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**STRATIFICATION OF IRON DEFICIENCY RISK IN SCHOOLCHILDREN OF
THE FERGANA VALLEY BASED ON MOLECULAR-GENETIC
POLYMORPHISMS AND DEVELOPMENT OF AN EARLY PREVENTION
MODEL YK**

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Introduction. Iron deficiency anemia (IDA) is one of the most prevalent micronutrient deficiencies among school-aged children and has a negative impact on their physical development, cognitive functions, and academic performance.

Recent genomic studies indicate that 20–30% of the variability in iron homeostasis is determined by genetic factors. In particular, polymorphisms in the Tmprss6 gene, which regulates iron metabolism, have been shown to be directly associated with hemoglobin levels and erythrocyte indices.

Identifying genetic risk factors within a regional population and integrating them with clinical parameters holds significant scientific and practical importance for the early detection of IDA and the development of individualized preventive strategies.

Keywords: Iron deficiency anemia; schoolchildren; iron metabolism; Tmprss6 gene; genetic polymorphism; rs855791; rs11704654; risk stratification; molecular-genetic screening; early prevention; personalized medicine; public health.

Study Objective. To stratify the risk of developing iron deficiency among schoolchildren in the Fergana Valley based on Tmprss6 gene polymorphisms and to develop an early prevention model.

Materials and Methods. The study was conducted using a case–control design and included a total of 201 schoolchildren aged 8–17 years. The main group consisted of 101 children diagnosed with iron deficiency anemia (mild – 26; moderate – 68; severe – 7), while the control group comprised 100 healthy schoolchildren.

The severity of IDA was assessed based on hemoglobin (Hb) levels and erythrocyte count.

Molecular-genetic analysis was performed using the PCR method to evaluate Tmprss6 gene polymorphisms: rs855791 (c.2207T>C), rs4820268 (c.1536C>T), and rs11704654 (c.72G>A).

Statistical analysis was carried out using the χ^2 test, Odds Ratio (OR, 95% CI), multivariate logistic regression, and ROC analysis. A p-value <0.05 was considered statistically significant.

Results. In the rs855791 polymorphism, the C allele accounted for 78.6% in the severe IDA group and was identified as a significant risk factor for the development of



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severe anemia ($p < 0.01$). The CC genotype was observed exclusively in the severe IDA group.

For the rs11704654 polymorphism, the A allele and AA genotype demonstrated a statistically significant association with severe IDA ($p < 0.05$).

Multivariate regression analysis identified the rs855791 C allele and rs11704654 A allele as markers of a high genetic risk profile.

ROC analysis showed high discriminative ability of the model ($AUC > 0.80$), with high sensitivity and specificity in predicting severe IDA.

Discussion. The findings confirm the regulatory role of the TMPRSS6 gene in iron homeostasis. The association of the rs855791 and rs11704654 polymorphisms with severe IDA suggests that genetic predisposition significantly contributes to disease progression and severity. In contrast, mild and moderate forms may be predominantly influenced by dietary and hygienic factors.

The three-tier risk stratification model (low, moderate, high risk), developed through the integration of genetic and clinical parameters, provides a rationale for implementing an individualized preventive approach.

Proposed Early Prevention Model.

Low-risk group: General hygienic recommendations and annual screening.

Moderate-risk group: Dietary correction and semiannual monitoring.

High-risk group: Extended laboratory surveillance, individualized iron supplementation, and a personalized nutrition program (follow-up every six months).

Conclusion. The rs855791 and rs11704654 polymorphisms of the TMPRSS6 gene represent important molecular markers for stratifying the risk of iron deficiency development among schoolchildren in the Fergana Valley.

The proposed early prevention model enables the prevention of progression to severe IDA, improves cost-effectiveness within the healthcare system, and facilitates the implementation of personalized preventive strategies.

