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Levels of Nutritional Adequacy and Bioavailability of Iron with The Incident of Anemia in Pregnant Women in Gorontalo City

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ABSTRACT: The level of adequate nutrition and iron availability in pregnant women can cause anemia, and inadequate food intake during pregnancy can affect Hb levels. The research formulation is about the incidence of anemia in pregnant women and whether there is a relationship between the level of adequate nutrition of energy, protein, vitamin A, vitamin C, iron, and bioavailability and the incidence of anemia in pregnant women. This research aims to analyze the level of adequacy and bioavailability of iron with the incidence of anemia in pregnant women. This type of observational research uses a cross-sectional design. This research was carried out at 10 Community Health Centers in Gorontalo City. The sample in this study consisted of 165 pregnant women using cluster random sampling techniques with bivariate analysis using the Chi-square test and multivariate analysis using the multinominal logistic regression test. The results of data analysis on the prevalence of anemia in pregnant women were 52.7%. The relationship between the level of nutritional adequacy and the incidence of anemia in pregnant women is energy (P value = 0.029 ≤ α = 0.05), protein (P value = 0.045 ≤ α = 0.05), vitamin A (P value = 0.108 ≥ α = 0 .05), vitamin C (P value = 0.003 ≤ α = 0.05), Iron (P value = 0.004 ≤ α = 0.05), bioavailability (P value = 0.016 ≤ α = 0.05). There is a relationship between adequate levels of the nutrients energy, protein, vitamin C, iron, and iron bioavailability with the incidence of anemia in pregnant women, and there is no relationship between adequate levels of the nutrient vitamin A and the incidence of anemia in pregnant women. Pregnant women increase their need for good nutrition during pregnancy to prevent anemia.

KEYWORDS: Anemia Incidence, Adequacy Level, Nutrients, Bioavailability, Iron.

INTRODUCTION

Anemia is the most significant public health problem in the world, especially for women of reproductive age (WUS). The causes are deficiencies of iron and folic acid, and chronic bleeding can occur due to the interaction of the two. Anemia is one of the causes of maternal death, which is generally referred to as (Potential Danger To Mother And Child), potential danger to mother and child (Dewi P & Madinah, 2021).

According to the World Health Organization (WHO, 2020), the estimated maternal mortality is 303,000 people, or around 216/100,000 live births. Worldwide, anemia in pregnant women is 41.8%. About half of anemia cases are caused by iron deficiency. The prevalence of anemia in pregnant women in Africa is 57.1%, Asia 48.2%, Europe 25.1%, and America 24.1%. In developing countries, around 40% of maternal deaths are related to anemia during pregnancy.

In Indonesia, the incidence of anemia in pregnant women tends to increase. Based on the results of Basic Health Researc (Riskesdas) in 2013, the prevalence of anemia in pregnant women was 37.1%, rising to 48.9% in 2018. The results of the 2018 Riskesdas also showed that 84.6% of pregnant women aged less than 25 years experienced anemia. And 57.6% of pregnant women aged more than or equal to 35 years experienced anemia (RI Ministry of Health, 2018).

Gorontalo Province itself has a prevalence of anemia cases in pregnant women of 44,409 out of 170,279 pregnant women who examined themselves, consisting of 40,042 people (0.23%) who experienced mild anemia, 4,367 people (0.02%) who experienced severe anemia and as many as 115.87 (0.68%) did not experience anemia (Gorontalo Provincial Health Service, 2021). From data from the Gorontalo City Health Service in 2022, as many as 3232 mothers were examined, and 357 pregnant women (12.7%) suffered from anemia; this number increased from the previous year, with a prevalence of 11.6% of pregnant women experiencing anemia.

Pregnant women can make efforts to prevent anemia during pregnancy by increasing iron intake through food, consuming sufficient amounts of animal food, and reducing consumption of foods that can inhibit iron absorption, such as phytates, phosphates, and tannins (Triharini, 2019). Prevention of anemia in pregnancy can be done by increasing knowledge and changing attitudes to be positive through education about adequate nutritional intake during pregnancy, where education can be given during ANC visits, giving blood supplement tablets of at least 90 tablets during pregnancy, carrying out Hb checks, processing

and serving food by fortifying the food (Erryca et al., 2022).

The health problem in pregnant women is anemia, which will hurt pregnant women during pregnancy and will also have a direct effect on the fetus and baby after giving birth. During pregnancy, pregnant women need excellent and adequate nutritional intake. Anemia in pregnant women is greatly influenced by eating habits and nutritional intake that are less than optimal during pregnancy. From the results of the background of the problem, the researchers wanted to research "Nutritional Adequacy Levels and Iron Bioavailability with the Incidence of Anemia in Pregnant Women in Gorontal City."

Research methods

The locations in this research were all the Community Health Centers in Gorontalo City, totaling 10 Community Health Centers. This research has been ongoing for 3 months and will be carried out in December 2023 – February 2024. This research uses a cross-sectional study design or observational research method that collects data at a particular time from several individuals or populations to simultaneously describe or understand the relationship between specific variables or characteristics. The population in this study was the total number of pregnant women who came for pregnancy checks at the Community Health Center, totaling 282 pregnant women in December 2023. The sample size collection technique used the Slovin formula. The sample in this study amounted to 165 people. From the results of the sampling formula using the Cluster Random Sampling technique, the sample used in this study was 165 pregnant women. The data collected in this research consists of primary data and secondary data. In this study, univariate analysis was carried out on the variables hemoglobin levels, levels of protein-energy nutrient adequacy, iron intake, and Vitamin C intake.). Bivariate analysis in this study uses the Chi-square statistical test to analyze the relationship between variables in a non-parametric or definite form. Multivariate analysis in this study uses the Multidimensional Logistic regression method.

METHODS

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RESULTS AND DISCUSSION

Table 1. Relationship between Adequate Levels of Energy Nutrients and the Incidence of Anemia in Pregnant Women

Energy nutrient adequacy level	currence of anemia				
	ɣere anemia	ɹderate Anemia	t Anemic	ːal	
ficit	0	2	8	)	29
ɔugh		9	9	)	
ıount		0	3	)	

Source: Primary Data 2024

In the table of the relationship between the level of energy nutrient adequacy and the incidence of anemia in pregnant women, there are 13 pregnant women (14.0%) with the level of energy nutrient adequacy deficit with pregnant women who experience severe anemia (14.0%), the level of energy nutrient adequacy deficit with pregnant women experiencing anemia. Moderate, there were 43 pregnant women (46.2%); the level of energy nutrient adequacy was deficit with pregnant women who were not anemic; there were 37 pregnant women (39.8%), and the level of energy nutrient adequacy was sufficient for pregnant women who experienced severe anemia there were three pregnant women (4.2%), there were 28 pregnant women who had moderate anemia (38.9%), the level of energy nutrient adequacy was sufficient for pregnant women who were not anemic, there

were 41 pregnant women (56.9%).

Table 2. Correlation between Adequate Levels of Protein Nutrients and the Incidence of Anemia in Pregnant Women

Adequacy level of protein nutrition	currence of anemia				
	/ere Anemia	derate Anemia	t Anemic	tal	
ficit	5	2	3	)	45
ɔugh		2	6	)	
ıount		0	3	)	

Source: Primary Data 2024

In the table of the relationship between the level of adequacy of protein nutrients and the incidence of anemia in pregnant women, the results of the analysis of the relationship between the level of adequacy of protein nutrient deficit and pregnant women who experience severe anemia, there are 12 pregnant women (13.5%), the level of adequacy of protein nutrient deficit with pregnant women Those who experienced moderate anemia were 42 pregnant women (47.2%), the level of protein nutrient adequacy with the incidence of anemia in pregnant women, the level of protein nutrient adequacy was deficit with pregnant women who were not anemic, there were 35 pregnant women (39.3%) and the level of adequacy There were four pregnant women (5.3%) who had sufficient protein nutrition in pregnant women who had severe anemia. 29 pregnant women (38.2%) had enough protein nutrition. There were 43 pregnant women (56.6%).

Table 3 . Relationship between Adequate Levels of Vitamin A Nutrients and the Incidence of Anemia in Pregnant Women

Vitamin A nutritional adequacy level	currence of anemia				
	t Anemic	derate Anemia	/ere Anemia	al	
t enough	7	7	6	)	08
ɔugh		9	9	)	
ıount		0	3	)	

Source: Primary Data 2024

In the table of the relationship between the level of adequacy of vitamin A nutrition and the incidence of anemia in pregnant women, the results of the analysis of the relationship between the level of adequacy of vitamin A nutrition being less and pregnant women experiencing severe anemia, there are 15 pregnant women (12.7%), the level of adequacy of vitamin A nutrition is less with pregnant women experiencing moderate anemia, there were 48 pregnant women (40.7%). The level of adequacy of vitamin A nutrition with the incidence of anemia in pregnant women, the level of adequacy of vitamin A nutrition is less in pregnant women who are not anemic; there are 55 pregnant women (46.6%), and the level of adequacy of vitamin A nutrition is sufficient in pregnant women who experience severe anemia, there is one pregnant woman (2.1%), the level of adequacy of vitamin A nutrient was sufficient in pregnant women who had moderate anemia, there were 23 pregnant women (48.9%), the level of nutrient adequacy of vitamin A was sufficient in pregnant women who were not anemic, there were 23 pregnant women (48.9%).

Table 4. Relationship between Adequate Levels of Vitamin C Nutrients and the Incidence of Anemia in Pregnant Women

Adequate levels of vitamin C nutrition	currence of anemia				
	/ere Anemia	derate Anemia	emia	al	
t enough	5	0	5	)	03
ɔugh		3	3	)	
ıount		0	3	)	

Source: Primary Data 2024

In the table of the relationship between the level of adequacy of vitamin C nutrition and the incidence of anemia in pregnant women, the results of the analysis of the relationship between the level of adequacy of vitamin C nutrition being less and pregnant women experiencing severe anemia, there are 13 pregnant women (13.5%), the level of adequacy of vitamin C nutrition is less

with pregnant women who have moderate anemia, there are 48 pregnant women (50.0%), the level of adequacy of vitamin C nutrients with the incidence of anemia in pregnant women, the level of adequacy of vitamin C nutrients is less, with pregnant women who are not anemic there are 35 pregnant women (36.5 %) and the level of nutritional adequacy of vitamin C was sufficient in pregnant women who experienced severe anemia, there were 3 pregnant women (4.3%), the level of adequacy of nutritional vitamin C was sufficient in pregnant women who experienced moderate anemia, there were 23 pregnant women (33.3 %), the level of nutritional adequacy of vitamin C was sufficient in pregnant women who were not anemic, there were 43 pregnant women (62.3%).

Table 5. Correlation between Iron Adequacy Levels and the Incidence of Anemia in Pregnant Women

Adequate level of iron nutrition	currence of anemia				
	ere Anemia	derate Anemia	emia	al	
t enough	7	1	2	)	04
ough		1	3	)	
ount		0	3	)	

Source: Primary Data 2024

In the table of the relationship between the level of iron nutrient adequacy and the incidence of anemia in pregnant women, the results of the analysis of the relationship between the level of deficient iron nutrient adequacy and pregnant women who experience severe anemia, there are 15 pregnant women (14.7%), the level of deficient iron nutrient adequacy with pregnant women Those with moderate anemia were 47 pregnant women (46.1%), iron adequacy was low, with pregnant women who were not anemic there were 38 pregnant women (60.3%). The level of iron adequacy was sufficient for pregnant women with severe anemia in 1 pregnant woman (1.6%), the level of iron adequacy was sufficient in pregnant women who experienced moderate anemia, there were 24 pregnant women (38.1%), the level of iron adequacy was sufficient in pregnant women who did not experience anemia, there were 38 pregnant women (60 .3%).

Table 6. Relationship between Iron Bioavailability and the Incidence of Anemia in Pregnant Women

availability of iron	currence of anemia				
	emia avy	derate Anemia	emia	al	
t enough	2	3	5	)	16
ough		7	6	)	
ount		0	3	)	

Source: Primary Data 2024

Table shows the relationship between iron bioavailability and the incidence of anemia in pregnant women and the results of the analysis of the relationship between iron bioavailability and the incidence of anemia in pregnant women. Iron bioavailability is less in pregnant women with severe anemia; there are 15 pregnant women (14.2%), iron bioavailability is less than There were 47 pregnant women who experienced moderate anemia (44.3%), the bioavailability of iron was low, with pregnant women who did not experience anemia, there were 44 pregnant women (41.5%), and the bioavailability of iron was sufficient in pregnant women who experienced severe anemia. There was 1 pregnant woman (1.7%). Iron bioavailability was sufficient in pregnant women who experienced moderate anemia; there were 24 pregnant women (40.7%) with adequate bioavailability and 34 pregnant women who did not experience anemia (57.6%).

Table 7. Multivariate Analysis of Levels of Nutrient Adequacy and Iron Bioavailability with the Incidence of Anemia in Pregnant Women

Anemia		B	Sig.	Exp(B)
Severe Anemia	Energy	1,684	**.023**	5,387
	Proteins	1,244	,069	3,471
	Vitamin C	1,245	,093	3,473
	Iron	2,572	**.018**	13,092
	Bioavailability	2,401	**.028**	11,033
Moderate Anemia	Energy	,503	,152	1,654
	Proteins	,553	.113	1,738
	Vitamin C	,830	**.019**	2,294
	Iron	,527	,139	1,693
	Bioavailability	,274	,453	1,316

Source: Primary Data 2024

a. Category reference: Not anemic

b. Numbers marked with an asterisk (*) have a sig value ≤ 0.05

The results of the multivariate analysis table in table 4.17 show that the following variable that is most related to the incidence of anemia in pregnant women in the severe anemia category, namely the level of energy nutrient adequacy and the incidence of anemia in pregnant women in the severe anemia category has a significant value (P value = 0.023 ≤ α = 0.05), it can be interpreted that the level of energy nutrient adequacy has a substantial relationship with the incidence of anemia in the severe category, from the coefficient value of the energy nutrient adequacy level, namely 1.684, which is positive, this value can be interpreted that there are more and more pregnant women with a deficit level of energy nutrient adequacy. Then, the probability of pregnant women experiencing severe anemia also increases; from the results of the odds ratio or Exp(B) variable, the level of energy nutrient adequacy in the deficit category has a value of 5.387; this indicates that the level of energy nutrient adequacy in the deficit category is estimated to have a chance of experiencing anemia. Weight 5.387 times higher compared to pregnant women who are not anemic.

The level of iron adequacy and the incidence of anemia in pregnant women in the severe anemia category has a significant value (P value = 0.018 ≤ α = 0.05), which means that the level of iron adequacy has a substantial relationship with the incidence of anemia in the severe category, from the coefficient value of the level of adequacy of iron. iron, namely 2.572, has a positive value, so this value can be interpreted as meaning that the more pregnant women with a deficit level of iron adequacy, the greater the probability of pregnant women experiencing severe anemia, from the results of the odds ratio or Exp(B) variable for the level of iron adequacy in the deficient category. The value is 13.092; this indicates that the level of iron adequacy in the low category is estimated to have a 13.092 times higher chance of experiencing severe anemia than pregnant women who are not anemic.

Iron bioavailability and the incidence of anemia in pregnant women in the severe anemia category has a significant value (P value = 0.028 ≤ α = 0.05), which means that iron bioavailability has a substantial relationship with the incidence of anemia in the severe category, from the coefficient value of iron bioavailability, namely 2.401 is positive then this value can be interpreted as meaning that the more pregnant women with a deficit in iron bioavailability, the greater the probability of pregnant women experiencing severe anemia. From the results of the excellent ratio or Exp(B) variable, the low category of iron bioavailability has a value of 11.033; this indicates that iron bioavailability in the low category is estimated to have an 11.033 times higher chance of experiencing severe anemia compared to pregnant women who are not anemic.

The variable most related to the incidence of anemia in pregnant women in the moderate anemia category is the level of adequacy of the nutrient vitamin C with a significant value (P value = 0.042 ≤ α = 0.05), which means that the level of vitamin C consumption has an essential relationship with the incidence of anemia in the moderate category. , from the coefficient value of vitamin C, namely 0.830, which is positive, this value can be interpreted that the more pregnant women who consume less vitamin C, the greater the probability of pregnant women experiencing moderate anemia; from the results of the odds ratio or Exp(B) variable for the level of vitamin consumption. The low category C has a value of 2.294, which indicates that the level of vitamin C consumption in the low category is estimated to have a 2.294 times higher chance of experiencing moderate anemia than that of pregnant women who are not anemic.

Levels of Nutritional Adequacy and Bioavailability of Iron with The Incident of Anemia in Pregnant Women in Gorontalo City

Relationship between Adequate Levels of Energy Nutrients and the Incidence of Anemia in Pregnant Women in Gorontalo City.

The results of the bivariate analysis of the relationship between the level of energy nutrient adequacy and the incidence of anemia in pregnant women obtained a significant value (P value = 0.029 ≤ α = 0.05); it can be concluded that there is a relationship between the level of energy adequacy and the incidence of anemia in pregnant women. In this study, the average energy consumption of pregnant women was 2181.8 kcal; this amount is still meager compared to the RDA of pregnant women, namely 2250 kcal/day. In this study, pregnant women's consumption did not match the recommended portions; from the results of interviews conducted by researchers, pregnant women's food consumption was only around 50-75 grams or 1-1.5 scoops of rice in one meal and side dishes around 70 grams, from the interview results When pregnant women eat, pregnant women only eat 2 times a day, namely in the afternoon and at night, it is rare for pregnant women to eat 3 times a day.

The results of the analysis of the level of energy adequacy with anemia in pregnant women show that the majority with the most significant percentage of pregnant women who have a sufficient level of energy deficit experience moderate anemia, as many as 43 pregnant women (46.2%) and the lowest rate of adequate levels of energy deficit in pregnant women experience severe anemia as many as 13 pregnant women (14.0%). Meanwhile, the majority of pregnant women with sufficient energy adequacy who did not experience anemia were 41 pregnant women (56.9%). The lowest percentage of sufficient energy adequacy levels were pregnant women who experienced severe anemia, namely 3 (4.2%).

According to researchers, the low level of energy adequacy of pregnant women causes anemia in pregnant women; this is because the lack of energy in food intake tends to be low in iron, and the production of red blood cells requires energy to produce red blood cells, a lack of energy intake in food will lead to anemia, adequate levels of energy from food intake can affect iron levels in the body and ultimately influence the risk of developing anemia, the body needs energy for iron metabolism processes, including absorption, transportation and storage of iron, the better the energy intake in pregnant women, it can reduce the risk of anemia, conversely, the less energy intake in pregnant women, the greater the possibility of anemia in pregnant women.

This is in line with research conducted by Kurniasari (2021) regarding the relationship between the level of energy nutrient adequacy and the incidence of pregnant women, showing that there is a significant relationship between the level of energy nutrient adequacy and the incidence of anemia in pregnant women with a substantial value of 0.021 ≤ 0.05. Research conducted by Ekawati et al . (2022) regarding energy adequacy in pregnant women shows that the level of consumption of pregnant women in the city of Malang is in the inferior category of 54.7%, less than 28.1% category, and the average level of energy nutrient adequacy category of 17.2%.

According to Hanley et al . (2022), energy intake influences the incidence of anemia. The energy that comes in through food must be balanced with a person's energy needs. If this balance is not achieved, energy imbalance will occur. An imbalance between energy intake and needs that lasts for an extended period will cause health problems, including anemia. When energy intake from food is lacking, the body will break down protein into energy; this will cause anemia because the breakdown of protein is no longer aimed at forming red blood cells but rather at producing energy or forming glucose.

Correlation between Protein Adequacy Levels and the Incidence of Anemia in Pregnant Women in Gorontalo City

The results of the bivariate analysis regarding the level of protein nutrient adequacy and the incidence of anemia in pregnant women obtained significant results (P value = 0.045 ≤ α = 0.05), which means that there is a relationship between the level of protein nutrient adequacy and the incidence of anemia in pregnant women. In this study, the average protein consumption of pregnant women was 54.1 g, which is still very low compared to the RDA of pregnant women, which is 70 g/day. The results of interviews with pregnant women are sources of animal protein, namely fish consumed by pregnant women with a frequency of eating 4-6 times with a percentage of only (44.2%), and also from the results of interviews and food recalls, pregnant women consume only 75-80 grams of fish a day. This is far from the WHO's recommendation (2018) that fish consumption should be 100-150 grams or 3-5 ounces daily. Meanwhile, the most significant percentage of consumption of vegetable protein sources, namely tofu, is (33.3%) at a meal frequency of 4-6 times, and tempeh consumption with a percentage of (33.3%) at a meal frequency of 1-3 times; this shows protein intake from food sources. Animal and vegetable sources are still lacking.

The results of the analysis of the level of protein adequacy and anemia in pregnant women show that the majority with the most significant percentage, namely pregnant women who have a sufficient level of protein deficit, experience moderate anemia in as many as 42 pregnant women (47.2%) and the lowest percentage of the level of adequate energy deficit in pregnant women experience severe anemia. as many as 12 pregnant women (13.5%). Meanwhile, the most significant percentage of pregnant women with a sufficient level of energy adequacy did not experience anemia, as many as 43 pregnant women (56.6%), and the lowest rate with sufficient energy adequacy levels in pregnant women who experienced severe anemia was 4 pregnant women (5.3%).

According to researchers, a low level of protein adequacy causes anemia in pregnant women. In research, low protein intake in pregnant women results in insufficient animal and vegetable protein consumption. Protein helps in the absorption of iron in the

body, so inadequate protein intake has the potential to cause iron deficiency. Adequate protein levels can reduce the risk of developing anemia; protein can influence iron levels as the formation of hemoglobin, which carries oxygen in the blood, means that better protein intake can reduce the risk of anemia. Conversely, if protein intake is insufficient, it can increase the risk of anemia.

This is in line with research conducted by Dewi et al . (2022) showing that pregnant women at risk of anemia are those whose protein intake is deficient, namely 57.3%, compared to pregnant women whose protein intake is normal (17.3%) and more (18.7%), with a p-value of 0.000. This shows that protein intake has a significant relationship with the risk of anemia in pregnant women.

Other research conducted by Sinaga et al . (2014) states that protein intake directly influences the incidence of anemia with p-value=0.001, meaning that it greatly influences the risk of anemia in pregnant women in Naga Timbul Village. From the results of this study, it was found that pregnant women with less protein intake were 20 people (83 .3%) experienced anemia, while 2 pregnant women with good protein intake (12.5%) experienced anemia. In research conducted, almost all pregnant women consumed animal protein but in small amounts or portions, and the vegetable protein that pregnant women often consumed was tofu and tempeh; the iron in vegetable protein (non-heme protein) was only absorbed by 1-2 %, while iron derived from animal protein (heme protein) is more easily absorbed by the body, namely 10-20%.

Protein is one of the nutrients needed for iron absorption. Low protein consumption can cause low iron absorption by the body. This situation can result in the body lacking iron and can cause anemia or a decrease in Hb levels (Ganji et al ., 2023). In research conducted by Tarigan et al . (2021), the intake of energy, protein, iron, folic acid, and anemia status of pregnant women was obtained from the results of protein intake with the incidence of anemia in pregnant women having an RR value of 4.12, meaning that mothers whose protein intake was less at risk. 4.12 times will experience anemia.

Relationship between Adequate Levels of Vitamin A Nutrients and the Incidence of Anemia in Pregnant Women in Gorontalo City

The results of bivariate analysis of the level of adequacy of vitamin A nutrients with the incidence of anemia in pregnant women showed significant results (P value = 0.108 ≤ α = 0.05); it can be concluded that there is no relationship between the level of adequacy of vitamin A nutrients and the incidence of anemia in pregnant women. In this study, the average consumption of vitamin A for pregnant women was 486.7 RE. This amount is still meager compared to the RDA of vitamin A for pregnant women, which is 900 RE/day. Lack of consumption of foods that contain good vitamin A, such as fruit and vegetables, results in pregnant women's vitamin A adequacy in the deficient category.

The analysis of the level of vitamin A adequacy and anemia in pregnant women shows that the majority with the most significant number, namely pregnant women who have a low level of vitamin A adequacy, do not experience anemia as many as 55 pregnant women (46.6%). The lowest number of low levels of vitamin A adequacy in pregnant women 15 pregnant women (12.7%) experienced severe anemia. Meanwhile, the same number of sufficient vitamin A adequacy levels was found in pregnant women who were not anemic and moderately anemic, namely 23 pregnant women (48.9%), and the lowest number of sufficient vitamin A adequacy levels were in pregnant women who experienced severe anemia, namely 1 pregnant woman (2 .1%).

According to researchers, the level of vitamin A adequacy in pregnant women does not affect the incidence of anemia. Still, in this study, the consumption of vitamin A for most pregnant women was in the deficient category because most foods contain good vitamin A foods, such as liver, eggs, milk, Green vegetables, and fruit, are rarely consumed or in portions that do not meet the vitamin A needs of pregnant women. Vitamin A functions to maintain red blood cells but is influenced by protein intake. Protein intake, which transports and helps absorb vitamin A. In this study, pregnant women's protein intake was classified as deficient, thus affecting the absorption of vitamin A. Researchers believe that vitamin A intake has a limited role in this study. Preventing or treating anemia directly significantly impacts overall body health.

This aligns with research conducted by Purwaningtyas & Prameswari (2020) regarding vitamin A intake and the incidence of anemia in pregnant women. The statistical test results obtained a p-value of 0.083 ≥ 0.05, which means there is no significant relationship between vitamin A intake. and the incidence of anemia in pregnant women. This research is also in line with research conducted by Zahra (2020), which states that the results of statistical tests with Pearson Product Moment between the variable vitamin A intake and the incidence of anemia obtained ρ=0.457 (ρ≥0.05), which means there is no significant relationship between intake. Vitamin A with the incidence of anemia. The absence of a relationship between vitamin A intake and hemoglobin levels can be caused by several factors, one of which is vitamin A absorption. Vitamin A absorption depends on protein consumption because RBP transports vitamin A. So, if the protein is low, vitamin A absorption is reduced even though vitamin A intake is in sufficient quantities.

Levels of Nutritional Adequacy and Bioavailability of Iron with The Incident of Anemia in Pregnant Women in Gorontalo City

Relationship between Adequate Levels of Vitamin C Nutrients and the Incidence of Anemia in Pregnant Women in Gorontalo City.

The results of the bivariate analysis of the level of adequacy of vitamin C nutrition and the incidence of anemia in pregnant women showed significant results (P value = 0.003 ≤ α = 0.05); it can be concluded that there is a relationship between the level of adequacy of vitamin C nutrition and the incidence of anemia in pregnant women. In this study, the average consumption of vitamin C for pregnant women was 50.6 mg. This amount is still meager compared to the RDA of vitamin C for pregnant women, which is 85 mg/day. The results of interviews and food recalls carried out were a lack of vitamin C intake due to insufficient consumption of vegetables and fruit in pregnant women during pregnancy, consumption of vegetables by pregnant women with a frequency of 1-3 times with a percentage (44.8%) and also in the portion of vegetables that a little at meal time ranges from 40-45 grams or half a glass in URT, and also in a day pregnant women only consume 1-2 portions of vegetables, while for fruit consumption the most significant percentage (35.5%) with frequency is in the never category so This results in pregnant women's vitamin C intake being less than recommended.

The results of the analysis of the level of vitamin C adequacy and anemia in pregnant women show that the majority with the most significant number, namely pregnant women who have a low level of vitamin C adequacy, suffer from moderate anemia as many as 48 pregnant women (50.0%) and the lowest number of low levels of vitamin C adequacy in pregnant women. 13 pregnant women (13.5%) experienced severe anemia. Meanwhile, the most significant number of pregnant women with adequate levels of vitamin C did not experience anemia. Namely, 43 pregnant women (62.3%), and the lowest number of pregnant women with sufficient levels of adequate energy was 3 pregnant women (4.3%).

According to researchers, insufficient levels of vitamin C can cause the risk of anemia in pregnant women. This study classified the vitamin C intake in pregnant women as inadequate. Consumption of fruit and vegetable foods is a good source of vitamin C. Lack of vitamin C intake in food can affect the substance's absorption. Iron impacts anemia; vitamin C can change iron, which is difficult for the body to absorb and more accessible to absorb. Adequate levels of vitamin C in the body, apart from increasing iron absorption in the body, also function as an antioxidant, which can help protect red blood cells from damage, which means that the better the consumption of vitamin C in pregnant women, the better absorption of iron can be. The body thereby reduces the risk of anemia; on the other hand, insufficient consumption of vitamin C can lead to anemia in pregnant women.

Correlation between Adequate Levels of Iron Nutrition and the Incidence of Anemia in Pregnant Women in Gorontalo City

The results of the bivariate analysis of the level of iron adequacy and the incidence of anemia in pregnant women obtained results with a significant value (P value = 0.004 ≤ α = 0.05), which means that there is a relationship between the level of adequacy of iron nutrition and the incidence of anemia in pregnant women. In this study, the average iron consumption of pregnant women was 10.1 mg. This amount is still meager compared to the RDA for iron in pregnant women, which is 27 mg/day. Iron in food is primarily found in poultry and fish. From the results of food recall interviews, iron sources are generally animal foods such as meat, which are relatively more expensive and difficult to reach for people with low incomes, while fish consumption is less. More than 70-80 grams, this figure is insufficient to meet nutritional needs during pregnancy and inadequate consumption of vegetables and fruit. The low level of consumption of pregnant women causes the iron intake of pregnant women to be in the deficient category.

The results of the analysis of the level of iron adequacy and anemia of pregnant women show that the majority with the most significant number, namely pregnant women who have a low level of iron adequacy, suffer from moderate anemia in as many as 47 pregnant women (46.1%) and the lowest number of low iron adequacy levels in pregnant women. 15 pregnant women (14.7%) experienced severe anemia. Meanwhile, the most significant number of pregnant women with sufficient iron levels did not experience anemia, namely 38 pregnant women (60.3%), and the lowest number of pregnant women with adequate levels of iron who experienced severe anemia was 1 pregnant woman (1.6%).

According to researchers, the level of iron adequacy is related to the incidence of anemia in pregnant women. In the research, the lack of iron consumption in pregnant women was caused by consuming foods high in iron, such as red meat, liver, fish, and vegetables, which were insufficient or in inappropriate portions, causing Most pregnant women to have adequate levels of iron. Inadequate iron intake in food is closely related to anemia. Iron significantly influences the production of hemoglobin, which acts as a means of transporting oxygen, which impacts the incidence of anemia. The better the level of iron consumption, the lower the risk of anemia, whereas the lower the level of iron consumption, the greater the risk of anemia. This is accompanied by a good intake of energy, protein, and vitamin C so the body can absorb iron properly.

This is in line with research conducted by Meliyani et al . (2022). Based on bivariate analysis tests, it was found that there was a relationship between iron intake and the incidence of iron deficiency anemia carried out at 4 Community Health Centers in Seluma Regency. Measurement of iron intake uses a 3x24-hour food recall. The results obtained were p-value = 0.003. This means that not only respondents with insufficient Fe intake but also the majority of iron intake need to be improved.

This research is also in line with research conducted by Tarigan et al . (2021) regarding the intake of energy, protein, iron, folic acid, and anemia status of pregnant women in the working area of the Petumbukan Community Health Center, explaining that pregnant women with insufficient iron intake suffer from anemia was 36.8% and the number of pregnant women who had good iron intake and were not anemic was 51%. There is a tendency for pregnant women whose iron intake is low to experience anemia. This is confirmed by the bivariate analysis test where the p-value is 0.001 at $\alpha = 0.05$, meaning that there is a relationship between iron intake and the anemia status of pregnant women.

Relationship between Bioavailability and the Incidence of Anemia in Pregnant Women in Gorontalo City

The results of the bivariate analysis test of iron bioavailability and the incidence of anemia in pregnant women obtained results with a significant value (P value = $0.016 \leq \alpha = 0.05$), which means that there is a relationship between the bioavailability of iron and the incidence of anemia in pregnant women. In this study, the average iron bioavailability for pregnant women was 3.2%; this percentage is still meager. Bioavailability in this study was influenced by driving and inhibiting factors. Factors that can encourage bioavailability are insufficient vitamin C intake in pregnant women and inhibiting factors, namely phytates and tannins, which are abundant in tea, coffee, and nuts; this causes a low percentage of iron bioavailability in pregnant women.

The results of the analysis of the level of iron bioavailability with anemia in pregnant women show that the majority with the most significant number, namely pregnant women who have low iron bioavailability, have moderate anemia, 47 pregnant women (44.3%) and the lowest number of low iron bioavailability in pregnant women have anemia. Weight as many as 15 pregnant women (14.2%). Meanwhile, the most significant number of pregnant women with adequate levels of iron did not experience anemia, namely 34 pregnant women (57.6%), and sufficient iron bioavailability in the case of severe anemia was 1 pregnant woman (1.7%)

According to researchers, the bioavailability of iron is related to the incidence of anemia in pregnant women. In this study, stimulating and inhibiting substances influenced the lack of iron bioavailability. This factor will affect the value of iron bioavailability. The higher the value, the higher the vitamin C and protein value. Heme and non-heme, the smaller the bioavailability inhibitor value, the higher the bioavailability percentage. In research, driving factors such as vitamin C and protein have adequate levels in the deficient category, resulting in low iron bioavailability values in pregnant women.

This aligns with research conducted by Warda & Fayasari (2021) regarding food consumption and iron bioavailability related to anemia status. From the bivariate analysis results, the p-value = 0.000 can be interpreted as a relationship between iron bioavailability and iron status. anemia. Iron bioavailability is significantly related to the anemia status of adolescent girls; low bioavailability has a 9.927 times risk of experiencing anemia. The iron absorbed by the body is around 1 mg out of the 10 mg consumed. The bioavailability of iron in this study was 4.63 ± 3.22%. This figure is less than the bioavailability of iron when consuming a mixed diet, which is 8─10% in individuals who do not have Fe stores in the body using the isotope study method.

Variables Most Associated with the Incidence of Anemia

The level of iron adequacy and the incidence of anemia in pregnant women in the severe anemia category has a significant value (P value = $0.018 \leq \alpha = 0.05$), which means that the level of iron adequacy has a substantial relationship with the incidence of anemia in the severe category, from the coefficient value of the level of adequacy of iron. iron, namely 2.572, has a positive value, so this value can be interpreted as meaning that the more pregnant women with a deficit level of iron adequacy, the greater the probability of pregnant women experiencing severe anemia, from the results of the odds ratio or Exp(B) variable for the level of iron adequacy in the deficient category. The value is 13.092; this indicates that the level of iron adequacy in the low category is estimated to have a 13.092 times higher chance of experiencing severe anemia than pregnant women who are not anemic.

Iron deficiency is a significant risk factor for anemia, especially the type of anemia caused by iron deficiency. Iron is the main component of hemoglobin, a protein in red blood cells that transports oxygen throughout the body. When the body is deficient in iron, the ability to produce adequate hemoglobin in red blood cells is impaired; this can result in a low red blood cell count or anemia. Anemia due to iron deficiency can cause symptoms such as fatigue, weakness, shortness of breath, dizziness, and pale skin. In more severe cases, anemia can affect a person's ability to carry out daily activities and negatively impact well-being and quality of life.

According to Renzo et al . (2022), iron deficiency is the most widespread nutritional deficiency globally, accounting for 75% of all types of anemia in pregnancy. Iron deficiency is one of the causes of consuming foods that do not contain enough iron and suboptimal absorption of iron. The cause of anemia can be influenced by the quality of the food sources of iron that a person consumes. Food sources of non-heme iron are more difficult to absorb than heme iron. Heme iron will be absorbed into the mucosal cells as an intact porphyrin complex. The porphyrin ring will be broken down by a particular enzyme (heme oxygenase) in the mucosal cells, and the iron can be liberated. Non-heme iron in the stomach is converted into ferrous iron, and vitamin C is needed to absorb it more easily. Iron absorption will occur in the duodenum, and then it will be carried through the mucous and serous membranes into the blood. Most of the transferrin will carry iron to the bone marrow, which is used to make hemoglobin. If

the body lacks iron, the process of forming red blood cells will be disrupted, which will cause anemia (Woźniak et al ., 2022).

CONCLUSIONS

1. There is a relationship between the level of energy nutrient adequacy and the incidence of anemia in pregnant women in Gorontalo City with a significant value (P value = 0.029 ≤ α = 0.05).
2. There is a relationship between the level of adequate protein nutrition and the incidence of anemia in pregnant women in Gorontalo City with a significant value (P value = 0.045 ≤ α = 0.05).
3. There is no relationship between adequate vitamin A nutrition levels and anemia incidence in pregnant women in Gorontalo City with a significant value (P value = 0.108 ≤ α = 0.05).
4. There is a relationship between the level of adequate vitamin C nutrition and the incidence of anemia in pregnant women in Gorontalo City with a significant value (P value = 0.003 ≤ α = 0.05)
5. There is a relationship between adequate levels of iron nutrition and the incidence of anemia in pregnant women in Gorontalo City with a significant value (P value = 0.004 ≤ α = 0.05).
6. There is a relationship between bioavailability and the incidence of anemia in pregnant women in Gorontalo City with a significant value (P value = 0.016 ≤ α = 0.05).
7. A variable is most related to the incidence of anemia in pregnant women in Gorontalo City, namely the level of iron adequacy in the low category. Pregnant women who are in this category are estimated to have a 13,092 times higher chance of experiencing severe anemia compared to pregnant women who are not anemic.

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