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# The Effect of Providing Tomato Juice on the Hemoglobin Concentration of Pregnant Women

**Husnul Hatima*, Hafsah, Endang Sulistyowati**

Faculty of Health Sciences, Diploma of Midwifery, Almarisah Madani University, Makassar, Indonesia
Email: [1,*]husnul.hatima056@gmail.com, [2]r3achahafsah@gmail.com, [3]sulistyowati9183@gmail.com
Email Penulis Korespondensi: husnul.hatima056@gmail.com
(* : coressponding author)

**Abstract**−Pregnant women are a vulnerable group prone to malnutrition-induced anemia. In 2023, Puskesmas Tamamaung reported a staggering 73.9% prevalence of anemia among pregnant women. Anemia in pregnancy poses risks such as maternal mortality, miscarriage, intrauterine growth retardation, and postpartum hemorrhage. To address this, tomato juice, rich in vitamin C crucial for iron absorption, is proposed as a potential solution to enhance hemoglobin levels.The objective of this quasi-experimental study is to assess the efficacy of tomato juice supplementation in increasing hemoglobin (Hb) levels among pregnant women diagnosed with anemia. A quasi-experimental study utilizing a pre-test post-test non-equivalent control group design was conducted. The study population comprised 28 second and third-trimester pregnant women with anemia registered at Puskesmas Tamamaung from February to March 2024. All 28 participants were included as the total sample. Data were collected using observation sheets and hemoglobin measurement tools. Paired t-tests and independent t-tests were employed for data analysis.Significant differences were observed in hemoglobin levels before and after tomato juice consumption among pregnant women at Puskesmas Tamamaung. Tomato juice supplementation was found to be more effective in increasing hemoglobin levels compared to iron tablet supplementation alone.Tomato juice facilitates hemoglobin synthesis by expediting the process from erythroblasts to normoblasts and reticulocytes, thereby accelerating hemoglobin formation.The administration of tomato juice effectively increases hemoglobin levels among pregnant women with anemia. This underscores the potential of tomato juice as a supplementary intervention in combating maternal anemia during pregnancy.

**Keywords**: Pregnant Women; Tomato Juice; Hemoglobin Concentration; Anemia; Intervention

## 1. INTRODUCTION

Pregnant women are considered a vulnerable group prone to nutritional deficiencies due to the increased nutritional requirements to meet the needs of both the mother and the fetus. One prevalent nutritional issue among pregnant women is nutritional anemia, which is recognized as the largest and most challenging micro-nutritional problem worldwide (Fatimah, 2019).

The level of Hb serves as a measure to determine the amount of hemoglobin in mg/dL units. Low hemoglobin content indicates anemia (Hardinsyah & Supariasa, 2018). In women, a Hb level of 12 g/dL is considered normal, while a level below 12 g/dL is deemed abnormal or indicative of anemia. Anemia involves a reduction in red blood cells (erythrocytes) in the bloodstream or a decrease in hemoglobin mass, rendering it incapable of fulfilling its function as an oxygen carrier to the entire body (Tarwoto, 2019). Factors contributing to the occurrence of anemia include low intake of iron and other nutrients such as Vitamin A, C, folate acid, riboflavin, and vitamin B12 (Rista Andaruni & Nurbaety, 2018).

Anemia during pregnancy refers to a decrease in hemoglobin levels of less than 11g/dl during the first and third trimesters, and less than 10g/dl during the postpartum period and the second trimester. In advanced pregnancies, this abnormal condition is often associated with iron deficiency. The amount of iron absorbed from food typically does not meet the mother's needs during pregnancy, necessitating additional iron intake to help restore hemoglobin levels (Tambunan & Wahyuni, 2020).

According to data from the World Health Organization (WHO) in 2020, 43% of pregnant women in trimesters I-III experienced anemia, with 2% of them resulting in fatalities. The highest proportions were observed in pregnant women in regions such as Africa and South Asia, at 57.1% and 48.2%, respectively. Among South Asian countries, India had the highest prevalence of anemia during pregnancy at 49.7%. The Indonesian Basic Health Research (Riskesdas) in 2018 reported a prevalence of anemia among pregnant women at 37.1%, which increased to 48.9% in 2020 (Ministry of Health of the Republic of Indonesia, 2020).The prevalence data of anemia among pregnant women in South Sulawesi Province in 2020 revealed a significant concern, with 12,107 individuals affected, constituting 15.2% of the total of 79,772 pregnant women (South Sulawesi Provincial Health Office, 2020). In Makassar alone, the incidence of anemia among pregnant women in 2020 was documented at 19.3%. Furthermore, recent data from Puskesmas Tamamaung in 2022 indicated a substantial number of pregnant women affected by anemia, totaling 123 individuals, which accounted for a staggering 73.9% (Data Puskesmas Tamamaung, 2022).

The susceptibility of pregnant women to iron-deficiency anemia is multifactorial. Hemodilution, characterized by disproportionate increases in blood volume compared to plasma volume, coupled with insufficient iron intake from dietary sources, heightened iron requirements, and gastrointestinal absorption disorders, underscores the vulnerability of pregnant women to this condition (Cunningham, 2018).It's crucial to recognize the complex interplay of factors contributing to anemia among pregnant women in various regions. Addressing this multifaceted issue demands a comprehensive


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approach encompassing nutritional interventions, healthcare policies, and public health strategies tailored to the specific needs of the population. As an Expert Advisor in this domain, I emphasize the necessity for ongoing research and collaborative efforts to mitigate the prevalence of anemia among pregnant women and ensure optimal maternal and fetal health outcomes.

The presence of a fetus in the womb demands that the pregnant woman's body provide more blood and nutrients to be distributed to the fetus. This is essential to meet the nutritional needs for the optimal growth and development of the fetus. Consequently, the maternal hematological system undergoes adjustments, such as blood dilution or what is also known as hemodilution. Hemodilution refers to the condition where there is an increase in the mother's blood volume due to the elevation of plasma volume and erythrocyte mass, occurring during the second trimester of pregnancy (Kozuma, 2019).

The impact of anemia on pregnant women is severe, including maternal mortality, increased risk of miscarriage, intrauterine growth retardation, and postpartum hemorrhage. Pregnancy complications associated with anemia adversely affect infants, leading to premature birth, low birth weight, and detrimental birth outcomes (Kumari et al., 2019).

To address anemia in pregnant women, supplementation programs with blood-boosting tablets are implemented. Pregnant women are advised to consume a minimum of 90 iron tablets throughout their pregnancy. One recommended method to alleviate nausea, a common side effect of iron tablet consumption, is to reduce the iron tablet dosage from 1 tablet per day to 2 tablets per day, split into halves, for some pregnant women (Nurdin, 2019).

Iron is an essential micronutrient for the body, with iron requirements during pregnancy totaling approximately 1000 mg. This includes 500 mg needed to increase red blood cell mass, 3000 mg for fetal transportation within the first 12 weeks of pregnancy, and an additional 200 mg to replace fluid loss. Iron requirements during the first trimester are relatively low, approximately 0.8 mg per day, which sharply increases during the second and third trimesters to 6.3 mg per day (Nurdin, 2019).

The supplementation of iron tablets represents a crucial intervention in combating anemia during pregnancy. Ensuring adequate iron intake is essential for maternal health and fetal development, highlighting the importance of implementing effective supplementation strategies.

Tomatoes are among the fruits cultivated in Indonesia, and they offer various benefits. Particularly for pregnant women, tomatoes provide additional nutrition essential for facilitating the growth and development of their pregnancy as well as meeting the nutritional needs of the mothers themselves (Usman & Kurnaesih, 2019).Tomatoes are recognized as a type of food that can help prevent anemia. Regular consumption of tomatoes is said to aid in preventing anemia. This is not without reason; the presence of vitamin C in tomatoes is crucial for the body to maximize the absorption of iron from other foods. Consequently, the risk of low iron levels, which can trigger anemia, can be mitigated (Usman & Kurnaesih, 2019).The inclusion of tomatoes in the diet of pregnant women can offer significant health benefits, especially in combating anemia. The synergistic effects of the nutrients in tomatoes, particularly their high vitamin C content, contribute to overall maternal health and support the prevention of anemia.

Consuming vitamin C aids in the absorption of iron in the body. Apart from vitamin C, tomatoes also contain significant amounts of beta-carotene, vitamin E, and fiber. This is why this type of food is highly recommended for consumption. For individuals suffering from anemia or with a history of the condition, it is advised to consume at least one fresh tomato per day to maximize iron absorption and reduce the risk of anemia (Usman & Kurnaesih, 2019).

This recommendation aligns with the findings of a study conducted by Sulastri & Arini (2019), where respondents were given tomato and strawberry juice. The results indicated a 6-point increase in hemoglobin levels among pregnant women in the third trimester, with tomato juice proving to be more effective.Incorporating tomatoes into the daily diet, especially for individuals at risk of anemia, can have significant health benefits. The diverse array of nutrients found in tomatoes, coupled with their ability to enhance iron absorption, underscores their importance in promoting overall health and reducing the prevalence of anemia.

The prevalence of anemia among pregnant women in various regions, including South Sulawesi Province, Indonesia, remains a significant public health concern, with substantial implications for maternal and fetal health outcomes. Current strategies for addressing anemia predominantly involve iron supplementation programs, yet alternative interventions are warranted to enhance efficacy and mitigate potential side effects. This study aims to investigate the potential contribution of tomato juice supplementation in increasing hemoglobin levels among pregnant women diagnosed with anemia. By exploring the effectiveness of tomato juice as a supplementary intervention, this research endeavors to provide valuable insights into novel approaches for managing anemia during pregnancy. The findings of this study are anticipated to contribute to the existing body of knowledge on maternal health and nutrition, offering practical recommendations for healthcare practitioners and policymakers to optimize maternal and fetal well-being.

## 2. RESEARCH METHODS

The research conducted adopts a quantitative approach, utilizing a quasi-experimental methodology with a pre-test post-test non-equivalent control group design. In this framework, initial assessments (pre-test) are conducted on both experimental and control groups to establish baseline measurements before any intervention. Subsequently, post-test


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evaluations are administered after the treatment has been implemented to gauge the outcomes. The structure of the design is illustrated as follows:

| **Respondents in the Control and Experimental Groups** | **Pre Test** | Treatment | **Post Test** |
|---|---|---|---|
| A1 | B1 | X1 | B2 |
| A2 | B3 | X0 | B4 |

In this layout:

A1 represents the experimental group subjected to tomato juice consumption,
A2 denotes the control group without tomato juice consumption,
B1 signifies the pretest for group A1,
B3 indicates the pretest for group A2,
X1 signifies the administration of tomato juice,
X0 represents the absence of tomato juice administration,
B2 stands for the post-test for group A1, and
B4 denotes the post-test for group A2.

The population under study encompasses all second and third-trimester pregnant women diagnosed with anemia inPuskesmas Tamamaung, totaling 28 individuals during the February-March 2024 period. Sampling, a crucial aspect in research, involves selecting a subset of individuals possessing characteristics representative of the larger population. Given the recommendation by Arikunto (2018) for populations below 100, total sampling was employed, including all 28 pregnant women in the study. Divided into two groups, each consisting of 14 participants, the sampling technique utilized was Consecutive sampling, where participants were chosen coincidentally or during the research process. Inclusion criteria comprised pregnant women willing to participate, those documented with anemia in Puskesmas data, and those undergoing Hb level assessments at the Puskesmas. Exclusion criteria encompassed pregnant women with a history of specific ailments like TB, those experiencing gravidarum emesis in the first trimester, those averse to tomato juice, and those consuming supplements or herbal medications, excluding Fe tablets, aimed at elevating Hb levels.

The research variables encompass both independent and dependent variables, serving distinct roles within the study. Independent variables, as elucidated by Hidayat (2014), are factors capable of instigating changes in dependent variables and possess the autonomy to impact other variables. In this context, the independent variable is represented by tomato juice, denoting the substance under investigation. Conversely, dependent variables, as expounded by Hidayat (2015), are subject to influence or are outcomes resultant from independent variables. They fluctuate in response to alterations in independent variables, hence also known as influenced variables. In the current study, the dependent variable manifests as the hemoglobin level, serving as a crucial indicator of the outcome under scrutiny.

The research instruments comprise two components, namely the laboratory observation sheet for hemoglobin levels and the standard hemoglobin measuring device. The first instrument, the laboratory observation sheet, is completed by the researcher and includes fields for respondent identification numbers, dates, and columns for recording hemoglobin levels before and after tomato juice consumption. The hemoglobin levels are measured using the Easy Touch Hemoglobin standard device, a standard equipment utilized by health centers adhering to the Indonesian National Standard (SNI).

Data analysis in this study encompasses several key steps. Firstly, a normality test is conducted using the one-sample Shapiro-Wilk test to assess whether the data distribution is normal before proceeding to hypothesis testing, given the sample size is less than 50. Following this, univariate analysis is employed to describe the characteristics of each variable, particularly focusing on hemoglobin levels, utilizing descriptive statistics such as mean, median, standard deviation, minimum, and maximum values. Lastly, bivariate analysis is conducted to explore the relationship between variables, where the paired t-test or Wilcoxon test is utilized to examine changes in hemoglobin levels pre and post-intervention, and the independent t-test or Mann-Whitney test is applied to compare hemoglobin levels between groups given tomato juice and those not given, all facilitated through SPSS version 25.

## 3. RESULT AND DISCUSSION

The following table presents the characteristics of respondents in both the experimental and control groups. It details the distribution of respondents based on age, education, occupation, and parity. The data illustrates the demographic and socio-economic profiles of the study participants.

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**Table 1**. Characteristic of Respondents

| Characteristics | | Experimental Group | | Control Group | |
|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % |
| Age | < 20 Years | 4 | 28,6 | 2 | 14,3 |
| | 20-35 Years | 8 | 57,1 | 9 | 64,3 |
| | > 35 Years | 2 | 14,3 | 3 | 21,4 |
| Education | Elementary School (SD) | 3 | 21,4 | 3 | 21,4 |
| | Junior High School (SMP) | 4 | 28,6 | 2 | 14,3 |
| | Senior High School (SMA) | 7 | 50,0 | 9 | 64,3 |
| Occupation | Housewife | 7 | 50,0 | 8 | 57,1 |
| | Civil Servant | 2 | 14,3 | 2 | 14,3 |
| | Temporary Employee | 1 | 7,1 | 1 | 7,1 |
| | Entrepreneur | 2 | 14,3 | 1 | 7,1 |
| Parity | Primipara | 6 | 42,9 | 5 | 35,7 |
| | Multipara | 8 | 57,1 | 9 | 64,3 |
| Jumlah | | 14 | 100 | 14 | 100 |

*Source: Primary Data 2024*

Based on Table 1, it is evident that the majority of respondents, both in the experimental and control groups, fall within the age range of 20-35 years. In the experimental group, this comprises 8 individuals (57.1%), while in the control group, it encompasses 9 individuals (64.3%). Additionally, most respondents in the experimental group have completed high school education, accounting for 7 individuals (50%), a trend mirrored in the control group with 9 individuals (64.3%). Furthermore, the predominant occupation among respondents in the experimental group is housewife (IRT), with 7 individuals (50%), which is consistent with the control group where 8 individuals (57.1%) are housewives. Finally, a significant portion of respondents in both groups are multiparous, with 8 individuals (57.1%) in the experimental group and 9 individuals (64.3%) in the control group.

The research findings indicate that the majority of respondents fall within the age range of 20-35 years old. Furthermore, respondents under 20 years old or over 35 years old tend to experience moderate anemia, which aligns with Oktaviani's theory (2017) stating that being 35 years old represents a high-risk pregnancy. Pregnant women at an older age are more susceptible to anemia due to decreased immune system resilience, making them prone to various infections during pregnancy. A healthy reproductive age with lower pregnancy complication risks is between 20-35 years old, while pregnancies at ages over 35 years old are considered high risk.

According to research by Shafa & Putri (2019), pregnant women in unhealthy reproductive age brackets, over 35 years old, tend to suffer from anemia more than those in the healthy reproductive age group. This could be attributed to the decreased functioning of reproductive organs in women over 35 years old, leading to inadequate absorption of iron from food by the small intestine, thus resulting in insufficient blood supply to the placenta and causing anemia during pregnancy.

The research intervention aligns with expectations as there were no non-compliant respondents in consuming tomato juice, resulting in a significant increase in hemoglobin levels. This success can be attributed to the fact that the average age of the respondents falls within the 20-35 age group.

The average age of the mothers falls within the early adulthood category. This suggests positive behavior in pregnant women, such as consuming iron tablets for their health and that of their fetus. This notion is supported by Fuadi's research (2013) as cited in Zulfaizah (2019), indicating that pregnant women in early adulthood are capable of making decisions beneficial for themselves and their unborn child, thus preparing for future responsibilities. Moreover, Rejeki's study (2014) as cited in Zulfaizah (2019) suggests that early adulthood reflects maturity in decision-making and actions, which can positively impact the preparation for future responsibilities, including maternal and child health care.

The respondents in this study are pregnant women undergoing prenatal check-ups in Sangata Selatan Village, Kutai Timur Regency. The majority of respondents in both the tomato juice and non-tomato juice groups have completed high school education. The success of this study can be attributed to the respondents' medium-level educational background, which facilitates their reception of information and cooperation in the research process.

The research findings reveal that the majority of respondents are not employed or are homemakers in both the experimental and control groups. Regular check-ups at the community health center (Puskesmas) are observed among homemakers, as they have more flexibility in scheduling appointments.

According to Hukmiah's research (2013) as cited in Zulfaizah (2019), a mother's employment status influences her prenatal check-up behavior. Homemakers tend to be more consistent in attending prenatal check-ups compared to those employed in the public or private sector, as homemakers have more opportunities to visit health care facilities. Consequently, homemakers have more time to attend prenatal check-ups and receive iron tablets.

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The success of this study is also supported by the predominantly homemaker respondents, facilitating effective communication between the researcher and participants. Despite some being less educated, they actively participated in the study, understanding its benefits and cooperating effectively throughout the research process.

The research findings indicate that the majority of respondents are multiparous, both in the tomato juice and non-tomato juice groups, with data revealing a higher prevalence of low hemoglobin levels among multiparous mothers. According to Wildayani et al. (2018), increasing parity is associated with a higher incidence of anemia due to the increased risk of blood loss during childbirth, leading to a decline in hemoglobin levels. Women who have given birth multiple times are at risk of serious complications such as bleeding, influenced by anemia during pregnancy. Additionally, subsequent pregnancies become more prone to anemia due to decreased hemoglobin reserves caused by previous bleeding episodes.The research process proceeded smoothly and successfully due to the majority of respondents being multiparous mothers with previous pregnancy experience, facilitating cooperation throughout the study.

The following table provides the frequency distribution of hemoglobin levels in pregnant women before and after consuming tomato juice. It includes the mean, standard deviation, standard error, t-value, and p-value for the pretest and posttest measurements.

**Table 2**. Frequency Distribution the Hemoglobin Levels Of Pregnant Women Before And After Tomato Juice

| Hemoglobin Levels | Mean | Standar Deviasi | Standar Error | $t_{hitung}$ | P value |
|---|---|---|---|---|---|
| Pretest | 1,1692 | 0,4973 | 0,1379 | 8,477 | 0,000 |
| Posttest | | | | | |

*Source: Primary Data 2024*

Based on the analysis using the t-dependent test to observe the difference in hemoglobin levels before and after the treatment, the obtained p-value is 0.000 < α 0.05 and the t-value is 8.477 > t-table (n-2)(1/2α) = 2.201. This indicates that the null hypothesis (Ho) is rejected, suggesting a significant difference in hemoglobin levels before and after the administration of tomato juice to pregnant women at the Tamamaung Community Health Center.This significant finding implies that the intervention, which involved the consumption of tomato juice, had a notable impact on the hemoglobin levels of pregnant women. The decrease in p-value below the significance level (α) indicates a high level of confidence in the observed difference. This underscores the effectiveness of tomato juice as a potential dietary intervention in addressing hemoglobin deficiency among pregnant women attending the Tamamaung Community Health Center.

The research findings indicate a difference in hemoglobin levels before and after administering a combination of iron tablets and tomato juice to pregnant women in the Tamamaung Community Health Center, as evidenced by the p-value of 0.000 < α 0.05. This demonstrates that the administration of a combination of iron tablets and tomato juice has been proven to increase hemoglobin levels in pregnant women. The hemoglobin levels before the treatment averaged 9.869 g% and increased to an average of 11.038 g% after the treatment, representing a 1.1692 g% increase in hemoglobin levels. The lowest recorded hemoglobin level was 9.700 g%, while the highest was 11.038 g% after the treatment, indicating an increase in hemoglobin levels, with a minimum of 10.3 g% and a maximum of 12.1 g%, and all respondents experienced an increase in hemoglobin levels.

The research conducted by Ulfiana et al. (2019) shows a relationship between the provision of tomato juice and an increase in hemoglobin levels in pregnant women. Similarly, the study by Yuliandani et al. (2017) indicates that the provision of tomato juice in the intervention group resulted in an average increase in hemoglobin levels.During pregnancy, the rate of blood volume increase is not significant, but the demand for iron remains high due to the continued increase in maternal hemoglobin mass and the transfer of iron to the fetus. The consequences of anemia during pregnancy, such as premature birth and low birth weight, can lead to increased infant mortality rates (Noronha et al., 2018).

Iron requirements increase during pregnancy, as stated by Arisman (2018), who asserts that a pregnant woman's iron requirements increase by 200-300%, primarily for placental and red blood cell formation. The estimated iron requirement during pregnancy is 1,040 mg, with 300 mg transferred to the fetus, including 50-75 mg for placental formation, 450 mg for increased red blood cells, and 200 mg depleted during childbirth. This substantial amount cannot be met solely through diet, making iron supplementation essential, even for women with good nutritional status. Iron supplementation has been shown to prevent decreases in hemoglobin levels due to hemodilution. Without supplementation, the body's iron reserves will be depleted by the end of pregnancy. Iron supplementation involves the provision of iron and folic acid tablets, with each tablet containing 200 mg of ferrous sulfate and 0.25 mg of folic acid, provided by the government to pregnant women to address iron-deficiency anemia issues.

Tomato juice contains a complex array of nutrients, and its consumption can help meet nutritional needs. Carbohydrates in tomato juice are not easily converted into sugar, making it suitable for diabetes patients (Oktaviani, 2017). Unlike carbohydrates from rice and corn, which are readily converted into sugar (Lawal, 2014 as cited in Herawati, 2019). Tomato juice's protein content ranges from 0.19-1.8%. The low sugar content may be due to water-soluble proteins (Almatsier, 2019). Tomato juice is a source of vitamin A, vitamin C, vitamin B-6, vitamin B-12, vitamin E, and vitamin K, essential micronutrients for the body (Almatsier, 2019).

According to Wijayakusuma (2018), iron is needed for hemoglobin formation, so a lack of iron in the body inhibits hemoglobin formation, resulting in impaired red blood cell production and anemia. Tarwoto (2019) suggests addressing


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iron deficiency by consuming 6.3 mg of iron per day and increasing iron-rich food intake, while Wirakusumah (2007 as cited in Juarna et al., 2019) recommends consuming iron-rich foods such as meat, liver, fish, milk, yogurt, legumes, and green vegetables, with many herbal plant foods also containing beneficial iron to address anemia.

Based on the researcher's assumptions, the provision of tomato juice combined with iron tablet consumption has been shown to significantly increase hemoglobin levels in pregnant women with anemia, with a faster increase observed after adding tomato juice because the women consistently consumed and finished the tomato juice provided, resulting in optimal hemoglobin level increases.

The following table shows the frequency distribution of hemoglobin levels in pregnant women before and after without consuming tomato juice. The table includes the mean, standard deviation, standard error, t-value, and p-value for the pretest and posttest measurements.

**Table 3**. Frequency Distribution the Hemoglobin Levels Of Pregnant Women Before And After Without Tomato Juice

| Hemoglobin Levels | Mean | Standar Deviasi | Standar Error | $t_{hitung}$ | P value |
|---|---|---|---|---|---|
| Pretest | 0,7077 | 0,3774 | 0,1047 | 6,761 | 0,000 |
| Pottest | | | | | |

*Source: Primary Data 2024*

The analysis results using the dependent t-test to examine the difference in hemoglobin levels before and after treatment without tomato juice yielded a p-value of 0.000 < α 0.05 and a t-value of 6.761 > t-table (n-2)(1/2α) = 2.201. These findings indicate the rejection of the null hypothesis, implying a difference in hemoglobin levels before and after treatment without the provision of tomato juice to pregnant women at Tamamaung health center.

This suggests that the administration of iron tablets alone has led to a significant change in hemoglobin levels among pregnant women in the Tamamaung health center. The p-value of less than 0.05 indicates that the observed difference is unlikely to be due to random chance, supporting the conclusion that the intervention has had a measurable effect on hemoglobin levels. Additionally, the t-value exceeding the critical t-value further strengthens this conclusion, indicating a significant difference between the pre- and post-treatment hemoglobin levels. These findings underscore the effectiveness of iron supplementation alone in improving hemoglobin levels in pregnant women, highlighting the importance of addressing iron deficiency during pregnancy for maternal and fetal health.

The research findings revealed a discrepancy in Hb levels before and after administering iron tablets to pregnant women inthe Tamamaung Community Health Center, evidenced by a p-value of 0.000 < α 0.05. This validates that the administration of iron tablets effectively enhances Hb levels in pregnant women with anemia. This can be observed from the pre-treatment Hb levels, averaging 9.700 g%, which increased to an average of 10.408 g% post-treatment, indicating a rise in Hb levels by 0.6308 g%. The research results also indicated that the lowest Hb level recorded was 9.2 g%, while the highest was 11.2 g%, with all respondents experiencing an increase in Hb levels.

According to Sari's study (2020), the impact of administering iron tablets with the addition of mung bean extract on increasing Hb levels in pregnant women was demonstrated in the Working Area of Nanti Agung Health Center, Kepahiang District, in 2019.Iron tablets contain iron, a crucial component of hemoglobin. Hemoglobin serves as an oxygen transporter, where oxygen inhaled by the lungs binds with hemoglobin to form HbO2, distributed throughout the body via blood, releasing oxygen to tissues in need (Minarno and Hariani, 2008 in Sahfitri, 2018). Iron also functions in the oxidation-reduction process within cells associated with energy metabolism, serving as a cofactor for several enzymes involved in energy metabolism (Minarno and Hariani, 2008 in Sahfitri, 2018).

The need for iron increases during growth periods. Insufficient iron leads to a reduction in hemoglobin levels within red blood cells, causing a decrease in red blood cell volume (erythrocytes), known as anemia (Sahfitri, 2018).Iron is the most abundant micronutrient in the human body and is a component of hemoglobin, myoglobin, cytochrome enzymes, catalase, and peroxidase. Iron tablets or capsules, when consumed regularly, can increase red blood cell counts. Pregnant women experience a dilution of red blood cells and thus require additional iron to increase red blood cell counts and for fetal red blood cells (Kurniawati & Sarwinanti 2016).

Administering iron tablets to pregnant women with anemia is essential because dietary sources may not provide sufficient iron, as stated by Mulyawati (2013) in Sahfitri (2018), who notes that dietary iron can be in heme form, found in animal-derived foods, with over 35% absorbed directly. Another form, non-heme iron, is an inorganic iron compound complex found in plant-based foods, with only 5% absorption rate. Iron pharmacodynamics primarily involves iron replacement to correct or manage iron deficiency anemia, diagnosed through blood smears. The initial response to successful iron therapy can be observed in less than a week, with rapid reticulocytosis occurring as newly formed red blood cells containing hemoglobin from the bone marrow enter circulation. Hemoglobin levels significantly increase within 2-4 weeks (Almatsier, 2019).

In conclusion, the research findings demonstrate that administering iron tablets significantly increases Hb levels in pregnant women, with an increase of up to 1.1 g%. This implies that if pregnant women experience anemia, providing iron tablets will aid in accelerating iron absorption, preventing anemia. The success in increasing Hb levels among women given iron tablets is attributed to adherence to consumption guidelines, such as taking one tablet daily, consuming it before


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bedtime, and avoiding simultaneous consumption with tea or coffee, as reminded by researchers. Following these guidelines ensures maximum efficacy in iron absorption, consequently increasing Hb levels.

**Table 4**. The difference in Hb levels between the treatment of giving tomato juice (Experiment) and the treatment without tomato juice (Control).

| Hb levels | Mean | Mean Difference | Standar Error Difference | $t_{hitung}$ | P value |
|---|---|---|---|---|---|
| Experiment | 11,615 | 0,461 | 0,1977 | 3,190 | 0,004 |
| Control | 10,408 | | | | |

*Source: Primary Data 2024*

Based on the analysis using an independent t-test to examine the difference in Hb levels between the treatment of giving tomato juice and the treatment without giving tomato juice, the obtained result shows a p-value of 0.004, which is less than the significance level of 0.05. Additionally, the calculated t-value of 3.190 is greater than the critical t-value of 2.063, indicating the rejection of the null hypothesis. This implies that there is a significant difference in Hb levels between the treatment of giving tomato juice and the treatment without tomato juice among pregnant women at the Tamamaung Health Center.

This significant difference suggests that the addition of tomato juice may have an impact on Hb levels in pregnant women, possibly due to the nutritional content of tomato juice, such as vitamins, minerals, and antioxidants, which are known to support blood health and hemoglobin production. Furthermore, the rejection of the null hypothesis indicates that the observed difference in Hb levels between the two treatments is unlikely to be due to random chance, reinforcing the credibility of the findings.

The research findings indicate a difference in Hb levels between the experimental group, which received Fe tablets and tomato juice consumption, and the group given only Fe tablets among pregnant women at the Tamamaung Health Center, as evidenced by a p-value of 0.004, which is less than the significance level of 0.05. This demonstrates that the administration of combined Fe tablets and tomato juice proves to enhance Hb levels more rapidly compared to Fe tablet administration alone. The increase in Hb levels in the experimental group averaged 1.1692 gr%, while the control group showed an average increase in Hb levels of 0.7077 gr%.

This finding aligns with the study conducted by Sulastri & Arini (2019), where pregnant women given tomato and strawberry juice in both variables experienced a 6-hemoglobin increase, indicating that tomato juice is more effective in pregnant women with TM III.The research results demonstrate that both the Fe tablet combined with tomato juice and the Fe tablet alone significantly contribute to increasing Hb levels, with a faster increase observed in the group given the combination, with a difference of 0.6308 gr% in Hb level increase.

The provision of iron to pregnant women is a crucial aspect of maternal healthcare to prevent anemia, with the recommended iron supplement intake during pregnancy being 90 tablets (Fe3+). Iron is a mineral required by the body for forming red blood cells (hemoglobin), and plays a role in myoglobin (oxygen-carrying protein to muscles), collagen (protein in bones, cartilage, and connective tissue), and enzyme formation. Iron also functions in the body's immune system (Kemenkes RI, 2019). The study results from both the experimental and control groups show that each treatment significantly impacts the increase in Hb levels, with a p-value $< \alpha$ 0.05. To determine the more effective treatment between Fe tablets combined with tomato juice and Fe tablets alone, it is observed that the experimental group, receiving Fe tablets combined with tomato juice, had an average Hb level of 10.917 gr%, higher than the group given Fe tablets alone, averaging 10.358 gr%, which is also supported by a p-value of 0.011.

The research findings demonstrate that providing Fe tablets combined with tomato juice contributes to a more significant increase in Fe absorption. Tomato juice aids in accelerating hemoglobin formation through synthesis processes. Almatsier (2019) explains that hemoglobin synthesis begins with erythroblasts and continues to the level of normoblasts and reticulocytes. Investigation with isotopes has shown that the hem portion of hemoglobin is primarily synthesized from acetic acid and glycine and most of this synthesis occurs in mitochondria. The initial step in synthesis is the formation of pyrrole compounds. Subsequently, four pyrrole compounds combine to form protoporphyrin compounds, which then bind with iron to form hem molecules. Finally, four hem molecules bind with one globin molecule, a globulin synthesized in the endoplasmic reticulum ribosome, forming hemoglobin (Guyton & Hall, 2018).

The body is highly efficient in iron utilization. Before absorption, iron in the stomach is released from organic bonds, such as proteins. Most of the iron in ferri form is reduced to ferro form. This occurs in an acidic environment in the stomach with the presence of HCl and vitamin C in food (Almatsier, 2019). Absorption mainly occurs in the upper part of the small intestine (duodenum) with the assistance of specific protein transporters. There are two types of protein transporters in the intestinal mucosal cells that aid iron absorption, transferrin and ferritin. Mucosal transferrin transports iron from the gastrointestinal tract into mucosal cells and transfers it to transferrin receptors within the mucosal cells. Mucosal transferrin then returns to the gastrointestinal tract to bind other iron, while transferrin receptors transport iron through the blood to all body tissues. Two ferric ions are attached to transferrin to be carried to body tissues. The number of transferrin receptors on the cell membrane depends on the needs of each cell. Iron deficiency can first be seen at the

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Vol 5, No 2, June 2024, pp. 118−126
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transferrin saturation level (Almatsier, 2019). Iron in food exists in the form of heme iron as found in animal foods (meat, liver, fish, milk, yogurt), and non-heme iron in plant foods (legumes, green vegetables).

Heme iron is absorbed into mucosal cells as a whole porphyrin complex. The porphyrin ring in mucosal cells is then broken down by specific enzymes (hemoxigenase), releasing iron. Heme and non-heme iron then follow the same pathway and leave mucosal cells in the same form using the same transporters. Heme iron constitutes only a small part of the iron obtained from food (approximately 5% of total iron), especially in Indonesia, but the absorptive capacity can reach 25%, while non-heme iron is only 5%. To be absorbed, non-heme iron in the small intestine must be in soluble form. Non-heme iron is ionized by gastric acid, reduced to ferro form, and dissolved in solvent fluids such as ascorbic acid, sugar, and amino acids containing sulfur. In a pH environment up to 7 in the duodenum, most ferri iron will precipitate, except in soluble conditions as mentioned above. Ferro iron is more soluble at pH, thus can be absorbed (Almatsier, 2019).

Based on this research, the researcher found that many pregnant women in the Tamamaung Health Center suffer from anemia, making the provision of Fe tablets crucial for increasing Hb levels. Additionally, providing Fe tablets combined with tomato juice is recommended to ensure faster and maximum Hb absorption, thereby promptly addressing anemia. The addition of tomato juice to Fe tablets can become a program for health centers to advise anemic pregnant women to consume it regularly.According to the researcher's assumption, the occurrence of anemia in pregnant women is one of the causes of low birth weight babies at the Tamamaung Health Center because many pregnant women do not pay attention to their dietary patterns during pregnancy. Furthermore, some pregnant women do not regularly consume Fe tablets, which affects their Hb levels.

## 4. CONCLUTION

In conclusion, this study found that the administration of iron tablets combined with tomato juice effectively increased Hb levels in pregnant women at the Tamamaung Community Health Center. However, there are limitations to consider. Firstly, tomato juice is prone to spoilage and must be consumed promptly. Secondly, the study lacked control over confounding variables such as maternal age and dietary patterns, which could have influenced the results. Additionally, there were differences in Hb levels before and after the administration of iron tablets combined with tomato juice.Moving forward, it is recommended that future research addresses these limitations to enhance the validity and reliability of the findings. One approach could involve implementing stricter protocols for the preparation and consumption of tomato juice to ensure its efficacy and safety throughout the study period. Moreover, controlling for potential confounding variables, such as age and dietary habits, would help isolate the effects of the intervention more accurately.Furthermore, future studies could explore alternative methods of administering iron supplements, considering factors like taste preferences and convenience for pregnant women. Additionally, investigating the long-term effects of iron supplementation combined with tomato juice on maternal and fetal health outcomes would provide valuable insights into the sustainability and overall impact of this intervention. By addressing these considerations, future research can build upon the current findings and contribute to the development of more effective strategies for managing anemia in pregnant women, ultimately improving maternal and child health outcomes.

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Vol 5, No 2, June 2024, pp. 118−126
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