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Impact of education on anemia in pregnant women attending Bandung community health centers: knowledge, therapy adherence, hemoglobin, and iron intake

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ABSTRACT: Anemia in pregnant women poses risks to maternal and infant health. Iron supplementation therapy (IST) adherence and adequate dietary iron intake are crucial for maintaining normal hemoglobin (Hb) levels. This study investigates the impact of education on iron deficiency anemia (IDA) knowledge, IST adherence, iron intake, and Hb levels in pregnant women. A pre-post test study was conducted at Padasuka and Pagarsih Community Health Centers in Bandung. Questionnaires measuring IDA knowledge, Brief Medication Questionnaire (BMQ) for IST adherence, and Food Frequency Questionnaire (FFQ) for iron intake were utilized. This study included a total of 88 pregnant women. The majority of the participants were aged 26-35 years (55.7%), had normal BMI values (45.4%), and exhibited normal blood pressure (60.2%). Additionally, 89.8% had no history of anemia, 90.9% had no other medical history, 92% reported having a good appetite, and 97.7% did not smoke. Education significantly improved IDA knowledge ($p = 0.011$), IST adherence ($p = 0.006$), iron intake ($p = 0.001$), and Hb levels ($p = 0.011$). Strong positive correlations were found between knowledge of IDA in pregnant women and adherence to IST ($r = 0.957$; $p<0.001$), knowledge and Fe intake ($r = 0.972$; $p<0.001$), knowledge and Hb levels ($r = 0.988$; $p<0.001$), adherence to IST and Fe intake ($r = 0.933$; $p<0.001$), adherence to IST and Hb levels ($r = 0.948$; $p<0.001$), as well as Fe intake and Hb levels ($r = 0.978$; $p<0.001$). Enhanced knowledge, IST adherence, and iron intake may mitigate anemia risks in pregnant women.

KEYWORDS: Anemia; education; hemoglobin; iron supplements; pregnancy.

INTRODUCTION

Anemia is a condition in which the number of red blood cells or hemoglobin (Hb) levels is lower than normal and is insufficient to meet a person's physiological needs, which vary according to age, gender, altitude of residence, smoking habits, and pregnancy status, affecting about one-third of the world's population [1], [2]. Low Hb levels are considered when they are <12 g/dL for non-pregnant women, <11 g/dL for pregnant women in the first and third trimesters, and <10.5 g/dL for pregnant women in the second trimester [3-5]. In 2019, according to data from the World Health Organization (WHO), the global prevalence of anemia reached 29.9% among women of reproductive age (15-49 years), with 29.6% occurring in non-pregnant women and 36.5% in pregnant women. However, in Indonesia, the prevalence of anemia was even higher, reached 31.2% among women of reproductive age (15-49 years), where 30.6% occurred in non-pregnant women and 44.2% in pregnant women. This made Indonesia as one of the countries facing double nutritional burdens, with high rates of anemia in pregnant women and stunting in children.

Anemia in pregnant women can increase maternal and infant morbidity and mortality, the risk of giving birth to low birth weight (LBW) infants, preterm birth, miscarriage, and the risk of bleeding before or during childbirth. Additionally, it can cause disturbances in the growth and development of the fetus, hinder reaching optimal height or result in stunting, lead to changes in brain cell morphology and metabolism, disrupt neurotransmitter function, and have negative effects on oligodendrocytes, altering myelination and increasing the risk of poor cognitive, motor, and socio-emotional performance [3],[4]. The causes of anemia include hemoglobinopathies, nutritional deficiencies, especially micronutrients (iron, folic acid, vitamin B12), and infectious diseases (bacterial/viral infections like tuberculosis or HIV/AIDS, parasitic infections like malaria or helminthiasis). Iron (Fe) deficiency is the most common cause of anemia in pregnant women [2],[6]. Fe is an essential component of Hb, a protein present in red blood cells that binds and carries oxygen to body tissues

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[2],[7]. During pregnancy, the mother's Fe requirement increases to produce a larger number of red blood cells and expand the blood plasma volume to compensate for Fe losses during childbirth and meet the Fe stores needed for the baby [3],[4].

Supplementation with Fe supplement tablets is one of the efforts in preventing and managing iron deficiency anemia (IDA). The Fe supplement tablets consist of 60 mg Fe and 400 mcg folic acid, given to women of reproductive age once a week and once a day during menstruation, and to pregnant women every day during pregnancy or at least 90 tablets [8]. In 2018, the data from the Riskesdas show that out of 24% of pregnant women in Indonesia who received ≥90 Fe supplement tablets, only 38.1% consumed ≥90 tablets, while the remaining 61.9% consumed <90 tablets. Adherence with iron supplementation therapy (IST) among pregnant women in Indonesia is still low. Therefore, the screening of factors influencing therapy adherence and education for pregnant women on how to consume Fe supplement tablets and the importance of taking them during pregnancy is necessary. Balanced and nutritious dietary intake can also be done by pregnant women to meet their Fe needs during pregnancy. Pregnant women need 27 mg of Fe per day and should consume a minimum of 5-6 servings of carbohydrates, 4 servings of animal protein, 4 servings of plant-based protein, 4 servings of vegetables, and 4 servings of fruits; they should limit their intake to a maximum of 5 servings of fat/oil, 2 servings of sugar, and 1 serving of iodized salt; and should drink 8-12 glasses of water per day [9]. In regulating this balanced dietary intake, pregnant women's knowledge about nutrition, especially foods rich in Fe, is crucial. Therefore, education on balanced nutrition during pregnancy is necessary. On the other hand, the government plays a role in preventing and managing anemia in pregnant women through Antenatal Care (ANC) services that are integrated with health facilities, two of which include the provision of IST and laboratory examination of Hb levels. ANC services should be provided at least 6 times during pregnancy, with 2 visits in the first trimester, 1 visit in the second trimester, and 3 visits in the third trimester. The examination results should be recorded in the Mother and Child Health Booklet (KIA) [10]. Additionally, in enhancing the knowledge of pregnant women, four Mother's Class sessions are conducted during pregnancy by healthcare workers. With education about anemia, IST, and nutrition, especially Fe, for pregnant women, it is hoped that their knowledge will improve, therapy adherence will increase, and they will be able to regulate a balanced and nutritious diet to maintain proper Hb levels as has been reported in previous studies in Nepal [11], [12] and India [13].

The objective of this study is to determine the influence of education on the knowledge of IDA in pregnant women, adherence to IST, Fe intake, and Hb levels in pregnant women, as well as to determine the relationship between the knowledge of IDA in pregnant women, adherence to IST, Fe intake, and Hb levels at the Padasuka and Pagarsih Community Health Centers in Bandung City. The results of this study can be used as input for healthcare facilities in planning the prevention and management of anemia in pregnant women, particularly IDA, in an integrated and holistic manner.

▪ MATERIALS AND METHODS

Materials

The data collected for the research includes primary data obtained through a questionnaire instrument and secondary data obtained from records of Hb laboratory examination results from the Mother and Child Health Booklet (Buku Kesehatan Ibu dan Anak / KIA) of the research subjects. The data on adherence to IST were obtained from a questionnaire adapted from the Brief Medication Questionnaire (BMQ) [14] , which has been validated in Bahasa Indonesia. It showed a Cronbach's alpha of 0.65 for the entire questionnaire, 0.71 for the Regimen screen, 0.84 for the Belief screen, and 0.76 for the Recall screen [15]. data on Fe intake were obtained from a questionnaire adapted from the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) [16], validated in Bahasa Indonesia with a Cronbach's alpha of 0.82 [17, 18]. Additionally, data on pregnant women's knowledge of IDA were obtained from a questionnaire used in previous research which has been tested for validity and reliability, yielding a Cronbach's alpha of 0.739 [19].

Data on adherence to iron supplementation therapy (IST) were collected using a questionnaire adapted from the Brief Medication Questionnaire (BMQ), which has been validated in Bahasa Indonesia. It showed a Cronbach's alpha of 0.65 for the entire questionnaire, 0.71 for the Regimen screen, 0.84 for the Belief screen, and 0.76 for the Recall screen (Faridah, 2015). Data on iron intake were derived from a questionnaire adapted from the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), validated in Bahasa Indonesia with a Cronbach's alpha of 0.82 (Febryanti et al., 2020; Fitri, 2017). Additionally, data on pregnant women's

knowledge of iron deficiency anemia (IDA) were collected from a questionnaire previously used in research, which has been tested for validity and reliability, yielding a Cronbach's alpha of 0.739.

The knowledge of pregnant women is divided into 3 categories: good, sufficient, and poor knowledge. Each correct answer is given a score of 1, while each incorrect answer is given a score of 0. For good knowledge, a score of ≥ 19 is obtained; for sufficient knowledge, the score is between 14-18, and for poor knowledge, the score is ≤ 13.

The Brief Medication Questionnaire (BMQ) consists of 3 parts: the Regimen screen, the Belief screen, and the Recall screen. The Regimen screen consists of 5 items asking about the patient's adherence behavior related to the therapy regimen in the past week. The Belief screen consists of 2 items asking about the patient's beliefs regarding the therapy's effects, and the Recall screen consists of 2 items asking about potential difficulties in remembering and other barriers to therapy adherence. The adherence scores for the Regimen screen range from 0-5, while the Belief screen and Recall screen range from 0-2, making the maximum total adherence score 9. Each screen is considered positive if it obtains a score of ≥1. Therapy adherence is categorized as low if the total score is ≤3, moderate if the total score is between 4-6, and high if the total score is ≥7 ***[15, 20]***.

The semi-quantitative FFQ method uses a list of food items to be asked to the research subjects, with measurements of daily, weekly, and monthly time duration, and also provides information about the portion size and weight of each portion commonly consumed in the community. The total daily Fe intake is obtained from the sum of Fe intake from all food groups ***[16]***. Fe intake is categorized as sufficient if ≥ 27 mg/day, insufficient if between 18.1-26.9 mg/day, and severely insufficient if ≤ 18 mg/day ***[19]***.

Fe intake is categorized as sufficient if ≥ 27 mg/day, insufficient if between 18.1-26.9 mg/day, and severely insufficient if ≤ 18 mg/day ***[19]***. Low Hb levels are considered when they are <11 g/dL for pregnant women in the first and third trimesters and <10.5 g/dL in the second trimester ***[3-5]***. Hb levels in pregnant women are divided into 2 categories: anemia and non-anemia.

Baseline data were collected shortly before education was provided to each research subject according to the schedule of the Mother and Child Health (KIA) polyclinic at each Community Health Center, on Mondays and Thursdays for the Pagarsih Community Health Center, and on Wednesdays and Fridays for the Padasuka Community Health Center. Baseline data include the demographic data of the research subjects, Hb levels, adherence to IST, Fe intake, and knowledge of IDA. After obtaining the baseline data, on the same day, education was provided through direct face-to-face sessions with each research subject in the counseling room and booklet distribution. At the next scheduled visit after the education session (2-4 weeks depending on the visit scheduled by the community health center for each subject based on gestational age), follow-up was conducted by using the same questionnaire and re-examining the Hb levels as post-education data.

Methods

An experimental one-group pre-post test study was conducted by recruiting subjects from the Padasuka and Pagarsih Community Health Centers.

Subjects

An experimental one-group pre-post test study was conducted by recruiting subjects from the Padasuka and Pagarsih Community Health Centers with the following inclusion criteria: 1) Pregnant women who received IST for a minimum of 7 days before the study, during January - February 2023, 2) Pregnant women who underwent Hb laboratory examination in January 2023. Subjects were excluded using he following criteria: 1) Pregnant women with complications of kidney disorders or infectious diseases (tuberculosis, HIV/AIDS, malaria, or helminthiasis), 2) Pregnant women who withdraw their participation statement from the study, and 3) Pregnant women who are lost to follow-up. The sampling method was based on non-probability sampling technique through purposive sampling, and the sample size was calculated using the Slovin formula (margin of error 5%). Ethical clearance was issued by Health Research Ethics Committee Health Polytechnic Ministry of Health (No. 40/KEPK/EC/VI/2023).

Education process

The education materials were generated from the Ministry of Health of the Republic of Indonesia, specifically the Directorate General of Public Health, particularly the Directorate of Health Promotion and Community Empowerment, and the Directorate of Nutrition and Maternal and Child Health. The education materials presented in this study were divided into three parts. The first part was related to IDA in pregnant women (definition, signs and symptoms, causes, impacts, prevention, and therapy). The second part focused

on IST (consumption methods, recommended dosage for pregnant women, do's and don'ts when consuming them, side effects, and how to obtain IST). The third part covered balanced nutrition during pregnancy (macro and micronutrients, daily nutritional recommendations for pregnant women).

The education method used in this study was direct face-to-face education with each research subject in the counseling room of each Community Health Center, with a duration of 10-15 minutes. Educational aids, such as educational videos and booklets, were utilized during the sessions. The educational videos and booklets contained the aforementioned education materials. The booklet was given to the research subjects to take home as a self-guided reference, and the educational videos could be accessed again by the research subjects by scanning the QR codes provided in the booklet or using the links bit.ly/GiziSeimbangIbuHamil1 for the video related to balanced nutrition during pregnancy and bit.ly/AnemiaPadaIbuHamil2 for the video related to IDA in pregnant women and IST.

Data analysis

The collected data were processed using univariate analysis to describe the frequency distribution and percentage of the characteristics of the research subjects and bivariate analysis to explore the relationships between variables using Paired t-Test, Wilcoxon Signed Rank Test, Pearson, and Spearman correlation coefficient tests with the statistical software Minitab v.21. p-value <0.05 was considered statistically significant.

▪ RESULTS AND DISCUSSION

Subject characteristics

At the beginning of the study in January 2023, a total of 94 pregnant women participated. However, only 88 pregnant women became the subjects of the study. The remaining pregnant women were excluded because of incomplete data on laboratory examination of Hb levels, incomplete questionnaire data, and some pregnant women who lost follow-up or did not undergo further pregnancy check-ups. As seen from Table 1, a total of 88 pregnant women were categorized into three groups: the late adolescent group aged 17-25 years (30.7%), the early adulthood group aged 26-35 years (55.7%), and the late adulthood group aged 36-45 years (13.6%). Naturally, there is a decline in fertility with increasing age, where fertility gradually declining starting at the age of 32 and declining more rapidly after the age of 37 [21].

Table 1. Subject characteristics.

Characteristics		n (%)
Age	Late adolescents (17-25 years)	27 (30.7)
	Early adults (26-35 years)	49 (55.7)
	Late adults (36-45 years)	12 (13,6)
Pregnancy data	Trimester	
	First (0-13 weeks)	11 (12.5)
	Second (14-26 weeks)	31 (35.2)
	Third (27-40 weeks)	46 (5.3)
	Gravida	
	Primigravida	27 (30.7)
	Second gravida	28 (31.8)
	Multigravida	33 (37.5)
	Partus	
	Nullipara	29 (33.0)
	Primipara	31 (35.2)
	Multipara	28 (31.8)
	Abortus	
	Never	79 (89.8)
	Ever	9 (10.2)
Body Mass Index (BMI) (Before pregnancy)	Underweight	14 (15.9)
	Normal	40 (45.4)
	Overweight with risk	16 (18.2)
	Obese 1	13 (14.8)
	Obese 2	5 (5.7)
Blood pressure	Normal	53 (60.2)
	Pre-hypertension	31 (35.2)
	Hypertension 1	4 (4.6)

	Characteristics	n (%)
	Hypertension 2	0 (0.0)
Socioeconomic data	Ethnicity	
	Sundanese	64 (72.7)
	Javanese	18 (20.4)
	Batak	2 (2.3)
	Minang	2 (2.3)
	Acehnese	2 (2.3)
	Highest Education Attainment	
	Elementary school	5 (5.7)
	Junior high school	15 (17.0)
	Senior high school	55 (62.5)
	College/University	13 (14.8)
	No formal education	0 (0.0)
	Occupation	
	Student/College Student	4 (4.5)
	Stay-at-home mother	62 (70.5)
	Private Employee	10 (11.4)
	Entrepreneur	7 (7.9)
	Civil Servant	3 (3.4)
	Others	2 (2.3)
	Average Monthly Income	
	Low (<Rp1,500,000)	24 (27.3)
	Medium (Rp1,500,000-Rp2,500,000)	20 (22.7)
	High (Rp2,500,000-Rp3,500,000)	27 (30.7)
	Very High (>Rp3,500,000)	17 (19.3)
	Meal Availability	
	Sufficient	88 (100.0)
	Insufficient	0 (0.0)
	Kitchen Facilities	
	Available	88 (100.0)
	Not Available	0 (0.0)
History of Diseases/Health Conditions	History of Anemia	
	Present	9 (10.2)
	Absent	79 (89.8)
	History of Other Diseases	
	Present	8 (9.1)
	Absent	80 (90.9)
	Appetite	
	Present	81 (92.0)
	Absent	7 (8.0)
	Conditions Affecting Nutrient Digestion	
	Present	12 (13.6)
	Absent	76 (83.4)
	Smoking Habit	
	Present	2 (2.3)
	Absent	86 (97.7)
	Use of Other Drugs/Supplements Besides IST	
	Present	26 (29.6)
	Absent	62 (70.4)
History of Treatment/Healthcare Services	Medication Intake Supervised by	
	Parents	9 (10.2)
	Spouse	77 (87.5)
	Others	2 (2.3)
	Distance from Home to Community Health Center	
	Near (<1 km)	12 (13.6)
	Moderate (1-3 km)	53 (60.2)
	Far (3-5 km)	21 (23.9)
	Very Far (>5 km)	2 (2.3)
	Routine Visits to the Community Health Center	
	1-2 times a week	19 (21.6)
	Every 3 weeks - 1 month	59 (67.0)
	Irregular	10 (11.4)

Before pregnancy, the majority of the research subjects had normal BMI values, which accounted for 40 pregnant women (45.4%). However, 14 pregnant women (15.9%) were underweight, 16 pregnant women (18.2%) were overweight with risk, 13 pregnant women (14.8%) had stage 1 obesity, and 5 pregnant women (5.7%) had stage 2 obesity. Additionally, anemia in pregnant women can lead to low blood pressure (hypotension) or high blood pressure (hypertension).

The majority of the research subjects, which included 53 pregnant women (60.2%), had normal blood pressure and none had low blood pressure (hypotension). However, 31 pregnant women (35.2%) had high blood pressure with risk or pre-hypertension and 4 pregnant women (4.6%) had stage 1 high blood pressure (hypertension).

Based on the medical history or health conditions of pregnant women, 9 pregnant women (10.2%) had a history of anemia, whether it was due to IDA or folate deficiency in previous pregnancies, and 79 pregnant women (89.8%) had no history of anemia. Other diseases were reported by 8 pregnant women (9.1%), included asthma and hypertension, and 80 pregnant women (90.9%) not having any other medical history. Almost all research subjects had a good appetite, accounting for 81 pregnant women (92.0%), and 7 pregnant women (8.0%) had a poor appetite due to mouth sores and toothache. 12 out of 88 pregnant women (13.6%) had conditions that could affect digestion, such as diarrhea, constipation, bloating, and gastric acid, while other 76 pregnant women (83.4%) did not have such conditions. Almost all research subjects did not smoke, where 86 pregnant women (97.7%) reporting no smoking habit, while 2 pregnant women (2.3%) had the habit of smoking 2-3 times per week.

Impact of education on the outcomes

Results shown in Table 2 and Table 3 indicate a significant increase in the knowledge of pregnant women, adherence with IST, Hb level, and Fe intake following education.

Table 2. The impact of education on outcomes.

Outcomes		Mean ± SE	Median (IQR)	P-Value
Knowledge[a]	Pre- education		16.00 (3.75)	0.011*
	Post- education		17.00 (3.00)	
Adherence with IST[a]	Pre- education		7.00 (2.00)	0.006*
	Post- education		7.00 (1.00)	
Fe intake[b]	Pre- education	20.749±0,303		0.001*
	Post- education	21.934±0,230		
Hb levels[b]	Pre-education	11.476±0,151		0.011*
	Post- education	11.966±0,117		

[a] Wilcoxon Signed Rank Test
[b] Paired t-Test
* There is a significant difference ($p < 0.05$) between pre-education and post-education

Table 3. Changes of outcomes on pregnant women before and after education.

Outcomes		Pre-education	Post-education	Changes (%)
		n (%)	n (%)	
Knowledge	Good	18 (20.4)	26 (29.5)	(+) 44.4
	Sufficient	55 (62.5)	60 (68.2)	(+) 9.1
	Poor	15 (17.1)	2 (2.3)	(-) 86.6
Adherence with IST	High	56 (63.6)	70 (79.5)	(+) 25.0
	Moderate	32 (36.4)	18 (20.5)	(-) 43.7
	Low	0 (0.0)	0 (0.0)	0.0
Fe intake	Sufficient	2 (2.3)	2 (2.3)	0.0
	Insufficient	70 (79.5)	84 (95.4)	(+) 20.0
	Very Insufficient	16 (18.2)	2 (2.3)	(-) 87.5

(+) = Positive change or an increase in the percentage of the number after education
(-) = Negative change or a decrease in the percentage of the number after education

The knowledge median (IQR) significantly increased from 16 (3.75) to 17 (3) and respondent with good level of knowledge increased 44.4%. These findings are consistent with the study conducted by Sukmawati et al., [22], which also showed a significant difference in the knowledge of pregnant women before and after education using a presentation method on the prevention and management of anemia among 37 pregnant

women at Haurpanggung Community Health Center, Garut District (p<0.001). Similarly, the study by Adawiyani [23] found a significant difference in the knowledge of pregnant women before and after education using a booklet on anemia among 93 pregnant women in the second and third trimesters at Dr. Ramelan Military Hospital, Surabaya (p< 0.001).

The adherence to IST significantly increased and respondent with high level of adherence increased 25%, which is consistent with the study conducted by Adawiyani [23] who found a significant difference in therapy adherence of pregnant women before and after education with the method of providing anemia booklet to 93 pregnant women in the second and third trimesters at Dr. Ramelan Military Hospital, Surabaya (p < 0.0079). Similarly, the study by Ekayanthi and Purnamasari [24] also found a significant difference in therapy adherence of pregnant women before and after education with counseling method among 44 pregnant women in the second trimester at Pancasan and Mekarwangi Health Centers, Bogor.

The mean of Fe intake significantly increased from 20.749±0.303 to 21.934±0.230 and respondent with very insufficient Fe intake reduced to 87.5%. Unfortunately, the Fe intake is still insufficient following education.

The mean of Hb level significantly increased from 11.476 ± 0.151 to 11.966 ± 0.117 and respondent with anemia status reduced to 64% and 60% for pregnant women in trimester I and III and pregnant women in trimester II, respectively (Table 4).

Table 4. Hb levels before and after education.

Hb status	Pre-education n (%)		Post-education n (%)		Changes (%)	
	A	B	A	B	A	B
Non-Anemia	32 (36.4)	26 (29.5)	48 (54.5)	29 (33.0)	(+) 50.0	(+) 11.5
Anemia	25 (28.4)	5 (5.7)	9 (10.2)	2 (2.3)	(-) 64.0	(-) 60.0

A Pregnant Women in Trimester I and III
B Pregnant Women in Trimester II
(+) Positive change or an increase in the percentage of the number after education
(-) Negative change or a decrease in the percentage of the number after education

Correlation among the outcomes

Table 5 shows the correlation among observed outcomes. The level of knowledge of pregnant women and the adherence with IST showed a very strong correlation (r=0.957, p <0.001). The results indicate that the higher the level of knowledge of pregnant women, the higher their adherence with IST. This finding is consistent with the study conducted by Utami et al., [25], which also found a positive relationship between the level of knowledge of pregnant women and adherence with IST, with a strong strength of correlation (r=0,602). Their study involved 45 pregnant women at the Cempaka Health Center, Banjar Baru.

Table 5. Correlation among outcomes following education.

Outcomes	Hb levels	Adherence with IST	Fe intake	Knowledge
Knowledge	0.988*[b]	0.957*[b]	0.972*[b]	NA
Adherence with IST	0.948*[b]	NA	0.933*[b]	0.957*[b]
Hb levels	NA	0.948*[b]	0.978*[a]	0.988*[b]
Fe intake	0.978*[a]	0.933*[b]	NA	0.972*[b]

Correlation tests were conducted only on post-education data
[a] Pearson Correlation Test
[b] Spearman Correlation Test
* There is a significant difference (p < 0.05) between the two variables.

Strength of correlation coefficient (r) = 0.8 – 1.0 (Very strong); 0.6 – <0.8 (Strong); 0.4 – <0.6 (Moderate); 0.2 – <0.4 (Weak); and 0.0 – <0.2 (Very weak)

The correlation between the level of knowledge of pregnant women and Fe intake is very strong (r=0.972, p < 0.001), indicating that the higher the level of knowledge of pregnant women, the higher their Fe intake. This finding is in line with the study conducted by Koerniawati et al., [26], which also found a positive relationship between the level of knowledge of pregnant women and Fe intake with a strong strength of correlation (r = 0.677). Their study involved 65 pregnant women at the Cadasari Health Center, Pandeglang Banten.

The correlation between the level of knowledge of pregnant women and the Hb level is very strong (r=0.988, p < 0.001), indicating that the higher the level of knowledge of pregnant women, the higher their Hb level. This finding is consistent with the study conducted by Siwi [27], which also found a positive relationship between the level of knowledge of pregnant women and the Hb level but with a moderate strength of correlation (r=0.492). The study involved 50 pregnant women in the second trimester at the Pucangsawit and Sibela Health Centers, Jebres District, Surakarta.

There is a very strong correlation between therapy adherence of IST and Fe intake (r=0.933, p < 0.001). This indicates that as the therapy adherence of pregnant women with IST increases, their Fe intake also increases. This finding is consistent with the study conducted by Yulianti et al., [28], which found a positive and strong relationship between therapy adherence of IST and Fe intake (r = 0.851). The study was conducted on 63 pregnant women at Simpur Health Center, Lampung.

There is a very strong correlation between therapy adherence of IST and Hb levels with a Spearman correlation coefficient of 0.948. This indicates that as the therapy adherence of pregnant women with IST increases, their Hb levels also increase (p < 0.001). This finding is consistent with the study conducted by Wulandari [29], which found a positive relationship (p < 0,001) between therapy adherence of IST and Hb levels with a strong strength (r = 0.756). The study was conducted on 47 pregnant women in the third trimester at the Pasar Minggu Health Center, South Jakarta.

There is a very strong correlation between Fe intake and Hb levels (r=0.978, p < 0.001). This indicates that as the Fe intake of pregnant women increases, their Hb levels also increase. However, these findings are not consistent with the study conducted by Putri et al. [30], which did not find a positive relationship between Fe intake and Hb levels with a very weak strength (r < 0.2). The study was conducted on 66 pregnant women in the Jatinangor District using the food record method for 3 days, without investigating the adherence of IST in pregnant women. On the other hand, in line with the study conducted by Pratiwi and Widari (2018)[31], a positive relationship between Fe intake and Hb levels was found, but with a moderate strength (r = 0.424, p = 0.005). The study was conducted on 81 pregnant women in the third trimester at the Pajarakan Health Center, Probolinggo Regency.

In general, the results indicate the needs of comprehensive strategy to prevent and treat anemia in pregnant women: effective education will lead to increase adherence towards IST and better Fe intake among pregnant women. Finally, it may reduce the incidence of anemia.

Strength and limitations

This study has multiple outcomes compared to previous studies. Therefore, a more comprehensive positive impact of education can be seen through comprehensive assessments. However, the follow-up period is relatively short, averaging about 3 weeks to 1 month, which may not fully represent the long-term or prolonged effects of education. Additionally, the education material related to balanced nutrition provided to the participants was limited, resulting in few questions regarding the knowledge of pregnant women about balanced nutrition.

▪ CONCLUSION

We found that the knowledge of pregnant women regarding IDA, adherence to IST, and nutrition, especially Fe intake, increased significantly after the education. Education has a positive impact on knowledge of IDA in pregnant women, adherence to IST, Fe intake, and Hb levels in pregnant women. Furthermore, a significant very high positive correlation was observed between knowledge of IDA in pregnant women and adherence to IST, knowledge and Fe intake, knowledge and Hb levels, adherence to IST and Fe intake, adherence to IST and Hb levels, as well as Fe intake and Hb levels. Improved knowledge, resulting in higher adherence to IST and increased iron intake among pregnant women, may contribute to reducing the occurrence of anemia. Community health centers and local health departments should consider implementing several strategies to reduce the incidence of anemia among pregnant women. These include conducting regular educational workshops, creating customized educational materials, and providing training for healthcare providers. Additionally, integrating nutrition assessments and counseling into routine care, along with employing reminder systems for iron supplementation therapy adherence, could further enhance outcomes for this population.

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