International Journal of Women's Health

Dovepress
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ORIGINAL RESEARCH

Analysis of Influencing Factors of Fundus Functional Lesions in Patients with Pregnancy-Induced Hypertension and Construction of Prediction Model

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Objective: Fundus functional lesions are an important complication of pregnancy-induced hypertension (PIH) that may threaten visual function. This study aimed to identify factors associated with retinal functional lesions in PIH patients and to develop a nomogram model for individualized risk prediction.

Methods: A retrospective analysis was conducted on 307 PIH patients admitted to our hospital between May 2020 and July 2024. Patients were randomly divided into a training set (n=215) and a validation set (n=92). According to the presence of fundus functional lesions, patients in the training set were classified into lesion and non-lesion groups. Multivariate logistic regression analysis was used to identify independent influencing factors. A nomogram model was constructed using R software and evaluated through internal validation and split-sample validation. Model performance was assessed using the receiver operating characteristic (ROC) curve, calibration curve, Hosmer–Lemeshow test, and decision curve analysis (DCA).

Results: No significant differences in baseline clinical characteristics were observed between the training and validation sets. Patients with fundus functional lesions showed lower pre-pregnancy body mass index (BMI) and platelet count (PLT), while higher systolic blood pressure (SBP), higher hematocrit, and a greater prevalence of obstructive sleep apnea (OSA) were observed. Multivariate analysis identified pre-pregnancy BMI, highest SBP, presence of OSA, hematocrit ≥35%, and PLT as independent influencing factors for fundus functional lesions. The nomogram model demonstrated good discrimination and calibration in both training and validation sets. Decision curve analysis indicated favorable clinical utility across a wide range of threshold probabilities.

Conclusion: Pre-pregnancy BMI, maximum systolic blood pressure, OSA, hematocrit, and platelet count were independent predictors of retinal functional lesions in PIH patients. The developed nomogram model demonstrated good predictive performance and may serve as a helpful clinical tool, pending further external validation.

Keywords: pregnancy-induced hypertension, fundus functional lesions, influencing factors, prediction, nomogram model

Introduction

Pregnancy-induced hypertension (PIH) is a common obstetric complication and one of the major causes of adverse maternal and perinatal outcomes.[1–3] Ocular physiological changes are common complications of PIH, potentially resulting from long-term or markedly elevated maternal blood pressure, as prolonged hypertension may damage ocular blood vessels, impair the autoregulatory function of retinal vessels, lead to vasospasm or even ischemia, and ultimately trigger a series of fundus functional lesions.[4] Previous reports indicate that bilateral serous retinal detachment is one cause of visual impairment in PIH patients, with prevalence ranging from 0.1% to 32.4%.[5] At present, the clinical management of PIH-related fundus lesions relies heavily on regular ophthalmic screening. Diagnosis is based on fundus photography, optical coherence tomography (OCT), and abnormalities detected by visual function tests, including retinal

https://doi.org/10.2147/IJWH.S569532
Received: 23 September 2025
Accepted: 20 January 2026
Published: 29 January 2026

arterial spasm, macular retinal thickening, and serous retinal detachment. However, standardized criteria for screening timing, screening frequency, and the identification of high-risk populations are still lacking.[6] Additionally, systematic prediction tools specifically targeting PIH-related fundus functional lesions and integrating multidimensional clinical and biochemical indicators remain scarce. Therefore, the development of an accurate and user-friendly risk prediction tool to enable early identification and risk stratification of fundus functional lesions in patients with PIH could reduce the frequency of routine ophthalmic screening and address an important clinical need. Based on this, the present study explored the influencing factors of fundus functional lesions in patients with PIH and innovatively developed a nomogram-based risk prediction model. This model is expected to complement existing risk assessment strategies and provide quantitative support for targeted screening and early intervention in clinical practice, thereby improving maternal and perinatal outcomes.

Materials and Methods

General Information

This study was approved by the hospital's medical ethics committee. A retrospective cohort of 307 PIH patients admitted to our hospital from May 2020 to July 2024 was selected. Using simple random sampling, patients were divided into a training set (215 cases) and a validation set (92 cases, internal split-sample validation) at a 7:3 ratio. The training set was used to construct the nomogram model for predicting fundus functional lesions in PIH patients. Within the training set, patients were further categorized into a lesion group (50 cases) and a non-lesion group (165 cases) based on the presence of fundus functional lesions.

Inclusion criteria: ① Diagnosis of PIH and fundus functional lesions meeting established criteria;[7,8] ② Complete clinical data; ③ Age >18 years. Exclusion criteria: ① Pre-existing fundus functional lesions prior to pregnancy; ② Cognitive impairment or psychiatric disorders; ③ Other pregnancy-related comorbidities, including gestational diabetes mellitus, pregnancy-related renal disease, autoimmune diseases, thyroid dysfunction, and hematologic disorders; ④ Recent trauma or craniocerebral injury; ⑤ Malignancy; ⑥ Other endocrine or gynecological diseases. A flowchart of case selection is shown in Figure 1.

Methods

Clinical Data Collection

Collected variables included age, gestational weeks, parity, pre-pregnancy body mass index (BMI), disease duration (defined as the diagnostic course of PIH), obstructive sleep apnea (OSA) (diagnosed based on polysomnography; for patients with symptoms such as daytime sleepiness, unrefreshing sleep, or nocturnal choking/awakening, an apnea–hypopnea index [AHI] ≥5 events/h with predominantly obstructive events was considered diagnostic; for asymptomatic patients, an AHI ≥15 events/h with predominantly obstructive events was required), and indicators measured at the time of PIH diagnosis, including maximum systolic blood pressure (SBP) (refers to the highest systolic blood pressure measured at the time of PIH diagnosis), minimum SBP, maximum diastolic blood pressure (DBP), minimum DBP, proteinuria[9] (graded as negative: <0.15 g/24 h; weakly positive: 0.15–<0.5 g/24 h; positive: 0.5–<2.0 g/24 h; strongly positive: 2.0–<4.0 g/24 h), edema severity[10] (graded as no edema, mild, moderate, or severe according to clinical criteria), hematocrit (the median hematocrit among all PIH patients in this study was 35%), platelet count (PLT), albumin (ALB), alanine aminotransferase (ALT), and aspartate aminotransferase (AST). All clinical and laboratory data were obtained from the hospital electronic medical record system and laboratory information system. All data were independently entered by two investigators, with discrepancies resolved by a third investigator through review of the original records.

Fundus Functional Lesions

In this study, fundus functional lesions[8] were defined as the presence of any of the following abnormalities detected by fundus photography, optical coherence tomography (OCT), or visual function examinations: (1) Abnormal fundus photography findings, including retinal arterial spasm, arteriovenous crossing changes, cotton-wool spots, flame-shaped hemorrhages, hard exudates, and optic disc edema, which are characteristic manifestations of hypertensive retinopathy; (2) Abnormal OCT findings,

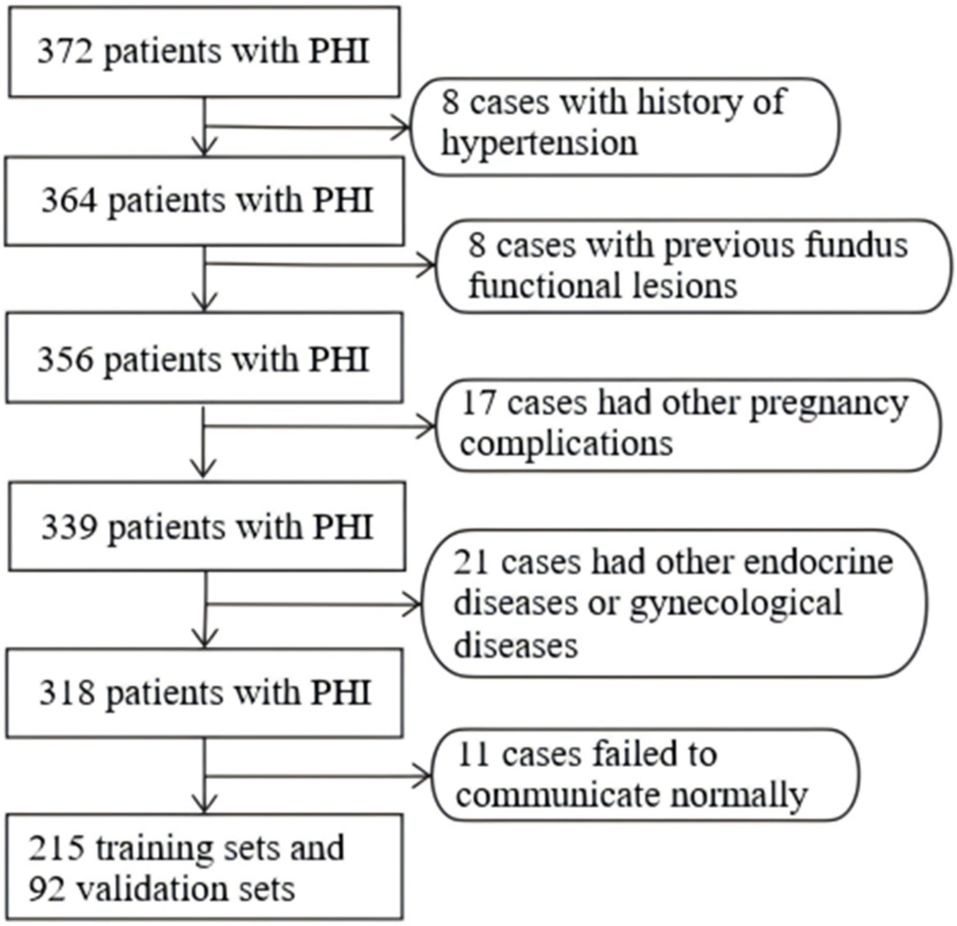

Figure 1 Flowchart of case collection.

including macular retinal thickening, abnormal retinal nerve fiber layer thickness, serous retinal detachment, and retinal pigment epithelial detachment; (3) Abnormal visual function findings, including decreased visual acuity, visual field defects, and reduced contrast sensitivity.

Statistical Analysis

IBM-SPSS 25.0 software was used for statistical analysis. Measurement data (all normally distributed) are expressed as mean ± standard deviation ($\bar{x} \pm s$) and analyzed using independent-sample t-tests. Count data are expressed as [n (%)] and analyzed using χ^2-tests. Multivariate logistic regression was performed to identify influencing factors of fundus functional lesions in PIH patients, after multicollinearity analysis was conducted for variables with $P < 0.05$ in univariate analysis, and variables without multicollinearity were entered into the multivariate mo additionally, restricted cubic spline analyses showed that the continuous variables pre-pregnancy BMI, maximum SBP, and PLT satisfied the logit linearity assumption (all $P > 0.05$). R 4.3.3 software was utilized to construct the nomogram model and perform internal and split-sample validation. The receiver operating characteristic (ROC) curve was used to evaluate the model's discrimination (pROC package), the Hosmer-Lemeshow test to assess model fit, and calibration curves to evaluate consistency (rms package). Decision curve analysis (DCA) was applied to assess clinical utility (rmda package). A $P < 0.05$ indicated statistical significance.

Results

Comparison of Clinical Data Between the Validation and Training Sets

No statistically significant differences were observed between the validation and training sets in age, gestational weeks, parity, pre-pregnancy BMI, maximum SBP, minimum SBP, maximum DBP, minimum DBP, proteinuria, edema severity, disease duration, OSA, hematocrit, PLT, ALB, ALT, or AST ($P > 0.05$).

Univariate Analysis of Fundus Functional Lesions in PIH Patients in the Training Set

No significant differences were found between the non-lesion and lesion groups in age, gestational weeks, parity, minimum SBP, maximum DBP, minimum DBP, proteinuria, edema severity, disease duration, ALB, ALT, or AST ($P > 0.05$). The lesion group had lower pre-pregnancy BMI and PLT, but higher maximum SBP, proportion of OSA, and proportion of hematocrit ≥35% compared to the non-lesion group ($P < 0.05$). See Table 1.

Multivariate Logistic Regression Analysis of Fundus Functional Lesions in PIH Patients in the Training Set

Variables with $P < 0.05$ in the univariate analysis (pre-pregnancy BMI, maximum SBP, OSA, hematocrit, and PLT) were included as independent variables, with fundus functional lesions as the dependent variable. Variable assignments are detailed in Table 2. The variance inflation factor (VIF) values for all independent variables were <10, indicating no

Table 1 Univariate Analysis of Fundus Function Lesions in Patients with PIH in the Training Set[n (%)/($\bar{x} \pm s$)]

Index	No Lesion Group (n=165)	Lesion Group (n=50)	χ^2/t	P
Age (years)	30.14±3.26	30.22±3.67	0.148	0.883
Gestational age (weeks)	32.75±1.40	32.50±1.85	1.022	0.308
Gravidity[n (%)]			0.081	0.775
<2 times	83 (50.30)	24 (48.00)		
≥2 times	82 (49.70)	26 (52.00)		
Pre pregnancy BMI (kg/m^2)	22.45±1.76	20.18±1.64	8.113	0.000
Maximum SBP (mmHg)	163.28±9.73	175.46±8.82	7.918	0.000
Minimum SBP (mmHg)	135.26±14.75	138.62±15.08	1.404	0.162
Maximum DBP (mmHg)	108.44±9.12	109.63±9.25	0.806	0.421
Minimum DBP (mmHg)	89.32±7.96	90.08±8.10	0.589	0.556
Proteinuria[n (%)]			0.810	0.847
–	25 (15.15)	8 (16.00)		
+	74 (44.85)	20 (40.00)		
++	44 (26.67)	13 (26.00)		
+++	22 (13.33)	9 (18.00)		
Degree of edema[n (%)]			3.738	0.291
–	21 (12.73)	9 (18.00)		
+	73 (44.24)	21 (42.00)		
++	47 (28.48)	9 (18.00)		
+++	24 (14.55)	11 (22.00)		
Duration (weeks)	3.02±1.01	3.10±1.12	0.478	0.633
OSA[n (%)]	5 (3.03)	11 (22.00)	17.387	0.000
Hematocrit (%)			18.985	0.000
<35	107 (64.85)	15 (30.00)		
≥35	58 (35.15)	35 (70.00)		
PLT (×10^9/L)	191.76±42.48	138.92±30.15	8.187	0.000
ALB (g/L)	31.92±5.13	32.66±5.40	0.883	0.378
ALT (U/L)	36.32±7.15	36.98±6.84	0.577	0.564
AST (U/L)	20.86±4.10	21.11±4.28	0.374	0.709

 https://doi.org/10.2147/IJWH.S569532

Table 2 Variable Assignment Table

Influence Factor	Assignment
Fundus functional lesion	Yes=1, no=0
Pre pregnancy BMI	Continuous variable
Maximum SBP	Continuous variable
OSA	Yes=1, no=0
Hematocrit	≥35%=1, <35%=0
PLT	Continuous variable

Table 3 Multivariate Logistic Regression Analysis of Fundus Function Lesions in Patients with PIH

Influence Factor	*β*	*SE*	*Waldχ^2*	*OR (95% CI)*	*P*	*VIF*
Pre pregnancy BMI	−1.379	0.339	16.552	0.252(0.130~0.489)	0.000	2.045
Maximum SBP	0.225	0.049	20.989	1.253(1.138~1.379)	0.000	1.459
OSA	2.436	1.127	4.674	11.430(1.256~14.045)	0.031	1.918
Hematocrit	1.726	0.738	5.470	5.619(1.323~23.874)	0.019	2.446
PLT	−0.029	0.010	9.200	0.971(0.953~0.990)	0.002	2.207
Constant	−6.963	9.453	0.543	0.461(-)	0.001	-

significant multicollinearity, and therefore all variables were eligible for inclusion in the multivariate logistic regression analysis. Multivariate logistic regression revealed that pre-pregnancy BMI, maximum SBP, OSA, hematocrit ≥35%, and PLT were independent influencing factors for fundus functional lesions in PIH patients ($P < 0.05$). Specifically, PIH patients with lower pre-pregnancy BMI, higher maximum SBP, the presence of OSA, hematocrit ≥35%, and lower PLT had an increased risk of developing fundus functional lesions. See Table 3.

Construction of the Nomogram Model

A nomogram model was constructed based on the multivariate logistic regression results, incorporating pre-pregnancy BMI, maximum SBP, OSA, hematocrit, and PLT. The equation was: Logit(P) = −6.963 − 1.379 × pre-pregnancy BMI + 0.225 × maximum SBP + 2.436 × OSA + 1.726 × hematocrit − 0.029 × PLT. The total score, derived by summing the points of all variables, was used to predict the risk probability of fundus functional lesions in PIH patients via a vertical line projection. See Figure 2.

Split-Sample Validation of the Nomogram Model

Internal validation showed that the ROC curve had an AUC (95% CI) of 0.926 (0.893–0.960), indicating high discrimination. The Hosmer-Lemeshow test yielded $\chi^2 = 1.417$ ($P = 0.994$), suggesting excellent model fit, and the calibration curve demonstrated strong consistency between predicted and actual probabilities. See Figure 3. Split-sample validation revealed an AUC (95% CI) of 0.852 (0.797–0.907), with the Hosmer-Lemeshow test showing $\chi^2 = 1.795$ ($P = 0.864$) and a well-fitted calibration curve. See Figure 4. The ROC curve analyses in both internal validation and split-sample validation yielded high AUC values, indicating excellent discriminative performance of the mo however, as this was a single-center study, the true predictive performance of the model may have been overestimated.

Clinical Utility of the Nomogram Model

Decision curve analysis (DCA) was performed to evaluate the clinical net benefit of the nomogram model. The “all-line” represents the assumption that all PIH patients have fundus functional lesions, while the “none-line” assumes no lesions. The nomogram model provided greater clinical benefit when the threshold probability ranged from 0.04 to 0.68. See Figure 5.

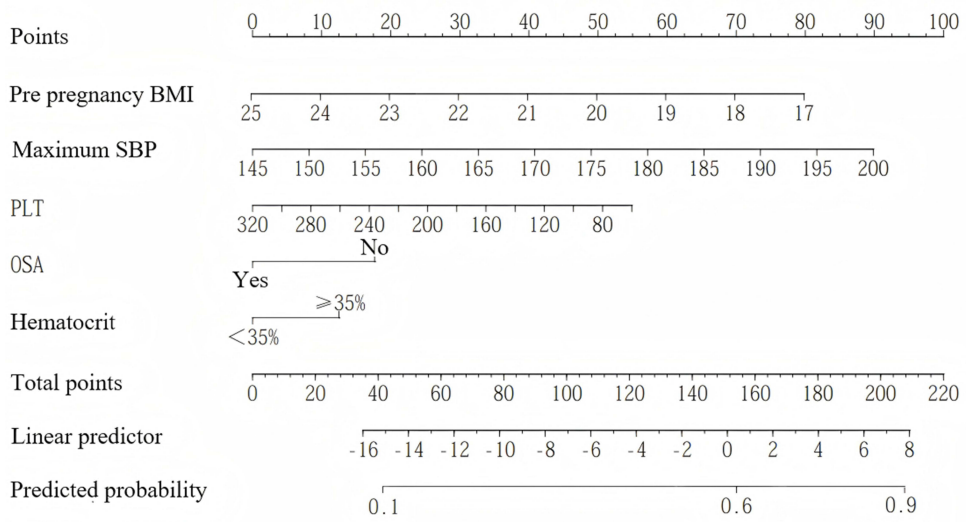

Figure 2 Nomogram model for fundus functional lesion risk in PIH patients.

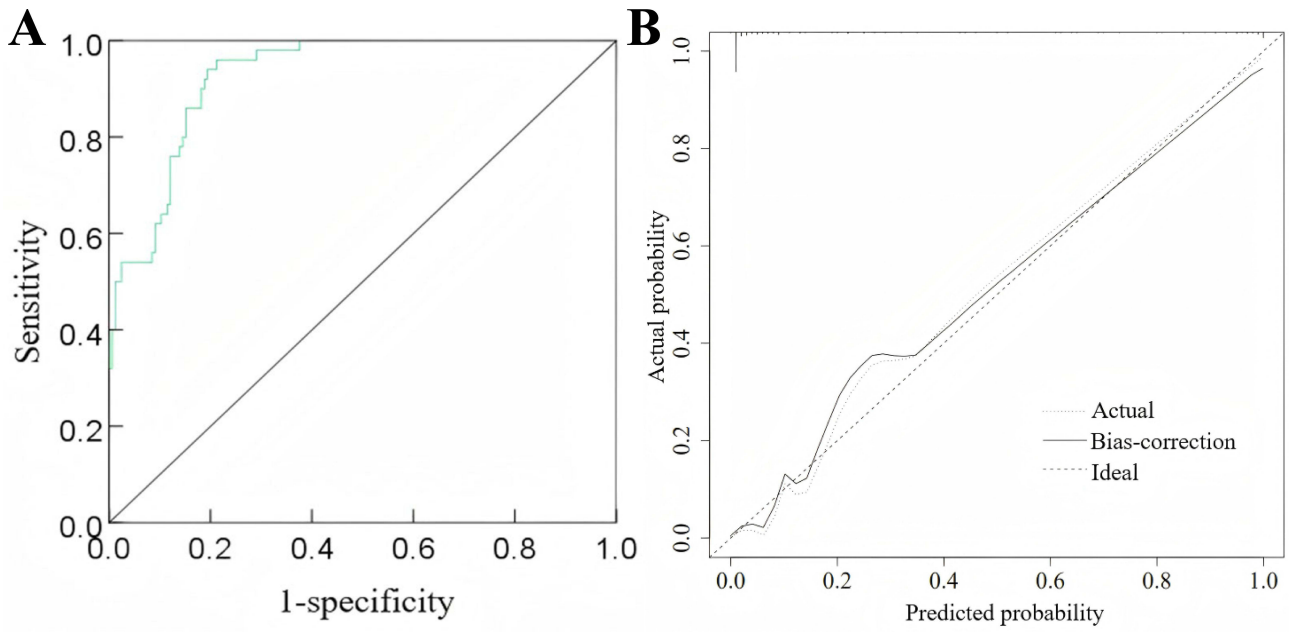

Figure 3 Internal validation of the nomogram model (**A**) ROC curve, (**B**) Calibration curve).

Discussion

Pregnancy-induced hypertension (PIH) is a common gestational complication, and its pathogenesis is linked to hemodynamic changes in the ocular arteries and characteristics of fundus lesions.[11] Elevated blood pressure in PIH leads to hemodynamic alterations in pregnant women, including inflammatory responses in blood vessel walls, vasospasm, and vasoconstriction.[12] Prolonged poorly controlled hypertension can induce pathological changes in fundus vessels, such as arterial spasm, hemorrhage, and vascular leakage,which subsequently lead to abnormalities in vascular structure and patterns and ultimately result in fundus functional lesions.[13–15] Therefore, early prevention is of great importance.

Pre-pregnancy BMI and maximum SBP: Kawakita et al[16] similarly reported that lower pre-pregnancy BMI was associated with retinopathy in PIH patients. Individuals with lower pre-pregnancy BMI often face risks such as underweight, comorbidities, and malnutrition. Poor health status may compromise immune function, while persistently elevated SBP levels under chronic hypertension may further disrupt systemic hemodynamic balance, aggravate

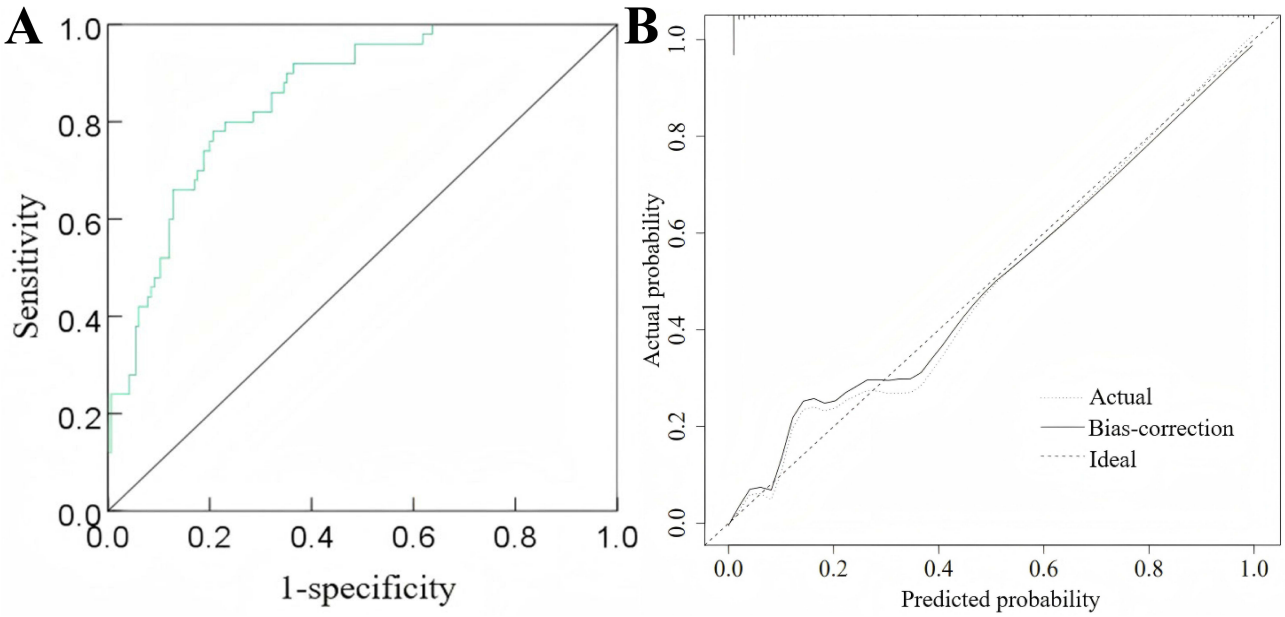

Figure 4 Internal split-sample validation of the nomogram model for fundus functional lesion risk in PIH patients (**A**) ROC curve, (**B**) Calibration curve).

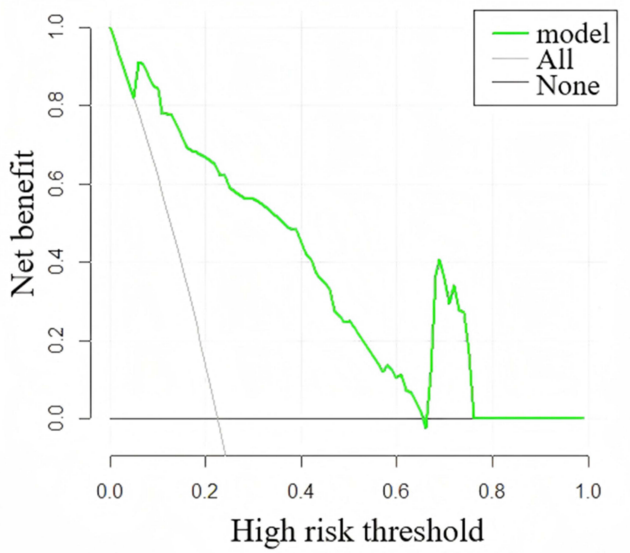

Figure 5 DCA curve of the nomogram model for fundus functional lesion risk in PIH patients.

generalized vascular spasm, and exacerbate retinal endothelial cell injury, ultimately leading to pathological retinal changes and the development of fundus functional lesions. OSA: During pregnancy, factors such as weight gain and tongue enlargement increase the likelihood of OSA. Prior studies found OSA prevalence rates of 10.7% in early pregnancy and 24.1% in late pregnancy.[17] Pan et al[18] further demonstrated an association between central serous chorioretinopathy and OSA severity. OSA may induce recurrent nocturnal hypoxia, triggering stress responses and hypothalamic-pituitary-adrenal axis dysfunction, thereby disrupting choroidal vascular microenvironments. Hematocrit: Morikawa et al[19] also identified hematocrit ≥35% as a risk factor for fundus functional lesions in PIH patients. Elevated hematocrit reflects increased blood volume expansion, which may disrupt arterial hemodynamic balance, alter blood flow velocity and vascular permeability, and accelerate retinal vasculopathy, choroidal infarction, or retinal detachment. PLT: Pathological features of PIH include vascular endothelial damage, characterized by platelet aggregation, increased

https://doi.org/10.2147/IJWH.S569532

vascular permeability, and release of active substances.[20] In preeclampsia, reduced PLT and elevated mean platelet volume may promote thrombogenic factors, exacerbating vasospasm, retinal ischemia, hypoxia, and detachment.[21] In the present study, the mean platelet count (PLT) in patients with fundus functional lesions fell within the clinically significant range of thrombocytopenia. In PIH, thrombocytopenia is not only a typical feature of severe preeclampsia/HELLP syndrome but also reflects the severity of disease progression. Thrombocytopenia mainly results from endothelial injury, whereby exposure of collagen fibers activates platelets, leading to platelet aggregation within the microvasculature and excessive platelet consumption and activation. This consumptive thrombocytopenia is closely associated with microthrombus formation; therefore, a reduced PLT level serves as an important marker of microvascular damage and a key predictive factor for fundus functional lesions.

The nomogram, a widely used predictive model in recent years, integrates multiple factors into a user-friendly, visual mathematical tool.[22] This study consolidated five key predictors of fundus functional lesions in PIH patients to construct a nomogram model. Validation revealed high consistency between calibration and ideal curves, with ROC curves showing AUCs >0.85 in both internal and split-sample validation. Previous studies have constructed prediction models incorporating nine factors, including maternal age, eclampsia and preeclampsia, and gestational diabetes mellitus, achieving AUC values of 0.75 and 0.74 for predicting adverse ocular outcomes in pregnant women.[23] Compared with these studies, the present model achieved higher predictive performance using fewer predictors; however, the single-center study design may have led to an overestimation of its performance. The Hosmer-Lemeshow test confirmed no significant discrepancy between predicted and actual data, indicating strong calibration and predictive accuracy. Furthermore, decision curve analysis (DCA) demonstrated favorable net benefits across most threshold probabilities, indicating good clinical applicability. The potential clinical applications of this model include early screening and risk stratification, whereby obstetricians assess high-risk pregnant women in early gestation, develop individualized monitoring plans, perform dynamic evaluations, and adjust management strategies in a timely manner. For patients at very high risk of fundus functional lesions, the model can guide the timing and level of referral. Preventive interventions may include lifestyle modifications such as weight control, low-salt diet, regular sleep patterns, vascular management, and treatment of obstructive sleep apnea (OSA). Establishing a multidisciplinary management team allows for regular consultations and tailored treatment plans for high-risk patients. The model enables identification of high-risk individuals before clinical symptoms appear, improving early detection of fundus lesions and preventing severe complications. Additionally, it facilitates optimal allocation of medical resources by prioritizing high-risk patients, improves maternal and fetal outcomes, reduces healthcare costs, and guides individualized treatment.

Limitations of this study include: First, as a retrospective study, many traditional key risk factors were not collected, which may represent potential confounders,such as family history, smoking history, alcohol use,and glycemic control. Future studies should incorporate these variables to refine the model. Second, due to the retrospective design,causal relationships cannot be inferred. Third, the sample size was at the lower limit of the EPV principle, which may increase the risk of overfitting, and larger datasets are needed for validation. Fourth, the relatively small sample size led to wide 95% confidence intervals for some variables, indicating potential instability and imprecision of the results. Fifth, the timing of measurements for variables such as maximum SBP needs to be expanded; future studies could collect data at multiple time points to further explore their predictive value. Despite the absence of these traditional key variables, the model still performed well, highlighting the significance of the current findings. Finally, the data are from a single-center; although internal split-sample validation was conducted to assess the stability of the nomogram, external validation with multicenter cohorts and diverse populations is still needed, making multicenter studies the direction for future research.

Conclusions

Pre-pregnancy BMI, maximum systolic blood pressure, OSA, hematocrit, and platelet count were independent predictors of retinal functional lesions in PIH patients. The developed nomogram demonstrated good predictive performance and may serve as a helpful clinical tool, pending further external validation;however,multicenter, prospective studies are still needed to confirm its clinical applicability.

Data Sharing Statement

The datasets in this study are available from the corresponding author.

Ethics Approval and Consent to Participate

The study was in accordance with Meizhou People's Hospital ethics review board (ethics number: 2024-C-91, approval date: May 25, 2024) and with the 1964 Helsinki Declaration. Written informed consent to participate in this study was provided by the participants.

Consent for Publication

All authors give consent for publication.

Funding

There is no funding to report.

Disclosure

The authors declared no conflicts of interest in this work.

References

1. Farahi N, Oluyadi F, Dotson AB. Hypertensive disorders of pregnancy. *Am Fam Physician*. 2024;109(3):251–260.
2. Barry MJ, Nicholson WK, Silverstein M, et al. Screening for hypertensive disorders of pregnancy: US Preventive Services Task Force Final Recommendation Statement. *JAMA*. 2023;330(11):1074–1082. doi:10.1001/jama.2023.16991
3. Newman C, Petruzzi V, Ramirez PT, et al. Hypertensive Disorders of Pregnancy. *Methodist Debakey Cardiovasc J*. 2024;20(2):4–12. doi:10.14797/mdcvj.1305
4. Lee H, Yang S-W, Kim Y, et al. Risk of retinopathy in women with pregnancy-induced hypertension: a nationwide population-based cohort study of 9-year follow-up after delivery. *Am J Obstet Gynecol MFM*. 2023;5(7):100985. doi:10.1016/j.ajogmf.2023.100985
5. Yata K, Hashimoto R, Masahara H, et al. Changes in choroidal circulation and pulse waveform in a case of pregnancy-induced hypertension with serous retinal detachment. *Am J Ophthalmol Case Rep*. 2020;20:100911. doi:10.1016/j.ajoc.2020.100911
6. Dai X, Kang L, Ge H. Doppler parameters of ophthalmic artery in women with preeclampsia: a meta-analysis. *J Clin Hypertens*. 2023;25(1):5–12. doi:10.1111/jch.14611
7. Cífková R. Hypertension in pregnancy: a diagnostic and therapeutic overview. *High Blood Press Cardiovasc Prev*. 2023;30(4):289–303. doi:10.1007/s40292-023-00582-5
8. Warad C, Midha B, Pandey U, et al. Ocular manifestations in pregnancy-induced hypertension at a Tertiary Level Hospital in Karnataka, India. *Cureus*. 2023;15(2):e34887. doi:10.7759/cureus.34887
9. Aynaoğlu Yildiz G, Topdağı Yilmaz EP. The association between protein levels in 24-hour urine samples and maternal and neonatal outcomes of pregnant women with preeclampsia. *J Turk Ger Gynecol Assoc*. 2022;23(3):190–198. doi:10.4274/jtgga.galenos.2022.2022-4-3
10. Yanagisawa N, Koshiyama M, Watanabe Y, et al. A quantitative method to measure skin thickness in leg Edema in pregnant women using B-scan portable ultrasonography: a comparison between obese and non-obese women. *Med Sci Monit*. 2019;25:1–9. doi:10.12659/MSM.911799
11. Matias DS, Santos R, Ferreira T, et al. Predictive value of ophthalmic artery Doppler velocimetry in relation to hypertensive disorders of pregnancy. *J Clin Ultrasound*. 2020;48(7):388–395. doi:10.1002/jcu.22823
12. Diniz ALD, Paes MMBM. Ophthalmic artery Doppler in hypertensive pregnancies: small vessel, many possibilities. *BJOG*. 2023;130(1):118–119. doi:10.1111/1471-0528.17318
13. Silverman RH, Urs R, Wapner RJ, et al. Plane-wave ultrasound Doppler of the eye in preeclampsia. *Transl Vis Sci Technol*. 2020;9(10):14. doi:10.1167/tvst.9.10.14
14. Ansari Y, Kale AU, Tallouzi MO, et al. Sudden onset peripheral visual deficit secondary to retinal artery spasm in Raynaud's phenomenon. *BMJ Case Rep*. 2021;14(2):e239954. doi:10.1136/bcr-2020-239954
15. Fung AT, Yang Y, Kam AW. Central serous chorioretinopathy: a review. *Clin Exp Ophthalmol*. 2023;51(3):243–270. doi:10.1111/ceo.14201
16. Kawakita T, Bowers K, Coviello E, et al. Prepregnancy weight in women with type I diabetes mellitus: effect on pregnancy outcomes. *Am J Perinatol*. 2016;33(13):1300–1305. doi:10.1055/s-0036-1586506
17. Izci-Balserak B, Zhu B, Gurubhagavatula I, et al. A screening algorithm for obstructive sleep apnea in pregnancy. *Ann Am Thorac Soc*. 2019;16(10):1286–1294. doi:10.1513/AnnalsATS.201902-131OC
18. Pan CK, Vail D, Bhattacharya J, et al. The effect of obstructive sleep apnea on absolute risk of central serous chorioretinopathy. *Am J Ophthalmol*. 2020;218:148–155. doi:10.1016/j.ajo.2020.05.040
19. Morikawa M, Cho K, Kojima T, et al. Risk factors for central serous chorioretinopathy in pregnant Japanese women. *J Obstet Gynaecol Res*. 2017;43(5):866–872. doi:10.1111/jog.13289
20. De Almeida LGN, Young D, Chow L, et al. Proteomics and metabolomics profiling of platelets and plasma mediators of thrombo-inflammation in gestational hypertension and preeclampsia. *Cells*. 2022;11(8):1256. doi:10.3390/cells11081256
21. Ye L, Shi M-D, Zhang Y-P, et al. Risk factors and pregnancy outcomes associated with retinopathy in patients presenting with severe preeclampsia: a retrospective cohort study. *Medicine*. 2020;99(11):e19349. doi:10.1097/MD.0000000000019349

22. Zhong X, Zhang P. Analysis of risk factors associated with different degrees of postpartum hemorrhage in patients with pregnancy-induced hypertension and construction of a prediction model using line graph. *J Matern Fetal Neona*. 2023;36(2):2239983. doi:10.1080/14767058.2023.2239983
23. Liu X, Wen Y, Zou H, et al. A model to predict the risk of adverse ocular outcomes in pregnant women. *Br J Hosp Med*. 2024;85(11):1–15. doi:10.12968/hmed.2024.0365