

COMPARATIVE ANALYTICS FOR OBSTETRIC DELIVERY METHODS USING MACHINE LEARNING ALGORITHMS

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Abstract -- Childbirth mode prediction is a critical aspect of obstetric care, aiding healthcare professionals in making informed decisions to ensure maternal safety. Traditional approaches rely on clinical expertise and heuristic-based risk assessment methods, which may not always generalize well across diverse populations. Recent advances in Machine Learning (ML) provide an opportunity to develop data driven predictive models that improve accuracy and support evidence-based decision-making to assist physicians in choosing the most effective delivery method, a number of models have been developed and compared, including the KNN, RF, SVM, Decision Tree, and a stochastic classifier. This study explores the application of machine learning (ML) algorithms for predicting the mode of childbirth based on patient data. We utilize various datasets containing demographic, clinical, and obstetric history features, including maternal age, gestational age, body mass index (BMI), medical conditions (e.g., diabetes or hypertension), previous delivery history, and fetal health indicators.

Keywords — childbirth prediction, machine learning, decision support system, delivery mode classification, maternal and infant health.

INTRODUCTION

Maternal healthcare is evolving rapidly, and with that comes a growing need for smarter tools that can truly support doctors in making the best choices for mothers and their babies. As we look ahead, artificial intelligence especially machine learning is emerging as a transformative force in healthcare, offering new ways to make sense of complex medical data. In obstetrics, one of the most promising uses of this technology is predicting how a baby is likely to be delivered whether through a natural birth or a cesarean section before labor even starts. At the same time, there's a growing concern within the medical community: the rising number of cesarean deliveries, many of which may not actually be necessary. Often, these decisions are influenced by non-medical factors—such as time constraints, fear of legal risk, or hospital routines—rather than the specific needs of the mother or baby. As a result, the rate of C-sections has surged around the world.

Since the 1980s, it's more than doubled, and by 2015, it had surpassed the World Health Organization's recommended rate by 35.5%.

In countries like Bangladesh, the situation is especially worrisome. Between 2017 and 2018, the number of cesarean deliveries rose by 51%, and by 2018, nearly 77% of them were classified as unnecessary, according to *Save the Children*.

Adding to the challenge is the issue of maternal mortality. In many South Asian countries, the risk of death related to pregnancy and childbirth remains unacceptably high. In 2017, Bangladesh had a maternal mortality rate of 0.000113% several times higher than the United States' rate of 0.000017%. These numbers highlight a troubling inequality in maternal care and a pressing need for change. Through this project, we hope to make a meaningful difference. By applying machine learning to support early and accurate delivery planning, we aim to reduce avoidable surgeries, improve outcomes, and make childbirth safer and more equitable especially for women in regions where such support is needed the most.



Fig.1. Visual Illustration

The following points denote the main contributions of this research paper:

- We propose an intelligent, computer-based approach to assist in making informed decisions about the most suitable mode of childbirth.
- By using machine learning, our system minimizes human error and enhances the consistency of decision-making.
- The model is capable of analyzing vast amounts of maternal and fetal health data far beyond what a human could process manually making it a powerful tool for supporting clinical judgment.

LITERATURE SURVEY

- 1) The research paper “**Early Stage Prediction of the Mode of Childbirth Using Supervised Machine Learning Algorithms**” by Michael Owusu Adjei et al. (2024) looks into how machine learning can support early predictions about whether a woman is likely to have a vaginal or cesarean delivery. Using clinical data from 1,200 patients at a hospital in India, the researchers applied a range of supervised learning models including Logistic Regression, Support Vector Machine, Decision Tree, Random Forest, K-Nearest Neighbors, and Gradient Boosting. Among these, the Random Forest model performed the best, achieving an impressive accuracy of 91.25%, along with strong precision, recall, and F1 scores. These findings suggest that machine learning could be a valuable tool for clinicians, helping them make better-informed decisions early in pregnancy and improving the overall care and preparation for childbirth.
- 2) The paper, “**An AI-Based Approach to Predict Delivery Outcome Based on Measurable Factors of Pregnant Mothers**” published by Sakshi Govind Ahire et al., 2023 reveals that the research focuses on predicting delivery outcomes by analyzing measurable maternal features, including real-time data from partographs. The study emphasizes the importance of maternal history, particularly the impact of spontaneous, threatened, and inevitable abortions on delivery outcomes. However, the study is limited by its relatively small sample size of 842 participants, which may affect the generalizability of the results. Furthermore, the research does not explore the potential influence of socio-economic factors on delivery outcomes, which could provide a more comprehensive understanding of the issue.
- 3) The paper named “**Prediction of the Mode of Delivery Using Artificial Intelligence Algorithms**” by Vasiliki E. Georgakopoulou et al., 2024 is about evaluating the application of artificial intelligence (AI) algorithms, specifically Support Vector Machines (SVM), Multilayer Perceptron (MLP), and Random Forest, to predict the mode of delivery in obstetric care. The research utilized a comprehensive clinical database consisting of 25,038 records from women who attended the University Clinical Hospital "Virgen de la Arrixaca" in Spain. The results indicated that all three algorithms achieved an impressive accuracy of 90% or higher in distinguishing between caesarean and vaginal deliveries, with slightly lower accuracy (around 87%) for differentiating between instrumental and eutocic deliveries.
- 4) The research paper “**Artificial Intelligence in Predicting the Mode of Delivery: A Systematic Review**” authored by Alberto De Ramón Fernández et al., 2022 is a systematic review that aims to evaluate the current state of research on AI applications in predicting the mode of delivery. The review encompasses 18 studies that employed various AI models, including logistic regression, random forest, gradient boosting, and neural networks. The studies were assessed for quality using the Prediction Model Risk of Bias Assessment Tool (PROBAST), and data were synthesized narratively due to heterogeneity in methodologies.
- 5) The paper “**Predicting Modes of Childbirth Using Machine Learning**” by S. Sonika, J. Venu, and their team et al., 2023 looks at how machine learning can help predict the way a baby will be born. Using a large dataset of over 6,000 birth records, the researchers zoomed in on the most important factors that affect delivery outcomes. They pinpointed 32 key features and organized them by how much they mattered. Of all the models they tested, the stacking classifier performed the best, showing the most accurate predictions. These encouraging findings suggest that machine learning could become a valuable tool for healthcare providers, helping them make smarter, more informed decisions when it comes to childbirth.
- 6) The research paper “**Predicting Maternal Health Risk Using Machine Learning Models and Comparing the Performance of Percentage Split and K-Fold Cross Validation**” by Bogini Naveen Kumar and colleagues et al., 2022, takes a closer look at how machine learning can help identify risks to maternal health. In the study, the researchers experimented with different machine learning models and assessed how well they performed using two commonly used validation techniques: percentage split and K-Fold cross-validation. The findings offer useful insights, but the study isn't without its limitations. One key issue is the small size of the dataset, which might limit how broadly the results can be applied. Another important point is that the research doesn't consider socio-economic factors like income levels, education, or access to healthcare which often play a big role in maternal health outcomes. Including these could have provided a more complete picture.
- 7) The paper “**Exploring Machine Learning Algorithms to Find the Best Features for Predicting Modes of Childbirth**” by Abdul Salaam Gaddafi and colleagues et al., 2025 dives into how machine learning can play a vital role in improving decisions about childbirth. Drawing on data from a health center in Kishorganj, Bangladesh, the team experimented with 32 different algorithms and 11 training methods to create a model that predicts the best mode of delivery. Their work really underscores how crucial it is to get this decision right, since the wrong choice can seriously affect the health of both mother and baby. By demonstrating that their model can help lower these risks, the study highlights the real potential of using AI to guide smarter, more data-driven choices in maternity care.
- 8) The research paper “**Predicting Childbirth Modes: A Comparative Analysis of Machine Learning Algorithm**” by Aman Sharma et al., 2024 is a study that conducts a comparative analysis of various machine learning algorithms for predicting childbirth modes, aiming to identify the most significant characteristics that influence delivery outcomes. The authors utilized a dataset containing relevant maternal features and tested several classification techniques, including decision trees, support vector machines, K-Nearest Neighbors, random forests, and stacking classifiers. The results revealed that the Stacking Classifier achieved the highest accuracy of 95%, demonstrating the potential of machine learning to optimize maternal healthcare decision-making.
- 9) The paper titled “**Prediction of Modes of Childbirth Using SVC**” by N. Vijitha and colleagues et al., 2025, looks into how machine learning—specifically the Support Vector Classifier (SVC) algorithm—can help predict how a baby will be delivered. The researchers used a range of information, such as a mother's health status, medical history, and prenatal care, to build a model that could assist doctors in making more informed decisions, especially in identifying pregnancies that may be at higher risk. The study found that the SVC model was quite effective in predicting childbirth outcomes, showing promising potential for applying machine learning in maternal healthcare. At the same time, the authors point out a few hurdles, like the complexity of working with such diverse medical data and the challenge of understanding exactly how the SVC model reaches its conclusions.

- 10) Arul Natarajan et al., 2023 paper, “**Machine Learning to Predict Pregnancy Outcomes: A Systematic Review**,” explores how machine learning is being applied to predict key aspects of pregnancy, such as the type of delivery and possible complications. The review underscores the potential of these technologies to enhance maternal healthcare by offering more accurate and timely predictions. It also identifies important gaps in the current research, pointing to opportunities for further study and improvement. That said, the findings should be interpreted carefully, as variations in study methods and data sources across the reviewed papers could influence the strength and consistency of the conclusions.
- 11) The research paper “**Predicting Preterm Birth Using Machine Learning Methods**” by Nishani S. and team et al., 2025, looks at how machine learning can help predict the risk of preterm birth using data from maternal health records. The researchers tested a range of algorithms including XGBoost, CatBoost, logistic regression, and support vector machines to figure out which ones were most effective at identifying pregnancies that might lead to early delivery. However, since the research was conducted with a relatively small group of participants, the results might not fully represent broader populations. To strengthen these findings, future studies with larger and more diverse datasets will be essential.
- 12) The study “**Quantitative Prediction of Postpartum Hemorrhage in Cesarean Section Using Machine Learning**” by Islam et al. (2022) investigates how machine learning can be used to predict postpartum hemorrhage (PPH) during cesarean sections. Drawing on data from 6,144 patients, the researchers evaluated several models including logistic regression, linear regression, gradient boosting, and random forest to identify the most effective approach for predicting PPH. The random forest model emerged as the top performer, achieving a mean absolute error of just 21.7 ml. Still, it's worth noting that the study relied on data from a single hospital, which may limit how broadly its findings can be applied to other populations or healthcare settings.
- 13) The research paper “**Development and External Validation of Machine Learning Models to Predict Cesarean Section Following Induction of Labour**” published by Yanan Hu et al., 2024 is a study that aims to develop and validate machine learning models that predict the likelihood of a caesarean section (CS) following the induction of labor (IOL). The study identifies ten key predictors, such as parity, pre-pregnancy BMI, and maternal age, which significantly influence the probability of CS.
- 14) The paper titled “**An AI-based approach to predict delivery outcome based on measurable factors of pregnant mothers**” by Anna Kloska et al., 2025 is a research that focuses on the development of an AI-based approach to predict delivery outcomes by analyzing measurable maternal features. The study emphasizes the importance of factors such as maternal birth history, health conditions, and real-time data from partographs in influencing delivery choices. The authors employed three supervised learning techniques, including Gradient Boosting, Logistic Regression, and Random Forest, to evaluate their performance in predicting delivery outcomes. The results indicated that the Gradient Boosting classifier achieved a prediction accuracy score of 91%, while Logistic Regression scored 93%.

However, the research may lack comprehensive data on maternal history, particularly regarding spontaneous abortions, which could impact the accuracy of the predictions and the overall effectiveness of the model.

- 15) The research paper named “**Predicting the Mode of Childbirth Using Machine Learning**” by Meng Wang et al., 2024 is a research that investigates the use of machine learning algorithms to predict the mode of childbirth, focusing on the increasing trend of unnecessary cesarean deliveries. The authors developed a machine learning-based decision-making model that employs five different algorithms: XGBoost, K-Nearest Neighbors (KNN), Random Forest, Support Vector Machine (SVM), and Logistic Regression. The study utilized a dataset containing various maternal features, including age, amniotic fluid levels, height, and weight.

The results underscore the potential of machine learning to enhance decision-making in obstetrics, providing healthcare professionals with tools to make more informed choices regarding childbirth methods.

Several studies and systems have been developed to assist in predicting the mode of childbirth, but many fall short in terms of real-time applicability, scalability, or predictive accuracy as seen below.

Table.1.Comparison of Existing Systems

Sl. No	Author/Year	Methodology/Algorithm	Advantages	Limitations	Performance
1	Michael Omosu-Adjei et al., 2024	AI-based partograph for real-time labor data	Interpretable ML for clinical use	Small dataset limits generalization	Logistic Regression most reliable
2	Sakshi Govind Ahire et al., 2023	Five ML algorithms on maternal and clinical features	Diverse algorithm comparison ensures robustness	Data from Spanish hospitals only	Stacking Classifier: Highest accuracy
3	Vasiliki E. Georgakopoulou, 2024	Systematic review of AI in maternal care	AI aids complex decision-making	Study heterogeneity across populations	Logistic Regression, RF, Gradient Boosting used
4	Alberto De Ramón Fernández et al., 2022	Delivery classification with two classifiers	CDSS aids delivery prediction	Not useful for emergency cases	SVM, MLP, RF: High accuracy
5	S. Sonika, J. Venu, 2023	Feature Selection (Age, BMI, etc.)	Improved accuracy of summarization	Not effective for large documents	Enhanced decision-making
6	Bogini Navon Kumar, 2022	Classification to improve care and reduce childbirth risk	Reduces maternal and fetal risk	Poor generalization	Random Forest: 92% accuracy
7	Abdul Salaam Gaddafi, 2025	Model Training & Testing	Aids clinical decision-making	Data-dependent performance	Decision Tree: 89% accuracy
8	Anas Shams, 2024	Dataset-based model (UCI, Hospital, Kaggle)	Personalized healthcare	Historical data may not reflect trends	Logistic Regression: 87% accuracy
9	N. Vajitha, 2025	SVC with RBF kernel on UCI dataset	High prediction accuracy for childbirth mode	Small dataset limits generalization	SVC: High accuracy (exact not mentioned)
10	Arul Natarajan, 2023	Random Forest with Cross-Validation	Reduced overfitting and improved generalization	High computational complexity	Random Forest: Best performance
11	Nishani S., 2025	Comparative study with normalization	Shows best-performing algorithm	Only 80 records; limits robustness	SVM: 91.25% accuracy
12	Islam et al., 2022	Review of ML for pregnancy outcomes	Broad insight into ML applications	No experiments; review-based	No model accuracy; conceptual framework
13	Yanan Hu et al., 2024	XGBoost, RF, CatBoost, etc. on IOL data	Personalized CS risk prediction; public tool	Excludes previous CS cases	XGBoost AUROC: 0.766/0.757/0.747
14	Anna Kloska et al., 2025	SVM, XGBoost, CatBoost, Logistic Regression	Linear SVM best for small data; high F1-score	Only 50 samples; generalization limits	SVM: 82% accuracy, F1-score: 84%
15	Meng Wang et al., 2024	Random Forest for quantitative PPH prediction	Quantifies bleeding volume; interpretable	Only cesarean data; potential biases	RF: MAE 21.7 ml, RMSE 33.75 ml

PROPOSED SYSTEM

In most situations, the decision about how a baby will be delivered whether through a natural birth or a cesarean section is made by the medical professional overseeing the case. However, having a smart maternal healthcare application that can assist doctors by suggesting the most suitable delivery method based on each mother's unique health profile could make a meaningful difference in reducing risks and improving outcomes during childbirth. In our study, for instance, we developed classification models using data mining techniques to predict the mode of delivery in real time by analyzing obstetric risk factors.

Looking ahead, it's important for future research to identify which machine learning algorithms perform best when working with specific sets of features. During labor, time is critical, and it's often not possible to consider every single factor. That's why pinpointing the most relevant and impactful features is essential for creating fast, reliable, and helpful tools that can truly support healthcare professionals in the moment.

• **LOAD DATASET**

The first step involves gathering and loading the dataset, which contains medical records and key details that play a role in delivery decisions. This typically includes important patient information like blood pressure, maternal age, previous pregnancies, fetal health, and other vital signs. The data may also include labels that show the methods of delivery previously considered, such as whether a vaginal birth or cesarean section was chosen. Since this dataset is the backbone of the entire decision-making process, it's vital to load it accurately and quickly to ensure the system works smoothly.

• **DATA PREPROCESSING**

The model's performance can be influenced by problems like noise, outliers, missing values, and irrelevant information that often appear in the dataset. To make sure the data is ready for machine learning algorithms, it first needs to be cleaned and organized. A crucial part of this process is dealing with missing data depending on how important the missing information is and the overall quality of the dataset, we either fill in or remove the missing values during the preprocessing stage.

• **CHOICE OF FEATURES**

This part of the project focuses on figuring out which factors in the dataset are most important for predicting how a baby will be delivered. Not all information is equally useful some data can be repetitive or just add noise so we use feature selection to clean things up and help the model make better predictions. To do this, we apply different techniques like statistical tests, recursive feature elimination (RFE), and correlation analysis. These help us pinpoint the features that really make a difference. For instance, maternal health issues such as high blood pressure or gestational diabetes often have a stronger impact on the mode of delivery than factors like past childbirth experiences.

• **TRAINING AND TESTING**

This module is a crucial part of the machine learning process, as it splits the data into training and testing sets. The testing set is used to see how well the model performs on new, unseen data, while the training set helps the model learn. Machine learning makes it easier to identify patterns and relationships within the data. By using methods like SVM, Random Forest, Decision Trees, KNN, and Stochastic Classifiers, the models are trained to understand how different factors interact and influence the choice of delivery method.

• **CLASSIFICATION**

In the final module, the trained machine learning model takes in new patient data and predicts the best delivery method. It looks at key factors, like the baby's condition and the mother's health, to determine whether a cesarean section or a natural delivery would be the safest choice. The system then offers these predictions as suggestions to healthcare providers, helping them make faster and more confident decisions about the delivery method.

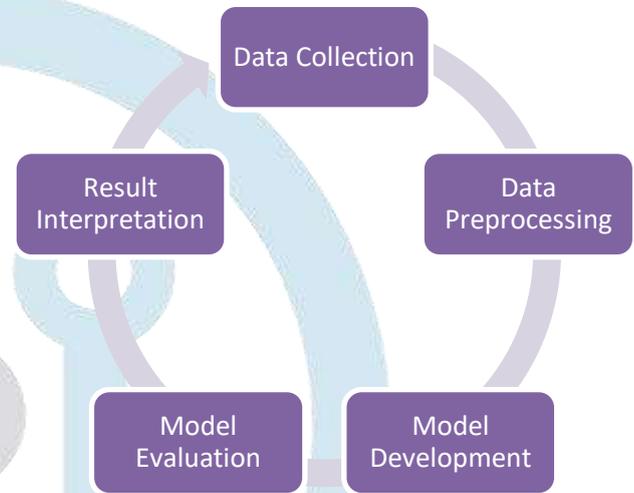


Fig.2. Architecture

RESULT ANALYSIS

To evaluate how well the machine learning-based decision support system could predict the most appropriate delivery method, the researchers tested a range of algorithms. These included Support Vector Machine (SVM), Random Forest, Decision Tree, k-Nearest Neighbours (KNN), and a Stochastic Classifier. They used a separate dataset to test the models and assessed their performance using important measures like accuracy, precision, recall, and F1-score.

Out of all the models, Random Forest came out on top. It consistently delivered the most accurate results. What made it stand out was its ability to recognize complex patterns in the data without overfitting—meaning it could make accurate predictions without being too tailored to the training data.

Table.2. Accuracy Comparison

Algorithm	Accuracy
existed	86
proposed	93

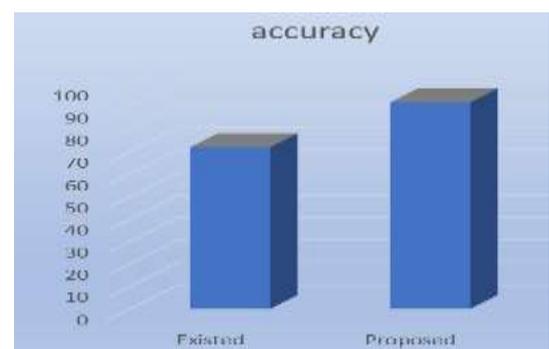


Fig.3. Accuracy Graph

FUTURE WORK

As we look to the future, there are several important directions that this research can take to make the machine learning-based decision support system even more effective and practical for real-world use in clinical settings. One of the top priorities is expanding the dataset—not just in size, but also in diversity. By including a wider variety of patient backgrounds, medical histories, and childbirth experiences, we can create a model that's more accurate and adaptable to different populations and healthcare environments. We also plan to explore more advanced machine learning techniques, such as ensemble models and deep learning. These cutting-edge approaches can help the system recognize even more complex patterns in the data, improving its ability to make precise and trustworthy predictions.

Finally, to ensure that healthcare professionals can rely on this tool, future research will focus on real-world clinical studies. These prospective trials will test how well the system performs in actual medical settings, helping to build trust and demonstrate its value in supporting safe, data-driven decisions.

CONCLUSION

This project is designed to improve decision-making in obstetric care by using advanced machine learning (ML) models to predict the most likely mode of childbirth. By analyzing a combination of clinical records, demographic information, and obstetric history, we explore how ML techniques—such as logistic regression, decision trees, and random forests—can enhance the accuracy of these predictions. The ultimate goal is to support doctors and healthcare providers in making timely, evidence-based decisions that can reduce complications for both mothers and newborns, while also helping healthcare systems use their resources more effectively.

That said, one of the biggest challenges still lies in identifying the most relevant features—or data points—that influence the delivery method. This is where artificial intelligence (AI) truly shows its potential. By allowing machines to learn from large and complex datasets, we can uncover the hidden patterns and indicators that might not be obvious through traditional analysis. Today, technologies like machine learning, deep learning, and other intelligent systems are becoming increasingly common in healthcare, helping doctors make faster and more accurate decisions. With this project, we aim to contribute to that growing movement by using AI to better understand childbirth, ultimately striving for safer and more personalized care for every mother and baby.

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