Research Article

Heart Disease Prediction Using Machine Learning Approaches: A Conceptual Review

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ARTICLE INFO	ABSTRACT
	Heart disease is becoming a serious health concern in India, mainly due to fast-changing lifestyles and lack of early diagnosis. In recent years, machine learning has shown great potential in predicting such diseases by analyzing patient data. This paper reviews various ML techniques like decision trees, SVM, and neural networks used for heart disease prediction. It also covers recent research trends, practical tools like wearable devices and telemedicine, and stresses on including both medical and lifestyle factors for better results. The review ends by pointing out present research gaps and objectives of proposed research. **Keywords:** Heart disease, techniques, SVM.

1.   INTRODUCTION

Heart-related illnesses, especially cardiovascular diseases, have become the top reason for deaths across the globe. In the last ten years, these diseases have gone up drastically. The main reasons include changes in our lifestyle, growing age of the population, fast-paced urban life, and common health issues like obesity, sugar (diabetes), and high BP (blood pressure). In countries like India, and other developing nations, the situation has become more serious because of sudden economic and social changes. This section takes a closer look at how heart diseases have changed in the past decade, what are the main causes, and the major hurdles in controlling these illnesses both in India and worldwide. As heart disease continues to rise, further research is critical. Prospective studies that track risk factors and outcomes across diverse populations will be instrumental in developing effective interventions (Reddy and shah, 2024). Heart diseases pose a significant public health challenge in India, influenced by a combination of genetic, lifestyle, and socioeconomic factors. Continued research and policy initiatives are essential in addressing the growing burden of cardiovascular diseases and improving health outcomes across the nation.

Over the past decade, significant advances in cardiac care technology have contributed to better management and treatment of heart diseases globally and in India. Techniques like minimally invasive cardiac surgeries, advanced stenting procedures, and improved diagnostic tools (such as CT angiograms and MRI scans) have revolutionized heart disease treatment. In India, the expansion of telemedicine, mobile health platforms, and ehealth services have also improved access to care in remote areas, offering potential solutions to the issue of healthcare accessibility.

The use of Artificial Intelligence (AI) in healthcare is transforming heart disease management. AIenabled systems are being used for early detection of heart diseases, analyzing patient data to identify risk patterns, and predicting adverse cardiac events. AIdriven tools are particularly useful in remote and under resourced regions where access to specialists is limited. Digital health applications for heart disease prevention, such as wearable devices that monitor heart rate, blood pressure, and other vitals, have also gained popularity globally, include in India. Figure 2.1 shows the intensity of heart disease patients, around the globe.
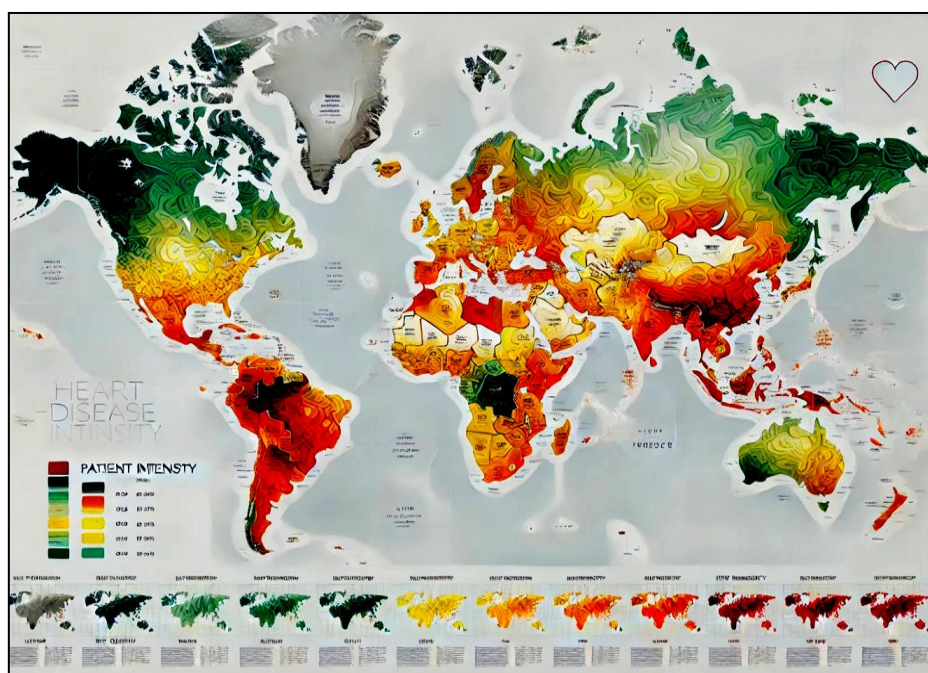
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Figure 1.1: Intensity of heart patients in the world (https://openart.ai/)

Considering these facts, the present research work is devoted to the a brief overview of heart diseases, presents their investigations techniques, contributions of researchers in the field, and concludes the investigated gaps in the research and objectives of proposed research.

2.   HEART DISEASE PREVENTION TECHNIQUES

Table 2.1 shows the summary of different heart disease prevention techniques, along with their description (Goergen et al., 2016, Neumann et al., 2011, Williams & Kirkman, 2011, Jeong, 2021, Yue & Claes, 2020).

Figure 2.1: Heart Disease Prevention Techniques Chart

S.No	Category	Techniques/Interventions	Description
1.	Lifestyle Modifications	Increased physical activity Smoking cessation Weight management	Regular exercise and smoking cessation improve cardiovascular health and lower disease risk.
2.	Dietary Interventions	Mediterranian diet High fiber diets Polyphenolrich foods	Diets rich in MUFAs, whole grains, fruits, vegetables, and polyphenols reduce the risk of coronary heart disease.
3.	Pharmacological Approaches	Statins ACE inhibitors SGLT2 inhibitors	Medications like statins lower cholesterol; ACE inhibitors prevent heart failure; SGLT2 inhibitors help in diabetic patients.
4.	Emerging Technologies	Wearable devices Telehealth Digital health tools	Wearable devices Telehealth Digital health tools
5.	Psychological Support Psychological Support	Integrated care approaches Mental health interventions	Addressing mental health reduces cardiovascular event risks, improving overall outcomes.
6.	Genetic Considerations	Genetic screening Personalized preventative	Identifying genetic markers allows for targeted interventions based on

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		strategies	individual susceptibility.
7.	Community Strategies	Public health initiatives Collaborative community programs	Community efforts promote healthy eating and physical activity, reducing population level cardiovascular risks.
8.	Education/Awareness	Health education programs Regular screening awareness	Increasing knowledge about heart disease and prevention empowers individuals to take charge of their cardiovascular health.

3. SCENARIO OF RESEARCH IN THE FIELD OF PREDICTIONS OF HEART DISEASES IN LAST TEN YEARS

Figure 3.1 shows the number of research publications published in last ten years, all over the world.
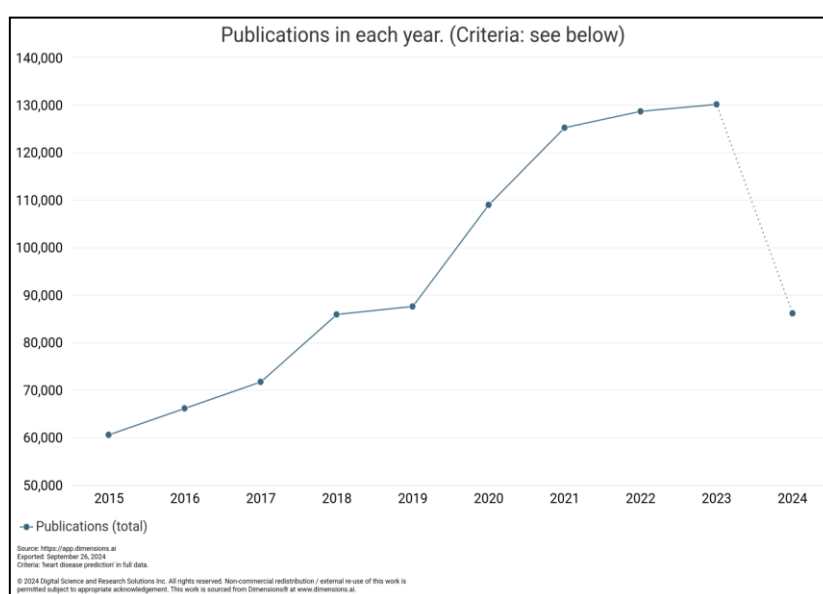

Figure 3.1: number of research publications published in last ten years (www.dimensions.ai)

Following are the key observations noticed from above figure.

There is a noticeable upward trend in the number of publications from 2015 onwards, indicating growing research interest and activity in the field of heart disease detection.

- 2015 to 2019: The number of publications steadily increases each year, reflecting a heightened focus on heart disease detection during this period.
- 2020 to 2021: A sharp increase is observed, suggesting an escalation in research efforts possibly due to the global health focus arising from the COVID-19 pandemic, which highlighted cardiovascular health issues.
- 2022 to 2023: The publication numbers peak, indicating these years saw the highest level of research output on this topic.
- 2024: The year is still running; therefore, anything cannot be predicted.

Figure 3.2 shows the density visualization for the number of research publications, provided by the countries in last ten years, obtained from VOSViewer software.
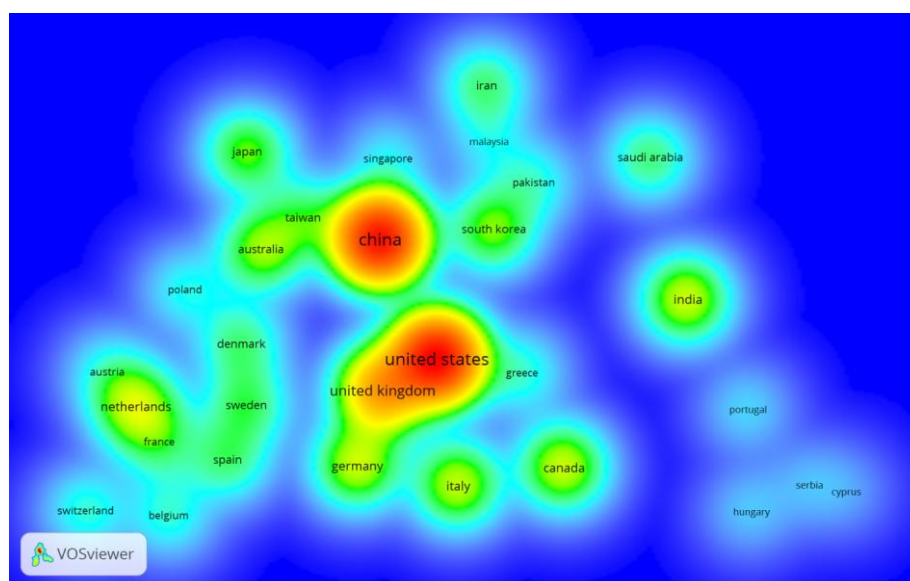
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Figure 3.2: Density Visualizations for research publications contributed from different countries

Following are the key observations noticed from above figure.

- Both China and the United States are at the center of the diagram with bright red areas, indicating they have the highest number of research publications in heart disease detection.
- United Kingdom, Germany, and India also show significant publication volumes, though slightly less than China and the U.S.
- Australia, South Korea, and Taiwan: These countries display moderate activity in this research area, as indicated by the orange region.
- Countries like Poland, Iran, Malaysia, and Greece exhibit lower volumes of research, indicated by lighter hues.

Proceeding in the similar manner, network visualization obtained from VOWViewer represents the strength of relationships among beyond country research activities, on the research topic.
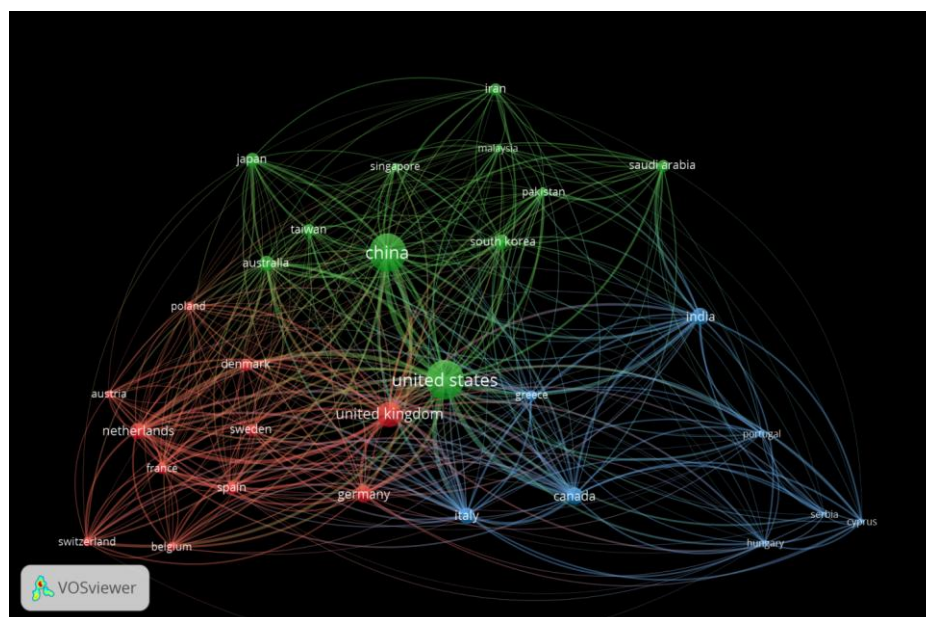

Figure 3.3: Strength of research based relationships among different countries

From the above analysis, one can realize the importance of research in the field of heart disease detection.

4. CONTRIBUTIONS OF RESEARCHERS IN THE FIELD OF HEART DISEASE DETECTION

Heart diseases have emerged as one of the leading causes of mortality in India, reflecting a complex interplay of genetic, lifestyle, and environmental factors. The Global Burden of Disease Study reports that ischemic heart diseases account for approximately 15% of total deaths in India, presenting a stark statistic when compared to global averages (GBD 2019 Diseases and Injuries Collaborators, 2020). Recent data from 2024 indicate a further increase in the prevalence, especially among the urban population (Reddy and Shah, 2024).

Emerging technologies, such as wearable health devices and telehealth, present new opportunities for heart disease management in India. Studies are increasingly focusing on how these technologies can improve patient compliance and lifestyle changes (Khan and Gupta, 2023). As heart disease continues to rise, further research is critical. Prospective studies that track risk factors and outcomes across diverse populations will be instrumental in developing effective interventions (Reddy and Shah, 2024), but still there are many opportunities for research in this field.

In recent years, predicting heart disease using machine learning has become an important area of research. Several studies have shown that machine learning models like Naïve Bayes, Logistic Regression, k-Nearest Neighbors, Decision Trees, and Support Vector Machines can help in identifying heart disease at an early stage. Researchers like Agarwal (2024), Chen (2024), and Mondal *et al.* (2023) focused on building models using these techniques to classify patients based on symptoms and clinical history. Other studies, including those by Bhuvana (2024) and Paithane (2024), highlighted the use of multiple algorithms to handle different datasets and improve prediction accuracy. Deep learning methods, such as Artificial Neural Networks and Long Short-Term Memory (LSTM), were also explored in works by Karthi & Kalaivani (2023), showing better results in some cases.

Some researchers have gone further by combining multiple algorithms to create hybrid or ensemble models. For example, Barfungpa *et al.* (2023) used a hybrid deep learning network, while Chang *et al.* (2019) combined XGBoost and SVM to improve accuracy. Latha & Jeeva (2019) used stacked and ensemble techniques, which helped reduce errors and make better predictions. Feature selection and dimensionality reduction were also found useful, as shown in studies by Reddy *et al.* (2019), where they helped remove unnecessary data and focus on key health indicators. These studies show that choosing the right combination of methods plays a big role in building an accurate and reliable prediction system.

Other interesting approaches were also tried by researchers. Yazdani *et al.* (2021) used rule mining to spot useful patterns in health data, while Usman *et al.* (2022) used nature-inspired algorithms for selecting the most important features. Diwakar *et al.* (2021) worked on combining images with clinical data, and Saboor *et al.* (2022) focused on improving model accuracy for better medical decisions. Some studies, like those by Emam *et al.* (2019), showed how intelligent systems can adapt to patients' behavior and lifestyle to predict risks more effectively. These works prove that machine learning, when used properly, can play a big role in saving lives by helping doctors catch heart problems before they become serious.

5. GAPS IN THE RESEARCH AND OBJECTIVES OF PROPOSED RESEARCH

From the survey of available literature, it was found that there were a few research papers available, which focused on applications of machine learning techniques in heart disease predictions. The limited research in this area presents an opportunity to innovate by developing and testing new ML models or improving existing ones. This can include building more accurate predictive models, incorporating real-time data (such as wearable sensors), or personalizing predictions based on genetic, lifestyle, and clinical data.

The following points represent the objectives of proposed research:

a) Creation of robust system for heart disease detection using machine learning; and
b) Validation of proposed system with experts.

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6. CONCLUSION

The present research work was devoted to the contributions of researchers in the field of heart disease detection techniques and concluded with the investigated gaps in the research and objectives of proposed research. Considering the dire need of time, the research work should be fruitful for upcoming researchers and practitioners, working in the direction of enhancing medical facilities, around the globe.

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