Analysis of Cases of Abortion and Miscarriage in India: A Data Mining Approach

Rakshith Dasari[1], Jasmin Rishikesh Chaughule[2], Devesh S[3], Suraj S Patil[4]

Birla Institue Of Technology and Science(Hyderabad), Hyderabad 50078, India

***Abstract*—In this paper the authors have attempted to accurately find the factors or series of factors that can cause an abortion or a miscarriage from a census recorded in 2019. The census data was divided into halves to get relevant columns and entries pertaining to the factors that affect the likelihood of a women having an abortion or miscarriage. The relevant data columns and entries were then used as training data on a model that used various data preprocessing techniques (Sampling, Feature Aggregation etc.) to accurately find the factors that can subject a woman to having an abortion or miscarriage.**

I. Introduction

The lack of statistical data on the occurrence of an abortion or miscarriage especially in a country of the population size such as India is a major concern, particularly for women who as unskilled daily wage laborer, which is why there is a need for further research and analysis in the field to estimate the factors leading to a miscarriage. This project aims to accurately predict the factors that lead to a miscarriage based on living conditions and livelihoods of women from certain areas and help in developing appropriate strategies and policies to prevent miscarriage and provide support and care to women who experience it. The data obtained from the analysis can be used to raise awareness about the issue and promote better healthcare and working conditions for women.

II. Literature Reviews

1. S Meaney, P Corcoran, N Spillane, K O'Donoghue, "Experience of miscarriage: An interpretative phenomenological"

The miscarriage rate, which ranges from 20% to 30% of births, is discussed in the current article along with the need for improved knowledge and treatment for those who experience it. While improvements in prenatal treatment have reduced the rates of mother and perinatal deaths, miscarriage still happens frequently for unknown reasons. Miscarriage can have a significant emotional effect on people, according to studies, and assistance is necessary afterward. This study seeks to provide a more complete perspective by examining the experiences of both males and women who have experienced loss, whereas the majority of prior research has concentrated on women's experiences of miscarriage. In order to understand participants' hopes for pregnancy, their encounters with miscarriage diagnosis and treatment, and their general experience, the research employs an interpretative phenomenological analysis method. The paper makes the case for the need for more research into the reasons of miscarriage, continuity of care for future pregnancies, and the requirement that medical professionals give miscarriage victims the proper clinical and supportive information.

2.Ana Paula Vidal dos Santos, Edmeia de Almeida Cardoso Coelho, Maria Enoy Neves Gusmao, Diorlene Oliveira da Silva, Patricia Figueiredo Marques, Mariza Silva Almeida "Factors Associated with Abortion in Women of Reproductive Age".

In Brazil, abortion is a large public health concern and a leading cause of maternal mortality, disproportionately impacting young and poor women. Abortion-seeking women frequently struggle to find dependable, secure methods, which can result in hospitalization and dangerous circumstances. Contraception and informational resources, however, can help women make knowledgeable choices about their bodies and sexual health. In order to obtain fertility control, women in socially and economically vulnerable regions can use the Family Health Strategy (FHS). This research sought to look into the variables linked to the incidence of abortion among women of reproductive age in the FHS coverage region in a city in Northeast Brazil. 350 women between the ages of 15 and 49 who resided in FHS-registered homes were a part of the cross-sectional research. The account of an induced or spontaneous abortion was used as the outcome variable, and information on sociodemographic traits was gathered using organized and semi-structured questionnaires. Estimates of the frequency of reports of abortion and prevalence ratios

were made in order to identify correlations between sociodemographic factors and the incidence of abortion. The Ethics Committee in Research in Nursing authorized the research, and each subject gave their written permission.

3.Abinath Yogi, Prakash K.C & Subas Neupane, "Prevalence and factors associated with abortion and unsafe abortion in Nepal: a nationwide cross-sectional Study".

The frequency of unsafe abortion in Nepal, which is said to be the third most common cause of maternal mortality there, is discussed in the piece. The Nepal Demographic and Health Survey 2011, which questioned women who had ever had a terminated pregnancy, provided the data for the study's nationally representative group. The poll gathered data on most recent abortions, and unsafe abortion was described in accordance with the abortion service providers. According to the research, 16.0% of all abortions were risky, and among women of reproductive age who had ever had a pregnancy ended, the five-year frequency of abortion was 21.1%.
Education, religion, age, and awareness of safe abortion locations and legal abortion were among the variables linked to abortion that the research found. According to the research, women who are literate, aware of secure locations for abortion services, and aware of lawful abortion are more likely to have an abortion. On the other hand, youthful, uneducated, and impoverished women were more prone to have unsafe abortions. In order to decrease the incidence of unsafe abortions and maternal fatalities in Nepal, the research advises intervention studies among these target groups.

4.Mehdi Moradinazar, Farid Najafi, Zeinab Moradi Nazar, Behrooz Hamzeh, Yahya Pasdar and Ebrahim Shakiba, "Lifetime Prevalence of Abortion and Risk Factors in Women: Evidence from a Cohort Study.

The rate of spontaneous abortion, the most frequent pregnancy complication, and its risk factors are discussed in this paper for Iranian women who have taken part in the Ravansar Non-Communicable Disease (RaNCD) cohort study and are between the ages of 35 and 65. In 10–20% of pregnancies, spontaneous abortion—defined as the removal of an egg or fetus before it enters a stable period of life—occurs. Abortion can result from a variety of conditions, including hereditary disorders, chromosomal anomalies, uterine deformities, infectious diseases, and neglected maternal illnesses. Approximately 25.7% of the women in this cohort had previously experienced an unplanned abortion, and the abortion ratio was 0.10. They also found variables like education level, age at first marriage and first conception, social status, hyperthyroidism, diabetes, physical exercise, BMI, and place of living that influence the risk of spontaneous abortion. According to the research, women who have high blood pressure have statistically meaningful odds of non-spontaneous abortion reduced by 63%. To lower the frequency of spontaneous abortion, the experts advise better treatment for women who have risk factors.

5. CRAIG P. GRIEBEL, M.D., JOHN HALVORSEN, M.D., THOMAS B. GOLEMON, M.D., AND ANTHONY A. DAY, M.D., University of Illinois College of Medicine at Peoria, Peoria, Illinois, "Management of Spontaneous Abortion".

Miscarriage, also known as a spontaneous abortion, is the unplanned loss of a baby before 20 weeks of gestation. It can be divided into different kinds and impacts up to 20% of known pregnancies. Together with other diagnostic procedures, ultrasonography is a crucial diagnostic instrument to rule out ectopic pregnancy. About 50% of spontaneous miscarriages are caused by chromosomal anomalies, though several other variables may also be involved. Recent studies recommend expectant or medical care in some patients instead of the conventional therapy of surgical evacuation of the uterus. Typically, women who successfully undergo a natural abortion do not need any kind of medical or surgery help. Up to two weeks of expectant management of an incomplete spontaneous miscarriage is possible, with little extra benefit from medical treatment. Before 20 weeks of pregnancy, 20% of expectant women experience bleeding, and 50% of these pregnancies end in spontaneous miscarriage. To identify a threatened abortion, a thorough history and physical evaluation, as well as blood tests and ultrasounds, are required. Empty uterus on ultrasound inspection may indicate a finished spontaneous miscarriage, but ectopic pregnancy must be ruled out before the diagnosis can be made with certainty. The majority of studies discovered that a sizable proportion of women, particularly those who are infertile and have lost a desired pregnancy, experience mental symptoms after spontaneous abortion. To prevent patient dissatisfaction with the medical care they receive, doctors should give care that is attentive to the medical and psychologic elements of a partner who has a spontaneous abortion.

6.Ushma D. Upadhyay, M.Antonia Biggs & Diana Greene Foster, "The effect of abortion on having and achieving aspirational one- year plans".

An investigation into whether women who pursue abortions can accomplish their life objectives after the procedure was the focus of the research discussed in the article. 757 women who underwent abortions at 30 different facilities across the United States participated in the research. They were questioned one week, six months, and a year after the operation. Based on whether they were refused an abortion or got one that was either just under or over the facility's gestational limit, the subjects were divided into four groups. In comparison to women who were refused the operation and continued to parent the child, the study's findings revealed that those who had an abortion were more likely to have ambitious one-year goals and accomplish them. The participants' one-year goals most frequently concerned work and education. According to the research, having the option to get a wanted abortion enables women to keep an optimistic perspective on the future and accomplish their life objectives. These findings can help shape policies targeted at enhancing access to safe and lawful abortion services and are crucial for understanding how abortion access affects women's lives.

7. ANGELA J TAFT, RHONDA L POWELL, LYNDSEY F.WATSON, JAYNE C LUCKE, DANIELLE MAZZA, KATHLEEN MCNAMEE, " FACTORS ASSOCIATED WITH INDUCED ABORTION OVER TIME: SECONDARY DATA ANALYSIS OF FIVE WAVES OF THE AUSTRALIAN LONGITUDINAL STUDY ON WOMEN'S HEALTH"

Due to cultural, legal, religious, and societal considerations, the data on the prevalence and causes of abortion that is currently accessible is of poor quality. In lower- and middle-income nations, women who are wealthier, younger, and more educated frequently get abortions. Abortion and intimate partner violence have been linked in high-income nations. The setting has a significant impact on the factors that determine abortion. There are no standardized data in Australia, a high-income nation with good access to abortion. The project, which is the first longitudinal study of its sort in a high-income nation, attempts to discover characteristics related with abortion across various periods of Australian women's reproductive lives.
The study used data from just those who replied to two questions, 9,021 women, and 25,511 observations.

8. *Cheryl L. Woods-Giscombé, Marci Lobel, Jamie L. Crandell, "*The Impact of Miscarriage and Parity on Patterns of Maternal Distress in Pregnancy"

Women with and without a history of miscarriage participated in the study, which examined state anxiety and pregnancy-specific discomfort. The findings showed that both groups experienced higher levels of anguish in the first trimester, but women who had previously miscarried reported higher levels of worry in the second and third trimesters. For pregnant women with a history of miscarriage, effective resources and support are required to lessen the effects of stress on their health.
The goal of this study was to investigate the factors that influence Australian women's abortion rates as they get older. The findings demonstrated that characteristics like intimate partner violence and recent illicit drug use have a significant impact on a woman's likelihood of having an abortion, and that the prevalence of abortion and violence may be overestimated due to underreporting. Other factors included the number of children, prior abortions, and contraception use.

9. Fan Qu, Yan Wu, Yu- Hang Zhu, John Barry, Tao Ding, Gianluca Baio, Ruth Muscat, Brenda K Todd, Fang-Fang Wang & Paul J Hardiman, "The association between psychological stress and miscarriage: A systematic review and meta-analysis"

This study sought to determine whether there was a relationship between mother psychological stress and the likelihood of miscarriage. The research team found that women who had gone through psychological stress had a higher chance of miscarriage after examining eight studies. These results offer convincing proof that psychological stress during early pregnancy is hazardous.
According to this study, psychological stress during pregnancy—including stress from life events and the workplace—increases the likelihood of miscarriage. The results underline the necessity of additional high-quality research into the connection between stress and miscarriage as well as the significance of including a structured psychological examination into standard antenatal care. It is even more crucial to recognise and manage stress because it has been associated to pregnancy-induced hypertension, premature birth, and low birth weight.

10. Carla Dugas, Valori H Slane, “Miscarriage”

The most frequent cause of pregnancy loss is miscarriage, which can occur in up to 26% of pregnancies. Preterm labor is defined as the loss of a pregnancy before 20 weeks of gestation, and the first trimester accounts for 80% of cases. Different types of miscarriage are referred to by different names, such as threatening, inevitable, complete, and missed abortion. Chromosome abnormalities, hormone disorders, infections, and other illnesses are among the causes. Vaginal bleeding and cramping are potential symptoms. Expectant management, medication, or surgical procedures are available as treatments. It's critical for those who have miscarried to seek emotional assistance.
Miscarriage risk is influenced by a number of variables, and no single predictor can reliably forecast pregnancy loss. The risk is increased by advanced maternal age, a history of consecutive Risk is further increased by maternal comorbidities such thrombophilia and antiphospholipid antibody syndrome, as well as by behavioral variables like smoking and excessive coffee consumption.

11. Andreea Mihaela Nita & Cristina llie Goga, “A research on abortion: ethics, legislation and socio-medical outcomes. Case study: Romania”

The study discussed in the article examines abortion from both theoretical and empirical angles. While the empirical section offers the findings of a sociological survey done in Romania with a sample of 1260 women with the goal of understanding their opinions and justifications for having an abortion, the theoretical section investigates many elements of abortion.
According to the study, people who are very religious often regard abortion as the elimination of a child rather than a fetus and tend to associate it with criminality. Unexpectedly, 27% of women who identify as strongly religious think that abortion is both a crime and a woman's right. Furthermore, according to the timing of the abortion, 31% of religious women think that it is possible to abort both a child and a fetus.
According to the study, the majority of Romanian women accept abortion under specific conditions and after 14 weeks of pregnancy. A lot of people see it as both a right and a crime, with religious people more inclined to link it to criminal activity. The primary causes of abortion are the mother's lack of desire for the child and the kid's health issues. Surprisingly, a large number of respondents believe that women who have illegal abortions should be punished. The largest social issue in Romania is the decreasing birth rate.

III. METHOD

Data cleaning refers to the process of identifying and correcting errors and inaccuracies in a dataset. The ultimate goal of performing data cleaning here is to ensure that the dataset to be worked on is available for analysis in a readable and interpretable form without allowing the inconsistencies and unwanted data to mask the relevant data columns need for the analysis. Some of the important steps of data cleaning are removing duplicate or irrelevant observations, fixing structural errors, filtering unwanted outliers, handling missing values and validating. To be able to use any dataset for analysis the first step is data cleaning which has been done here by scanning the data to filter out the duplicate and unwanted data columns which will help us to narrow the dataset to the relevant factors leading to a miscarriage in women.
The first step to clean the data to allow the model to learn accurately was to eliminate all the rows where the target column of whether the pregnancy ended in a miscarriage have a missing value.
In the dataset that has been used to determine the most likely factors that will lead to a miscarriage in women, the data was first read and then all the columns that did not have data even a 20% of its rows were dropped. Any further blank entries left were then replaced with the mode of the column after which clean dataset to be worked on was obtained.

Data Preprocessing:
Once the cleaned dataset is obtained by the above analysis, the dataset was then used to perform various data preprocessing techniques which were used to obtain a more precise output. Some of the data preprocessing techniques used were:

Sampling: Data sampling is a statistical analysis technique to analyze a subset of the dataset. Sampling is done in a number of ways for example, data sampling can be done by using probability or can be done by putting certain subsets of the data in clusters to get a more precise output.
For the above cleaned dataset, a simple random sampling technique was used. The threshold set for picking up the sample was twenty percent of the total dataset.

Normalization: While minimizing or eliminating data is one of the many benefits of normalization, it is not the only purpose. Normalization is also used for ensuring data consistency, improve data quality and to make the data overall more readable. Normalization is done by organizing data in a structured way by creating a link between data elements in different tables, reducing data duplication and making sure that all of the data is stored in one single place. There are multiple

levels to normalization and the level of normalization selected for a dataset depends on its complexity and structure. All in all, normalization is an important step in data preprocessing and data mining as it helps to ensure data quality and reduce inconsistencies in the dataset.

In our analysis, a subset of normalization known as the Z-Score normalization has been used. Z-Score normalization is done by finding a new value for each data point in the dataset, the new value can be calculated by using the given datapoint and subtracting the mean of the data from it and dividing the result by the standard deviation of the data. This can also be given by,

$$\textbf{New value}=(x-\mu)/\sigma$$

Here,
x: Original value
μ: Mean of the data
σ: Standard deviation

Z-Score normalization is done on the dataset needed for our analysis using the above formula to obtain a concise dataset consisting of relevant columns in which the data has a mean of 0 and a standard deviation of 1.

Phi Coefficient/Mean Square Contingency Coefficient: The Phi Coefficient is a measure of how closely two binary features are correlated. It ranges from -1 to 1, where:

- 0 signifies no correlation
- 1 signifies a very strong correlation
- -1 signifies a very strong negative correlation

In a confusion matrix between two columns, the Phi Coefficient (∅) is defined as:

$$\emptyset = \frac{TP \times TN - FP \times FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$

In this paper, we created a phi matrix consisting of the phi coefficients of all columns and eliminated columns which had a value of the coefficient over 0.96, thereby, reducing the number of columns through correlation.

Feature Engineering / Aggregation: Feature engineering is a data mining pre processing technique which leverages data from a dataset to create a new variable that can be done by using an aggregate of the selected columns or features to create a new feature that can be used for the analysis or can give us more information about the dataset than the original features were able to give us. This method of preprocessing can produce new features for both supervised and unsupervised data, with the goal of simplifying or speeding data transformations as well as being able to enhance the data or model accuracy.
Feature Engineering is a rather important data preprocessing technique has a bad feature or a feature that gives us no useful information can be devastating, time wasting and have a direct impact on the model.
One method among many of doing feature engineering is the by the process of Imputation, among which are numerical imputation and categorical imputation.

In the above analysis of finding the most important factors leading to a miscarriage in women the method of categorical imputation to do feature engineering. The
Missing values in the relevant columns have been replaced with the mode values of the relevant columns. The feature engineering is done by aggregating a number of columns to enable the newly created feature to make a better prediction or give us more information about the dataset than the original features, for example, the columns that refer to whether or not a person indulges in different intoxicants like tobacco or cigarettes have been aggregated into a single feature called smoking which will give us a better understanding of how many people in the sample space indulge in these activities and helps us in making our dataset more concise with more relevant and useful information which can be easily interpreted for the analysis.
Similarly, another such new feature generation has been done called prenatal care which aggregates all the columns referring to the factors that might affect the quality-of-care women are given during their pregnancy. This aggregation gives us a more clear and thorough understanding of the relevant information in the aggregated columns and enable us to reach a logical conclusion based on the aggregated information contained in the new feature.

IV. Data Analysis

Naïve Bayes Classifier: Naive bayes classifier is a probalistic algorithm that is usually used for classification tasks in data mining or machine learning. This algorithm is based on Bayes theorem and it assumes that the presence or absence of a certain feature is independent of the presence or absence of any other feature. This algorithm has many uses mainly in text classification, spam filtering, and sentiment analysis. Naive bayes classifier has advantages such as its simplicity and its ability to handle high- dimensional

data with a small number of training examples that make it a widely used algorithm.

By counting the number of cases in each class that have the feature and dividing by the total number of examples in that class, the classifier determines the conditional probability of each feature given each class based on this supposition. The possibility of observing the feature given the class is provided by this.

The prior probability of each class, which is just the percentage of examples in the training set that belong to that class, is determined by the classifier prior to classifying a new example. The probabilities obtained are then normalized so that they add up to 1 and are multiplied by the likelihood of witnessing each feature given the prior probability of each class. The posterior probability of each class given the input is provided by this.
The classification algorithm then places the example in the class with the highest posterior probability. The assigned class should match the example's actual class label if the classifier is functioning properly.

Apriori: The apriori algorithm is an algorithm used for frequent itemset mining and association rule mining and has become a fundamental algorithm for reducing and mining large datasets.
The basic principle of the apriori algorithm is to generate a list of candidate itemsets based on the frequent itemsets that were generated in the previous iteration and then to prune the candidate itemsets that do not meet the minimum support threshold requirements. The support can be defined as the proportion of transactions in the dataset that contain the itemset.
The apriori algorithm has some advantages namely its simplicity, efficiency and ability to handle large datasets. This algorithm also has some disadvantages such as its sensitivity to the minimum support threshold and its tendency to generate large number of candidates itemset.
In this analysis to find the most important factors that lead to a miscarriage in women, the apriori algorithm has been used on a number of features to reach a conclusion. Using the apriori algorithm the most frequent datapoints were initially shortlisted by testing the datapoints against a minimum support threshold to eliminate all the infrequent datapoints, i.e., the datapoints that do not satisfy the minimum support threshold.
In the next iteration the shortlisted datapoints were again tested against the minimum support threshold to further eliminate a number of infrequent datapoints with whom the output would be further skewed. This iterative process is continuously done until we obtain the most frequent itemset.

Logistic Regression:
Logistic Regression is a supervised learning technique. It is used for predicting categorical dependent variable using a set of independent variables. In this project logistic regression was applied to a dataset containing features like prenatal care, place of delivery, social class and level of education. The importance of these factors in predicting whether or not a woman suffers a miscarriage depends on the values of the weights obtained.

WEIGHT	FEATURE
-0.05073195	Prenatal Care
-0.16877503	Contraception Use
0.0708956	Anemia
-0.45123524	Educated
0.2197683	home delivery
0.18772083	private hospital
-0.17699874	Toilet with flush
0.04173991	Latrines
0.08178138	Pit toilet
0.01640701	One child before
0.13763087	Two children befire
0.138	Three children before
0.56285742	Four children before
-0.46378302	Urban

The negative weights indicate that when the attribute goes from 0 to 1, the target variable will go from 1 to 0, and vice versa for the positive values of weights. It can be seen that receiving prenatal care and use of contraception reduces risk of miscarriage. It was also seen that women who live in urban areas are more likely to have a healthy delivery than women from rural areas. Women who are more educated are less likely to have a miscarriage as opposed to less educated or uneducated women. Women who have a delivery at home have a greater risk of suffering from a miscarriage than those who deliver in a hospital. Women with access to proper toilets less likely of suffering a miscarriage than ones using latrines or pit toilets. The risk of having a miscarriage greatly increases with an increase in the number of children delivered before current pregnancy.

V. RESULT

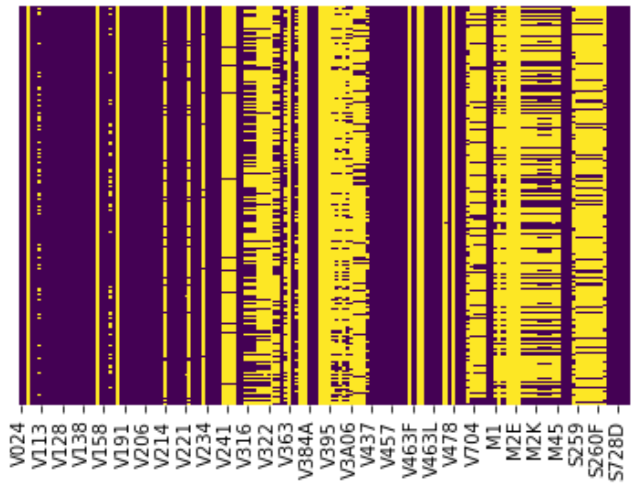
In this we have tried to main factors that lead to miscarriages among pregnant women. The data frame was preprocessed and then feature engineering was applied to reduce the number of columns. We applied Naïve Bayes algorithm, Apriori Algorithm and Logistic Regression techniques.

In logistic regression based on the value of weights it was discovered that lack of education, sanitation and proper medical facilities were some of the leading causes. Rural women were at a higher risk than women living in urban areas are at a lower risk. The chance of miscarriage also increases with an increase in the numberof deliveries

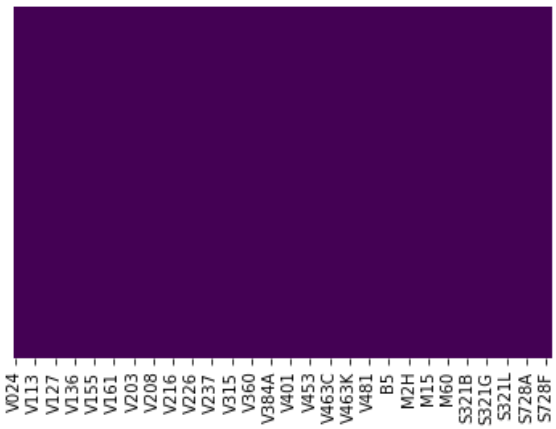
VI.

VII. VISUALIZATION

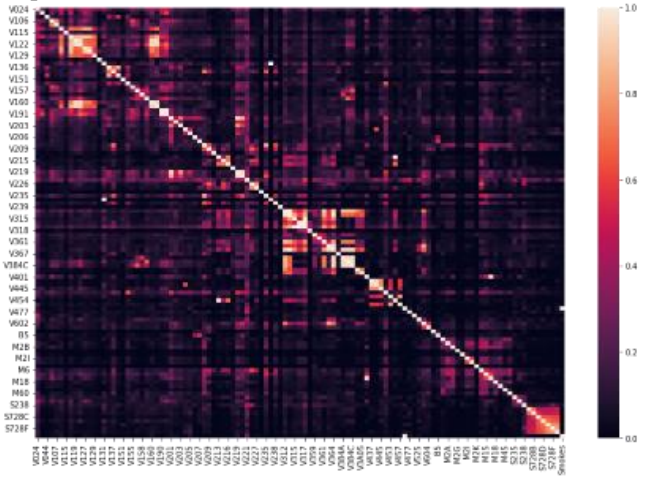
This is a heatmap of all the columns where the yellow boxes indicate that there's a missing value in that location. As we can see, there are a lot of missing values present in a few columns and hence these columns had to be either cleaned or removed.



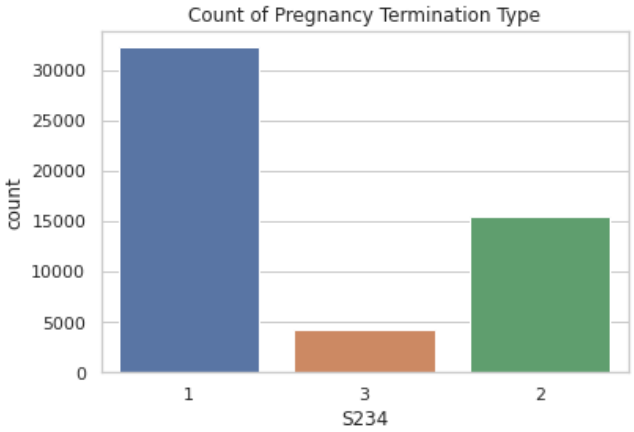
This is the heatmap of all the columns after cleaning the data and after removing a few columns.



The following plot is a heatmap of the phi correlation matrix obtained by calculating the phi coefficients for each column. In the plot, white signifies that the correlation between the column is 1 which means they are highly correlated and hence one of the columns can be removed while black signifies that the columns are not correlated at all. We can notice that most columns are not correlated and hence most columns are important and cannot be removed.

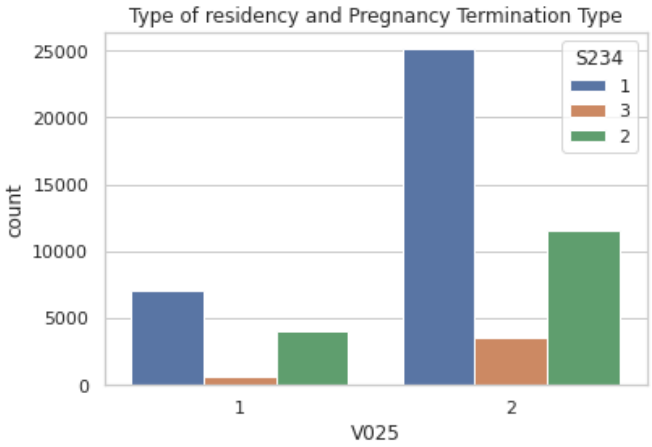


This plot is a plot of the number of miscarriages, abortions and still births. 1 stands for miscarriages, 2 for abortions and 3 for still births.

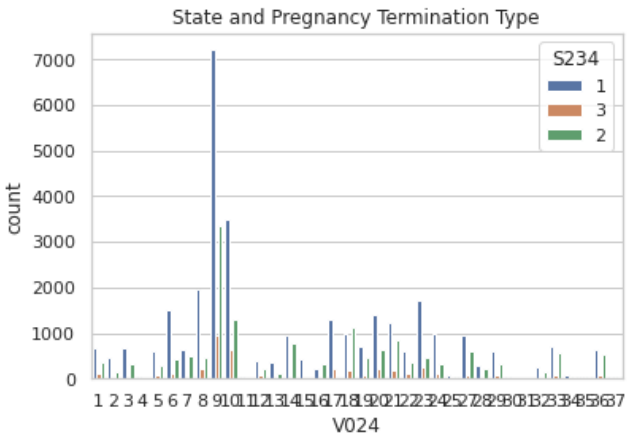


The next graph shows the relation between the miscarriage numbers and the region of living. Rural areas show a much higher rate of miscarriage than its

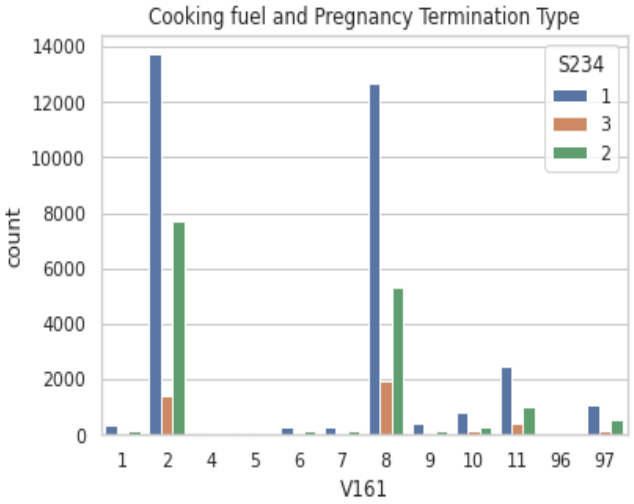
urban counterpart.



This is the graph of state vs pregnancy termination. It can be observed that most of the miscarriages occur in state no 9 and 10 which correspond to Uttar Pradesh and Bihar.



Through the graph below it can be observed that using cooking fuels like wood and biogas often results in pregnancy complications.



VIII. Acknowledgment

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Colab Link: https://colab.research.google.com/drive/1IE7NisZTNiBxwiJXN2tzm9S2VWUlnQpi?usp=sharing