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PRENATAL YOGA PRACTICE INCREASES FERRITIN AND MCV LEVELS IN PREGNANT WOMEN

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ABSTRACT
This study aimed to determine the effect of prenatal yoga practice on hemoglobin, ferritin, and MCV levels. Prenatal yoga asanas were hypothesized to have a significant impact on Hb levels. Prenatal yoga is potentially an intervention to improve iron metabolism by increasing heme synthesis in the body, and ferritin plays an important role in the relationship between prenatal yoga and hemoglobin in pregnant women. A quasi-experimental design with a pre-post test was employed. The study sample consisted of 137 pregnant women in their second trimester. Data were analyzed using the Mann-Whitney U test. The results showed no significant increase in hemoglobin levels (p=0.056), but there were significant increases in ferritin (p=0.004) and MCV levels (p=0.000). Prenatal yoga practice can maintain hemoglobin levels and increase both ferritin and MCV levels.

Keywords: ferritin levels; hemoglobin levels; MCV levels; prenatal yoga

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INTRODUCTION

During pregnancy, iron requirements increase significantly to support both maternal health and fetal development, and to prevent complications. In addition to hemoglobin synthesis, iron plays a vital role in various cellular physiological functions and nervous system development, such as neurotransmitter formation and myelination. Iron deficiency anemia is one of the most common types of anemia. The prevalence of iron deficiency anemia among pregnant women in Indonesia is 48.9% (Riskesdas, 2018). Iron deficiency anemia during pregnancy poses significant risks to both maternal and fetal health. Globally, the prevalence of iron deficiency anemia varies, affecting approximately 18% of pregnant women in developed countries and up to 56% in developing regions (Pratima Verma & Anuradha Roy, 2024; Yang & Seo, 2023) This condition is associated with adverse outcomes such as low birth weight, preterm birth, and increased maternal complications like postpartum hemorrhage (Nargis et al., 2023; Obianeli et al., 2024).

Ferritin's primary function is to store and regulate iron in the body and serve as an indicator of iron stores. It is the main storage site for iron within cells. These stores allow the body to have iron reserves that can be utilized when needed, especially when dietary iron intake is insufficient or when demand increases, such as during pregnancy or growth. Low ferritin levels indicate iron deficiency. Therefore, measuring serum ferritin levels is essential in diagnosing iron deficiency anemia. Research also indicates a correlation between ferritin levels and red blood cell indices such as MCV(Mean Corpuscular Volume) and MCH (Mean

Corpuscular Hemoglobin) (Sharma et al., 2016). While not all red blood cell indices show a significant relationship with ferritin levels, some indicators, such as MCHC (Mean Corpuscular Hemoglobin Concentration), demonstrate a meaningful difference in patients with iron deficiency anemia (Mohammed, 2018).

Exercise has a significant impact on hemoglobin levels through various adaptive mechanisms, including increased erythropoiesis and changes in plasma volume. Regular moderate-intensity exercise can stimulate erythropoiesis. (Hu & Lin, 2012; Mohamady et al., 2017), Because the body requires more oxygen during physical activity, red blood cell production increases to meet this demand. As plasma volume decreases, hemoglobin concentration can appear to increase relatively. Prenatal yoga asana practice can be categorized as physical exercise because it involves various poses or postures designed to improve the health and fitness of pregnant women. Asana practice is not merely physical activity but a comprehensive method for enhancing physical, mental, and spiritual well-being. Several studies support a positive relationship between yoga practice and increased hemoglobin levels, especially in pregnant women. Regular prenatal yoga can increase ferritin levels in pregnant women after eight weeks of practice (Bara et al., 2024). Other research also suggests that prenatal yoga can increase hemoglobin levels and reduce discomfort during the third trimester of pregnancy (Andriyani & Agustin, 2022; Bara & Tandipasang, 2021). This suggests yoga's potential as an intervention to improve health by increasing hemoglobin levels, which are related to heme synthesis. Prenatal yoga asana practice has a lower cardiovascular impact compared to other forms of exercise, making it a good alternative for pregnant women experiencing cardiovascular system changes.

Ferritin plays a key role in the relationship between yoga and hemoglobin levels in pregnant women. Studies examining the effects of prenatal yoga have found that regular practice leads to increased serum ferritin levels, although this increase may not be statistically significant. However, these studies also note a significant decrease in hepcidin, a hormone that regulates iron metabolism, suggesting improved iron availability for hemoglobin synthesis during pregnancy (Bara et al., 2024). The anti-inflammatory effects of prenatal yoga may also contribute to iron metabolism and utilization, potentially stimulating the release of stored iron from reticuloendothelial cells, making it more available for hemoglobin production. This study aims to determine the increase in ferritin and MCV levels in pregnant women after being given prenatal yoga exercises.

METHOD

This study employed a quasi-experimental pretest-posttest design, conducted in the Ma'rang and Bungoro sub-districts of Pangkajene and Kepulauan Regency. The study included 137 pregnant women in their second and third trimesters who met the inclusion criteria. The sample was divided into two groups: 62 pregnant women in the intervention group and 75 in the control group. The intervention group practiced prenatal yoga for 60 minutes twice a week for four weeks, while the control group received routine antenatal care. Iron supplement tablet consumption was monitored throughout the study, with a minimum consumption of 28 tablets. Purposive sampling was used for participant recruitment. Measurement of Hb and MCV levels using a hematology analyzer at the Prodifa Laboratory, Pangkajene Islands Regency, and measurement of Ferritin levels using the ELISA method at the Hum-RC Laboratory.

RESULT

Based on Table 1, it shows that the average age of the mothers in this study was 27 years, with an average gestational age of 18 weeks. The majority of pregnant women were multigravida, with 44 (72.1%) in the intervention group and 50 (66.7%) in the control group.

Tabel 1.
Distribution characteristics of pregnant women

Variables	Group Intervention (n=62) n (%)/Mean±SD	 Control (n=75) n (%)/ Mean±SD
Maternal Age	26.98±4.63	27.74±4.62
Gestasional Age	18.00±3.48	17.75±3.86
Parity		
Primigravida	17 (27.9)	25 (33.3)
Multigravida	44 (72.1)	50 (66.7)

Table 2.
Analysis of differences in Hemoglobin, Ferritin, and MCV levels in mothers practicing prenatal yoga (Mann Whitney Test)

Variables	Intervention (n=62)		Control (n=75)		*P*
	Pre Mean (SD)	Post Mean (SD)	Pre Mean (SD)	Post Mean (SD)	
Haemoglobin (gr/dl)	11.3(0.89)	11.1(0.97)	11.7(1.04)	11.3(0.9)	0.563
Ferritin (pg/ml)	56.5(47.3)	121.3(95.8)	50.4(40.2)	109.7(61.95)	0.004
MCV (fl)	87.2(4.86)	88.7(5.04)	87.44(4.8)	87.44(4.8)	0

Based on table 2, show the analysis of differences in hemoglobin, ferritin, and MCV levels in mothers practicing prenatal yoga the average hemoglobin level in the intervention group was 11.1 g/dL, while the control group had an average hemoglobin level of 11.3 g/dL. With a p-value of 0.563, there was no significant difference in hemoglobin levels between the two groups. The average ferritin level in the intervention group was 121.3 pg/mL, compared to 109.7 pg/mL in the control group. The Mann-Whitney U test yielded a p-value of 0.040, indicating a statistically significant difference in ferritin levels between mothers who practiced prenatal yoga and those who did not. The average MCV level in the intervention group was 88.8 fL, while the control group had an average MCV of 87.4 fL. The Mann-Whitney U test resulted in a p-value of 0.000, indicating a statistically significant difference in MCV levels between the two groups.

DISCUSSION

Hemoglobin levels remained unchanged after one month of prenatal yoga practice. This was also true for the control group. Previous studies have shown increases in hemoglobin levels in pregnant women during their second and third trimesters after two months of prenatal yoga (Bara & Tandipasang, 2021). A two-month regimen of yoga asanas and aerobic exercise can also increase hemoglobin levels in anemic adolescents (Tharani et al., 2021).

Hemoglobin levels decrease as hemodilution increases, starting between 16 and 20 weeks of gestation and peaking at 32–36 weeks. Hemodilution leads to a decrease in hematocrit due to increased plasma volume, a phenomenon known as physiologic anemia. The amount of iron transferred to the fetus begins to rise in the second trimester and increases further in the third, placing greater demands on the mother's iron stores. Prenatal yoga, a low-to-moderate intensity physical activity, can help maintain maternal hemoglobin levels by enhancing iron absorption in the duodenum and boosting red blood cell production. This increased red blood cell production ensures adequate iron supply for enhanced hemoglobin synthesis. Prenatal yoga asanas enhance flexibility, strength, and overall body awareness through breath-synchronized movements, combining stretching and isometric exercises (Bucea-Manea-Tonis

et al., 2024). Yoga asanas share similarities with other forms of physical exercise but also have key differences. Yoga asanas can build strength using body weight and balance (Bhowmik Bhunia & Ray, 2024). Stretching is a fundamental component of yoga, serving to enhance muscle elasticity and joint mobility.

Prenatal yoga offers numerous benefits for expectant mothers, including improved relaxation, flexibility, and strength. Practicing prenatal yoga asanas can help alleviate common pregnancy discomforts, improve posture, and prepare the body for childbirth. Prenatal yoga asanas combine static exercises (holding the final pose for a set duration, typically 2-3 breaths) with dynamic exercises (flowing through a sequence of poses). Holding yoga poses involves muscle contraction and stretching. Muscle contraction creates an imbalance between increased oxygen demand and oxygen supply. This imbalance leads to deoxygenation in skeletal muscles during exercise. Physical activity also enhances iron distribution to tissues with higher oxygen demands, such as skeletal muscles (Fujii et al., 2011).

Yoga asanas involve holding various postures that require both stretching and isometric contractions. Isometric contractions occur when muscles are engaged and held in a fixed position without movement, which helps stabilize joints and engage specific muscle groups (Bhowmik Bhunia & Ray, 2024). This technique not only increases strength but also prepares the muscles for deeper stretching, promoting flexibility and muscle awareness. Incorporating isometric activation into asana practice contributes to overall muscle engagement and can enhance performance in yoga.

Studies on exercise in non-pregnant individuals demonstrate that physical activity can elevate hemoglobin levels and red blood cell mass, thereby enhancing the body's oxygen-carrying capacity (Hu & Lin, 2012; Tharani et al., 2021). Physical activity increases the body's demand for oxygen, and higher hemoglobin concentrations help meet this demand efficiently. Exercise enhances blood flow to active muscles, improving oxygen and nutrient delivery, which is essential for erythropoiesis (red blood cell formation) (Stefanović et al., 2024). This increased oxygen demand leads to adaptations in red blood cell characteristics, enhancing their metabolic and functional capacity (Stefanović et al., 2024). Light resistance training has been shown to improve iron status in young women with non-anemic iron deficiency, even without iron supplementation. Serum ferritin levels, hemoglobin, red blood cell count, and total iron-binding capacity increased significantly after 12 weeks of resistance training (dumbbell exercises) in these women. Yoga can be considered a form of strength training, particularly involving bodyweight exercises and isometric movements, which can help build muscle endurance and strength.

Physical activity increases levels of erythropoietin and erythroferrone, which stimulate erythropoiesis (red blood cell production) and potentially ALAS1 activity (Dziembowska et al., 2021). Increased activity of aminolevulinate synthase 1 in muscle tissue in response to exercise leads to enhanced heme synthesis. This increase is necessary to meet the demands of oxygen transport and energy metabolism in muscles during physical activity. Exercise modulates heme synthesis and enhances erythropoiesis. (Dunaway et al., 2024; Hu & Lin, 2012). The increase in ferritin levels is influenced by hepcidin levels. Hepcidin, the iron regulatory hormone, decreases significantly during pregnancy, especially in the second and third trimesters, to enhance iron availability for fetal development and maternal erythropoiesis (Koenig et al., 2014)(Fisher & Nemeth, 2017a). The suppression of hepcidin during pregnancy is influenced by a variety of factors, including hormonal changes and placental signals (Satué et al., 2023)(Guo et al., 2019). Ferritin levels are negatively correlated with

hepcidin, indicating that lower hepcidin levels allow for higher ferritin concentrations (Satué et al., 2023)
Ferritin levels increased in both groups of pregnant women, with the highest increase observed in the group practicing prenatal yoga. The increase in both groups is attributed to the iron supplementation program provided to all participants. The response of ferritin levels to iron supplementation is known to be rapid (Arosio et al., 2017). A cohort study by Hirosawa et al (2022). found that iron supplementation significantly increased ferritin levels (Hirosawa et al., 2022). This research aligns with previous studies, demonstrating that after 2 months of prenatal yoga practice, there's an increase in ferritin levels in anemic, normal-weight, and overweight/obese pregnant women, with the highest increase observed in the anemic and overweight/obese groups (Dziembowska et al., 2021).

Ferritin serves as a key indicator of iron stores in the body, reflecting the body's iron reserves. It oxidizes ferrous iron [Fe] to ferric iron [Fe] for storage via its ferroxidase sites. Ferritin is considered a gold standard for diagnosing iron deficiency. In the iron depletion stage (the early stage of iron deficiency anemia), serum ferritin decreases (<40 µg/L), while hemoglobin and serum iron levels may still be normal. A decrease in hemoglobin levels occurs in the later stages of iron deficiency anemia. Ferritin is also an acute-phase reactant that increases during inflammation. Therefore, in pregnancies complicated by inflammation, such as pre-eclampsia or gestational diabetes, elevated ferritin levels may indicate iron overload as iron is withheld from circulation due to inflammation. (Wibowo et al., 2021). Without iron supplementation, ferritin levels tend to decline throughout pregnancy (Milman, 2006). Serum ferritin concentrations typically decrease during the second trimester and remain relatively constant until the third trimester (Fisher & Nemeth, 2017b). Population studies in Nigeria have shown a decline in ferritin levels in pregnant women across trimesters (Possamai & Blasi, 2020). In conditions of reduced iron stores, hemoglobin and other iron-containing protein functions may still be normal, but serum ferritin levels decrease. Ferritin is known to be influenced by infection, inflammation, and other diseases, as well as dietary intake.

Physiological hemodilution and erythropoiesis cause changes in hematological indices during pregnancy. From the second trimester onward, iron requirements increase progressively with the expanding maternal red blood cell mass and the accelerated growth of the placenta and fetus. In pregnant women without iron deficiency, there's a rise in the number of large, young erythrocytes, leading to an increase in MCV of 4–20 fL. This physiological rise makes assessing iron deficiency through erythrocyte volume challenging, as iron deficiency can occur even with normal MCV values. Mean Corpuscular Volume measures the average size of red blood cells. In pregnant women, a low MCV (less than 80 fL) suggests potential microcytic anemia, which can be associated with iron deficiency, although the sensitivity for detection is low (Chao et al., 2024). During pregnancy, erythrocytes tend to adopt a more spherical shape, leading to increased osmotic fragility and a shorter lifespan. As pregnancy progresses and iron demands increase, hepcidin production in the liver is downregulated, partly due to reduced iron stores and increased iron requirements in the erythroid marrow. Concurrently, the rate of erythropoiesis increases, the percentage of reticulocytes rises, and erythrocytes become larger and less dense, indicating a younger red blood cell population. This is reflected in red blood cell indices like mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration. These changes include increased MCV and red cell distribution width, while MCHC remains unchanged. (Vega-Sánchez et al., 2020)

CONCLUSION

Prenatal yoga practice can increase both ferritin and MCV levels in pregnant women.

Hemoglobin levels remained unchanged, likely due to hemodilution that occurs during pregnancy. Prenatal yoga can be a complementary effort to improve iron metabolism during pregnancy. A limitation of this study is the lack of monitoring of dietary iron intake among pregnant women. Further research is needed to investigate the effects of yoga exercises on ferritin levels while monitoring dietary iron intake.

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