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Determine the Prevalence of Hepatitis B and C During Pregnancy by Using Machine Learning Algorithm

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Abstract*:* South Punjab has a high frequency of Hepatitis B and C among pregnant women, making it a highly endemic region. Lack of knowledge, drinking tap water, dental procedures, and past surgery all raise the risk of infection. The anticipated model's accuracy is 86.32%. A low socioeconomic position and a history of surgical therapy are also important considerations. Using medical data sets, this research attempted to illustrate the performance of ensemble approaches in identifying Hepatitis infection. Three algorithms were used, and the suggested model was evaluated using data from actual hepatitis patients. The research discovered that 64% of pregnant women in rural regions had Hepatitis B and C, whereas 36% of pregnant women in urban areas had Hepatitis B and C. Hepatitis C was more prevalent in cities than in rural regions. The research underlines the necessity of correct diagnosis in clinical decision support systems, as well as data set compatibility.

Keywords: *Medical Data Set, Hypothyroidism Symptoms, SVM, KNN, Naive Bayes*

1. Introduction

Hepatitis is an inflammatory liver disease that results in eating problems, pain, and yellowing of the skin. It may be either acute or chronic, and can spread via body piercings, medical procedures, drug injection equipment sharing, sexual transmission, and sharing of razors and toothbrushes [1]. Contact with infected blood or body fluids may result in the transmission of hepatitis B and C, with B being the more common. With over 350 million individuals chronically infected and over 20 million yearly cases, hepatitis B is a major worldwide public health concern [2]. The most common blood-borne infection, affecting around 3% of the global population, is hepatitis C. Nearly half of all instances develop into chronic carriers, which increases their risk of cancer and liver cirrhosis [3]. Hepatitis caused by viruses during pregnancy is associated with a higher risk of complications for mothers, such as fetal and neonatal hepatitis, which may be fatal to the newborn and cause maternal mortality. The most common times for hepatitis C transmission are during pregnancy and delivery.

The Orthohepadna virus genus, which causes hepatitis B and C, is transferred by contact with contaminated blood or bodily fluids. Reducing HCV incidence and mortality by 80% and 65%, respectively, is the goal of the WHO-GHSS [4]. The first step in therapy is to identify people who are infected, and it is essential to have a comprehensive screening program in place for those who are at risk. To provide the finest screening opportunities and raise the quality of their services, government agencies must constantly adapt their practices [5]. With the ability to evaluate large datasets and potentially surpass conventional screening methods, artificial intelligence and machine learning technologies may provide a complete picture of regional epidemiological trends [6].

The paper's contribution is as follows:

1. To forecast symptoms and other relevant aspects. We will be able to save the patient and inform medical professionals and corporations about this issue thanks to our research.
2. To anticipate more hidden characteristics using machine learning, deep learning, and data mining methods and methodologies.
3. Data analysis from a hepatitis B and C dataset of pregnant women utilizing several classification algorithms (Logistics regression, Nave Bayes, and SVM) to precisely predict the outcome in each instance of data.

The structure of this work is as follows: The methodology of the investigation is presented in Section 2. Section 3 explains the results. Section 4 finally describes the conclusion and future work.

2: Literature Review

In Brazil, there are around three million chronic carriers of the hepatitis C virus and two million chronic carriers of the hepatitis B virus, making viral hepatitis a serious public health concern [7]. Because these infections are quiet and often difficult to diagnose, they may cause acute or persistent liver damage. In order to reduce infant and maternal mortality, enhance basic care, encourage health promotion, and identify cures for newly emerging diseases—such as serologically proven hepatitis B and C—the Ministry of Health launched the Health Pact in 2021 [8]. The goals of the Pact for Life in Goias, however, have not been met, since only 77% of recorded cases of hepatitis B have confirmed serology [9]. The highly immunogenic hepatitis B vaccination causes the production of antibodies against the hepatitis B surface antigen (HBsAg). In addition to smoking,

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obesity, diabetes mellitus, and HIV infection, additional variables that impact the immunogenicity of the vaccination include age [10]. Studies have shown the safety of vaccinations during pregnancy and the long-term protection against clinical illness and chronic infection provided by a recombinant vaccine administered as a first vaccination for a baby [11]. The goal of the hepatitis B virus campaign in Brazil was to immunize every pregnant woman to the fullest extent possible. This treatment prevents infection more than 90% of the time [12].

The two most prevalent hepatotrophic viruses that cause viral hepatitis, a dangerous systemic infectious illness, are the hepatitis B virus (HBV) and the hepatitis C virus (HCV). Infected moms may spread HBV to their unborn children vertically during pregnancy or delivery, or horizontally via direct contact with contaminated bodily fluids and blood products [13]. A infant born to a mother with a chronic infection has a 70%–90% chance of developing a chronic infection. In regions where the virus is highly prevalent, up to 75% of chronic carriers get the infection from their mothers. Public health is seriously threatened by HBV, especially in underdeveloped countries [14]. Every year, between three and four million individuals get infected, and over half of those infections lead to chronic carriers who run the risk of liver cirrhosis and cancer. Together with changing the course of HBV infection and boosting HBV replication, co-infection with HIV has become a major cause of morbidity and death. It also increases the risk of liver damage associated with anti-retroviral treatment [15]. Approximately 380 million individuals globally are chronic carriers of the hepatitis B virus (HBV), and the infection is responsible for approximately 2 million deaths annually from related illnesses. Between 0.1% and 4.4% of pregnant women in Spain were infected with HBV [16]. Vertical transmission (VT) of HBV infection is possible, particularly in regions where the virus is common [17]. The most significant risk factor is high viral load (VL), which mostly affects women who test positive for HBeAg (HBeAg+ve). Pregnant women in Spain are estimated to have anti-HCV antibodies 0.5% to 1.4% of the time, but viraemia rates vary from 42% to 72%. Preventive and therapeutic approaches are being used in the fight against HBV and HCV; nevertheless, screening for HCV during pregnancy is not routine [18-23]. The major goal of this research is to determine the prevalence of HBV and HCV in pregnant Spanish women while accounting for the women's place of origin, epidemiological variables, and the risk of VT.

3. Methodology

This section contains the methodology of the study.

2.1 Data Collection

All of the data was collected at Nishtar Hospital in Multan. We visited the hospital and saw a number of specialists. In order to learn more about the risk factors and symptoms of Hepatitis (B) and Hepatitis (C), we also spoke with the patients. The group under research included all expectant mothers who visited Nishtar Hospital Multan in order to give birth. 180 pregnant patients with Hepatitis B and C were included in the research. Patients are drawn from both rural and urban areas. Based on patient data from January to September of 2022, the information is provided. The dataset considers twenty different attributes. Table 1 presents the attributes of the dataset.

Table 1. The Features of Data Set

Sr No	Attributes	Parts
1	Patient ID	Factors
2	Patient Age	
3	Residential Status	
4	During Pregnancy Diagnosis(DPD)	
5	Occupation	
6	Education	
7	Soico- Economic	
8	Blood Transfusion	
9	Ear/Nose Piercing	
10	Dental Procedure	
11	Sharing Needles	
12	Partner Affected	
13	Drinking water	
14	Previous Surgery	
15	Beauty Salon/Parlor	
16	Liver Pain	
17	Weakness	
18	Fever	
19	Fatigue	
20	Jaundice	

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16	Liver Pain	
17	Weakness	
18	Fever	
19	Fatigue	
20	Jaundice	

2.2 Questionnaire

A questionnaire is a kind of research tool made up of a set of standard questions intended to elicit data on a particular topic from one or more respondents that is statistically significant. The main goal of a questionnaire is to get data from respondents; it's an inexpensive, efficient, and fast method of gathering large amounts of data. We came up with a survey to collect information. The questionnaire asks for details about the patient, including name, age, residential status, kind of hepatitis diagnosis (Hep B&C) during pregnancy, family history, socioeconomic status, and factors and symptoms of hepatitis B and hepatitis C. Table 2 explain that pregnant patients at Nishtar Hospital with hepatitis B and C using a regression approach.

Table 2. Multan uses a framework for data mining and a regression-based approach.

Patient Name: _____	Age: _____
Residential Status: Rural Urban	
During Pregnancy Diagnosis: Hep B Hep C Not Affected	
Family History	
1- Family Wife ☐	2- Employed Lady ☐
Husband Job: _____	Scheduled Income _____
Teaching: Literate ☐	Illiterate ☐
Socio- Economic:	
☐ Poor ☐	Middle Income: ☐ Rich: ☐
Factors/ Causes: (Hep B & C)	
Blood Transfusion	✓/×
Ear/Nose	✓/×
Recent/Childhood	✓/×
Dental Process	✓/×
Distribution Needles	✓/×
Partner Affected	✓/×
Drinking Liquid	✓/×
Purified/Pipe Water	✓/×
Previous Surgery	✓/×
Beauty Salons/parlor	✓/×
Transfusion of Blood	✓/×
Symptoms of hepatitis(B&C)	
High temperature	✓/×
Frailty	✓/×
Hepatic Pain	✓/×
Vomiting	✓/×
Skin Rash/Itching	✓/×
Exhaustion	✓/×
Jaundice, or yellow eyes or skin	✓/×

3.3 Steps of Methodology

Support Vector Machine (SVM), Nave Bayes, and Logistics Regression models were used in this study using the Weka tool. The main goal of this is to predict the objective by using information from pregnant women with hepatitis B and C. It was established what the proportion of pregnant women with hepatitis B and hepatitis C was in urban and rural areas.

The phases of our technique shown in figure 1 are as follows:

I. Gathering patient data
II. Data pre processing
   a) Delete PID column
   b) Remove Errors
   c) Validation
   d) Define Variable Value
   e) Selected Data
a. Cross Validation
b. Train Data (70%)
c. Test Data (30%)
III. Classifiers
   a. LR
   b. SVM
   c. NBs
IV. Prediction
V. Validate & Accurate

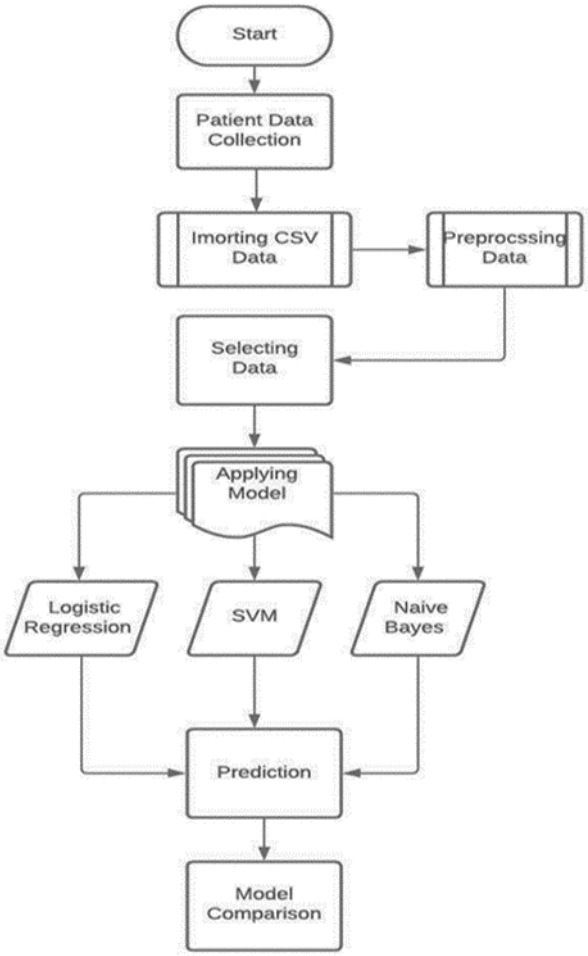

Fig. 1. The Steps of Method

3.4 Data Preprocessing

Preprocessing is a crucial step in improving data quality, often using machine learning techniques like SVM, Logistics regression, and NB. Bioinformatics has made significant progress in classifying and predicting biological data. Raw data requires preprocessing to remove noise and outliers, and then data reduction and projection are used to find relevant features. The training set is then subjected to various data mining techniques, including clustering, classification, and prediction. Inaccuracies in the data collection were eliminated during preprocessing, and certain errors in the output class DPD were also addressed.

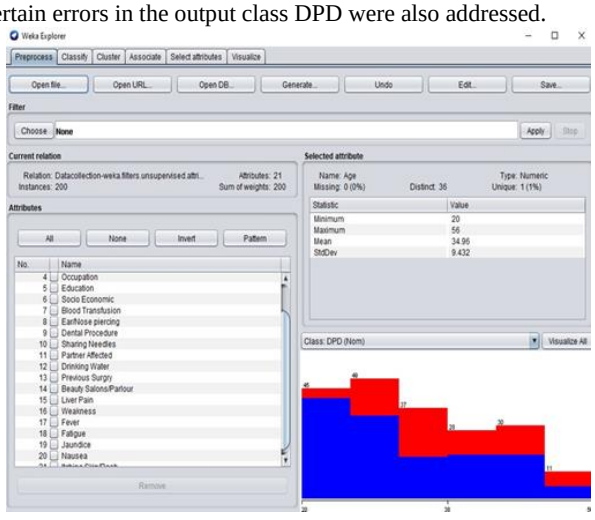

Fig. 2. Data Preprocessing

3.5 Data Mining Phase

This section discusses data mining approaches such as Support Vector Machine, Logistics Regression, and Nave Bayes for identifying hepatitis B and hepatitis in pregnant women. Figure 3 depicts a block diagram of the data mining process. Data mining methods are divided into two stages:

- During the training/learning phase, the model is taught by matching the input with the predicted output.
- The testing/validation step is used to evaluate the model's quality.

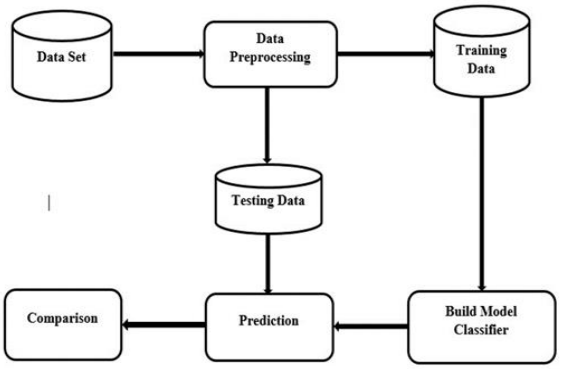

Fig. 3. Block Diagram

4. Results & Discussions

Most people who have Hepatitis B and C don't even know that they have the diseases or know how to prevent them. A chronic stage of Hepatitis, which is almost hard to cure and so costly that the impoverished cannot afford it, is caused by a number of factors, including insufficient health facilities, low socioeconomic position, unqualified healthcare personnel, and misunderstanding about the condition and its treatment. Although immunizations are available, there is currently no approved treatment for hepatitis. The costs associated with treating hepatitis-related liver failure place a significant financial burden on the healthcare system. If disease is anticipated and found early on, many lives may be saved. Examining effective classification accuracy for hepatitis B and hepatitis C diagnosis is one of the main contributions of this study. We looked at a number of data mining techniques, including Logistic Regression and Naive Bayes, on the hepatitis B and C dataset. Find the best algorithmic performance for the prediction of hepatitis B and C. In our study, 180 individuals with hepatitis B and C were included. All of the individuals received hepatitis B and C diagnoses during pregnancy. Table 3 and Figure 4 illustrate the 20 variables in the dataset, which include the patient's family history (occupation), hepatitis B and C symptoms, and factors.

Table 3. HEP (B) and HEP (C) patients based on their occupation

Factor	Patients Hep B&C	Hep(B)	Hep(C)
House Wife Patients	115	15	95
Working Lady	65	45	25

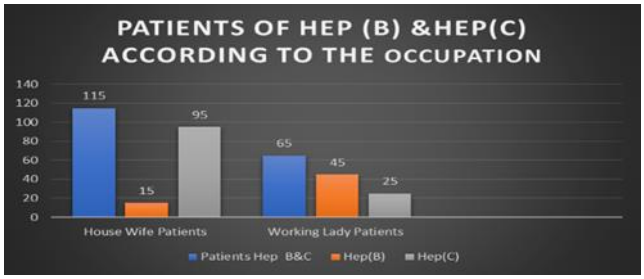

Fig. 4. Patients of Hep (B) &Hep(C)

In this research, we have several input classes that include hepatitis B and hepatitis C variables and symptoms. DPD is an output class that includes HEP (B) &HEP(C). First, we analyze each class independently based on the output class, DPD (During Pregnancy Diagnosis), to determine the number of patients with hepatitis B and hepatitis C. Table 4 and Figure 5 depict HEP (B) &HEP(C) diagnoses pregnancy in literate and illiterate individuals.

Table 4. HEP (B) &HEP(C) Diagnosis Pregnancy

Education	Patients Hep B&C	HEP(B)	HEP(C)
Literate Patients	84	64	40
Illiterate Patients	96	6	70
Education	Patients Hep B&C	HEP(B)	HEP(C)

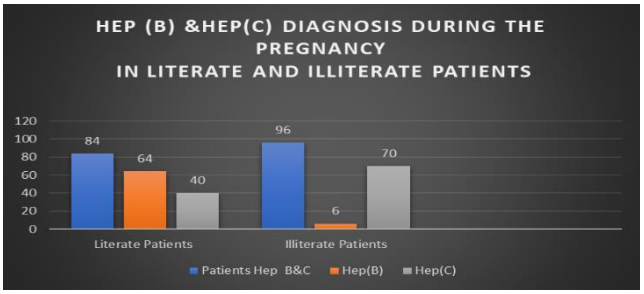

Fig. 5. Hep (B) &Hep(C) Diagnosis Pregnancy

The most frequent causes of the transmission of hepatitis (B) and hepatitis (C) include dental procedures, partner illness, drinking pipe water, and prior surgery, according to the aforementioned (table 5-table 9) and (figure 6-figure 9). According to our research, partner illness is the most frequent cause of hepatitis B and C cases. Sexual activity may cause a male partner who has Hep B or Hep C to change in the female partner.

Table 5: Hepatitis B&C due to Dental Treatment

Factor	Patients Hep B&C	Hep(B)	Hep(C)
Dental treatment Occurred	96	54	49
Dental treatment not Occurred	84	31	46

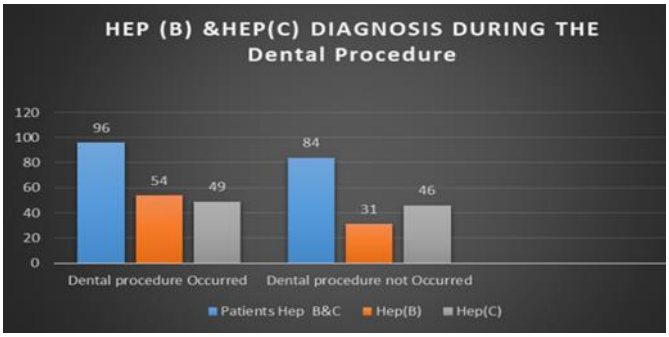

Fig. 6. Hepatitis Diagnosis Due to Dental Treatment

Table 6: Hepatitis B&C Diagnosis due to Partner

Patients Status	Patients Hep B&C	Hep(B)	Hep(C)
Partner Affected	147	65	86
Partner not Affected	33	25	4

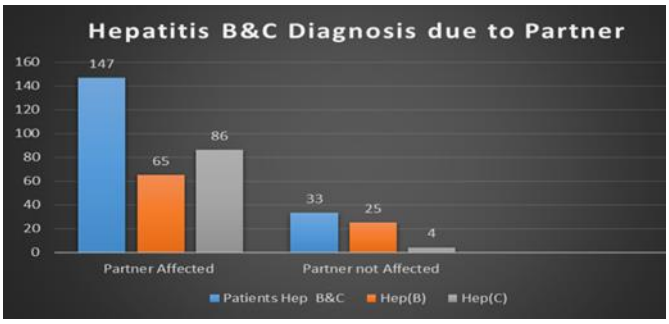

Fig. 7. Hepatitis Diagnosis Due to Dental Treatment

Table 7: Hepatitis B&C Diagnosis due to Partner

Patients Status	Patients Hep B&C	Hep(B)	Hep(C)
Pipe Water	93	15	102
Purified Water	87	43	20

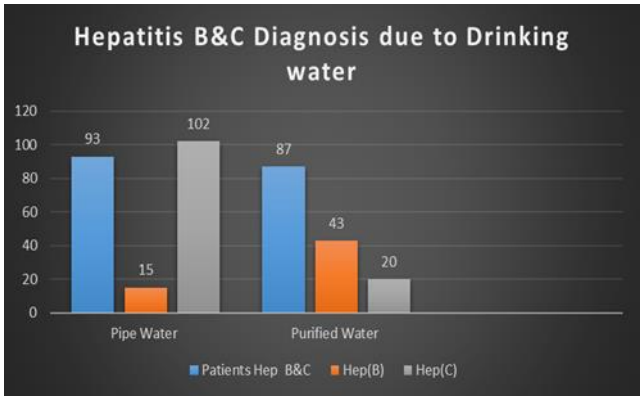

Fig.8. Hepatitis Diagnosis Due To Drinking Water

Table 8: Hepatitis B&C Diagnosis due to previous surgery

Patients Status	Patients Hep B&C	Hep(B)	Hep©
Previous Surgery Occurred	115	35	75
Previous Surgery not Occurred	65	25	45

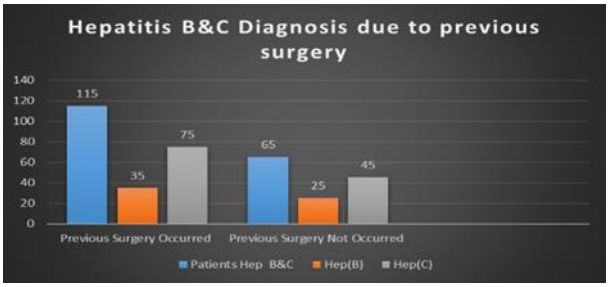

Fig. 9. Hepatitis B&C Diagnosis Due To Previous Surgery

The most typical signs of hepatitis B and hepatitis C, such as jaundice (yellow eyes and skin), exhaustion, and fever, are shown in our study in tables 9 and figure 10. The majority of people with hepatitis B and C during pregnancy exhibit these symptoms.

Table 9. Most Common Symptoms of Hepatitis B&C Patients

Symptoms	Patients Hep B&C	Hep(B)	Hep(C)
Fatigue	130	22	59
Fever	96	59	75
Jaundice	112	26	97

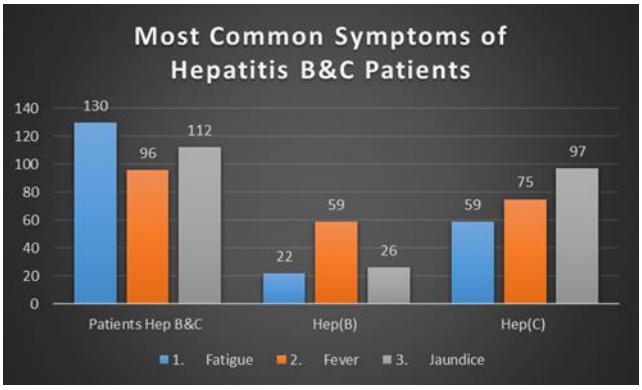

Fig. 10. Comparison Results of Machine Learning Classifier

4.1 Performance Measurement

The accuracy rate is a model's evaluation exponent in classification problems, assessing the classifier's ability to evaluate the entire dataset. It is calculated by dividing the number of correctly categorized datasets by the total number of datasets. However, accuracy is often more relevant in imbalanced data, making it less suitable in certain situations. Figure 11 show confusion matrix.

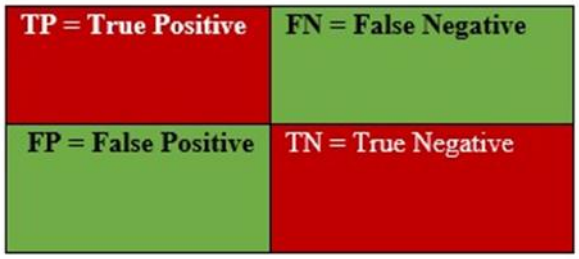

Fig.11. Confusion Matrix

Table 10: NB using 20-FOLD

Class	FPR	TPR	Recall	Precision	F Measure
HEP(C)	28.30%	76.56%	73.60%	83.60%	80.30%
HEP(B)	26.80%	76.64%	73.80%	60.30%	64.60%

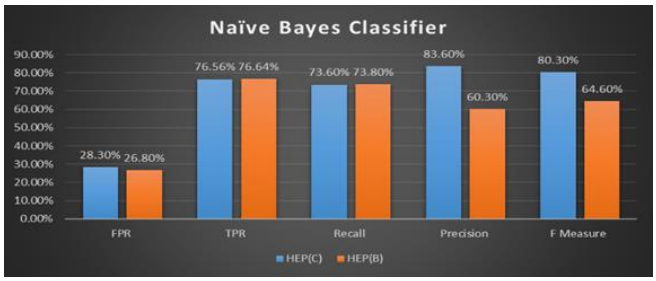

Fig.12. NB Using 20-Fold

Table 11: LR using 20-Fold

Class	FPR	TPR	Recall	Precision	F Measure
HEP(C)	31.50%	84.90%	84.50%	85.80%	84.60%
HEP(B)	15.43%	74.30%	73.60%	73.50%	72.60%

Fig.13. LR Using 20-Fold

Table 12: SVM using 20-Fold

Class	FPR	TPR	Recall	Precision	F Measure
HEP(C)	32.40%	88.40%	82.40%	88.10%	81.10%
HEP(B)	18.56%	81.60%	72.50%	78.80%	69.20%

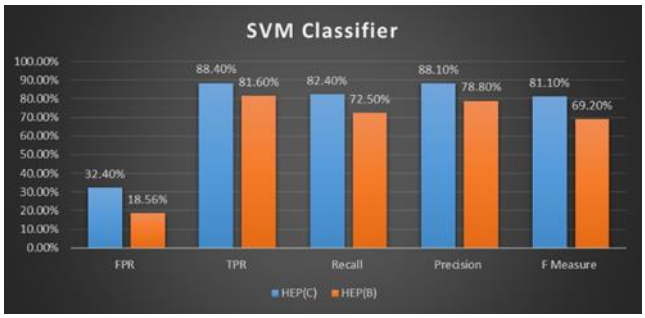

Fig.14. SVM Using 20-Fold

Table 13: Average Results

Classifier	Accuracy	TPR	FPR	Precision
Naïve Bayes	84.87%	76.64%	26.80%	83.60%
Logistic Regression	88.62%	84.90%	31.50%	85.80%
SVM	86.32%	88.40%	32.40%	88.10%

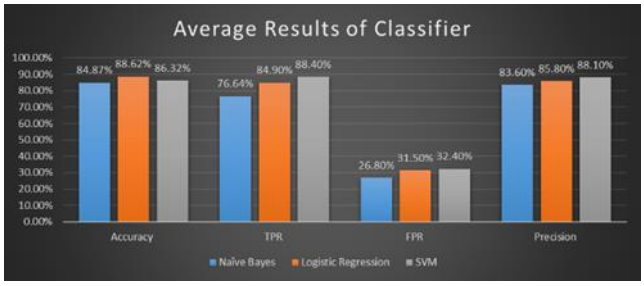

Fig.15. Average Results

Table 14: Hepatitis (B) and Hepatitis (C) Patient Ratios in Rural and Urban Areas

Residential Status	Patients Hep B&C	Hep(B)	Hep(C)	Total Patients	%Patients of Hep (B) &(C)
Rural Area Patients)	115	15	95	180	64%
Urban Area Patients	18.56%	81.60%	25	180	36%

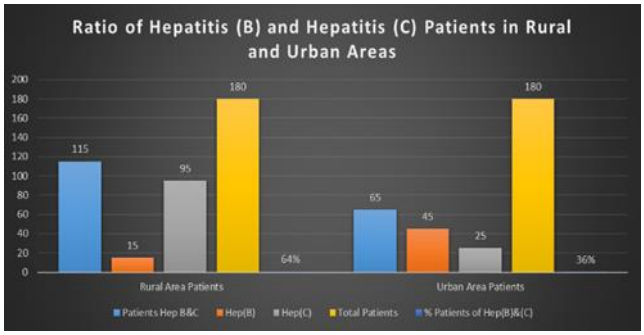

Fig.16. Hepatitis (B) and Hepatitis (C) Patient Ratios in Rural and Urban Areas

The expected model accuracy is 86.32%. Pregnant women at Multan's Nishtar Hospital were more likely to be infected with Hep C and Hep B. Low socioeconomic status and a history of surgical therapy are two key contributors to this trend. The research discusses data mining approaches for identifying hepatitis infection, which is one of the world's most severe medical conditions and requires costly treatment. The study demonstrated the usefulness of ensemble approaches on a medical dataset to improve the accuracy of machine-learning systems. Three algorithms were utilized in the research, and real hepatitis patient data were used to test the proposed model. The study underlines the need of selecting an appropriate data mining approach based on the application's goals and the adequacy of the data gathering. In this study, 36% of the pregnant women with Hepatitis B and C came from urban areas, whereas 64% came from rural areas. Pregnant women with Hepatitis C are more probable than pregnant women with Hepatitis B. The residence status of the patient is connected to the tables 10-14 and figures 12-16 above. The ratios of Hep (B) to Hep (C) in rural and urban

regions are shown in the tables 14. Rural locations have a larger proportion of Hep (B) patients than metropolitan ones. According to the data, 36% of patients with hepatitis (B) and (C) live in cities, whereas 64% live in rural regions. Pregnant women in south Punjab are more likely to get Hepatitis B and C in rural regions than in urban ones, according to the research. 36% of these patients live in cities, whereas 64% live in rural regions. The area is very endemic, contributing for over 68% of pregnancies. Other important infection risk factors include having a sick spouse, drinking tap water, having dental work done, not having a basic education, and having had previous surgery.

The accuracy of the anticipated model is 86.32%. In Multan's Nishtar hospital, pregnant women had increased rates of Hep C and Hep B infection. Low socioeconomic position and a history of surgical treatment are two important factors contributing to this tendency. The study explores data mining tactics for detecting hepatitis infection, which is one of the world's worst medical illnesses and needs expensive treatment. The research proved the use of ensemble techniques on a medical dataset for improving machine-learning system accuracy. In the study, three algorithms were applied, and actual hepatitis patient data were used to evaluate the proposed model. The research emphasizes the need of choosing a suitable data mining technique based on the application's objectives and the sufficiency of data collection. In this research, 36% of pregnant women with Hepatitis B and C lived in cities, whereas 64% lived in rural regions. Pregnant women with Hepatitis C are more likely to get it than those with Hepatitis B.

5. Conclusion and Future work

Because of the high frequency of Hepatitis B and C among pregnant women, South Punjab is a highly endemic area. A history of surgical treatment and a poor socioeconomic position may explain the greater occurrence of Hep C and Hep B. Using real patient data, this study sought to establish the usefulness of ensemble approaches in identifying hepatitis infection. When three distinct algorithms were utilized, the suggested model proved success in detecting Hepatitis viruses. According to the survey, 36% of pregnant women in cities and 64% of pregnant women in rural regions have Hepatitis B and C. The study emphasizes the need of deploying proper data mining tools for healthcare applications.

The study examined hepatitis D at Multan's Nishtar Hospital using the Weka data mining technology. There are four interfaces in the model, the most popular being the Explorer interface. In order to enhance hepatitis virus detection, future study might broaden the scope by using a variety of classification approaches, different categorization algorithms, and cutting-edge models like deep learning and fuzzy learning.

Author contributions

Awad bin Naeem 1: Conceptualization, Methodology, Software, Writing-Reviewing. **Biswaranjan Senapati 2:** Data curation, Writing-Original draft preparation, Field study. **Alok Singh Chauhan 3:** Methodology, Visualization, Investigation. **Mukta Makhija 4**: Writing-Reviewing and Editing. **Arpita Singh 5**: Writing-Reviewing and Editing. **Meghna Gupta 6:** Software. **Pradeep Kumar Tiwari 7:** Field study. **Wael M. F. Abdel-Rehim 8**: Software.

Conflicts of interest

The authors declare no conflicts of interest.

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