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# Correlation of Iron, Vitamin C and Vitamin A Intake with Ferritin Levels in Third Trimester Pregnant Women at Andalas Health Center in 2023

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## ABSTRACT

Iron deficiency anemia is a disease related to nutrition. Ferritin examination is one of the parameters for determining iron deficiency anemia, especially in pregnant women. Ferritin is an iron reserve that is stored in the liver and bone marrow. In iron metabolism, the first sign of anemia can be seen from a decrease in ferritin reserves in the blood. This study aims to examine the relationship between intake of iron, vitamin C and vitamin A with ferritin levels in third trimester pregnant women. This research is an observational analytical study using a cross-sectional design. Data collection was carried out in the Andalas Community Health Center work area in June – July 2023. The sampling technique was proportional sampling, totaling 35 pregnant women. Data on intake of iron, vitamin C and vitamin A were collected using the FFQ questionnaire and data collection on ferritin levels was carried out by taking maternal blood for examination using the ELISA method at the Biomedical Laboratory of Andalas University. The data normality test was carried out using the Shapiro Wilk test and data analysis used the Pearson correlation test. The results showed that the mean ferritin level was 25.10 µg/L, iron intake was 21.13 mg, vitamin C intake was 40.91 mg, vitamin A intake was 602.33 µgRE. There is a significant relationship between iron intake, vitamin C and vitamin A intake with ferritin levels. The conclusion of this study is that there is a positive correlation with a strong correlation between iron, vitamin C and vitamin A intake and ferritin levels in third trimester pregnant women.

***Keywords:*** Ferritin, Iron intake, Vitamin C intake, Vitamin A intake, SQ-FFQ

## INTRODUCTION

Nutritional disorders are a major public health problem in developing countries, one of which is Indonesia. Among the nutritional problems faced in Indonesia currently is nutrition during pregnancy (1). A nutritional problem that often occurs in pregnant women is anemia. The occurrence of anemia in some pregnant women is due to an increase in the need for food intake or substances needed by the body (2). According to the World Health Organization (WHO), in 2019 almost half of all pregnant women in the world suffered from anemia, it is estimated that maternal deaths amounted to 303,000 people or around 216/100,000 live births worldwide. Globally, the prevalence of anemia in pregnant women is 41.8%. About half of anemia cases are caused by iron deficiency (3).

Indonesia is a developing country with a fairly high prevalence of anemia in pregnancy, the frequency of iron deficiency will increase 2-5 times to iron deficiency anemia caused by several factors such as infection and malnutrition. In Indonesia, the problem of micronutrient deficiencies still dominates nutritional problems in Indonesia, which is shown by the increasing prevalence of anemia in pregnant women from 37.1% in 2013 to 48.9% in 2018 (4).

One of the causes of anemia is a lack of intake of micronutrients consumed and disruption of the ability to absorb micronutrients such as iron, vitamins A, B, C, folic acid and zinc (5). The effects of anemia during pregnancy can cause miscarriage, premature birth, uterine atony, bleeding and shock, and can be fatal if not treated immediately. This is related to many factors that influence it, one of which is nutritional status (6).

Sufficient iron stores will meet the need for the formation of red blood cells in the bone marrow. The amount of iron stored is reduced and low intake of Fe consumed causes the balance of iron in the body to be disturbed, as a result hemoglobin levels fall below normal values resulting in iron deficiency anemia. Iron deficiency anemia is indicated by a decrease in hemoglobin and ferritin levels in plasma (7). The best indicator to determine iron deficiency anemia is to measure the ferritin value in blood serum. Ferritin is an iron storage protein that occurs extracellularly in the serum. Low ferritin levels reflect low iron stores which cause iron deficiency resulting in anemia in pregnant women (8).

Effective and efficient iron absorption requires an acidic environment and the presence of conductors such as vitamin C increases iron absorption by reducing ferric iron to ferrous iron (9). Absorption of iron in non-heme form increases four times faster if vitamin C is available, then vitamin C plays a role in transferring iron from transferrin in plasma to ferritin (10).

Vitamin A is a fat-soluble vitamin which can help the absorption and mobilization of iron for the formation of erythrocytes. Low vitamin A status will mean that iron stores cannot be utilized for the erythropoiesis process. In addition, vitamin A and carotene will form a complex with iron to keep iron dissolved in the intestinal lumen so that iron absorption can be helped. (11) Andalas Health Center is one of the health centers in Padang City with the highest incidence of anemia in 2021. There are 1586 pregnant women at Andalas Health Center and there are cases of anemia, namely 361 (22.8%) pregnant women (12).

## LITERATURE REVIEW

Ferritin is the major iron storage protein and is essential for iron homeostasis (13). The ferritin molecule is an intracellular hollow protein shell, consisting of 24 subunits surrounding an iron core containing as many as 4000 – 4500 iron atoms. In the body, small amounts of ferritin are secreted into the blood circulation. In the absence of inflammation, these serum ferritin concentrations correlate positively with the size of total body iron stores (7). Ferritin is also an iron reserve that is stored in the liver and bone marrow. In the iron metabolism cycle, the first sign of anemia can be seen from a decrease in iron reserves (ferritin) in the blood (14). Ferritin is one of the parameters for determining anemia in pregnant women. Iron deficiency anemia is a disease related to nutrition. This can occur because the supply of iron for erythropoiesis is reduced to the point that the formation of hemoglobin is hampered. Pregnant women need more iron than before pregnancy to form red blood cells needed by the mother, fetus and placenta. Lack of iron during pregnancy can cause premature birth, bleeding, anemia, post partum complications and the impact on the fetus can cause stunted fetal growth (15).

Iron is a very important element for forming hemoglobin (Hb). In the body, iron has functions related to the transport, storage and utilization of oxygen and is in the form of hemoglobin, myoglobin or cytochrome (16). To meet the needs for the formation of

hemoglobin, most of the iron that comes from the breakdown of red blood cells will be reused and the deficiency must be met and obtained through food. The nutritional level of iron for a person is greatly influenced by the amount consumed through food, some of which is absorbed through the digestive tract, iron reserves in tissues, excretion and body needs (17). The body's need for iron increases during growth and pregnancy. Iron is needed during pregnancy for the baby, placenta and an increased number of red blood cells. The total iron requirement during pregnancy is around 1000 mg. If iron reserves are empty, the total iron requirements during pregnancy must be met from diet and supplements (18).

Vitamin C is a water-soluble vitamin that can play an important role in preventing various diseases. This vitamin is also known by the chemical name ascorbic acid. Vitamin C is included in the group of antioxidant vitamins which can fight various extracellular free radicals (19). The recommended requirement for vitamin C during pregnancy is 85 mg. Vitamin C has a very important role in the absorption of iron, especially from nonheme iron which is found in many plant foods. Vitamin C will reduce non-heme iron in ferric form to ferrous which is ready to be absorbed (20).

Vitamin A plays an important role in reproduction, vision, the immune system and cell differentiation (21). Vitamin A requirements increase during pregnancy. Vitamin A is used for fetal growth, Vitamin A stores in the fetus and maternal tissue growth. The highest vitamin A is needed during the third trimester because at this time the fetus grows rapidly and intake of vitamin A during pregnancy is useful in preserving the mother's and baby's balance as a protector to prevent deficiencies in the prenatal and postnatal periods (22). According to Murray in Bauty et.al 2020, vitamin A in the form of retinol levels is known to influence several processes that will affect iron and ferritin in the absorption of iron, especially non-heme iron, so pregnant women need intake containing vitamin A such as beef, duck meat. , liver, eggs, egg yolks, cheese, milk, fish, green vegetables, nuts, light colored fruits to help the hematopoiesis process (5)

## MATERIALS & METHODS

This research is an observational analytical study using a cross-sectional design. Data collection was carried out in the Andalas Health Center work area in June – July 2023. The sampling technique was proportional sampling, totaling 35 pregnant women. Data on intake of iron, vitamin C and vitamin A were collected using the FFQ questionnaire and data collection on ferritin levels was carried out by taking maternal blood for examination using the ELISA method at the Biomedical Laboratory of Andalas University.

## STATISTICAL ANALYSIS

For univariate analysis of the average of each research outcome variable. Bivariate analysis uses a normality test with Shapiro Wilk and a correlation test using Pearson Product Moment

## RESULT

a. Average results of ferritin, iron intake, vitamin C and vitamin A in third trimester pregnant women in the Andalas Health Center working area

**Table 1**

| Variable | n | Mean ± SD |
|---|---|---|
| Ferritin levels | 35 | 25,10 ± 39,90 |
| Iron intake | | 21,13 ± 10,21 |
| Vitamin C Intake | | 40,91 ± 23,56 |
| Vitamin A Intake | | 602,3 ± 241,0 |

Table 1 above, it can be seen that the average ferritin level is 25.10 µg/L, iron intake is 21.13 mg/day, vitamin C intake is 40.91 mg/day and vitamin A intake is 602.3 µgRE. This shows that the average results above are not in accordance with those recommended by the government.

b. Relationship between iron intake and ferritin levels in third trimester pregnant women

**Table 2**

| | | Iron Intake |
|---|---|---|
| **Ferritin levels** | r | 0,937 |
| | ρ | 0,001 |

Table 2 shows that there is a significant correlation between iron intake and ferritin with p = 0.001 (p < 0.05). The direction of the relationship between the two variables is positive with a strong correlation strength with r = 0.937. This explains that, when iron intake is met, the ferritin levels of pregnant women in the third trimester will get better or vice versa. The linear R2 value is 0.879, which means that ferritin is influenced by iron by 87.9%.

c. Relationship between vitamin C intake and ferritin levels in third trimester pregnant women

**Table 3**

| | | Vitamin C Intake |
|---|---|---|
| **Ferritin levels** | r | 0,638 |
| | ρ | 0,001 |

Table 3 shows the correlation between vitamin C intake and ferritin levels. A significant correlation was found between vitamin C intake and ferritin levels in third trimester pregnant women with p = 0.001 (p <0.05). The direction of the relationship between these two variables is positive with a strong correlation strength with r = 0.638, meaning that the better the intake of vitamin C, the higher the ferritin levels of pregnant women in the third trimester. The linear R2 value is 0.407, which means that ferritin is influenced by vitamin C by 40.7%.

d. Hubungan asupan vitamin A dengan kadar feritin ibu hamil trimester III

**Tabel 4**

| | | Vitamin A Intake |
|---|---|---|
| **Ferritin levels** | r | 0,824 |
| | ρ | 0,001 |

Table 4 shows the correlation between vitamin A intake and ferritin levels. A significant correlation was found between third trimester pregnant women with p=0.001 (p<0.05). The direction of the relationship between these two variables is positive with a strong correlation strength with r = 0.824, meaning that if vitamin A intake is good, pregnant women's ferritin levels are high. The linear R2 value is 0.678, which means that ferritin is influenced by vitamin A by 67.8%.

## DISCUSSION

The average ferritin level in pregnant women has not met the minimum limit that has been set and iron intake, vitamin C and vitamin A intake in pregnant women in the third trimester at the Andalas Community Health Center is also not in accordance with the established nutritional adequacy figures. According to research by Pobee et al 2020, iron deficiency anemia is caused by various factors, some of these factors can be inadequate food intake, consumption of less diverse foods, poor nutritional status, and low iron stores (23). The above is supported by research conducted by Gumilang et al 2021 that iron intake has a significant relationship with serum ferritin levels. It is explained in this study that mothers' knowledge regarding fulfilling nutritional iron consumption is still lacking so efforts are needed to increase awareness of iron adequacy (24).

a. Relationship between iron intake and ferritin in third trimester pregnant women

Table 2 shows that there is a significant correlation between iron intake and ferritin with p = 0.001 (p < 0.05). The direction of the relationship between the two variables is positive with a strong correlation strength with r = 0.937 and R2 87.9%, meaning that ferritin is influenced by iron by 87.9%.

This is confirmed by Deswizar's 2023 research, which in his research reported that there was a significant relationship between iron intake and ferritin in maternal outcomes and the strength of the relationship (p=0.000 r=0.836), which means that the higher the iron intake, the higher the ferritin levels

(25). Iron is one of the micro minerals that is important in the formation process which is important in the process of forming red blood cells. Iron is naturally obtained from food. Lack of iron in the daily diet can cause a lack of blood hemoglobin (26).

According to Abriha's 2014 research, meat consumption is also a factor that shows a significant relationship with anemia in pregnant women. Pregnant women who eat meat once a week have a 2.2 times higher risk of developing anemia compared to pregnant women who eat meat more than twice a week. The fact is that the increase in hemoglobin concentration caused by red meat is an important source of heme iron (27).

Anemia during pregnancy is found to increase in the third trimester, during pregnancy the body requires more iron to produce hemoglobin due to fetal growth, therefore consuming adequate food diversity is very important. In this study, pregnant women in their third trimester were found to have poorer appetite, consume less dark vegetables and consume less milk than mothers in their second trimester (28).

b. Relationship between vitamin C intake and ferritin in third trimester pregnant women

Table 3 shows the correlation between vitamin C intake and ferritin levels. A significant correlation was found between vitamin C intake and ferritin levels in third trimester pregnant women with p = 0.001 (p <0.05). The direction of the relationship between these two variables is positive with a strong correlation strength with r = 0.638. The linear R2 value is 0.407, which means that ferritin is influenced by vitamin C by 40.7%.

The results of this study are in line with Yuliati et al 2017 who said that the frequency of vitamin C consumption and Hb levels showed a significant relationship (p=0.000). The linear regression equation shows that every time the frequency of consuming vitamin C increases, the Hb level will increase by 0.06 g/dL. This means that the more often a person consumes vitamin C, the higher the Hb level (29).

Vitamin C or ascorbic acid is an essential micronutrient that is soluble in water, vitamin C is unstable in alkaline solutions, but is quite stable in acidic solutions. Humans cannot synthesize vitamin C and therefore require adequate intake of vitamin C to maintain body stores and vitamin C is also found in many vegetables and fruit (30). Consuming vitamin C can help increase iron absorption. Low vitamin C intake can have implications for the hemoglobin levels of pregnant women. Vitamin C helps the absorption of iron from food so that it can be processed into red blood cells again (31).

Vitamin C also functions in mobilizing iron stores, especially hemosiderin in the spleen and absorption of iron in non-heme form can increase 4-fold with vitamin C as an iron enhancer (32). the process of absorbing iron by helping reduce ferric iron to ferrous iron in the small intestine so that it is easily absorbed, the reduction process will be greater when the pH in stomach acid becomes more acidic and iron absorption is up to 30% (7). This is confirmed by research by Hiola et al 2019 that the Hb levels in pregnant women who consume iron and vitamin C are higher than in pregnant women who consume iron alone, this is because vitamin C is one of the factors that can increase iron absorption (33).

c. Relationship between vitamin A intake and ferritin in third trimester pregnant women

Table 4 shows the correlation between vitamin A intake and ferritin levels. A significant correlation was found between third trimester pregnant

women with p=0.001 (p<0.05). The direction of the relationship between these two variables is positive with a strong correlation strength with r = 0.824. The linear R2 value is 0.678, which means that ferritin is influenced by vitamin A by 67.8%.

The results of research conducted by Ririn et al 2021 reported that there was a statistically significant positive relationship between vitamin A intake and ferritin levels in pregnant women with moderate iron deficiency anemia (r=0.475 p=0.003). This indicates that the lower the intake of vitamin A the lower the ferritin level (34).

This is confirmed by Bauty's 2020 research showing that there is a significant relationship between vitamin A consumption and ferritin levels of pregnant women in the first trimester with p= 0.001 r= 0.403 which shows a positive relationship with moderate strength (5).

Vitamin A plays a role in iron metabolism, mobilization of minerals from storage in the liver, modulation of erythropoiesis, and helps the process of iron absorption in the gastrointestinal tract (35). The bioavailability of iron in the intestine is regulated in response to iron stores in the body and also the amount of iron needed for erythropoiesis, and also the protein that plays a role in iron metabolism is transferrin (36). In food there are two main sources, namely retinyl ester which is found in animal foods with the highest absorption rate, namely liver, egg yolk, milk and margarine. Another form of vitamin A is beta-carotene which comes from vegetables and fruit (37). in accordance with research by Sa et al 2018 which explains that fulfilling vitamin A intake is obtained through consuming a variety of foods rich in animal and vegetable sources (38).

## CONCLUSION

This study concluded that there was a relationship between iron intake, vitamin C intake and vitamin A intake with ferritin levels in third trimester pregnant women.

### *Declaration by Authors*

**Ethical Approval:** This research has received ethical approval from the Ethics Committee of the Faculty of Medicine, Andalas University no. 295/UN.16.2/KEP-FK/2023

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