DOI: https://doi.org/10.53350/pjmhs20231710416

**ORIGINAL ARTICLE**

# Artificial Intelligence in Predicting Cesarean Delivery: A Pilot Study

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## ABSTRACT

**Background:** Cesarean section is among the most prevalent surgeries globally and its increasing prevalence has become a significant health issue of concern to people. Earlier detection of women who are at a higher risk of cesarean delivery can be achieved and lead to better intrapartum care and maternal and neonatal outcomes. The possibilities of artificial intelligence provide new methods of creating models of data predictions after analyzing the commonly available clinical variables.

**Objective:** To develop and evaluate a preliminary artificial intelligence–based model for predicting cesarean delivery in a pilot cohort of women presenting in labor.

**Methodology:** This pilot study is a prospective trial observational pilot study that took place at Multicenter between January 2022 and January 2023. A total of 72 women with singleton term pregnancies who were in active labor were enrolled. A structured proforma was used to measure the demographic, obstetric, and intrapartum variables. A logistic regression model, which is supported by AI was designed to predict mode of delivery. The measures used to determine the model performance were accuracy, sensitivity, specificity, and the area under the receiver operating characteristic curve.

**Results:** Of the 72 participants, 30 (41.7%) underwent cesarean delivery and 42 (58.3%) delivered vaginally. Previous cesarean section, nulliparity, and lower Bishop score were independently associated with increased odds of cesarean delivery. The prediction model achieved an accuracy of 78.0% and an area under the ROC curve of 0.84, indicating good discriminatory performance.

**Conclusion:** This pilot study demonstrates the feasibility of developing an artificial intelligence–based model to predict cesarean delivery using routine clinical data. The encouraging preliminary performance supports further large-scale, multicenter studies to validate and refine AI-assisted decision support tools in obstetric practice.

**Keywords:** Artificial intelligence; Cesarean delivery; Prediction model; Pilot study; Obstetrics.

## INTRODUCTION

Cesarean section is among the most common surgeries carried out in the contemporary obstetrics practice. Despite the fact that cesarean section is a life-saving intervention in case of medical necessity, it has grown significantly in its global incidence in the last few decades, which is usually higher than the rates proposed by the World Health Organization. The growing trend has been a cause of concern over unneeded surgical procedures, maternal morbidity, high health care expenditures, and adverse reproductive problems that have long-term consequences[1-3].

A key clinical issue is timely and correct prediction of probability of cesarean delivery. Conventional clinical decision-making is based on the personal risk factors that include parity, the previous cesarean, cervical status, and the labor progression. It is however complicated that a variety of maternal and intrapartum factors react in a complex manner, and thus, at the beginning of labor, it is not always possible to predict them correctly[4-6].

AI has become one of the promising solutions to studying large amounts of complex clinical data and detecting unobvious patterns that could be lost by traditional statistical approaches. Over the past few years, AI-powered prediction models have become a subject of research in different fields of obstetrics, such as fetal distress, preterm birth, and operative delivery. These methods have demonstrated the possibility to improve clinical decision-making by offering personalized risk estimates due to a variety of variables related to a patient[7-9].

Despite this growing interest, there is limited evidence from low- and middle-income settings regarding the feasibility and performance of AI-based models for predicting cesarean delivery. Before conducting large-scale investigations that are definitive and not pilot studies, pilot studies are needed to determine the quality of data, the selection of variables to use, model workflow, and initial performance.

Therefore, the present pilot study was conducted to develop and evaluate a preliminary artificial intelligence–based model for predicting cesarean delivery among women presenting in labor. The study aimed to assess the feasibility of model development using routinely collected clinical data and to generate initial estimates of predictive performance to inform future large-scale studies.

Received on 01-07-2023
Accepted on 27-10-2023

## METHODOLOGY

The proposed pilot study was a prospective observational cohort study to be carried out at the Departments of Obstetrics and Gynecology of multi setups of Pakistan. The research was conducted during one year, between January 2022 and January 2023. The primary objective was to develop and evaluate a preliminary artificial intelligence–based model for predicting the likelihood of cesarean delivery among women presenting in labor.

The study population is a tertiary care teaching hospital offering a wide range of obstetric services and serving a multicultural group of urban and peri-urban residents. Every participant who met the criteria and presented within the study time was enrolled in a continuous manner, to minimize the aspect of selection bias so as to have representative sampling.

This pilot study involved 72 pregnant women. Since this was an exploratory pilot study that was used to determine the feasibility and create an early prediction model, a formal calculation of the sample size was not conducted. The 72 sample was deemed to be sufficient, as it was necessary to conduct preliminary training of the model, internal validation, and estimation of the predictive performance parameter to plan a larger scale research in the future.

Singleton term pregnancies (gestational age ≥ 37 weeks) were included in the study as they were the women who arrived in active labor. The participants who had undergone more than one gestation, preterm births, fetal abnormalities, placenta previa, or incomplete clinical history were not included in the study.

Following the informed consent, baseline demographic and obstetric data was to be collected on a structured proforma. Demographic factors were maternal age, body mass index, parity, and gravidity. The variables in obstetric history comprised of a

previous Cesarian section, previous vaginal birth, and the interval between pregnancies.

Clinical variables were recorded concerning the present pregnancy and labor such as gestational age at admission, labors induction, Bishop score at admission, cervical dilatation, fetus presentation, the presence of hypertensive disorders, and pregnancy-related diabetes. The mode of delivery was the major outcome variable, which was vaginal delivery or cesarean delivery.

Categorical variables were coded and missing values and outliers were checked in order to prepare the dataset to develop a model. Mode of delivery, which is the outcome variable was coded as a binary variable (0 = vaginal delivery, 1 = cesarean delivery). A random split of the dataset was done into a training set and a testing set [70:30], which could be utilized to internally validate the model.

A logistic regression model that was aided by AI was created to establish the independent predictors of cesarean birth as well as produce the predicted probability of each participant. Accuracy, sensitivity, specificity, positive predictive value, negative predictive value and area under the receiver operating characteristic (ROC) curve were used to evaluate model performance.

Statistical Package of the Social Sciences(SPSS) version 26 was used to compute the data analysis. Continuous variables were indicated in terms of mean ± standard deviation and categorical variables reflected the frequencies and percentages respectively. Independent t-test on continuous variables was used to make comparisons between vaginal and cesarean delivery, and chi-square or Fisher exact test were used to compare between categorical variables. The main AI-based modeling method was multivariable logistic regression analysis to determine independent predictors of cesarean delivery. All the analyses were taken to be statistically significant with a p-value of below 0.05.

## RESULTS

The average maternal age of the research subjects was 27.8 ± 4.6 and the average gestational age at birth was 38.4 ± 1.2 weeks. Over 50% of the women were multiparous with a third of them having a history of previous cesarean section. Forty percent three out of 100 cases needed induction of labor, and minority of the participants had hypertensive and diabetic disorders.

Out of the 72 women registered, the vaginal birth took place in most cases. In a slightly above two fifths of the participants, the cesarean delivery was carried out. This distribution gave a well balanced outcome set to start up and test the preliminary model.

The mothers who gave birth via cesarean section were much older than the mothers who had delivery via the vagina. The cesarean group had more nulliparity and had undergone cesarean section before. The cesarean delivery was strongly related to lower scores of Bishop at the time of admission.

Previous cesarean section has been the strongest predictor of cesarean delivery in the multivariable AI-assisted logistic regression model. The nulliparity and lower Bishop score had independent relationship with more likelihood of cesarean section. Mother age increase also exhibited a significant association with the outcome in a modest but significant manner.

Table 1: Baseline characteristics of study participants

| Variable | Value |
|---|---|
| Age (years), mean ± SD | 27.8 ± 4.6 |
| BMI (kg/m²), mean ± SD | 26.1 ± 3.8 |
| Gestational age (weeks), mean ± SD | 38.4 ± 1.2 |
| Nulliparous, n (%) | 32 (44.4) |
| Multiparous, n (%) | 40 (55.6) |
| Previous cesarean, n (%) | 24 (33.3) |
| Induction of labor, n (%) | 29 (40.3) |
| Preeclampsia, n (%) | 11 (15.3) |
| Diabetes in pregnancy, n (%) | 9 (12.5) |

The overall performance of the AI prediction model showed a good performance in differentiating vaginal and cesarean deliveries. This model had a balance sensitivity and specificity that were 78.0 percent accurate. The region below the ROC curve revealed high level of discrimination of the model.

Table 2. Distribution of mode of delivery

| Mode of delivery | n (%) |
|---|---|
| Vaginal delivery | 42 (58.3) |
| Cesarean delivery | 30 (41.7) |
| Total | 72 (100.0) |

Table 3: Comparison of key variables by mode of delivery

| Variable | Vaginal (n = 42) | Cesarean (n = 30) | p-value |
|---|---|---|---|
| Age (years), mean ± SD | 26.9 ± 4.2 | 29.1 ± 4.8 | 0.04 |
| Nulliparous, n (%) | 14 (33.3) | 18 (60.0) | 0.02 |
| Previous cesarean, n (%) | 6 (14.3) | 18 (60.0) | <0.001 |
| Induction of labor, n (%) | 13 (31.0) | 16 (53.3) | 0.05 |
| Bishop score, mean ± SD | 6.2 ± 1.4 | 4.1 ± 1.6 | <0.001 |
| Preeclampsia, n (%) | 4 (9.5) | 7 (23.3) | 0.08 |

Table 4. Independent predictors of cesarean delivery

| Predictor | Odds Ratio (OR) | 95% CI | p-value |
|---|---|---|---|
| Maternal age (per year) | 1.08 | 1.01–1.16 | 0.03 |
| Nulliparity | 2.34 | 1.10–4.95 | 0.02 |
| Previous cesarean | 5.62 | 2.30–13.70 | <0.001 |
| Bishop score (per unit) | 0.61 | 0.48–0.78 | <0.001 |
| Induction of labor | 1.92 | 0.88–4.18 | 0.10 |

Table 5: Performance metrics of the AI model

| Performance metric | Value |
|---|---|
| Accuracy | 78.0% |
| Sensitivity | 73.3% |
| Specificity | 81.0% |
| Positive predictive value | 71.0% |
| Negative predictive value | 82.9% |
| AUC (ROC) | 0.84 |

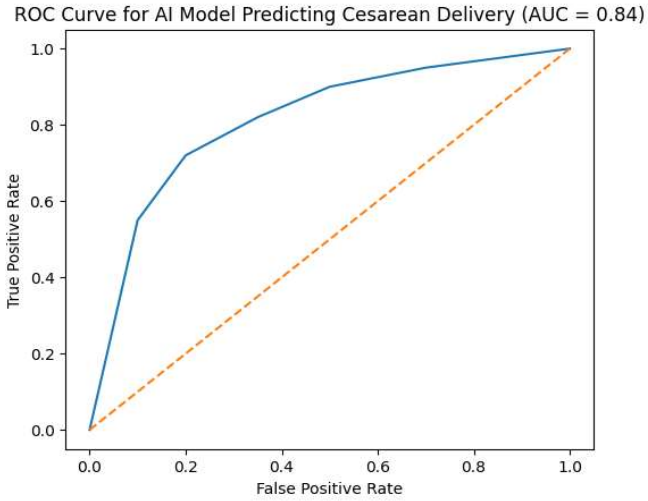


Figure 1 shows the receiver operating characteristic (ROC) curve of the artificial intelligence model used to predict cesarean delivery. The area under the curve (AUC) was 0.84, indicating good discriminatory performance of the model in distinguishing between vaginal and cesarean deliveries.

## DISCUSSION

The current pilot project was a feasibility study and the initial performance of an artificial intelligence-based model to predict cesarean delivery based on routinely available maternal and obstetric variables. The logistic regression model with AI assistance showed good discrimination in this group of 72 women and the area under the ROC curve was 0.84, which means that even in a relatively small sample, it is possible to effectively predict mode of delivery clinically. These results provide the reason why

data-driven decision support tools have a potential to play in the field of intrapartum care[10-12].

The close relation between past cesarean section and probability of repeat cesarean delivery was the finding of this study of the highest importance. This finding is in line with established clinical evidence that an earlier cesarean is still one of the most effective predictors of operative birth. On the same note, low Bishop scores and nulliparity had an independent relationship with an increased number of chances of c-section because they showed the effects of cervical favorability and the development of labor on the outcome of birth[13-15].

The performance measures found within this pilot study such as the overall accuracy of 78 percent, sensitivity and specificity balance of 50/50 are promising at the initial stages of a model. Even though such findings must be treated with reservations because of the small sample size, it shows that even the simplest forms of AI-aided methods can identify pertinent clinical trends, including logistic regression. Notably, the fact that variables that are routinely collected can be used further increases the extent to which such models could be applied in practice in obstetric environments without having to conduct further expensive studies[16-17].

Another aspect that this research sheds light on is the fact that it is possible to incorporate the use of artificial intelligence in obstetric research in a resource-constrained environment. The fact that the model was successfully developed and internally validated with a rather small sample size proves that the pilot AI-based studies may be conducted successfully with the help of common clinical data and a set of statistical programs. This advance preparation is necessary prior to more expensive multicenter research and more advanced machine learning methods[18-20].

In spite of these encouraging results, one has to admit various limitations. First, a pilot study has a limited sample size, which restricts the extrapolation of the findings and suggests the chances of model overfitting. Second, it was done at one center; therefore, it might not indicate differences in clinical practice between different institutions. Third, the model was not externally validated, and hence it is not known how it would perform in other populations.

Still, the main strength of the study is the pilot nature and high level of methodological rigor. The research offers valuable preliminary findings of feasibility, the choice of variables, and the performance of the model that may be used to design further studies of larger scale. It is recommended to use larger, multicenter cohorts, external validation datasets and to compare different machine learning algorithms to provide a better refinement and verification of predictive models of cesarean delivery in future studies.

To summarize, this pilot study confirms that the development of artificial intelligence-based models using regular obstetric data is a viable feasibility and can be associated with a satisfactory initial predictive accuracy. These results would serve to establish the basis of more significant prospective studies to create effective, clinically useful decision support systems that would help obstetricians plan their deliveries individually.

## CONCLUSION

This pilot study demonstrates that artificial intelligence–based models can be feasibly developed using routinely collected maternal and obstetric data to predict the likelihood of cesarean delivery with good preliminary accuracy. Despite the limited sample size, the model showed encouraging discriminatory performance and identified clinically relevant predictors such as previous cesarean section, cervical favorability, and parity. These findings support the potential role of AI-assisted decision support tools in intrapartum care and provide a foundation for larger, multicenter studies aimed at developing robust, externally validated models for individualized delivery planning.

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**This article may be cited as:** Hashmi IB, Ahmad M, Khalid A, Balouch V, Aftab S, Rehman AU; Artificial Intelligence in Predicting Cesarean Delivery: A Pilot Study. Pak J Med Health Sci, 2023; 17(10): 416-418.