ORIGINAL ARTICLE

Prediction by fullPIERS Model (Preeclampsia Integrated Estimate of Risk) in Preeclampsia Patients for Adverse Maternal and Neonatal Outcomes

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Abstract

Introduction: Hypertensive disorder of pregnancy is one of the leading causes of maternal and perinatal mortality worldwide. Preeclampsia complicates 2–8% of pregnancies globally. Despite the serious clinical consequences, there is currently no effective preventive measure for preeclampsia; hence, the focus has shifted to identifying good predictors for diagnosing the severity of preeclampsia.

Material and methods: This was a prospective cohort hospital-based study done in our Department of Obstetrics and Gynaecology, SN Medical College, Agra, Uttar Pradesh, India over a period of 12 months from January 2020 to January 2021. A total of 400 women were found to be eligible for the study after meeting inclusion criteria. All patients underwent detailed evaluation and investigation and the risk was calculated using the preeclampsia integrated estimate of risk (fullPIERS) calculator. All patients were followed weekly till delivery. Adverse maternal and fetal outcome were assessed. If the predicted probability of the adverse outcome came out to be ≥30%, then the case was considered as high risk. *T*-test and Chi-squared test were used for statistical analysis as appropriate.

Results: Considering our cut-off value ≥30% in our study, out of 384 patients, 82 were categorized into high-risk group; among them, 54 (65.85%) patients had adverse maternal outcome ($\chi^2 = 96.413$, $p \leq 0.0001$).

Among 377 patients, excluding seven women who expired in antenatal period, 75 patients (19.89%) were categorized into high-risk group (≥30% predicted probability), among them, 59 (78.67%) patients had adverse fetal outcome ($\chi^2 = 96.413$, $p \leq 0.0001$).

Conclusion: The fullPIERS model successfully stratifies population into clinically relevant high-risk categories by using few important clinical and biochemical parameters and does not require extensive laboratory testing. It is economically feasible and quick to use, and predicts probability of an adverse outcome.

Thus, the timely referral to higher center will help in having a significant impact in reducing the maternal morbidity and mortality; and perinatal morbidity and mortality associated with preeclampsia in low resource settings.

Keywords: fullPIERS model, Prediction of severity of preeclampsia, Prospective cohort study, Risk calculation by fullPIERS calculator.

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Introduction

Preeclampsia characterized by gestational hypertension and proteinuria, is a state of exaggerated systemic inflammation that remains a leading direct cause of maternal and perinatal morbidity and mortality worldwide.

Numerous studies have tried to evaluate the predictability of various tests including clinical characteristics (mean arterial pressure), biochemical markers, and ultrasound markers (uterine artery pulsatility index; Doppler analysis), individually or in combination, to predict early-, late-, and any-onset preeclampsia. Biochemical markers are expensive; therefore, they are not considered to be cost-effective and are not available at low resource settings.

To predict preeclampsia, many trials using a combination of first-trimester uterine artery pulsatility index and various biochemical serum markers have been tried. However, facilities to assess these parameters are available only at tertiary levels and higher centers.

The fullPIERS model is a tool developed for predicting adverse maternal outcomes following the diagnosis of preeclampsia within 48 hours after admission to the hospital. The fullPIERS model is based on biochemical and clinical parameters that do not require extensive laboratory testing.[1]

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The goal of fullPIERS model was to develop and validate a tool that identifies the women with preeclampsia who are prone for developing adverse maternal or perinatal outcome and so to plan time and place of delivery.

The likelihood ratio associated with higher risk group (predicted probability of the outcome ≥30%) showed excellent correlation of fullPIERS model.[2]

It will be helpful for health workers at primary and secondary health care centers to identify high-risk women with preeclampsia, so that they are referred timely to higher center for appropriate care.

Materials and Methods

This was a prospective hospital-based cohort study done in our Department of Obstetrics and Gynaecology, SN Medical College, Agra, Uttar Pradesh, India; ethical clearance was taken for the same. A total of 400 women were found to be eligible for the study after meeting inclusion criteria. Among these 16 patients were lost to follow-up, so, 384 women fulfilling the study criteria were included in the study after informed consent.

Inclusion Criteria

Patient with preeclampsia attending OPD after 32 weeks of gestation and patient with Preeclampsia being admitted in labor room after 32 weeks of gestation diagnosed by American College of Obstetricians and Gynecologists (ACOG) 2020 diagnostic criteria[3] for preeclampsia.

Exclusion Criteria

Women were excluded if any adverse outcome occurred before their meeting the eligibility criteria or before calculation by using predictor variables was possible. Also, patients of the following diseases were excluded:

- Eclampsia
- Severe anemia (<7 gm/dL)
- Congestive heart failure
- Chronic renal disease
- Known case of liver disease
- Idiopathic thrombocytopenia

In the fullPIERS calculator,[4] the following parameters were used for the risk calculation (Fig. 1):

- Gestation age
- Presence of dyspnea/chest pain
- SpO_2
- Platelet count
- Serum creatinine (the kit used in our institution have the reference range 0.4–1.4; hence, 1.4 mg/dL is taken as cutoff for analysis.
- Aspartate transaminase also known as aspartate aminotransferase/serum glutamic oxaloacetic transaminase [AST/SGOT (U/L)].

All patients underwent detailed evaluation and investigation and risk was calculated. All patients were followed weekly till delivery. Adverse maternal and fetal outcome were assessed. If the predicted probability of the adverse outcome came out to be ≥30%, then the case was considered as high risk.

Adverse Maternal Outcome

- Eclampsia
- Abruptio placentae
- Thrombocytopenia
- Acute renal failure
- Hemolysis, elevated liver enzymes, low platelet counts (HELLP)
- Pulmonary edema
- Postpartum hemorrhage
- Thromboembolic episodes
- Cortical blindness
- Admission to intensive care unit (ICU)
- Maternal death

Adverse Fetal Outcome

- Prematurity
- Apgar score less than 4 at the time of birth

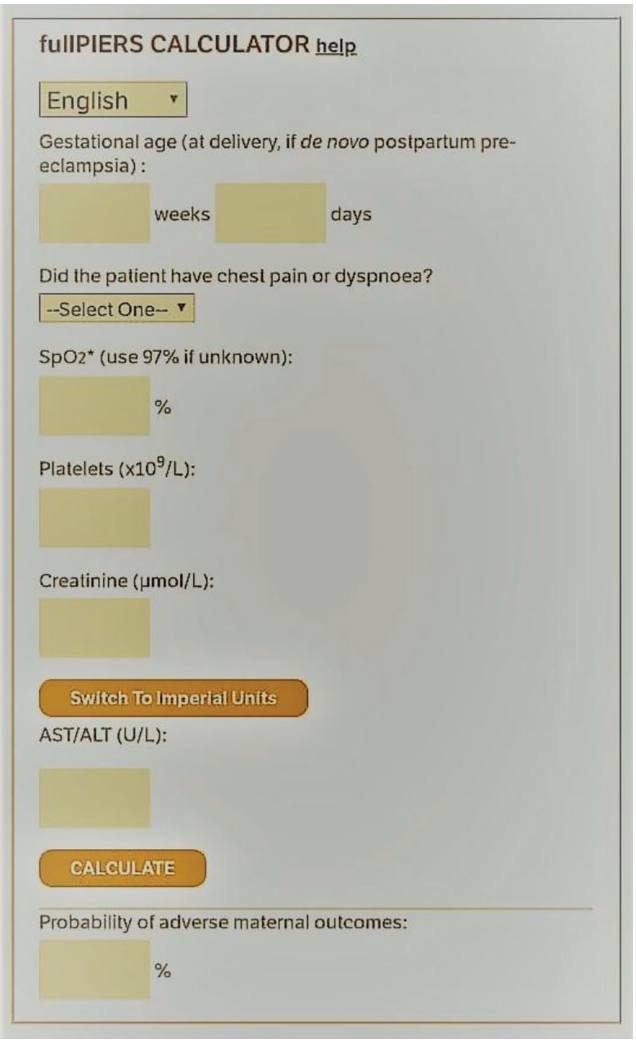

Fig. 1: Shows the fullPIERS calculator, which was used for risk calculation

- Meconium-stained liquor
- NICU admission
- Neonatal death
- Intrauterine death

For statistical analysis, *t*-test and Chi-squared test were used.

Results

Among 384 subjects, the patients (45.83%) were mostly in the age group 23–27 years. However, the mean ± SD values for maternal age at presentation was 26.98 ± 4.775.

Out of 384 subjects, 182 (47.40%) were primigravida; 202 (52.6%) subjects were multigravida, among which 120 patients (59.41%) were second gravida.

Mostly, the patients presented with headache, which was present in 129 (33.59%) patients, chest pain was present in 76 (19.79%) patients and excessive weight gain was present in 79 (20.57%) patients, whereas visual disturbances, severe nausea, and epigastric pain was present in 30 (7.81%), 28 (7.29%), and 24 (6.25%) patients, respectively (Table 1).

As shown in Figure 2, among 384 patients, 42 (10.94%) patients were having gestation age <34 weeks and among these, 15 patients had adverse maternal outcomes, whereas 125 patients (32.55%) were

Table 1: Parameters of fullPIERS calculator used for risk estimation of adverse events in patients of preeclampsia and their statistical correlation

	Parameters of fullPIERS calculator		*Number (in %) (n = 384)*	*Adverse maternal outcomes*		
				Present	*Absent*	
Variables (for risk calculation)	*Gestational age (in weeks)*	<34	42 (10.94%)	15	27	$\chi^2 = 18.816$ $p = 0.0003$
		34–36	125 (32.55%)	51	74	
		37–39	181 (47.135%)	38	143	
		≥40	36 (9.375%)	00	36	
	Chest pain	Present	76 (19.79%)	53	23	$\chi^2 = 84.620$ $p \leq 0.0001$ OR = 11.612
		Absent	308 (80.21%)	51	257	
	SpO_2 (in %)	<94.9	97 (25.26%)	62	35	$\chi^2 = 97.456$ $p \leq 0.0001$
		>95	287 (74.74%)	42	245	
	Platelet count/cumm	<100,000	86 (22.40%)	35	51	$\chi^2 = 9.532$ $p \leq 0.0020$ OR = 2.278
		>100,000	298 (77.60%)	69	229	
	Serum creatinine (mg/dL)	<1.4	328 (85.42%)	83	245	$\chi^2 = 3.011$ $p = 0.0827$ OR = 0.5646
		>1.4	56 (14.58%)	21	35	
	Serum SGOT levels (IU/L)	<40	80 (20.83%)	06	74	$\chi^2 = 18.392$ $p \leq 0.0001$ OR = 0.1704
		>40	304 (79.17%)	98	206	

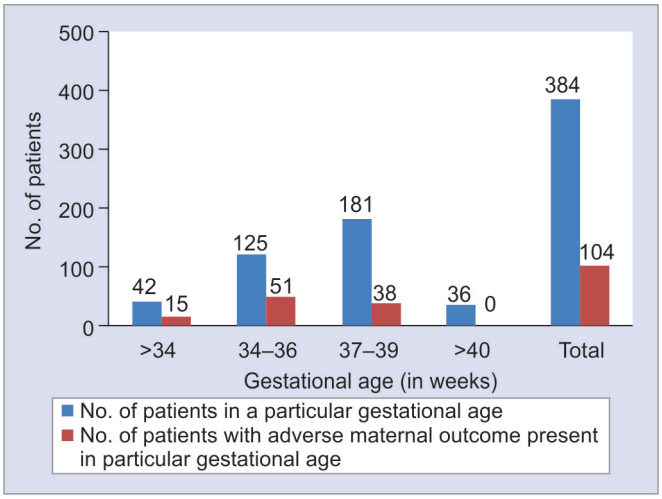

Fig. 2: Distribution of women according to gestational age along with incidence of adverse maternal outcome in that gestational age

of 34–36 gestation age, from which 51 patients had adverse maternal outcomes and out of 217 (56.51%) patients who were of gestation age ≥37 weeks; 38 patients had adverse maternal outcomes. Our study significantly shows association between the early disease onset and disease severity. ($\chi^2 = 18.816$, $p = 0.0003$) (Table 1).

Chest pain was present in 76 (19.79%) patients, 53 (69.74%) patients had adverse maternal outcomes, while 308 (80.21%) patients who were not having either chest pain or dyspnea, and out of these non-symptomatic patients, 51 (16.56%) had adverse maternal outcomes [$p < 0.001$, and odds ratio (OR) = 11.612]. Out of 30 patients with $SpO_2 < 88\%$, 25 patients (83.33%) had adverse maternal outcome, while out of 287 patients with $SpO_2 > 95\%$, 42 (16.67%) had adverse maternal outcome. Hence, SpO_2 levels used with success to predict adverse maternal outcome. Adverse maternal outcome showed an increase with the decrease SpO_2 value ($p < 0.0001$).

Table 2: Distribution of patients according to predicted probability (in %) calculated by fullPIERS calculator in predicting maternal adverse outcome

Predicted probability (%)	*Number n = 384*	*Adverse maternal outcomes*	
		Present (in %)	*Absent (in %)*
0.00–0.99	48	5 (10.42%)	43 (89.58%)
1.0–2.4	73	11 (16.07%)	62 (84.93%)
2.5–4.9	95	08 (8.42%)	87 (91.58%)
5.0–9.9	48	11 (22.92%)	37 (77.08%)
10.0–19.9	27	09 (33.33%)	18 (66.67%)
20.0–29.9	11	06 (54.55%)	05 (45.45%)
≥30	82	54 (65.85%)	28 (34.15%)
Total	384	104 (27.08%)	280 (72.92%)

In the study, 86 patients had platelet count <1 lakh/cumm, 35 patients (40.70%) had adverse outcome. Out of 298 (77.40%) patients having >1 lakh/cumm, 69 (23.15%) patients had adverse outcomes, while 229 (76.85%) patients did not have any adverse outcomes ($p < 0.0020$, OR = 2.278)

Majority of participants of the study, 328 (85.42%) patients were having serum creatinine value <1.4 mg/dL, out of which 83 had adverse outcome, and among 56 (14.58%) patients having serum creatinine >1.4 mg/dL, 21(37.5%) patients had adverse outcome ($p = 0.0827$, OR = 0.5646). Among the biochemical markers, serum creatinine did not show any significant association.

In our study, 98 (32.24%) women out of 304 with AST >40 U/L had adverse maternal outcome, whereas 06 (7.5%) out of 80 with AST ≤ 40 U/L had adverse outcome ($p \leq 0.0001$, OR = 0.1704).

Among 384 patients, 133 patients (35.28%) delivered *via* vaginal delivery while 244 patients (64.72%) had caesarean section.

According to Table 2, among 384 patients, using fullPIERS calculator, 82 patients were categorized into high-risk group (≥30%

predicted probability), among them, 54 (65.85%) patients had adverse maternal outcome ($\chi^2 = 96.413$, $p \leq 0.0001$)

As shown in Figure 3, out of 384 patients, 27 (7.03%) had eclampsia, 24 (6.25%) had abruptio placentae, 86 (22.40%) had thrombocytopenia, 31 (8.07%) developed HELLP syndrome, 63 (16.41%) had postpartum hemorrhage, 28 (7.29%) required intubation, and ICU admission and there were 13 (3.38%) maternal deaths, out of whom seven died in antenatal period

As seven women died in antenatal period, calculation for adverse fetal outcome was possible in 377 patients. As shown in Table 3, using fullPIERS calculator, 75 patients were categorized into high-risk group (≥30% predicted probability); among them, 59 (78.67%) patients had adverse fetal outcome ($\chi^2 = 96.413$, $p \leq 0.0001$).

In Figure 4, out of 377 neonates, 167 (44.30%) were premature, 203 (53.85%) had fetal growth restriction, 64 (16.97%) had Apgar score less than 4 at the time of birth, 67 (17.77%) had meconium-stained liquor, 90 (25.50%) neonates were admitted to NICU, 24 (6.37%) died intrauterine, and 06 (1.59%) died in neonatal period.

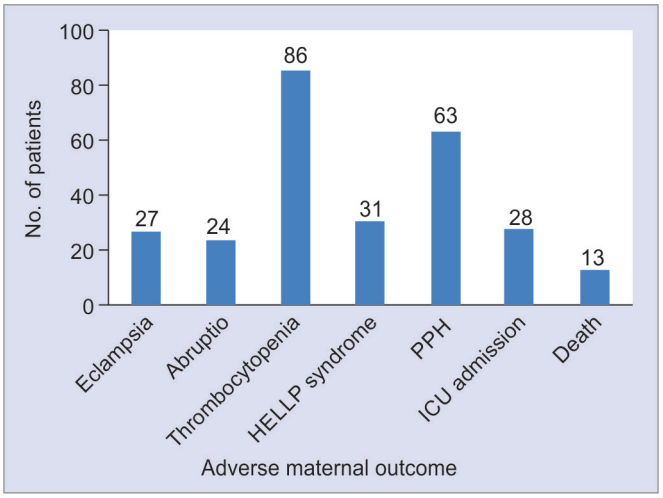

Fig. 3: Depicts distribution of women according to adverse maternal outcomes

Table 3: Distribution of variables of PIERS calculator and calculated probability score for adverse outcome in mortality cases

Gravida, parity	*Gestation age*	*Chest pain*	*Breathlessness*	*SpO_2 levels*	*Platelet count*	*Creatinine (mg/dL)*	*AST/SGOT*	*Probability*	*Outcome*
G2P1L1A0	35	1	1	88	48	0.91	98	65.2	Death
G1P0L0A0	36	1	1	85	75	0.88	71	74	Death
G2P1L1A0	34	1	1	84	44	0.9	99	76.1	Death
G1P0L0A0	34		1	88	90	1.4	78.9	65.7	Death
G6P2L2A3	35		1	88	105	1	59	64.2	Death
G2P1L1A0	37		1	88	69	0.98	105	61.8	Death
G5P4L4A0	34	1	1	84	260	0.66	78.9	98.5	Death
G1P0L0A0	38		0	84	60	0.65	202.31	65.4	Death
G1P0L0A0	35		1	89	85	1.2	92	56	Death
G6P2L2A3	31		1	83	110	1.3	63	90.6	Death
G2P1L1A0	37		1	88	269	0.98	87	92.5	Death
G1P0L0A0	36	1	1	87	31	0.79	68.9	66.3	Death
G2P1L1A0	35	1	1	87	49	0.91	102	68.3	Death

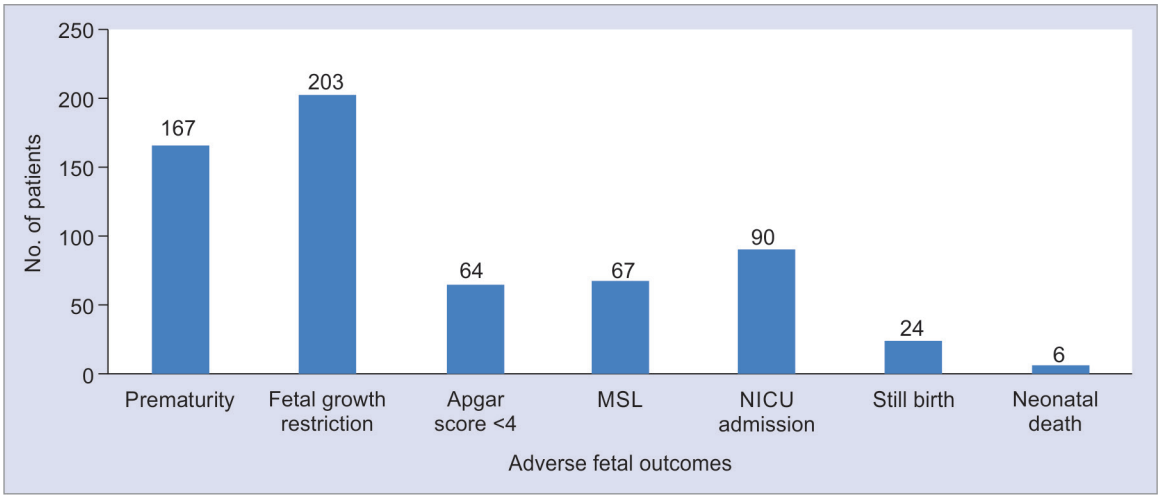

Fig. 4: Shows distribution of women according to adverse fetal outcome

Discussion

Table 4 shows the significant association found from our study between the early disease onset and disease severity ($\chi^2 = 18.816$, $p = 0.0003$). In a study by Ni and Cheng on early- and late-onset preeclampsia, concluded that the early-onset preeclampsia is a distinct and more severe clinical entity with earlier gestational age onset and delivery.[4–6]

In our study, the significant association was found between the decreased SpO_2 level and adverse maternal outcome ($p < 0.0001$). Srivastava et al., in their study found that SpO_2 successfully predicted adverse maternal outcome.[7]

In our study, the platelet counts of <1 lakh/cumm was significantly associated with adverse maternal outcome. In the studies by Agarwal and Maitra[2] and Srivastava et al.,[7] low platelet count was significantly associated with adverse maternal outcome. In a similar study by Bhamri et al. concluded that the mean platelet volume increases in the late first trimester (11–14 weeks) in women destined to develop a preeclampsia.[8] In a study by Dadhich et al. concluded that the patients with preeclampsia are more likely to have rapid and significant decrease in platelet count, increase in PDW and MPV in comparison to the normotensive counterparts.[9]

In our study, among the biochemical markers, serum creatinine did not show any significant association. In the study by Srivastava et al., no correlation was found between Serum creatinine levels and adverse outcomes.[7] In a study on fullPIERS by Agarwal and Maitra, serum creatinine was found to be an independent predictor of adverse maternal outcome.[2]

As shown in Table 5, in our study, 98 (32.24%) women out of 304 with AST > 40 U/L had adverse maternal outcome ($p \leq 0.0001$, OR = 0.1704). In a systematic review of PIERS data, Thangaratinam et al. found that the presence of increased liver enzymes was associated with an increased probability of maternal and fetal complications, but normal liver enzyme levels did not rule out disease, as specificity was often higher than sensitivity.[10] In a similar study by Srivastava et al., serum AST levels of more than 40 U/L were not significantly associated with adverse maternal outcome.[7]

As shown in Table 6, in the study by Agarwal and Maitra, the risk prediction model used showed that the likelihood ratio associated with the highest risk group (predicted probability of the outcome ≥30%) showed excellent performance (i.e., 17.5) of fullPIERS model as a rule in test.[2] Srivastava et al. in their study found that 21 patients in all had adverse maternal outcome. Six patients who belonged to the high-risk group according to fullPIERS calculator and five women had adverse outcome ($p < 0.00001$). The result was statistically significant in identifying high-risk cases in their study.[7]

Table 4: Distribution of women according to predicted probability (in%) calculated by fullPIERS calculator in predicting adverse fetal outcome

Predicted probability (%)	*Number (n = 377)*	*Adverse fetal outcomes*	
		Present (in %)	*Absent (in %)*
0.00–0.99	48	4 (8.3%)	44 (91.7%)
1.0–2.4	73	21 (28.77%)	52 (71.23%)
2.5–4.9	95	25 (26.31%)	70 (73.69%)
5.0–9.9	48	30 (62.5%)	18 (37.5%)
10.0–19.9	27	15 (55.5%)	12 (44.5%)
20.0–29.9	11	10 (90.9%)	1 (9.1%)
≥30	75	59 (78.67%)	16 (21.33%)
Total	377	164 (43.50%)	213 (56.50%)

Conclusion

In our study, the fullPIERS model performed well in the prediction of adverse maternal and fetal outcomes in women with preeclampsia. The fullPIERS model successfully stratifies population into clinically relevant high-risk categories by using few important clinical and biochemical parameters and does not require extensive laboratory testing. It is economically feasible and quick to use, and predicts probability of an adverse outcome.

Table 5: Comparison between different studies on assessment of variables of fullPIERS model in predictability of adverse maternal outcome

	Gestational age	*Chest pain*	*Oxygen saturation*	*Platelet count (>1.5 lacs/cumm)*	*Serum creatinine level (>1 mg/dL)*	*AST level (>40 IU/L)*	*Predictability of fullPIERS model*
In our study	Significant $p = 0.0003$	Significant OR = 11.612 $p < 0.0001$	Significant $p < 0.0001$	Significant OR = 2.278 $p < 0.002$	Not significant OR = 0.5646 $p = 0.0827$	Significant OR = 0.1704 $p < 0.0001$	Significant $p < 0.0001$
In Srivastava et al.[7] study	Significant $p < 0.05$	Significant $p < 0.05$	Significant $p < 0.0001$	Significant $p < 0.05$	Not significant $p > 0.05$	Not significant $p > 0.05$	Significant $p < 0.0001$
In Agarwal et al.[9] study	Significant $p = 0.01$	Significant OR = 4.69 $p < 0.0001$	Significant $p < 0.05$	Significant OR = 1.89 $p = 0.014$	Significant OR = 8.9 $p < 0.0001$	Not significant $p = 0.21$	Significant positive likelihood ratio = 17.53 for predicted probability >30

Table 6: Comparison of different studies in stratifying cases according to fullPIERS score and assessing predictability of adverse maternal outcome

	Distribution of cases according to fullPIERS score	*Number of women in high-risk group*	*Number of women with adverse outcome*	*Women with adverse outcome (%)*
In our study	High risk (≥30)	82	54	65.85
In Srivastava et al.[7] study	High risk (≥30)	06	05	83.33
In Agarwal et al.[9] study	High risk (≥30)	27	15	55.55

Hence, it will be of great help to health workers at primary and secondary health care centers to identify women with preeclampsia who are at high risk of developing complications and will need specialist care by timely referral to higher center for appropriate care. This will go a long way in having a significant impact in reducing the maternal morbidity and mortality; and perinatal morbidity and mortality associated with preeclampsia in the countries with low resource settings of health care belonging to South East Asia.

References

1. Payne B, Hodgson S, Hutcheon J, et al. Performance of the fullPIERS model in predicting adverse maternal outcomes in pre-eclampsia using patient data from the PIERS (pre-eclampsia integrated estimate of risk) cohort, collected on admission. BJOG 2013;120(1):113–118. DOI: 10.1111/j.1471-0528.2012.03496.x.
2. Agarwal S, Maitra N. Prediction of adverse maternal outcomes in preeclampsia using a risk prediction model. J Obstet and Gynaecol India 2016;66(Suppl 1):104–111. DOI: 10.1007/s13224-015-0779-5.
3. Gestational hypertension and preeclampsia: ACOG Practice Bulletin, Number 222. American College of Obstetricians and Gynecologists. Obstet Gynecol 2020;135(6):e237–e260. DOI: 10.1097/AOG.0000000000003891.
4. Pre-eclampsia integrated estimate of risk (PIERS) Calculator. https://pre-empt.obgyn.ubc.ca/home-page/past-projects/fullpiers. Accessed 29-06-2022.
5. Anitha GS, Krishnappa TK, Shivamurthy G, et al. Maternal and fetal outcome in HELLP syndrome: an observational study. J South Asian Feder Obst Gynae 2020;12(3):122–132. DOI: 10.5005/jp-journals-10006-1779.
6. Ni Y, Cheng W. Comparison of indications of pregnancy termination and prognosis of mothers and neonates in early- and late-onset preeclampsia. Hypertens Pregnancy 2016;35(3):315–322. DOI: 10.3109/10641955.2016.1143486.
7. Srivastava S, Parihar BC, Jain N. PIERS calculator predicting adverse maternal outcome in preeclampsia. Int J Reprod Contracept Obstet Gynecol 2017;6(4):1200–1205. DOI: 10.18203/2320-1770.ijrcog20170889.
8. Bhamri SS, Singh U, Mehrotra S, et al. Association of mean platelet volume in the late first trimester of pregnancy and development of preeclampsia. J South Asian Feder Obst Gynae 2019;11(3):172–174. DOI: 10.5005/jp-journals-10006-1672.
9. Dadhich S, Agrawal S, Soni M, et al. Predictive value of platelet indices in development of preeclampsia. J South Asian Feder Obst Gynae 2012;4(1):17–21. DOI: 10.5005/jp-journals-10006-1164.
10. Thangaratinam S, Koopmans CM, Iyengar S, et al. Accuracy of liver function tests for predicting adverse maternal and fetal outcomes in women with preeclampsia: a systematic review. Acta Obstet Gynecol Scand 2011;90(6):574–585. DOI: 10.1111/j.1600-0412.2011.01112.x.