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# Effect of Iron Rich Foods SMS Intervention on Iron Intake in Pregnant Women with Anemia

## Pengaruh Intervensi SMS Makanan Tinggi Besi terhadap Asupan Makanan pada Ibu Hamil dengan Anemia

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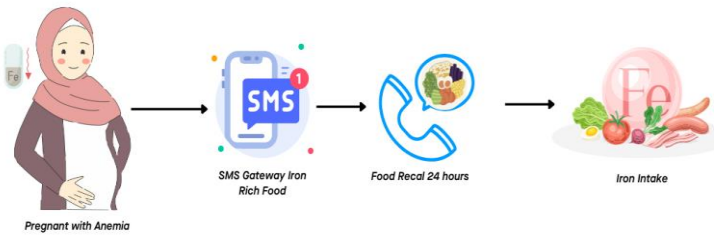
**Abstract**
Pregnancy-related anemia has been linked to many undesirable consequences for both mothers and their children. Prevention of anemia in pregnant women can be supported through health promotion media such as SMS-gateway. This study was focused on knowing the effect of SMS gateway knowledge about foods high in iron on intake of foods high in iron in anemic pregnant women. The study was used a double-blind randomized controlled trial to analyze the effect of SMS intervention on iron-rich food on 68 anemic pregnant women at seven health centers in Makassar City. The intervention applied the software Gili SMS® to deliver SMS interventions. The intervention was given on days 3, 10, 17, and 24 of the study, and food recalls were carried out on days 0 and 28 of the study using the 24-hour food recall method. We found that there was no significant difference on intake of iron but a significant difference between intake of energy and carbohydrate between control and intervention group after SMS gateway intervention. By the recommendations in one of the verses in the Qur'an, pregnant women are encouraged to choose and consume good food such as vegetable and animal protein produced by plants and animals. Foods are suitable for the body and provide all the nutrients needed for the body's normal functioning. We found no increased of iron intake after SMS intervention in pregnant women with anemia.

**Abstrak**
Anemia terkait kehamilan telah dikaitkan dengan banyak konsekuensi yang tidak diinginkan bagi ibu dan anak-anak mereka. Pencegahan anemia pada wanita hamil dapat didukung melalui media promosi kesehatan seperti SMS-gateway. Studi ini berfokus pada mengetahui efek dari pengetahuan SMS gateway tentang makanan yang tinggi zat besi pada asupan makanan dengan kandungan besi tinggi pada wanita hamil dengan anemia. Penelitian ini menggunakan double-blind randomized controlled untuk menganalisis efek intervensi SMS pada makanan kaya zat besi pada 68 wanita hamil dengan anemia di tujuh pusat kesehatan di Kota Makassar. Intervensi menggunakan perangkat lunak Gili SMS® untuk menyampaikan intervensi SMS. Intervensi diberikan pada hari 3, 10, 17, dan 24 penelitian, dan pengingat makanan dilakukan pada hari 0 dan 28 penelitian menggunakan metode food-recall 24 jam. Kami menemukan bahwa tidak ada perbedaan signifikan dalam asupan zat besi, tetapi perbedaan yang signifikan antara asupan energi dan karbohidrat antara kelompok kontrol dan intervensi setelah intervensi SMS Gateway, sesuai dengan anjuran pada salah satu ayat dalam alqur'an, ibu hamil dianjurkan untuk memilih dan mengonsumsi makanan yang baik dari sumber protein nabati dan hewani yang dihasilkan oleh tumbuhan dan hewan. Makanan yang baik untuk tubuh dan memberikan semua zat gizi yang dibutuhkan untuk fungsi normal tubuh. Kami tidak menemukan peningkatan asupan zat besi setelah intervensi SMS pada wanita hamil dengan anemia.

**Graphical Abstract**




**Keyword**
anemia; iron; pregnancy; pregnant women; sms gateway

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## INTRODUCTION

The Sustainable Development Goals (SDGs) aim to reduce maternal mortality to less than 70 deaths per 100,000 live births globally by 2030. Nevertheless, poor maternal and infant health remains a significant problem in many nations (Sahoo et al., 2021). In 2019 the most common causes of maternal death were bleeding (1,280 cases), hypertension in pregnancy (1,066 cases), and infection (207 cases). In 2018 from South Sulawesi Province, there were 169,000 live births and 139 maternal deaths. One of the Indonesian government's measures in achieving the fourth and fifth MDGs goals in 2015 is to reduce child mortality and improve maternal health by preventing anaemia in pregnancy (Kementerian Perencanaan Pembangunan Nasional, 2020; Safiri et al., 2021).

The maternal mortality rate is one of the targets in the MDGs fifth, reduce the maternal mortality rate. In 2017 the maternal mortality rate (MMR) in the world there are around 810 women who die every day due to complications of pregnancy or childbirth (World Health Organization, 2019). The survey results from the Central Bureau of Statistics, in Indonesia, there were 305 cases of MMR per 100,000 live births and anemia (Hb <11 gr/dl) contributed for a huge percentage for about 40% of all cases (Badan Pusat Statistik, 2016). WHO data found that 41.8% of pregnant women worldwide experienced anemia and that about half of these cases were caused by iron deficiency.

Anaemia relates to higher morbidity and death rates in women and children, unsuccessful pregnancies, lower work productivity in adults, and delayed cognitive and behavioural growth in kids. Anaemia in pregnancy is a significant concern since it affects productivity, cognitive development, physical health, and economic status. Iron deficiency is the most common cause of anaemia in pregnancy; most studies advise pregnant women to take enough iron supplements to do so. Knowledge and attitude were essential components influencing pregnant women's behaviour on iron intake. Mothers' knowledge regarding food, especially sources of iron, is needed to improve nutritional status (Chaparro & Suchdev, 2019; Zhang et al., 2022).

Nowadays, using cell phone technology to improve public health status through SMS gateways as health promotion media is popular. Herlina has proved that the application of the SMS gateway model has an effectiveness of 60%. It is helpful as a reminder for mothers to always maintain the health and safety of the fetus they contain. SMS has a high flexibility and acceptability to disseminate health information to many people, especially pregnant women. The SMS gateway promotion model can provide knowledge about pregnancy education to the community (Herlina, 2018; Peiris et al., 2023). Several studies that intervene in the problem of anemia in pregnant women have been carried out, such as intervention program with the infographic video clips (Abd Rahman et al., 2022), dietary interventions (Skolmowska et al., 2022), and virtual counseling intervention (Bhattarai et al., 2023). This study will complement the intervention method to overcome anemia problems by using SMS gateways. This study aimed to analyze the effect of the SMS gateway on increasing iron-rich food consumption in pregnant women.

## METHODS

This study was a double-blind, randomized controlled trial (RCT) design. We studied from January 2021 to April 2021 in Makassar City at seven health centres: Pampang, Dahlia, Cendrawasih, Makkasau, Tarakan, Rappokalling, and Kassi-Kassi. We obtained 68 pregnant women (35 samples from the control and intervention groups) who met the inclusion and exclusion criteria. Inclusion criteria were pregnant women with anaemia, pregnant women with gestational age <32 weeks, willing to participate in the study, able to communicate well and have a handheld telephone. Exclusion criteria in this study were mothers who could not read and could not operate cell phones and mothers who had chronic diseases.

The Research assistant 1 performed a simple randomization while research assistant 2 was assigned to send SMS to the intervention group and blinding from group classification. Gili SMS ® delivers SMS interventions by downloading software on a laptop/pc and connecting it to a modem, making it easier for senders to send broadcast messages to participants (Wardono, 2020). SMS content was refered to Guidelines for Prevention and management of Anemia in young women and fertile women and modified to be suit for SMS information. SMS content was referred to Guidelines for Prevention and Management of Anemia in young and fertile women and modified to suit SMS information (Kementerian kesehatan RI, 2016). The intervention was given to this study on days 3, 10, 17 and 24 of the study and food recalls were carried out on days 0 and 28. We

Table 1.
***Characteristics of respondents***

| Characteristics | Group | | | | P value[a] |
|---|---|---|---|---|---|
| | Control | | Intervention | | |
| | n | % | n | % | |
| Mother's Age (Years) | | | | | |
| 17 - 25 | 12 | 34.3 | 16 | 48.5 | |
| 26 - 35 | 18 | 51.4 | 13 | 39.4 | 1.43 |
| 36 - 45 | 5 | 14.3 | 4 | 12.1 | |
| Mother's Education | | | | | |
| No Education | 0 | 0 | 1 | 3 | |
| Elementary Graduate | 5 | 14.3 | 9 | 27.3 | |
| Junior School Graduate | 4 | 11.4 | 2 | 6.1 | 3.68 |
| High School Graduate | 19 | 54.3 | 17 | 51.5 | |
| Bachelor's Degree | 7 | 20 | 4 | 12.1 | |
| Husband's Education | | | | | |
| No Education | 0 | 0 | 1 | 3 | |
| Elementary Graduate | 7 | 20 | 6 | 18.2 | |
| Junior School Graduate | 4 | 11.4 | 3 | 9.1 | 2.55 |
| High School Graduate | 19 | 54.3 | 21 | 63.6 | |
| Bachelor's Degree | 5 | 14.3 | 2 | 6.1 | |
| Mother's Occupation | | | | | |
| Working | 6 | 17.1 | 6 | 18.2 | 0.01 |
| Not working | 29 | 82.9 | 27 | 81.8 | |
| Husband's Occupation | | | | | |
| Working | 34 | 97.1 | 32 | 97 | 0.00 |
| Not working | 1 | 2.9 | 1 | 3 | |
| Monthly Income | | | | | |
| < 1,000,000 IDR | 9 | 25.7 | 11 | 33.3 | |
| 1,000,000 – Rp. 3,000,000 IDR | 19 | 54.3 | 16 | 48.5 | 0.47 |
| >3,000,000 IDR | 7 | 20 | 6 | 18.2 | |
| Length of Pregnancy | | | | | |
| Trimester I | 5 | 14.3 | 11 | 33.3 | |
| Trimester II | 28 | 80 | 19 | 57.6 | 4.12 |
| Trimester III | 2 | 5.7 | 3 | 9.1 | |
| Parity | | | | | |
| 0 (Nulliparous) | 10 | 28.6 | 11 | 33.1 | |
| 1 (Primiparous) | 11 | 31.4 | 6 | 18.2 | 2.49 |
| 2 – 5 (Multiparous) | 14 | 40 | 15 | 45.5 | |
| >5 (Grandemultipara) | 0 | 0 | 1 | 3 | |
| ANC Frequency | | | | | |
| 1 | 13 | 37.1 | 14 | 42.4 | |
| 2 | 7 | 20 | 9 | 27.3 | 2.15 |
| 3 | 9 | 25.7 | 4 | 12.1 | |
| ≥4 | 6 | 17.1 | 6 | 18.2 | |
| Hb Levels | | | | | |
| 10.0 – 10.9 gr/dL | 19 | 54.3 | 16 | 48.5 | |
| 7.0 – 9.9 gr/dL | 16 | 45.7 | 17 | 51.5 | 0.23 |
| < 7 gr/dL | 0 | 0 | 0 | 0 | |
| Husbands Support | | | | | |
| Good | 10 | 28.6 | 6 | 18.2 | |
| Fair | 14 | 40 | 15 | 45.5 | 1.02 |
| Less | 11 | 31.4 | 12 | 36.4 | |

*Note*: [a] chi-square test; n= frequency ; % = percentage

calculate nutritional intake using the 24-hour food recall method for two non-consecutive days—the skilled enumerator collected data by asking what the mother consumes over the telephone during 24 hours. The data collected before and after the intervention included data on the macronutrient (calories, carbohydrates, protein, and fat) and micronutrient-related pregnancy (vitamins A, C, and folate), also minerals such as (iron and calcium).

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25 software. We presented descriptive data with mean ± SD, interquartile range, and frequency tables. We performed the Wilcoxon test for paired data. Next, we calculate the difference between groups using an independent t-test and Mann-Whitney test for unpaired data.

## RESULTS

The total number of respondents was 68 pregnant women with a mean age of 27.76±6.09 years. Both respondents and their husbands

Table 2.
*Macronutrient Intake in The Control and Intervention Group*

| Macronutrient | Control Group | | P value | Intervention Group | | P value | P value |
|---|---|---|---|---|---|---|---|
| | Pre | Post | | Pre | Post | | |
| Energy (Kkal) | 1962.68 ±189.18 | 1967.94±110.09 | 0.89[a] | 2039.48±145.72 | 1924.95±137.24 | 0.01[a] | 0.03[a] |
| Carbohydrate (gr) | 266.37 – 336.50 | 334.18 – 2918.40 | 0.40[b] | 289.58±45.05 | 251.63±33.07 | 0.01[a] | 0.05[c] |
| Protein (gr) | 71.52±10.69 | 62.27±6.60 | 0.01[a] | 73.91±11.63 | 61.74±8.32 | 0.01[a] | 0.39[a] |
| Fat (gr) | 66.10±14.05 | 76.94±12.68 | 0.01[a] | 64.03±12.74 | 74.37±12.16 | 0.01[a] | 0.92[a] |

*Note*: Mean±SD, Median (mean-max); [a]T paired test; [b]Wilcoxon test; [c]Mann Withney

graduated from high school (52.9% for the mother and 58.8% for the husband). Although 82,4% of the respondents were housewives, their spouses were employed with a total monthly household income of Rp1,000,000 to Rp3,000,000 (51.5%) with provincial minimum wage (PMW) Rp3,165,000. Finally, about 33.8% of the respondents received less support from their husbands (Table 1).

The intake of energy and carbohydrates between the two groups was statistically significant ($p<0.05$). However, there was a decline in intake in the intervention group, the average protein and fat intake between groups was not significant ($p>0.05$), but only fat intake experienced improvement in both groups before and after the intervention.

There were differences in the intake of Fe and vitamin A in the two groups before and after the intervention, but they were statistically not significant between the two groups. There was an increase in vitamin C intake in the intervention group before and after the intervention but not statistically significant between the two groups. Next, We found an increase in folate intake in the control group before and after the intervention.

In this study, most participants consumed eggs as an iron source. The participants could consume eggs three times a day. Tempeh and tofu became the most eaten as source of vegetable protein.

## DISCUSSION

The intervention of nutrition knowledge is an important determinant of dietary practices regarding the consumption of iron-rich foods in pregnant women (Adjei-Banuah et al., 2021). The influence of nutrition education with information tools such as booklets and social media at ANC increased pregnant women's food portions (from 69.3% to 97.2%) and eating two servings of green leafy vegetables (from 56.7% to 81.4%) at six weeks after the intervention (Khotimah et al., 2019; Marfuah & Kusudaryati, 2020; Nahrisah et al., 2020; Teweldemedhin et al., 2021).

In this study, we found that the intake of iron and calorie was not fulfilled in Indonesia's daily requirement recommendation. The average energy consumption in both groups was 1.973.5 kcal. The required energy adequacy rate is around 2150-2250 kcal, and an additional energy intake of 300 kcal in the second trimester for pregnant women. Meanwhile, iron intake was 9.6 mg, less than the nutritional adequacy rate, which is 18 mg and an additional iron intake of 9 mg for pregnant women (Permenkes Republik Indonesia Nomor 28 Tahun 2019, 2019). Next, vitamin C ( 56.5 mg), vitamin A (1433.2 µg), folic acid (170.1 mcg), and calcium intake (804.3 mg). When compared with the RDA, namely vitamin C (75 mg additional 10 mg), vitamin A (600 µg additional 300 µg), folate (400 mcg additional 200 mcg), calcium (1000-1200 mg additional 200 mg), this means intake of vitamin C, folate, and calcium does not meet the RDA.

**Table 3**
*Micronutrient Intake in The Control and Intervention Group*

| Micronutrient | Control Group | | P value | Intervention Group | | P value | P value |
|---|---|---|---|---|---|---|---|
| | Pre | Post | | Pre | Post | | |
| Fe (mg) | 8.38 – 14.20 | 10.37 – 13.90 | 0.01[b] | 9.32 – 14.70 | 10.64 – 15.50 | 0.07[b] | 0.55[c] |
| Vitamin C (mg) | 47.76 – 324.70 | 37.32 – 119.20 | 0.31[b] | 31.28 – 84.40 | 111.16 – 629.40 | 0.05[b] | 0.42[c] |
| Vitamin A (µg) | 1299.48 – 2320.10 | 1616.61 – 2855.10 | 0.01[b] | 1295.77 -2729.60 | 1517.81 -2433.60 | 0.03[b] | 0.75[c] |
| Folate (µg) | 159.27 – 363.60 | 165.22 – 229.20 | 0.04[b] | 183.94 – 509.10 | 172.97 – 280.10 | 0.61[b] | 0.75[c] |
| Calcium (mg) | 1055.28 – 9582.20 | 700.51 – 1307.90 | 0.05[b] | 779.64 – 1057.30 | 672.80 – 1031.80 | 0.01[b] | 0.95[c] |

*Note:* Mean±SD, Median (mean-max); [b] Wilcoxon test; [c]Mann Withney

**Table 4**
*Iron Rich Food Consumption on Participants*

| Iron Rich Food | Iron content | Number of participants |
|---|---|---|
| Egg | 1.2 mg | 25 |
| Tempeh | 2.7 mg | 17 |
| Tofu | 4.1 mg | 11 |
| Sauteed water spinach | 1.0 mg | 14 |
| Soup | 1.8 mg | 11 |
| Skipjack tuna | 2.1 mg | 12 |
| Fried chicken | 7.3 mg | 22 |
| Meatballs | 1.9 mg | 18 |

A proper diet during pregnancy is essential for providing the mother and child with essential nutrients and energizing them. Protein and iron are crucial for cell energy production, and carbohydrates provide energy for cellular processes. The protein binds with iron to form myoglobin in muscle fibres and enzymes, while vitamins and minerals participate in biochemical reactions to form amino acids. Iron in developing red blood cells is incorporated into protoporphyrin, a heme component, which combines with amino acid-synthesized globin chains to form functional haemoglobin. Micronutrients like folic acid, vitamin C, and vitamin A affect haemoglobin metabolism, while calcium acts as phytate and tannins inhibit iron absorption. Folic acid is a carbon carrier for heme formation in the bone marrow, while vitamin A mobilizes iron from the liver. Vitamin C chelates iron in the intestinal lumen, increasing iron absorption and preventing binding to inhibitory ligands. Calcium inhibits both nonheme and heme iron absorption, and phytate and tannins found in tea, coffee, and whole grains also inhibit iron absorption (Handari et al., 2022; Malhotra et al., 2023; Nadiyah et al., 2021; Tarigan et al., 2021).

This study showed an increase in vitamin C intake before and after the intervention in the SMS education group. A previous study found increased vitamin C intake after nutrition education was carried out in pregnant women. Vitamin C enhances iron absorption, especially for pregnant anaemic women. Nonheme iron absorption from plant-based sources is less efficient than heme iron. Vitamin C facilitates the absorption of nonheme iron by converting it into a more soluble form and increasing its bioavailability. It also chelates iron in the intestinal lumen, preventing binding to inhibitory substances (Mousa et al., 2019; Sunuwar et al., 2019).

Family income and education status might influence the low intake of respondents. The mean income of participants was between Rp1,000,000 to Rp3,000,000; a comparison of the South Sulawesi Provincial Minimum Wage (PMW) is Rp3,165,000. Low income reduces food purchasing power to meet needs, affecting the quality and quantity pregnant women consume. Following research conducted by Sugiharti shows that family income less than PMW affects the occurrence of anaemia in pregnant women. Low economic conditions are generally closely related to the health problems they face. People with a middle and upper socioeconomic level of education will have many choices in choosing iron sources, especially heme iron, the largest iron source for the body. Additionally, higher-income families have better access to prenatal care, screenings, and education, which can help identify iron deficiency early on and provide appropriate interventions. Healthcare providers may recommend iron supplements, which can be more affordable and accessible for pregnant individuals (Nadiyah et al., 2021; Sugiharti & Cahyaningrum, 2020). In this study, the average education level of pregnant women is high school. Mothers with low education have non-adherence in consuming iron compared to mothers with higher education. The higher the education, the easier it is to receive nutritional information (Hidayatunnikmah, 2021; Ibikunle et al., 2021).

The participant of the study mostly consumed eggs as an iron source. The participants could consume eggs three times a day. Most of them also get iron from legumes and cereals such as tofu and tempeh, categorized as nonheme iron sources. Pregnant women prefer vegetable side dishes, which are always available and affordable. In addition, they often consume sweet tea, which can inhibit iron absorption (Malhotra et al., 2023).

In taking care of the health of pregnant women who suffer from anemia need nutrition and nutrition by eating food that God has given them. God said in the Q.S Al-An'am/6:142 which is translated:

> *"And of the grazing livestock are carriers [of burdens] and those [too] small. Eat of what Allah has provided for you and do not follow*

*the footsteps of Satan. Indeed, he is to you a clear enemy.."*

The content of this verse relates to the wisdom given by God in the form of knowledge, which can be helpful for pregnant women to choose foods that suit their needs so that the wisdom will lead them to goodness in the form of health. We are recommend to choose and consume good food and mention several food sources of vegetable and animal protein produced by plants and animals.

This research utilizes SMS as an educational medium, making it cheaper and accessible to all participants. However, it faces limitations such as incomplete data, damaged equipment, and difficulty contacting pregnant women. The study also faces potential bias due to the small sample size and lack of social relationships due to the use of telephones.

## CONCLUSIONS

We found no increased of iron intake after SMS intervention. Family income and education might influence the intake of iron and other nutrients of pregnant women with anemia. This study recommends that future researchers to enlarge samples size and modify media instruments to enrich the result of the study. Moreover, we encourage health agencies and the government to intensify counseling or promotive efforts for pregnant women from health agencies by using means of social media technology. Specifically for pregnant women, we enforce them to eat iron rich foods routinely and use social media to get a healthy pregnancy.

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**AUTHORS' CONTRIBUTIONS**
Andi Faradilah developed research concepts and designs, assisted in data analysis, provided suggestions, and input and improved manuscripts, Nadhirah A. Idris drafted the research, collected and analyzed data, prepared manuscripts. Rauly Ramadhani and Henny Fauziah provided input and suggestions.

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**COMPETING INTERESTS**
The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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