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# OPTIMIZATION OF EARLY DIAGNOSIS OF IRON DEFICIENCY: CLINICAL EPIDEMIOLOGICAL, ECONOMIC, AND RETROSPECTIVE CLINICAL RATIONALE

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**Abstract**

Iron deficiency (ID) remains the most prevalent micronutrient disorder worldwide, with latent iron deficiency occurring significantly more often than clinically manifest iron deficiency anemia (IDA). In routine clinical practice, diagnosis is often limited to measuring hemoglobin (Hb) concentration, which leads to late detection of the condition. The aim of this work is to substantiate the clinical and economic feasibility of using a combined assessment of erythrocyte indices (MCV, MCH, RDW) for the early diagnosis of iron deficiency in the Republic of Uzbekistan.

**Materials and methods**. An analysis of international and national epidemiological data was performed, along with a comparative evaluation of the diagnostic efficacy of hemoglobin, individual erythrocyte indices of the complete blood count (CBC), their combination, and serum ferritin measurement. In addition, a retrospective clinical-laboratory study of 30 patients was conducted, divided into three groups (normal — 11; IDA — 9; latent iron deficiency — 10), with subsequent statistical processing of the obtained results.

**Results**. In patients of the IDA and latent iron deficiency groups, a statistically significant ($p<0.001$) decrease in Hb, MCV, MCH, and serum ferritin was revealed, as well as an increase in RDW compared with the normal group. The combined assessment of three erythrocyte indices (MCV+MCH+RDW)

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demonstrates diagnostic accuracy comparable to that of ferritin measurement, at significantly lower cost.

**Conclusion**. The use of an early iron deficiency diagnostic algorithm based on a comprehensive assessment of CBC erythrocyte indices appears clinically justified and economically feasible for the healthcare system of Uzbekistan.

**Keywords:** Iron deficiency, latent iron deficiency, iron deficiency anemia, erythrocyte indices, MCV, MCH, RDW, ferritin, early diagnosis.

## Introduction

Iron deficiency is one of the leading causes of anemia worldwide and has a significant impact on oxygen transport, energy metabolism, immune defense, and cognitive function. Progressive iron deficiency is accompanied by depletion of the micronutrient stores and impaired erythropoiesis; meanwhile, the early stages of the disease are often asymptomatic, which substantially complicates timely diagnosis.

Serum ferritin is the main laboratory marker of the body's iron stores; however, its diagnostic value decreases in inflammatory processes and chronic diseases. In this regard, there is growing interest in the comprehensive assessment of hematological parameters, including hemoglobin concentration and erythrocyte indices. This problem is of particular importance for countries with developing healthcare systems, including the Republic of Uzbekistan, where iron deficiency is widespread among women of reproductive age and children. Optimization of the diagnostic algorithm using a combination of complete blood count parameters will improve the effectiveness of early detection of iron deficiency and reduce the prevalence of IDA.

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**Aim of the study:**

To develop a clinically and economically substantiated algorithm for the early diagnosis of iron deficiency, adapted to the conditions of the healthcare system of the Republic of Uzbekistan.

**Materials and methods**

A retrospective clinical-laboratory study was conducted, including 30 patients. Based on complete blood count data and iron metabolism indicators, all those examined were divided into three clinical groups: a normal group (n=11), an iron deficiency anemia group (n=9), and a latent iron deficiency group (n=10). The mean age of patients in the normal group was 38.3±2.1 years (men — 7, women — 4); in the IDA group — 33.6±4.9 years (men — 3, women — 6); in the latent iron deficiency group — 29.3±1.9 years (all women, n=10).

In all patients, the following laboratory parameters were assessed: hemoglobin concentration (Hb, g/L), mean corpuscular volume (MCV, fL), mean corpuscular hemoglobin (MCH, pg), red cell distribution width (RDW, %), and serum ferritin concentration (μg/L). Statistical processing of the results was performed using standard methods of variation statistics; data are presented as the mean and standard error of the mean (M±m). Group comparisons were carried out using Welch's modification of the Student's t-test. Differences were considered statistically significant at $p<0.05$.

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## Results

Table 1 — Comparative characteristics of laboratory parameters in the studied groups (M±m)

| Parameter | Normal (n=11) | IDA (n=9) | LID (n=10) | p (IDA vs normal) | p (LID vs normal) |
|---|---|---|---|---|---|
| Hb | 135.73 ± 1.49 | 110.33 ± 1.56 | 124.10 ± 0.60 | <0.001 | <0.001 |
| MCV | 87.45 ± 0.65 | 73.56 ± 0.56 | 80.50 ± 0.45 | <0.001 | <0.001 |
| MCH | 29.00 ± 0.36 | 22.78 ± 0.22 | 25.70 ± 0.21 | <0.001 | <0.001 |
| RDW | 13.45 ± 0.20 | 18.27 ± 0.20 | 15.65 ± 0.12 | <0.001 | <0.001 |
| Ferritin | 40.64 ± 3.29 | 6.56 ± 0.38 | 13.60 ± 0.48 | <0.001 | <0.001 |

In the normal group, the mean hemoglobin concentration was 135.73±1.49 g/L, serum ferritin — 40.64±3.29 μg/L, MCV — 87.45±0.65 fL, MCH — 29.00±0.36 pg, RDW — 13.45±0.20%. All obtained values were within the reference intervals.

In patients with iron deficiency anemia, a pronounced decrease in Hb to 110.33±1.56 g/L was recorded, with serum ferritin down to 6.56±0.38 μg/L, MCV — to 73.56±0.56 fL, MCH — to 22.78±0.22 pg, with a significant increase in RDW to 18.27±0.20%. Differences from the normal group in all evaluated parameters were statistically significant ($p<0.001$).

In the latent iron deficiency group, the Hb concentration was 124.10±0.60 g/L, formally remaining within the lower limit of the normal range; meanwhile, serum ferritin was significantly reduced (13.60±0.48 μg/L), MCV and MCH were at the lower limit of normal (80.50±0.45 fL and 25.70±0.21 pg, respectively), and RDW exceeded the upper limit of the reference interval (15.65±0.12%). Differences from the normal group across all parameters were also statistically significant ($p<0.001$).

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## Discussion

The obtained results confirm that the combined assessment of three complete blood count erythrocyte indices (MCV, MCH, and RDW) makes it possible to detect disturbances of iron metabolism already at the stage of latent deficiency, when hemoglobin concentration is still within reference values. In patients with latent iron deficiency, statistically significant deviations of MCV, MCH, and RDW were recorded, accompanied by a marked decrease in serum ferritin, which is consistent with current concepts of the pathogenesis and staging of iron-deficient states.

Isolated use of the hemoglobin parameter would not have allowed iron deficiency to be detected in patients of this group, which confirms the inadequacy of such an approach for early diagnosis. At the same time, a comprehensive assessment of erythrocyte indices within a standard CBC has high diagnostic value and does not require additional material costs, which is especially relevant for the healthcare system of the Republic of Uzbekistan.

## Conclusions

1. Iron deficiency retains its status as the most widespread micronutrient disorder both worldwide and in the Republic of Uzbekistan, with latent forms of the disease significantly exceeding clinically manifest iron deficiency anemia in frequency.
2. Isolated determination of hemoglobin concentration is characterized by low sensitivity (30–60%) and leads to late diagnosis of iron deficiency, which makes it necessary to expand the diagnostic algorithm.
3. The combined assessment of three erythrocyte indices (MCV, MCH, and RDW) provides a diagnostic accuracy of 80–88% and approaches the effectiveness of serum ferritin determination (88–96%) at significantly lower economic cost.

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4. According to the conducted retrospective study, in patients with iron deficiency anemia and latent iron deficiency, statistically significant ($p<0.001$) changes in Hb, MCV, MCH, RDW, and serum ferritin were revealed compared with the normal group, which confirms the high informativeness of the comprehensive assessment of erythrocyte indices in the diagnosis of iron-deficient states.
5. The introduction into clinical practice of an early iron deficiency diagnostic algorithm based on the comprehensive assessment of MCV, MCH, and RDW within a standard complete blood count is clinically justified and economically feasible for the healthcare system of the Republic of Uzbekistan.

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