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MATERNOCARE PREDICTION FOR MATERNAL AND CHILD WELL-BEING USING SURVEY DATA AND MACHINE LEARNING APPROACHES

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Abstract

The fact that high-risk pregnancies provide serious obstacles to maternal and newborn outcomes, mother and child health is a crucial area of attention in healthcare. This study uses survey data from pregnant women to estimate the chances of perilous pregnancies using machine learning techniques. Maternal age, height, weight, obstetric history, anemia status, blood pressure, fetal movement, fetal heart rate and the outcomes of diagnostic tests are among the many characteristics included in the dataset. Predictive models were constructed using three machine learning algorithms, AdaBoost Classifier, Random Forest Classifier and Gradient Boosting Classifier. The Gradient Boosting Classifier outperformed Random Forest (0.95) and AdaBoost (0.93) exhibiting the greatest accuracy (0.97) among them. These findings demonstrate how well machine learning works to accurately detect high-risk pregnancies. The study emphasizes how incorporating these prediction models into maternal health initiatives may help with early identification, setting priorities for medical resources and creating focused treatments.

***Keywords** : MaternoCare, high-risk, pregnancies, AdaBoost Classifier, Random Forest Classifier, Gradient Boosting Classifier*

INTRODUCTION

One of the most crucial facets of global health is maternal and child health as it affects not just the health of mothers and children but also that of future generations. Despite improvements in healthcare, maternal and infant mortality rates continue to be a major problem worldwide. With several programs targeted at lowering avoidable deaths and enhancing general health outcomes, the desire to improve mother and child well-being has propelled the global healthcare agenda. Mother and child health is complex during the pregnancy time, it integrates economic, social and environmental factors along with medical and biological aspects. Due to complexity, predicting the risk factors and making the prediction which will be accurate becomes challenging. For timely delivery it reduces the effectiveness. The development of data science and AI technology has opened to new possibilities for addressing these materno care. For identifying the patterns machine learning is the best way for large scale dataset and making accurate predictions. Using Machine learning model in healthcare technology is very effective to detect and find out the prediction to detect the specific diseases, in this project mother s and child's nutrients will be also forecasting it will be taken care of maternal and fetal. To further improve health technology, machine learning models need to be improved. Using these machine learning models, we can predict the nutrition of mothers and children and receive subsequent suggestions. By utilizing survey data, we will be able to solve real-life problems. Access to healthcare, lifestyle choices and socioeconomic status are often in detail included in survey data, which have a significant impact on health outcomes. Using machine learning methods, predictive models can be developed by evaluating data, which can identify individuals who may require additional care or treatment and predict maternal and child health risks. In the research, survey data will be analyzed to identify trends and relationships among various factors affecting maternal and child health, including education, socioeconomic status, nutrition and prenatal care. Machine learning will be used to apply this data to predict health outcomes and improve healthcare delivery for mothers and children. The main goal of the research is to create predictive models that will assist medical professionals in identifying high-risk pregnancies or children. These predictions will help improve health outcomes and reduce mortality rates and preventive treatments and early interventions can be guided through them. There can be various factors influencing health outcomes, which pose a major challenge in maternal and child health research. Issues related to age and medical conditions often present high-risk factors. To create more accurate and sophisticated predictions, we can use conventional statistical techniques. This research aims to illustrate the potential of artificial intelligence in enhancing health treatments and promoting improved healthcare outcomes for women and children worldwide by utilizing survey data to forecast maternal and child health outcomes. The future of maternity and child healthcare is bright, with prospects for more individualized, efficient and timely treatment due to the growing amount of data available and the developments in machine learning.

LITERATURE REVIEW

For this study, a number of research publications have been analyzed with the goal of identifying a novel and enhanced finding that goes above the contributions made in earlier works. In [1] E. A. Turjo et al. women's malnutrition is a serious public health concern, especially in poor nations like Bangladesh, where it is associated with negative health effects. Factors such as age, socioeconomic status and access to resources like clean water have been identified as risk factors associated with women's malnutrition. Machine learning techniques are becoming increasingly popular for predicting malnutrition through the analysis of large datasets, where classifiers like Random Forest, Decision Trees and Logistic Regression have shown the potential for making accurate predictions. In [2] M. A. Sayeed et al. the main goal of the research is to create predictive models that will assist medical professionals in identifying high-risk pregnancies or children. These predictions will help improve health outcomes and reduce mortality rates and preventive treatments and early interventions can be guided through them. There can be various factors influencing health outcomes, which pose a major challenge in maternal and child health research. Issues related to age and medical conditions often present high-risk factors. In [3] N. S. Borson et al in developing countries like Bangladesh, approximately 22.6% of babies are born with low birth weight (LBW), making it a serious public health issue. Several clinical factors are known to cause LBW, but newborn health outcomes are also significantly influenced by non-clinical and demographic factors. The availability of statistics like the Bangladesh Demographic and Health Survey (DHS) provides valuable information. These findings suggest that by integrating demographic and health data into prediction models, the accuracy of identifying LBW risks can be improved. In [4] T. B. Reza et al Many studies have analyzed various clinical, demographic and environmental factors contributing to LBW, and these factors can vary significantly across different regions. Low birth weight (LBW) is a serious global health issue with significant impacts on neonatal survival and long-term health outcomes. Based on these various risk factors, more accurate predictions of LBW are becoming possible. Traditional methods such as Logistic Regression (LR) have been widely used in LBW prediction, but newer machine learning techniques like (DT), (SVM) and (RF) have shown greater predictive accuracy. Recent studies emphasize the importance of evaluating model performance to ensure reliable and robust predictions for healthcare interventions.[5] S. Akber et al et al the eating patterns in the early years of a child's life have a significant impact on their development. Just 21% of newborns in Pakistan were exclusively breastfed at four months. However, new data from the percentage has somewhat improved to 48%. Notwithstanding these advancements, further work is required to boost breastfeeding rates and guarantee the timely introduction of semisolid meals at the suggested 6–8 months. According to research, by giving moms timely and pertinent information mobile health (mHealth) treatments can significantly improve infant and young child feeding (IYCF) habits. Research has indicated that mHealth initiatives aimed at expectant and nursing moms. In [6] R. A. Putranto et al For moms and babies to stay healthy, especially in the early postpartum period, postpartum health monitoring is essential. Cloud computing (CC) and other technological integration have been the subject of recent studies aimed at improving the effectiveness of postpartum healthcare services. Real-time access to medical data made possible by cloud-based systems makes it possible to evaluate an infant's nutritional condition more quickly and accurately, particularly when using anthropometric indices. It has been discovered that using Forward Chaining (FC) techniques to categorize baby nutrition according to anthropometric measurements and vital signs is a useful way to provide timely insights into infant health. The advantages of cloud computing platforms, such faster data processing and lower system latency, have been shown in earlier studies. These features are essential for effectively managing big datasets. Furthermore, research. In [7] G. Saranya et al One of the biggest causes of infant mortality in developing nations, especially India, is still malnutrition, which has drawn a lot of attention from public health researchers. Using datasets like the Indian Demographic and Health Survey (IDHS), which offers useful demographic and health data, some researches have employed machine learning approaches to forecast and categorize malnutrition. Key markers that are used to describe and categorize malnutrition, such as BMI. Recent research has demonstrated that machine learning techniques can reveal other important characteristics that were previously disregarded, even while the body of current literature highlights a few essential characteristics linked to malnutrition. In [8] R. K. Megalingam et al Accessing high-quality healthcare is extremely difficult for rural communities in developing nations like India, particularly for expectant mothers. Many women in rural regions skip critical prenatal treatment since there aren't any hospitals close by and they have to travel far for even routine examinations. This can raise the risk of problems and maternal death. Preventing birth abnormalities and lowering fetal death rates need routine, early examinations. In order to address these concerns, studies have highlighted the significance of accessible and reasonably priced healthcare options for expectant mothers in rural locations. Mobile health systems, such as those that offer ultrasound scans and vital sign monitoring, have become affordable options that help close the healthcare gap. Healthcare professionals may remotely monitor expectant mothers thanks to these tools. In [9] L. I. Octovia et al Mobile phones, computers, and the internet are examples of information and communication technologies (ICTs) that have become indispensable for improving healthcare, particularly in poor nations. Applications for mobile health (m-Health) are significantly enhancing the health of vulnerable populations, especially youngsters and pregnant women. Numerous apps, both from the public and private sectors, are designed to improve early life nutrition, according to an analysis of current m-Health systems. Although its uptake has been sluggish, the Indonesian Ministry of Health has released an app to supplement the mother and Child Health Book. This study's suggested m-Health system emphasizes an integrated, modular strategy to improve early life. In [10] T. Rahman et al Women face several health hazards during pregnancy. Socioeconomic difficulties in poor nations increase these dangers, therefore ongoing support and monitoring are essential. Although many elements of life have been digitalized by technology, there is still a lack of a complete system that integrates financial aid, healthcare providers and support groups for the health of mothers and children. In order to provide prompt medical treatment and financial assistance, this study presents a digital platform designed to close the gap between expectant mothers, physicians, health professionals, volunteers, and contributors. The suggested approach lowers the danger of data loss by offering a safe, intuitive platform for effectively managing and organizing data. In [11] L. Swastina et al Assessing children's health and well-being requires keeping an eye on their nutritional condition. Predicting nutritional status, providing public health insights and directing intervention efforts are all made possible by machine learning (ML). To increase these ML frameworks' accuracy and applicability and open the door to more effective nutritional treatments, more refinements and validation using local data are required. In [12] A. M. Oprescu et al particularly in addressing pregnancy-related both complications that can affect the mother and fetus. Emotional factors such as anxiety, stress and depression have been identified as relevant risk factors during pregnancy, which makes the integration of AI and affective computing into maternal health care increasingly important. AI and affective computing have the potential to enhance maternal well-being by automatically analyzing emotional states, though this area remains underexplored. The methodologies and algorithms used in this domain are still evolving, with limited studies on automatic emotion analysis in pregnancy. This highlights the need for more research to develop AI-driven solutions that can assess and improve the emotional health of pregnant women. Future work in this field could lead to innovative health interventions that address both the physical and emotional well-being of pregnant women, reducing risks associated with pregnancy complications. In [13] M. N. Islam et al Traditionally, the choice of delivery method has been determined by the physician's opinion, but selecting the wrong method can lead to significant health risks for both parties. Recent studies have sought to improve this process by exploring. A review of relevant literature and a survey of 6157 birth records identified 32 features that are essential for analysis. Among the various ml models tested, stacking classification (SC) showed the most promising results, followed closely by random forest (RF). These findings highlight the promise of AI-based models in enhancing maternal and child health by improving delivery method predictions. In [14] S. N. Tumpa et al People may now receive vital support from AI, particularly in the area of maternal health. One such system, Smart Care, seeks to assist expectant mothers by offering tailored counsel and direction over the course of their pregnancy. Pregnant women and healthcare professionals may communicate more easily thanks to this cloud-based technology, which also offers personalized food recommendations and pregnancy stage guidance. Smart Care can help moms feel less stressed and encourage a healthy maternity time in nations like Bangladesh where access to resources and knowledge is restricted. The solution makes sure that rural moms who have little access to the internet may still use the platform by storing data in both local and cloud databases. In [15] T. M. Kadarina et al By facilitating preventative treatment and automating procedures to lower human error, IoT has demonstrated a great deal of promise to improve the quality of healthcare. Improving mother and child healthcare has been a top priority for the Indonesian government, where maternal and child death rates are still high. By combining portable medical devices with several sensors that gather health data and send it to a server, a suggested Internet of Things-based solution seeks to solve this problem. A smartphone application acts as a gateway, giving users access to teleconsultation services, remote medical monitoring, and tailored health information. The quality of maternity and pediatric healthcare is enhanced by this cloud-based technology, which enables ongoing care and early health risk identification. The technology will be developed and tested in both urban and rural populations in future work.

PROPOSED METHODOLOGY

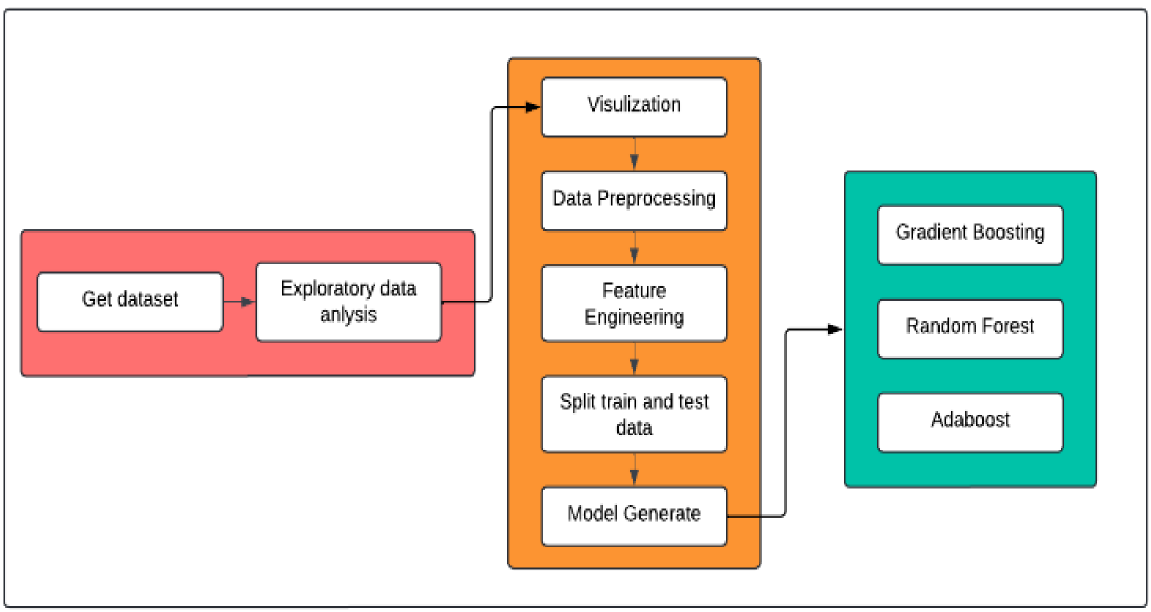

Fig.1. Diagram of proposed methodology

The process used in this study to create machine learning models is depicted in the flowchart figure 1. After the data collection some steps are doing in these sections. Identify the pattern and relationship between variables by the data then gain the insights using various visualizations charts. In preprocess sections includes fixing missing values, encoding categorical variables and normalizing features. To improve model performance using feature engineering. For model evaluation split the data into train and test. Finally, machine learning techniques like Gradient Boosting, Random Forest, and AdaBoost are applied based on their suitability for the problem. Ensure a clear process from understanding and preparing the data to training and evaluating the model and find out the expected accurate and reliable predictive models.

Dataset Collection and Data Discription

To collect data through a survey for maternal care, primarily focusing on pregnant women. The questions in the survey are mainly related to the health of women and children. In our survey, we gather information on the history of pregnancy, the number of pregnancies (gravida), past issues, and risks. Demographic information, such as age, helps identify risks related to adolescent pregnancies or advanced maternal age. It also helps track healthy weight gain. Key physical indicators, like blood pressure, are used to detect conditions like preeclampsia and other hypertension-related issues, which can be extremely dangerous for both the mother and the unborn child. Variables like the baby's position, movement, and heart rate inside the womb are used to assess fetal health, which is crucial for monitoring health and preparing for birth. Important tests, such as albumin and sugar urine tests, help in diagnosing diseases like gestational diabetes and preeclampsia. It also includes screenings for infectious diseases like syphilis (VDRL) and Hepatitis B (HRsAG). Finally, the dataset helps determine whether a pregnancy is categorized as high-risk by considering various factors like sociodemographic characteristics, medical history, and current health issues. This comprehensive dataset is useful for predicting maternal and child health outcomes and creating targeted interventions to improve well-being.

Analysis Visualization

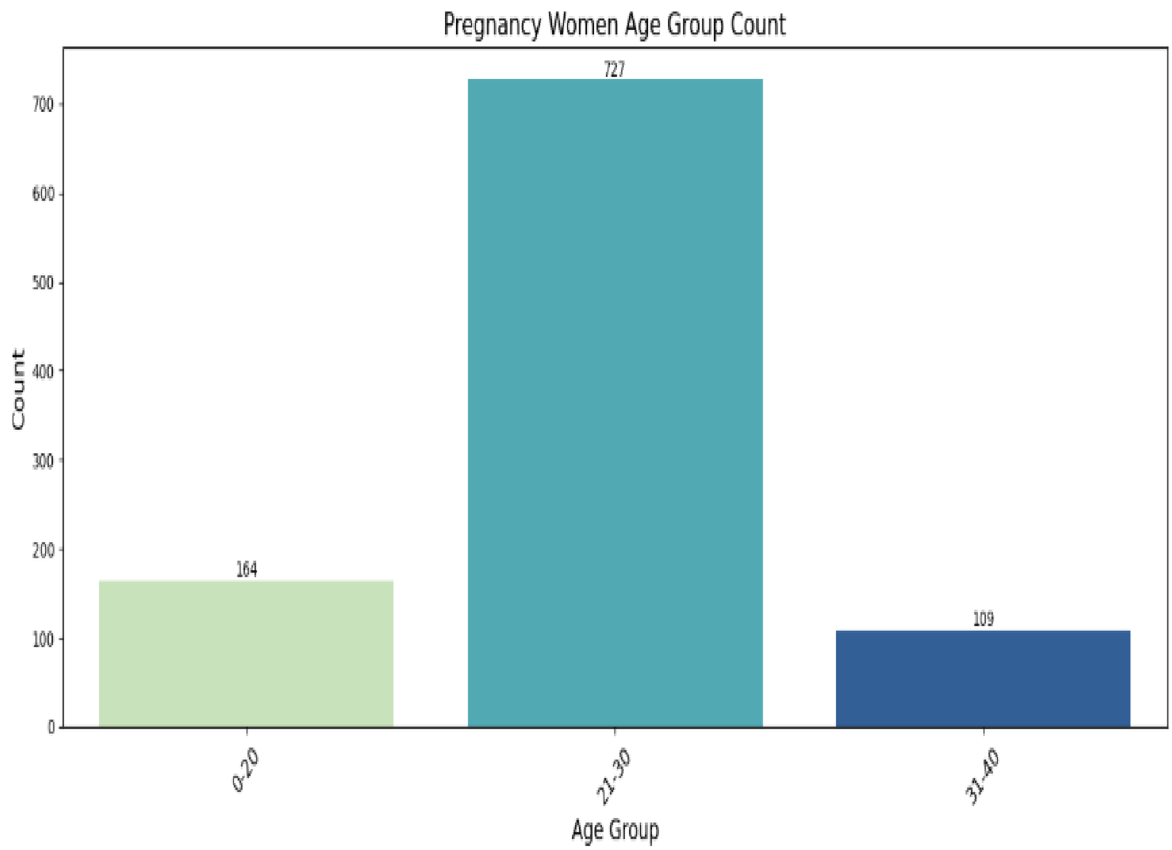

Fig.2. Age group count bar chart

Figure 2, bar chart distribution of pregnant women in three age groups. Divided three age groups first group is 0 to 20 years ,2nd group is 21 to 30 years and lastly the age group 31 to 40 years. Most women. Are in group two, the figure 2 are describe these in the pregnancy women age group counts. The age range of 21-30 accounts for 72.7% of pregnancies, the 0–20 age group (16.4%) and the 31–40 age group (10.9%). By using colored bars with percentages displayed above them, the chart makes it abundantly evident that the majority of pregnancies occur among those aged 21 to 30.

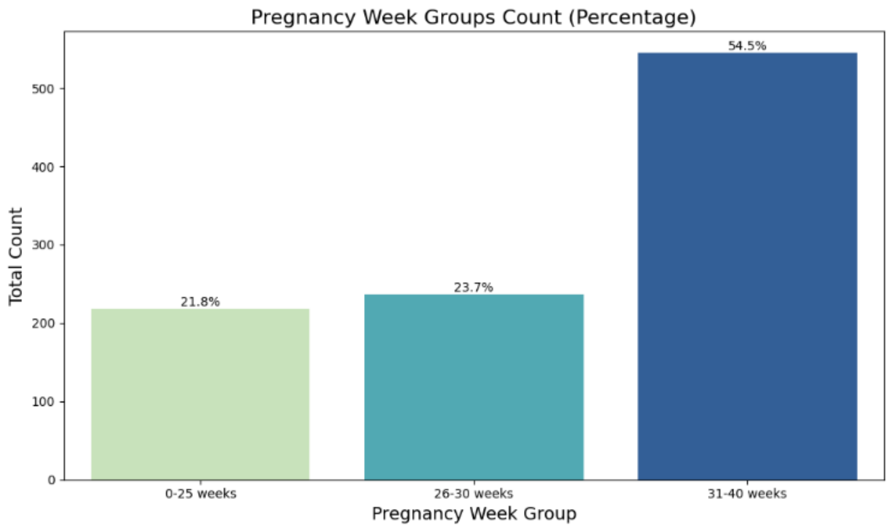

Fig.3. Bar chart distribution of weeks group count

The figure 3 distribution of pregnancies throughout three-week groups 0–25 weeks, 26–30 weeks and 31–40 weeks is shown in the bar chart "Pregnancy Week Groups Count (Percentage)". Pregnancies between 31 and 40 weeks account for the majority (54.5%) followed by those between 26 and 30 weeks (23.7%) and 0–25 weeks (21.8%). It is evident from the chart's usage of different colored bars with percentages above that the majority of pregnancies occur in the later weeks of the term, especially between weeks 31 and 40.

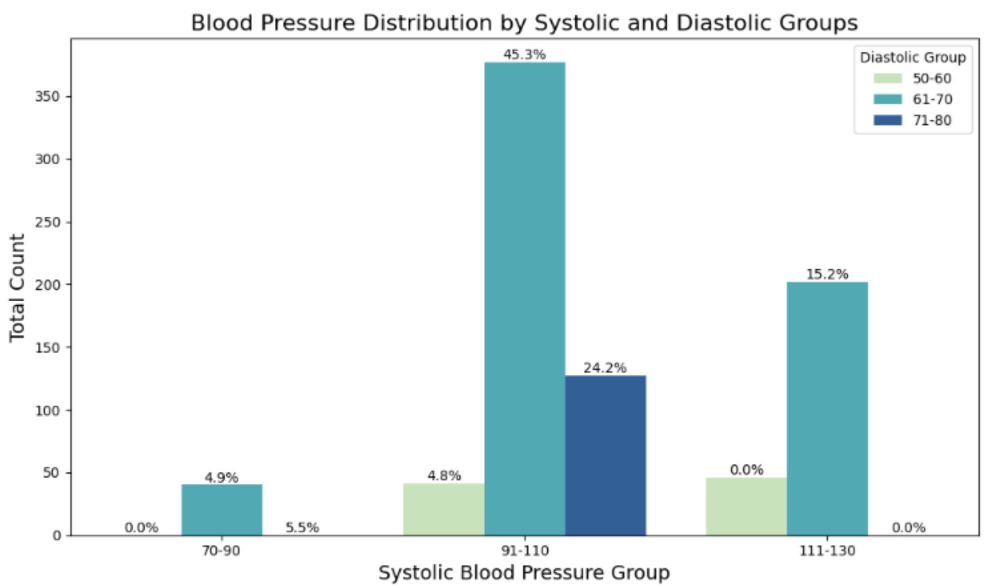

Fig.4. Bar chart distribution of systolic blood pressure group

In figure 4, sequence of blood pressure readings across various systolic and diastolic groups is shown in the bar chart. Systolic blood pressure is divided into three ranges (70-90, 91-110, and 111-130), and diastolic blood pressure is divided into three groups (50-60, 61-70, and 71-80). The graph shows that the 61-70 diastolic group had the highest percentage (45.3%) in the 91-110 systolic range, followed by the 71-80 diastolic group (24.2%). While the 70-90 range has very low counts across all groups, the 111-130 systolic range has 15.2% in the 61-70 group. The bars clearly compare distributions because they are labeled with percentages.

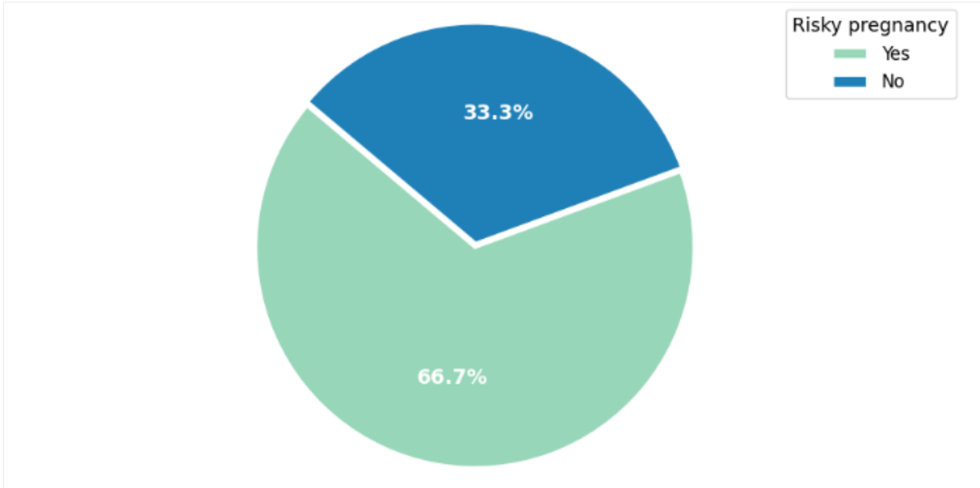

Fig.5. Pie chart distribution of risky pregnancy category

In figure 5, distribution of pregnancies by risk category is depicted in this pie chart. 66.7% of pregnancies are categorized as "risky," according to the graphic, while 33.3% are categorized as "not risky." This demonstrates that a sizable fraction of pregnancies in the sample are classified as high-risk, underscoring the significance of spotting and treating possible issues.

Feature Engineering and model generate

In order to prepare categorical data for machine learning models, label encoding was utilized in this work to transform it into numerical values. Three algorithms were applied Gradient Boosting Classifier, Random Forest Classifier and AdaBoost Classifier, to predict hazardous pregnancies. Because of their capacity to manage intricate data patterns and reduce mistakes, these models were selected. Gradient Boosting improves predictions by building models one after the other, each of which fixes the one before it. In order to manage feature interactions and reduce overfitting, Random Forest builds an ensemble of decision trees. AdaBoost aims to increase accuracy by repeatedly modifying weights based on prior errors in weak models. When it comes to prediction tasks that involve complex and dependent characteristics, these ensemble approaches are very successful. The project intends to offer insights into maternal health by applying these models to survey data. This will help with early diagnosis and intervention for pregnancies that are at risk, hence enabling improved outcomes for the well-being of both the mother and the child.

RESULTS AND DISCUSSION

With a focus on the wellbeing of mothers and children using survey data and ml model to make predictions for MaternoCare.survey data analyzed using ml algorithm and analysis to get insights full info to make it useful for the health sector.

$$Precision = \frac{True\ positive}{True\ positive + False\ positive}$$

$$Precision_0 = \frac{108}{108 + 3} \approx 0.96$$

$$Precision_1 = \frac{184}{184 + 5} \approx 0.98$$

Precision: 98% of the predictions indicated as "Yes" in the precision equations are true for the "Yes" class, while 96% of the forecasts designated as "No" are correct for the "No" class.

$$Recall = \frac{True\ positive}{True\ positive + False\ Negative}$$

$$Recall_0 = \frac{108}{108+5} \approx 0.97$$

$$Recall_1 = \frac{184}{184+3} \approx 0.97$$

Recall: 97% of the actual "No" cases for the "No" class were identified via recall. Similarly, the "Yes" class correctly predicted 97% of the actual "Yes" occurrences.

$$F1\ Score = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

$$F1\ Score_0 = 2 \times \frac{0.96 \times 0.97}{0.96 + 0.97} \approx 0.96$$

$$F1\ Score_1 = 2 \times \frac{0.98 \times 0.97}{0.98 + 0.97} \approx 0.98$$

F1 score: The "No" class's F1-score is 0.96, indicating strong recall and precision for predicting "No," whereas the class's F1-score is 0.98. The model's ability to handle both classes is demonstrated by these high F1-scores.

$$Accuracy = \frac{True\ Positives\ + True\ Negatives}{Total\ Number\ of\ class}$$

$$Accuracy = \frac{108\ + 184}{300} \approx 0.97$$

Accuracy: The gradient boosting algorithm provides 97% accuracy which is the highest accuracy among all the models.

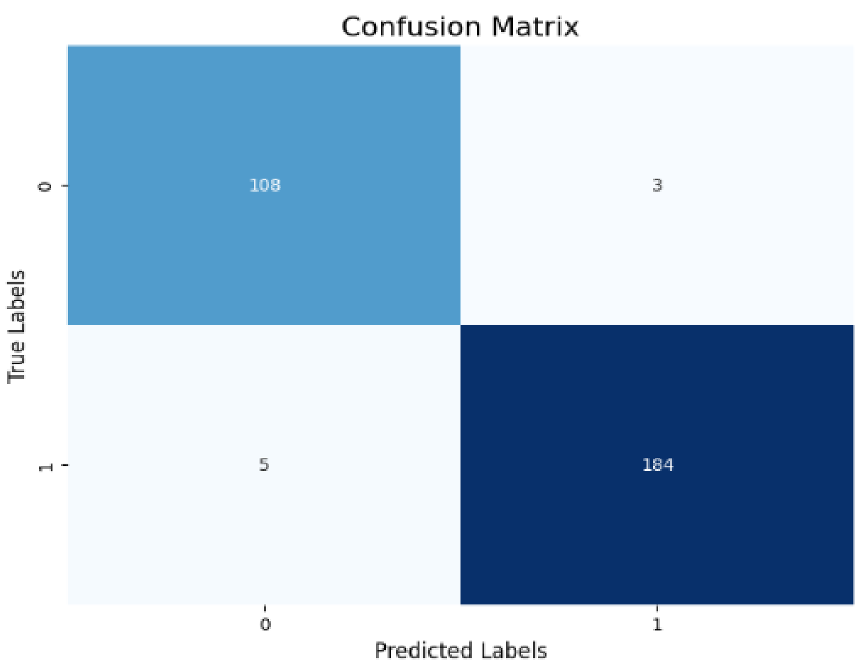

Fig.6. Confusion matrix heatmap of GradientBoosting Classifier

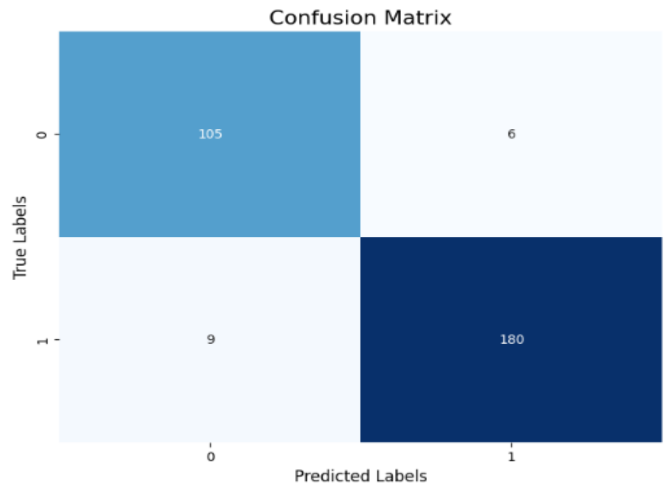

Fig.7. Confusion matrix heatmap of RandomForest Classifier

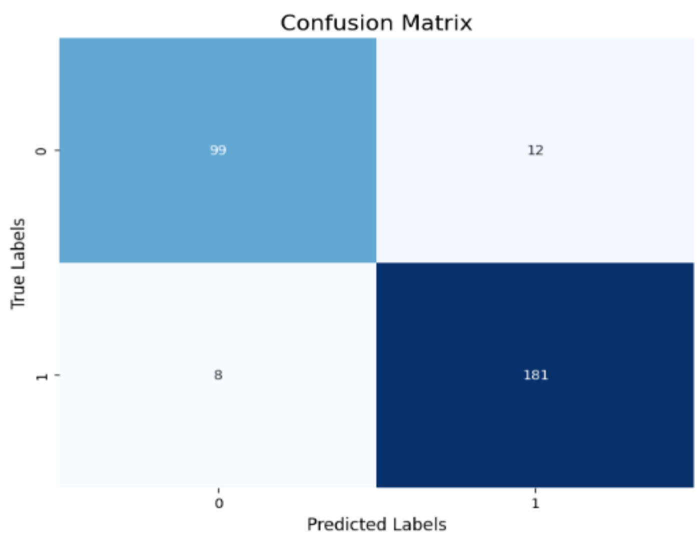

Fig.8. Confusion matrix heatmap of AdaBoostClassifier

This confusion matrix figure 6, which displays the numbers of accurate and inaccurate predictions, assesses how well a categorization model performs. 108 cases of class 0 (True Negatives) and 184 instances of class 1 (True Positives) were accurately predicted by the model. The low number of mistakes and strong diagonal values in the matrix show that the model performs well, with the majority of predictions being correct. In figure 7, confusion matrix assesses how well a classification model performs; it correctly predicted 105 instances as class 0 (True Negatives) and 180 instances as class 1 (True Positives), but it made 6 mistakes by predicting class 1 instead of class 0 (False Positives) and 9 mistakes by predicting class 0 instead of class 1 (False Negatives). The dominant diagonal values of the matrix show that the model performs well, with the majority of predictions being accurate and errors being relatively low. In figure 8, tests a classification model's performance and demonstrates that it accurately identified 181 occurrences as class 1 (True Positives) and 99 examples as class 0 (True Negatives).Although there is considerable space for improvement in terms of lowering false positives, the model performs well because most predictions are accurate.

Performances of Different Classifiers

Algorithm	Value name	Precision	Recall	F1-Score	Accuracy
GradientBoosting Classifier	No	0.96	0.97	0.96	0.97
	Yes	0.98	0.97	0.98	
RandomForest Classifier	No	0.92	0.95	0.93	0.95
	Yes	0.97	0.95	0.96	
AdaBoostClassifier	No	0.93	0.92	0.93	0.93
	Yes	0.93	0.93	0.93	

Using 3 algorithm among them gradient boosting provides expected outcomes. Researchers are sing this model to their technology to predict the maternocare prediction. Overall, both Random Forest and Gradient Boosting showed increased precision as a result of label encoding, with Gradient Boosting displaying the greatest metrics. The findings imply that these models—in particular, Gradient Boosting are useful for forecasting pregnancies that carry a high risk and that label encoding improves model performance.

CONCLUSION

Based on survey data gathered from women who are pregnant, employed machine learning in this work to forecast the probability of hazardous pregnancies. Age, weight, height, obstetric history, anemia status, blood pressure, fetal movement, fetal heart rate and diagnostic test findings were among the important characteristics of mother and fetal health that were included in the dataset. Our goal in evaluating this data was to help medical professionals improve mother health by early detection of high-risk pregnancies. To create prediction models, we used three machine learning algorithms AdaBoost Classifier, Random Forest Classifier and Gradient Boosting Classifier. With the greatest accuracy of 0.97, the Gradient Boosting Classifier was followed by AdaBoost (0.93) and Random Forest (0.95). These findings show how well machine learning methods interpret maternal health data to forecast births at high risk. The most dependable algorithm was the GradientBoosting Classifier, which performed exceptionally well while managing intricate data connections. These results highlight how predictive models may be included into maternal health programs to help prioritize resources, provide focused treatments, and provide care on time. In order to improve forecast accuracy, future studies should concentrate on verifying these models using bigger, more varied datasets and investigating more parameters, such socioeconomic determinants.

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