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Effective Kyphosis Disease Prediction Using Machine Learning Algorithms

R Siva, V Hemambica, B Avanthika, S Tharun Sai

Department of Computer Science and Engineering, Ramachandra College of Engineering (A), Eluru Andhra Pradesh, India.

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ABSTRACT

Kyphosis is the term used to describe the inward arching of the upper back. This specific ailment is sometimes referred to as"round back" or "hunchback" if there is a noticeable curvature. Kyphosis often occurs due to weakened spinal bones, leading to compression or fractures. Other forms of kyphosis in children or adolescents may result from spinal abnormalities or a progressive twisting of the spinal bones. While it can occur at any age, kyphosis is most common in teenagers. Many factors, from poor posture and developmental problems to structural abnormalities in the spine, can lead to kyphosis. This research introduces a machine learning approach to predict kyphosis disease, aiming to enhance early detection and improve patient outcomes. The main goal of this work is to apply various machine learning techniques to biological data, including Random Forest and Decision Tree, and to evaluate the accuracy of the algorithms. This shows that machine learning (ML) is a valuable tool that should be used to solve biological problems in general.

KEYWORDS- Spine, Biological Problems, Posture, Detection, Algorithms, Machine Learning

1. INTRODUCTION

Traditional methods of kyphosis detection often rely on manual examination and interpretation of X-ray images by trained specialists. However, this process can be time consuming and subjective, leading to variations in diagnosis among healthcare providers. Moreover, the increasing demand for healthcare services has put additional pressure on medical professionals, highlighting the need for automated solutions to streamline diagnostic procedures. Technology, such as computers, smartphones, tablets, and video games, often promotes sedentary behaviours, leading to prolonged periods of sitting or reclining with poor posture. Excessive screen time can result in individuals spending extended hours in positions that contribute to spinal misalignment, Poor Posture, Decreased Physical Activity and muscle imbalances, ultimately leads to increasing the risk of kyphosis. The early detection and prediction of kyphosis disease using Machine Learning are essential for implementing preventative measures, initiating timely interventions, improving patient outcomes, preventing complications, optimizing healthcare resource utilization, empowering patients, and ensuring long-term spinal health and well-being.[1,2]

By exploring the intersection of ML and healthcare, this Project aims to demonstrate the efficacy of computational approaches in addressing complex biological problems such as Kyphosis. Moreover, it underscores the transformative potential of ML in medical diagnosis and prognosis, highlighting its role in advancing personalized healthcare and improving patient outcomes. This project focuses on leveraging machine learning (ML) techniques to enhance the prediction of kyphosis disease. We aim to develop robust predictive models capable of identifying individuals at heightened risk of developing kyphosis. Some excessive curves can be passed on by parents. Some are brought on from bad posture, while others can develop from a disorder which causes abnormal shape, size, or loss of bone to the vertebrae (bone blocks) of the spine.

In older people, kyphosis is often due to weakness in the spinal bones that causes them to compress or crack. Other types of kyphosis can appear in infants or teens due to malformation of the spine or wedging of the spinal bones over time. Mild kyphosis causes few problems, Severe kyphosis can cause pain and be disfiguring.[3]

Treatment for kyphosis depends on your age, and the cause and effects of the curvature. Normal kyphosis angles vary between 20° and 40° in the younger public 48° to 50 deg inwomen and about 44 deg in men in older population

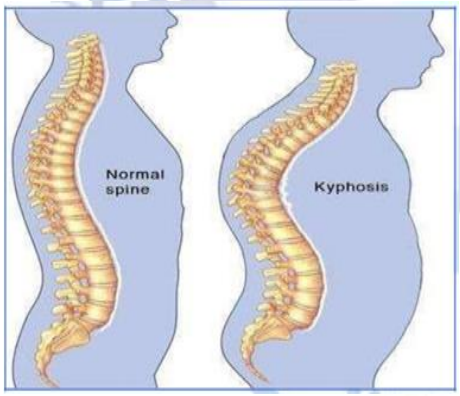

Figure 1: Normal Spine VS Kyphosis

Kyphosis can affect the young and the old. It can have varying effects on patients and is caused by various issues.

There are 3 primary types of kyphosis:

- Congenital Kyphosis
- Postural Kyphosis
- Scheuermann's kyphosis

Congenital kyphosis: This kind occurs when a baby's spine develops abnormally in certain areas. Surgery can sometimes be used to treat this, which is discovered very early in life. Sometimes it may not be discovered until adolescence, at which point surgery may be somewhat more difficult.

Postural kyphosis: In younger individuals, it usually results from persistently bad posture, which "trains" the muscles to maintain the hunched-over position of the spine. It can be caused by weak bones (osteoporosis) in the elderly patient or by spine fractures that cause the bone blocks to collapse.

Scheuermann's kyphosis: This illness process causes the vertebrae to become trapezoids rather than rectangles. through a section of the spine with misplaced vertebrae piled on top of each other. When vertebrae are deformed, Schmorl ' s nodes—pockets or indentations in the bone where the disc presses against the bone at the top and bottom of the bones—are sometimes seen.[4]

This project's goal is to use machine learning to design and develop a website. methods to determine if a person has kyphosis, a spinal condition, with the main goal being improved early identification and eventually better patient outcomes. By The website aims to give accurate assessments, enabling timely intervention and therapy for persons at risk of or currently experiencing kyphosis-related symptoms. It does this by employing complex algorithms like as Random forest and Decision tree, as well as data analysis. The project's goal is to make the website's interface user-friendly and intuitive so that anyone looking to self-assess or work with healthcare experts can access it. The website seeks to improve kyphosis detection accuracy and offer consumers more individualized information.

Comprehensive data collection of pertinent medical information, such as spinal measures, patient demographics, and medical history, would be necessary for an efficient kyphosis disease prediction project. To find the best predictive elements, feature selection is essential after pre-processing the data to manage missing values and outliers. Models would be created and trained using machine learning algorithms like logistic regression, decision trees, or neural networks using the pre-processed data. Metrics including accuracy, precision, and recall would be used for evaluation, and

iterative refinement would be used to maximize model performance.

Before being used in actual environments, generalization capability would be confirmed through validation on untested data. and reporting to compile project results and make them easier for medical practitioners to access for possible application in early diagnosis and treatment planning.[5,6]

2. DISCUSSION

The final form of the project will be an automated kyphosis detection system integrated with clinical workflows. It will offer healthcare professionals a valuable tool for expediting the diagnostic process and improving the accuracy of kyphosis detection. The system streamlines workflow, reduces time on manual assessments, and enables clinicians to allocate resources more efficiently. Ultimately, the project aims to enhance patient care and satisfaction by providing timely and accurate diagnosis of kyphosis, thereby highlighting the potential of machine learning in solving biological problems and advancing healthcare practices. effective kyphosis disease prediction machine learning project would be the development of a reliable model capable of accurately identifying individuals at risk of developing kyphosis. This model could assist healthcare professionals in early diagnosis and intervention, potentially leading to improved patient outcomes and quality of life. By leveraging machine learning algorithms and predictive analytics, the project aims to enhance the efficiency of kyphosis screening processes, facilitate timely medical interventions, and ultimately reduce the burden of kyphosis-related complications on individuals and healthcare systems. Additionally, the project may contribute to advancing our understanding of the risk factors and underlying mechanisms associated with kyphosis, paving the way for further research and development of targeted prevention and treatment strategies.

In the existing system, kyphosis diagnosis heavily relies on manual assessment conducted by medical professionals. This process involves physical examination, where healthcare providers visually assess spinal curvature and may conduct palpation. Additionally, imaging tests such as X-rays might be used to confirm the diagnosis and evaluate the severity of kyphosis. However, this manual approach has significant limitations. Firstly, it is subjective and prone to human error, as interpretations of spinal curvature can vary among healthcare providers. Moreover, manual diagnosis can be time-consuming, requiring careful examination and analysis of patient data. It often necessitates specialized expertise, leading to challenges in healthcare facilities with limited access to specialized medical professionals. Furthermore, the existing system faces challenges related to scalability, inconsistency in diagnosis due to human variability, and potential delays in diagnosis and treatment initiation, impacting patient outcomes and satisfaction.[7,8]

The proposed system introduces a machine learning-based approach to kyphosis detection, aiming to overcome the limitations of manual assessment. This involves developing a machine learning model trained on data collected from patients diagnosed with kyphosis. The dataset includes various features such as age, sex, vertebral measurements, and other relevant medical indicators. Key steps in the proposed system include feature selection, where domain expertise from medical professionals is utilized to identify the most relevant features for prediction. Subsequently, appropriate machine learning algorithms, such as decision trees, support vector machines, or neural networks, are selected and trained on the preprocessed data to learn patterns and relationships between input features and kyphosis diagnosis. Validation techniques like cross-validation are employed to ensure the model's performance generalizes well to unseen data. Continuous improvement is integral to the proposed system, involving the monitoring of model performance in real-world settings, collecting feedback from users, and periodically retraining the model with new data to enhance its accuracy and robustness over time. Overall, the proposed system aims to automate the diagnosis process, improve accuracy, efficiency, and scalability, thereby enhancing kyphosis detection in clinical practice.

3. RESULTS

1. EVALUATION METRICS

Accuracy, Recall, precision, and F1-score are among the metrics used to evaluate how successfully the proposed model classifies Kyphosis Present and absent Cases. The percentage of accurately classified Kyphosis among all the ages of different patients in a given dataset is called

accuracy. The formulas for these measurements are as follows.

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+TN+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{F1-Score} = \frac{2*TP}{(2*TP)+FP+FN}$$

True positives are denoted by TP, true negatives by TN, false positives by FP, and false negatives by FN.

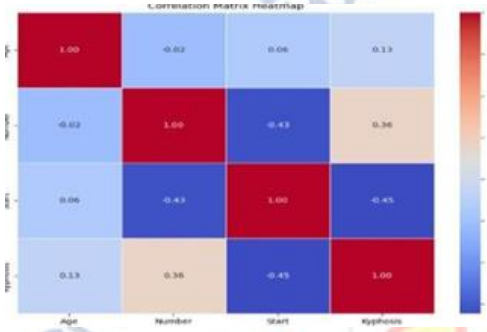

Figure 2: Correlations between different features in the data

2. RESULT ANALYSIS

The results for accuracy, recall, F1-score, and support are shown. Also, 84% accuracy for Decision Tree and 90% accuracy for Random Forest .all attained by the suggested model. Additionally The results show that the precision, recall, and F1-score are 82%, 88%, and 85% respectively.

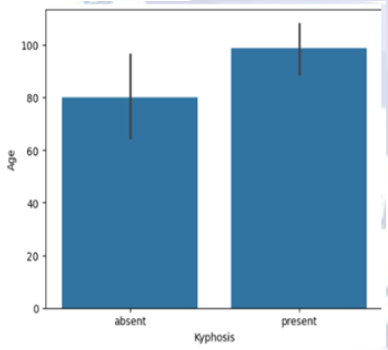

Figure 3: Classification Of Kyphosis Disease Status

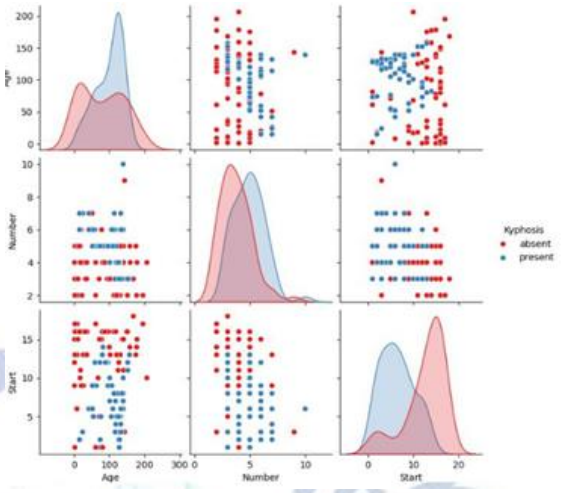

Figure 4: Patterns of the kyphosis Disease among the three input features(Age, Start, and Number)

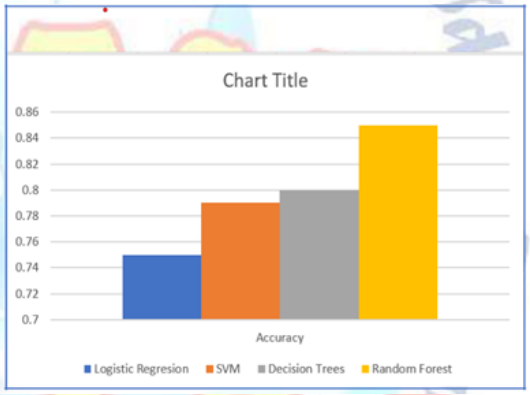

Figure 5 : Accuracies Gained by Different Algorithms

4. CONCLUSION

Predicting Kyphosis disease is crucial for early detection and effective management. Through the use of advanced medical technologies and predictive models, healthcare professionals can identify individuals at risk of developing Kyphosis before the condition progresses to a more severe stage.the development of a machine learning-based kyphosis disease prediction system marks a significant step forward in spinal disorder diagnosis and management. By leveraging advanced techniques in data preprocessing and machine learning the system demonstrates promising capabilities in accurately predicting the presence and severity of kyphosis. Through rigorous validation and comparison of results, the system offers clinicians a reliable tool for early detection, intervention, and personalized treatment planning. With further refinement and validation, this system has the potential to revolutionize kyphosis management, leading to improved patient outcomes and enhanced quality of life for individuals affected by this condition

if we want to extend this project we can try by Expand the feature set used for kyphosis prediction by incorporating additional clinical parameters or imaging data, such as MRI or CT scans. This could enhance the accuracy and robustness of the predictive models. Develop a system for real-time monitoring of patients' spinal health based on continuous data collection and analysis. Implement alerts for healthcare providers to intervene promptly when signs of kyphosis development or progression are detected. Collect feedback from healthcare providers and patients using the system to identify areas for improvement and iteratively enhance the system's functionality, usability, and performance.

Early intervention is essential in preventing complications and improving the overall quality of life for affected individuals. By combining medical expertise with predictive tools, we can pave the way for timely interventions, personalized treatment plans, and ultimately, a better outcome for those at risk of Kyphosis. Public awareness and regular screenings also play a vital role in this process, fostering a proactive approach to healthcare that prioritizes prevention and early detection[9,10].

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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