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The Correlation between Protein, Iron, and Vitamin C Intake with Hemoglobin Levels in Pregnant Women

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Abstract: Hemoglobin is an important component of the human body. It aims to transport oxygen and carbon dioxide. Anemia during pregnancy often occurs in the second trimester. Pregnant women tend to be vulnerable to malnutrition since their nutritional needs will increase to satisfy the needs of both the mother and the fetus. Protein intake plays a crucial role in the transportation of iron in the body. Meanwhile, vitamin C serves as a promoter of iron absorption. This research aims to determine and analyze the correlation between protein, iron, and vitamin C intake and hemoglobin levels in pregnant women at Kayon Public Health Center, Jekan Raya District. This research used an analytic observational method with a cross-sectional approach and a purposive sampling technique. Bivariate analysis was also applied by using the Spearman test. The latter results obtain a p-value of 0.748 between protein intake and hemoglobin level; a p-value of 0.222 between vitamin C intake and hemoglobin level; and a p-value of 0.050 between iron intake and hemoglobin level. There was a correlation between iron intake and hemoglobin level, yet there was no correlation between protein and vitamin C intake with hemoglobin level.

Keywords: protein; iron; vitamin C; hemoglobin level; pregnant women

INTRODUCTION

Anemia is when the amount of red blood cells (or the concentration of hemoglobin in them) is lower than normal. Hemoglobin is needed to carry oxygen; therefore, if the red blood cells are abnormal, or if there is a lack of hemoglobin, then the capacity of the blood to carry oxygen to the body's tissues will decline. World Health Organization (WHO) argues that anemia is a serious global health problem, especially since it can affect children and pregnant women.[1] Based on the data from the National Institute of Health Research and Development (2018), the prevalence of anemia in pregnant women in Indonesia is 48.9%. Furthermore, it mostly occurs to the ones aged 15-24, amounting to 84.6%. Moreover, based on the data from the same source as mentioned above, the prevalence of anemia in women in Central Kalimantan is 4.17% (in the age group 15-49 years old).[2] Based on the cumulative data from Palangkaraya City Health Office in the year 2020-2021; the prevalence of anemia in pregnant women in Jekan Raya District increased in 2021 - from 27.11% in 2020 (450 pregnant women) to 40.43% in 2021 (606 pregnant women).

Hemoglobin is a crucial component of the human body. It can be found in red blood cells, which transport oxygen and carbon dioxide. It is composed of complex proteins, which are globin and heme proteins. Meanwhile, anemia in pregnancy is defined as when a pregnant woman has a Hb level that is less than 11 gr/dl. The average Hb for pregnant women is 12.3 gr/dl in the first trimester, 11.3 gr/dl in the second trimester, as well as 10.8 gr/dl in the third trimester. Due to blood dilution, anemia in pregnancy is more likely to happen.[3] The need for nutrients during pregnancy has increased to satisfy the needs of the developing fetus and pregnant women and as a preparation for breastfeeding. Both macro and micronutrients must be fulfilled to avoid nutrient deficiencies.[4]

During pregnancy, the role of protein is for the growth and development of the fetus, the formation of the placenta and amniotic fluid, the growth of maternal tissue, as well as for the addition of blood volume. The development of tissue also demands higher protein. Since protein is required for the synthesis of hormones and neurotransmitters, a lack of protein during pregnancy can lead to fetal growth retardation. Meanwhile, iron also plays a part in cofactor enzymes, which involve metabolic activities and fetal growth and development. Moreover, it is also a crucial part of hemoglobin, which carries oxygen in red blood cells throughout the body. As a result of increased blood volume during pregnancy, the latter condition may increase the body's need for iron. Pregnant women are suggested to consume foods or drinks containing vitamin C and iron to aid absorption; the former can increase the absorption of non-heme iron.[4] Based on this fact, this research aims to identify the correlation between protein intake, iron (Fe), and vitamin C with hemoglobin levels in pregnant women at Kayon Public Health Center.

MATERIAL AND METHOD

This research used an analytic observational method with a cross-sectional approach. The materials used in the research included Hb strips, alcohol cotton, and blood lancets, whereas the tools used included digital hemoglobin examination tools and documentation tools such as phones and laptops. Finally, the research instrument utilized a semi-quantitative food frequency questionnaire (sq-ffq), nutrition survey, and SPSS software.

This research started with the determination of the research subjects, where the criteria were: pregnant women aged 15-45 years old; pregnant women in their first, second and third trimesters; pregnant women willing to perform an Hb check at Kayon Public Health Center; pregnant women who could communicate well; as well as pregnant women willing to sign an informed consent form (hence willing to be the respondents of this research). Furthermore, the data were collected by performing the "Ethics Committee test" after receiving the ethical approval. Afterward, it was continued by requesting permission at One Stop Integrated Service, Health Office, and Public Health Center. Then, the data were collected directly through interviews to fill the respondents' identity sheet form, check the Hb levels with a digital hemoglobin checking tool, and complete the data regarding protein, iron, and vitamin C intake in the respondents by asking them to fill semi-quantitative food frequency questionnaire (sq-ffq) with the assistance of images of food. The SQ-FFQ sheets' data were analyzed with the nutrition survey program and compared with the Nutrition Adequacy Rate (RDA).

Finally, Spearman's correlation test was used to find the correlation between protein, iron and vitamin C intake with Hb levels in pregnant women.

RESULT

Of all the pregnant women at Kayon Public Health Center, 67 were successfully analyzed following the pre-determined criteria.

The characteristics of the respondents can be seen in Table 1, which shows that the age of pregnant women with the highest percentage is 20-35 years old, precisely as many as 58 (86.6%) respondents. In this case, most respondents are in the best age for pregnancy. Furthermore, most respondents are in their second trimester, precisely as many as 31 (46.3%) respondents; most of the respondents' Hb levels belong to the normal category, precisely in 54 (80.6%) respondents; the most protein intake is in the high category (≥ 1²0% RDA), precisely in 33 (49.3%) respondents; the most iron intake is in the less category (< 70% RDA), precisely in 47 (70.1%) respondents; and the most vitamin C intake is in the sufficient category (≥ 77% RDA), precisely in 56 (83.6%) respondents.

Table 1. Distribution of The Frequency of The Characteristics of Respondents

The Characteristics of Respondents	Amount (n=67)	Percentage (%)
Mothers' age		
< 20 years old	1	1.5 %
20-35 years old	58	86.6 %
> 35 years old	8	11.9 %
Gestational age		
First Trimester	8	11.9 %
Second Trimester	31	46.3 %
Third Trimester	28	41.8 %
Hb Level		
Abnormal (≤ 11 gr/dl)	13	19.4 %
Normal (> 11 gr/dl)	54	80.6 %
Protein intake		
Less (< 70% AKG)	11	16.4 %
Sufficient (70-119% AKG)	23	34.3 %
High (≥ 120% AKG)	33	49.3 %
Iron intake		
Less (< 70% AKG)	47	70.1 %
Sufficient (70-119% AKG)	11	16.4 %
High (≥ 120% AKG)	9	13.4 %
Vitamin C intake		
Less (< 77% AKG)	11	16.4 %
Sufficient (≥ 77% AKG)	56	83.6 %

Table 2 shows the results of the statistical test analysis between protein intake and hemoglobin levels in pregnant women, with a p-value of 0.748, which is higher than 0.05. It indicated no correlation between them and pregnant women. Meanwhile, the statistical test between iron and vitamin C intake with Hb levels in pregnant women, with a p-value of 0.050, is 0.05. It indicated a correlation in pregnant women. Furthermore, the statistical test between vitamin C intake and Hb levels in pregnant women, with a p-value of 0.222, is higher than 0.05. It indicated no correlation between the two in pregnant women.

Table 2. Analysis of The Correlation Between Protein, Iron, and Vitamin C Intake with Hemoglobin Levels

Variables	Hemoglobin Levels
	P
Protein Intake	0.748
Iron Intake	0.050*
Vitamin C Intake	0.222

DISCUSSION

The research results showed that the age group of 20-35 is the best age for healthy reproduction. Pregnant women that are aged <20 and >35 years old tend to have a high risk during their pregnancy, specifically when they hit the second; since at that time, the hemoglobin levels (in pregnant women) usually decrease. During this age, it is not optimal for healthy reproduction.[5] A proper age can affect one's maturity and strength, where they can be more mature both in thinking and working. Regarding public trust, a more mature woman is usually trusted by others who are still not mature. It is because when one is getting older, their experiences and maturity will also increase. Therefore, the older the age is, the more experience they will receive - where they can increase the knowledge level.[6]

Groups in their second and third trimesters normally have abnormal hemoglobin levels. In research done by Irdayanti (2014) on the identification of hemoglobin levels in pregnant women in the first, second, and third trimesters, it is stated that pregnant women often have anemia in the second and third trimesters. During these times, the fetus will store the iron reserves for itself as a supply for the first month after birth. The daily requirement of iron for pregnant women will increase when they start their final trimester.[7-9]

Most of the hemoglobin levels of the respondents belong to the normal category. The center of the red blood cell contains hemoglobin, a biomolecule that can bind oxygen, which is also the first step in forming hemoglobin. The spinal cord will produce red blood cells for humans, which then construct a biconcave plate. Moreover, the synthesis of heme (or the early production of hemoglobin) will happen, particularly in mitochondria, through a series of biochemical processes that start with the condensation of glycine and

succinyl coenzyme A. Important enzymes control the rate of reaction in this process.[10] The formation of erythrocytes from pro-normoblast usually takes 2-4 days. Afterwards, it will be followed by the alteration of reticulocytes into erythrocytes - which normally takes 2-3 days. If all components necessary for the production of erythrocytes are available, then the formation of erythrocytes through hemoglobin from pro-normoblast will take 5–9 days (under "normal" conditions). In this research, the food intake of the respondents is done through a semi-quantitative food frequency questionnaire after checking their hemoglobin levels. It relates to the formation of hemoglobin, which normally takes 7 days and is necessary to fill the data concerning respondents' intake. If it is taken in a week, then only the fifth - seventh-day food intake will be obtained.[11]

The research results indicated no correlation between protein intake and hemoglobin levels. Furthermore, it aligns with research done by Rachmawati (2015), revealing that out of 31 pregnant women, most have normal hemoglobin levels with insufficient protein intake; 18 pregnant women have normal hemoglobin levels with normal protein intake; and 1 pregnant woman have abnormal hemoglobin level with high protein intake.[12] This research does not discuss the food intake of pregnant women. Most pregnant women in this research rarely consumed animal protein. However, it is actually a protein with high biological value since it contains all types of essential amino acids in a proper amount for pregnant women as well as for the growth of the fetus. In contrast, vegetable protein (except soybean and other peanuts) are incomplete or low-quality proteins since they do not contain all the essential amino acids needed by pregnant women. Pregnant women need adequate consumption of energy and nutrients to support the growth and health of their fetus, as well as themselves. This particular need will depend on the mother's nutritional status, body size and composition, level of physical activity, stage of pregnancy, and health status. A balanced nutrition diet during pregnancy can support the health of both the mother and the fetus.[13] Moreover, protein also plays an important role in forming red blood cells, namely to carry iron, since the body cannot obtain it freely. Iron will mix with proteins to form transferrin, where transferrin will carry iron to the bone marrow to form hemoglobin. If an individual does not have enough transferrin, it will be unable to carry iron to erythroblasts in the bone marrow, hence resulting in impaired hemoglobin formation and anemia.[14]

The results from the statistical tests between iron intake and hemoglobin levels indicated a significant correlation. It aligns with research conducted by Ambarsari et al. (2023), demonstrating that there is a correlation between iron intake and hemoglobin levels of pregnant women. It revealed that pregnant women with sufficient iron intake tend to have normal hemoglobin levels, while those with insufficient iron intake tend to have abnormal hemoglobin levels.[15] As mentioned before, most of the pregnant women with normal hemoglobin levels have sufficient iron intake, where they have consumed iron tablet supplements and food that contains much iron (such as chicken, fish, and beef).[16] The iron intake of respondents in this research is compared to the Adequacy of Nutritional Rate (RDA) based on the age of the mother and their gestational age. The results of the respondents' food frequency form indicated that most consume animal protein, vegetable protein, and vegetables daily. The more iron-containing foods they consume, the higher their hemoglobin level will be. The link between iron intake and Hemoglobin level can be explained by the fact that the former is the main component with a crucial role in the formation of blood (hemopoiesis), namely synthesizing hemoglobin. Moreover, several enzymes also require it as a strengthening factor. During pregnancy, it is necessary to increase it through food or by supplementing with iron tablets. The latter method has been proven to be able to prevent decreased hemoglobin levels due to hemodilution. It can increase hemoglobin levels by at least 0.3 gr/dL/week or for 10 days. However, an increased Hemoglobin level of pregnant women is not just influenced by Fe supplementation. Instead, it is also supported by the consumption of foods that contain much iron, mainly from heme iron that is found in animals whose absorption is up to 25%, green vegetables, as well as fruit (as a source of vitamin C which can aid the absorption of iron in the body). Heme iron has a higher bio-availability than non-heme iron. Its absorption can reach up to 7-22% compared to non-heme absorption, which is only 1-6%, yet the average absorption of iron is just 10%. However, if the absorption of iron is perfect, then not only iron is needed to create hemoglobin, but also protein - especially the amino acids glycine and succinyl Co-A to create protoporphyrin and heme (after interacting with iron with the assistance of ferrochelatase). As for the synthesis of globin, amino acids, biotin, folic acid, vitamin B6, and vitamin B12 are needed. The interaction between heme and globin will produce hemoglobin; which is needed to synthesize heme.[17,18]

Furthermore, the results of the statistical tests between vitamin C intake and hemoglobin levels did not show a significant correlation. It aligns with research by Habibie et al. (2018), which shows no correlation between vitamin C intake and hemoglobin levels. The lack of correlation between vitamin C intake and hemoglobin levels in this research may be caused by several factors, such as the supplementation of vitamin

C, which is not provided continuously in the pre-determined schedule so that the correlation between vitamin C intake and the hemoglobin level is not visible.[18] Vitamin C is a nutrition that can help improve or enhance the absorption of iron. The recommended requirement for it during pregnancy is 85 mg. If its intake is 100 mg/day, it will be absorbed efficiently (by 80-100%). Giving vitamin C in tablet form can increase the absorption of iron in pregnant women (by 37.5-46%). 80–100% of a 100 mg daily dose of vitamin C will be properly absorbed. Meanwhile, giving vitamin C to pregnant women in pill form can increase their bodies' ability to absorb iron (by 37.5–46%). The absorption of iron is greatly helped by vitamin C, specifically when it comes to non-heme iron, which is available in various vegetables. Moreover, vitamin C can help to create iron ascorbate groups in the duodenum, which remain soluble at higher pH levels. Therefore, it is highly recommended that pregnant women consume vitamin C with every meal. Non-heme iron in ferric form will be converted to ferrous by vitamin C. Fe will be transferred in the form of transferrin, then stored in the liver, spleen, and spinal cord - after being absorbed through mucosal cells and bound by apoferritin to ferritin (Fe + apoferritin). In the research results, pregnant women whose vitamin C intake is in the sufficient category have normal hemoglobin levels. It aligns with the theory that vitamin C is a substance that helps increase the absorption and mechanism of iron metabolism in the body. Thus, if the vitamin C intake is sufficient, then the hemoglobin level will be normal. However, if the vitamin C intake is insufficient (or if one consumes it without consuming enough iron), its function in absorbing iron will not go optimally, resulting in decreased hemoglobin levels.[19,20]

This research has several limitations, such as respondents finding it hard to recall the food they consume for 1 week to fill the food frequency form and the researchers do not differentiate between the respondents who regularly take Fe tablets and vitamin C supplements.

CONCLUSION

Based on research on the correlation between protein, iron (Fe), and vitamin C intake with hemoglobin levels in pregnant women at Kayon Public Health Center, Jekan Raya District, it can be concluded that there was no correlation between protein, iron, and vitamin C intake with hemoglobin levels in pregnant women at Kayon Public Health Center.

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CONFLICT OF INTEREST

The researchers state that there is no conflict of interest in this research.

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