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ORIGINAL PAPER

Association between animal protein adequacy and anemia among pregnant women in Palembang, Indonesia

Ardesy Melizah Kurniati,[1] Eka Handayani Oktharina,[2] Aryani Aziz,[3] Corinna Faustina[4]

1. *Nutrition Department, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia*
2. *Biochemistry Department, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia*
3. *Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia*
4. *Undergraduate, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia*

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Abstract

Background: Palembang City has the highest prevalence of anemia in South Sumatra, Indonesia. Protein contributes to hemoglobin formation and insufficient protein intake increases the risk of anemia. However, Sumatera studies on protein intake based on protein sources in pregnant women are still limited.
Objective: This study aimed to examine the association between animal protein consumption and anemia prevalence in pregnant women.
Methods: A cross-sectional analytic study was conducted from July to October 2024 at six public health centers and seven private midwife clinics selected to represent Palembang's geographic diversity. A total of 62 pregnant women in their second or third trimester were recruited using consecutive sampling. Dietary intake was assessed via interviewer-administered 2×24-hour recalls on non-consecutive days. Protein intake was analyzed using modified NutriSurvey 2004 and categorized based on the Indonesian RDA. Hemoglobin levels were measured using venous blood samples and classified according to trimester-specific anemia thresholds. Bivariate analysis with Fisher's exact test was used to examine the association between animal protein intake and anemia prevalence.
Results: The Fisher Exact Test showed a statistically significant association between animal protein consumption levels and anemia in pregnant women in Palembang City ($p = 0.018$). The mean total protein intake was 80.40 ± 20.53 g/day, with animal and vegetable proteins contributing 40.22 ± 18.63 g/day and 40.91 ± 24.5 g/day, respectively. Mean hemoglobin level was 11.18 ± 1.17 g/dL.
Conclusion: Sufficient consumption of animal protein was found to be more protective against the occurrence of anemia.

Keywords: animal protein, pregnant woman, anemia, Palembang

Corresponding author:
Name : Ardesy Melizah Kurniati
Affiliations : Nutrition Department, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia
Email: ardesy.gizi@fk.unsri.ac.id

Introduction

The first thousand days of life are critical in shaping the child's ability to grow, develop, and learn throughout their lifetime. Pregnancy marks the beginning of this period, and any disruptions during this stage can significantly impact pregnancy outcomes.[1] Therefore, establishing an optimal nutritional foundation for pregnant women is crucial, including protein intake because this process is irreversible and will determine the long-term health of the mother and child in the future.[2,3]

Protein contributes for several physiological functions, including maintaining cell structure, facilitating biochemical reactions, and supporting tissue formation.[4] During pregnancy, the body's protein requirements increase to promote fetal growth and development.[5,6] Although there is no national data on protein adequacy among pregnant women, a 2022 study conducted in Malang City found that 82.8% of 64 pregnant women had insufficient protein intake.[7] Similarly, research by Dewi, Dery, and Tampubolon in 2021 reported that 80% of 50 pregnant women experienced protein deficiencies.[8] Protein is also crucial for hemoglobin synthesis and insufficient intake of protein may reduce hemoglobin production, thus increasing the risk of anemia during pregnancy.[9]

Anemia is a condition which a woman's hemoglobin level is below 11 g/dL during the first and third trimesters of pregnancy or below 10.5 g/dL in the second trimester.[10] It is estimated that anemia affects around 56–59 million pregnant women worldwide, accounting for 41.8%–43.8% of pregnancies. Indonesia is among the countries with a high prevalence of anemia in pregnant women, with an estimated 70% (7 out of 10) affected.[11]

Anemia during pregnancy is associated with adverse outcomes, including an increased risk of preterm birth, low birth weight, and miscarriage.[12] Additionally, it can contribute to long-term impairments in a child's growth and development. These risks highlight the critical need for anemia prevention through appropriate dietary interventions.

Dietary iron is classified into two main forms: heme and non-heme iron. Heme iron, primarily found in red meat and blood, is considered a promising source for iron supplementation and fortification due to its higher bioavailability and fewer side effects compared to non-heme iron.[13,14] Pregnant women are encouraged to consume animal protein, as it provides all essential amino acids necessary for fetal development.[4,15]

Palembang City, the capital of South Sumatra Province, Indonesia, is well known for its diverse traditional fish-based cuisine. The primary source of fish in the region comes from inland waters, and fish products are a major part of the daily protein intake for the local population. According to 2024 data from Statistics Indonesia (BPS), Palembang ranks among the cities with the highest average per capita fish consumption in South Sumatera. The population also consumes significant amounts of marine fish, including Indonesian wahoo fish (*tenggiri*), red snapper (*kakap merah*), and Spanish mackerel.[16]

Despite this high intake of fish and other animal protein sources, Palembang City has the highest reported prevalence of anemia in the province, reaching 34.8%, according to the South Sumatra Provincial Health Office in 2024. While several studies in Indonesia have examined the relationship between animal protein intake and anemia, none have specifically focused on the Sumatra region, particularly Palembang. Therefore, this study aims to investigate the association between animal protein consumption and the prevalence of anemia in pregnant women in Palembang city.

Methods

This study employed an analytic observational approach with a cross-sectional design using primary data. The Palembang region consists of 13 sub-districts in Ilir and 5 sub-districts in Ulu. The research was conducted at six randomly selected public health centers and seven independent midwives, representing the Palembang City Health Center work area. Those places were purposively selected to represent the city's diverse districts and populations. This ensured coverage of different geographic areas and service volumes within Palembang. We recognize that not all places were included, but by choosing places from various parts of the city, the sample broadly reflects the target population.

The study was conducted from July to October 2024. The inclusion criteria for this study are women with singleton pregnancies who have been screened in the triple elimination program, in second or third trimester, and have agreed to participate by signing the informed consent form. Exclusion criteria included having chronic illnesses (such as diabetes mellitus, HIV/AIDS, tuberculosis, kidney disease, COPD, cancer, or cardiovascular conditions), being multigravida, following special dietary patterns, or opting not to complete the research procedures. Pregnant women in the first trimester were excluded because dietary intake patterns are often inconsistent in the first trimester due to nausea, vomiting, and food aversions, which may not reflect typical nutrient intake.[17,18] Ethical approval for this study was granted by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Sriwijaya University, under protocol number 371-2024.

Minimum sample for this study is counted with P_1=0.545, P_2=0.258, $Z_{1-\alpha/2}$= 1,96, and $Z_{1-\beta/2}$= 1,28, thus 62 people were recruited.[19] Pregnant women meeting the inclusion criteria were recruited using consecutive sampling method. The respondents' characteristics were collected directly from respondents using questionnaires. Before completing the questionnaire, respondents were provided with detailed instructions on how to fill it out correctly and informed consent was obtained.

Data on pregnant women's food intake was gathered through a 2×24-hour food recall method, covering one weekday and one weekend day in non-consecutive day via interviewer-administered questionnaire. Trained enumerator conducted the interviews and guided participants through a 2x24-hour recall of their dietary intake. The study has shown that 2x24-hour recall was valid and feasible to estimate protein intakes.[20] Interviewers ensured that participants understood each question, and standardized food portion measurements were facilitated using food photo portionimetry, which was validated by the Indonesian Ministry of Health and supported by validated food pictures to improve accuracy. [21,22] The protein data from the 2 days will be averaged to determine the protein intake.

Modified Nutrisurvey 2004 software that has been synchronized to Indonesia Food Composition Table is used to calculate the protein content of the consumed foods.[23] If specific food items were not available in the portion references, the researcher utilized food databases from the US Department of Agriculture and the Energy and Nutrient Composition of Food, Health Promotion Board, Singapore, to estimate their nutritional content.[24,25] If food data remained unavailable, the ingredient and portion details were calculated as a new recipe.

According to the Indonesian RDA, the protein requirement for pregnant women is 75 grams per day during the second trimester and 95 grams per day during the third trimester.[26] The adequacy of total protein, vegetable protein, and animal protein intake was assessed by dividing the amount of total protein, vegetable protein, and animal protein consumed by the Indonesian RDA. Total protein intake levels were categorized as insufficient (<100% RDA) and sufficient (≥100% RDA).

Animal protein intake levels were categorized as insufficient (<20% RDA) and sufficient (≥20 RDA). This cut-off was determined by following prior study in Indonesia, this categorization helps identify women with substantially insufficient versus sufficient protein intake from animal sources.[27] Vegetable protein intake levels were categorized as insufficient (≥80% RDA) and sufficient (<80% RDA) based on on dietary modeling research showing that nutrient-sufficient diets require vegetable protein contribution between approximately 15–80% of total protein. Diets beyond 80% PP, predominantly plant-based with little animal protein give a risk insufficient intake of key nutrients unless supported by fortification or supplementation.[28]

The prevalence of anemia in this study was determined based on hemoglobin levels. Hemoglobin levels were measured through blood sample screening conducted by trained enumerators. Blood samples were collected intravenously, with 2 mL drawn per subject, and stored in EDTA tubes. The collected samples were analyzed at the Center for Health Laboratories to measure hemoglobin levels using the Blood Cell Counter method.

Venous blood is preferred over capillary blood due to its more stable consistency and higher quality. In contrast, capillary blood obtained from a finger prick may lead to inaccurate hemoglobin measurements, as water loss from the capillaries can artificially lower hemoglobin concentrations. Previous studies have also recommended the use of venous blood samples to minimize pre-analytical bias associated with capillary blood collection.[29] Respondents were classified as anemic if their hemoglobin levels are below 11 g/dL during the third trimesters of pregnancy or below 10.5 g/dL in the second trimester.[10]

Data was processed using Microsoft Excel and SPSS 27th edition. The characteristics of respondents were analyzed using univariate analysis to obtain percentage values. Bivariate analysis was conducted using a 2×2 crosstab with Fisher's exact test to determine the association between participants' characteristics and protein intake with the prevalence of anemia.

Results

The majority of pregnant women were in their third trimester, aged between 20 and 35 years old, unemployed, multiparous, had a birth spacing of more than two years, had a secondary education, an income above the regional minimum wage, and with no supplementation (**Table 1**).

All participants consumed cereals, with high intake also observed for fruits (98.4%), eggs (96.8%), meat/poultry (95.2%), fish/shellfish (93.5%), and legumes (91.9%). Tubers were consumed by 62.9% of participants, while milk and dairy products had the lowest intake at 45.2%. Overall, most respondents consumed both plant- and animal-based protein sources, though dairy consumption was relatively low (**Table 2**).

The mean total protein intake was 80.40 ± 20.53 g/day, indicating that most participants were approaching the recommended daily intake for pregnancy. Animal protein contributed an average of 40.22 ± 18.63 g/day, while vegetable protein intake was slightly higher at 40.91 ± 24.5 g/day. This relatively balanced contribution suggests a mixed dietary pattern, with higher proportion of vegetable protein intake. The wide range in animal protein intake (14.40–112.80 g/day) also indicates that a substantial proportion of participants may have had insufficient intake of high-quality, heme-iron-rich protein sources. The mean hemoglobin level was 11.18 ± 1.17 g/dL, with values ranging from 8.80 to 13.40 g/dL **(Table 3)**.

The analysis revealed a statistically significant relationship between the level of animal protein consumption and the prevalence of anemia among pregnant women in Palembang City ($p = 0.023$). Pregnant women with insufficient animal protein intake had a 10.56-fold higher risk of developing anemia compared to those with sufficient or excessive protein consumption. Sufficient levels of animal protein intake were found to be protective against anemia. However, there is no statistically significant relationship between the level of total protein, vegetable protein, and iron consumption with the prevalence of anemia among pregnant women in Palembang city (**Table 4**).

There was significant association between pregnancy trimester and anemia status ($p = 0.009$), with a higher proportion of anemia observed in the third trimester (47.7%) compared to the second trimester (11.1%). No statistically significant associations were found for age, occupation, parity, birth spacing, education level, or household income ($p > 0.05$) **(Table 5).**

Regression Linear statistic was used for animal protein intake, pregnancy age, education level, and trimester with anemia prevalence ($p>0.25$). Education level showed a protective effect, with women having higher education significantly less likely to experience anemia ($p = 0.028$; OR = 0.045). Pregnancy age (trimester) was also a significant factor ($p = 0.014$), with those in the third trimester at greater risk of anemia (OR = 0.089). Adequate intake of animal protein was strongly associated with a reduced risk of anemia ($p = 0.022$), with an odds ratio of 30.255, indicating that women with sufficient animal protein intake had substantially lower odds of being anemic. In contrast, short birth spacing (<2 years) was associated with an increased risk of anemia ($p = 0.037$; OR = 7.136). These findings underscore the importance of maternal education, adequate animal protein consumption, optimal pregnancy spacing, and consideration of gestational stage in preventing anemia during pregnancy (**Table 6**).

Table 1. Respondents' characteristics (n = 62)

Variable	Total	Percentage (%)
Age		
<20 years	2	3.23
20–35 years	49	79.03
>35 years	11	17.74
Pregnancy age		
2nd trimester	18	29.03
3rd trimester	44	70.97
Occupation		
Employed	12	19.35
Unemployed	50	80.65
Parity		
Nuliparous	16	41.94
Primiparous	16	25.81
Multiparous	20	32.26
Birth spacing		
<2 years	12	20.35
≥2 years	50	80.65
Education level		
Primary[a]	9	14.52
Secondary[b]	43	69.35
Higher[c]	10	16.13
Household income[30]		
<Regional Minimum Wage[d]	18	29.03
≥Regional Minimum Wage	44	70.97
Iron supplementation consumption		
90 mg		
60 mg	2	3.22
30 mg	28	45.16
No Supplementation	14	22.59
	18	29.03

[a]Graduated from elementary school/junior high school
[b]Graduated from senior high school
[c]Graduated from diploma or bachelor's degree
[d]Regional minimum wage for South Sumatera= Rp.3.456.874/month (212.47 USD)

Table 2. Distribution of food source consumption among pregnant women (n = 62)

Food Sources	Total (n=62)	Percentage (%)
Cereals and their products		
Yes	62	100
No	0	0
Tubers and their products		
Yes	39	62.9
No	23	37.1
Nuts, seeds, beans, and their products		
Yes	57	91.9
No	5	8.1
Fruits and their products	61	98.4
Yes	1	1.6

Food Sources	Total (n=62)	Percentage (%)
No		
Meat, poultry, and their products		
Yes	59	95.2
No	3	4.8
Fish, shellfish, shrimp, and their products		
Yes	58	93.5
No	4	6.5
Eggs and their products		
Yes	60	96.8
No	2	3.2
Milk and dairy products		
Yes	28	45.2
No	34	54.8

Table 3. Hemoglobin and nutrient intake data

Variable	Mean ± SD	Median	Minimum	Maximum
Total protein intake (g)	80.40 ± 20.53	79.8	41.95	132.90
Total animal protein intake (g)	40.22 ± 18.63	36.13	14.40	112.80
Total vegetable protein intake (g)	40.91 ± 24.5	38.95	0.95	104.50
Total hemoglobin (g/dL)	11.18 ± 1.17	11.05	8.80	13.40

Table 4. Association between protein intake with anemia prevalence among pregnant women in Palembang

Variable	Anemia prevalence				OR	*p*
	Yes		No			
	n	%	n	%		
Total protein adequacy						
Insufficient	18	40	27	60	1.6	0.321
Sufficient	5	38.46	12	61.54	0.625	
Animal protein adequacy						
Insufficient	5	83.3	1	16.7	10.56	0.023
Sufficient	18	32.1	38	67.9	0.09	
Vegetable protein adequacy						
Insufficient	20	37.04	34	16.7	0.98	0.633
Sufficient	3	37.5	5	62.5	1.02	

Table 5. Association between participants' characteristic with anemia prevalence among pregnant women in Palembang

Variable	Anemia Prevalence				p
	Yes		No		
	n	%	n	%	
Age					
<20 years	0	0	2	100	0.538
20–35 years	19	39.8	30	61.2	
>35 years	4	36.4	7	63.6	
Pregnancy age					
2nd trimester	2	11.1	16	88.9	0.009
3rd trimester	21	47.7	23	52.3	
Occupation					
Employed	2	16.7	10	83.3	0.633
Unemployed	21	42	29	58	
Parity					
Nuliparous	4	25	12	75	0.376
Primiparous	12	47.2	14	53.8	
Multiparous	7	35	13	65	
Birth spacing					
<2 years	7	58.3	5	41.7	0.185
≥2 years	12	35.3	22	64.7	
Education level					
Primary	4	44.4	5	55.6	0.152
Secondary	18	41.9	25	58.1	
Higher	1	10	9	90	
Household income					
<Regional minimum wage	7	38.9	11	61.1	0.537
≥Regional minimum wage	16	36.4	28	63.6	
Iron supplementation					
Yes	5	14.7	29	85.3	
No	18	64.29	10	35.71	0.314

Table 6. Multivariate analysis between cofounding factors with anemia prevalence among pregnant women in Palembang

Variable	B	SE	Wald	Df	Sig	Exp(B)
Education level	-3.111	1.417	4.819	1	0.028	0.045
Pregnancy age	-2.424	0.991	5.977	1	0.014	0.089
Animal protein level	3.410	1.489	5.242	1	0.022	30.255
Birth spacing	1.965	0.944	4.334	1	0.037	7.136

Discussion

There was a statistically significant association between the amount of animal protein consumed and the prevalence of anemia in pregnant women in Palembang City (p=0.018). This outcome is consistent with earlier studies by Kusumawati, *et al.*, Fera, *et al.*, Soleha, Mayasari, *et. al.*[9,31–34]

Iron, which comes in two types, heme and non-heme, is one of the hemoglobin components. Plant protein contains non-heme iron, while animal protein has heme iron. In contrast to heme iron, non-heme iron cannot be utilized as a material that forms hemoglobin until it has been absorbed and processed by the duodenum's cytochrome B enzyme. While heme iron has a variable absorption rate, it is estimated that 10–20% of the heme in food is fully absorbed.[35] The body's heme iron also contributes to a higher rate of non-heme iron absorption.[14] Therefore, eating animal protein can raise the body's iron levels, which helps to prevent anemia.

Interestingly, neither total protein nor vegetable protein alone was associated with anemia prevalence in this study. This underscores the importance of protein quality over quantity. In Palembang, where plant-based dishes such as Indonesian sour vegetable soup (*sayur asem*), vegetable in coconut milk soup (*lodeh*), and vegetable fritters (*bakwan*) are widely consumed, it is possible that non-heme iron absorption remains suboptimal despite seemingly adequate total intake. Non-heme iron from plant sources has lower absorption rates and may be inhibited by other dietary components.[14] Thus, high vegetable protein consumption does not necessarily mean high protein delivery to the body. Additionally, the relatively low intake of milk and dairy products (45.2% of respondents) reflects a gap in high-quality protein sources.

Palembang were also renowned with its traditional cuisine called "*pempek*", made from fish paste and tapioca flour, served with a sweet and tangy vinegar-based sauce. These dishes are rich in protein, particularly from fish and other seafood.[36] This helped to explain why nearly all respondents had an adequate intake of animal protein, which was linked to a lower risk of anemia.

This study demonstrated the need to promote the consumption of accessible and culturally accepted animal proteins, such as freshwater fish, eggs, and chicken among pregnant women. Traditional dishes can be nutritionally enhanced, for instance, by increasing the fish portion in *pempek* or adding eggs to Palembang fish ball soup (*tekwan*) or fish ball and tofu soup (*model*), to help pregnant women meet their nutritional needs without needing to drastically alter their dietary habits.

The utilization of primary data gathered using validated instruments, such as the 2×24-hour food recall and venous hemoglobin tests, which improved data accuracy, was one of this study's strengths. However, the small sample size (n = 62) limited generalizability, and the cross-sectional design restricted causal inference. Although trained enumerators were used and portionometry was applied in this study, there was still a risk of reporting bias and portion estimating mistakes that may have impacted the dietary recall data.

Conclusion

There is an association between the level of animal protein consumption and the prevalence of anemia among pregnant women in Palembang city. Sufficient level of animal protein consumption is protective against anemia. Furthermore, being in the third trimester of pregnancy is an independent risk factor for anemia. Therefore, further health promotion is needed so that pregnant women increase the level of animal protein consumption to prevent anemia. Future studies with larger sample sizes and longitudinal designs are recommended to confirm these findings and explore the impact of specific food sources and supplementation programs on maternal anemia outcomes.

Conflict of interest

The authors declared no conflict of interest regarding this article.

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