МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
ЗАПОРІЗЬКИЙ ДЕРЖАВНИЙ
МЕДИКО-ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ЗБІРНИК МАТЕРІАЛІВ

Всеукраїнської науково - практичної конференції з міжнародною участю «Узагальнення досвіду теоретичної та практичної роботи дерматовенерологічної спільноти країни та світу»

22 травня 2026 р.

М. ЗАПОРІЖЖЯ
2026

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PSYCHOLOGICAL AND BIOCHEMICAL PREDICTORS OF HYPERTENSIVE DISORDERS IN HIGH-RISK PREGNANT WOMEN

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Hypertensive disorders of pregnancy (HDP), particularly preeclampsia (PE), remain among the leading causes of maternal and perinatal morbidity and mortality worldwide [Mitta S et al., 2023]. PE is a multisystem pathological condition characterized by new-onset hypertension combined with signs of maternal organ dysfunction after 20 weeks of gestation [ACOG, 2020]. According to the World Health Organization, severe forms of preeclampsia and eclampsia are associated with a significant proportion of maternal deaths [WHO, 2023]. In addition to the direct threat to maternal health, HDP increases the risk of preterm birth, fetal growth restriction, placental dysfunction, and perinatal complications [Dimitriadis E et al., 2023]. Current approaches to preeclampsia prediction are mainly based on the assessment of maternal clinical characteristics, medical history, and ultrasound screening data [Rode L et al., 2025]. However, the sensitivity of such models remains insufficient, particularly in patients with a moderate risk of HDP [Nguyen-Hoang L et al., 2024]. This determines the need to develop novel predictive approaches based on the comprehensive assessment of pathophysiologically relevant biochemical and psychological factors. One of the key mechanisms underlying preeclampsia is endothelial dysfunction

resulting from impaired placentation, placental ischemia, and oxidative stress [Torres-Torres J et al., 2024]. The nitric oxide (NO) system plays an important role in maintaining vascular homeostasis during pregnancy by regulating vascular tone and ensuring adequate perfusion of the fetoplacental complex [Sutton EF et al., 2020]. In HDP, decreased endothelial nitric oxide synthase (eNOS) activity, suppression of NO synthesis, and increased oxidative damage are observed [Guerby P et al., 2021]. Simultaneously, depletion of the antioxidant defense system and activation of oxidative protein modification (OPM) processes occur, which are considered sensitive markers of oxidative stress [Negre-Salvayre A et al., 2022]. In recent years, increasing attention has also been paid to the role of psychological factors in the development of obstetric complications. Chronic stress, high anxiety levels, and impaired adaptation mechanisms are associated with an increased risk of HDP [Dunkel Schetter C et al., 2022].

The aim of the study was to develop a predictive model for hypertensive disorders of pregnancy in women at risk based on a comprehensive assessment of psychological and biochemical indicators.

A prospective study involving 32 pregnant women at risk of HDP was conducted. The risk group was formed according to current clinical guidelines of the Ministry of Health of Ukraine [Ministry of Health of Ukraine, 2022]. All patients received standard prophylaxis with acetylsalicylic acid and calcium supplements. The comprehensive examination included clinical evaluation, medical history assessment, ultrasound examination of the fetus, and Doppler evaluation of uteroplacental and fetoplacental blood flow. Psychological status was evaluated using the State-Trait Anxiety Inventory scales (STAI-S/STAI-T) and the Perceived Stress Scale (PSS-14). Biochemical assessment included determination of eNOS concentration and activity, stable NO metabolites, superoxide dismutase (SOD) activity, glutathione reductase activity, total SH-groups, and indicators of oxidative protein modification. Subsequently, 37.5% of

women experienced HDP, predominantly gestational hypertension and moderate preeclampsia.

The study demonstrated that pregnant women who later developed HDP significantly more often exhibited signs of psychological distress and oxidative stress. A high level of situational anxiety according to the STAI-S scale was detected in 100% of women who subsequently developed HDP, whereas among women without HDP this indicator was observed in only 25.0% of cases. Trait anxiety ≥40 points according to the STAI-T scale was registered in 91.67% of women who later developed HDP. Similarly, a perceived stress level ≥20 points according to the PSS-14 scale was found in the majority of women who subsequently developed HDP.

At the same time, a significant increase in oxidative protein modification indicators and a decrease in antioxidant defense activity were identified. The most informative biochemical predictors of HDP development were indicators of aliphatic aldehyde-protein hydrazones (APH) and SOD activity. The level of spontaneous APH ≥2.2 arbitrary units/g protein was detected in 91.67% of women with HDP, whereas among pregnant women without HDP this indicator was observed in only 10.0% of cases. Decreased SOD activity ≤12.0 arbitrary units/mg protein/min was also significantly associated with subsequent hypertensive complications.

Based on the obtained results, a comprehensive predictive model was developed using Wald's sequential analysis procedure with the calculation of diagnostic coefficients and Kullback information measures. The most informative predictors of HDP development included spontaneous APH ≥2.2 arbitrary units/g protein, stimulated APH ≥5.0 arbitrary units/g protein, SOD activity ≤12.0 arbitrary units/mg protein/min, perceived stress level ≥20 points, trait anxiety ≥40 points, and a high level of situational anxiety. It was established that when the sum of diagnostic coefficients reached ≤ −13, a high probability of HDP development was predicted with 95% confidence ($p<0.05$), whereas at ≤ −20 the prediction accuracy reached 99% ($p<0.01$).

Conclusions

Thus, the results of the present study highlight the important role of psychological disturbances, oxidative stress, and endothelial dysfunction in the pathogenesis of hypertensive disorders of pregnancy. The most informative predictors of hypertensive disorders development were indicators of oxidative protein modification, superoxide dismutase activity, and psychological stress. The proposed comprehensive predictive model allows early risk stratification for the development of hypertensive disorders and may be used for the individualization of preventive and diagnostic strategies in pregnant women at risk.