International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 11 | November - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

An Overview on Osteoporosis Risk Assessment and AI-Backed Treatment Advice

Nidhi Sawant[1], Shweta Munde[1], Prajakta Mohite[1], Mehvish Shaikh[1], Nitisha Rajgure[2]
[1]BE Students, Department of Computer Engineering, Zeal College of Engineering and Research, Pune, Maharashtra, India
[2]Professor, Department of Computer Engineering, Zeal College of Engineering and Research, Pune, Maharashtra, India

Abstract:
Bone diseases are often a "silent" disorder until they cause fractures. One such disease is osteoporosis. Osteoporosis is a chronic bone disease that causes bones to become weak and brittle, increasing risk of fractures. It's a major public health problem, affecting millions of people worldwide. It impacts the lives of more than 1 crore people in India every year. Early detection and intervention can help to prevent fractures and improve quality of life for people with osteoporosis as they are essential for preventing osteoporotic fractures, which can lead to significant morbidity, mortality, and disability. This project aims to develop and implement an osteoporosis risk assessment program by using validated risk assessment tools to identify individuals at high risk of osteoporosis or osteopenia. Patients identified as high risk will be referred for bone mineral density (BMD) testing, and will be provided with information about the disease and fracture prevention, and will be connected with resources for diagnosis, treatment, and support. The system will also recommend orthopedic specialists, orthopedic surgeons, and chiropractors to the individuals based on their location. It will further help them keep track of their treatment, including their medication, reports, nutrition and appointments with their orthopedist using personalized reminders.

Keywords: Osteoporosis, Bones, Fractures, Assessment, Detection, Prediction, Treatment, Convolutional Neural Networks (CNN), X-Ray, Bone Mineral Density (BMD), Dual-Energy X-Ray Absorption, Support Vector Machine (SVM).

I. INTRODUCTION

Osteoporosis is a common metabolic systemic bone disease characterized by increased bone fragility, low bone mass, and a high risk of fractures leading to falls and decreased bone mineral density (BMD). Osteoporosis is considered a great public health problem and the most common metabolic bone disease as it causes more than 8.9 million fractures per year, resulting in one fracture every three seconds and affecting more than 200 million people worldwide. For physicians to be aware and to identify at-risk patients, understanding the risk factors and appropriately diagnose the disease is crucial. Several factors such as gender, age, body mass index (BMI), height, body weight, levels of physical activity, nutritional status, family history, calcium, and vitamin D intake, back pain, and other endocrine and cardiometabolic factors are associated with osteoporosis and very important in diagnosing it during lifetime. Although the most widely used clinical tool for measuring BMD and assessing bone strength is laboratory dual-energy X-ray absorption (DXA), the availability of DXA is very limited and does not indicate bone quality. Therefore, we need appropriate methods for screening, diagnosis and monitoring these patients. Many researchers have also aimed to develop predictive models using risk factors for the screening of osteoporosis.[1] In recent years, other than traditional modelling, classification algorithms have gained popularity because of their ability to detect more complex relationships between input and output features and flexible modelling. Classification algorithms, use large volumes of data, and infer and learn new patterns and relationships. This new information and relationships embedded in large and complex datasets are then made visible. At present, the machine learning approach is not sufficient to predict osteoporosis and requires further study. Hence, the first goal is to determine osteoporosis risk factors in clinical data comprising of physical characteristics, personal and medical history of the subjects. By using classification algorithms in clinical practice as a screening tool, both physicians and patients would be more aware of osteoporosis risk factors and take more preventive measures in the early stages of the disease to avoid adverse outcomes.[4] Drug treatments, fall precautions, and lifestyle changes suggested to patients with osteoporosis have led to a 21–66 percent reduction in fracture risk. Despite the availability of effective anabolic and anti-absorption drugs, osteoporosis and related fractures remain an unsolvable problem. Exaggerated concerns regarding the side effects of some medications have resulted in the use of exercise to prevent osteoporosis.[2] Physical activity (PA) is recommended as a safe and low-cost non- pharmacological intervention strategy to change bone risk factors and maintain musculoskeletal health. It has been shown that the mechanical load resulting from PA increases muscle mass, creates mechanical stress on the skeleton, and increases osteoblast activity. Due to the beneficial effects of PA in the prevention of osteoporosis, physician and patient accessibility to appropriate and effective sports activities is essential. The second goal is to develop artificial intelligence to propose appropriate exercise protocols and diet for health improvement.[5]

II. MOTIVATION, AIM AND ONJECTIVE

The motivation behind our work is to improve the accuracy, efficiency, and accessibility of osteoporosis diagnosis. Osteoporosis is a common bone disease that causes bones to become weak and brittle. It is a major cause of fractures, especially in older adults and early diagnosis and treatment are essential to prevent fractures and their associated complications. The motivation to develop a **CNN-based CAD system** for osteoporosis detection is to improve the health and well-being of patients at risk of osteoporosis and there is a growing interest in developing AI-powered solutions for healthcare in general. This is due to the potential of AI to improve the efficiency and effectiveness of healthcare delivery, while also reducing costs.[4]

The aim is to develop a **computer-aided diagnosis (CAD) system** that can accurately detect osteoporosis, improved accuracy and increased efficiency using dual-energy X-ray absorptiometry (DEXA) images.

Objective is to [1] design a computer-aided diagnosis system that can accurately detect osteoporosis using dual-energy X-ray absorptiometry images [2] predict and personalize recommendations based on results. [3] implement a system which tracks the number of missed diagnoses and ensures that patients with osteoporosis receive the treatment they need to prevent fractures.

III. SYSTEM DESIGN

3.1 System Architecture:

The system consists of the following components: [1] **User interface:** Allows users to upload X-ray images, enter other relevant information, and view the predicted osteoporosis and bone density results. [2] **Image processing:** It extracts the relevant features from the X-ray images, such as identifying the bones in the image and calculating their density. [3] **Machine learning:** Predicts osteoporosis based on the extracted features. [4] **Database:** Stores the X-ray images, user information, and predicted osteoporosis and bone density results. [5] **Bone health monitoring system:** Allows users to track their bone health over time by storing their X-ray images and predicted results. The system then generates reports the user's bone density is changing over time. [6] **Location-based medical support:** Finds and contacts nearby professionals specializing in osteoporosis by using the user's location to display a list.

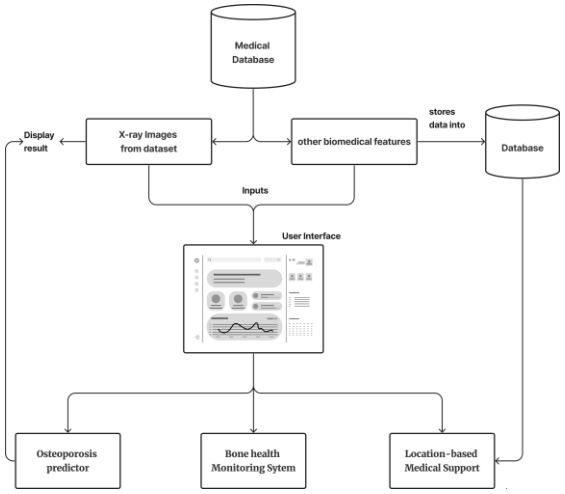

Fig.1.: System Architecture

3.2 Proposed Algorithms:

Algorithm 1: Convolutional Neural Network (CNN): CNNs are trained on a dataset of X-ray images from patients with and without osteoporosis. It learns to extract features from the images that are relevant to osteoporosis detection and bone density prediction. Once the CNN is trained, it can be used to predict osteoporosis and bone density for new X-ray images. The prediction is a probability score that indicates the likelihood of osteoporosis and the predicted bone density.

Algorithm 2: Support Vector Machine (SVM): The SVM would be trained on a dataset of X-ray images and clinical data from patients with and without osteoporosis. The SVM would learn to find a hyperplane in the feature space that separates the data into two classes (osteoporosis and non-osteoporosis). The hyperplane is chosen to maximize the margin between the two classes. Once the SVM is trained, it can be used to predict osteoporosis and bone density for new X-ray images and clinical data. The SVM would first extract features from the X-ray image and clinical data. The extracted features would then be used to calculate a distance to the hyperplane. The distance to the hyperplane is used to make a prediction. If the distance is less than a certain threshold, the SVM predicts that the patient has osteoporosis. If the distance is greater than the threshold, the SVM predicts that the patient does not have osteoporosis.

IV. EXPECTED OUTCOME

Machine learning and artificial intelligence promise to bring in a profound transformation in healthcare. The application of algorithms like CNN is expected to revolutionize the way risk assessment of diseases like osteoporosis takes place. Firstly, machine learning and artificial intelligence are anticipated to identify individuals at high risk of osteoporosis and provide personalized treatment advice. This project is poised to help prevent fractures and improve the quality of life for people with osteoporosis. Secondly, this project has the potential to significantly improve the early detection and intervention of osteoporosis and osteoporotic fractures, and can help improve people's bone

health. Thirdly, the incorporation of this technology ushers to enhance risk assessment practices by analyzing patients' medical history and their family's medical data and optimize the treatment process. Additionally, the patients' healthcare costs can be significantly reduced as the detection and treatment can happen in very early stages of osteoporosis. Lastly, this project is expected to increase awareness of osteoporosis and its prevention methods within the society.

V. LIMITATIONS

The research subjects for osteoporosis majorly happen to be elderly people. This group contains people over the age of 70. There is a significant lack of research being done on subjects aged 18 to 25. This results in a lack of DXA and BMD measurements, which leads to partial osteoporosis prediction and assessment.

VI. CONCLUSION

The conclusion of our work focuses on developing tools that can help people with osteoporosis to manage their condition more effectively. It strives to help people track their symptoms, medications, and lifestyle choices. Additionally, our work also emphasizes the need for providing people with personalized reminders and support.

VII. REFRENCES

[1]. Abulkareem Z. Mohammaed, Loay E. George, "Osteoporosis detection using CNN based on dual-energy X-ray absorptiometry images", Science Direct vol 29 January 2023.
[2]. P. Keerthika, P. Suresh, et .al, "An intelligent bio-inspired system for detection and prediction of osteoporosis.", Science Direct, 19 August 2020.
[3]. Vikas Kajla, Anju Gupta, Anil Khatak, "Analysis of X-Ray Images with Image Processing Techniques", IEEE, 2018.
[4]. Anu T C, Mallikarjun Swami, M S, Rajesh Raman, "Detection Of Bone Fracture using Image Processing methods", IJCA, 2015.
[5]. General, O.O.T.S. "The Burden of Bone Disease. Bone Health and Osteoporosis", NCBI Bookshelf, 2004.
[6]. R. Dendere, J. H. Potgieter, S. Steiner, S. P. Whiley, and T. S. Douglas, "Dual- energy X-ray absorptiometry for measurement of phalangeal bone mineral density on a slot-scanning digital radiography system," IEEE Trans Biomed Eng.
[7]. Hemmati E, Mirghafourv and M, Mobasseri M, Shakouri SK, Mikaeli P, Farshbaf-Khalili A. Prevalence of primary osteoporosis and low bone mass in postmenopausal women and related risk factors. J. Educ. Health Promote, Google Scholar,2021.
[8]. Yu X, Ye C, Xiang L. Application of artificial neural network in the diagnostic system of osteoporosis.Neuro-computing, Google Scholar,2016