

ORIGINAL ARTICLE

Serum Vitamin D Combined with Obstetric Parameters to Construct a Nomogram Model for Predicting the Risk of PFD Disorders

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ABSTRACT

Background: Postpartum pelvic floor dysfunction (PFD) significantly impacts women's quality of life and mental health. Although existing studies suggest various obstetric factors may contribute to PFD, there is a lack of early prediction tools based on readily available indicators. This study aimed to develop a nomogram model incorporating serum 25-hydroxyvitamin D [25(OH)VitD] levels and routine obstetric parameters to predict the risk of PFD.

Methods: A total of 300 women who delivered and completed a 6-week postpartum follow-up were enrolled. Data on age, body mass index (BMI), duration of the second stage of labor, neonatal birth weight, and serum 25(OH)VitD levels within 24 hours postpartum were collected. Participants were divided into PFD and non-PFD groups based on follow-up outcomes. Logistic regression analysis was used to identify independent risk factors for PFD, and a nomogram prediction model was constructed. The model's performance was evaluated using receiver operating characteristic curve analysis, calibration curves, and decision curve analysis (DCA).

Results: Multivariate logistic regression revealed that age, BMI, duration of the second stage of labor, birth weight, and 25(OH)VitD levels were independent predictors of PFD ($p < 0.05$). The nomogram model achieved an AUC of 0.830 with calibration curves demonstrating good agreement between predicted and observed probabilities. DCA indicated substantial clinical net benefit across a wide probability threshold range.

Conclusions: The developed nomogram model effectively predicts postpartum PFD risk using easily obtainable pre- and post-delivery indicators. This model may facilitate early identification of high-risk individuals, guiding personalized rehabilitation strategies and improving early intervention and prevention of PFD.

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KEYWORDS

pelvic floor dysfunction, 25-hydroxyvitamin D, nomogram, prediction model

INTRODUCTION

Pelvic floor dysfunction (PFD), including pelvic organ prolapse, stress urinary incontinence, and chronic pelvic pain, is highly prevalent among postpartum women. Its complex clinical manifestations, prolonged course, and associated functional impairments, social role limitations, and psychological distress significantly affect quality of life and psychosocial functioning [1-3]. Pregnancy and childbirth are recognized as major risk fac-

tors for PFD. Both vaginal delivery and cesarean section may cause varying degrees of damage to the pelvic floor muscles and connective tissues, with some injuries potentially leading to irreversible occult harm, thereby establishing a foundation for subsequent PFD development [4,5]. Although clinical assessments at 6 weeks postpartum using symptom scales guide rehabilitation strategies, the lack of effective tools for early individualized PFD risk prediction hinders timely identification and preventive interventions.

Existing studies have identified advanced maternal age, high body mass index (BMI), and prolonged second-stage labor as significant obstetric risk factors for PFD [2,6]. Nomograms, as visual predictive tools, have been increasingly applied for individualized PFD risk assessment, thereby improving clinical identification efficiency [7,8]. However, current models primarily focus on structural or demographic factors, with limited integration of modifiable exogenous variables such as nutritional, metabolic, or inflammatory markers, which restricts their generalizability and interventional utility.

Vitamin D, typically assessed via serum 25-hydroxyvitamin D [25(OH)D] levels, plays essential physiological roles beyond calcium-phosphate metabolism, including muscle strength regulation, connective tissue remodeling, and inflammatory response modulation [9,10]. Evidence suggests that vitamin D deficiency contributes to reduced muscle strength and impaired neuromuscular balance, potentially weakening pelvic floor support structures by affecting skeletal muscle contraction and connective tissue homeostasis [11,12]. Furthermore, low vitamin D levels have been associated with increased musculoskeletal pain and diminished pelvic floor muscle strength in women [13]. As a modifiable nutritional biomarker, vitamin D's predictive value is gaining attention, yet its role in PFD risk assessment remains poorly quantified.

This study aims to develop and validate a nomogram integrating serum 25(OH)D levels and key obstetric factors to predict individualized PFD risk at 6 weeks postpartum. Leveraging routinely collected clinical and biochemical data from the early postpartum period, this model seeks to provide a concise and reliable risk stratification tool for early high-risk identification and personalized intervention strategies, ultimately reducing PFD incidence and disease burden.

MATERIALS AND METHODS

Study participants

This prospective study enrolled postpartum women who completed follow-up at a tertiary hospital between January 1, 2020, and January 1, 2025. Inclusion criteria included: age 22 - 42 years, singleton pregnancy, gestational age ≥ 37 weeks at delivery, vaginal or cesarean delivery, serum sample collection within 24 hours postpartum, completion of 6-week postpartum follow-up with questionnaire data, and availability of complete

clinical and laboratory records (including serum 25(OH) VitD levels and obstetric parameters). Exclusion criteria comprised: prior diagnosis or treatment for PFD (including stress urinary incontinence or organ prolapse); neurological conditions affecting pelvic floor assessment (such as spinal cord injury or degenerative central nervous system disorders); high-dose vitamin D supplementation during pregnancy/postpartum (exceeding recommended intake); pregnancy-related severe hepatic or metabolic disorders (including intrahepatic cholestasis and chronic kidney disease); active or treated malignancies; and incomplete data or loss to follow-up. All participants provided written informed consent, and the study protocol was approved by the Institutional Ethics Committee of the Muping District Traditional Chinese Medicine Hospital.

Data collection

Baseline variables associated with PFD were collected, comprising demographic characteristics and obstetric parameters: age (years), pre-delivery BMI (kg/m^2), mode of delivery, episiotomy (yes/no), perineal tear (yes/no), tear grade, duration of the second stage of labor (minutes), neonatal birth weight (grams), fetal macrosomia (yes/no), and serum 25(OH) VitD level (nmol/L). All variables were extracted from electronic medical records and follow-up questionnaires for subsequent group comparisons and nomogram model construction.

Definition of PFD outcomes

Pelvic floor function was assessed using the Pelvic Floor Distress Inventory-20 (PFDI-20) questionnaire, originally developed by Barber et al. (2005) in the United States and subsequently validated in diverse linguistic and cultural contexts, including Dutch and Chinese populations [14,15]. This internationally recognized tool evaluates symptoms across three domains: urinary, colorectal, and pelvic organ prolapse, through 20 items with total scores ranging from 0 to 300. Using established international criteria and previous studies, participants with PFDI-20 scores > 60 were classified into the PFD group, whereas those scoring ≤ 60 were assigned to the non-PFD group. This classification served as the foundation for subsequent statistical analyses and model development.

Measurement of serum total 25(OH) VitD levels

Venous blood samples (5 mL) were collected within 24 hours postpartum using BD Vacutainer® SST™ tubes (Becton Dickinson, USA; Cat. No. 367986) containing clot activator. Following 30 minutes of clotting at room temperature, samples were centrifuged at $3,000 \times g$ for 10 minutes to separate serum, which was either immediately analyzed or stored at 4°C until testing. Serum total 25(OH) VitD concentrations were measured using electrochemiluminescence immunoassay on a Cobas e601 automated analyzer (Roche Diagnostics, Switzerland). The assay employs a competitive binding princi-

ple utilizing vitamin D-binding protein for specific detection of both 25(OH)D₂ and 25(OH)D₃ metabolites. Results were automatically converted from mass units (ng/mL) to molar concentrations (nmol/L) using a standard conversion factor (1 ng/mL - 2.5 nmol/L) and reported to one decimal place. The assay demonstrated an analytical measurement range of 12.5 - 250 nmol/L, with a lower limit of quantification of 12.5 nmol/L. Method validation studies showed coefficients of variation < 10% for medium/high concentration samples (50 - 250 nmol/L) and 10 - 15% for low concentration samples (12.5 - 50 nmol/L). Based on Endocrine Society clinical practice guidelines, vitamin D status was categorized as deficient (< 50 nmol/L), insufficient (50 - 74 nmol/L), or sufficient (≥ 75 nmol/L) [16]. The 75 nmol/L sufficiency threshold was adopted for all analyses in this study.

Statistical analysis

All analyses were performed using R software (version 4.3.1; R Foundation for Statistical Computing, Austria). Continuous variables with normal distribution were presented as mean ± standard deviation, while non-normally distributed variables were expressed as median (interquartile range). Categorical variables were reported as counts (percentages). The Shapiro-Wilk test assessed normality assumptions. Between-group comparisons were conducted using independent samples *t*-tests (normal distribution) or Mann-Whitney U tests (non-normal distribution) for continuous variables, and Pearson's χ^2 test or Fisher's exact test for categorical variables, as appropriate.

Univariate logistic regression analyses were performed to evaluate potential predictors of PFD ($p < 0.05$ for inclusion). Significant variables were subsequently entered into a multivariate logistic regression model using the `glm()` function (family = binomial) in R. Results were reported as regression coefficients with standard errors, Wald statistics, *p*-values, odds ratios (OR), and corresponding 95% confidence intervals (CIs).

The nomogram was developed using the `rms` and `regplot` packages in R, incorporating all significant predictors from the multivariate analysis. Model discrimination was assessed by calculating the area under the receiver operating characteristic (ROC) curve (AUC) with 95% CI. The optimal cutoff value was determined by maximizing Youden's index (sensitivity + specificity - 1). Calibration was evaluated using 1,000 bootstrap samples to generate calibration plots comparing predicted versus observed probabilities.

Decision curve analysis (DCA) was performed to evaluate clinical utility by calculating net benefits across probability thresholds ranging from 0% to 80%. All statistical tests were two-tailed, with *p*-values < 0.05 considered statistically significant.

RESULTS

Baseline characteristics of the study population

A total of 356 postpartum women were initially screened. Fifty-six were excluded because they did not meet the predefined inclusion criteria or had incomplete clinical or laboratory data, leaving 300 eligible postpartum women who were categorized into PFD ($n = 76$) and non-PFD ($n = 224$) groups based on pelvic floor dysfunction status (Table 1).

The PFD group demonstrated significantly higher maternal age (34.77 ± 4.86 vs. 30.45 ± 3.30 years, $p < 0.001$) and slightly elevated pre-delivery BMI (24.80 ± 2.33 vs. 24.11 ± 2.21 kg/m², $p = 0.026$). Regarding delivery parameters, prolonged second-stage labor (34.47 ± 26.96 vs. 24.21 ± 22.86 minutes, $p = 0.004$) and greater neonatal birth weight ($3,313.5 \pm 377.73$ vs. $3,166.84 \pm 394.38$ g, $p = 0.004$) were observed in the PFD group. Serum 25(OH)VitD levels were significantly lower in PFD participants (44.13 ± 12.49 vs. 52.07 ± 15.04 nmol/L, $p < 0.001$).

For categorical variables, no significant intergroup differences were noted in perineal tear incidence/grade ($p > 0.05$) or macrosomia rates (3/76 [3.9%] in the PFD group vs. 5/224 [2.2%] in the non-PFD group, $p = 0.697$).

Analysis of PFD risk factors and prediction model development

Univariate logistic regression analysis identified significant associations between pelvic floor dysfunction and several variables (Table 2): age (OR = 1.312, 95% CI: 1.215 - 1.418, $p < 0.001$), body mass index (OR = 1.145, 95% CI: 1.019 - 1.288, $p = 0.029$), episiotomy (OR = 2.005, 95% CI: 1.122 - 3.585, $p = 0.018$), second-stage duration (OR = 1.018, 95% CI: 1.007 - 1.029, $p = 0.001$), birth weight (OR = 1.001, 95% CI: 1.000 - 1.002, $p = 0.015$), and serum 25(OH)VitD levels (OR = 0.961, 95% CI: 0.943 - 0.980, $p < 0.001$).

Multivariate logistic regression analysis confirmed the following independent predictors of PFD: age (adjusted OR = 1.306, 95% CI: 1.203 - 1.418, $p < 0.001$), BMI (adjusted OR = 1.174, 95% CI: 1.017 - 1.356, $p = 0.028$), duration of second stage of labor (adjusted OR = 1.019, 95% CI: 1.006 - 1.033, $p = 0.004$), neonatal birth weight (adjusted OR = 1.001, 95% CI: 1.000 - 1.002, $p = 0.030$), and serum 25(OH)D concentrations (adjusted OR = 0.960, 95% CI: 0.938 - 0.982, $p < 0.001$). Variance inflation factors for all included variables were below 2.0, indicating no significant multicollinearity.

The final nomogram prediction model (Figure 1) was developed using the `rms` package in R and incorporated five independent predictors: maternal age, pre-delivery body mass index, duration of the second stage of labor, neonatal birth weight, and serum 25(OH)VitD concentration. In the nomogram, each predictor variable is assigned a corresponding point value on the upper axis scale. The sum of these points corresponds to a predict-

Table 1. Baseline Characteristics of Participants Stratified by PFD Status.

Variable	Non-PFD (n = 224)	PFD (n = 76)	p-value
Age (y)	30.45 ± 3.3	34.77 ± 4.86	< 0.001
BMI (kg/m ²)	24.11 ± 2.21	24.8 ± 2.33	0.026
Second stage (min)	24.21 ± 22.86	34.47 ± 26.96	0.004
Birth weight (g)	3,166.84 ± 394.38	3,313.5 ± 377.73	0.004
Serum 25(OH)VitD (nmol/L)	52.07 ± 15.04	44.13 ± 12.49	< 0.001
Mode of Delivery			0.289
Vaginal delivery	133 (72.3%)	51 (27.7%)	
Cesarean delivery	91 (78.4%)	25 (21.6%)	
Episiotomy			0.027
No	180 (77.9%)	51 (22.1%)	
Yes	44 (63.8%)	25 (36.2%)	
Perineal Tear			0.167
No	140 (77.8%)	40 (22.2%)	
Yes	84 (70.0%)	36 (30.0%)	
Tear Grade			0.286
None	140 (77.8%)	40 (22.2%)	
Mild	57 (71.2%)	23 (28.7%)	
Moderate-to-Severe	27 (67.5%)	13 (32.5%)	
Macrosomia			0.697
No	219 (75.0%)	73 (25.0%)	
Yes	5 (62.5%)	3 (37.5%)	

Continuous variables are expressed as mean ± standard deviation. Categorical variables are presented as number (percentage), with percentages calculated within each category across the two groups (row percentages). p-values were derived from Student's *t*-test for continuous variables and chi-squared test for categorical variables. *p* < 0.05 indicates statistical significance.

BMI: body mass index, 25(OH)VitD: 25-hydroxyvitamin D, Macrosomia: birth weight ≥ 4,000 g.

Table 2. Univariate and Multivariate Logistic Regression Analysis for Predictors of Postpartum PFD.

Factors	Univariate analysis			Multivariate analysis		
	p	OR	95% CI	p	OR	95% CI
Age (years)	< 0.001	1.312	1.215 - 1.418	< 0.001	1.306	1.203 - 1.418
BMI (kg/m ²)	0.029	1.145	1.019 - 1.288	0.028	1.174	1.017 - 1.356
Mode of delivery	0.232	1.396	0.807 - 2.414			
Episiotomy (yes vs. no)	0.018	2.005	1.122 - 3.585	0.253	1.525	0.740 - 3.143
Perineal tear (yes vs. no)	0.129	1.500	0.887 - 2.536			
Second stage (min)	0.001	1.018	1.007 - 1.029	0.004	1.019	1.006 - 1.033
Birth weight (g)	0.015	1.001	1.000 - 1.002	0.030	1.001	1.000 - 1.002
Serum 25(OH)VitD level (nmol/L)	< 0.001	0.961	0.943 - 0.980	< 0.001	0.960	0.938 - 0.982
Fetal macrosomia (yes vs. no)	0.422	1.800	0.420 - 7.717			

Univariate logistic regression was used to estimate crude odds ratios (ORs) and 95% confidence intervals (CIs). Variables with *p* < 0.05 in univariate models were included in the multivariate logistic regression to calculate adjusted ORs. Wald χ^2 tests were used to assess statistical significance in both models.

p < 0.05 was considered statistically significant.

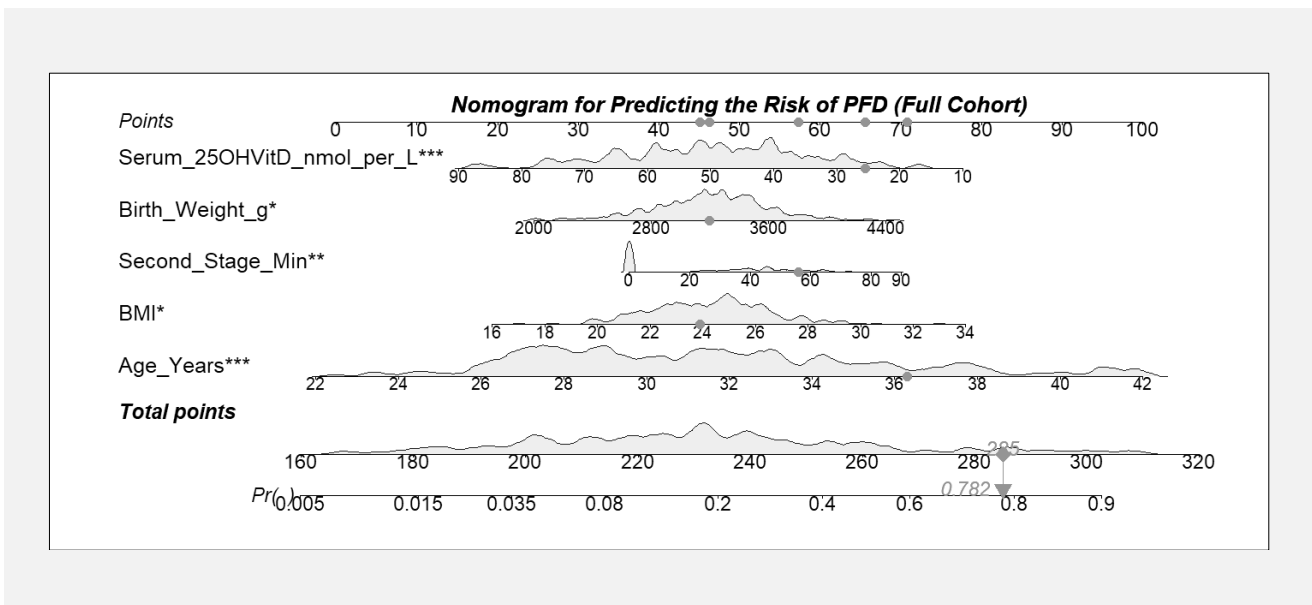
OR: odds ratio, CI: confidence interval, BMI: body mass index, 25(OH)VitD: 25-hydroxyvitamin D.

Table 3. Discriminative Performance of the Nomogram Model and Individual Predictors for Postpartum PFD.

Indexes	AUC	95% CI	Sensitivity (%)	Specificity (%)	Youden index
Age	0.749	0.679 - 0.820	48.68	95.98	0.447
BMI	0.584	0.507 - 0.661	28.95	87.05	0.160
Second stage duration	0.620	0.543 - 0.698	51.32	75.00	0.263
Birth weight	0.594	0.521 - 0.667	82.89	32.59	0.155
Serum 25(OH)D	0.660	0.593 - 0.728	72.37	55.80	0.282
Nomogram model	0.830	0.777 - 0.882	76.32	74.55	0.509

The nomogram prediction model showed the highest discriminative ability among all tested predictors. Youden index = (sensitivity + specificity) - 1.

AUC: area under the curve, CI: confidence interval, PFD: pelvic floor dysfunction, BMI: body mass index, 25(OH)D: 25-hydroxyvitamin D.

**Figure 1. Nomogram for predicting postpartum PFD risk.**

The predictive model incorporates five independent risk factors identified through multivariate logistic regression analysis: maternal age, BMI, duration of second stage of labor, neonatal birth weight, and serum 25(OH)VitD levels. Each variable is assigned a corresponding point value on the points scale, with the sum of these points converting to predicted probability on the bottom probability scale. The density distributions behind each axis represent the cohort's variable distributions. Statistical significance levels are denoted as: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

ed probability of developing postpartum pelvic floor dysfunction on the lower probability axis. Notably, serum 25(OH)VitD level was identified as the only protective factor in the model, with higher concentrations associated with decreased risk of PFD, suggesting its potential as a modifiable target for pre-ventive interventions.

Model performance evaluation

The predictive performance of the nomogram was comprehensively evaluated across three key metrics: discrimination, calibration, and clinical utility.

Discrimination ability, assessed through ROC curve analysis, demonstrated that the multifactorial model incorporating five predictors achieved superior performance (AUC = 0.830, 95% CI: 0.777 - 0.882) compared with individual predictors. Among individual predictors, maternal age showed the highest discriminative ability (AUC = 0.749), followed by serum 25(OH)VitD level (AUC = 0.660). Comparative ROC curves and detailed performance metrics (including sensitivity, specificity, and Youden's index) are presented in Figure 2 and Table 3, respectively.

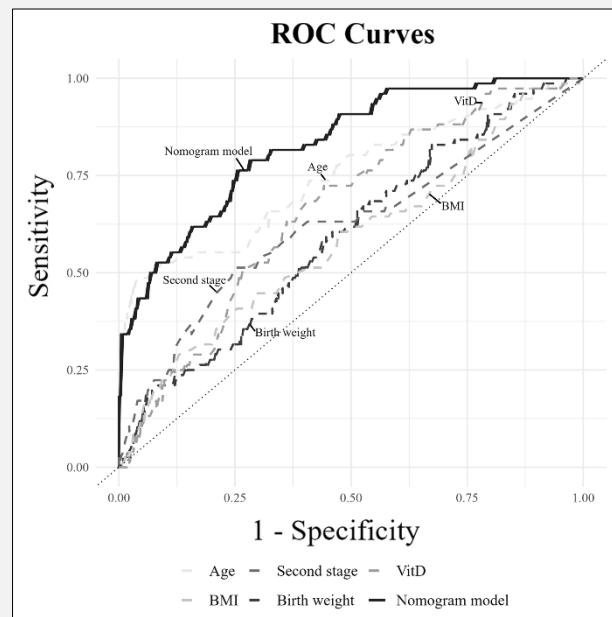


Figure 2. ROC curves comparing the nomogram model with single predictors.

The nomogram model (thick solid line) achieved an AUC of 0.830. Individual predictors are distinguished by different line types: age (dashed), BMI (dotted), second-stage duration (dotdash), birth weight (longdash), and serum 25(OH)VitD level (twodash). The gray dotted diagonal line represents random prediction (AUC = 0.5).

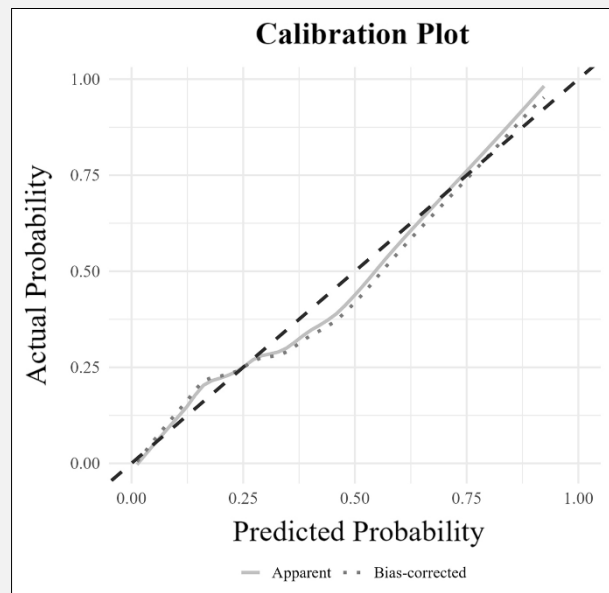


Figure 3. Calibration curve of the nomogram model for predicting postpartum PFD.

The calibration curve assesses the agreement between model-predicted probabilities and observed outcomes. The apparent (solid line) and bias-corrected (dotted line) curves after 1,000 bootstrap resamples closely approximate the ideal reference line (dashed line), with excellent calibration indicated by a mean absolute error of 0.03.

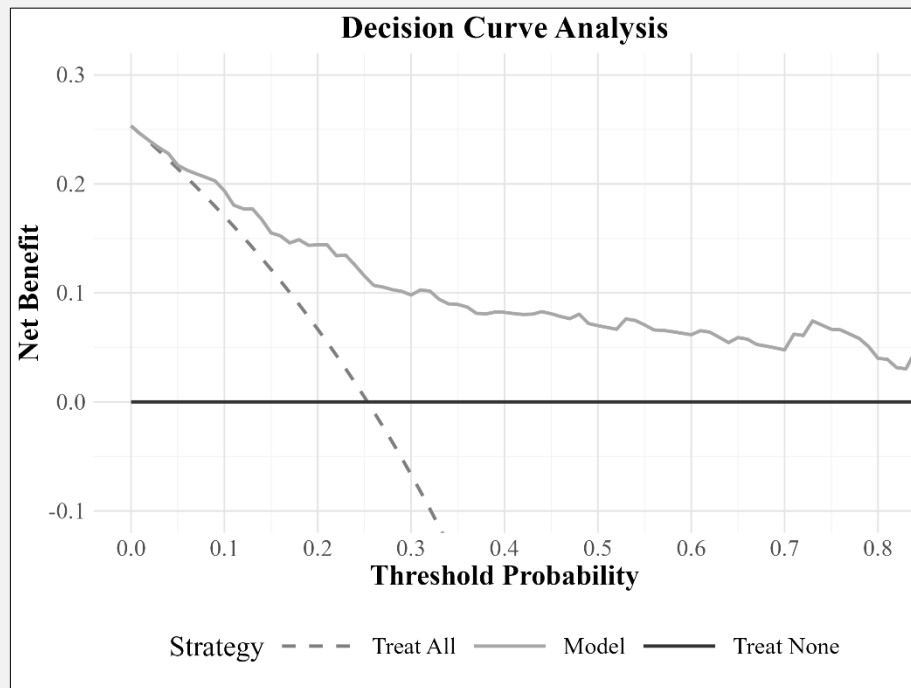


Figure 4. DCA of the nomogram model for predicting postpartum PFD.

The nomogram model (solid line) provides greater net benefit than the “treat all” (dashed line) and “treat none” (dotted horizontal line) strategies across threshold probabilities of 5% - 75%.

Calibration performance was evaluated using 1,000 bootstrap resamples, with the resulting calibration curve (Figure 3) demonstrating excellent agreement between predicted probabilities and observed outcomes (mean absolute error = 0.03). The bias-corrected curve closely followed the ideal reference line, indicating high predictive accuracy across the entire risk spectrum.

Clinical utility, examined through decision curve analysis (Figure 4), revealed that the nomogram provided greater net benefit than both “treat all” and “treat none” strategies across clinically relevant probability thresholds (5% - 75%). This finding supports the model’s practical value for guiding clinical decision-making in postpartum care.

DISCUSSION

This study developed and validated a nomogram model incorporating serum 25(OH)VitD levels and key obstetric parameters (age, BMI, second-stage duration, neonatal birth weight) to predict postpartum pelvic floor dysfunction risk. The model demonstrated excellent discrimination (AUC = 0.830), strong calibration (mean absolute error = 0.03), and significant clinical utility

across probability thresholds of 0.05 - 0.75 in decision curve analysis.

Vitamin D has been demonstrated to play crucial roles in skeletal muscle function maintenance, connective tissue homeostasis, and inflammatory regulation beyond its classical calcium-phosphorus metabolism functions [17]. The observed inverse association between serum 25(OH)VitD levels and PFD risk may be explained by vitamin D’s ability to enhance neuromuscular function and tissue repair capacity [13,18]. Systematic reviews indicate that vitamin D supports pelvic floor muscle integrity through regulation of skeletal muscle cell proliferation and extracellular matrix remodeling [17]. Although vitamin D supplementation trials have shown inconsistent effects on muscle strength improvements, observational studies consistently report better postural control and musculoskeletal coordination in individuals with sufficient vitamin D status [11]. Genetic variations in vitamin D receptor genes, particularly ApaI and BsmI polymorphisms, may modify individual susceptibility to PFD when combined with vitamin D deficiency [18], suggesting the potential for personalized risk assessment combining biochemical and genetic markers.

The study confirmed age as an independent predictor of PFD, consistent with existing literature demonstrating

progressive declines in pelvic floor muscle elasticity and connective tissue integrity with advancing age [19, 20]. Population-based studies report an increasing prevalence of PFD across successive decades of life after 30 years [2], highlighting the importance of age stratification in risk prediction models.

BMI demonstrated significant associations with PFD risk through multiple potential mechanisms, including mechanical stress from increased abdominal pressure, metabolic dysregulation, and reduced treatment adherence [21-23]. The observed association between elevated BMI and PFD risk persisted after adjustment for other obstetric factors, supporting its inclusion as an independent predictor in the model.

Delivery-related mechanical factors, particularly prolonged second-stage labor and higher birth weight, were strongly associated with PFD risk. These parameters likely reflect the degree of mechanical trauma to pelvic floor support structures during delivery [24-26]. The predictive value of these objectively measurable delivery parameters supports their incorporation into clinical risk assessment tools. The developed nomogram integrates both modifiable (vitamin D status, BMI) and non-modifiable (age, delivery parameters) risk factors, providing a comprehensive tool for early identification of high-risk individuals. The inclusion of serum 25(OH) VitD levels is particularly noteworthy, as it represents a potentially modifiable risk factor that could be targeted through nutritional interventions. Future research should focus on validating the model in diverse populations and evaluating the clinical impact of vitamin D supplementation in high-risk groups identified by the model. The association between episiotomy and pelvic floor dysfunction remains controversial. The current findings demonstrated no significant relationship between episiotomy/perineal tear grade and PFD development, consistent with previous reports suggesting that properly performed episiotomy with optimal wound management may not independently determine PFD risk [27]. Prospective studies have documented only mild, self-limiting PFD symptoms in episiotomy cases, typically associated with low PFDI-20 scores [27]. Enhanced postoperative care protocols, including targeted perineal rehabilitation, have shown efficacy in alleviating discomfort and promoting tissue healing, potentially mitigating PFD-related symptoms [28]. However, the long-term consequences of episiotomy on pelvic floor integrity require further investigation, particularly considering its potential dual role in both protecting against prolonged second stage while simultaneously introducing perineal trauma. More comprehensive studies incorporating extended follow-up periods and standardized intervention protocols are needed to elucidate the precise impact of episiotomy on pelvic floor function.

The developed prediction model represents a significant advancement through its innovative integration of serum 25(OH)D levels with established obstetric risk factors. This approach enhances predictive accuracy beyond conventional models based solely on anatomical

or symptomatic parameters, while simultaneously identifying potential targets for nutritional intervention. The exclusive use of routinely collected clinical data ensures practical implementation across diverse healthcare settings, including resource-limited environments, thereby facilitating widespread clinical adoption.

Several study limitations should be acknowledged. The single-center design and moderate sample size may affect generalizability, necessitating validation in larger, multicenter cohorts. Seasonal variations in vitamin D status and lack of standardized assay protocols across institutions represent potential confounding factors that future studies should address. The reliance on questionnaire-based PFD assessment without complementary objective measures may introduce reporting bias. Furthermore, the optimal therapeutic range for vitamin D supplementation and precise mechanisms underlying its protective effects require clarification through dedicated intervention studies.

In conclusion, this study established a validated nomogram that effectively combines measurable nutritional and obstetric parameters to predict postpartum PFD risk. The model provides both a practical clinical tool for early risk stratification and a scientific framework for developing targeted prevention strategies, particularly through modification of vitamin D status. Future research should focus on external validation, mechanistic investigations, and evaluation of intervention efficacy in high-risk populations identified by the model.

CONCLUSION

This study successfully developed and validated a nomogram prediction model that incorporates serum 25 (OH)D levels and key obstetric parameters for assessing postpartum pelvic floor dysfunction risk. The model demonstrates excellent discriminative capacity (AUC = 0.830) and calibration accuracy (mean absolute error = 0.03) while utilizing routinely collected clinical data from prenatal and delivery records. This practical risk stratification tool facilitates early identification of high-risk individuals and provides an evidence-based foundation for implementing timely preventive interventions and personalized management strategies in clinical practice.

Data Available:

Data is available from the corresponding author on request.

Consent to Participate:

Written informed consent was obtained from each subject.

Consent to Publish:

Written informed consent for publication was obtained from all participants.

Ethics Statement:

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All subjects were approved by Muping District Traditional Chinese Medicine Hospital (No. 201809MP-31).

Declaration of Generative AI in Scientific Writing:

The authors declare that no generative AI was used in the writing of this manuscript.

Declaration of Interest:

The authors have no conflicts of interest to declare.

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