

Results of First-Trimester Preeclampsia Screening Using the FMF Model and Aspirin Prophylaxis at Quang Ninh Obstetrics and Pediatrics Hospital

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ABSTRACT

Objectives: To assess the results of first-trimester preeclampsia (PE) screening using the Fetal Medicine Foundation (FMF) model and outcomes of aspirin prophylaxis in high-risk pregnant women . ***Materials and methods:*** A prospective descriptive longitudinal study was conducted on 1187 singleton pregnant women with gestational ages from 11 weeks 3 days to 13 weeks 6 days. All participants underwent first-trimester PE screening using the FMF model between 11/2023 and 11/ 2025 at Quang Ninh Obstetrics and Pediatrics Hospital. ***Results:*** Among the 1187 screened pregnant women, 84 cases (7.1%) were classified as high risk for preeclampsia according to the FMF model. Each 1 mmHg increase in mean arterial pressure (MAP) was significantly associated with an approximately 12.5% increase in the risk of preeclampsia, each 0.1-unit increase in uterine artery pulsatility index (UtA-PI) was associated with an approximately 27.8% increase in preeclampsia risk, and each 1 pg/mL decrease in PlGF concentration was associated with an approximately 7.0% increase in preeclampsia risk. The overall incidence of preeclampsia was 0.8% (9/1187), of which 66.7% (6/9) occurred in the high-risk group; 92.9% of high-risk women did not develop preeclampsia. No cases of preeclampsia occurred before 34 weeks of gestation; most cases developed at ≥ 37 weeks and were predominantly non-severe. Pregnant women who developed preeclampsia had a lower gestational age at delivery and lower neonatal birth weight compared with those without preeclampsia. Intrauterine growth restriction and neonatal intensive care unit admission were predominantly observed in the preeclampsia group and the high-risk group. ***Conclusion:*** First-trimester preeclampsia screening using the FMF model combined with early aspirin prophylaxis in high-risk pregnant women was associated with favorable clinical outcomes. This approach is highly feasible and suitable for widespread implementation in routine obstetric practice.
Keywords: *preeclampsia, first-trimester screening, FMF, aspirin prophylaxis.*

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INTRODUCTION

Preeclampsia–eclampsia (PE–E) is a multisystem disorder specific to pregnancy, affecting approximately 2 – 10% of all pregnancies and remaining one of the leading causes of maternal and perinatal morbidity and mortality worldwide [1,2]. Preeclampsia is closely associated with a wide range of adverse pregnancy outcomes, including preterm birth, intrauterine growth restriction, fetal distress, and perinatal mortality. In addition, it may lead to serious maternal complications such as eclampsia, HELLP syndrome, placental abruption, acute renal failure, pulmonary edema, and intracerebral hemorrhage. Beyond its acute manifestations, preeclampsia is also recognized as a significant risk factor for long-term cardiovascular disease, chronic kidney disease, and stroke in affected women [3].

Risk factors for preeclampsia have been identified, prediction based solely on maternal history and traditional clinical risk factors remains limited, with a detection rate of only approximately 30 – 40% for early-onset preeclampsia [4]. This approach not only fails to identify a substantial proportion of truly high-risk pregnant women but also results in unnecessary aspirin prophylaxis in many low-risk cases.

The incidence of preeclampsia has shown an increasing trend, particularly early-onset disease, which is associated with a substantially higher risk of severe complications for both the mother and the fetus. With advances in the understanding of preeclampsia pathophysiology and the development of fetal medicine, the Fetal Medicine Foundation (FMF) has developed a first-trimester preeclampsia screening model that integrates maternal characteristics with mean arterial pressure (MAP), uterine artery Doppler pulsatility index (UtA-PI), and the biochemical marker placental growth factor (PlGF). This combined model allows individualized risk stratification, accurate identification of pregnant women at high risk for preeclampsia, and optimization of aspirin prophylaxis. Currently, the FMF screening model is recommended for clinical practice by several authoritative organizations, including the World Health Organization (WHO), the International Federation of Gynecology and Obstetrics (FIGO), the American College of Obstetricians and Gynecologists (ACOG), and the National Institute for Health and Care Excellence (NICE) [5].

In Vietnam, The Ministry of Health has issued national guidelines for the screening, diagnosis, and management of preeclampsia, first-trimester preeclampsia screening using the FMF model. However, evidence remains limited, and few studies on real-world effectiveness rates have been conducted. Therefore, we conducted the present study entitled "Results of First-Trimester Preeclampsia Screening Using the FMF Model and Aspirin Prophylaxis at Quang Ninh Obstetrics and Pediatrics Hospital" with the following objectives: to evaluate the effectiveness of first-trimester preeclampsia screening using the FMF model at Quang Ninh Obstetrics and Pediatrics Hospital, and to assess the outcomes of aspirin prophylaxis in pregnant women identified as high risk according to the FMF model.

MATERIALS AND METHODS

Study population

The study population consisted of all pregnant women attending antenatal care and receiving pregnancy management at Quang Ninh Obstetrics and Pediatrics Hospital during the study period, who met the inclusion criteria and did not meet the exclusion criteria.

Inclusion criteria: Pregnant women with singleton pregnancies, gestational age from 11 weeks 3 days to 13 weeks 6 days, with a live fetus confirmed by ultrasound and no detected fetal structural abnormalities at the time of screening. Participants were followed until the end of pregnancy, had no contraindications to low-dose aspirin use, and provided informed consent to participate in the study.

Exclusion criteria: Cases of miscarriage, preterm birth, or stillbirth not related to preeclampsia, eclampsia, or complications of preeclampsia/eclampsia; and cases of non-compliance with aspirin prophylaxis after being identified as high risk for preeclampsia.

Study setting and duration

Study setting: Quang Ninh Obstetrics and Pediatrics Hospital.

Study period: From November 2023 to November 2025.

Study design

This was a prospective, descriptive cross-sectional study with longitudinal follow-up.

Sample size and sampling method

The sample size was calculated using the formula for a single proportion:

$$n = Z^2_{1-\alpha/2} \frac{p.q}{d^2}$$

In this study, α = 0.05; the expected prevalence was set at p = 0.038 (prevenlance of PE) based on the study by Tran Manh Linh (2020), and the absolute precision was d = 0.011. The minimum required sample size was calculated to be 1160 pregnant women. At the end of the study period, 1187 pregnant women met all inclusion and exclusion criteria and were included in the final analysis.

Study procedure

Eligible pregnant women underwent first-trimester preeclampsia screening and counseling. Screening-related information was collected using a standardized data collection form. Maternal height and weight were measured to calculate body mass index (BMI). Blood pressure was measured in both arms according to a standardized protocol. Ultrasound examination was performed to determine crown–rump length (CRL) and to measure bilateral uterine artery Doppler pulsatility index (UtA-PI). Venous blood samples were collected for quantification of placental growth factor (PlGF) levels. The risk of preeclampsia was calculated using the Fetal Medicine Foundation (FMF) software. Participants were counseled regarding screening results and followed until delivery to assess pregnancy outcomes.

Study variables

Maternal characteristics: age, body mass index (BMI), gravidity, method of conception (spontaneous or in vitro fertilization), obstetric history, and underlying medical conditions.

Screening parameters: mean arterial pressure (MAP), uterine artery Doppler pulsatility index (UtA-PI), and PlGF concentration.

Primary outcome: Risk of preeclampsia according to the FMF model, occurrence of preeclampsia

Secondary outcome: Gestational age at delivery, neonatal birth weight, and related pregnancy outcomes.

Data processing and statistical analysis

Data were entered using Microsoft Excel and analyzed using SPSS software. Continuous variables were presented as mean ± standard deviation or median (interquartile range), depending on data distribution. Categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using appropriate statistical tests, including the chi-square test, Fisher's exact test, independent t-test, or Mann – Whitney U test, regression logistic model. Receiver operating characteristic (ROC) curve analysis was used to assess the predictive performance of screening parameters. Statistical significance was defined as $p < 0.05$.

Assessment criteria

Preeclampsia was diagnosed and classified according to current obstetrics and gynecology guidelines. The risk of preeclampsia was determined using the combined Fetal Medicine Foundation (FMF) model, incorporating maternal factors, mean arterial pressure, uterine artery Doppler indices, and first-trimester PlGF concentration.

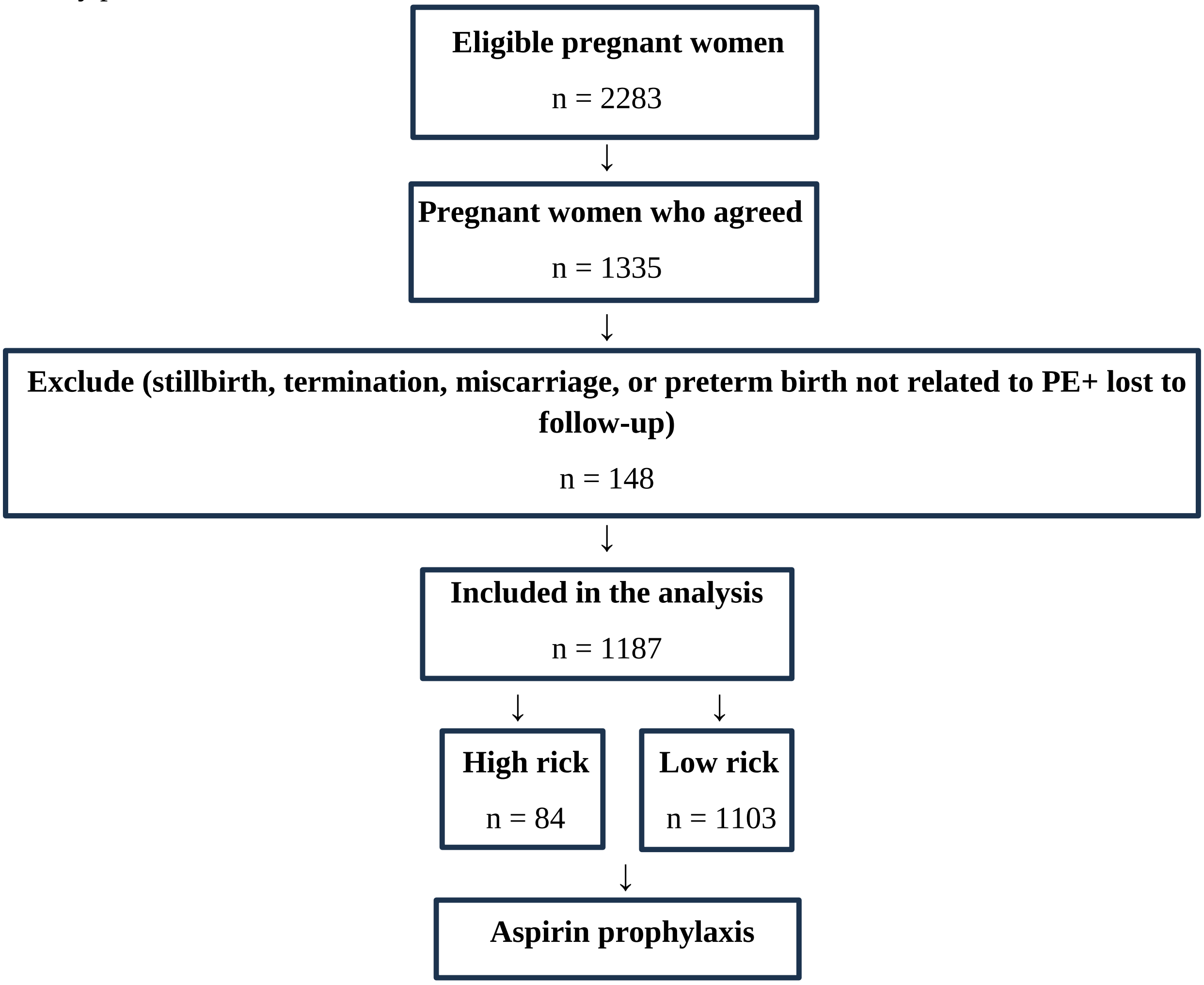
Ethical considerations

The study was approved by the Biomedical Research Ethics Committee of Quang Ninh Obstetrics and Pediatrics Hospital. All participants were fully informed about the study objectives, procedures, and benefits prior to enrollment. Personal information was kept strictly confidential and used solely for scientific research purposes.

RESULTS

From November 2023 to November 2025, a total of 2283 pregnant women underwent preeclampsia (PE) screening at 11 – 13+6 weeks of gestation at Quang Ninh Obstetrics and Pediatrics Hospital. Among them, 1335 pregnant women agreed to participate in the study. After excluding 41 cases due to stillbirth, pregnancy termination, miscarriage, or preterm birth not related to preeclampsia, and 107 cases lost to follow-up, a total of 1187 pregnant women met the eligibility criteria and were included in the analysis.

Study procedure flowchar:



Prevalence of high-risk preeclampsia according to the FMF model

Table 3.1.1. *Age, BMI distribution of pregnant women participating in the study*

Features		Number (n)	High risk (n)	Low risk (n)	OR (95% CI)	P
Age	**Mean ± SD: 29.76 ± 5.74** **Min – Max: 16 – 49**					
	≥ 35	258	22	236	1.30 (0.78 – 2.16)	0.30
	< 35	929	62	867		
	Total	1187	84	1103		
BMI (kg/m²)	**Mean ± SD: 21.62 ± 3.11** **Min – Max: 13.49 – 44.06**				1.9 (1.08 – 3.33)	0.02
	≥ 25	147	17	130		
	< 25	1040	67	973		
Total		1187	84	1103		

The mean maternal age was 29.76 ± 5.74 years. Minimum age: 16 years. Maximum age: 49 years. The 18 – 34 year age group accounted for the highest proportion with 929/1187 pregnant women (78.3%). Twenty-two of eighty-four high-risk cases (26.2%) occurred in women aged ≥ 35 years. In the ≥ 35 age group, the prevalence of high risk showed no significant difference compared to the < 35 age group ($p = 0.30$).
The mean BMI was 21.62 ± 3.11 (kg/m²). Minimum BMI was 13.49 (kg/m²), and maximum BMI was 44.06 (kg/m²). In the obese patient group with BMI ≥ 25 (147/1187), the risk of high-risk preeclampsia screening was significantly higher compared to the group with BMI < 25 (1040/1187) (OR = 1.9; $p = 0.02$).

Table 3.1.2. *Medical history of pregnant women participating in the study*

Features	Number (n)	Percentage (%)	High risk (n)	Low risk (n)	Pregnancies with PE (n)	Pregnancies without PE (n)
History of preeclampsia	4	0.34	2	2	3	1
Chronic hypertension	1	0.08	1	0	1	0
Diabetes mellitus	1	0.08	1	0	1	0
Systemic lupus erythematosus	1	0.08	1	0	0	1
Antiphospholipid syndrome; chronic kidney disease; smoking; alcohol abuse	0	0	0	0	0	0

Underlying medical conditions accounted for a very low proportion (< 0,5%). A history of preeclampsia and chronic hypertension was associated with preeclampsia, but the number of cases was limited.

Table 3.1.3. *Characteristics of pregnancies participating in the study*

Features	Number (n)	Percentage (%)	High risk (n)	Low risk (n)	Pregnancies with PE (n)	Pregnancies without PE (n)
Nulliparous	487	41.03	51	436	2	485
Multiparous	700	58.97	33	667	7	693
Interpregnancy interval < 10 years	579	48.78	24	555	6	573
Interpregnancy interval ≥ 10 years	121	10.19	9	112	1	120
Natural conception	1125	94.78	77	1048	8	1117
IVF	62	5.22	7	55	1	61

Nulliparous women accounted for 41.03% compared with 58.97% multiparous women, but the number of high-risk cases was higher (51/487 vs 33/700). Pregnancies with an interpregnancy interval < 10 years accounted for 48.78% compared with 10.19% for ≥ 10 years, with a comparable number of high-risk cases (24/579 vs 9/121). IVF pregnancies accounted for 5.22% but had a higher proportion of high-risk cases compared with natural conception (7/62 vs 77/1125).

Table 3.1.4. *MAP, UtA-PI, and PlGF of pregnant women participating in the study*

Features	Mean ± SD	Threshold	ROC AUC	Sensitivity	Specificity	OR (95% CI)	p
MAP (mmHg)	80.45 ± 7.60	81.40	0.70	0.69	0.62	3.70 (2.29–5.97)	< 0.001
MAP (MoM)	0.98 ± 0.09	1.00	0.70	0.68	0.64	3.78 (2.36–6.08)	< 0.001
UtA-PI	1.75 ± 0.47	1.81	0.78	0.84	0.6	8.08 (4.42–14.76)	< 0.001
UtA-PI (MoM)	1.04 ± 0.28	1.10	0.78	0.81	0.62	6.81 (3.90–11.89)	< 0.001
PlGF (p/mL)	67.63 ± 30.32	44.55	0.75	0.57	0.84	7.12 (4.49–11.29)	< 0.001
PlGF (MoM)	1.05 ± 0.42	0.733	0.77	0.60	0.82	7.10 (4.46–11.29)	< 0.001

All parameters were significantly associated with high-risk preeclampsia screening results. A Mean Arterial Pressure (MAP) threshold of 81.40 mmHg yielded the highest sensitivity (0.69)

and specificity (0.62), with an AUC of 0.70. Each 1 mmHg increase in MAP was associated with an approximately 12.5% increase in the risk of preeclampsia (p < 0.001).
The uterine artery Pulsatility Index (UtA-PI) threshold of 1.81 achieved the highest sensitivity (0.84) and specificity (0.60), with an AUC of 0.78. Each 0.1-unit increase in uterine artery PI was associated with an approximately 27.8% increase in the risk of preeclampsia (p < 0.001).
The PlGF threshold was 44.55 pg/mL, providing the highest sensitivity (0.57) and specificity (0.84), with an AUC of 0.75. Each 1 pg/mL decrease in PlGF concentration was associated with an approximately 7.0% increase in the risk of preeclampsia (p < 0.001).

Aspirin prophylaxis in pregnant women at high risk of preeclampsia

The gestational age at screening was 12,45 ± 0,54 weeks, and aspirin prophylaxis was initiated early at 12,71 ± 0,54 weeks, with most women continuing until 36 weeks. Among 84 cases receiving aspirin prophylaxis, the number of cases discontinuing aspirin due to adverse effects or development of preeclampsia was low (3/84).

Table 3.2.1. *Characteristics of preeclampsia cases by risk group*

Features (n = 84)	High risk n (%)	Low risk n (%)	OR	p
Preeclampsia cases	6 (7.14)	3 (0.27)	28.21	<0.001
- PE <34 weeks	0 (0.00)	0 (0.00)		
- PE 34–<37 weeks	3 (3.57)	0 (0.00)		
- PE ≥37 weeks	3 (3.57)	3 (0.27)	13.58	0.006
PE with symptoms	6 (7.14)	3 (0.27)	28.21	<0.001
- Without severe features	5 (5.95)	3 (0.27)	23.21	<0.001
- With severe features	1 (1.19)	0 (0.00)		

In the high-risk group, 6/84 (7.14%) pregnancies developed preeclampsia compared with 3/1103 (0.27%) in the low-risk group (OR = 28.21; p < 0.001). No cases occurred before 34 weeks; preeclampsia at 34 – <37 weeks was observed only in the high-risk group, while cases at ≥ 37 weeks occurred in both groups but were significantly higher in the high-risk group (OR = 13.58; p = 0.006).
All cases were symptomatic; non-severe preeclampsia was more frequent in the high-risk group (OR = 23.21; p < 0.001), whereas severe preeclampsia occurred only in the high-risk group.

Table 3.2.2. *Pregnancy outcomes with PE*

Outcome	Total (n = 1187)	PE (n = 9)	No PE (n =1 178)
Gestational age at delivery (weeks) Mean ± SD	**38.84 ± 0.88**	**36.86 ± 1.35**	**38.85 ± 0.85**
Birth weight (g), Mean ± SD	**3176 ± 366**	**2244 ± 623**	**3183 ± 355**
Fetal growth restriction	**35 (2.9%)**	**7 (77.8%)**	**28 (2.4%)**
NICU admission	**13 (1.1%)**	**2 (22.2%)**	**11 (0.9%)**

Outcome	Total (n = 1187)	PE (n = 9)	No PE (n =1 178)
Eclampsia / HELLP / placental abruption / stillbirth / perinatal death	**0**	**0**	**0**

The gestational age at delivery was lower in the PE group (36.86 ± 1.35 weeks) compared with the non-PE group (38.85 ± 0.85 weeks). The mean birth weight was also markedly lower in the PE group (2244 ± 623 g) than in the non-PE group (3183 ± 355 g).

The rate of fetal growth restriction was substantially higher among pregnancies complicated by preeclampsia (77.8% vs 2.4%). Similarly, NICU admission occurred more frequently in the PE group (22.2%) compared with the non-PE group (0.9%). No cases of eclampsia, HELLP syndrome, placental abruption, stillbirth, or perinatal death were recorded in either group.

Table 3.2.3. *Pregnancy outcomes with high-risk PE*

Outcome	Total (n = 1187)	Low risk (n = 1103)	High risk + Aspirin (n = 84)
Gestational age at delivery (weeks)	**38.84 ± 0.88**	**38.86 ± 0.86**	**38.53 ± 1.06**
Birth weight (g)	**3175 ± 367**	**3193 ± 358**	**2944 ± 398**
Fetal growth restriction	**35 (3.0%)**	**28 (2.5%)**	**7 (8.3%)**
NICU admission	**13 (1.1%)**	**8 (0.7%)**	**5 (6.0%)**
Eclampsia, HELLP syndrome, placental abruption, stillbirth, perinatal death	**0**	**0**	**0**

The gestational age at delivery in the low risk group 38.86 ± 0.86 and in the high risk + The gestational age at delivery was slightly lower in the high-risk + aspirin group (38.53 ± 1.06 weeks) compared with the low-risk group (38.86 ± 0.86 weeks). The mean birth weight was also lower in the high-risk + aspirin group (2944 ± 398 g) than in the low-risk group (3193 ± 358 g).

The rate of fetal growth restriction was higher in the high-risk + aspirin group (8.3% vs 2.5%), as was the NICU admission rate (6.0% vs 0.7%). No cases of eclampsia, HELLP syndrome, placental abruption, stillbirth, or perinatal death were recorded in either group.

DISCUSSION

Maternal age, BMI, and clinical factors associated with the risk of preeclampsia

In our study, the mean maternal age was 29.76 ± 5.74 years, and women aged 18 – 34 years accounted for the largest proportion (78.3%). This distribution is consistent with the reproductive-age structure in Vietnam and is comparable to the study by Nguyen Thi Huong, indicating that the optimal reproductive-age group remains predominant among pregnant women receiving antenatal care in current practice [6]. However, the proportion of pregnant women aged ≥ 35 years was 18.11%, reflecting the increasing trend of advanced maternal age in recent years, similar to observations reported by Bartsch et al. in large-population meta-analyses [2]. Our analysis showed that women aged > 35 years tended to have a higher risk of preeclampsia (OR = 1.30, p=

0.30). This finding is consistent with the Finnish cohort study by Lamminpää, which identified advanced maternal age as an independent risk factor for preeclampsia, with a particularly pronounced effect in women aged ≥ 40 years [7]. The lack of statistical significance in our study is likely related to the small number of preeclampsia cases and the impact of early screening combined with aspirin prophylaxis.

The mean body mass index (BMI) in our population was 21.62 ± 3.11 kg/m², which is consistent with the body habitus of Asian women and notably lower than that of Western populations. Nevertheless, the risk of preeclampsia increased with higher BMI, with OR = 1.9 in the BMI ≥ 25 group, although this did not reach statistical significance(p= 0.02). This trend is consistent with the meta-analysis by Motedayen et al., showing that overweight and obesity increase the risk of preeclampsia by approximately 3 – 4 fold [8]. The underlying mechanisms are thought to involve chronic inflammation, insulin resistance, and endothelial dysfunction in overweight women, thereby exacerbating the pathophysiological processes of preeclampsia.

Classic clinical factors such as a history of preeclampsia and chronic hypertension, although infrequent in our study, were associated with a high risk of preeclampsia. This aligns with the systematic review by Duckitt and Harrington and international recommendations from the International Society for the Study of Hypertension in Pregnancy (ISSHP), which classify these factors as high baseline risk for preeclampsia [9,10].

Regarding nulliparity, assisted reproduction (IVF), and an interpregnancy interval ≥ 10 years, our study observed an increased risk tendency but without statistical significance. This differs from large studies by Ananth and Conde-Agudelo, in which these factors were significantly associated with preeclampsia [11,12]. This difference may be explained by the use of the FMF early screening model and targeted aspirin prophylaxis, which could have substantially reduced the number of clinically manifest preeclampsia cases in our study population.

Overall, advanced maternal age, higher BMI, and a history of underlying conditions remain important baseline risk factors for preeclampsia. However, when incorporated into an early screening model with timely prophylactic intervention, the adverse effects of these factors on preeclampsia risk may be mitigated, supporting the role of integrated screening strategies in modern clinical practice [4,5].

MAP, UtA-PI, and PlGF in relation to the risk of preeclampsia

Mean arterial pressure (MAP)

Mean arterial pressure reflects systemic vascular tone and baseline perfusion and is therefore included as one of the three core components of the FMF first-trimester preeclampsia screening model. According to the two-stage model proposed by Roberts and Hubel, impaired trophoblast invasion and spiral artery remodeling occur very early, leading to increased vascular resistance and endothelial dysfunction, which may manifest as elevated MAP as early as the first trimester [13]. In our study, the overall mean MAP was 80.45 ± 7.60 mmHg. MAP was higher in the high-risk group than in the low-risk group (86.41 ± 10.54 vs 79.99 ± 7.14 mmHg), with a mean difference of 6.42 mmHg. This difference is comparable to findings by Poon et al., in which MAP in pregnancies that later developed preeclampsia was approximately 4 – 7 mmHg higher than in pregnancies without preeclampsia at 11 – 13^{+6} weeks [14]. This suggests that the hemodynamic pattern in our population is consistent with the international literature and supports the biological plausibility of our findings. A Mean Arterial Pressure (MAP) threshold of 81.40 mmHg yielded the highest sensitivity (0.69) and specificity (0.62), with an AUC of 0.70. Each 1 mmHg increase in MAP was significantly associated with a 12.5% increase in preeclampsia risk ($p < 0.001$). Recent evidence emphasizes that MAP should not be used alone because it is influenced by measurement technique and physiological factors; instead, measurement procedures should be standardized and MAP should be integrated with other parameters in a multiparametric model [15]. Waks et al. (AJOG 2024) proposed an MAP threshold ≥ 88.5 mmHg for predicting preeclampsia; the mean MAP in our high-risk group approached this threshold, suggesting comparable hemodynamic characteristics to international populations [16]. Importantly, in our study, MAP was not used to "diagnose" preeclampsia but as one component within the screening model, consistent with contemporary preventive approaches.

Uterine artery pulsatility index (UtA-PI)

Within the FMF first-trimester screening model, uterine artery pulsatility index (UtA-PI) is considered a key pathophysiological marker reflecting impaired uterine spiral artery remodeling the central mechanism of placenta-related preeclampsia. Foundational FMF studies have shown that UtA-PI is elevated as early as 11 – 13^{+6} weeks in pregnancies that later develop preeclampsia, particularly early-onset and preterm preeclampsia [17,18].

In our study, the uterine artery Pulsatility Index (PI) threshold of 1.81 achieved the highest sensitivity (0.84) and specificity (0.6), with an AUC of 0.78. Each 0.1-unit increase in uterine artery PI was significantly associated with an approximately 27.8% increase in preeclampsia risk ($p < 0.001$). This magnitude of increase is consistent with FMF reports, where first-trimester UtA-PI in pregnancies developing preeclampsia typically rises by about 20 – 30% compared with normal pregnancies and often exceeds an absolute threshold of approximately 2.1 – 2.2 [17,18]. These findings indicate that uterine artery Doppler characteristics in our population align with those reported in standardized FMF cohorts. Overall interpretation remains consistent with FMF evidence that UtA-PI is among the Doppler parameters with the strongest discriminatory value for placenta-related preeclampsia [19]. ROC analysis showed an AUC of 0.78 for UtA-PI, indicating good predictive performance and comparable to FMF model development studies, in which UtA-PI plays a major role in predicting preterm preeclampsia when combined with other factors [19,20]. Notably, despite higher UtA-PI in the high-risk group, the observed preeclampsia rate in our study remained low, which is consistent with the FMF concept that UtA-PI is used for early identification of placental-risk pregnancies to enable timely prophylaxis and thereby reduce clinical disease expression.

Placental Growth Factor (PlGF)

Placental growth factor (PlGF) is a core biochemical marker in the FMF preeclampsia screening model, reflecting placental angiogenesis and functional development. FMF studies have shown that PlGF decreases early in the first trimester in pregnancies that later develop preeclampsia, especially early-onset and preterm preeclampsia—phenotypes closely related to placental insufficiency [18,19]. In our study, PlGF in the high-risk group was approximately 21.1% lower than in the low-risk group. This decrease is consistent with FMF findings, where PlGF MoM in early-onset preeclampsia often falls around 0.60 – 0.65 [18,19]. These results suggest that placental dysfunction may already be present from the first trimester in the high-risk group, consistent with the pathogenesis of preeclampsia. The PlGF threshold was 44.55 pg/mL, providing the highest sensitivity (0.57) and specificity (0.84), with an AUC of 0.75. Each 1 pg/mL decrease in PlGF concentration was associated with an approximately 7.0% increase in the risk of preeclampsia ($p < 0.001$) [19,21]. However, FMF emphasizes that PlGF should not be used as a standalone marker; rather, it provides important incremental value when integrated with MAP and UtA-PI in a multiparametric model. FMF studies have shown that adding PlGF improves prediction of preterm preeclampsia and reduces false-positive rates at a screening-positive rate of 5 – 10% [21]. In our study, the concurrent pattern of decreased PlGF with increased MAP and increased UtA-PI in the high-risk group forms a triad consistent with the key pathophysiological axes targeted by the FMF model: maternal hemodynamic changes, impaired uteroplacental perfusion, and reduced placental angiogenic function. This concordant pattern supports that the screening model captured meaningful pathophysiological signals rather than relying solely on formal risk factors.

First-trimester FMF preeclampsia screening results and the effectiveness of aspirin prophylaxis

In our study, first-trimester preeclampsia screening using the FMF model at 11 – 13^{+6} weeks classified 7.1% of pregnant women as high risk. This proportion falls within the optimal screening-positive rate of 5 – 10% recommended by FMF and FIGO, suggesting appropriate real-world application identifying truly high-risk women while limiting unnecessary aspirin prophylaxis in the low-risk population [5]. This finding is comparable to studies by Poon et al. applying the FMF model in general populations, where the proportion classified as high risk is commonly around 8 – 10% [5]. The FMF model demonstrated clear risk stratification in our population. Although the high-risk group accounted for only 7.1% of the cohort, it included most preeclampsia cases, whereas the low-risk group comprised > 90% of pregnant women with very few preeclampsia cases. This pattern is consistent with studies using the FMF competing risks approach, in which the primary value of first-trimester screening is accurate identification of truly high-risk women, outperforming screening based solely on maternal clinical risk factors [4,20]. The mean gestational age at aspirin initiation in our study was 12.83 ± 0.59 weeks (earliest 11+6 and latest 14+1 weeks), and no participant initiated aspirin after 14 weeks. This timing lies within the “golden window” associated with optimal prophylactic benefit, particularly for early-onset disease. Aspirin discontinuation timing in our study also aligns with international practice: the mean gestational age at discontinuation was 35.95 ± 0.26 weeks, consistent with FIGO recommendations and the ASPRE trial, in which aspirin is generally stopped at 36 weeks to maintain preventive benefit without increasing intrapartum bleeding risk. Adherence was high: 1 case (1.2%) discontinued early due to gastric pain; 3 cases (3.6%) temporarily interrupted due to vaginal bleeding and later resumed; and 2 cases (2.4%) discontinued before 36 weeks due to the development of preeclampsia. Evidence from Roberge et al. and meta-analyses by Henderson et al. indicates that adherence < 80% substantially reduces, or may abolish, aspirin's preventive effect; therefore, high adherence likely contributed to the favorable outcomes observed. The effectiveness of aspirin prophylaxis is reflected by the low overall preeclampsia rate (0.8%) and the absence of cases with onset before 34 weeks. Most high-risk women received 150 mg aspirin initiated within the first-trimester "golden window," similar to the ASPRE protocol. In ASPRE, Rolnik et al. demonstrated that early aspirin prophylaxis significantly reduced preterm preeclampsia compared with placebo [22]. The absence of early-onset preeclampsia in our study supports the effectiveness of early screening combined with targeted aspirin prophylaxis. Notably, most preeclampsia cases in our study were late-onset and without severe features, and no severe complications such as eclampsia, HELLP syndrome, or placental abruption were observed. This pattern is consistent with the "shift in disease spectrum" described in recent reviews, whereby aspirin reduces severe, placenta-related early-onset forms, while any remaining cases tend to occur later and have a more favorable maternal–fetal prognosis [19,22]. Chaemsaithong et al. emphasized that the greatest benefit of first-trimester screening combined with aspirin lies in reducing preterm and severe preeclampsia rather than eliminating all cases [19].

Pregnancy outcomes

Pregnancy outcomes in our study reflect the predictive value and practical impact of the FMF first-trimester screening model and aspirin prophylaxis in the high-risk group. Although the overall preeclampsia rate was low (0,8%), adverse outcomes were concentrated mainly in the preeclampsia group and the high-risk group, consistent with placental perfusion-related pathophysiology. Gestational age at delivery was lower in the preeclampsia group than in the non-preeclampsia group (36.86 ± 1.35 vs 38.85 ± 0.86 weeks; $p < 0.01$), likely reflecting medically indicated earlier delivery to reduce maternal and fetal risk. Birth weight was also significantly lower in the preeclampsia group (2244 ± 623 g vs 3183 ± 355 g; $p < 0.01$), consistent with the consequences of chronic uteroplacental hypoperfusion. These findings are in line with studies by Nicolaides, Poon, and Akolekar, which link preeclampsia with preterm birth and low birth weight [18,19]. Notably, no births occurred before 34 weeks; three deliveries occurred at 34 – 37 weeks and all were in the high-risk group. This distribution resembles findings from ASPRE, in which early screening and aspirin prophylaxis reduced early-onset disease and shifted adverse events to later gestation with improved prognosis [22]. Fetal growth restriction was observed in 2.9% of the cohort, and 77.8% of preeclampsia cases were accompanied by fetal growth restriction. The high-risk group receiving aspirin prophylaxis had a higher fetal growth restriction rate than the low-risk group (8.3% vs 2.5%), suggesting that the FMF model may also identify other placenta-related adverse outcomes beyond preeclampsia [18,19].

The NICU admission rate was low (1.1%) but higher in the preeclampsia and high-risk groups. No severe events such as eclampsia, HELLP syndrome, placental abruption, stillbirth, or perinatal death were recorded, which may be attributable to early screening, accurate risk stratification, and close follow-up.

In summary, our pregnancy outcome data suggest that the FMF first-trimester preeclampsia screening model has clear practical value, enabling accurate risk stratification, reducing early-onset and severe disease, and improving obstetric and neonatal outcomes, consistent with recommendations from FMF, FIGO, and WHO [5,23].

CONCLUSION

From November 2023 to November 2025, the study was conducted on 1,187 pregnant women who underwent first-trimester preeclampsia (PE) screening (11 – 13^{+6} weeks of gestation) using the FMF model and were followed until the end of pregnancy at Quang Ninh Obstetrics and Pediatrics Hospital. The main conclusions are as follows:

First-trimester PE screening results using the FMF model: The proportion of pregnant women classified as high risk for PE was 7.1%, which falls within the optimal recommended range of 5 – 10% by FMF and FIGO. All three core components of the FMF model (MAP, UtA-PI, and PlGF) demonstrated clear predictive value, consistent with PE pathophysiology and supporting that the screening procedure at the hospital was standardized and reliable.

Outcomes of aspirin prophylaxis in high-risk pregnant women: High-risk women initiated aspirin early, at a mean gestational age of 12.7 weeks, within the optimal intervention window before 16 weeks. The time of discontinuation was consistent with international practice, and adherence was high. The overall incidence of PE in the study population was low (0.8%), and 92.9% of high-risk women did not progress to PE. No cases of PE with onset before 34 weeks were recorded; most cases occurred after 37 weeks (6/9) and were predominantly without severe features (8/9). These results indicate that early aspirin prophylaxis reduces early-onset and severe PE and shifts the disease toward later and milder forms.

Pregnancy outcomes: The PE group had a lower gestational age at delivery and lower birth weight compared with the non-PE group. Fetal growth restriction and neonatal intensive care unit admission were mainly concentrated in the PE group and the high-risk group. No severe complications such as eclampsia, HELLP syndrome, placental abruption, stillbirth, or perinatal death were recorded.

Overall conclusion: First-trimester PE screening using the FMF model, combined with early aspirin prophylaxis, provides high predictive value, accurate risk stratification, and clear clinical benefits, including reducing early-onset PE, decreasing disease severity, and improving maternal and fetal outcomes. This model is highly feasible and suitable for wide implementation in obstetric practice at the provincial level.

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