienced anemia in pregnancy as much as 37.1% of the total population, while in East Java it was recorded that 5.8% of the pregnant women's population experienced anemia (Riskesdas, 2018). The study from El-Kholy et al. 2023 found that the prevalence of anemia was 44% with a hemoglobin concentration of<11 g/dl. This result is higher than the country's average of about 40%. The prevalence is also higher than in the Asir region, 31.9%, Makkah 39 39%, and less than in Jazan, 58.9% (7). The study from Yang et al. 2023 in China states that haemoglobin concentrations and prevalence of anaemia among participants. The mean haemoglobin concentration in the study population was 115.17 ± 14.21 g/L. In total, 204 of the 586 pregnant women had haemoglobin

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concen- trations <110 g/L, resulting in an overall anaemia prevalence of was 21.7%; the rate of moderate anaemia (70 g/L ? haemoglobin 34.8%. The rate of mild anaemia (100 g/L ? haemoglobin <110 g/L) <100 g/L) was 13.0%; and only one participant (0.2%) was severely anaemic (Hb < 70 g/L) (8).

Anemia in pregnant women, especially in coastal areas, is a health problem that develops gradually due to various interrelated factors. This condition often begins before pregnancy, when many mothers have low iron reserves due to a less diverse diet, low consumption of heme iron sources such as red meat, and habits that inhibit iron absorption, such as tea and coffee consumption. During pregnancy, iron needs increase dramatically to support fetal growth and increased blood volume, but if iron intake is insufficient, anemia becomes more severe (9). The second trimester, the body undergoes natural hemodilution, which further lowers hemoglobin levels if not balanced with adequate iron supplementation. In the third trimester, anemia can lead to serious complications such as premature labor and low birth weight (10). After childbirth, mothers with anemia are at risk of longer recovery and impaired milk production, while babies born to anemic mothers tend to develop iron deficiency early on, potentially hindering their cognitive development and growth (11).

To overcome anemia in pregnant women in coastal areas, increasing the consumption of marine resources is one of the potential and sustainable solutions. Marine resources such as shellfish, oysters, small fish, and seaweed are rich in iron, protein, as well as other important micronutrients that can help increase hemoglobin levels in the blood (8). In contrast to red meat, which is more difficult to access by coastal communities, seafood is easier to obtain and can be used as a source of heme iron, which is easier for the body to absorb than non-heme iron from plants. In addition, diversification of seafood-based foods, such as processing fish and shellfish into more nutritious processed foods, can increase the attractiveness of consumption for pregnant women. Nutritional assistance through education on how to cook and combine seafood with vitamin C sources is also important to optimize iron absorption (12).

Based on this background, this study aims to analyze the correlation between marine resource consumption patterns and the incidence of anemia in pregnant women in coastal areas of Indonesia in January 2025, focusing on food intake.

METHODS

This study uses a cross-sectional study design to analyze the relationship between marine resource consumption patterns and the incidence of anemia in pregnant women in coastal areas of Indonesia. The population in this study is pregnant women living in coastal areas totaling 369 pregnant women, with inclusion criteria including pregnant women in the first to third trimester, living in coastal areas for at least one year, and willing to become respondents by signing informed consent. Exclusion criteria in this study included pregnant women who had chronic diseases that can affect hemoglobin levels, such as thalassemia, as well as those who routinely took iron supplements before pregnancy.

The sampling technique used in this study is Simple Random Sampling, where respondents are randomly selected from a list of pregnant women available at local health facilities or data obtained from health offices. The sample size will be determined using the Lemeshow formula with a sample of 189 respondents. This research will be conducted in January 2025.

The dependent variable in this study was the incidence of anemia measured based on hemoglobin levels (Hb < 11 g/dL). Meanwhile, the independent variables include marine resource consumption patterns. The FFQ questionnaire used was a version specifically developed for this study, adapted from commonly used FFQs in nutritional research in coastal areas. The questionnaire includes a list of seafood frequently consumed by the target population, such as various types of fish (skipjack tuna, mackerel), shellfish, shrimp, squid, and seaweed. Consumption frequency was categorized into daily, weekly, and monthly intervals to capture consumption patterns in more detail. Portion size estimation was done by providing examples using local measurement units (plates or standard cups) so respondents could approximate their intake. Consumption patterns were then grouped into low, medium, and high based on the distribution of total consumption frequency over the past month, using quantitative analysis of the FFQ data.

Nutrient intake data was collected using the 24-hour recall method over three consecutive days,

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recording all foods and beverages consumed by respondents in the previous 24 hours each day. This data was analyzed using nutrition software (the latest version of Nutrisurvey) to estimate intake of iron, protein, vitamin C, and other relevant micronutrients. This information was used as covariates in the analysis of the relationship between seafood consumption patterns and anemia status.

Anemia status was determined by measuring hemoglobin levels using the Cyanmethemoglobin method, which is a standard and accurate method. Measurements were conducted in a standardized laboratory using appropriate equipment. A hemoglobin cutoff of <11 g/dL was used as the anemia criterion based on WHO guidelines for pregnant women. Socioeconomic data, including education level, employment status, and family income, were collected using standardized questionnaires previously validated for the local context. The questionnaire was designed to obtain comprehensive information on respondents' socioeconomic conditions that could affect nutritional status and anemia. The status of anemia is determined through examination of hemoglobin levels using the Cyanmethemoglobin method.

Data analysis is carried out in several stages. Descriptive analysis was used to see the frequency and percentage distribution of each research variable. The spearman test will be used to identify the relationship between marine resource consumption patterns and the incidence of anemia. Furthermore, multivariate analysis using logistic regression will be performed to control for confounding factors that can affect the results of the study.

CODE OF HEALTH ETHICS

This study was approved by the Health Research Ethics Committee of IIKNU Tuban with approval number 256/0084223523/LEPK.IIKNU/I/2025.

RESULTS

Table 1. Characteristics of respondents of pregnant women in coastal areas

Characteristic		n	%
Mother's age	>20	35	18.5
	20-35	120	63.5
	>35	34	18
Education Level	Elementary School	40	21.2
	Yunior High School	60	31.7
	Senior High School	65	34.4
	Collage	24	12.7
Employment status	Housewives	145	76.7
	Work	44	23.3

Table 1 shows that most of the pregnant women who are respondents are in the age range of 20-35 years (63.5%), which is the optimal reproductive age. Most of the respondents had a high school education level (34.4%). Higher education can affect mothers' understanding of healthy consumption patterns, including iron intake from marine resources. Most of the pregnant women in this study are housewives (76.7%). Working mothers may have better economic access but can also have different consumption patterns from housewives.

Table 2 Marine resource consumption patterns with the incidence of anemia

		Incidence of Anemia		Total
		Not anemia	Anemia	
Marine Resources Consumption Patterns	Low	30	49	79
	Medium	28	28	56
	High	34	20	54
Total			97	189
Sig. (2-tailed) : 0.033, Correlation Coefficient :.162				

Based on the results of the Spearman test, the value of Sig. (2-tailed) = 0.033 was obtained, which shows that there is a significant relationship between seafood consumption patterns and the incidence of

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anemia in pregnant women in coastal areas. A significance value smaller than α = 0.05 indicates that seafood consumption patterns are associated with the incidence of anemia.

DISCUSSION

Based on the results of the questionnaire analysis which included the Food Frequency Questionnaire (FFQ) and the 24-Hour Recall method, it was found that the seafood consumption pattern in the respondents was in the high category. The majority of respondents reported that they routinely consume various types of seafood such as fresh sea fish, shrimp, and squid with a frequency of 2-4 times a week to every day. Respondents also consumed tea and coffee with a frequency of 1-3 times in one week. This shows that seafood is an important part of the respondents' daily diet. In addition, based on the recording of food intake through the 24-Hour Recall for three consecutive days, information was obtained that seafood contributes significantly to the fulfillment of nutrients, especially animal protein and heme iron, which are known to play an important role in the formation of hemoglobin.

Studies in Malawi involving children showed that more frequent consumption of large fish was actually associated with a higher prevalence of anaemia (prevalence ratio: 1.09; 95% CI: 1.01–1.19), although it was also associated with a lower prevalence of iron deficiency (0.96; 95% CI: 0.93–1.00). Consumption of small fish was more often associated with improved iron status, but did not significantly affect hemoglobin levels(7). However, a study by Yang et al. 2023 in China found that consumption of micronutrient-rich foods, including fish, was associated with a 35% decrease in the prevalence of anemia in adolescent girls and 59% in adolescent boys. This suggests that seafood intake can play an important role in the prevention of anemia, especially among adolescents(8).

The researchers assumed that although the respondents' seafood consumption patterns were relatively high and the intake of nutrients from animal sources was sufficient, the results of the anemia status examination showed that the prevalence of anemia was still high among the respondents. These findings suggest that high seafood consumption does not fully guarantee optimal hemoglobin status. This can be caused by a variety of other factors that affect the status of anemia, such as low bioavailability of iron due to high consumption of absorption-inhibiting substances (such as tea and coffee), lack of intake of supporting micronutrients such as vitamin C and folate, or the presence of chronic infections that can affect iron metabolism (13).

The high consumption of marine resources in coastal areas does not always have a positive impact on the prevention of anemia in pregnant women. Although seafood contains iron, it mostly comes from non-heme types that have a lower absorption rate than heme iron from red meat or liver. Several types of fish that are often consumed, such as anchovies (Engraulidae sp.), sardines (Sardinella sp.), tuna (Thunnus sp.), and mackerel (Rastrelliger sp.), contain compounds that inhibit iron absorption, such as phytate and oxalate, which can reduce the bioavailability of iron in the body (Burayu and Degefa 2024). Anchovies and sardines, which are often consumed in whole form including bones, contain phytates that can bind to iron and inhibit its absorption, especially in processed forms such as cans, can also contain additives that have the potential to reduce the effectiveness of iron absorption. Mackerel has certain levels of oxalate that can reduce the availability of iron for the body.Although coastal communities have high access to marine resources, fish consumption patterns and processing methods are important factors that need to be considered in efforts to prevent anemia in pregnant women (14).

Based on the data obtained from the questionnaire, it is known that most of the adolescents in this study do not routinely consume blood-boosting tablets. This can be seen from the respondents' answers which showed that the frequency of consumption of blood plus tablets was low or even not at all during the questionnaire filling period. The irregularity in the consumption of blood supplement tablets has the potential to contribute to the high incidence of anemia detected through the examination of hemoglobin levels using the cyanmethemoglobin method. Although seafood consumption patterns are quite high and can be a source of iron, irregular use of blood-boosting tablets that function as iron supplementation can lead to suboptimal iron intake. This supports the finding that anemia is still prevalent among adolescents despite relatively good nutritional intake from seafood(15).

According to Abdulsalam 2025, iron supplementation through blood supplement tablets is one of the effective interventions to reduce the incidence of anemia, especially in vulnerable groups such as

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adolescent girls who experience menstruation (16). However, compliance issues with the consumption of blood-boosting tablets are often a major obstacle to the success of these programs (9)

In this study, the high seafood consumption pattern in the respondents is expected to make a positive contribution to the overall nutritional status, especially hemoglobin levels, considering that seafood is a source of heme iron that is easily absorbed by the body compared to non-heme iron found in vegetable sources. Heme iron derived from seafood is essential in the formation of hemoglobin and prevents anemia. However, even though seafood consumption is relatively high, the results of the study show that there is still a significant prevalence of anemia in the adolescent population studied. This shows that there are other factors that also affect the status of anemia in addition to food intake(4). One of the important factors found is the irregularity of the consumption of blood-boosting tablets that serve as supplemental iron supplementation, which should help meet daily iron requirements and improve hemoglobin levels in individuals at risk of anemia. Irregularities in taking these blood-boosting tablets can be caused by various things, such as lack of knowledge about the importance of supplementation, perceived side effects, or lack of support from the surrounding environment. In addition, other factors that affect the incidence of anemia include impaired iron absorption in the digestive tract, which can be affected by parasitic infections or other health conditions, as well as low consumption of complementary foods that contain vitamin C or other nutrients that help iron absorption in the body(17).

In this study, it was also found that low socioeconomic status in coastal areas is the main factor contributing to the high prevalence of anemia in pregnant women(18). Limited access to nutritious foods, especially sources of heme iron such as red meat and liver, is a major obstacle in meeting nutritional needs during pregnancy(19). The low purchasing power of coastal communities for nutritious foods leads to greater dependence on more accessible food sources, such as fish and other marine products, which mostly contain non-heme iron with a lower absorption rate compared to heme iron. In addition, unbalanced consumption patterns and lack of dietary variations rich in vitamin C as an increase in iron absorption further exacerbate the risk of anemia among pregnant women in coastal areas (20).

Pregnant women from low socioeconomic groups are also more at risk of developing anemia due to lack of adherence to recommended iron supplements. Factors such as limited information on the importance of supplementation, economic barriers that limit access to health facilities, and the low frequency of pregnancy check-ups have also exacerbated this condition. In addition, high physical workloads, especially for pregnant women who are still involved in heavy work such as laborers or fishermen, increase iron requirements, but are often not balanced by adequate nutritional intake (21).

Researchers assume that low socioeconomic status has a significant contribution to the high prevalence of anemia in pregnant women in coastal areas. Financial limitations cause low people's purchasing power for nutritious foods, especially sources of heme iron such as red meat and liver. As a result, pregnant women in these areas are more dependent on non-heme iron sources that have lower absorption rates, thus increasing the risk of anemia. In addition, limited access to health services also hinders the fulfillment of nutritional needs during pregnancy, both through routine check-ups and adequate nutritional interventions (22).

To reduce the prevalence of anemia in pregnant women in coastal areas, a nutrition strategy is needed that focuses on optimizing the consumption of marine resources and diversifying balanced foods. Therefore, pregnant women are advised to increase the consumption of foods rich in heme iron, such as liver, red meat, or certain seafood such as oysters and shellfish, which have a higher iron content than regular fish (23). In addition, it is important to consume foods rich in vitamin C, such as oranges, tomatoes or guava, to increase iron absorption from seafood. Habits that inhibit iron absorption, such as drinking tea and coffee after meals, should be reduced. Nutrition education also needs to be improved so that pregnant women and adolescent girls can understand how to process and combine food optimally (24,25).

CONCLUSION

The results showed that there was a significant relationship between seafood consumption patterns and the incidence of anemia in pregnant women in coastal areas. Based on the results of the

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Spearman test, the value of Sig. (2-tailed) = 0.033 was obtained, which shows that there is a significant relationship between seafood consumption patterns and the incidence of anemia in pregnant women in coastal areas. A significance value smaller than α = 0.05 indicates that seafood consumption patterns are associated with the incidence of anemia. Although seafood is rich in iron, most of it comes from non-heme types that have a lower absorption rate than heme iron from red meat and liver. In addition, inhibitory compounds such as phytate and oxalate found in some types of fish can reduce the bioavailability of iron. Low consumption of red meat and liver also contributes to the high prevalence of anemia, as both foods are not only rich in heme iron, but also contain high-quality proteins that play a role in the formation of red blood cells. The suggestion for future research is to investigate how the processing methods of seafood (such as boiling, frying, grilling, or fermenting) affect iron content, iron bioavailability, and their impact on anemia status in pregnant women. The study results are expected to provide practical recommendations on optimal seafood processing methods to enhance iron absorption and prevent anemia in this vulnerable group.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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