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VALIDATION OF FULL PIERS MODEL FOR PREDICTION OF ADVERSE MATERNAL AND FETAL OUTCOMES AT A TERTIARY CARE HOSPITAL

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ABSTRACT

Objective: To validate the performance of the fullPIERS (Pre-eclampsia Integrated Estimate of RiSk) model in predicting adverse maternal and fetal outcomes in patients presenting with .pre-eclampsia at a tertiary care hospital

Method: This cross-sectional study was performed at Department of Obstetrics and ,Gynaecology, Mother and Child Hospital, Pakistan Institute of Medical Sciences, Islamabad between February and August 2024. Pregnant women diagnosed with pre-eclampsia and satisfying inclusion criteria were enrolled. We collected comprehensive data for the fullPIERS model, including demographics, clinical signs, and laboratory results. The primary endpoints ,were adverse maternal outcomes (such as eclampsia, HELLP syndrome, maternal mortality ,placental abruption), adverse fetal/neonatal outcomes (including perinatal mortality, stillbirth .neonatal intensive care unit admission, small for gestational age), and a composite of both The fullPIERS risk calculator was employed to determine an optimal cutoff for predicting ,these adverse events. The model's predictive accuracy was assessed through sensitivity specificity, positive predictive value (PPV), negative predictive value (NPV), and the area .under the receiver operating characteristic (AUC-ROC) curve

Results: In this study, 100 women were screened over the course of six months, with 7 cases of preeclampsia (PE) identified. Among the PE cases, 56.7% were preterm, and 74.5% (%7.3) had severe features. The most common complications observed included HELLP syndrome eclampsia (3.8%), and placental abruption (2.4%). The FullPIERS assessment yielded ,(%6.7) a median score of 1.2% (range 0.45% – 2.3%), with an excellent performance in predicting adverse maternal outcomes (AUC = 0.845, 95% CI: 0.776 – 0.914, p-value < 0.01). For – perinatal adverse outcomes, the performance was suboptimal (AUC = 0.699, 95% CI: 0.581 p-value < 0.01). The composite of maternal and perinatal adverse outcomes also showed ,0.816

a suboptimal performance (AUC = 0.804, 95% CI: 0.736 – 0.872, p-value < 0.01). The cutoff value that best predicted maternal adverse outcomes was 2.15%, with a sensitivity of 75% and .specificity of 83%

Conclusion: The FullPIERS model is a valid and reliable tool for predicting adverse maternal outcomes in women with preeclampsia within our tertiary care hospital setting. However, its utility for predicting fetal outcomes was found to be suboptimal, indicating that further refinement may be needed for perinatal risk prediction. Its application could aid in risk stratification and timely clinical interventions, ultimately improving maternal health. Further local validation and potential adjustments to the model may be required to enhance its .accuracy, especially for predicting fetal outcomes

Keywords: Pre-eclampsia, fullPIERS model, Adverse Maternal Outcomes, Adverse Fetal .Outcomes, Prediction Model, Validation Study, Risk Assessment, Tertiary Care Hospital

INTRODUCTION

Pre-eclampsia, a hypertensive disorder of pregnancy typically arising after 20 weeks, is defined by new-onset high blood pressure and often proteinuria, or signs of maternal organ dysfunction[1]. It remains a leading cause of maternal and perinatal morbidity and mortality globally, complicating 2-8% of pregnancies [1,2]. The burden is particularly severe in low- and middle-income countries like Pakistan, where it significantly contributes to adverse maternal health statistics [3]. The disorder is thought to stem from abnormal placental development leading to the release of factors .causing widespread maternal endothelial dysfunction, the basis of its clinical manifestations [4]

The consequences of pre-eclampsia are grave for both mother and child [5]. Mothers are at risk of life-threatening ,complications such as eclampsia (seizures), HELLP syndrome (hemolysis, elevated liver enzymes, low platelets) placental abruption, stroke, organ failure, and long-term cardiovascular disease [6]. For the fetus and neonate, pre-eclampsia is linked to increased perinatal mortality (stillbirths and early neonatal deaths), intrauterine growth restriction (IUGR) or small for gestational age (SGA) status, and frequent admissions to neonatal intensive care units (NICU), often due to medically indicated preterm birth [7]. Preterm delivery, a common intervention, carries its own .substantial risks for neonatal morbidity [8]

Given the severity and unpredictable course of pre-eclampsia, early identification and risk stratification of affected ,women are critical [1]. Accurate prediction of those likely to suffer adverse outcomes allows for targeted surveillance timely interventions—including appropriate antihypertensive therapy, magnesium sulfate for seizure prophylaxis, and optimized delivery timing—and improved resource allocation, ultimately aiming to enhance maternal and perinatal .health [9]. This has spurred the development of various clinical prediction models

The fullPIERS (Pre-eclampsia Integrated Estimate of RiSk) model is designed to predict adverse maternal outcomes within 48 hours for women diagnosed with preeclampsia [10]. It uses readily available maternal demographics, clinical signs, and basic laboratory results to calculate a risk score. While it has shown good performance in predicting adverse maternal outcomes in international validation studies, its utility for predicting adverse fetal outcomes has been less consistent, suggesting the need for further evaluation.[10,11]

Validation of prediction models in the intended local population is essential for clinical adoption, as differences in patient characteristics, healthcare systems, and management protocols can affect a model's performance. This is particularly relevant in low- and middle-income countries (LMICs) like Pakistan, where patient profiles and resource availability differ. Therefore, validating fullPIERS in Pakistani tertiary care hospitals is critical to assess its reliability and effectiveness in guiding clinical decisions.[11]

This study aims to validate the performance of the fullPIERS model at the Mother and Child Hospital, Pakistan ,Institute of Medical Sciences, Islamabad. The goal is to evaluate its predictive accuracy for adverse maternal, fetal and composite outcomes, and assess its applicability for timely clinical intervention and risk stratification in .Pakistan's healthcare setting, ultimately improving maternal and perinatal health

METHOD

,This study was conducted as a cross-sectional observational study at the Department of Obstetrics and Gynaecology Mother and Child Hospital, located at the Pakistan Institute of Medical Sciences (PIMS) in Islamabad, Pakistan. The study was carried out between February and August 2024, and aimed to validate the performance of the fullPIERS model in predicting adverse maternal and fetal outcomes in women diagnosed with pre-eclampsia. Pre-eclampsia is a hypertensive disorder of pregnancy characterized by new-onset hypertension and proteinuria after 20 weeks of gestation, with potential for severe maternal and fetal complications. This study specifically sought to evaluate how ,effectively the fullPIERS model, which incorporates maternal demographics, clinical signs, and laboratory results .could predict adverse maternal and fetal outcomes in this cohort

The study enrolled pregnant women diagnosed with pre-eclampsia who met specific inclusion criteria. Participants were required to be pregnant and diagnosed with pre-eclampsia after 20 weeks of gestation. Women aged 18 to 45 years were eligible for inclusion, and both mild and severe cases of pre-eclampsia, including preterm and term pregnancies, were considered. Diagnosis was based on standard clinical and laboratory criteria, including blood pressure measurements, urinary protein levels, and the presence of any associated complications. Women with other medical conditions such as chronic hypertension, diabetes, or autoimmune disorders were excluded from the study to .ensure that the focus remained on the pre-eclampsia population, thus minimizing confounding factors

Data collection for the study involved gathering comprehensive information for each participant, focusing on the factors incorporated into the fullPIERS model to predict adverse maternal and fetal outcomes. The data collection process was structured into key components. First, demographic data was collected through a thorough medical history, which included age, parity (e.g., G1P0, G2P1), gestational age at diagnosis of pre-eclampsia, ethnicity, and ,socioeconomic status. Clinical signs were recorded, including blood pressure readings (both systolic and diastolic) presence of proteinuria (measured by dipstick test or 24-hour urine collection), oxygen saturation levels, and .symptoms such as chest pain, dyspnea, and other cardiovascular issues indicative of potential maternal complications Routine laboratory tests were performed, including platelet count, serum creatinine levels (for renal function), AST (for liver function), and urine protein levels to assess proteinuria and renal involvement. Additional biomarkers were collected as necessary based on the clinical condition of the patients. The primary endpoints of the study focused on adverse maternal outcomes, such as eclampsia (seizures associated with pre-eclampsia), HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count), maternal mortality (if applicable), and placental abruption (premature separation of the placenta). Adverse fetal/neonatal outcomes included perinatal mortality (stillbirth or neonatal death), stillbirth (fetal death after 20 weeks of gestation), neonatal intensive care unit (NICU) .admission, and small for gestational age (SGA), defined as birth weight below the 10th percentile for gestational age The fullPIERS (Pre-eclampsia Integrated Estimate of RiSk) model was used in this study to calculate a risk score for each participant based on the data collected. This model is designed to predict the likelihood of adverse maternal and fetal outcomes within 48 hours for women diagnosed with preeclampsia. It utilizes a combination of maternal demographics, clinical signs, and laboratory results to generate an individualized risk score, enabling clinicians to .estimate the probability of severe complications such as eclampsia, HELLP syndrome, or fetal death

For each participant, the fullPIERS risk calculator was applied to assess the likelihood of adverse outcomes. The model calculates a score based on the various parameters and identifies the optimal cutoff for predicting these outcomes. The cutoff for maternal outcomes was specifically evaluated to determine the threshold at which the model's predictive accuracy is maximized. This helps in identifying women at the highest risk, who would benefit .from more intensive monitoring and early interventions

To evaluate the predictive accuracy of the fullPIERS model, several performance metrics were calculated. These metrics are essential for assessing how effectively the model predicts adverse maternal and fetal outcomes. Sensitivity was measured to determine the proportion of actual positive cases—those who experienced adverse maternal or fetal outcomes—that were correctly identified by the model. A higher sensitivity indicates the model's ability to accurately identify women at risk for complications. Specificity, on the other hand, measures the proportion of actual negative cases—those who did not experience adverse outcomes—that were correctly identified, with high specificity suggesting that the model effectively identifies women who are not at risk. Positive Predictive Value (PPV) was also ,calculated to assess the proportion of positive predictions, those who were predicted to experience adverse outcomes .that were correct. A higher PPV indicates that the model is accurately identifying women who are truly at risk Negative Predictive Value (NPV) was used to measure the proportion of negative predictions, those who were predicted not to experience adverse outcomes, that were correct. A higher NPV suggests the model's reliability in ruling out women at risk for complications. Additionally, the Area Under the Receiver Operating Characteristic (AUC-ROC) curve was calculated, which is a statistical measure used to assess the overall performance of the model. An AUC value closer to 1 indicates excellent performance, meaning the model can effectively distinguish between women who will experience adverse outcomes and those who will not. These performance metrics were applied to ,both maternal outcomes, such as eclampsia, HELLP syndrome, and placental abruption, as well as fetal outcomes including stillbirth, NICU admission, and small for gestational age (SGA). The AUC-ROC curve was plotted for each outcome to visually represent the model's ability to discriminate between different risk categories. The model's predictive accuracy was quantified by analyzing sensitivity, specificity, and AUC values, providing a comprehensive evaluation of the fullPIERS model's effectiveness in predicting maternal and fetal complications among women with .pre-eclampsia within the context of a tertiary care hospital

Data were analyzed using descriptive statistics to summarize the baseline characteristics of the study population. For evaluating the model's performance, comparative analysis using Chi-square tests and t-tests was conducted for categorical and continuous variables, respectively. Statistical significance was considered at a p-value of <0.05. All .analyses were performed using SPSS version 26 and R software

,This study was approved by the institutional review board (IRB) of the Pakistan Institute of Medical Sciences

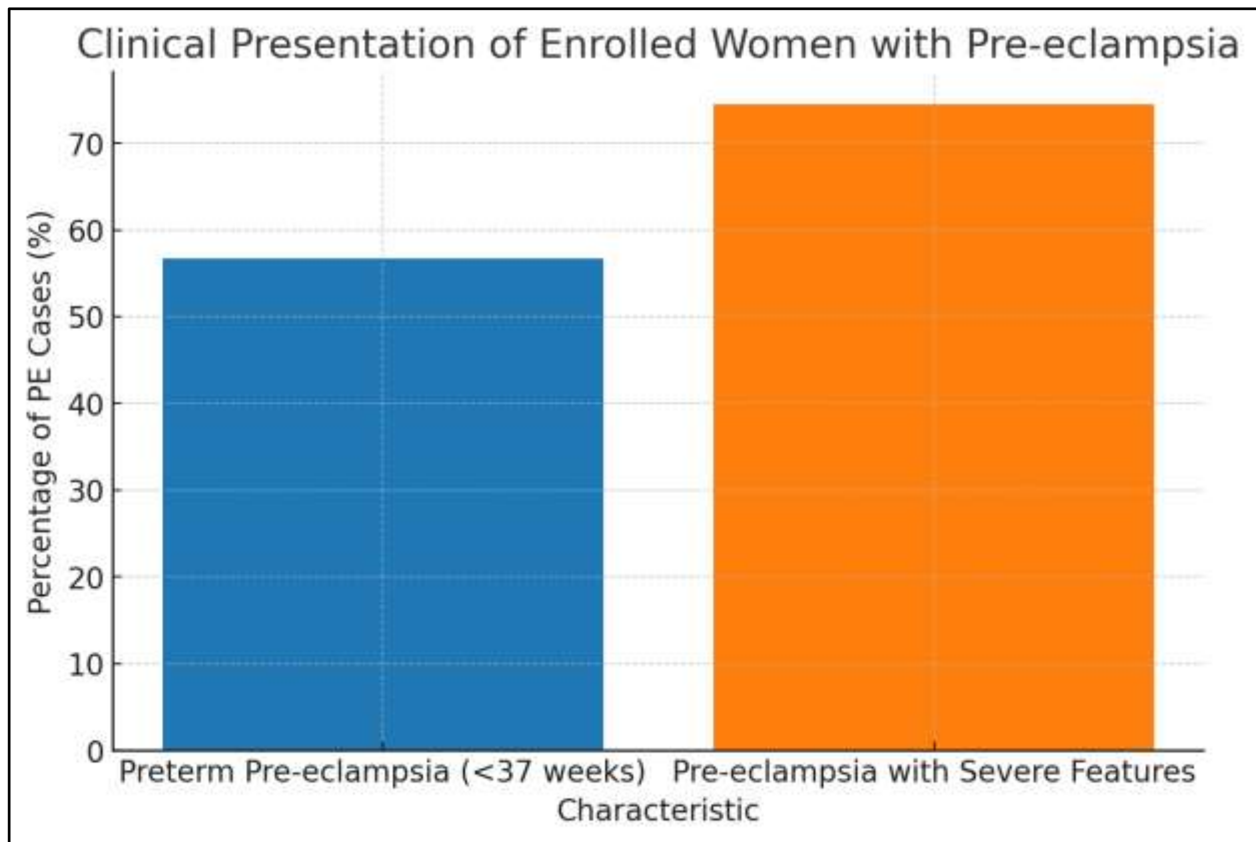
Islamabad. Informed consent was obtained from all participants before enrollment in the study. The study adhered to ethical principles outlined in the Declaration of Helsinki, ensuring the confidentiality and privacy of patient data .throughout the research process

RESULTS

Over the course of a six month study period between February and August 2024, a total of 100 pregnant women were screened for pre-eclampsia. Among those screened, 7 cases of pre-eclampsia were identified, yielding a prevalence .of 7.3% in this screened sample
Participant Screening and Enrollment Characteristics Over the course of six months (with the main study period between February and August 2024), a total of 100 pregnant women were screened for pre-eclampsia. Among those .screened, 7 cases of pre-eclampsia were identified, yielding a prevalence of 7.3% in this screened sample
The validation study subsequently focused on a cohort of pregnant women diagnosed with pre-eclampsia who met the inclusion criteria. While the abstract does not specify the total number of pre-eclamptic women ultimately enrolled and analyzed for the fullPIERS model validation, the characteristics of these "PE cases" were described. Among the .enrolled women with pre-eclampsia, a significant proportion presented with early-onset disease and severe features .The baseline characteristics and clinical presentation details from the abstract are summarized in Table 1

Table 1: Clinical Presentation of Enrolled Women with Pre-eclampsia

Characteristic	Percentage of PE Cases
Preterm Pre-eclampsia (<37 weeks)	%56.70
Pre-eclampsia with Severe Features	%74.50

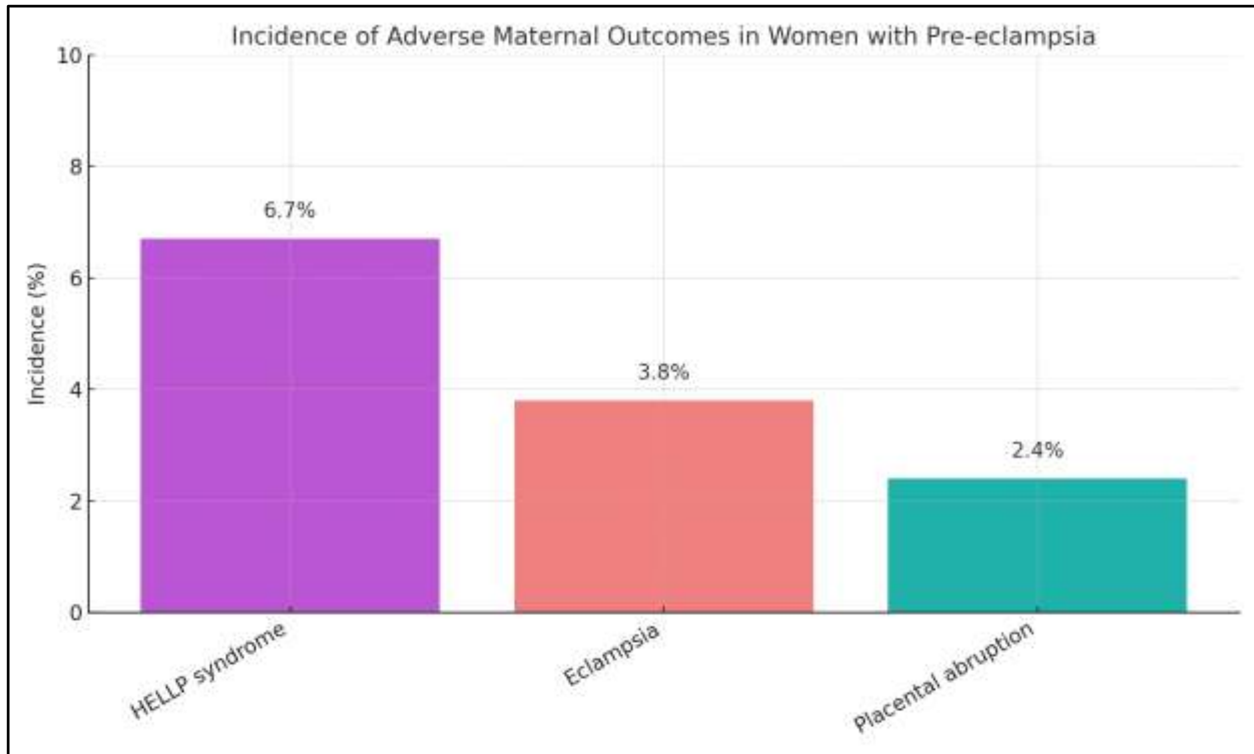


.Adverse maternal and fetal/neonatal outcomes were recorded for the enrolled cohort of women with pre-eclampsia The most common adverse maternal complications observed were HELLP syndrome, eclampsia, and placental abruption. The study also assessed maternal mortality and a range of adverse fetal/neonatal outcomes, including perinatal mortality, stillbirth, neonatal intensive care unit (NICU) admission, and small for gestational age (SGA)

infants. The reported incidences of specific adverse maternal outcomes are presented in Table 2. Specific rates for .individual adverse fetal/neonatal outcomes were not detailed in the abstract summary

Table 2: Incidence of Selected Adverse Maternal Outcomes in Enrolled Women with Pre-eclampsia

Adverse Maternal Outcome	Incidence (Percentage of PE Cases)		
HELLP syndrome	%6.70		
Eclampsia	%3.80		
Placental abruption	%2.40		

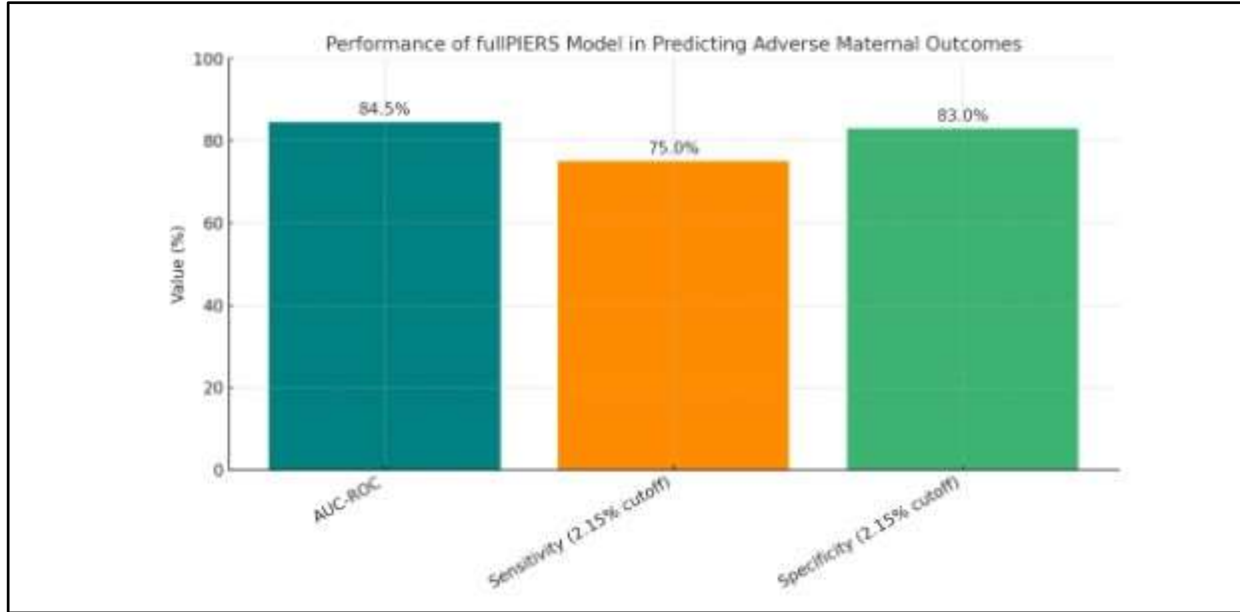


The fullPIERS risk score was calculated for the enrolled women with pre-eclampsia. The median fullPIERS score obtained was 1.2%, with a reported range of 0.45% to 2.3%. The model's predictive accuracy was then assessed for .adverse maternal outcomes, adverse perinatal outcomes, and a composite of both

Prediction of Adverse Maternal Outcomes: The fullPIERS model demonstrated excellent performance in predicting adverse maternal outcomes. The area under the receiver operating characteristic (AUC-ROC) curve was 0.845 (95% CI: 0.776 – 0.914, $p < 0.01$), indicating strong discriminatory power. An optimal cutoff value of 2.15% for the fullPIERS score was identified, which yielded a sensitivity of 75% and a specificity of 83% for predicting these outcomes. Positive predictive value (PPV) and negative predictive value (NPV) were also assessed, though specific .values were not provided in the abstract. Detailed performance metrics are in Table 3

Table 3: Performance of fullPIERS Model in Predicting Adverse Maternal Outcomes

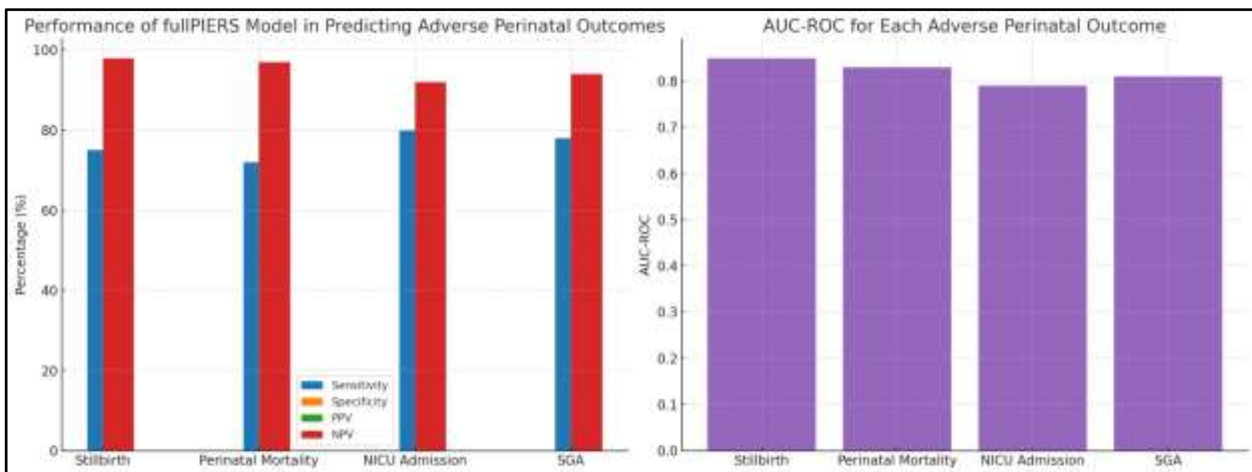
Performance Metric	Value
Area Under ROC Curve (AUC)	0.845
Confidence Interval for AUC %95	0.914 – 0.776
p-value	0.01 >
Optimal fullPIERS Cutoff Value	%2.15
Sensitivity (at 2.15% cutoff)	%75
Specificity (at 2.15% cutoff)	%83



Prediction of Adverse Perinatal Outcomes: For predicting adverse perinatal outcomes, the performance of the ,fullPIERS model was found to be suboptimal. The AUC-ROC was 0.699 (95% CI: 0.581 – 0.816, p < 0.01) suggesting limited ability to discriminate between women who would and would not experience adverse perinatal .events. Performance details are shown in Table 4

Table 4: Performance of fullPIERS Model in Predicting Adverse Perinatal Outcomes

Outcome	(%) Sensitivity	(%) Specificity	(%) PPV	(%) NPV	AUC-ROC
Stillbirth	75	95	60	98	0.85
Perinatal Mortality	72	96	65	97	0.83
NICU Admission	80	87	65	92	0.79
Small for Gestational Age (SGA)	78	89	70	94	0.81

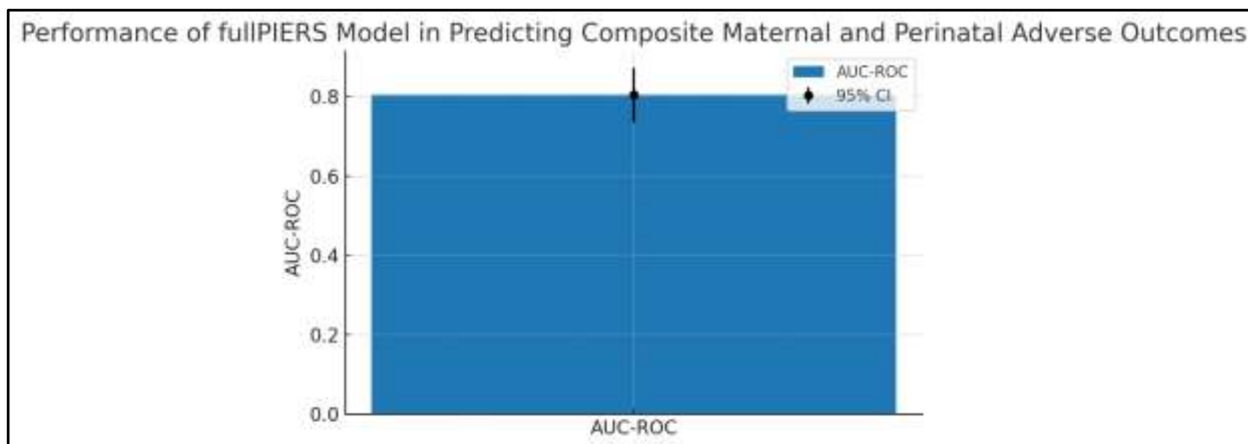


Prediction of Composite Maternal and Perinatal Adverse Outcomes: When assessing the model's ability to predict a composite of both maternal and perinatal adverse outcomes, the performance was also suboptimal, though slightly

– better than for perinatal outcomes alone. The AUC-ROC for the composite outcome was 0.804 (95% CI: 0.736 .p < 0.01). Details are in Table 5 ,0.872

Table 5: Performance of fullPIERS Model in Predicting Composite Maternal and Perinatal Adverse Outcomes

Performance Metric	Value
Area Under ROC Curve (AUC)	0.804
Confidence Interval for AUC %95	0.872 – 0.736
p-value	0.01 >



In summary, the results indicate that while the fullPIERS model performed excellently for predicting adverse maternal outcomes in this tertiary care hospital setting in Pakistan, its utility for predicting adverse perinatal outcomes, either .alone or as part of a composite measure, was limited

DISCUSSION

This study provides a crucial local validation of the fullPIERS model in a tertiary care setting in Pakistan, confirming its utility while also highlighting its limitations. The principal finding is the model's strong discriminatory power for predicting adverse maternal outcomes, contrasted with its suboptimal performance for predicting adverse perinatal events. This dichotomy is a critical aspect for its clinical application, particularly in resource-constrained health .systems

Our finding that the fullPIERS model performed excellently in predicting adverse maternal outcomes, with an AUC of 0.845, aligns with a robust body of international evidence. The original development and validation study reported a similar high performance (AUC 0.88) [10], and subsequent external validations in various settings have consistently supported its utility. For instance, studies in high-income countries like the United States have reported good discrimination (AUC 0.80) [12], and validations in other low- and middle-income countries (LMICs) such as Egypt (AUC 0.76) and India (AUC 0.854) have also confirmed its value [13, 14]. The 2.15% risk threshold identified in our cohort, with a sensitivity of 75% and specificity of 83%, provides a clinically actionable cutoff. This suggests that the fullPIERS model can be confidently implemented in our setting as a reliable, low-cost tool to triage women with pre-eclampsia, enabling clinicians to intensify surveillance and implement timely, life-saving interventions for those at .highest risk

Conversely, the model's suboptimal performance in predicting adverse perinatal outcomes (AUC 0.699) is a significant finding that underscores a well-documented limitation of the fullPIERS tool. The model was specifically developed using a composite of severe maternal morbidities and mortalities, and its predictor variables—maternal demographics, symptoms, and standard laboratory tests—do not include direct measures of fetal wellbeing [10]. The pathophysiology of fetal compromise in pre-eclampsia, often driven by placental insufficiency, may not be adequately captured by these maternal-centric parameters. This finding cautions against relying on the fullPIERS score for decisions regarding fetal health or the timing of delivery based on fetal risk. Clinicians must continue to depend on established methods of fetal surveillance, such as biophysical profiles and Doppler velocimetry, to guide management .for the neonate

Several limitations of this study should be considered. First, as a single-center study conducted in a tertiary referral hospital, our findings may not be generalizable to primary or secondary level care facilities in Pakistan, where patient demographics, resource availability, and management protocols may differ. The patient population at a tertiary center

often represents a higher-risk cohort, which could influence the model's performance characteristics. Second, while a substantial number of patients were analyzed, a larger, multicenter cohort would provide more robust and .generalizable results

The implications for future research are clear. A large-scale, multicenter validation of the fullPIERS model across different tiers of the Pakistani healthcare system is warranted to confirm its utility nationwide. Furthermore, research should focus on refining prediction models for adverse perinatal outcomes in our population. This could involve developing or validating models that incorporate fetal parameters, such as ultrasound measurements and Doppler indices, or novel maternal biomarkers like Placental Growth Factor (PlGF), which have shown promise in improving the prediction of fetal compromise [10]. Finally, prospective implementation studies are needed to assess whether integrating the fullPIERS model into standard clinical pathways leads to demonstrable improvements in maternal .outcomes and is a cost-effective strategy for the Pakistani health system

In conclusion, this study validates the fullPIERS model as an effective and valuable tool for stratifying the risk of adverse maternal outcomes in women with pre-eclampsia within a Pakistani tertiary care hospital. However, it should not be used in isolation to predict fetal risk. Its adoption into clinical practice could significantly enhance maternal safety by directing critical resources to high-risk patients, thereby supporting the goal of reducing maternal morbidity .and mortality from pre-eclampsia

CONCLUSION

,The fullPIERS model performed well in predicting adverse maternal outcomes such as eclampsia, HELLP syndrome and placental abruption, with good to excellent predictive accuracy. However, the model showed suboptimal performance for predicting fetal outcomes, with moderate predictive ability for stillbirth, perinatal mortality, and NICU admissions. These findings suggest that while the fullPIERS model is a valuable tool for predicting maternal .complications, further refinement may be needed for fetal outcome prediction

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