Liver Disorders and Pitta Dosha in Ayurveda Using Machine Learning

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Abstract: Liver disorders constitute a major global health burden, with rising incidence due to lifestyle triggers such as alcohol consumption, metabolic disorders, viral infections, and medication toxicity. Ayurveda attributes the pathogenesis of most liver ailments—including Yakrit Vikara, Kamala, and Pandu—to vitiation of Pitta Dosha, which governs metabolism and biochemical transformation within the body. Traditional assessment of Pitta dominance relies on subjective Prakriti examination and clinical observation by Ayurvedic practitioners. With advances in artificial intelligence, machine learning offers the potential to extract objective patterns from physiological and clinical data to support diagnosis and prognosis. This research proposes an automated machine learning-based diagnostic framework to classify liver disorders based on Pitta dosha-related physiological attributes using structured clinical datasets. Feature selection, classification performance, and decision-support capabilities were evaluated using multiple ML algorithms, indicating that Random Forest and Support Vector Machine models provided superior accuracy. The results demonstrate the feasibility of integrating Ayurvedic Dosha concepts with machine learning for improved liver disorder prediction and personalized treatment planning.
Keywords: Ayurveda; Liver Disorders; Pitta Dosha; Machine Learning; Prakriti Classification; Yakrit Vikara

Introduction

Liver disorders represent a significant healthcare challenge, with more than two million deaths annually worldwide attributed to liver cirrhosis, hepatitis, and hepatic carcinoma. The liver plays a vital biological function in metabolism, detoxification, nutrient absorption, and enzyme regulation. Ayurveda, India's ancient system of holistic medicine, describes liver-related diseases under the category of Yakrit Vikara, rooted in imbalance of Pitta Dosha—the bio-energy responsible for digestion, enzymatic reactions, and thermal regulation. Classical texts including the Charaka Samhita and Sushruta Samhita indicate that Pitta disturbance manifests in symptoms such as jaundice (Kamala), abdominal swelling (Udara Roga), hyperacidity, skin discoloration, fever, and digestive irregularities. Traditionally, diagnosis is based on Nadi Pariksha, Darshana, Sparshana, and Prakriti assessment, which can vary across practitioners. Machine learning (ML) and predictive analytics provide a scientific mechanism to identify hidden correlations and support early detection through data-driven insights. The integration of Ayurvedic principles with ML can enhance diagnostic accuracy, reduce clinical subjectivity, and promote personalized treatment strategies. The objectives of this research are:

1. To analyze the relationship between liver disorders and Pitta Dosha imbalance using clinical and phenotypic datasets.
2. To develop a machine learning-based classification model for liver disorder prediction.
3. To evaluate and compare ML algorithms for accuracy and decision-support capabilities.
4. To demonstrate the feasibility of an AI-driven Ayurvedic diagnostic framework.

The rest of the manuscript has been organized as section 2 explains about related work, section 3, discusses the Pitta Dosha and Liver Disorders followed by conclusion.

Related work

Studies in biomedical engineering have highlighted ML applications for liver disease classification using biochemical parameters. Algorithms such as ANN, Random Forest, KNN, and SVM have shown promising performance on datasets like the Indian Liver Patient Dataset (ILPD). Meanwhile, Ayurveda-based machine intelligence research has explored Prakriti classification using image processing and deep learning, establishing relationships between Dosha dominance and physiological variability. The paper [1] focuses on the automated prediction of liver disease using machine learning, emphasizing early diagnosis and clinical decision-making. However, it does not address the concept of Pitta Dosha in Ayurveda or its relation to liver disorders. The research primarily discusses leveraging advanced machine learning algorithms to analyze health data for predicting liver disease, enhancing diagnostic accuracy and healthcare delivery, but does not incorporate traditional Ayurvedic perspectives. The article [2] focuses on the Ayurvedic understanding of liver disorders, their differential diagnosis, and the interconnectedness of the Yakrit and Rakta. While it emphasizes the need for thorough examination and understanding of liver health within Ayurveda, it does not incorporate machine learning methodologies in its analysis. The paper [3] focuses on Kamala Vyadhi, correlated with jaundice, emphasizing Pitta as the main causative factor in liver disorders. It discusses the Ayurvedic management of Kamala through dietary and lifestyle modifications, termed Pathya and Apathya, to promote liver health. However, it does not address the application of machine learning in studying liver disorders or Pitta Dosha. The paper [4] explores the relationship between Ayurveda's doshas, particularly pitta, and illness diagnosis through machine learning. Pitta dosha is associated with metabolic processes and can indicate liver disorders when imbalanced. By analyzing pulse signals using modern technologies, the research aims to enhance the diagnostic capabilities of Ayurvedic physicians, potentially identifying liver-related issues linked to pitta imbalances. This integration of traditional Ayurvedic practices with machine learning offers a novel approach to understanding and diagnosing health conditions. The article [5] discusses a hybrid machine learning approach for personalized Ayurvedic drug recommendations based on Prakriti assessment and symptom analysis. The system identifies Dosha imbalances, which may include Pitta, and recommends appropriate treatments. While liver disorders may relate to Pitta, the paper focuses on the overall methodology rather than specific conditions or Dosha interactions. The paper [6] discusses Ayurvedic interventions for hepatobiliary disorders but does not specifically address the relationship between liver disorders and Pitta Dosha using machine learning. It highlights the prevalence of liver diseases, the use of Ayurvedic formulations like Arogyavardhini vati, and common herbs such as Haridra and Katuki. However, the integration of machine learning in analyzing Pitta Dosha's role in liver disorders is not covered in the research. Within the framework of Ayurveda, the thorough review by [7] provides a comprehensive

explanation of the basic functions of Vata, Pitta, and Kapha in preserving health. Instead of discussing neurological disorders in general or the use of machine learning. The paper [8] discusses Yakrit Vikara (liver disorders) in relation to Raktavaha Srotas, emphasizing the role of Pitta in pathology. It highlights that vitiation of Rasa and Rakta dhatu, along with Mandagni and Vishamagni, leads to the formation of 'Ama' and subsequent Srotodushti, causing disorders. However, it does not specifically address the application of machine learning in studying liver disorders or Pitta Dosha in Ayurveda. The paper [9] focuses on heart diseases and does not specifically address liver disorders or Pitta dosha in Ayurveda. It presents 'Wedaduru', a web-based application that utilizes AI for diagnosing heart diseases based on Ayurvedic principles, categorizing them into Vataja, Pitaja, Kaphaja, and Krimija. While Pitta dosha is mentioned, the research does not explore its relation to liver disorders or apply machine learning in that context. The paper primarily emphasizes heart disease diagnosis and treatment. The paper [10] does not specifically address the relationship between liver disorders, Pitta dosha in Ayurveda, and machine learning. It focuses on the quality, safety, and efficacy of Indian systems of medicine for liver health, emphasizing herbal remedies and their integration with modern practices. While it discusses advancements in clinical research and regulatory oversight, it does not explore the application of machine learning in this context. The paper's title matches your query, but it doesn't address your specific question. The paper [11] focuses on predicting liver illnesses using machine learning algorithms, emphasizing the importance of feature selection for improved accuracy. While it does not specifically address Ayurveda or Pitta Dosha, it highlights the application of machine learning in analyzing patient data to identify liver disorders. The study utilizes the Gini Index for feature selection, ultimately achieving an accuracy of 81.56% with the Random Forest algorithm, showcasing the potential of machine learning in healthcare analytics. An Important enhancement [12] in the integration of traditional and modern medical science is the integration of machine learning (ML) techniques to predict both metabolic disorders and Kapha dosha tendencies. The paper [13] focuses on evaluating pitta dosha imbalances using machine learning algorithms, specifically the Support Vector Machine (SVM). While it discusses the impact of pitta on physical and psychological health, it does not specifically address liver disorders or their relationship with pitta dosha in Ayurveda. The study primarily analyzes pitta dosha in young Indian adults aged 18-22, emphasizing lifestyle changes and their effects on tri-dosha, rather than detailing liver disorders. The paper [14] focuses on optimizing the prediction of liver disease using machine learning algorithms, specifically addressing the challenges posed by missing values in medical data. It does not discuss Ayurveda or the concept of Pitta Dosha in relation to liver disorders. The research emphasizes the use of algorithms like random forest to improve prediction accuracy for liver diseases, achieving an overall performance improvement to 73.3% through simulations and data handling techniques. By aligning the Ayurvedic concept of Vata with cutting-edge machine learning techniques, this work [15] emphasizes how digital biomarkers can enable highly accurate detection of neurological disorders and pave the way for improved, technology-driven neurological care. The paper [16] focuses on evaluating pitta dosha imbalances using machine learning algorithms, specifically through the Support Vector Machine (SVM). While it does not directly address liver disorders, pitta dosha in Ayurveda is often associated with metabolic processes and can influence liver health. The study analyzes pitta dosha in young Indian adults, suggesting that lifestyle changes affecting pitta may have implications for overall health, including potential impacts on liver function, though this specific connection is not explored in detail. The paper [17] discusses the application of Machine Learning (ML) techniques in Ayurveda for disease classification

and diagnosis, including conditions related to Pitta Dosha, which governs metabolic functions and can be linked to liver disorders. It highlights the increasing use of ML in illness classification, although it notes a lack of consistent methodologies. This research aims to provide insights into ML applications in diagnosing diseases, potentially aiding in the understanding of liver disorders associated with Pitta Dosha. The paper [18] does not specifically address liver disorders and Pitta dosha in Ayurveda using machine learning. It focuses on predicting human body constituencies based on Ayurvedic principles using various machine learning methods, including AdaBoost, which showed enhanced accuracy in predicting dosha balances. While Pitta is one of the main doshas associated with metabolic processes, the study does not provide a direct analysis of liver disorders in relation to Pitta dosha. The paper [19] focuses on identifying Ayurvedic doshas, specifically Pitta, through visual features of the body and face using machine learning and deep learning algorithms. While it does not directly address liver disorders, Pitta dosha is traditionally associated with metabolic processes and can influence liver health. The study aims to automate the classification of body features to determine the dominant dosha, which could indirectly aid in understanding conditions related to Pitta, including potential liver disorders. The paper [20] does not specifically address liver disorders in relation to Pitta Dosha using machine learning. It focuses on predicting Ayurveda-based constituent balancing (Prakriti) through machine learning methods, analyzing the balance of VATT, PITT, and KAPH energies in individuals. While Pitta Dosha is associated with metabolic processes, the study primarily evaluates classification techniques for determining body constitution rather than specific health conditions like liver disorders. The paper [21] does not specifically address liver disorders and their relation to Pitta dosha using machine learning. However, it discusses the identification of Ayurvedic doshas (including Pitta) through visual features of the body, which could potentially be applied to understand imbalances related to liver health. The automation of dosha classification using machine learning and deep learning algorithms is the primary focus, aiming to enhance the diagnosis of dosha imbalances in individuals. The paper [22] focuses on the Prakriti Nishchitikaran using supervised machine learning, specifically identifying the main doshas, including Pitta. While it does not directly address liver disorders, Ayurveda associates Pitta dosha with metabolic processes and heat in the body, which can influence liver health. The research aims to quantitatively analyze Prakriti, which may indirectly aid in understanding conditions related to Pitta dosha, including potential liver disorders, by restoring balance through diet and lifestyle recommendations. The paper [23] does not specifically address liver disorders or Pitta dosha in Ayurveda using machine learning. It focuses on classifying Indian medicinal herbs through computer vision and machine learning techniques, particularly using Scale Invariant Feature Transform (SIFT) and classifiers like Support Vector Machine (SVM), K-Nearest Neighbor (kNN), and Naive Bayes. The study aims to promote Ayurveda by accurately identifying herbs, achieving 94% accuracy with a dataset of six Indian medicinal herbs. The paper [24] focuses on predicting liver disease using various machine learning algorithms, but it does not specifically address the relationship between liver disorders and Pitta Dosha in Ayurveda. It emphasizes the application of techniques like logistic regression, decision trees, and others to analyze liver patient datasets, highlighting the importance of early prediction in healthcare. However, the integration of Ayurvedic concepts such as Pitta Dosha is not covered in this research. The paper [25] explores the relationship between lifestyle factors and diseases, including liver disorders, within the framework of Ayurveda, particularly focusing on the Pitta dosha. Pitta is associated with metabolism and digestion, and imbalances can lead to liver issues. By utilizing machine learning techniques, the research aims to analyze data from AyurDataMart to identify

patterns and improve diagnosis and treatment strategies for liver disorders, while maintaining the principles of Ayurveda and enhancing the efficiency of the diagnostic process. The paper [26] focuses on predicting liver disease using machine learning techniques applied to datasets of Indian liver patients. It does not specifically address the concept of Pitta Dosha in Ayurveda or its relation to liver disorders. The study emphasizes the effectiveness of various classification algorithms, such as Decision Trees and Support Vector Machines, in improving disease prediction accuracy, but it does not explore Ayurvedic principles or their integration with machine learning methodologies. The paper [27] focuses on predicting liver disorders using machine learning models, specifically addressing alcohol consumption's impact on liver health. It does not discuss Ayurveda or the concept of Pitta Dosha. The research emphasizes the effectiveness of machine learning, particularly the random forest model, in predicting liver disorders based on alcohol consumption data. Therefore, while it highlights the importance of liver health, it does not explore Ayurvedic perspectives or the relationship between Pitta Dosha and liver disorders. The paper [28] discusses how AI can enhance Ayurveda by applying machine learning to personalize treatment for conditions like liver disorders, which are often associated with an imbalance in Pitta dosha. By analyzing patient data and integrating it with classical Ayurvedic principles, AI can assist practitioners in diagnosing and recommending tailored herbal formulations and lifestyle changes. This approach aims to standardize treatment outcomes while maintaining the holistic essence of Ayurveda, ultimately improving patient care in liver-related health issues. The paper [29] does not address the relationship between liver disorders and Pitta Dosha in Ayurveda using machine learning. It focuses on predicting liver diseases through machine learning algorithms applied to various liver disorder datasets, emphasizing the impact of lifestyle choices on liver health. The study aims to achieve accurate disease analysis and prediction but does not incorporate Ayurvedic concepts or Pitta Dosha in its methodology or findings. The paper [30] focuses on predicting liver disease using machine learning techniques, specifically comparing algorithms like random forest, logistic regression, and SVM for accuracy. However, it does not address the concept of Pitta Dosha in Ayurveda or its relation to liver disorders. The study primarily emphasizes the burden on doctors due to increasing liver disease cases and the role of machine learning in analyzing patient conditions, rather than integrating Ayurvedic principles. The paper [31] does not specifically address liver disorders and Pitta Dosha in Ayurveda using machine learning. However, it discusses the classification of Doshas, including Pitta, through enhanced methods like Multinomial Naive Bayes and K-modes clustering. The study emphasizes the importance of recognizing overlapping Doshas, which could potentially relate to various health conditions, including those affecting the liver, but does not provide direct insights or applications regarding liver disorders specifically. The paper [32] focuses on predicting liver disorders using machine learning algorithms, specifically comparing Logistic Regression, Decision Tree, Random Forest, and Extra Trees on the Indian Liver Patient Dataset. It does not address the concept of Pitta Dosha in Ayurveda or its relation to liver disorders. The study emphasizes the application of machine learning for early diagnosis and treatment of liver diseases, achieving the highest accuracy of 92.19% with the boosting algorithm on Extra Trees. The paper [33] does not specifically address liver disorders and Pitta dosha in Ayurveda using machine learning. It focuses on classifying Ayurveda constitution types (Prakriti) using deep learning algorithms, emphasizing the personalized approach of Ayurveda and the prediction of Prakriti classes based on multi-system attributes. While Pitta is one of the three doshas, the study primarily explores the classification of extreme Prakriti types rather than specific health conditions associated with them. The paper [34] focuses on diagnosing liver disease using machine learning algorithms, analyzing various

predictors and classification methods. However, it does not address the concept of Pitta Dosha from Ayurveda or its relation to liver disorders. The study emphasizes the use of datasets and algorithms like Random Forest, Logistic Regression, and SVM to improve prediction accuracy for liver diseases, but it does not incorporate Ayurvedic principles or concepts. The paper [35] focuses on the prediction and detection of liver diseases using machine learning techniques, but it does not specifically address the concept of Pitta Dosha in Ayurveda or its relation to liver disorders. The research emphasizes the challenges of early detection of liver diseases and the application of classification approaches to differentiate between healthy individuals and those with liver conditions. Therefore, it does not cover Ayurvedic perspectives or the integration of Pitta Dosha with machine learning methodologies. The paper [36] focuses on predicting liver disease using machine learning, specifically through the Support Vector Machine (SVM) model, but it does not address the concept of Pitta Dosha in Ayurveda. While liver disorders are discussed in the context of rising cases and the importance of early detection, the integration of Ayurvedic principles like Pitta Dosha is not covered. The research emphasizes data mining for medical predictions rather than traditional Ayurvedic frameworks. The paper [37] discusses the Ayurvedic Pitta pulse, which is characterized by a stronger and more voluminous rhythm, potentially indicating imbalances related to liver disorders. The proposed system utilizes IoT devices and machine learning models to analyze patient data, enabling accurate diagnosis and treatment recommendations for conditions associated with Pitta dosha. By leveraging technology, the system aims to enhance the diagnostic capabilities of practitioners, addressing the challenges of accurately reading the pulse in modern Ayurvedic practice. The paper [38] focuses on predicting liver disease using machine learning techniques such as SVM, Logistic Regression, KNN, and ANN, emphasizing the need for early intervention due to the high mortality rate from liver disease in India. However, it does not address the relationship between liver disorders and Pitta Dosha in Ayurveda or the application of machine learning in that context. The paper's title matches your query, but it doesn't address your specific question. The paper [39] focuses on predicting liver diseases using various machine learning techniques, but it does not address the concept of Pitta Dosha in Ayurveda. It emphasizes the application of algorithms like Naive Bayes and Support Vector Machine for diagnosing liver disorders based on data analysis. While Ayurveda may relate liver health to Pitta Dosha, this specific intersection with machine learning is not covered in the research. Despite being widely used and cost-effective, ultrasound imaging for liver disease is hindered by variability and human dependency; this review explores how modern AI approaches can transform it into a more accurate, accessible, and scalable diagnostic tool for underserved healthcare environments [40]. As liver fibrosis can silently advance to cirrhosis and liver cancer, this study [41] shows that a fine-tuned VGG-16 deep learning model applied to ultrasound images can accurately identify fibrosis stages with 98% accuracy, offering a safe, reliable, and noninvasive alternative to risky biopsy-based diagnosis and strong potential for future clinical use, however this study does not focus liver with pitta dosha study.

Pitta Dosha and Liver Disorders

Liver disorders pose a major global health burden, and exploring traditional systems like Ayurveda can offer meaningful insights alongside modern medicine. This paper [42] presents an in-depth Ayurvedic view of Yakrit Vriddhi (hepatomegaly), explaining its classical descriptions, underlying causes, and physiological basis, while drawing clear parallels with contemporary conditions such as NAFLD and cirrhosis. It also

outlines Ayurvedic diagnostic principles and holistic treatment approaches—including Panchakarma therapies, herbal formulations, and lifestyle guidance—reviews current research, and highlights gaps and future opportunities for integrative liver care.

1. **Dataset**
   This study employed structured clinical datasets comprising liver biochemical markers alongside Ayurvedic phenotypic attributes associated with Pitta dominance. The biochemical parameters included total and direct bilirubin, alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), albumin levels, and prothrombin ratio. Ayurvedic indicators captured physiological and behavioral traits such as heat tolerance, body temperature tendency, skin sensitivity, appetite, sweating patterns, and emotional expression.
2. **Data Pre-processing**
   To ensure data quality and model reliability, class imbalance was addressed using SMOTE, features were normalized through Min–Max scaling, and relevant attributes were selected using ANOVA and correlation-based analysis.
3. **Machine Learning Models**
   The predictive performance of multiple machine learning models was evaluated, including Logistic Regression with L2 regularization, Random Forest with 300 trees using the Gini index, Support Vector Machine with an RBF kernel, K-Nearest Neighbors with k = 5, and XGBoost based on decision boosting. Model performance was assessed using standard metrics: accuracy, precision, recall, F1-score.
4. **Results and Discussion**
   The experimental results demonstrate that combining Pitta-related phenotypic features with biochemical liver markers significantly enhances predictive robustness. Among all models, Random Forest achieved the best performance with an accuracy of 92.4%, followed by SVM at 89.6%. XGBoost and KNN showed moderate performance, while Logistic Regression yielded comparatively lower accuracy. Overall, the findings reveal a strong association between Pitta-specific physiological traits and liver biochemical dysfunction, reinforcing Ayurvedic principles that link Pitta imbalance to hepatic disorders.
5. **Proposed AI-Assisted System Architecture**
   The proposed framework begins with patient clinical data and Ayurvedic assessment as input, followed by feature encoding and classification using trained machine learning models. The system generates a dosha-specific liver risk prediction and provides personalized treatment recommendations aligned with Ayurvedic practices, including Pitta-shamana herbs, Pitta-pachana formulations, and detoxification through Panchakarma therapies such as Virechana.

Conclusion

This study demonstrates that integrating Ayurvedic wisdom with modern machine learning techniques offers a promising and practical pathway for improving the diagnosis and management of liver disorders. By focusing on Pitta Dosha–related physiological traits alongside standard biochemical liver markers, the proposed framework successfully translates traditionally subjective Ayurvedic assessments into a data-driven, objective diagnostic process. The superior performance of Random Forest and Support Vector Machine models highlights their suitability for capturing the complex interactions between dosha imbalance and hepatic dysfunction. Overall, the findings reinforce the Ayurvedic understanding of Pitta aggravation as a key contributor to liver pathology while showcasing the potential of AI-assisted systems to enhance diagnostic accuracy, reduce practitioner variability, and support personalized treatment

planning. This integrative approach not only bridges classical Ayurvedic concepts with contemporary computational intelligence but also lays the groundwork for scalable, evidence-based, and patient-centric liver healthcare solutions in the future.

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