

Prevention of Iron Deficiency Anemia Through Blood Immunochemical Detection in Improving the Quality of Life of Elderly

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ABSTRACT

The increase in the elderly population poses challenges to health services in Indonesia, particularly regarding degenerative diseases and malnutrition due to reduced physical activity and dietary changes. Supporting the Asta Cita program for elderly assistance, it is essential to monitor elderly health to maintain wellness and functionality in old age. This study used descriptive analytical observation on 25 women aged 55 to 75 years. Results showed that hemoglobin levels declined below the normal range of 12–15 g/dL. Serum iron levels and lactate dehydrogenase (LDH) enzyme activity were measured using a spectrophotometer to assess anemia potential, while immune status was evaluated through vitamin D levels by immunofluorescence. Statistical analysis with SPSS software using Spearman's correlation test revealed no significant relationships between hemoglobin and serum iron ($p = 0.520$), hemoglobin and LDH ($p = 0.615$), or serum iron with LDH ($p = 0.543$) and vitamin D ($p = 0.138$). Pearson correlation showed no association between hemoglobin and vitamin D ($p = 0.885$). These findings indicate weak or no correlation among these parameters in this sample. Factors such as small sample size and measurement limitations suggest that using more precise biomarkers, like Ferritin levels, could improve future research. This study contributes to understanding Prevention of Iron Deficiency Anemia Through Blood Immunochemical Detection in Improving the Quality of Life of Elderly—a valuable approach to elderly health monitoring.

KEYWORDS



deficiency anemia; Prevention of Anemia; Quality of Life for the Elderly; Biomarkers; Immunochemical Detection

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INTRODUCTION

Iron deficiency anemia (IDA) represents one of the most prevalent nutritional disorders globally, affecting approximately 1.62 billion people worldwide, with the elderly population being particularly vulnerable (World Health Organization, 2021). The global prevalence of anemia in individuals aged 60 years and older ranges from 12% to 40%, varying significantly across different geographical regions and socioeconomic contexts (Gaskell et al., 2012). In developed countries, the prevalence averages around 10–20%, while in developing nations, it can exceed 40% among older adults (Kassebaum et al., 2014). This high prevalence among the elderly is concerning given the substantial clinical and socioeconomic impacts, including increased morbidity, mortality, reduced functional capacity, decreased quality of life, higher healthcare costs, and increased hospitalization rates (Stauder et al., 2014).

In Indonesia, the aging population has grown substantially, with individuals aged 60 years and above comprising approximately 10.7% of the total population in 2020, and this figure is projected to reach 20% by 2045 (Statistics Indonesia, 2021). This demographic shift

presents significant challenges to the healthcare system, particularly regarding the management of age-related conditions such as degenerative diseases and nutritional deficiencies, including anemia. The increasing elderly population demands enhanced attention to preventive healthcare measures and early detection of health problems to maintain functional independence and quality of life.

Iron deficiency anemia is often associated with a type of anemia in the elderly characterized by low hemoglobin levels due to insufficient iron for hemoglobin synthesis. The pathophysiology of IDA in the elderly is complex and multifactorial, involving not only inadequate dietary intake but also reduced iron absorption due to age-related changes in gastrointestinal function, chronic blood loss, chronic diseases, polypharmacy, and hormonal changes (Andrès et al., 2013). Various factors such as chronic diseases, drug consumption, decreased organ function, and hormonal decline can affect iron deficiency anemia in the elderly. Furthermore, the elderly often experience decreased physical activity and dietary changes, which contribute to poor nutritional status and increased susceptibility to anemia (Smith et al., 2018).

The Indonesian government has recognized the importance of elderly care through the implementation of the Asta Cita program, which aims to improve the welfare and health of the elderly population. As part of this initiative, comprehensive health screening and monitoring programs are essential to detect and prevent health problems early, enabling the elderly to maintain their health and productivity in their golden years (Ministry of Health Indonesia, 2023).

The approach to detect iron deficiency anemia through the blood chemical immune method can provide a better picture of the health of the elderly because the measurement is not only based on blood cells but also involves the immune response and blood biochemistry. Traditional anemia screening typically relies on hemoglobin measurement alone, which, while useful for identifying anemia, does not provide information about the underlying cause or type of anemia (Camaschella, 2015). A more comprehensive approach incorporating multiple biomarkers—including serum iron, lactate dehydrogenase (LDH), and vitamin D—can offer a more complete picture of the patient's hematological and metabolic status.

Serum iron reflects the amount of iron circulating in the blood and available for hemoglobin synthesis, though it is subject to diurnal variation and can be influenced by recent dietary intake and inflammatory processes (Lopez et al., 2016). Lactate dehydrogenase is an enzyme released during tissue damage and hemolysis, and elevated levels may indicate red blood cell destruction or underlying pathological processes (Kato et al., 2006). Vitamin D, traditionally known for its role in calcium metabolism and bone health, has recently been recognized for its involvement in immune function and erythropoiesis, with several studies suggesting a relationship between vitamin D deficiency and anemia (Smith & Tangpricha, 2015; Atkinson et al., 2020).

Iron deficiency anemia in the elderly, for example, can also be caused by a decrease in vitamin D levels or an increase in lactate dehydrogenase enzyme activity related to hormones that stimulate red blood cell formation. Previous research by Zhao et al. (2018) demonstrated that vitamin D deficiency was significantly associated with anemia in elderly Chinese adults, suggesting a potential role for vitamin D in erythropoiesis. Similarly, a study by Patel et al. (2019) found that elderly individuals with anemia had significantly lower vitamin D levels

compared to non-anemic controls. However, interventional studies examining the effect of vitamin D supplementation on hemoglobin levels have shown inconsistent results, indicating that the relationship may be correlative rather than causative (Mousa et al., 2020). Furthermore, research by Smith et al. (2020) on LDH levels in elderly patients with nutritional anemia found that LDH elevation was not consistently associated with iron deficiency anemia, but rather with hemolytic processes or tissue damage.

Previous research has conducted anemia examinations based predominantly on hemoglobin values alone, which serves as simple screening but does not confirm anemia type. This approach, while practical for large-scale screening, lacks the specificity needed to guide appropriate treatment. The use of multiple biomarkers can help differentiate between various types of anemia—such as iron deficiency anemia, anemia of chronic disease, hemolytic anemia, and megaloblastic anemia—each requiring different management strategies (Goodnough et al., 2017).

Despite the growing body of research on anemia in the elderly, there remains a significant gap in understanding the interrelationships among various biomarkers in the Indonesian elderly population. Most existing studies have been conducted in Western populations or have focused on single biomarkers in isolation. The complex interplay between iron metabolism, immune function, and vitamin D status in the context of elderly health in Indonesia has not been adequately explored. This knowledge gap presents an urgent need for comprehensive research that can inform culturally appropriate and context-specific prevention and management strategies.

The clinical urgency of this research is underscored by the fact that anemia in the elderly is associated with numerous adverse outcomes, including increased risk of falls, cognitive decline, cardiovascular complications, reduced physical function, and increased mortality (Gómez-Ramírez et al., 2019). Early detection and prevention of IDA through comprehensive biomarker assessment can potentially mitigate these risks and improve health outcomes. Moreover, from a public health perspective, the socioeconomic burden of anemia in the elderly is substantial, including increased healthcare utilization, longer hospital stays, and reduced productivity, all of which strain healthcare resources and family support systems (Petrosyan et al., 2018).

The parameters in this study can provide an overview of overall health in the elderly so that preventive efforts can be made to improve the better quality of life of the elderly. The novelty of this research lies in its integrated approach to anemia detection, combining immunological (vitamin D) and biochemical (serum iron, LDH) markers with traditional hematological assessment (hemoglobin) specifically in the Indonesian elderly population. This multi-dimensional approach represents a departure from conventional single-marker screening and provides a more holistic understanding of the factors contributing to anemia in this demographic. Furthermore, this study contributes to the limited body of research on anemia biomarkers in Southeast Asian elderly populations, addressing a significant gap in the international literature.

The theoretical significance of this study extends to understanding the pathophysiological mechanisms underlying anemia in the elderly, particularly the potential roles of vitamin D in erythropoiesis and immune function, and LDH as an indicator of cellular damage or hemolysis. From a practical standpoint, the findings of this research can inform the

development of more effective screening protocols for elderly care programs in Indonesia, such as the Asta Cita initiative, and can guide clinical decision-making regarding appropriate interventions for preventing and managing anemia in the elderly.

The purpose of the study is to conduct a better analysis of the detection of iron deficiency anemia in the elderly based on immune and blood chemistry examinations so that more complete data can be obtained and clearly to be able to provide follow-up treatment as an effort to improve the quality of life of the elderly. Specifically, this study aims to: (1) assess the prevalence of low hemoglobin levels among elderly women in the study population; (2) evaluate the relationships between hemoglobin levels and serum iron, LDH, and vitamin D levels; (3) determine whether these biomarkers can serve as predictive indicators for iron deficiency anemia in the elderly; and (4) provide evidence-based recommendations for comprehensive anemia screening protocols in elderly care programs.

The expected theoretical benefits include advancing scientific understanding of the multifactorial nature of anemia in the elderly and the potential interactions between iron metabolism, cellular integrity (reflected by LDH), and immune function (reflected by vitamin D). Practically, this research is expected to contribute to improved health outcomes for elderly individuals through earlier detection and more targeted prevention strategies, ultimately enhancing their quality of life, functional independence, and overall well-being. Additionally, the findings may inform policy development for elderly health programs and resource allocation in healthcare settings serving aging populations.

METHOD

This study employed a descriptive analytical research design with a cross-sectional approach. The research was conducted at the Community Health Center in Jakarta, Indonesia, over a period from July 2025 to December 2025. The study location was selected based on its accessibility and the presence of a substantial elderly population participating in the local elderly care program (Posyandu Lansia).

This study used a descriptive analytical research design with a cross sectional study with a working period of July 2025 to December 2025 as many as 25 samples of elderly female patients with hemoglobin levels below 12 g/dL. The sample size was determined using convenience sampling due to resource constraints, though we acknowledge this represents a limitation. A total of 25 elderly women meeting the eligibility criteria were recruited for this study.

Inclusion criteria were strictly defined as follows: (1) elderly women aged 50-75 years; (2) hemoglobin levels below 12 g/dL as determined by initial screening; (3) absence of diagnosed comorbidities such as chronic kidney disease, chronic liver disease, heart failure, or active malignancy; (4) no consumption of iron supplements, vitamin D supplements, or medications known to affect iron metabolism or erythropoiesis within the past three months; (5) willingness to participate and provide informed consent; and (6) ability to provide adequate blood samples for all required tests.

The inclusion criteria are elderly women in the age range of 50-75 years, without comorbidities, without the consumption of drugs or vitamin supplements. The exclusion criteria were defined as: (1) elderly men, as gender differences in iron metabolism and hormonal factors may confound results; (2) elderly women with diagnosed comorbidities or

chronic diseases that could affect hematological parameters; (3) elderly women with physical limitations or medical conditions that contraindicated venipuncture or blood collection; (4) current use of medications or supplements that could interfere with study measurements; (5) acute infections or inflammatory conditions at the time of enrollment; and (6) history of blood transfusion within the past six months. The exclusion criteria in this study are elderly men, elderly women with comorbidities or elderly women with physical limitations so that blood collection cannot be done.

Data collection procedures were conducted as follows: After obtaining ethical approval from the Health Research Ethics Committee and informed consent from participants, demographic information including age, medical history, and medication use was collected through structured interviews. Physical examination was performed to assess general health status. Venous blood samples (approximately 10 mL) were collected in the morning (between 8:00-10:00 AM) after an overnight fast to minimize diurnal variation in serum iron levels.

Data analysis was conducted using SPSS statistical software version 26.0. Descriptive statistics including mean, standard deviation, median, and range were calculated for all continuous variables. The normality of data distribution was assessed using the Shapiro-Wilk test. For normally distributed variables, Pearson correlation coefficient was used to assess linear relationships between variables. For non-normally distributed variables, Spearman's rank correlation coefficient was employed. Correlation strength was interpreted as follows: $r < 0.3$ (weak), $r = 0.3-0.7$ (moderate), and $r > 0.7$ (strong). Statistical significance was set at $p < 0.05$. Scatter plots and correlation matrices were generated to visualize relationships between variables.

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the institutional review board prior to study commencement. All participants provided written informed consent after receiving detailed information about the study objectives, procedures, potential risks, and benefits. Participant confidentiality and data privacy were strictly maintained throughout the study. Participants were informed of their test results and referred for appropriate medical follow-up when abnormalities were detected.

RESULT AND DISCUSSION

The results of the study were obtained with 25 samples with average hemoglobin levels below normal values and followed by the measurement of serum iron levels, lactate dehydrogenase enzyme and vitamin D to determine the function of the immune system. Hemoglobin levels are found on average below the range of 12 – 16 g/dL (Table 1), average serum iron levels are in the normal range of 50 – 170 ug/dL, average lactate dehydrogenase enzyme levels are still in the normal range of 120 – 280 U/L, while average vitamin D levels are partly below the normal range and some are in the normal range of 30 – 100 ng/mL indicating a possible association between anemia and decreased vitamin D levels.

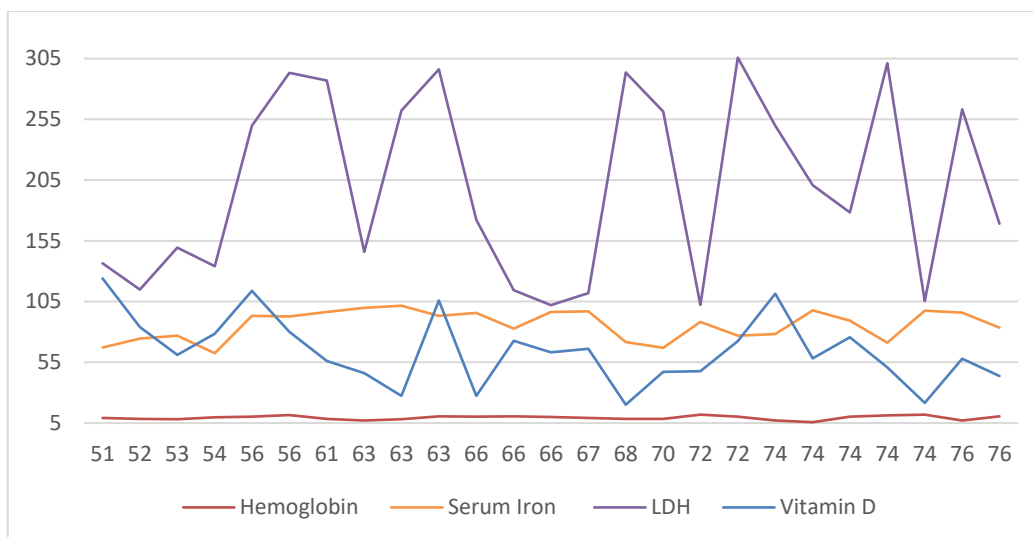


Figure 1. Average description of the results of measurements of hemoglobin (g/dL), serum iron (ug/dL), LDH (U/L) and vitamin D (ng/mL) levels in age variation.

The results showed low consistency and potential anemia, serum iron levels showed the possibility of iron metabolism that did not change much, LDH levels showed potential for possible inflammatory processes while vitamin D levels showed instability and possible potential disruptions of vitamin D metabolism.

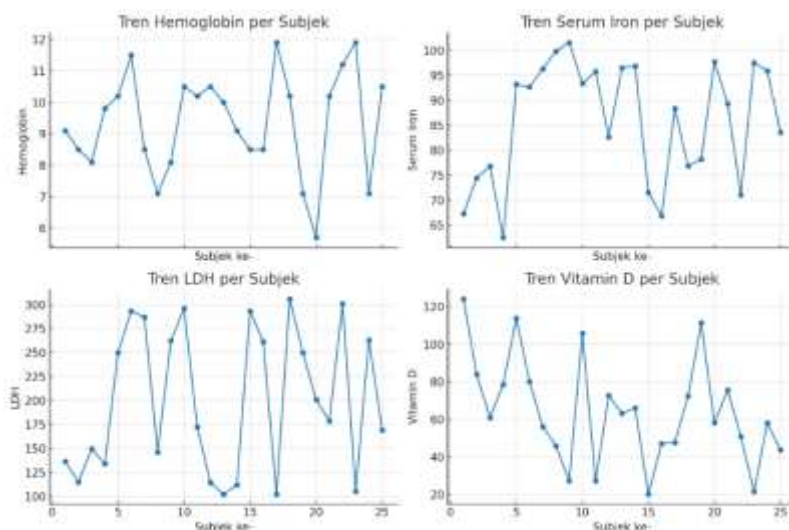


Figure 2. Graph of data from the measurement results of hemoglobin, serum iron, LDH and vitamin D based on the trend of the research subject

The graph showed that most of the subjects were below the normal adult standard value of 12-16 g/dL, the serum iron data showed variation between subjects with some results approaching the value below the normal limit although some had quite high levels, LDH levels showed sharp fluctuations in values between subjects showing a tendency not to be linearly related while the value in the study subjects showed sufficient heterogeneity large in population.

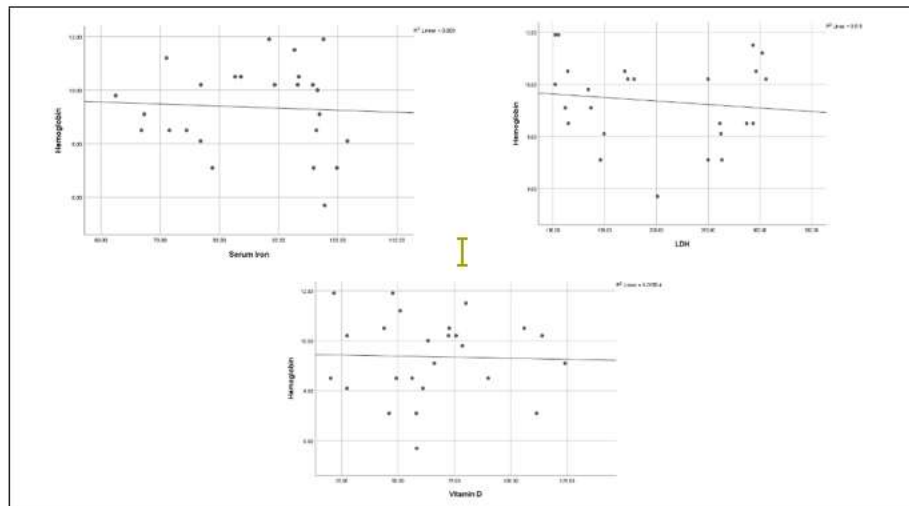


Figure 3. The distribution of Serum Iron, LDH and Vitamin D levels was related to Hemoglobin levels using a scater graph.

Based on the scatter graph above, a fairly random data distribution image was obtained in each parameter accompanied by a regression line that on average had a sloping slope indicating a weak relationship between the parameters.

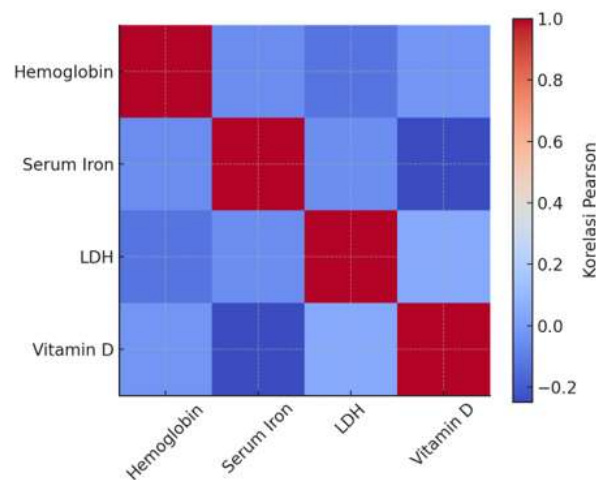


Figure 4. Correlation Matrix Graph between research parameters

Figure 4 shows a correlation matrix graph that measures the linearity of relationships between research variables based on color intensity with a numerical indicator on the right side of the graph as a marker of the strength and direction of the relationship. The color intensity of the graph shows that the relationships of each parameter have a weak linearity correlation. The use of SPSS statistical software with the Spearman correlation test showed that between hemoglobin and serum iron as well as hemoglobin and LDH levels showed no association with p 0.520 and p 0.615, respectively, while serum iron assessment parameters with LDH and vitamin D respectively also showed no association with p values of 0.543 and p 0.138 in each relationship. The Pearson correlation test showed a p value of 0.885 in the variable hemoglobin and vitamin D levels indicating no relationship. Hemoglobin and serum iron levels in this study

showed an insignificant relationship, one of which could be caused by a large variation in serum iron levels in the sample so that it was obtained from the study that the decrease in hemoglobin levels was not directly related to the serum iron of the existing elderly population. These results are in line with a 2021 study that stated the absence of variable relationships in adult populations (Gorkem, et al., 2021)¹. Research evidence suggests that low hemoglobin concentrations are not necessarily associated with iron deficiency (Jill, Vincent, & Ernest, 2002)². Iron has several roles in the body besides hemoglobin synthesis so anemia and iron deficiency are not always identical, where iron deficiency can occur without being accompanied by low hemoglobin levels (Al-Naseem, A., Choudhury, & Thachil, 2021)³. Conditions without anemia are likely to be iron deficiency where a decrease in iron storage remains indicative of normal Hb concentrations in the blood (Burns, L., Fontaine, & Connor, 2025)⁴. Serum iron levels can fluctuate throughout the day so they cannot be used as a single indicator of the status of iron levels in the blood personally, the use of serum ferritin level check markers can better illustrate the certainty of total iron stores (Kumar, Sharma, Marley, Samaan, & Brookes, 2022)⁵. Physiologically, it is expected that iron always supports haemoglobin production, but iron in the blood is very labile due to influences such as fasting, daily diet, and disease, so it is not the best indicator of the relationship between haemoglobin and iron levels in the blood, but ferritin and transferrin saturation are more stable to assess iron status (Soppi, 2018)⁶.

There was no significant relationship between the variable hemoglobin level as a marker of anemia and the level of lactate dehydrogenase (LDH) enzyme, so that hemoglobin levels in this study did not affect the results of the LDH examination performed. An insignificant association likely to be influenced by the absence of tissue damage in the study population only showed a decrease in hemoglobin levels below normal values. Several research articles have shown that low hemoglobin levels (anemia) with normal LDH levels (not significantly increased) suggest that red blood cell destruction (hemolysis) is not the cause, so a combination of laboratory results may indicate underlying causes of anemia such as nutritional deficiencies (Andrew, Freeman, & Muhammad, 2025)⁷. An insignificant increase in LDH levels when associated with low hemoglobin levels can be a potential indication of possible malnutrition anemia (Amrapali L & D. S., 2018)⁸. Among the hematologic parameters, there was no statistically significant difference between hemoglobin and LDH levels if it was not megaloblastic anemia. Based on research conducted by Deepthi et al. in 2018 on dimorphic anemia, decreased serum iron levels and red blood cell fragmentation that are not necessarily followed by decreased levels of hemoglobin may be normal in nutritional anemia (Noorin, Rasha, Kshama, Sumaiya, & Syed Riaz, 2021)⁹ (A., Prasad, & Raghavendra, 2018)¹⁰. An insignificant increase in LDH levels when paired with anemia may indicate nutritional deficiencies as a possible cause (Andrew, Freeman, & Muhammad, 2025)⁷. The possibility of an increase in LDH levels in anemia blood samples can technically be caused by lysed blood samples where in some conditions pre-analysis factors greatly affect the specimens examined in medical laboratories (Wan Norlina wan, Julia, Tan Say, Tuan, & Tuan, 2019)¹¹.

The Pearson correlation test on the hemoglobin and vitamin D variables at $r = 0.024$ showed no association so that vitamin D levels did not affect the hemoglobin levels of the elderly population as the study subjects. Nutritional status, chronic diseases or sun exposure have more influence on vitamin D levels. Research with the same results was conducted by

Sagita et.al 2025 on the pregnant population (Sagita Darma, Radiyati Umi, Pebby Maulina, & Iche, 2025)¹². The relationship between vitamin D levels and a significant decrease in hemoglobin levels can be seen in the case of chronic kidney disease so that in general, based on the results of research, vitamin D supplementation is not for the treatment of anemia (Seyed Mostafa, Golnaz, Leila Sadat, Mohammadreza, & Abdolreza, 2020)¹³. Some clinical studies that study low hemoglobin and vitamin D have not shown a significant effect, but in other studies, a relationship between the two variables has been found, especially for anemia due to inflammation. The diverse results of the study may be due to the presence of anemia types, differences in the target populations studied, and the complex mechanisms linking vitamin D to iron and red blood cell production (Ellen M&Vin, 2015)¹⁴. Recent meta-analysis research suggests that vitamin D deficiency may be associated with lower hemoglobin levels even though vitamin D supplementation does not have a significant effect on increased hemoglobin levels in all populations (Seyed Mostafa, Golnaz, Leila Sadat, Mohammadreza, & Abdolreza, 2020)¹³. A cross-sectional study in a 2009 study found a correlation between decreased vitamin D levels in populations with anemia prevalence but was not directly associated with decreased hemoglobin levels, and a meta-analysis study with randomized controlled trials showed no significant effect of vitamin D supplementation with a correction of increased hemoglobin levels. The observation of the relationship between low hemoglobin and vitamin D levels has been widely done in various studies, but controlled clinical trials show the potential failure of the effect of vitamin D supplementation with increased hemoglobin levels, so it can be known that vitamin D is a correlative factor and not the main cause of low hemoglobin levels, further studies can be carried out to observe vitamin D levels in cases of inflammation or other health problems (Ellen M, et al., 2019)¹⁶. Statistical analysis of the relationship variable of serum iron and lactate dehydrogenase (LDH) showed a weak and insignificant correlation in the Spearman test at $r = -0.128$. There are not many studies that discuss the relationship between serum iron and LDH enzymes because of the different mechanisms by which serum iron is related to iron metabolism and LDH enzymes are more likely to lead to cell or tissue damage. The results of the study showed that serum iron and lactate dehydrogenase (LDH) levels in the blood were not significantly significant, indicating that statistically there was no significant difference between the two variables tested so that the interpretation of the results could be influenced by various accompanying medical conditions (Aisha & Sarah L., 2025)¹⁷.

Serum iron or iron in the blood is one of the markers of laboratory testing that is limited because it can be influenced by various factors such as inflammation, diet and exam time, while LDH levels indicate enzymes that can be found in all body tissues so that increased levels can be an indication of tissue cell damage. The low level of relationship of the two variables indicates that the two components of measurement are not appropriate in the case studied. In addition, both variable components are classified as less specific disease indicators so that the absence of a correlation between the two is still acceptable (Singh, 2020)¹⁸. The Spearman correlation test was performed to assess the relationship between serum iron and vitamin D where $p=0.148$ and $r = -0.298$ indicated no relationship between the two variables, while negative correlation indicated a tendency that increased vitamin D levels were associated with decreased serum iron. It is possible that the results of the study are not significant between vitamin D and serum iron levels if the target population has possible comorbidities, while in

healthy individuals, especially the elderly, vitamin D supplementation has no effect on iron markers in the blood (Ahmed A., et al., 2016)¹⁹. The relationship between vitamin D levels and serum iron is not fully understood, some observational studies suggest a relationship, but many clinical implications show an insignificant relationship between the two variables (Azizi, F., Abiri, & Safavi, 2016)²⁰. A 2018 study on the adolescent population of Saudi Arabia with vitamin D supplementation found a decrease in serum iron levels so that it was stated that the severity or type of disorder of serum iron can affect the significance of the study results (Ahmed A., et al., 2016)¹⁹. The relationship between vitamin D and iron in the blood is strong in cases of chronic inflammation and is able to affect iron metabolism, whereas in moderate iron deficiency anemia, the administration of iron supplements shows more effect. Healthy individuals with normal vitamin D levels often do not exhibit significant changes in iron status in the blood (Mohammad S., et al., 2018)²¹. Influencing factors on the results of statistical analysis can occur, for example, due to the small size of the research sample, this causes a weak statistical power to detect small and meaningful changes in research variables, in addition to improper research design can also affect the significance of statistical analysis (Carboo, et al., 2023)²².

CONCLUSION

This study showed that the detection of iron deficiency anemia in the elderly through immune and blood chemistry examinations did not find a significant association between hemoglobin levels, serum iron, lactate dehydrogenase (LDH) enzyme, and vitamin D. Weak correlation values in all parameters indicated that decreased hemoglobin levels in the elderly were not always related to iron deficiency or vitamin D levels. Physiological variations, small sample sizes, and the influence of laboratory pre-analysis can affect the results of the study. Therefore, the use of additional indicators such as ferritin levels and transferrin saturation is recommended for future studies in order to obtain a more accurate picture of iron status and anemia in an effort to improve the quality of life of the elderly.

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