folia medica

Folia Medica 65(3):384-392
DOI: 10.3897/folmed.65.e86087

Original Article

Independent Predictors of Preeclampsia and Their Impact on the Complication in a Bulgarian Study Group of Pregnant Women

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Received: 3 May 2022 ♦ **Accepted:** 12 July 2022 ♦ **Published:** 30 June 2023

Citation: Stoilov B, Zaharieva-Dinkova P, Stoilova L, Uchikova E, Karaslavova E. Independent predictors of preeclampsia and their impact on the complication in Bulgarian study group of pregnant women. Folia Med (Plovdiv) 2023;65(3):384-392. doi: 10.3897/folmed.65.e86087.

Abstract

Introduction: One of the major obstetrical complications, affecting 2%–8% of all pregnancies, is preeclampsia. To predict the onset of preeclampsia, several methods have recently been put forth. The Fetal Medicine Foundation has developed combined screening that can identify the vast majority of women who will develop preeclampsia using a combination of maternal factors, obstetrical history, biochemical, and biophysical factors.

Aim: The objective of the present study was to identify and analyze which classical risk factors may be independent predictors of preeclampsia, and assess their impact on this complication. In order to assess the high risk of preeclampsia, we also suggest further predictors that may optimize the risk constellation.

Materials and methods: The study included 1511 pregnant women who were examined during their routine checkups in a two-phase retrospective study that took place from January 30, 2018, to August 31, 2020, in the Outpatient Department of the University Hospital in Plovdiv. All primary data were obtained from their archived medical records. Information about the maternal factors, the patients' medical and obstetric histories, and status was obtained during the first phase of the study (11th gestation week + 0 days – 13th gestation week + 6 days). The second phase was conducted as a telephone interview (up to six months after the birth of the child): we collected data on the mode of birth, weight of the newborn, PE occurrence, at which gestation week the PE onset occurred, presence of gestational hypertension (GH) and diabetes, intrauterine growth retardation (IUGR), whether patients took aspirin and in what dosage, other complications, etc. The patients were divided into two groups: a high-risk group (with a risk for PE higher than 1:150), and a low-risk group, with or without onset of IUGR, GH, diabetes, etc.

Results: The mean age of the analyzed 1511 pregnant women was 29.91±5.32 years (range 18 – 46 years). Of these, 38 (2.9%) women developed preeclampsia, and 5.9% had gestational hypertension. The classification of participants by risk of developing preeclampsia showed that 591 (39.1%) of the examined patients were reported as high-risk. All patients at risk higher than 1:150 were classified as high-risk, and it was recommended that they should take aspirin 150 mg every night from 12th to 36th week of gestation. 80.6% of the high-risk group took the medication regularly.

Comparing the beta coefficients for the parameters we studied (beta coefficient indicates the predictors' impact on PE), we established that the risk factors that are the most significant and apparently independent in predicting preeclampsia were (in ascending order): 1. Weight of newborn, β=0.157; 2. Mean arterial blood pressure (MAP), β=0.150; 3. IUGR, β=0.120; 4. Pregnancy associated plasma protein-A (PAPP-A), β=0.112; 5. Cervix length, β=0.095

Conclusions: In the analysis of the four multiple regression models, adequately describing the role (and independence) of the PE predictors – common to all pregnant women; in cases of early midterm and term PE: placental growth factor (PlGF), PAPP-A, MAP, mean

Ut PI, cervical length, newborn weight, and IUGR. As common for all cases with PE, and depending on whether the PE onset was ≤32, ≤4, or ≤36 week of gestation, the following conclusions can be made: independent predictors of PE in all studied pregnant women were (indicators are ranked according to their degree of impact on the occurrence of PE): 1. MAP; 2. Intrauterine growth retardation (newborn weight is an indirect indicator of probable IUGR); 3. Pregnancy-associated protein-A; 4. Cervix length (with the corresponding standardized coefficients being β=0.150; β=0.120; β=0.112; β=0.095, respectively).

Keywords

MAP, PAPP-A, PlGF, predictors, preeclampsia

INTRODUCTION

Screening for preeclampsia (PE) aims mainly to minimize the adverse perinatal complications for those pregnant women who develop PE, by determining the appropriate time for effective prevention[1] and/or mode of delivery[2]. This goal could be achieved by effectively determining the level of risk in the second and/or third trimester of pregnancy.[3]

It has been confirmed many times that the screening for PE in pregnancy done between 11th and 13th week of gestation according to the algorithm recommended by the Fetal Medicine Foundation (FMF), using a combination of maternal factors, MAP, UtA-PI, and PlGF, is significantly better than the methods recommended by NICE and ACOG.[4,5]

The FMF algorithm used to predict early PE in the first trimester can successfully identify a large number of women who will develop the disease. The identification of potential predictors, including cardiovascular, immunological or inflammatory biomarkers, and the use of systems biology approach to improve the overall effectiveness of the screening for early PE is at the heart of a number of studies.[6-12] But the first-trimester prediction algorithm is ineffective for late PE screening, which raises the hypothesis that the late PE has different pathophysiology than the early PE.[13]

The traditional approach to screening proposed by the NICE or ACOG guidelines, which are based on the maternal risk factors, has limited predictive efficiency and can no longer be considered sufficiently optimal to predict PE. Such guidelines need to be updated to reflect the latest scientific evidence that the goal of screening should be premature PE, and the best way to identify a high-risk group is the method based on Bayes' theorem that combines maternal factors and biomarkers.[14]

AIM

To analyze which risk factors may be independent predictors of preeclampsia and assess their impact on the complication.

MATERIALS AND METHODS

In a two-phase retrospective study conducted from January 30, 2018, to August 31, 2020 at the Outpatient Department of University Hospital in Plovdiv, 1511 pregnant women were examined during their regular examinations. The primary data were obtained from the patients' archived medical records. During the first phase (the 11th gestation week + 0 days – the 13th gestation week + 6 days), we collected information about the maternal factors, the patients' medical and obstetric histories, and their status. The second phase was performed as telephone interview (conducted up to six months after the birth of the child) collecting data about the mode of birth, weight of the newborn, PE occurrence, at which gestational week (GW) the PE onset was, presence of gestational hypertension (GH) and diabetes, fetal growth restriction (FGR), whether aspirin was taken by the patients and in what dosage, other complications, etc. All patients were screened for PE using the FMF algorithm. The patients were divided into two groups according to the preterm PE (before 37 weeks of gestation): high-risk group (combined risk for PE higher than 1:150), and low-risk group (combined risk for PE lower than 1:150).

Inclusion criteria

The study should be conducted between GW 11 + 0 days, up to GW 13 + 6 days of pregnancy or fetal size from 45 mm to 84 mm; viable fetus; singleton pregnancy; the woman must be 18 years of age or over; without serious mental and physical illnesses.

Exclusion criteria

Women younger than 18 years of age; multiple pregnancy; structural abnormalities of the fetus; abortion/miscarriage; ulcer and gastritis; coagulation disorders; aspirin intolerance; termination of pregnancy; stillbirth.

The monitoring characteristics were mainly divided into 2 groups.

Factorial characteristics: age, education, concomitant diseases, smoking, parity, interval between two pregnancies, previous PE, BMI, IVF, etc. The arithmetic mean of the pulsatility indices of the uterine arteries (mean UtPI), mean

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arterial pressure (MAP), biochemical markers of the mother - angiogenic placental factors involved in trophoblast invasion and placental growth and development: pregnancy associated plasma protein-A (PAPP-A); placental growth factor (PLGF), etc.

Resultative characteristics: PE occurrence and at which week of gestation the onset was, the ability to predict early (before 34 weeks of gestation), preterm (before 37 weeks of gestation) and late (at 37 and later weeks), PE and the premature birth. Assessment of the predictive role of additional risk factors. Analysis of which predictors remain independent and what their individual contribution is both to the occurrence of PE (at each phase) and to FGR.

Research methods

- Documentary method: the medical files were obtained from the outpatient register, after obstetric and gynecological examinations, anamnestic data, biochemical and biophysical indicators, telephone interview, etc.
- Clinical method – anthropometric methods: height, weight, BMI, etc.
- Laboratory methods: the tests were performed on a specialized automated biochemical analyzer by immunofluorescence Perkin ELmer DELFIA Xpress. The following were studied: pregnancy associated plasma protein-A (PAPP-A); and placental growth factor (PLGF).
- Ultrasound methods:
  - Transabdominal ultrasound of UtPI – with a high-end device from the GE group (Voluson E6) by abdominal ultrasound with 4-6 MHz transducer. The uterine arteries are revealed by: sagittal image of the cervix; Doppler color flow mapping; Moving the transducer from side to side parallel to the cervix; The arteries are at the level of the inner axis of the cervical canal; insonation window 2 mm wide to cover the entire container; insonation angle: less than 30°; Maximum systolic velocity: more than 60 cm/sec; mean pulsatility index: mean PI (left + right / 2) – cut-off 1.5.
  - Transvaginal ultrasound of UtPI – transvaginal access with 5-7 MHz probe in cases with technical impossibility to perform the transabdominal method (overweight, uterine fibroids, etc.). The same orientation and evaluation criteria apply as in the transabdominal examination but with a higher threshold of the mean pulsatility index of the uterine arteries (mPI-UA).
- Mean arterial pressure (MAP) – according to the protocol of the Australian CVD Association – with automatic devices 3BTO-A2, Microlife.
- Cervical length was measured transvaginally during the anomaly scan at 19-23 weeks.
- The risk calculation software used was FetView with calculator provided by Fetal Medicine Foundation.
- The diagnostic criteria for PE diagnosis are based on the ISSHP criteria for PE.

Statistical analysis

The data were analyzed using the SPSS v. 21 and are significant at the level of significance α=0.05. The following statistical analyses were performed: descriptive analysis; χ^2 (chi-squared test); Student's *t*-test; analysis of variance (one-way ANOVA), using last significant difference (LSD), or Dunnett's T3 for multiple intergroup comparisons; correlation analysis; and graphical analysis.

RESULTS

The study analyzed 1511 pregnant women with mean age of 29.91±5.32 years (range 18–46 years). The women who developed preeclampsia were 38 (2.9%) from the entire sample, and those with gestational hypertension were 5.9% (**Fig. 1**). The method of conception in the studied group was distributed as follows: 95.6% had spontaneous pregnancy, and 4.4% had assisted conception. Thrombophilia was diagnosed in 39 (3.7%) of the pregnant women. Gestational diabetes was developed by 4% of the subjects, and chronic hypertension was reported in 1.7%. According to the method of delivery, the distribution of the subjects was

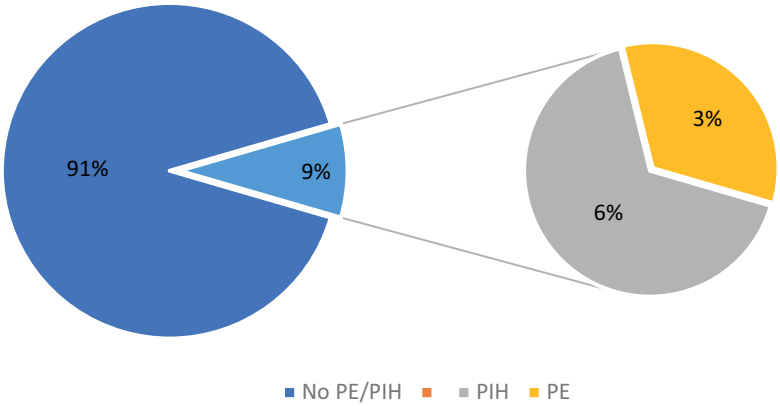

Figure 1. Hypertensive disorders.

as follows: the pregnancy of 37.6% ended with vaginal delivery, and 62.4% had Cesarean section.

The classification of participants according to their risk of preeclampsia showed that 591 (39.1%) of the examined patients were reported as high-risk. All patients had a screening for PE using the FMF algorithm and those with posterior risk more than 1:150 were classified as high-risk, and the recommendation for them was to receive 150 mg of aspirin every night from 12 to 36 weeks of gestation **(Fig. 2)**. 80.6% of the high-risk group took the medication regularly.

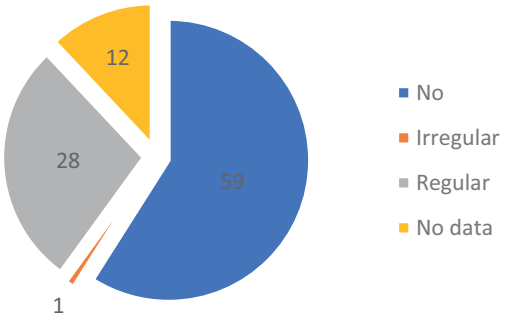

Figure 2. Patients receiving aspirin.

Fetal growth restriction (FGR) was reported in 85 (6.5%) participants. The cases in which there were both FGR and premature birth were 30, which is 2.3% of the total sample.

The focus of the research was to analyze which candidate predictors for PE are independent and to assess their impact when considering their combined effect through regression analysis.

Table 1 shows the factors that remained independent for the prediction of preeclampsia (common to all pregnant women with PE, regardless of the week of onset), considering their combined effect on this complication. The regression equation (adequately describing the interaction model – F=10.757, p=0.000) includes: pregnancy-associated protein A, mean arterial pressure, mean Ut PI, cervical length, weight of the newborn (an indirect indicator of the presence of FGR with a high probability). The regression models include indicators in which a significant correlation with PE has been previously established. Five indicators remained independent predictors, after multiple regression analysis for PE: PAPP-A, p=0.010, MAP, p=0.001, cervical length, p=0.026, the newborn weight, p=0.002, and FGR, p=0.017.

The comparison of the values for the standardized beta coefficients (indicating the predictors impact on PE) for the studied indicators shows that the most significant and apparent risk factors for PE are: 1. Newborn weight, β=0.157, followed by: 2. MAP, β=0.150; 3. FGR, β=0.120; 4. PAPP-A, β=0.112; 5. Cervix length, β=0.095 **(Table 1)**.

Tables 2 and **3** present the regression models of the combined factor impact in the cases of PE onset up to 37 and 34 weeks of gestation. Despite the high probability of type II errors, due to the limited number of studied patients, the same indicators that are cited in the analysis for all cases of PE (described in **Table 1**) turned out to be independent predictors in cases of PE occurring up to 37 weeks **(Table 2)**. In this adequate multiple regression analysis (F=11.087, p=0,000), once again (also applies to the top three predictors of PE) the strongest impact was registered for: 1. Newborn weight with standardized coefficient β=0.156, followed by 2. FGR, β=0.137, and 3. MAP, β=0.136. FGR was the second most influential predictor, ahead of the negative effect of elevated MAP. The first two indicators were associated with data on fetal retardation.

Table 1. Independent risk factors (predictors) for preeclampsia and their impact taking into account their combined effect

Model		Unstandardized coefficients		Standardized coefficients	t	p	95.0% Confidence Interval for B	
		B	Std. Error	β			Lower Bound	Upper Bound
1	(Constant)	−0.203	0.144		−1.409	0.160	−0.486	0.080
	Placental growth factor - PlGF MoM	−0.026	0.019	−0.062	−1.407	0.160	−0.063	0.010
	Pregnancy-associated plasma protein A MoM	−0.037	0.014	−0.112	−2.598	0.010	−0.065	−0.009
	Mean arterial pressure	0.004	0.001	0.150	3.488	0.001	0.002	0.006
	Arithmetic mean of the pulsation index of uterine arteries (Mean Ut PI))	0.029	0.018	0.071	1.594	0.112	−0.007	0.065
	Cervix length (mm)	0.004	0.002	0.095	2.231	0.026	0.000	0.007
	RRR Newborn weight	−6.281E-5	0.000	−0.157	−3.067	0.002	0.000	0.000
	Fetal growth restriction	0.096	0.040	0.120	2.385	0.017	0.017	0.175

a. Dependent variable: Preeclampsia

Table 2. Independent risk factors (predictors) for preeclampsia and their impact taking into account their combined effect (PE onset <37 weeks)

Model		Unstandardized coefficients		Standardized coefficients	t	*p*	95% Confidence interval for B	
		B	Std. Error	β			Lower bound	Upper bound
1	(Constant)	−0.179	0.138		−1.301	0.194	−0.449	0.091
	Placental growth factor - PlGF MoM	−0.020	0.018	−0.048	−1.106	0.269	−0.055	0.015
	Pregnancy-associated plasma protein A MoM	−0.037	0.014	−0.118	−2.749	0.006	−0.064	−0.011
	Mean arterial pressure	0.003	0.001	0.136	3.159	0.002	0.001	0.005
	Arithmetic mean of the pulsation index of uterine arteries (Mean Ut PI))	0.029	0.017	0.076	1.693	0.091	−0.005	0.064
	Cervix length (mm)	0.003	0.002	0.098	2.300	0.022	0.001	0.006
	RRR Newborn weight	−5.948E-5	0.000	−0.156	−3.047	0.002	0.000	0.000
	Fetal growth restriction	0.104	0.038	0.137	2.722	0.007	0.029	0.179

a. Dependent variable: Preeclampsia <37 weeks of gestation

Table 3. Independent risk factors (predictors) for preeclampsia and their impact taking into account their combined effect (PE onset ≤34 weeks)

Model		Unstandardized Coefficients		Standardized Coefficients	t	*p*	95% Confidence interval for B	
		B	Std. Error	β			Lower Bound	Upper Bound
1	(Constant)	−0.207	0.127		−1.635	0.103	−0.456	0.042
	Placental growth factor - PlGF MoM	−0.016	0.016	−0.042	−0.971	0.332	−0.048	0.016
	Pregnancy-associated plasma protein A MoM	−0.032	0.013	−0.109	−2.550	0.011	−0.056	−0.007
	Mean arterial pressure	0.003	0.001	0.135	3.146	0.002	0.001	0.005
	Arithmetic mean of the pulsation index of uterine arteries (Mean Ut PI))	0.035	0.016	0.098	2.189	0.029	0.004	0.067
	Cervix length (mm)	0.003	0.001	0.088	2.087	0.037	0.000	0.006
	RRR Newborn weight	−4.582E-5	0.000	−0.131	−2.543	0.011	0.000	0.000
	Fetal growth restriction	0.124	0.035	0.178	3.523	0.000	0.055	0.193

a. Dependent variable: Preeclampsia ≤34 week of gestation

Table 3 shows the predictors of PE in their combined impact in pregnant women with onset of PE up to 34 weeks (F=11.607, p=0.000). The same independent predictors for PE (also for the top three) were confirmed also here: PAPP-A, MAP, mean Ut PI, cervical length, newborn weight, and FGR. The ranking of the risk factors, in this case according to their ability to predict PE with the most significant impact, was: 1. FGR, β=0.178, followed by 2. MAP, β=0.135; 3. Newborn weight, β=0.131; 4. PAPP-A, β=0.109; 5. Mean Ut PI, β=0.098; and 6. The length of the cervix, β=0.088.

DISCUSSION

In recent years, a number of studies have found (mainly as a consequence of the moving of the Down syndrome screening from the second to the first trimester) that four

potentially useful indicators for PE screening can be added and these are the arterial pressure measurements, pulsatility index of the uterine arteries and quantification of the levels of two placental proteins (PAPP-A and PlGF) in the mother's blood.[15] A new mathematical model was recognized as optimal (Bayes' theorem – a formula calculating the probability of an event using the information already known about it), which combines information from the maternal factors, obstetric and medical history, PI of the uterine artery, mean arterial pressure (MAP) and serum PAPP-A and PlGF, during the 11th to the 13th week of gestation. This model actually identifies a significant number of women who are at high risk for early PE.[15-17]

It was found that compromised placental perfusion, indicated by increased PI of the uterine artery, is associated with the development of PE and indicates that the pathoetiology is based on impaired placentation. This hypothesis is supported by the results of previous Doppler examinations done in the first and second trimesters, as well as histological examinations of the maternal spiral arteries in the uterine wall.[18-20]

The arithmetic mean PI of the uterine artery is higher during 11 to 13 gestational weeks in the participants who subsequently develop PE and there is a significant negative linear correlation between the arithmetic mean PI of the uterine artery and the gestational age at birth.[15]

Decreased levels of PlGF and PAPP-A have been found to be predictors of PE, although some authors believe that low levels of PAPP-A do not contribute to the prediction model for PE.[21]

According to some researchers, the value of PAPP-A <5th centile (0.4 MoM) is present in only 8-23% of women with PE, and they believe that this indicator is not an accurate predictor as a stand-alone test for PE.[22-25] Our data, however, do not support this view and it is undeservedly underestimated in the risk constellation for PE. According to current data in the multiple logistic regression analysis in **Tables 1, 2** and **3**, this biochemical indicator always demonstrates a significant and independent impact on PE.

A number of authors report that in the first and second trimesters of pregnancy, decreased serum concentrations of PlGF and PAPP-A precede the clinical manifestation of PE[26-30], which was also confirmed by our results.

Some authors believe that the inclusion of serum PAPP-A in the predictive model for PE risk assessment does not improve the prediction of PE provided by maternal factors and PlGF and by maternal factors – MAP and UtA-PI, or maternal factors MAP, UtA- PI, and PlGF. It is important to note that according to our results for the low serum level of PAPP-A, this finding was not confirmed, and in all 3 multiple regression models it always shows an independent negative effect on PE **(Tables 1-3)**.

According to Zumaeta et al.[31], the inclusion of serum PlGF significantly improves the prediction of early PE, the effectiveness of MAP, UtA-PI and PlGF screening is better than that of MAP, UtA-PI and PAPP-A screening, as in both the whole study group and in the subgroups of women of different races.[31] It should be noted that in our study, PlGF did not demonstrate an independent impact on PE in all of the three regression models describing the predictive ability of biophysical and biochemical and maternal indicators **(Table 1)**. The main conclusions from the study by Zumaeta et al.[31] are that the first trimester screening of maternal PE, MAP, UtA-PI, and PlGF is better than the maternal screening of MAP, UtA-PI and PAPP-A[31], which contradicts our results.

When analyzing the cases with PE onset ≤34 weeks and <37 weeks **(Tables 2, 3)**, in addition to the listed five independent predictors, which are found in all cases with PE **(Table 1)**, the arithmetic mean of the pulsatility index of the two uterine arteries (mean Ut PI) was also found to be such independent factor (its significance for the occurrence of PE is at 90% reliability of the results). In these analyses, there are six independent predictors in pregnant women with PE onset ≤34 weeks and <37 weeks, as the strongest predictor in this case remains the FGR, β=0.178, followed by MAP, β=0.135, and the newborn weight, β=0.131 (this indicator in this case is used for indirect confirmation of FGR). Regardless of the PE onset, the first three independent predictors of PE always remain in the top three: FGR, low birth weight, and high MAP. Since the PE risk assessment is done in 11 – 13 weeks of gestation, here the newborn weight cannot be analyzed, but it must be considered whether there are available data on FGR.

The main limitation of the existing PE risk prediction models is that only a limited number of them have passed external validation.[32-34] Models developed through the logistic regression approach tend to rearrange, which may overestimate the effectiveness of screening and models may not perform well with additional data that were not originally included in the analysis.[35]

In our study, the patients at high risk were advised to receive low-dose aspirin from 12 to 36 weeks and 80.6% of them complied with this recommendation. Finally, the number of patients who developed PE was 23 before 34 weeks and 30 before 37 weeks of gestation. The limitation of the study is the low number of patients who developed PE and that most of them had prevention therapy with low-dose aspirin.

CONCLUSIONS

In the analysis of the three multiple regression models of the PE predictors – common to all pregnant women; in cases of early, preterm, and term PE are: placental growth factor, PAPP-A, MAP, mean Ut PI, cervical length, newborn weight, and FGR. As common for all cases with PE, and depending on whether the PE onset is ≤34 or <37 weeks of gestation, the independent predictors of PE in all studied pregnant women are: MAP, fetal growth restriction, pregnancy-associated protein-A, and cervix length.

In conclusion, it can be summarized that further analysis of the contribution of biophysical and biochemical indicators is needed to assess the risk of PE.

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Acknowledgements

The authors have no support to report.

Funding

The authors have no funding to report.

Competing Interests

The authors have declared that no competing interests exist.

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Независимые предикторы преэклампсии и их влияние на осложнения в исследовательской группе беременных женщин из Болгарии

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Дата получения: 3 мая 2022 ♦ **Дата приемки:** 12 июля 2022 ♦ **Дата публикации:** 30 июня 2023

Образец цитирования: Stoilov B, Zaharieva-Dinkova P, Stoilova L, Uchikova E, Karaslavova E. Independent predictors of preeclampsia and their impact on the complication in Bulgarian study group of pregnant women. Folia Med (Plovdiv) 2023;65(3):384-392. doi: 10.3897/folmed.65.e86087.

Резюме

Введение: Одним из основных акушерских осложнений, от 2% до 8% всех беременностей, является преэклампсия. Недавно было предложено несколько методов для прогнозирования начала преэклампсии. Фонд медицины плода разработал комбинированный скрининг, который может выявить подавляющее большинство женщин, у которых разовьётся преэклампсия, используя комбинацию материнских факторов, акушерского анамнеза, биохимических и биофизических факторов.

Цель: Целью настоящего исследования было выявить и проанализировать, какие классические факторы риска могут быть независимыми предикторами преэклампсии, и оценить их влияние на это осложнение. Чтобы оценить высокий риск преэклампсии, мы также предлагаем дополнительные предикторы, которые могут оптимизировать совокупность рисков.

Материалы и методы: В исследование были включены 1511 беременных женщин, которые были обследованы во время плановых осмотров в рамках двухэтапного ретроспективного исследования, которое проходило с 30 января 2018 г. по 31 августа 2020 г. в амбулаторном отделении Университетской больницы в Пловдиве. Все первичные данные были получены из их архивных медицинских карт. Информация о материнских факторах, истории болезни, акушерском анамнезе и статусе пациенток была получена на первом этапе исследования (11-я неделя гестации + 0 дней – 13-я неделя гестации + 6 дней). Второй этап проводился в форме телефонного интервью (до полугода после рождения ребенка): собирались данные о способе рождения, массе новорожденного, возникновении ПЭ, на какой неделе гестации произошло начало ПЭ, наличии гестационной гипертензии (ГГ) и сахарного диабета, задержки внутриутробного развития плода (ЗВУР), принимали ли пациентки аспирин и в

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какой дозе, другие осложнения и т.п. Пациентки были разделены на две группы: группа высокого риска (с риском ПЭ выше 1:150) и группу низкого риска, с или без начала ЗВУР, ГГ, диабета и т. д.

Результаты: Средний возраст проанализированных 1511 беременных составил 29.91±5.32 года (от 18 до 46 лет). Из них у 38 (2.9%) женщин развилась преэклампсия, а у 5.9% — гестационная гипертензия. Классификация участников по риску развития преэклампсии показала, что 591 (39.1%) обследованных пациенток относились к группе высокого риска. Все пациентки с риском выше 1:150 были отнесены к группе высокого риска, и им было рекомендовано принимать аспирин по 150 mg каждую ночь с 12-й по 36-ю неделю беременности. Регулярно препарат принимали 80,6% лиц из группы высокого риска.

Сравнивая бета-коэффициенты для изучаемых нами параметров (бета-коэффициент указывает на влияние предикторов на ПЭ), мы установили, что наиболее значимыми и, по-видимому, независимыми в прогнозировании преэклампсии факторами риска являются (в порядке возрастания): 1. Масса тела новорожденного, β=0.157; 2. Среднее артериальное давление (САД), β=0.150; 3. ЗВУР, β=0.120; 4. Ассоциированный с беременностью белок плазмы-А (PAPP-A), β=0.112; 5. Длина шейки матки, β=0.095.

Заключение: При анализе четырёх моделей множественной регрессии, адекватно описывающих роль (и независимость) предикторов ПЭ – общих для всех беременных женщин; в случаях ранней среднесрочной и доношенной ПЭ: плацентарный фактор роста (PlGF), PAPP-A, MAP, средний Ut PI, длина шейки матки, масса новорожденного и ЗВУР. Как общее для всех случаев ПЭ, и в зависимости от того, было ли начало ПЭ ≤32, ≤4 или ≤36 недели гестации, можно сделать следующие выводы: независимыми предикторами ПЭ у всех обследованных беременных были (показатели ранжированы). по степени их влияния на возникновение ПЭ): 1. САД; 2. Задержка внутриутробного развития (масса новорожденного является косвенным показателем вероятной ЗВУР); 3. Белок-А, ассоциированный с беременностью; 4. Длина шейки матки (при соответствующих стандартизированных коэффициентах β=0.150; β=0.120; β=0.112; β=0.095 соответственно).

Ключевые слова

САН, PAPP-A, PlGF, предикторы, преэклампсия