# RELATION OF THE NUMBER OF ERYTHROCITES WITH THE LEVEL OF IRON IN THE SERUM OF PATIENTS SUFFERING FROM SIDEROPENIC ANEMIA

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***Abstract***

*A retrospective study encompassing the analysis of laboratory results and medical charts was implemented on 147 patients with sideropenic anemia. The goal was to identify sex and age structure of the patients, and the statistical dependence of the number of erythrocytes with the level of free and bound iron in the serum. Out of the overall number of patients, 78% were females, 41,5% of them in the age group of up to 35 years. The largest group in male patients was in the age group of 50 years and older, with 20% of the overall number. The research showed that the iron (Fe) in the serum was lowered in 100% of the patients diagnosed with sideropenic anemia, which is, along with the values of hematocrits and hemoglobin which were lowered in about 70% of the patients, the basic parameter for diagnosing sideropenic anemia. It is confirmed that the number of erythrocytes is insufficient as an indicator of certain hematological disorders. Namely, the number of erythrocytes was lowered in only 28% of the patients. The average values of the number of erythrocytes by age groups indicate neither lowered values, nor the statistical dependence on values of the serum iron, whether it is free or bound. Thus, the starting hypothesis set forth at the beginning of the study was confirmed.*

***Key words**: sideropenic anemia, erythrocyte, serum iron*

## Introduction

Anemia is caused by decrease in number of erythrocytes or in quantity of hemoglobin. This could be caused by blood loss, deficient production of blood cells, their increased degradation, or by combination of everything aforementioned. Sideropenic anemia is caused by deficit of iron in the organism. It is a considerable health issue. Epidemiological data indicate that it is present in considerable percentage in both males and females. The main risk factor is lower intake or higher loss of the iron. It is most common in females of reproductive age due to considerable loss of blood during menstruation and due to heightened demands during pregnancy and nursing. For males and females who are not in reproductive age any longer, the most common cause of sideropenic anemia is inconspicuous bleeding of gastrointestinal tract. For these patients it is necessary to undertake examination of the entire digestive tube (for females, gynecological examination as well) in order to establish the cause of bleeding as soon as possible having in mind the possibility that the cause could be due to malignant disease. Sideropenic anemia is most common in vegetarians, which is understandable considering that the food of animal origin is richer in iron. Rarer causes of sideropenic anemia could be hemodialysis, Pulmonary Hemosiderosis, hypothyroidism and hyperthyroidism, and some intestinal parasites. Number of erythrocytes in peripheral blood is the result of balance between dynamic processes involved in production of erythrocytes (eritrocytopoesis) and loss of erythrocytes from peripheral blood. In the process of maintaining the hematopoesis on normal level, the iron plays important role as nutritive factor (as part of the HEM structure). For that reason, establishment of the iron level in serum (in it's every metabolic form) is important factor in maintaining normal quantity of blood i.e. normal oxyform function of the blood. There is a question if the relation of number of erythrocytes and level of free iron in the serum could be blamed for genesis of sideropenic anemia.

Primary hypotheses

- Level of free iron found in serum considerably affects the change in number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia
- Level of TIBC (total iron bounding capacity) considerably affects number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia.

Nil hypotheses

- Level of free iron found in serum does not considerably affect the change in number of erythrocytes found in peripheral blood in patients suffering
- Level of TIBC (total iron bounding capacity) does not considerably affect number of erythrocytes found in peripheral blood in patients suffering sideropenic anemia.

The main goals of this study were:

- Establishing sex and age structure of patients suffering sideropenic anemia in Medical Centre Zavidovići
- Establishing level of free and bound iron in serum of aforementioned patients
- Establishing number of erythrocytes in relation to age and sex structure of the patients
- Establishing correlation of number of erythrocytes in peripheral blood and levels of :
    1. Free iron
    2. Total Iron Bounding Capacity (TIBC)

**Materials and methods**

It was a random, retrospective study encompassing 147 patients in total. Patients were divided in following age groups: patients up to 25 years of age, 25-35, 35-50, and over 50 years of age. Their laboratory results were studied, as well as their patient records. Patients chosen for this study were those who contacted their doctors for the first time related to symptomatology of sideropenic anemia, as well as those patients suffering relapse of illness. To all of them sideropenic anemia was diagnosed based on anamnesis, clinical features and laboratory results.

**Results and discussion**

Total of 147 patients were included in this study, all of whom were diagnosed with sideropenic anemia based on clinical features and lowered values of ate least two of three set parameters: iron (Fe) in serum, hemoglobin (Hb) and hematocrit (Hct). Of the entire number of subjects (147), 78% are females, male patients make up for 22%. Higher occurrence of sideropenic anemia among female population was confirmed in the study done by Corraccio A. and associates. It is interesting that data reached by this study concur with data from aforementioned study (Corraccio A. and associates) related to age structure of the patients. Namely, over 40% of patients (41,5%) are females of up to 35 years of age. On the other hand, when considering the same age group for male patients they make up for just 3% of the entire number. From the entire number of male patients as much as 71% of them belong to age group of over 50. This particular group is often affected by illnesses of gastrointestinal tract (ulcers, tumors!) which is particularly important for diagnosis and treatment. Study confirmed that the number of erythrocytes is insufficient data when interpreting particular hematological disorders, especially sideropenic anemia. Namely, number of erythrocytes was lowered in 28% of subjects, normal in 63% of subjects, and heightened in 9% of subjects, and it cannot be taken as considerable factor when considering specific disorder. Study confirms researches done by Frewin and associates up to day, in which it is established that heightened or normal number of erythrocytes is physiological response of the organism to their lowered functioning. Namely, it is the case of abnormal form of erythrocytes (microcytes) which have lower oxyforming capability. It was established that values of hemoglobin and hematocrit are much more significant. Interesting fact is that hematocrit was lowered in as many as 78% of cases, when compared to 28% of cases with lowered number of erythrocytes. This could be explained by the fact that sideropenic anemia belongs to microcytes anemia, which implies decrease of erythrocytes volume.

This exactly is the reason why even when value of erythrocytes numbers were not decreased, values of hematocrites were still low. Total Iron Bounding Capacity (TIBC) is a blood test which indicates the ability of transferrin to carry iron. It should be noted that results of iron concentration without TIBC are with no consequences and that these two test should always be done simultaneously. Values of TIBC are especially significant differential diagnostic parameter when considering anemia of chronic illnesses. In both types of anemia, concentration of iron is decreased, but in the case of sideropenic anemia UIBC is high, TIBC is normal or high, concentration of ferritin is lowered. In anemia of chronic illnesses UIBC and TIBC are decreased, and concentration of ferritin is normal. Study showed that values of TIBC in patients suffering sideropenic anemia are increased in all age groups regardless of sex. In male patients values of TIBC are highest in age group up to 25 and over 50 years of age. Age group of female patients ranging 25 -35 years of age demonstrates highest values of TIBC. These heightened values of TIBC are result of physiological defense and endeavor of organism to increase the level of free iron by activating its bound form. TIBC represents indirect measuring of transferrin, the part that still has the ability to bind the iron. Exact opposite is right for values of transferrin saturation. Transferrin, serum protein which carries out transport, releases the iron in endeavor to compensate for its deficit. Study established considerable decrease in value of transferrin saturation in all patients. Normal values of transferring saturation are expressed in percentages and range from 25 to 45%. Patients from the age group of over 50 regardless of sex, demonstrate lowest values of transferring saturation, around 7%. Interesting facts were revealed by comparison of number of erythrocytes with values of free and bound iron in the blood. Number of erythrocytes does not exhibit lowered values in considerable percentage, which is to be expected when considering anemia.

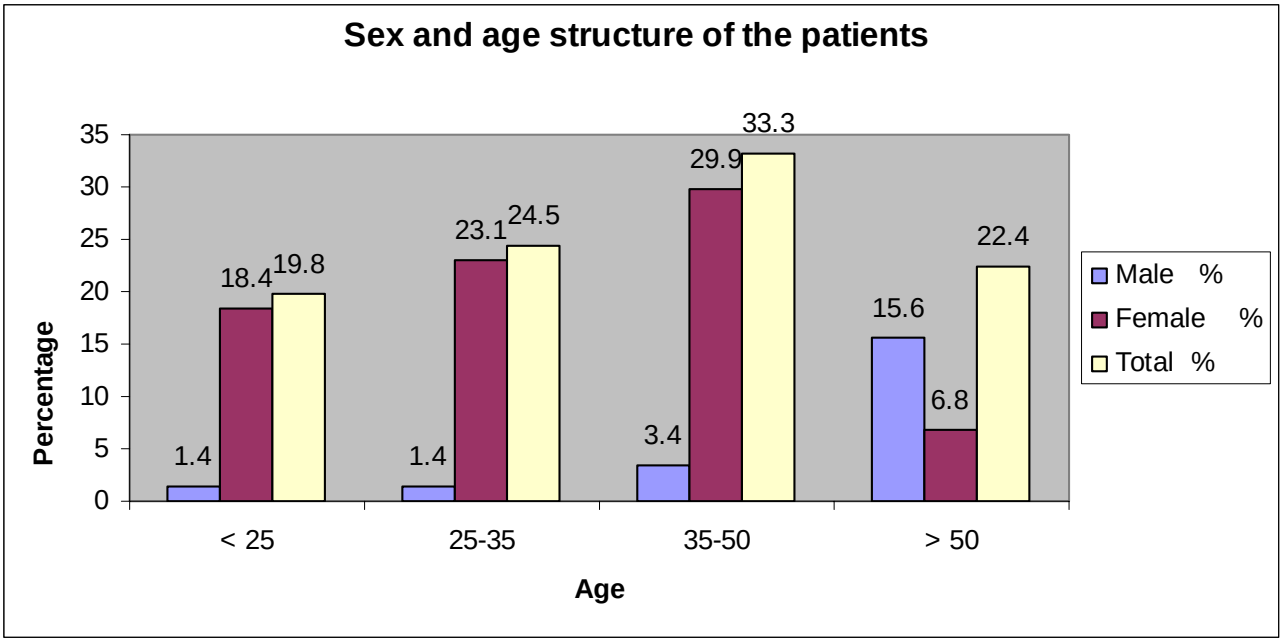


Figure 1. Sex and age structure of the patients

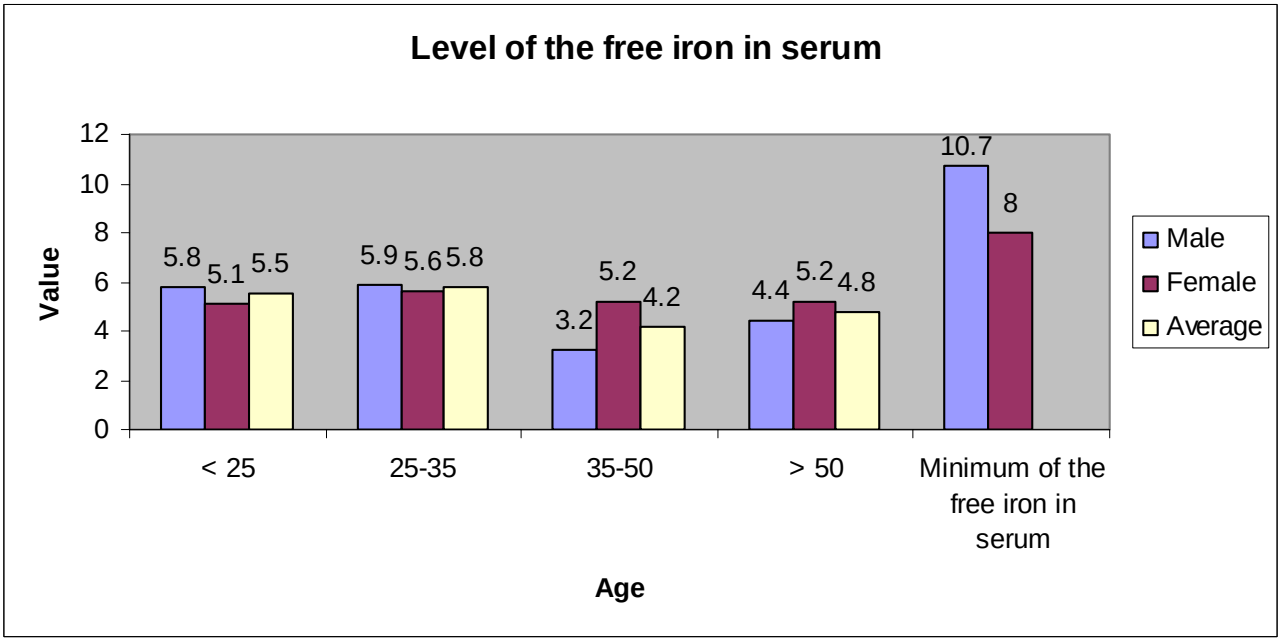


Figure 2. Level of the free iron in serum

(Physiological values of free iron in serum: Male: 10,7 – 28,6 μmol/L; Female: 8 – 26 μmol/L)

That is the sign that organism, even in situation of lowered values of iron in serum, still endeavors to improve oxyforming function of blood by producing erythrocytes. Nevertheless, thus produced erythrocytes are of lesser quality, with lowered volume and function. Erythrocytes of this kind are called microcytes. Considerable number of reticulocytes can be found in the blood as well, they are predecessors of genesis of mature erythrocytes. Obtained data confirm the nil hypotheses, i.e. hypothesis stating that level of free and bound iron does not considerably affect the number of erythrocytes found in peripheral blood of patients suffering from sideropenic anemia. This finding reinforces the facts that when diagnosing anemia other factors are of more significance, especially hemoglobin and hematocrit. Considering the sideropenic anemia, apart from factors mentioned above, weighting factors are values of free Fe, TIBC, as well as transferrin and ferritin.

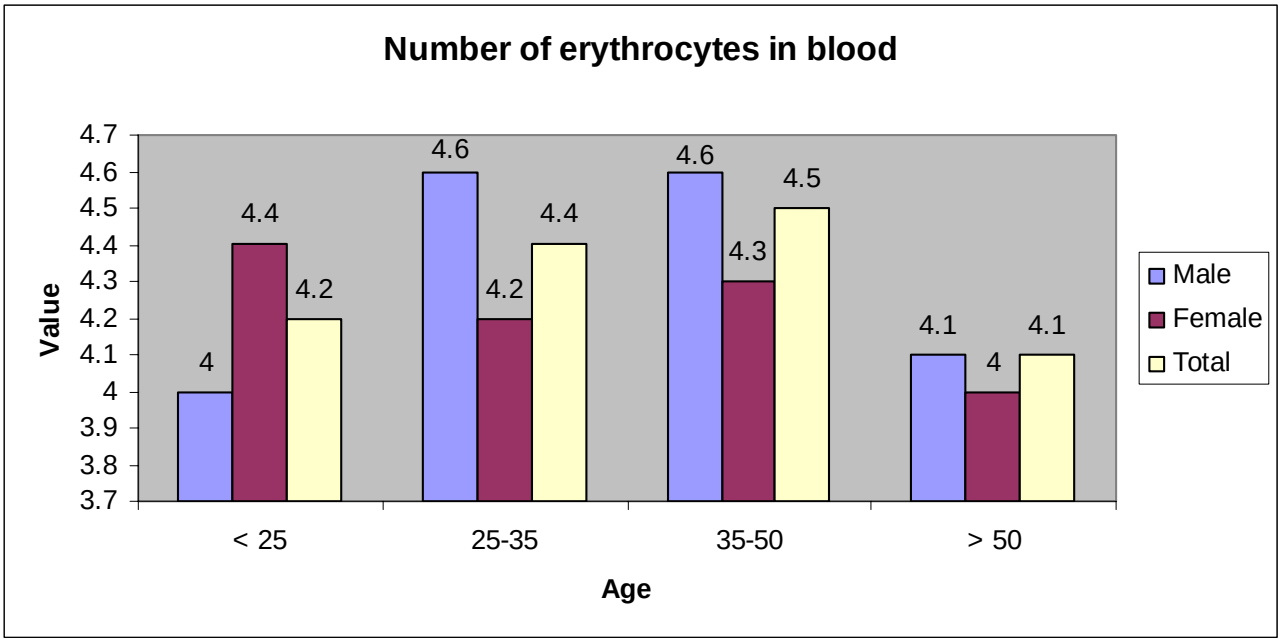


Figure 3. Number of erythrocytes in blood

(Physiological values of number of erythrocytes in blood: Male: 4-5 x10¹²/L; Female: 4-5 x10¹²/L)

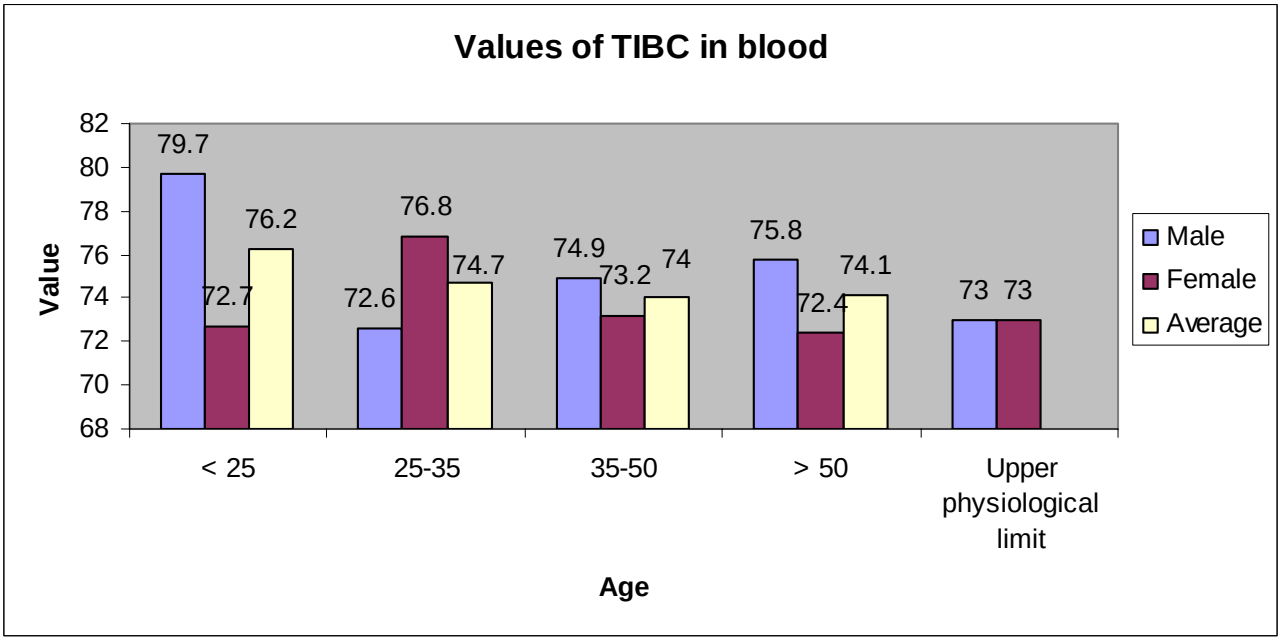


Figure 4. values of TIBC in blood

(Physiological values of TIBC in blood: Male: 45 – 73 μmol/L; Female: 45 – 73 μmol/L)

**Conclusions**

Based on results of this study as well as studies of other authors (results of which are available) we can make the following conclusions:

- In subject group of 147 patients, 115 were female patients, i.e. 78%;
- The largest percentage of female patients suffering from sideropenic anemia belongs to age group of up to 35 years of age, as much as 41,5% of the entire number;
- The largest percentage of male patients suffering from sideropenic anemia belongs to age group of over 50 years of age, approximately 20% of the entire number;
- Fe in serum is decreased in 100% of subjects diagnosed with sideropenic anemia;
- Values of transferring saturation are decreased in 100% of subjects diagnosed with sideropenic anemia;
- TIBC is decreased in 53% of examined patients;
- Level of free Fe in plasma of patients suffering sideropenic anemia has no significant effect on number of erythrocytes in peripheral blood;
- Level of bound Fe in plasma of patients ne has no significant effect on number of erythrocytes in peripheral blood.

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## RELACIJA BROJA ERITROCITA SA NIVOOM SLOBODNOG ŽELJEZA U SERUMU KOD PACIJENATA SA SIDEROPENIČNOM ANEMIJOM

**Sažetak**

*Vršena je retrospektivna studija koja obuhvata analizu laboratorijskih nalaza i zdravstvenih kartona ukupno 147 pacijenata oboljelih od sideropenične anemije. Cilj je bio utvrdit polnu i starosnu strukturu pacijenata, te statističku ovisnost broja eritrocita sa nivoom slobodnog i vezanog željeza u serumu. Od ukupnog broja ispitanika, 78% su bile osobe ženskog pola, od njih čak 41,5% u grupi pacijenata do 35 godina. Kod muškog pola, najveću grupu čine pacijenti starije životne dobi, preko 50 godina, sa oko 20% ukupnog broja. Istraživanje je pokazalo da je željezo (Fe) u serumu bilo sniženo kod 100% ispitanika sa dijagnosticiranom sideropeničnom anemijom, te su to, uz vrijednosti hematokrita i hemoglobina koje su bile snižene u prosjeku kod 70% pacijenata, osnovni parametri za postavljanje dijagnoze sideropenične anemije. Potvrđeno je da je broj eritrocita nedovoljan podatak za interpretaciju pojedinih hematoloških poremećaja. Naime, broj eritrocita je bio snižen samo kod 28% ispitanika. Prosječne vrijednosti broja eritrocita po starosnim grupama ne pokazuju snižene vrijednosti, niti statističku ovisnost o vrijednostima serumskog željeza, bilo vezanog bilo slobodnog. Na taj način je potvrđena nulta hipoteza postavljena na početku istraživanja.*

***Ključne riječi**: sideropenična anemija, eritrociti, serumsko željezo*

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