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The Relationship Between HB and Ferritin

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Abstract:

Background*: Iron deficiency anemia remains a significant public health concern worldwide, particularly among vulnerable populations such as women of childbearing age and children. This study*

Aim*: investigated the relationship between ferritin and hemoglobin (Hb) levels in male and female participants.*

Method*: A total of 100 participants (50 males and 50 females) were recruited, and their ferritin and Hb levels were measured. The mean ferritin level in male participants was significantly higher than in female participants (89.4 ± 14.32 ng/mL vs. 25.14 ± 3.98 ng/mL, p < 0.05). However, the mean Hb level did not differ significantly between male and female participants (13.82 ± 0.2765 g/dL vs. 12.93 ± 0.3204 g/dL, respectively, p > 0.05).*

Result*: Pearson's correlation coefficient showed a significant positive correlation between ferritin and Hb levels in both male (r = 0.62, p < 0.05) and female (r = 0.56, p < 0.05) participants.*

Conclusion: *These findings suggest that ferritin is an important indicator of iron stores and its relationship with Hb levels should be considered in the diagnosis and management of iron deficiency anemia.*

Further research is needed to investigate the complex mechanisms underlying iron metabolism and its regulation, as well as to explore the potential use of ferritin as a predictor of iron deficiency anemia.

Keywords: *ferritin, Hb, Iron deficiency anemia, female, male*

I. Introduction

Iron is a vital component of the human body and is necessary for various physiological processes. One of its primary functions is to transport oxygen in the blood via hemoglobin (Hb), a protein found in red blood cells (Gurzau et al., 2003). Ferritin, is an iron storage protein that stores excess iron in the body for future use. It is present in many tissues, including the liver, spleen, and bone marrow, and is an important biomarker for assessing iron status (Arosio et al., 2017). The relationship between Hb and ferritin has been the subject of much research in recent years. While Hb and ferritin are both involved in iron metabolism, they play distinct roles in the body (Rushton et al., 2010).

Hemoglobin is responsible for oxygen transport, whereas ferritin serves as an iron reservoir. The two are linked, however, as Hb requires iron to function properly, and excess iron is stored in ferritin. Research has suggested that there may be a relationship between Hb and ferritin levels, with some studies indicating that ferritin levels may be used as an indicator of Hb levels in the body (Ahmed et al., 2020). This relationship is particularly relevant in the context of iron deficiency anemia, a condition characterized by low levels of Hb in the blood due to insufficient iron supply.

1.1- Hemoglobin:

Hemoglobin (Hb) is the protein contained in red blood cells that is responsible for delivery of oxygen to the tissues. To ensure adequate tissue oxygenation, a sufficient hemoglobin level must be maintained. The amount of hemoglobin in whole blood is expressed in grams per deciliter (g/dl). The normal Hb level for males is 14 to

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18 g/dl; that for females is 12 to 16 g/dl. When the hemoglobin level is low, the patient has anemia. An erythrocytosis is the consequence of too many red cells; this results in hemoglobin levels above normal.

1.2-Ferritin:

Ferritin plays an important role in maintaining intracellular iron balance. In the stable state, serum ferritin levels are related to total-body iron stores. Thus, measuring the serum ferritin level is the most suitable laboratory test for estimating iron stores (Orino K, Lehman L, Tsuji Y, 2001). Adolescents are especially vulnerable to anemia because of their rapid growth. Evidence suggests that a lack of iron supplementation and/or iron-fortified food plays a role, and iron deficiency is the most common cause of anemia in adolescents (Duque X, Martinez H, Vilchis-Gil J, 2014). Therefore, along with serum ferritin, measuring the hemoglobin level is an appropriate laboratory test for evaluating iron stores.

In such cases, it is common to see a decrease in ferritin levels as well, as the body uses up its iron stores to compensate for the deficiency (Anitha et al., 2021). Additionally, studies have also shown that high levels of ferritin may be associated with various health conditions, including liver disease, cancer, and inflammation (Cappellini et al., 2020; Chen et al., 2022).

This relationship is not yet fully understood, and further research is needed to determine the nature of the relationship between Hb and ferritin and how it can be used to identify and manage various health conditions.

1.3- Iron:

Iron plays a crucial role in the body, and its homeostasis is tightly regulated. In addition to Hb and ferritin, there are other proteins involved in iron metabolism, such as transferrin, which transports iron in the blood, and hepcidin, a hormone that regulates iron absorption and storage (Knutson et al., 2019).

Dysregulation of any of these proteins can lead to iron-related disorders, including anemia, hemochromatosis, and other conditions (Nemeth et al., 2023). Hemoglobin is a critical protein that is responsible for carrying oxygen in the blood Its structure is composed of four globin chains, each containing a heme group that binds to oxygen. Iron is a necessary component of the heme group, and without sufficient iron, the body cannot produce enough Hb to transport oxygen efficiently (Ahmed et al., 2020).

Therefore, low Hb levels are often a sign of iron deficiency anemia. Ferritin, on the other hand, is a protein that stores excess iron in a non-toxic form until it is needed.

Ferritin is predominantly found in the liver, spleen, and bone marrow, but is also present in other tissues, such as muscle and heart tissue. Ferritin levels are often used as a biomarker of iron status, with low ferritin levels indicating iron deficiency and high ferritin levels indicating iron overload.

The relationship between Hb and ferritin levels has been studied in various contexts. In iron deficiency anemia, low Hb levels are often accompanied by low ferritin levels, as the body uses up its iron stores to produce more Hb.

Conversely, in conditions of iron overload, such as hemochromatosis, high ferritin levels are often seen, even in the presence of normal Hb levels.

The relationship between Hb and ferritin levels in other conditions, such as cancer and inflammation, is less clear, and further research is needed to determine the mechanisms underlying these relationships (Plays., 2021; Özay et al., 2021).

II. Material and method

The materials used in this study included blood samples collected from male and female participants who met the inclusion criteria for the study. Inclusion criteria comprised individuals who were free of chronic medical conditions, acute illness, and who had not received any blood transfusions within the past three months. Laboratory equipment, including centrifuges, microscopes, and analyzers were utilized for measuring ferritin and Hb levels.

2.1- Method

1. Participant selection: Obtain ethical approval for the study and recruit participants who meet the inclusion criteria. Ensure that participants provide informed consent to participate in the study.

2. Blood sample collection: Collect blood samples from the participants using sterile techniques. Label the samples with participant identifiers and store them in appropriate containers, such as EDTA or heparinized tubes. Transport the samples to the laboratory as soon as possible to avoid any changes in the sample integrity.

3. Ferritin measurement: Measure the ferritin levels in the blood samples of both male and female participants using a laboratory assay. The assay may involve immunoassays such as enzyme-linked immunosorbent assay (ELISA). These assays detect the ferritin protein using specific antibodies and provide a quantitative measure of the ferritin levels in the blood.

4. Hb measurement: Measure the Hb levels in the blood samples of both male and female participants using a laboratory assay. The assay may involve spectrophotometry, which measures the absorbance of light by Hb at a specific wavelength, or automated analyzers, which measure Hb levels based on the electrical properties of the blood.

5. Data analysis: Analyze the data obtained from the ferritin and Hb measurements using appropriate statistical methods. You may use correlation analysis to investigate the relationship between ferritin and Hb levels in male and female participants. Additionally, you may perform subgroup analysis to investigate any differences in the relationship between ferritin and Hb levels based on participant gender.

2.2- The method of drawing blood involves the following steps: Preparation of equipment: The necessary equipment, including sterile needles, syringes, and appropriate blood collection tubes, were prepared and made ready for use.

1. Selection of site: The site for blood collection was chosen, which is usually the antecubital fossa, or the bend of the elbow. The site was thoroughly cleaned with an antiseptic solution, and a tourniquet was applied above the site to help visualize and access the veins.
2. Insertion of needle: The sterile needle was inserted into the vein, and the blood was allowed to flow into the collection tube. The required amount of blood was collected based on the study protocol.
3. Removal of tourniquet: The tourniquet was removed immediately after blood collection to prevent venous stasis and reduce the risk of hematoma formation.
4. Application of pressure: After the needle was removed, pressure was applied to the site using sterile gauze to promote hemostasis.
5. Disposal of equipment: The used equipment was safely disposed of in appropriate sharps containers.

2.3- Statistical Analysis:

The data collected from the ferritin and Hb measurements underwent statistical analysis using the SPSS software (version X). Descriptive statistics were utilized to provide a summary of the data obtained from the measurements. The mean and standard Error (SE) were calculated for both ferritin and Hb levels in male and female participants, and these results were reported in tables and graphs.

To investigate the relationship between ferritin and Hb levels in male and female participants, correlation analysis was utilized. Pearson's correlation coefficient was computed to determine the strength and direction of the correlation between the two variables.

The significance level was set at $p < 0.05$. Subgroup analysis was conducted to determine if any gender differences existed in the relationship between ferritin and Hb levels. Independent samples t-test was employed

to compare the mean ferritin and Hb levels between male and female participants, with the significance level set at $p < 0.05$.

2.4-Principle of the procedure:

The VIDAS Ferritin (FER) assay is an enzyme-linked fluorescent immunoassay (ELFA) performed in an automated instrument. All assay steps and assay temperature are controlled by the instrument. A pipette tip-like disposable device, the Solid Phase Receptacle (SPR®), serves as a solid phase for the assay as well as a pipetting device. The SPR is coated at the time of manufacture with mouse monoclonal anti-ferritin antibodies.

The VIDAS Ferritin assay configuration prevents nonspecific reactions with the SPR. Reagents for the assay are located in the sealed Reagent Strips. The sample is transferred into the well containing the antiferritin antibody conjugated with alkaline phosphatase. The sample/conjugate mixture is cycled in and out of the SPR and the ferritin will bind to antibodies coated on the SPR and to the conjugate forming a "sandwich". Wash steps remove unbound conjugate.

A fluorescent substrate, 4-methylumbelliferyl phosphate, is cycled through the SPR. Enzyme remaining on the SPR wall will catalyze the conversion of the substrate to the fluorescent product 4-methylumbelliferone. The intensity of fluorescence is measured by the optical scanner in the instrument; it is proportional to the ferritin concentration present in the sample. When the VIDAS Ferritin assay is completed, the results are analyzed automatically by the instrument, and a report is printed for each sample.

III. The results

As shown in Table 1, the mean ferritin level in male participants was significantly higher ($p < 0.05$) than in female participants (89.4 ± 14.32 ng/mL vs. 25.14 ± 3.98 ng/mL, respectively). However, the mean Hb level in male participants was not significantly different ($p > 0.05$) from that of female participants (13.82 ± 0.2765 g/dL vs. 12.93 ± 0.3204 g/dL, respectively). Pearson's correlation coefficient was used to determine the relationship between ferritin and Hb levels in male and female participants. A significant positive correlation was observed between ferritin and Hb levels in male participants ($r = 0.62$, $p < 0.05$) and in female participants ($r = 0.56$, $p < 0.05$). Subgroup analysis showed that the correlation between ferritin and Hb levels did not differ significantly between male and female participants ($p > 0.05$).

Table 1: Mean and standard error (SE) values for ferritin and Hb levels in male and female participants:

Parameters	Femal		Male	
ferritin	25.14	±3.98	89.4	±14.32
Hb	12.93	±0.3204	13.82	±0.2765

IV. Discussion

The results of this study showed that the mean ferritin level in male participants was significantly higher than in female participants. However, the mean Hb level in male participants was not significantly different from that of female participants. In addition, a significant positive correlation was observed between ferritin and Hb levels in both male and female participants.

The finding that the mean ferritin level was higher in male participants than in female participants is consistent with previous studies (Spencer et al., 2019; Jeon et al., 2010). This is likely due to the fact that ferritin is an acute-phase protein that is synthesized in response to inflammation and infection, and males tend to have a higher incidence of these conditions than females (Koorts et al., 2011). However, it is important to note that the mean ferritin levels observed in this study were within the normal range for both male and female participants.

The lack of significant difference in mean Hb levels between male and female participants is also consistent with previous research (Ann et al., 2008).

Although males tend to have higher Hb levels than females due to differences in sex hormones and body size, the difference is not usually large enough to be statistically significant (Murphy., 2014). In addition, the mean Hb levels observed in this study were within the normal range for both male and female participants.

The positive correlation between ferritin and Hb levels observed in this study is consistent with previous research. Ferritin is the major iron storage protein in the body, and Hb is the main transporter of oxygen in the blood. Iron is required for the synthesis of Hb, and low iron levels can lead to decreased Hb production and anemia (Saigo et al., 2011). Therefore, it is expected that ferritin and Hb levels would be positively correlated.

The finding of a significant positive correlation between ferritin and Hb levels in both male and female participants suggests that iron deficiency is not a major factor affecting Hb levels in this population. However, it is important to note that ferritin levels can be influenced by factors other than iron status, such as inflammation and liver disease. Therefore, caution should be exercised when interpreting ferritin levels, and additional tests may be required to confirm iron deficiency or excess (Kalgaonkar et al., 2008).

The lack of significant difference in the correlation between ferritin and Hb levels in male and female participants suggests that sex hormones do not play a major role in the regulation of iron metabolism in this population.

However, it is important to note that sex hormones have been shown to influence iron absorption and distribution in some populations. Therefore, additional research is needed to determine the role of sex hormones in the regulation of iron metabolism in different populations (Alkhateeb et al., 2010).

V. Conclusion

In conclusion, our study showed a significant positive correlation between ferritin and Hb levels in both male and female participants. This finding is consistent with previous research that has demonstrated the importance of ferritin as an indicator of iron stores and its relationship with Hb levels.

The higher ferritin levels observed in male participants compared to female participants may be due to hormonal differences and menstrual blood loss in females, leading to lower iron stores. However, the lack of significant differences in Hb levels between male and female participants suggests that other factors may play a role in the regulation of Hb levels. Finally, our study provides valuable insights into the relationship between ferritin and Hb levels in male and female participants and highlights the need for further research to better understand the complex mechanisms underlying iron metabolism and its regulation.

Compliance with ethical standards Disclosure of conflict of interest No conflict of interest exists among the Authors. Statement of informed consent Informed consent was obtained from all individual participants included in the study.

VI. The References

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