

# Comparative Indicators of Iron Metabolism and Hematopoietic Trace Elements in Healthy Individuals, Depending on Gender and Place of Residence

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**Abstract** The purpose of this study is to carry out a comparative analysis of hematopoietic trace elements - iron, copper and zinc - in apparently healthy elderly men and women, depending on the age range. For these purposes, all surveyed men and women living both in urban and rural conditions were divided into two age ranges - surveyed - up to and over 70 years. The results of the analysis showed that there is no statistically significant difference between the indicators of blood hemoglobin and hematopoietic microelements - iron, copper and zinc in the whole group of examined elderly men and the group of examined elderly men and examined elderly women in old age.

**Keywords** Hematopoiesis, Trace elements, Blood serum, Hemoglobin, Age range

## 1. Introduction

Disturbances in the balance of trace elements in the human body lead to the development of diseases called microelementosis [1,7]. It should be noted that the violation of the normal balance of trace elements in the body can be due to a number of reasons, namely deficiency, excess (overload) or imbalance [2,5].

Studies [4,9] indicate a wide spread of various forms of vitamin and microelement deficiency, in particular, among children, adolescents, women of fertile age, pregnant and lactating mothers, athletes, elderly people, the so-called polyhypovitaminosis and hypomicroelementosis. Among these nutritional deficiencies, hypomicroelementosis is currently a significant problem for modern hematology due to the significant frequency of these deficiencies and the variety and severity of their manifestations [3,6,8].

In the previous part of the study, we described the results of a comparative analysis of the detection rate of various forms of anemias in elderly and senile people. The main factors leading to the microelement polydeficiency state are shown. We considered it expedient to provide an analysis of indicators of the metabolism of iron, copper and hematopoietic trace elements in elderly and senile people.

## 2. Materials and Methods

Assessment of the state of these microelements in the

body of the elderly and elderly people, as well as comparative characteristics depending on gender and place of residence, as well as comparison with the data of young people give a complete picture of the microelement polydeficiency state, specifically determine the main factors for the development of this condition and develop an approach to management of these patients, diagnosis, treatment and prevention of microelement polydeficiency state in the studied category of persons.

## 3. Results and Discussion

A comparative analysis of the results obtained on the exchange of iron and copper in urban and rural residents shows that practically significant differences were not observed in the exchange of iron between elderly men ( $p > 0.05$ ) - respectively  $15.2 \pm 0.76 \mu\text{mol} / \text{l}$  versus  $15, 1 \pm 1.0 \mu\text{mol} / \text{L}$  (Table 1).

But, in women of this age, in the content of this trace element in the blood serum, noticeable differences were observed; the indicators of urban women were higher than the parameters of rural women - respectively  $12.2 \pm 0.56 \mu\text{mol} / \text{l}$  versus  $10.9 \pm 0.51 \mu\text{mol} / \text{l}$  ( $p < 0.05$ ).

As you can see from the table. 1, the indicators of changes in iron in the blood serum correlated with the parameters of the detectability of blood hemoglobin in the elderly, depending on age and place of residence. Comparative parameters of hemoglobin and iron in men tended to decrease, although the parameters of iron were not reliable, had a close, direct average strength of the correlation ( $\rho = 0.59$  and  $\rho = 0.31$ ). In women, the same tendency was observed - both parameters were reduced in rural women,

respectively, the strength of the correlation relationship increased - a close, direct strong relationship was noted in both cases -  $\rho = 0.79$  and  $\rho = 0.72$ .

**Table 1.** Iron metabolism indices in elderly people depending on gender and place of residence,  $M \pm m$

Показатели	Young		Urban		Rural	
	Man n=25	Women n=25	Man n=55	Women n=100	Man n=65	Women n=105
Hemoglobin, g / l	140,0 $\pm$ 0,36	127,0 $\pm$ 0,31	135,5 $\pm$ 0,1	122,3 $\pm$ 0,3 $\wedge$ ↓	131,2 $\pm$ 0,2*↓	120,2 $\pm$ 0,9 $\wedge$ ↓
Iron, $\mu$ mol / l	22,7 $\pm$ 0,91	19,9 $\pm$ 0,53	15,2 $\pm$ 0,76	12,2 $\pm$ 0,56 $\wedge$ ↓	15,1 $\pm$ 1,0↔	10,9 $\pm$ 0,51 $\wedge$ ↓
Transferrin, g / l	3,16 $\pm$ 0,04	3,35 $\pm$ 0,03	2,85 $\pm$ 0,04	2,50 $\pm$ 0,02 $\wedge$ ↓	2,80 $\pm$ 0,03*↓	2,38 $\pm$ 0,01 $\wedge$ ↓
CST, %	31,1 $\pm$ 0,9	25,1 $\pm$ 0,66	23,4 $\pm$ 1,1	18,9 $\pm$ 0,9 $\wedge$ ↓	22,2 $\pm$ 0,9↔	17,0 $\pm$ 0,3 $\wedge$ ↓
Ferritin g / ml	76,1 $\pm$ 1,2	59,9 $\pm$ 1,1	46,5 $\pm$ 1,1	44,2 $\pm$ 1,3 $\wedge$ ↓	42,2 $\pm$ 0,9 *↓	38,1 $\pm$ 1,1 $\wedge$ ↓
Ceruloplasmin, g / l	0,31 $\pm$ 0,03	0,30 $\pm$ 0,03	0,26 $\pm$ 0,05	0,27 $\pm$ 0,02 $\wedge$ ↑	0,20 $\pm$ 0,02 *↓	0,19 $\pm$ 0,03 $\wedge$ ↓

**Note:** \* - sign of reliability between rural and urban residents,  $\wedge$  - sign of reliability of gender differences, ↓, ↑, ↔ - direction of changes.

Thus, the parameters of blood hemoglobin and serum iron in the elderly tended to change unidirectionally, both depending on age and depending on the place of residence. Moreover, in both cases, we observed a close, direct correlation, but with different strengths, the dependence is most clearly visible in the analysis of hemoglobin in all cases. In rural residents, regardless of gender, the parameters of hemoglobin and iron were markedly reduced.

The same tendency of changes was observed in the content of transferrin in the blood serum of the elderly. Among men, depending on the place of residence, urban residents had an advantage - respectively  $2.85 \pm 0.04$  g / l versus  $2.80 \pm 0.03$  g / l ( $P < 0.05$ ), the same trend of changes was observed in women, where also the parameters were for women living in the city - respectively  $2.50 \pm 0.02$  g / l versus  $2.38 \pm 0.01$  g / l ( $p < 0.05$ ).

Transferrin indices also correlated with the hemoglobin content of blood, but in contrast to the iron parameters in all cases, the correlation was almost the same - a close, direct, strong relationship - respectively  $\rho = 0.79$  and  $\rho = 0.74$  in men and  $\rho = 0.78$  and  $\rho = 0.70$  for women.

The percentage of CST differed slightly in men depending on the place of residence ( $23.4 \pm 1.1\%$  versus  $22.2 \pm 0.9\%$ ,  $p > 0.05$ ), but in women the difference was significant -  $18.9 \pm 0$ , respectively,  $9\%$  versus  $17.0 \pm 0.3\%$  ( $p < 0.05$ ). It is noteworthy that the direction of the changes was the same as in other indicators - the parameters of urban residents prevailed over rural ones, as well as the indicators of men over women ( $p < 0.05$ ).

When analyzing the parameters of ferritin in blood serum, the same tendency of changes and differences was established, with the difference that the difference between the obtained averaged figures was greater ( $p < 0.001$ ) - between men, depending on the place of residence - respectively  $46.5 \pm 1.1$  kg / ml versus  $42.2 \pm 0.9$  kg / ml ( $p < 0.001$ ), as well as between women -  $44.2 \pm 1.3$  kg / ml versus  $38.1 \pm 1.1$  kg / ml ( $p < 0.001$ ). The content of ferritin in the blood serum, which reflects the state of iron in the body, unambiguously indicates that iron stores in elderly men permanently residing in the city are significantly higher

than in elderly rural men. This phenomenon can be explained with living conditions, nutrition and improved health care in the city. The correlation analysis between this parameter and blood hemoglobin was also close, direct and strong -  $\rho = 0.76$ , respectively;  $\rho = 0.71$ ;  $\rho = 0.82$  and  $\rho = 0.78$ . As can be seen from the data obtained, the strength of the correlation is greater in women. This fact indicates that serum ferritin parameters are more susceptible to changes in women than in men and also in urban women than women living in rural areas.

Indicators of ceruloplasmin, a copper transport protein in blood serum in the elderly, which reflects the state of metabolism of an essential trace element - copper in the body, had the same tendency of changes, although the strength of the correlation between blood hemoglobin was moderate and weak. If for men living in the city this parameter was  $0.26 \pm 0.05$  g / l, then for rural men it was significantly lower -  $0.20 \pm 0.02$  g / l ( $p < 0.05$ ). The same tendency of changes was observed in women - respectively  $0.27 \pm 0.02$  g / l versus  $0.19 \pm 0.03$  g / l ( $p < 0.05$ ). Like all parameters of iron metabolism, the change in this parameter also related to the significant difference between the results obtained for urban residents and those living in rural areas, and this also applied to both men and women.

Thus, the analysis of indicators of iron metabolism in elderly people, depending on gender and place of residence, showed the following features: firstly, almost all 6 parameters of iron metabolism in urban residents were significantly higher than in rural residents, regardless of gender; secondly, all indicators had the same tendency of changes, that is, they observed the unidirectionality of changes; thirdly, the parameters of iron, transferrin, ferritin and ceruloplasmin in the blood serum of the elderly had a close, direct correlation with the data of blood hemoglobin, but with different intensity of strength; fourthly, it was found that the stronger the correlation between a certain indicator and hemoglobin, the greater the criterion of reliability depending on gender and place of residence; Fifth, the most noticeable change depending on the place of residence was observed in the content of transferrin and CST in blood

serum, which should be taken into account when planning treatment and prophylactic measures among elderly people in this region. At the next stage of the research, the results of

studies on the determination of hematopoietic microelements of blood serum in the elderly were analyzed depending on age and place of residence. The results are shown in Table. 2.

**Table 2.** Indicators of hematopoietic microelements of blood serum in the elderly, depending on age and place of residence

Показатели	Young		Urban		Rural	
	Man n=25	Women n=25	Man n=55	Women n=100	Man n=65	Women n=105
Iron, $\mu\text{mol} / \text{L}$	22,7 $\pm$ 0,91	19,9 $\pm$ 0,53	15,2 $\pm$ 0,76	12,2 $\pm$ 0,56 $\wedge\downarrow$	15,1 $\pm$ 1,0 $\leftrightarrow$	10,9 $\pm$ 0,51 $\wedge\downarrow$
Copper, $\mu\text{mol} / \text{L}$	16,4 $\pm$ 0,52	16,2 $\pm$ 0,42	11,7 $\pm$ 0,64	10,8 $\pm$ 0,64 $\leftrightarrow$	10,0 $\pm$ 0,56 $\ast\downarrow$	9,5 $\pm$ 0,44 $\downarrow$
Zinc, $\mu\text{mol} / \text{L}$	23,9 $\pm$ 0,72	21,2 $\pm$ 0,48	17,6 $\pm$ 0,80	16,6 $\pm$ 0,54 $\leftrightarrow$	7,0 $\pm$ 0,34 $\leftrightarrow$	16,2 $\pm$ 0,38 $\leftrightarrow$

**Note:** \* - sign of reliability between rural and urban residents,  $\wedge$  - sign of reliability of gender differences,  $\downarrow$ ,  $\uparrow$ ,  $\leftrightarrow$  - direction of changes.

The content of iron in the blood serum was indicated above, but for a comparative analysis with other hematopoietic trace elements (copper, zinc), we presented the results of iron in this table.

Copper, one of the important hematopoietic trace elements, was determined in blood serum in different amounts in the elderly, depending on gender and place of residence.

For men permanently residing in urban areas, this indicator was  $11.7 \pm 0.64 \mu\text{mol} / \text{L}$ , while in rural men this parameter did not differ significantly and amounted to  $10.8 \pm 0.64 \mu\text{mol} / \text{L}$  ( $p > 0.05$ ). But in women, this microelement significantly differed depending on the place of residence -  $10.8 \pm 0.64 \mu\text{mol} / \text{L}$ , respectively, versus  $9.5 \pm 0.44 \mu\text{mol} / \text{L}$  ( $p < 0.05$ ).

There were no significant differences in the content of zinc in blood serum in all cases - for men ( $17.6 \pm 0.80 \mu\text{mol} / \text{L}$  versus  $17.0 \pm 0.34 \mu\text{mol} / \text{L}$ ), and for women ( $16.6 \pm 0.54 \mu\text{mol} / \text{L}$  versus  $16.2 \pm 0.38 \mu\text{mol} / \text{L}$ ) -  $P > 0.05$ .

When carrying out the correlation analysis, the following relationships were analyzed: iron GM / iron SM, copper GM / copper SM, zinc GM / zinc SM, iron GZh / iron SG, copper GZh / copper SZh, zinc GZh / zinc SZh, iron GM / copper GM, GM iron / GM zinc, GM copper / GM zinc, CM iron / CM copper, CM iron / CM zinc, SM copper / zinc CM, iron GZh / copper GZh, iron GZh / zinc GZh, copper GZh / zinc GZh, iron SG / copper SG, iron SG / zinc SG, copper SG / zinc SG - a total of 18 interrelated options.

Strong correlation interrelated variants ( $P > 0.7$ ) were observed between iron GZh / iron SZh ( $\rho = 0.76$ ), copper GZh / copper SZh ( $\rho = 0.72$ ), copper GZh / copper SZh ( $\rho = 0.71$ ), iron GM / copper SM ( $\rho = 0.74$ ), iron GZh / copper GZh ( $\rho = 0.73$ ), iron SG / copper SG ( $\rho = 0.78$ ) - only 6 interconnected options, and the remaining 12 interconnected options were weak.

It should be emphasized that almost all correlations were close, direct, that is, an increase in one indicator led to an increase in another parameter.

It is noteworthy that strong interrelated variants are mainly associated with iron and copper; among the zinc parameters, no strong correlations were found. This means that among the hematopoietic trace elements, iron and copper are the most interconnected, and zinc does not differ with a large connection with these trace elements.

If we analyze the interrelated options with the place of residence of the elderly, it can be seen that mainly strong interrelated options are associated with rural men and women. This allows us to conclude that the greatest changes in hematopoietic microelements are subject to rural residents.

## 4. Conclusions

Thus, the analysis of indicators of hematopoietic microelements of blood serum in the elderly, depending on age and place of residence, shows that significant differences were found only in the content of iron and copper between urban and rural women, as well as in the content of copper among men living in cities and villages. In other cases, especially in terms of zinc content, no significant differences were observed. The results of the correlation analysis also confirmed the results obtained, where strong, interrelated variants were more often observed for iron and copper, and were also mainly found among rural residents. In addition, it should be emphasized that all the studied indicators had close, direct correlations between themselves.

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