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Relationship between iron inhibitor and enhancer consumption and hemoglobin levels in third trimester pregnant women in Pariaman City in 2016

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ABSTRACT

Background: Anemia is a condition in which the hemoglobin levels in the blood below normal. Anemia is the most common, especially in pregnant women is anemia due to iron deficiency. Anemia in the third trimester pregnant women are caused by many factors, namely the direct, indirect and basic. Directly anemia caused by frequent consumption of iron absorption inhibitors, promoters consume less non-heme iron absorption and the presence of parasitic infection. Therefore, researchers interested in conducting research with the aim to determine the relationship Consumption inhibitors and enhancers Iron with Hemoglobin In Third Trimester Pregnancy In Kota Pariaman 2016. **Methods**: Research that has been done is descriptive analytic cross-sectional study design, in which the independent and dependent variables were measured at the same time. The population in this study were pregnant women in the third trimester of Pariaman, amounting to 139 people and the sample size is 66 people. The sample was selected by stratified random sampling technique. Processing data using univariate and bivariate analysis with simple linear regression statistical test with a confidence level of 95%.. **Findings:** The results of the research that has been done is the consumption inhibitor with a hemoglobin level of third trimester pregnant women showed a strong relationship (r =0.545) and negatively patterned. Consumption enhancer with hemoglobin levels of pregnant women showed a connection was the third trimester (r = 0.489) and a positive pattern. The test results obtained statistically significant association between the consumption of inhibitors and enhancers of iron with hemoglobin levels of pregnant women third trimester (p = 0.000). **Conclusion**: The higher the consumption inhibitor, the hemoglobin levels of pregnant women will be low. Conversely, the higher the consumption enhancer maternal hemoglobin levels higher. **Novelty/Originality of this article:** This research provides new insights into specific dietary patterns affecting anemia in third-trimester pregnant women, particularly regarding the impact of iron absorption inhibitors and enhancers.

KEYWORDS: enhancer; inhibitor; pregnant women; the levels of hemoglobin.

1. Introduction

Pregnancy is a reproductive process in which the fetus develops in the mother's womb. In this situation, a woman feels more fulfilled as a mother. However, pregnant women are at risk of encountering various issues, particularly those related to diet and nutrition. Anemia, or low levels of hemoglobin (Hb) in the blood, is a common condition often experienced by pregnant women (Departemen Gizi FKM UI, 2010). Anemia affects approximately 1.62 million people worldwide, or 24.8% of the global population, as of 2008. Between 1995 and 2005, the prevalence of anemia during pregnancy rose to 41.8%, impacting around 56 million individuals globally. More than 80% of countries worldwide

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face serious to severe public health issues due to anemia among pregnant women. Several studies have revealed that maternal deaths during childbirth are often caused by bleeding, with nutritional anemia being a significant triggering factor.(Kementerian Kesehatan Republik Indonesia, 2013). A study of 21 research articles revealed that anemia caused by low hemoglobin levels during pregnancy accounts for 22.6% of maternal deaths in Asia. (WHO, 2008).

Hardiansyah and Martianto state that during pregnancy, two anabolic processes occur. The first process involves the development and maturation of the placenta and fetus, which will eventually result in a newborn baby. The second process includes the physiological and metabolic changes experienced by the pregnant woman. These processes are supported by changes in the mother's endocrine glands, leading to growth in the uterus, breasts, maternal blood volume, amniotic fluid, and adipose tissue (Cunningham, 2001; Hardiansyah, 1992).

Every pregnancy is associated with physiological changes that cause increased fluid volume and red blood cells, decreased concentrations of nutrient-binding proteins in the blood, and a reduction in micronutrient levels. Pregnancy leads to various anatomical, physiological, and biochemical changes. One such change is hematological alterations. Cunningham (2001) describes several systemic changes that occur during childbirth, including increased maternal blood volume, decreased hematocrit and hemoglobin levels, increased iron requirements, changes in leukocytes and the immune system, and blood loss.

In healthy women, blood volume increases by 40% to 45% as delivery approaches compared to non-pregnant states. Maternal blood volume starts to rise in the first trimester, increases more rapidly in the second trimester, and then continues to rise at a slower pace during the third trimester, reaching a stable condition in the final weeks of pregnancy. Blood volume increases progressively between weeks 32 and 34, and returns to normal within two to six weeks post-delivery (Cunningham, 2001).

Due to the doubling of iron requirements caused by increased blood volume without a corresponding expansion in plasma volume, iron deficiency anemia is common among pregnant women. This increased need must be met to prevent blood loss during delivery and to support fetal development (Cunningham, 2001). During pregnancy, physiological changes in the woman's body increase iron requirements. These changes also affect the type of iron consumed and factors in the diet that can either enhance or inhibit iron absorption. The type of iron consumed is more important than its quantity. Heme iron, found in animal myoglobin and hemoglobin, is more readily absorbed by the body and is not affected by iron inhibitors. In contrast, non-heme iron, which constitutes 90% of the iron in non-meat foods such as grains, vegetables, fruits, and eggs, is less easily absorbed by the body. (Departemen Gizi FKM UI, 2010).

Hemoglobin concentration tends to decrease between the 32nd and 34th weeks of pregnancy, from 12 g/dl to 10 g/dl (Mochtar, 1998). Nutritional deficiencies, inadequate intake of vitamin B12, and low consumption of folic acid exacerbate this condition. In addition to the increased needs during pregnancy, nutritional anemia is also influenced by several factors such as high parity, short birth intervals, inadequate prenatal care, income level, infectious diseases, low knowledge about iron, insufficient iron in the diet, and variations in iron absorption. (Departemen Gizi FKM UI, 2010).

Iron absorption can be enhanced by vitamin C and by meat, fish, and poultry (MFP), particularly for non-heme iron. Meat, fish, and poultry are excellent sources of MFP. Good sources of vitamin C include guava, oranges, papaya, cassava leaves, moringa leaves, and melinjo leaves. Vitamin C acts as an enhancer by converting ferric iron into the more absorbable ferrous form (Whitney, 2008).

Iron absorption can be inhibited by several compounds, including calcium phosphate, phytic acid, and polyphenols. Among these, phytic acid, commonly found in cereals and legumes, plays a significant role in reducing iron bioavailability in many plant-based foods. This compound has a strong affinity for binding minerals such as calcium, iron, manganese, and zinc, forming insoluble salts known as phytates. These phytates are poorly absorbed in the digestive tract, which in turn interferes with the efficient uptake of these essential minerals into the bloodstream. Foods rich in phytic acid include staples such as rice, corn, wheat, and soybeans, making it a major factor in limiting mineral absorption, especially in populations relying heavily on these foods.. (Laboratorium Kimia-Biokimia Pangan UGM, 2002). Polyphenols, including phenolic acids, flavonoids, and their polymerization products, are found in red wine, tea, coffee, and cocoa (Gibney et al., 2009).

The majority of people in poor countries still lack adequate access to iron-rich foods, with 20-30% of iron being absorbed from heme sources. Data from the Center for Agricultural Data and Information Systems indicate that the consumption of protein from heme sources in Indonesia remains low, at 13.83% from fish and 4.65% from meat, while the highest protein consumption comes from cereals, at 38.75% (Pusat Data, 2014). Iron absorption is reduced when combined with the habit of consuming foods that can inhibit iron absorption, such as coffee and tea, during meals.

2. Methods

The independent and dependent variables in this cross-sectional study design were measured simultaneously as part of a descriptive analytical study (Sastroasmoro, 2011). The aim of this research is to determine the relationship between iron consumption patterns and the prevalence of anemia in Pariaman City among pregnant women in their third trimester in 2016.

The study population consisted of 139 residents of Pariaman City who were in their third trimester of pregnancy. The sample was a subset of the population selected through systematic random sampling techniques. Based on Notoatmodjo's (2010) calculations, the sample size is as follows:

$$n = \frac{N}{1+N\,d^2} \tag{Eq.1}$$

Note:

N = Population = 139 individuals

d = Degree of accuracy = 10%

n = Sample size with a 95% confidence level

Thus, the sample size is:

$$n = \frac{139}{1+139\;0{,}1^2} \tag{Eq.2}$$

= 58.15 rounded up to 59 participants Correction for sample size to account for anticipated dropouts:

$$n^{!} = \frac{n}{(1-f)} \tag{Eq.3}$$

Note :

n = sample size calculated

f = dropout proportion estimate = 10% (0.1)

$$n^{!} = \frac{139}{(1-0{,}1)} \tag{Eq. 4}$$

= 65.56 is rounded up to 66.

Therefore, in this study, the sample size consists of 66 individuals

2.1 Data Analysis

The SPSS application for Windows was used to manage and analyze the data after it was entered. The analysis process consisted of two stages: univariate analysis and bivariate analysis.

2.1.1 Univariate Analysis

The distribution of respondent characteristics and hemoglobin (Hb) levels are dependent variables, with univariate analysis used to determine the frequency distribution of each variable. The independent variables include iron, protein, and vitamin C intake by the respondents, as well as their consumption of iron inhibitors and enhancers.

2.1.2 Bivariate Analysis

Using a 95% confidence level ($p < 0.05$) in Simple Linear Regression Analysis, bivariate analysis was performed to determine the nature of the relationship between the occurrence of anemia in the third trimester of pregnancy and the consumption of iron enhancers and inhibitors. The regression formula used is as follows:

$$Y = a + bX$$

Y : represents the dependent variable

X : represents the independent variable,

a : is the intercept, which estimates the average value of Y when X=0

b : is the slope, which estimates the change in Y for a one-unit change in

The relationship between iron inhibitors and enhancers and the occurrence of anemia can be qualitatively categorized into four areas, as follows (Hastono, 2001):

r = 0,00 - 0,25	No relationship/Weak relationship
r = 0,26 – 0,50	Moderate relationship
r = 0,51 – 0,75	Strong relationship
r = 0,76 – 1,00	Very strong/Perfect relationship

3. Result and Discussion

3.1 Result

3.1.1 Univariate Analysis

3.1.1.1 Characteristics of Third Trimester Pregnant Women Respondents in Pariaman City 2016

The respondents in this study were third-trimester pregnant women who met the inclusion and exclusion criteria in Pariaman City. This study involved 7 community health centers (Puskesmas) in the area: Puskesmas Pauh Pariaman, Puskesmas Kurai Taji, Puskesmas Marunggi, Puskesmas Santok, Puskesmas Kp Baru Padusunan, Puskesmas Naras, and Puskesmas Sikapak. The total number of respondents involved was 66 individuals. The characteristics of the respondents are detailed in Table 1.

Tabel 1. Frequency Distribution of Characteristics of Third Trimester Pregnant Women in Pariaman City, 2016

Respondent Characteristics	Frequency (f)	Percentage (%)
Mother's Age		
Risk (<20 and >35)	13	19,7
Not at Risk	53	80,3
Total	66	100,0
LiLA		
Malnourished (< 23.5 cm)	13	19,7
Normal (≥ 23,5 cm)	53	80,3
Total	66	100,0
Parity		
At Risk (> 3 times)	2	5,0
Not at Risk (≤ 3 times)	64	97,0
Total	66	100,0
Pregnancy Interval		
< 2 Years	7	10,6
≥ 2 Years or No Previous Pregnancies	59	89,4
Total	66	100,0
Education Level		
- No School/Did Not Complete Elementary	1	1,5
- Completed Elementary/Equivalent		
- Completed Junior High School	3	3,0
- Completed Senior High School	10	15,2
- Completed Higher Education/Equivalent	29	43,9
	23	34,8
Total	**66**	100,0
Occupation		
- Not Working/Housewife	44	66,7
- Farmer		
- Laborer	1	1,5
- Civil Servant/Private Employee	2	3,0
- Self-Employed	16	24,2
	3	4,5
Total	66	100,0
Family Income		
< 1.800.725	24	36,4
≥ 1.800.725	42	63,4
Total	66	100,0

3.1.1.2 Distribution of Hemoglobin Levels in Third Trimester Pregnant Women in Pariaman City, 2016

The analysis results reveal that the average hemoglobin level among third-trimester pregnant women is 9.75 g/dl, with a 95% confidence interval ranging from 9.404 to 10.096 g/dl. This suggests that the true average hemoglobin level for this population is likely to fall within this interval. The median hemoglobin level, which represents the midpoint value, is 9.650 g/dl, accompanied by a standard deviation of 1.4056 g/dl, indicating the extent of variation in the hemoglobin levels. The data also shows that the lowest recorded hemoglobin level is 6.0 g/dl, while the highest is 12.9 g/dl, reflecting a wide range within the sample. Based on the interval estimate, it can be projected with 95% confidence that the hemoglobin levels of third-trimester pregnant women fall between 9.404 g/dl and 10.096 g/dl. A more detailed distribution of hemoglobin levels is presented in Table 2 below, providing a visual representation of the variations observed in the sample.

Table 2: Distribution of Hemoglobin Levels in Third Trimester Pregnant Women in Pariaman City, 2016

Variable	Mean	Median	± SD	Min –Max	95% CI
hemoglobin levels in pregnant women in their third trimester (gr/dl)	9,750	9,650	1,4056	6,0 – 12,9	9,404–10,096

3.1.1.3 Distribution of Inhibitor Consumption Among Pregnant Women in the Third Trimester in Pariaman City, 2016

Table 3. Distribution of Consumption Among Pregnant Women in the Third Trimester Based on Types of Iron Inhibitor Foods

Type of Food	Average Inhibitor Consumption (gr)
Milk	93,28
Tea	163,3
Coffee	9,6
Chocolate	3,26
Sprite/cola	3,02
Ice Cream	8,01
Nuts	158,97

The analysis results indicate that the average hemoglobin level in pregnant women in their third trimester is 9.75 g/dL, with a 95% confidence interval ranging from 9.404 to 10.096 g/dL. The median hemoglobin level is 9.650 g/dL with a standard deviation of 1.4056 g/dL. The lowest recorded hemoglobin level is 6.0 g/dL, while the highest reaches 12.9 g/dL. Based on the interval estimate, it is projected that 95% of the hemoglobin levels in pregnant women in their third trimester fall between 9.404 g/dL and 10.096 g/dL. The distribution of hemoglobin levels in pregnant women in their third trimester is shown in Table 2 below.

Table 4 Distribution of Inhibitor Consumption Among Pregnant Women in the Third Trimester in Pariaman City, 2016

Variable	Mean	Median	± SD	Min –Max	95% CI
Inhibitor Consumption	439,4291	449,24	141,5547	135,05– 754,24	404,6306 – 474,4476

3.1.1.4 Distribution of Enhancer Consumption of Third Trimester Pregnant Women in Pariaman City in 2016

Tabel 5. Distribution of Consumption of Pregnant Women in the Third Trimester Based on Types of Iron Enhancer Food Ingredients

Type of Food	Average Consumption of Enhancers (gr)
Beef	4,38
Chicken	19,67
Fish	92,67
Guava	12,73
Papaya	27,47
Orange	26,15
Mango	2,97
Pineapple	2,44
Rambutan	0,38
Tomato	4,47

Based on the data presented in Table 5, the most frequently consumed enhancer foods by pregnant women in their third trimester are fish, with an average consumption of 92.67

grams, followed by papaya with an average consumption of 27.47 grams, and oranges with an average consumption of 26.15 grams. The lowest consumption was recorded for pineapple, at 2.44 grams.

The analysis reveals that the average total consumption of enhancers by pregnant women in their third trimester is 193.32 grams (95% CI: 164.77–221.87), with a median value of 168.55 grams and a standard deviation of 116.14 grams. The range of enhancer consumption varies from 34.0 grams to 644.64 grams. From this confidence interval, it can be concluded that, with a 95% confidence level, the average consumption of enhancers among pregnant women in their third trimester falls between 164.77 grams and 221.87 grams. The distribution of inhibitor consumption among pregnant women in their third trimester is shown in Table 6 below.

Table 6 Distribution of Enhancer Consumption Among Pregnant Women in Their Third Trimester in Pariaman City in 2016

Variable	Mean	Median	± SD	Min –Max	95% CI
Enhancer Consumption	193,3233	168,5450	116,1405	34,00– 644,64	164,7724–221,8742

3.1.2 Bivariate Analysis

3.1.2.1 The Relationship between Inhibitor Consumption and Hemoglobin Levels in Anemic Pregnant Women in the Third Trimester in Pariaman City in 2016

The analysis results indicate a strong and negative correlation between inhibitor consumption and hemoglobin levels in pregnant women in the third trimester, with a correlation coefficient (r) of -0.545. This suggests that higher levels of inhibitor consumption are associated with lower measured hemoglobin levels. Statistical testing reveals a significant relationship between inhibitor consumption and hemoglobin levels in third-trimester pregnant women, with a p-value of 0.000. Details of the correlation and regression analysis between inhibitor consumption and hemoglobin levels in third-trimester pregnant women can be found in Table 7 below.

Table 7: Correlation and Regression Analysis of Inhibitor Consumption and Hemoglobin Levels in Anemic Pregnant Women in the Third Trimester in Pariaman City in 2016

Variable	r	Line equation	P value
Inhibitor Consumption	- 0,545	Hemoglobin level = 12.128 – 0.005*Inhibitor Consumption	0,000

3.1.2.2 Relationship between Enhancer Consumption and Hemoglobin Levels in Anemic Pregnant Women in the Third Trimester in Pariaman City, 2016

The analysis results indicate a moderate (r = 0.489) and positive relationship between enhancer consumption and hemoglobin levels in pregnant women during the third trimester. This means that higher consumption of enhancers is associated with higher hemoglobin levels in these women. Statistical testing shows a significant relationship between enhancer consumption and hemoglobin levels in third-trimester pregnant women (p = 0.000). Detailed correlation and regression analysis regarding enhancer consumption and hemoglobin levels in third-trimester pregnant women can be found in Table 8 below.

Table 9 Correlation and Regression Analysis of Enhancer Consumption with Hemoglobin Levels in Anemic Pregnant Women in the Third Trimester in Pariaman City, 2016

Variable	r	Line Equation	P value
Enhancer Consumption	0,489	Hemoglobin Level= 8.606 + 0.006*Enhancer Consumption	0,000

3.2 Discussion

3.2.1 Relationship Between Inhibitor Consumption and Hemoglobin Levels in Third Trimester Pregnant Women in Pariaman City, 2016

Based on the findings, the relationship between inhibitor consumption and hemoglobin levels in third trimester pregnant women is significant (r = -0.545) and negative, indicating that higher consumption of inhibitors is associated with lower hemoglobin levels. Statistical analysis revealed a significant association between the use of inhibitors and hemoglobin levels in third trimester pregnant women (p = 0.000). Tea, coffee, cocoa, and red wine contain polyphenols, which include phenolic acids, flavonoids, and polymerized products.

Tannins, commonly found in tea, have the potential to act as inhibitors because they strongly bind iron, forming insoluble Fe-tannate complexes. The primary reason for the low bioavailability of iron in cereals and legumes is the presence of phytic acid. Since dietary fiber does not reduce iron absorption, the inhibitory effect of bran is mainly due to phytic acid. Phytic acid is also known as an anti-nutrient because of its ability to bind elements such as calcium (Ca), iron, manganese (Mg), and zinc (Zn) to form insoluble salts. The formation of these insoluble salts impedes the absorption of these elements into the bloodstream (Gibney et al., 2009).

The most frequently consumed iron inhibitors are tea (163.3 grams), followed by almonds (158.97 grams) and milk (93.28 grams). Sprite/cola is consumed the least (3.02 grams). The average consumption of iron inhibitors among pregnant women in the third trimester is 439.4291 grams. Research by Bungsu (2012) indicates that pregnant women with high tannin levels (>2.00 mg/mL) are 1.217 times more likely to experience iron deficiency anemia compared to those with low tannin levels.

Tristiyanti (2006) found that out of 28 pregnant women who consumed tea 9-30 times per month, 17 experienced anemia, while 11 did not. Bulkis (2013) reported that among 44 pregnant women who consumed iron inhibitors at least once a day or two to six times per week, anemia was observed, whereas 24 women did not experience anemia. Based on the findings of this study and previous research, it can be assumed that more frequent consumption of iron inhibitors is associated with lower recorded hemoglobin levels.

3.2.2 Relationship Between Iron Enhancer Consumption and Hemoglobin Levels of Pregnant Women in the Third Trimester in Pariaman City in 2016

According to Gibney (2009), dietary components categorized as iron enhancers function to improve the absorption of iron from daily food intake. Examples of foods that aid in iron absorption include meat, fish, chicken, and vitamin C.

The analysis reveals a moderate positive correlation (r = 0.489), indicating that higher consumption of enhancers is associated with higher hemoglobin levels in pregnant women during the third trimester. Statistical testing shows a strong relationship between enhancer consumption and hemoglobin levels in third-trimester pregnant women (p = 0.000).

The most frequently consumed enhancer is fish (92.67 grams), followed by papaya (27.47 grams) and oranges (26.15 grams). Pineapple is the least consumed food (2.44 grams). The study indicates that third-trimester pregnant women consume an average of 193.3233 grams of enhancers. Geographically, Pariaman City is located on the coast, so fish, especially sea fish, is the highest consumed iron supplement.

Pregnant women frequently consume papaya and oranges as sources of vitamin C due to the abundance of papaya orchards near Pariaman City and the constant availability of oranges in the market. As is known, vitamin C enhances the absorption of non-heme iron by converting ferric iron into ferrous iron in the small intestine, making it more easily absorbed. Vitamin C also prevents the production of hemosiderin, which is difficult to mobilize and release when needed. With the presence of vitamin C, the absorption of non-heme iron increases fourfold. Therefore, the risk of iron deficiency anemia may be reduced (Gibney, 2009).

4. Conclusion

Based on the study results regarding the Relationship between Inhibitor and Iron Enhancer Consumption with Hemoglobin Levels in Third Trimester Pregnant Women in Pariaman City, it can be concluded that the average hemoglobin level of third-trimester pregnant women is 9.75 g/dl (95% CI: 9.404-10.096), with a median of 9.650 g/dl and a standard deviation of 1.4056 g/dl. The lowest recorded hemoglobin level is 6.0 g/dl, while the highest is 12.9 g/dl. According to the interval estimate, 95% of third-trimester pregnant women have an average hemoglobin level ranging from 9.404 g/dl to 10.096 g/dl.

Furthermore, the relationship between inhibitor consumption and hemoglobin levels in third-trimester pregnant women shows a significant strength ($r = -0.545$) and is negative, indicating that higher inhibitor consumption is associated with lower hemoglobin levels. Statistical tests reveal a strong relationship between inhibitor use and hemoglobin levels in third-trimester pregnant women ($p = 0.000$). Conversely, the relationship between enhancer consumption and hemoglobin levels in third-trimester pregnant women is moderate ($r = 0.489$) and positive, indicating that higher enhancer consumption is associated with higher hemoglobin levels. Statistical tests also show a significant relationship between enhancer use and hemoglobin levels in third-trimester pregnant women ($p = 0.000$).

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Author Contribution

R. F., N . I. L., & H., conceived and designed the study, performed the experiments, analyzed and interpreted the data, contributed reagents/materials/analysis tools, wrote the paper, prepared figures and/or tables, reviewed drafts of the paper and approved the final draft.

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