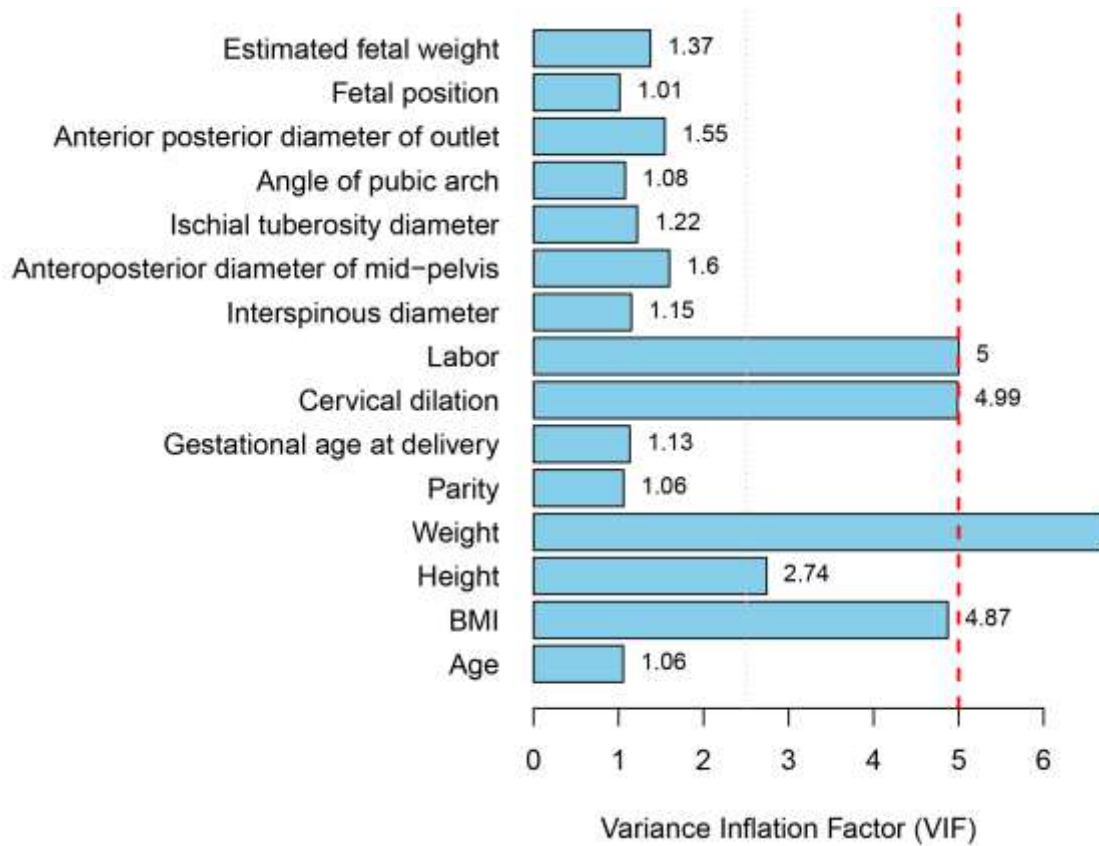


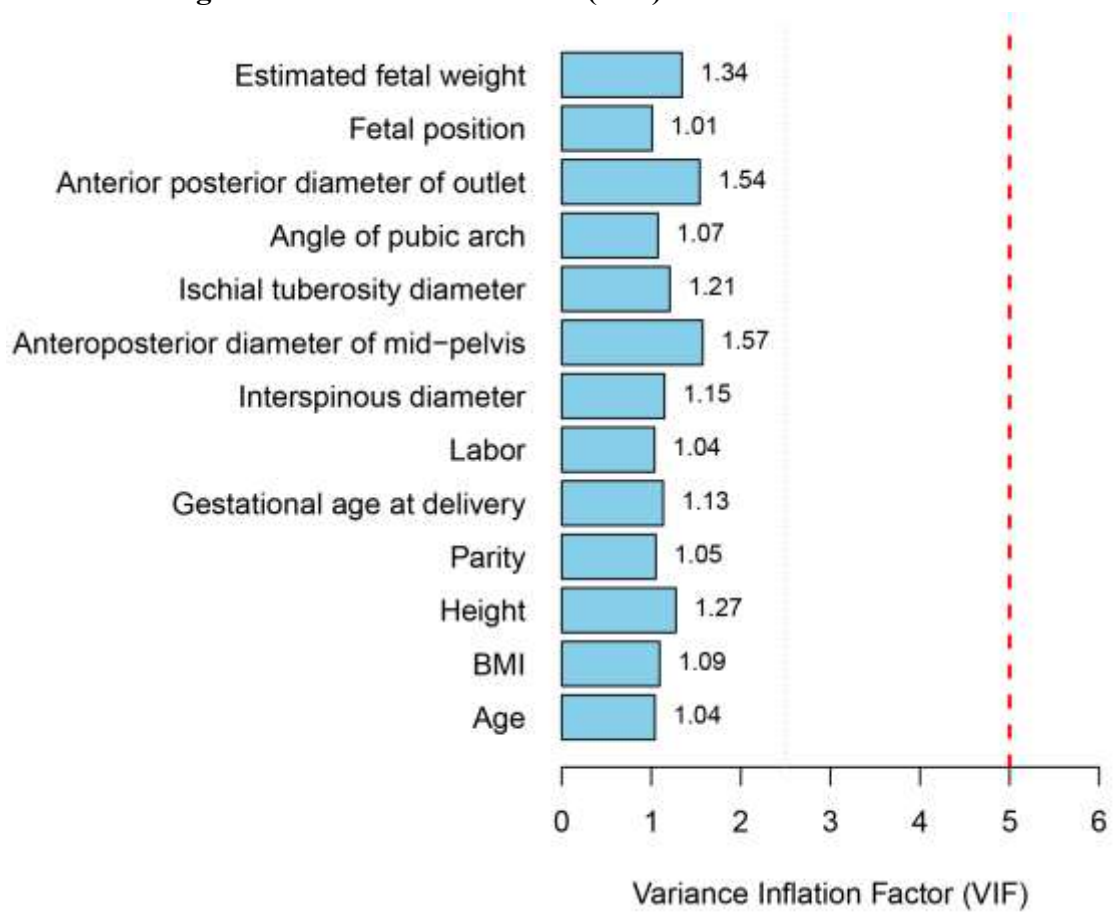
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Supplementary Figure 1. Multicollinearity diagnostic of all the predictive variables using Variance Inflation Factors (VIF)



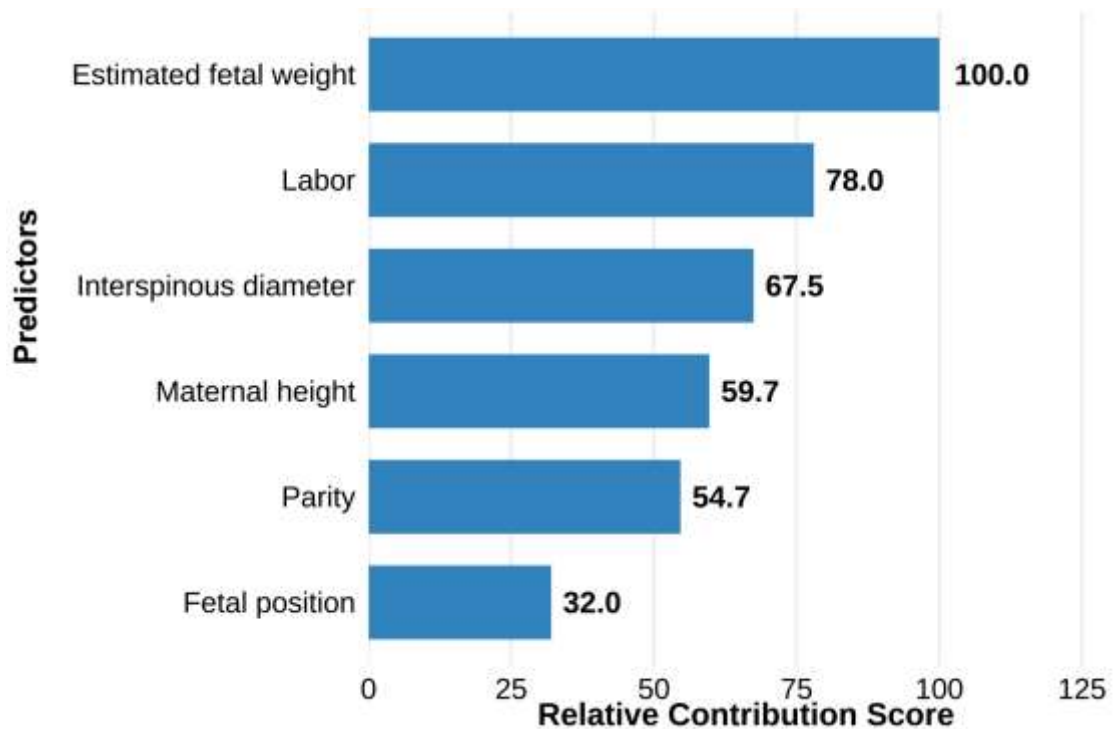
The bar chart illustrates the VIF values for maternal characteristics and clinical parameters. The dashed red line represents the commonly accepted threshold of 5.

Supplementary Figure 2. Multicollinearity diagnostic of the included predictive variables using Variance Inflation Factors (VIF)



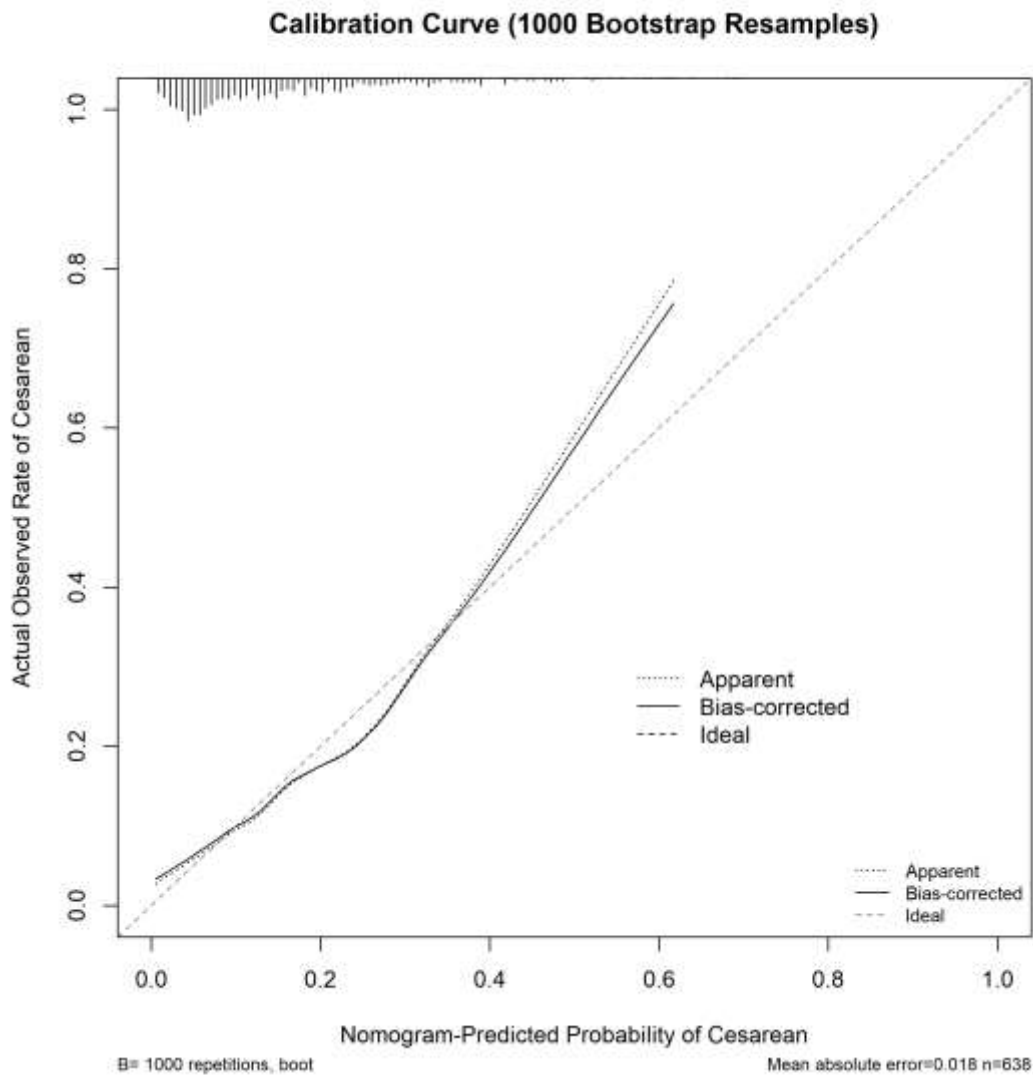
The bar chart illustrates the VIF values for maternal characteristics and clinical parameters. The dashed red line represents the commonly accepted threshold of 5.

Supplementary Figure 3. Relative importance of predictors in the predictive model



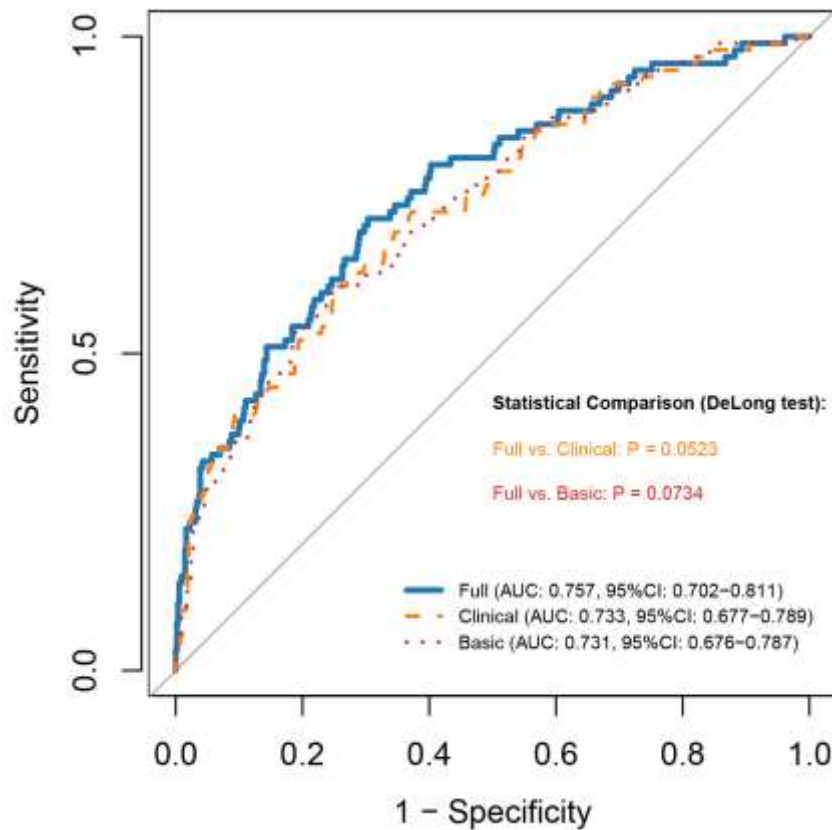
The chart displays the relative contribution of each variable to the final predictive model. Importance scores were derived from the Wald Z-statistics of the multivariable logistic regression analysis and standardized to a scale of 0-100, where a score of 100 represents the most significant predictor. Estimated fetal weight emerged as the primary contributor, followed by labor induction and interspinous diameter (measured via LaborPro system). Traditional maternal factors such as height and parity showed moderate contributions, while fetal position had the least relative impact on the model's discrimination capacity.

Supplementary Figure 4. Calibration curve of the nomogram for intrapartum cesarean delivery prediction in nulliparous women.



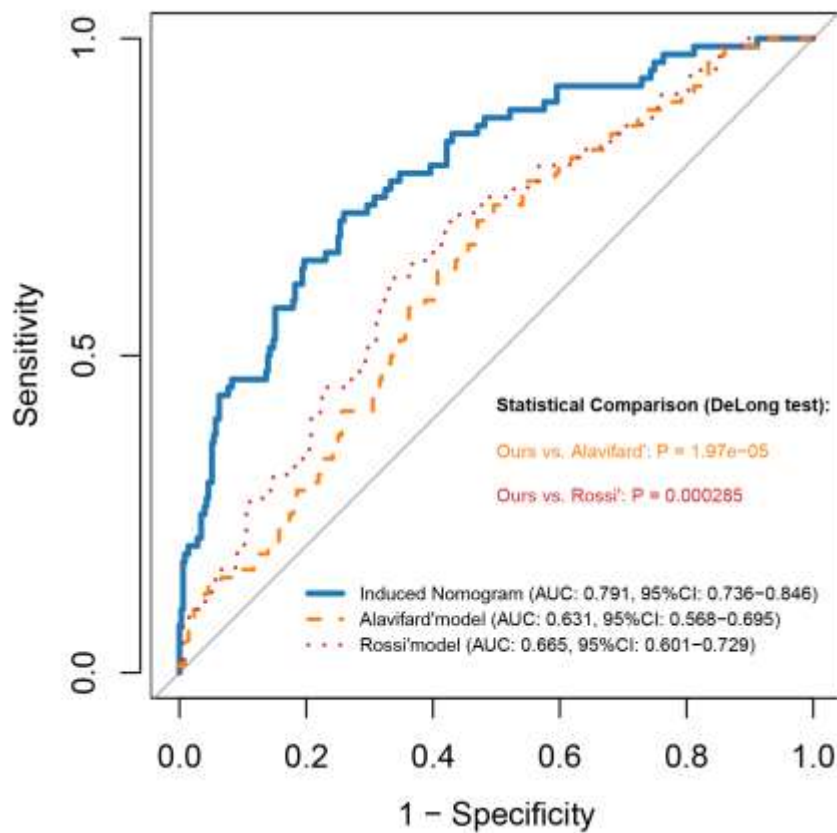
The x-axis represents the predicted probability calculated by the nomogram, and the y-axis represents the actual observed rate of cesarean delivery. The dashed line represents the ideal performance of a perfect model (diagonal 45-degree line). The dotted line represents the apparent performance of the model, and the solid line shows the bias-corrected performance after internal validation via 1000 bootstrap resamples. The mean absolute error was 0.018, suggesting strong consistency between the model's predictions and actual observations (n = 638).

Supplementary Figure 5. Comparison of ROC curves for the three predictive models in nulliparous women.



The ROC curves represent the discrimination performance of the full model (solid blue line), the clinical model (dashed orange line, excluding interspinous diameter), and the basic model (dotted red line, further excluding fetal position). Pairwise comparisons of AUCs were performed using the DeLong test. Abbreviations: ROC: receiver operating characteristic, AUC: area under the curve.

Supplementary Figure 6. Comparison of ROC curves between the enhanced induction-specific nomogram and established clinical models.



The solid blue line represents the enhanced induction nomogram, which incorporates both internal pelvic dimensions and the Bishop score. The dashed orange and dotted red lines represent the models developed by Alavifard et al. and Rossi et al., respectively. Pairwise comparisons of AUCs were performed using the DeLong test. Abbreviations: ROC: receiver operating characteristic, AUC: area under the curve.

Supplementary Table 1. Performance comparison of three predictive models at the optimal cutoff points (N = 705)

Metrics	Full Model (LaborPro)	Clinical Model	Basic Model
Discrimination			
AUC (95% CI)	0.771 (0.720-0.823)	0.752 (0.701-0.804)	0.751 (0.699-0.802)
<i>P</i> -value (vs. Full) ^a	Reference	0.067	0.087
Classification Performance			
Sensitivity (%)	70.83	70.83	73.96
Specificity (%)	73.07	67.16	62.73
PPV (%)	29.31	25.37	23.83
NPV (%)	94.08	93.59	93.86
Accuracy (%)	72.77	67.66	64.26
Kappa Value	0.275	0.217	0.195
Confusion Matrix			
TP / FP	68 / 164	68 / 200	71 / 227
TN / FN	445 / 28	409 / 28	382 / 25

Abbreviations: AUC, Area Under the Receiver Operating Characteristic Curve; CI, Confidence Interval; PPV, Positive Predictive Value; NPV, Negative Predictive Value; TP, True Positive; FP, False Positive; TN, True Negative; FN, False Negative. ^a Statistical significance of the differences between AUCs was assessed using the DeLong test, with the full model as the reference. Optimal cutoff: All metrics were calculated based on the optimal threshold determined by the Youden Index (Sensitivity + Specificity - 1).

Supplementary Table 2. Multivariable analyses of independent risk factors for intrapartum cesarean delivery in nulliparous women.

Variables	Overall (n=705)		Nulliparous (n=638)	
	Adjusted OR (95%CI)	P	Adjusted OR (95%CI)	P
Height (cm)	0.929 (0.880, 0.980)	0.007	0.925 (0.879, 0.974)	0.003
Parity		0.002		
Multiparous	Ref		NA	
Nulliparous	10.676 (2.375, 47.981)		NA	
Labor		< 0.001		< 0.001
Spontaneous	Ref		Ref	
Induced	3.288 (1.818, 5.945)		3.323 (1.854, 5.958)	
Interspinous diameter (cm)	0.518 (0.362, 0.742)	< 0.001	0.504 (0.356, 0.714)	< 0.001
Fetal position		0.104		0.104
Occiput anterior	Ref		Ref	
Occiput posterior	2.151 (1.053, 4.394)	0.036	2.156 (1.062, 4.378)	0.034
Occiput transverse	2.092 (0.882, 4.962)	0.094	1.924 (0.809, 4.575)	0.138
Estimated fetal weight (100g)	1.304 (1.180, 1.441)	< 0.001	1.303 (1.181, 1.436)	< 0.001

OR: odds ratio; CI: confidence interval; NA: not applicable

Supplementary Table 3. Adjusted odds ratios for intrapartum cesarean delivery predictors stratified by mode of labor onset.

Variables	Subgroup	Adjusted OR (95%CI)	P-value
Height (cm)			
	Spontaneous	0.91 (0.82, 1.02)	0.121
	Induced	0.92 (0.87, 0.98)	0.005
Nulliparous vs. Multiparous			
	Spontaneous	NA	NA
	Induced	7.87 (1.74, 35.71)	0.007
Interspinous diameter (cm)			
	Spontaneous	0.58 (0.27, 1.26)	0.17
	Induced	0.50 (0.34, 0.74)	<0.001
Occiput posterior vs. Occiput anterior			
	Spontaneous	1.29 (0.34, 4.86)	0.709
	Induced	2.55 (1.11, 5.84)	0.027
Occiput transverse vs. Occiput anterior			
	Spontaneous	0.46 (0.05, 4.71)	0.513
	Induced	2.88 (1.09, 7.63)	0.034
Estimated fetal weight (100g)			
	Spontaneous	1.09 (0.89, 1.33)	0.412
	Induced	1.36 (1.22, 1.52)	<0.001

OR: odds ratio; CI: confidence interval; NA: not applicable

Supplementary Table 4. Univariable and multivariable analyses of independent risk factors for intrapartum cesarean delivery in induced women.

Variables	Unadjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Age, year	1.055 (0.984, 1.132)	0.130	Not included	
Height, cm	0.940 (0.895, 0.988)	0.014	0.927 (0.873, 0.985)	0.014
Pre-pregnancy BMI, kg/m ²	1.049 (0.971, 1.134)	0.227	Not included	
Parity		0.035		0.014
Multiparous	Ref		Ref	
Nulliparous	4.735 (1.118, 20.052)		6.921 (1.482, 32.329)	
Highest level of education		0.368	Not included	
Primary or secondary school	Ref		Not included	
University	0.673 (0.353, 1.283)	0.229	Not included	
Higher professional education	0.980 (0.382, 2.516)	0.967	Not included	
Gestational age at delivery		0.299	Not included	
37 weeks 0 days to 37 weeks 6 days	Ref		Not included	
38 weeks 0 days to 38 weeks 6 days	0.712 (0.130, 3.909)	0.696	Not included	
39 weeks 0 days to 39 weeks 6 days	1.750 (0.381, 8.040)	0.472	Not included	
40 weeks 0 days to 40 weeks 6 days	1.893 (0.410, 8.750)	0.414	Not included	
41 weeks 0 days to 41 weeks 6 days	1.750 (0.205, 14.931)	0.609	Not included	
Bishop score for induction	0.586 (0.458, 0.749)	< 0.001	0.586 (0.447, 0.769)	< 0.001
Interspinous diameter, cm	0.546 (0.385, 0.773)	0.001	0.519 (0.343, 0.786)	0.002
Anteroposterior diameter of mid-pelvis, cm	0.779 (0.511, 1.189)	0.247	Not included	
Ischial tuberosity diameter, cm	0.762 (0.588, 0.988)	0.040	0.906 (0.663, 1.238)	0.536
Anterior posterior diameter of outlet, cm	0.738 (0.454, 1.197)	0.518	Not included	
Angle of pubic arch, degree	0.981 (0.951, 1.012)	0.219	Not included	
Fetal position		0.037		0.086
Occiput anterior	Ref		Ref	
Occiput posterior	2.124 (0.967, 4.668)	0.061	2.399 (1.033, 5.574)	0.042
Occiput transverse	3.326 (1.328, 8.331)	0.010	2.835 (1.048, 7.665)	0.040
Estimated fetal weight (100g)	1.213 (1.107, 1.330)	< 0.001	1.363 (1.217, 1.526)	< 0.001

OR: odds ratio; CI: confidence interval

Supplementary Table 5. Clinical applicability of the online dynamic nomogram

Variable	Patient 1	Patient 2	Patient 3
Parity	Multiparous	Nulliparous	Nulliparous
Maternal height, cm	160	155	152
Onset of labor	Spontaneous	Induced	Induced
Interspinous diameter, cm	10	10	9
Fetal position	Occiput anterior	Occiput anterior	Occiput posterior
Estimated fetal weight, g	3200	3500	3800
Predicted risk of intrapartum cesarean delivery (%)	4%	29.6%	83.0%
Suggestion	Encourage continued trial of labor with routine monitoring	Individualized monitoring and timely intervention are most critical to optimizing maternal outcomes	A more proactive surgical approach might be discussed to avoid traumatic labor