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PHENOTYPE-ORIENTED PREDICTION OF EMERGING POLYCYSTIC OVARY SYNDROME USING HORMONAL, METABOLIC AND OVARIAN STROMAL MARKERS

Kurbanova Z.Sh.
Bukhara State Medical Institute, Bukhara, Uzbekistan

Abstract. This study proposes a phenotype-oriented approach to predicting emerging polycystic ovary syndrome in adolescent girls based on the combined assessment of hormonal, metabolic, and ovarian stromal markers. The model integrates anti-Müllerian hormone, HOMA-IR, LH/FSH ratio, vitamin D status, ovarian stromal index, menstrual pattern, body mass index, and family history. Significant correlations between AMH, insulin resistance, gonadotropic imbalance, and vitamin D deficiency confirmed the interdependence of ovarian and metabolic mechanisms. The ovarian stromal index was also associated with the integral PCOS index, supporting the relationship between structural ovarian remodeling and biochemical dysfunction.

Keywords: phenotype-oriented prediction; ovarian stromal index; anti-Müllerian hormone; metabolic phenotype; adolescent PCOS; risk model.

Relevance. Emerging polycystic ovary syndrome is not a uniform condition. In some patients, androgenic and ovarian changes dominate, while in others metabolic dysfunction and insulin resistance are more prominent. This heterogeneity complicates early diagnosis and may reduce the effectiveness of standardized prevention. A phenotype-oriented prediction model can help distinguish the leading pathological direction and support more personalized clinical management.

Aim of the study. To develop a phenotype-oriented predictive model for emerging polycystic ovary syndrome based on hormonal, metabolic, and ultrasound markers.

Materials and methods. The study analyzed laboratory, clinical, and ultrasound parameters in adolescent girls with emerging PCOS. Hormonal assessment included anti-Müllerian hormone and LH/FSH ratio. Metabolic evaluation included HOMA-IR and serum 25(OH)D. Ultrasound assessment included the ovarian stromal index. Additional clinical variables included menstrual cycle disorders, body mass index, and family history of PCOS or diabetes mellitus. Correlation analysis was used to determine the relationships between ovarian, endocrine, and metabolic markers.

Results. The analysis demonstrated that AMH had a significant positive correlation with HOMA-IR ($r=0.61$; $p<0.001$), indicating a close relationship between ovarian reserve-related activity and insulin resistance. AMH was also positively associated with the LH/FSH ratio ($r=0.54$; $p<0.001$), confirming the role of gonadotropic imbalance in the formation of the ovarian phenotype. HOMA-IR correlated with the LH/FSH ratio ($r=0.49$; $p<0.01$), showing that metabolic and neuroendocrine disturbances may develop in parallel. Vitamin D status showed inverse associations with several key markers. HOMA-IR was negatively correlated with 25(OH)D ($r=-0.58$; $p<0.001$), AMH with 25(OH)D ($r=-0.46$; $p<0.01$), and LH/FSH ratio with 25(OH)D ($r=-0.41$; $p<0.05$). These findings support the hypothesis that vitamin D deficiency is involved in both metabolic and ovarian components of emerging PCOS. The integral PCOS index decreased from 3.9±0.4 before correction to 1.1±0.1 after rehabilitation, reflecting reduced severity of combined pathological changes. The ovarian stromal index was higher in patients with emerging PCOS than in controls and showed a positive association with the integral index. This confirms that ovarian stromal remodeling is not an isolated ultrasound sign but a structural reflection of hormonal-metabolic imbalance. Based on these findings, two main phenotypic orientations may be distinguished: an androgen-ovarian orientation, characterized by increased AMH, elevated LH/FSH ratio, menstrual dysfunction, and higher stromal index; and a metabolic orientation, characterized by increased HOMA-IR, elevated BMI, vitamin D

deficiency, and family history of diabetes or PCOS. Such differentiation may help determine whether the patient requires primarily endocrine-ovarian monitoring, metabolic correction, or combined management.

Conclusion. The phenotype-oriented prediction model provides a personalized approach to early assessment of emerging PCOS in adolescent girls. Integration of hormonal, metabolic, ultrasound, and anamnestic markers allows identification of the dominant pathological direction and supports individualized prevention. The model may be used for early risk detection, dynamic monitoring, and selection of targeted rehabilitation strategies.

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