

ARTIFICIAL INTELLIGENCE

AND

PERSONALIZED MEDICINE

IN MODERN HEALTHCARE



**ARTIFICIAL INTELLIGENCE AND
PERSONALIZED MEDICINE IN MODERN
HEALTHCARE- 2026**

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**ARTIFICIAL INTELLIGENCE AND PERSONALIZED
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PREFACE

This volume brings together a collection of scholarly contributions that explore the evolving landscape of modern healthcare through the integration of physiology, clinical research, and artificial intelligence. As medical science continues to advance, the incorporation of data-driven technologies and intelligent systems is transforming both diagnostic processes and treatment approaches.

The chapters in this book address key themes such as the foundations of exercise physiology and pathophysiology, the application of machine learning techniques in predicting and diagnosing skin diseases, and the emergence of personalized medicine driven by artificial intelligence. These contributions highlight how traditional medical knowledge is increasingly complemented by innovative computational methods, enabling more precise, efficient, and patient-centered healthcare solutions.

By adopting an interdisciplinary perspective, this volume integrates insights from medical sciences, data science, and clinical practice. It contributes to academic discourse while also offering practical implications for healthcare professionals, researchers, and policymakers seeking to improve the quality and effectiveness of healthcare delivery.

It is hoped that this book will serve as a valuable resource for scholars, practitioners, and students interested in medicine, artificial intelligence, and clinical innovation, while encouraging further research on the integration of technology in advancing global health outcomes.

Editorial Team

April 20, 2026

Türkiye

**CHAPTER 1
EXERCISE PHYSIOLOGY AND
PATHOPHYSIOLOGY**

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INTRODUCTION

Exercise physiology represents one of the most important interdisciplinary fields within modern medical sciences. It integrates concepts from physiology, biochemistry, biomechanics, molecular biology, and clinical medicine to explain how the human body responds and adapts to physical activity. The physiological responses to exercise involve coordinated interactions between the cardiovascular, respiratory, endocrine, and neuromuscular systems, allowing the body to maintain homeostasis under conditions of increased metabolic demand. In recent decades, the importance of physical activity in preventing chronic diseases has been strongly supported by epidemiological and clinical research. Sedentary lifestyles are associated with an increased risk of cardiovascular disease, obesity, diabetes mellitus, metabolic syndrome, osteoporosis, and several forms of cancer. Conversely, regular physical exercise improves functional capacity, enhances metabolic health, and reduces morbidity and mortality. Exercise pathophysiology focuses on the altered physiological responses to exercise that occur in individuals with disease. Patients with cardiovascular disorders, pulmonary diseases, metabolic disorders, or neuromuscular conditions often demonstrate impaired exercise tolerance due to limitations in oxygen delivery, energy metabolism, or muscular performance. Understanding the physiological mechanisms that govern exercise responses is therefore essential for clinicians, physiologists, sports scientists, and rehabilitation specialists. This chapter provides a comprehensive overview of the physiological foundations of exercise and the pathophysiological changes that occur in disease conditions. Exercise physiology represents one of the most important interdisciplinary fields within modern medical sciences. It integrates concepts from physiology, biochemistry, biomechanics, molecular biology, and clinical medicine to explain how the human body responds and adapts to physical activity. The physiological responses to exercise involve coordinated interactions between the cardiovascular, respiratory, endocrine, and neuromuscular systems, allowing the body to maintain homeostasis under conditions of increased metabolic demand. In recent decades, the importance of physical activity in preventing chronic diseases has been strongly supported by epidemiological and clinical research.

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Understanding the physiological mechanisms that govern exercise responses is therefore essential for clinicians, physiologists, sports scientists, and rehabilitation specialists. This chapter provides a comprehensive overview of the physiological foundations of exercise and the pathophysiological changes that occur in disease conditions.

1. ENERGY METABOLISM DURING EXERCISE

Muscular contraction during physical activity requires a continuous supply of adenosine triphosphate (ATP), the universal energy currency of biological systems. Because the amount of ATP stored within skeletal muscle is extremely limited, ATP must be rapidly regenerated through metabolic pathways. Three major energy systems contribute to ATP resynthesis during exercise: the ATP-phosphocreatine system, anaerobic glycolysis, and aerobic metabolism. The ATP-phosphocreatine system provides immediate energy for short bursts of high-intensity activity such as sprinting or jumping. Phosphocreatine stored within muscle fibers rapidly donates a phosphate group to adenosine diphosphate, regenerating ATP. However, this system can sustain maximal exercise for only a few seconds. Anaerobic glycolysis becomes the dominant energy pathway during short-duration high-intensity exercise lasting up to several minutes. In this process, glucose or glycogen is broken down to pyruvate, producing ATP without requiring oxygen. Under anaerobic conditions pyruvate is converted to lactate, which accumulates in the blood during intense exercise. Aerobic metabolism is the most efficient energy system and predominates during prolonged moderate-intensity exercise. Within the mitochondria, carbohydrates, fatty acids, and occasionally amino acids are oxidized through the tricarboxylic acid cycle and electron transport chain to produce large quantities of ATP. Training enhances mitochondrial density, oxidative enzyme activity, and substrate utilization, thereby improving endurance performance. Muscular contraction during physical activity requires a continuous supply of adenosine triphosphate (ATP), the universal energy currency of biological systems. Because the amount of ATP stored within skeletal muscle is extremely limited, ATP must be rapidly regenerated through metabolic pathways.

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2. CARDIOVASCULAR RESPONSES TO EXERCISE

The cardiovascular system plays a critical role in supporting exercise by delivering oxygen and nutrients to active tissues while removing metabolic waste products. During dynamic exercise, heart rate increases due to activation of the sympathetic nervous system and withdrawal of parasympathetic tone. Stroke volume also increases as a result of enhanced venous return and increased myocardial contractility. The combined rise in heart rate and stroke volume leads to a substantial increase in cardiac output, which may increase four- to six-fold during vigorous exercise in healthy individuals. Blood flow is redistributed toward active skeletal muscles and away from nonessential organs such as the gastrointestinal tract. Endurance training induces several structural and functional adaptations within the cardiovascular system. These include enlargement of the left ventricular chamber, increased stroke volume, improved capillary density in skeletal muscle, and enhanced endothelial function. Collectively these changes improve oxygen delivery and reduce cardiovascular strain during exercise. The cardiovascular system plays a critical role in supporting exercise by delivering oxygen and nutrients to active tissues while removing metabolic waste products. During dynamic exercise, heart rate increases due to activation of the sympathetic nervous system and withdrawal of parasympathetic tone. Stroke volume also increases as a result of enhanced venous return and increased myocardial contractility. The combined rise in heart rate and stroke volume leads to a substantial increase in cardiac output, which may increase four- to six-fold during vigorous exercise in healthy individuals. Blood flow is redistributed toward active skeletal muscles and away from nonessential organs such as the gastrointestinal tract.

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3. RESPIRATORY RESPONSES TO EXERCISE

The respiratory system supports exercise by facilitating the exchange of oxygen and carbon dioxide between the atmosphere and the bloodstream. As exercise intensity increases, ventilation rises through increases in both breathing frequency and tidal volume. This response ensures adequate oxygen supply for aerobic metabolism. Pulmonary ventilation during intense exercise may increase more than twenty-fold compared with resting levels. The increase in ventilation is regulated by neural and chemical mechanisms involving respiratory centers in the brainstem as well as peripheral chemoreceptors. Although the lungs themselves exhibit relatively limited structural adaptation to training, respiratory muscle strength and endurance can improve with regular physical activity. Enhanced respiratory efficiency contributes to improved exercise tolerance.

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4. NEUROMUSCULAR ADAPTATIONS

Skeletal muscle is the primary effector organ responsible for producing movement during exercise. Muscle contraction is controlled by the nervous system through the activation of motor units, each consisting of a motor neuron and the muscle fibers it innervates. Training induces significant neuromuscular adaptations. Resistance training leads to muscle hypertrophy through increased synthesis of contractile proteins, while endurance training enhances oxidative capacity and mitochondrial density. Neural adaptations such as improved motor unit recruitment and synchronization also contribute to increases in strength and power.

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5. ENDOCRINE RESPONSES TO EXERCISE

Exercise stimulates complex hormonal responses that support metabolic regulation and cardiovascular function. Catecholamines released from the adrenal medulla increase heart rate, blood pressure, and glycogen breakdown. Growth hormone and cortisol promote mobilization of energy substrates during prolonged exercise. Insulin secretion typically decreases during exercise, while glucagon secretion increases to maintain blood glucose levels. These hormonal changes ensure a continuous supply of metabolic fuels for working muscles. Exercise stimulates complex hormonal responses that support metabolic regulation and cardiovascular function. Catecholamines released from the adrenal medulla increase heart rate, blood pressure, and glycogen breakdown. Growth hormone and cortisol promote mobilization of energy substrates during prolonged exercise. Insulin secretion typically decreases during exercise, while glucagon secretion increases to maintain blood glucose levels. These hormonal changes ensure a continuous supply of metabolic fuels for working muscles.

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6. THERMOREGULATION DURING EXERCISE

Exercise generates large amounts of metabolic heat. To prevent excessive increases in core body temperature, the body relies on thermoregulatory mechanisms including sweating and cutaneous vasodilation. Sweat evaporation is the most effective mechanism for heat dissipation during prolonged exercise in warm environments. Failure of thermoregulation can lead to heat-related illnesses such as heat exhaustion and heat stroke. Adequate hydration, acclimatization, and appropriate environmental conditions are essential for maintaining thermal balance during exercise. Exercise generates large amounts of metabolic heat. To prevent excessive increases in core body temperature, the body relies on thermoregulatory mechanisms including sweating and cutaneous vasodilation. Sweat evaporation is the most effective mechanism for heat dissipation during prolonged exercise in warm environments. Failure of thermoregulation can lead to heat-related illnesses such as heat exhaustion and heat stroke. Adequate hydration, acclimatization, and appropriate environmental conditions are essential for maintaining thermal balance during exercise. Exercise generates large amounts of metabolic heat. To prevent excessive increases in core body temperature, the body relies on thermoregulatory mechanisms including sweating and cutaneous vasodilation. Sweat evaporation is the most effective mechanism for heat dissipation during prolonged exercise in warm environments. Failure of thermoregulation can lead to heat-related illnesses such as heat exhaustion and heat stroke. Adequate hydration, acclimatization, and appropriate environmental conditions are essential for maintaining thermal balance during exercise.

7. EXERCISE PATHOPHYSIOLOGY

Exercise pathophysiology examines how disease conditions alter the body's response to physical activity. In cardiovascular diseases such as heart failure or coronary artery disease, the ability of the heart to increase cardiac output during exercise may be limited. Pulmonary diseases such as chronic obstructive pulmonary disease impair gas exchange and increase the work of breathing. Metabolic disorders including obesity and type 2 diabetes mellitus are associated with reduced insulin sensitivity and impaired substrate utilization. Neuromuscular diseases may reduce muscle strength and endurance. Despite these limitations, appropriately prescribed exercise programs can significantly improve functional capacity and quality of life in individuals with chronic diseases. Exercise pathophysiology examines how disease conditions alter the body's response to physical activity. In cardiovascular diseases such as heart failure or coronary artery disease, the ability of the heart to increase cardiac output during exercise may be limited. Pulmonary diseases such as chronic obstructive pulmonary disease impair gas exchange and increase the work of breathing. Metabolic disorders including obesity and type 2 diabetes mellitus are associated with reduced insulin sensitivity and impaired substrate utilization. Neuromuscular diseases may reduce muscle strength and endurance. Despite these limitations, appropriately prescribed exercise programs can significantly improve functional capacity and quality of life in individuals with chronic diseases. Exercise pathophysiology examines how disease conditions alter the body's response to physical activity. In cardiovascular diseases such as heart failure or coronary artery disease, the ability of the heart to increase cardiac output during exercise may be limited. Pulmonary diseases such as chronic obstructive pulmonary disease impair gas exchange and increase the work of breathing. Metabolic disorders including obesity and type 2 diabetes mellitus are associated with reduced insulin sensitivity and impaired substrate utilization. Neuromuscular diseases may reduce muscle strength and endurance. Despite these limitations, appropriately prescribed exercise programs can significantly improve functional capacity and quality of life in individuals with chronic diseases.

8. THERAPEUTIC APPLICATIONS OF EXERCISE

Exercise is now widely recognized as a powerful therapeutic intervention. Cardiac rehabilitation programs incorporate structured exercise training to improve cardiovascular function following myocardial infarction or cardiac surgery. Similarly, pulmonary rehabilitation programs utilize exercise to improve respiratory function in patients with chronic lung diseases. Regular physical activity also plays a crucial role in the prevention and management of metabolic disorders. Exercise improves insulin sensitivity, promotes weight management, enhances lipid profiles, and reduces systemic inflammation. From a public health perspective, promoting regular physical activity represents one of the most effective strategies for reducing the global burden of chronic disease. Exercise is now widely recognized as a powerful therapeutic intervention. Cardiac rehabilitation programs incorporate structured exercise training to improve cardiovascular function following myocardial infarction or cardiac surgery. Similarly, pulmonary rehabilitation programs utilize exercise to improve respiratory function in patients with chronic lung diseases. Regular physical activity also plays a crucial role in the prevention and management of metabolic disorders. Exercise improves insulin sensitivity, promotes weight management, enhances lipid profiles, and reduces systemic inflammation. From a public health perspective, promoting regular physical activity represents one of the most effective strategies for reducing the global burden of chronic disease. Exercise is now widely recognized as a powerful therapeutic intervention. Cardiac rehabilitation programs incorporate structured exercise training to improve cardiovascular function following myocardial infarction or cardiac surgery.

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CONCLUSION

Exercise physiology and pathophysiology provide critical insights into how the human body functions during physical activity and how disease conditions alter these responses. Through coordinated interactions among multiple physiological systems, the body adapts to the increased metabolic demands imposed by exercise. Understanding these mechanisms allows clinicians and researchers to design effective exercise interventions that promote health, enhance performance, and aid in disease prevention and rehabilitation. As sedentary lifestyles become increasingly prevalent worldwide, the role of exercise as medicine will continue to expand within modern healthcare systems. Exercise physiology and pathophysiology provide critical insights into how the human body functions during physical activity and how disease conditions alter these responses. Through coordinated interactions among multiple physiological systems, the body adapts to the increased metabolic demands imposed by exercise. Understanding these mechanisms allows clinicians and researchers to design effective exercise interventions that promote health, enhance performance, and aid in disease prevention and rehabilitation. As sedentary lifestyles become increasingly prevalent worldwide, the role of exercise as medicine will continue to expand within modern healthcare systems. Exercise physiology and pathophysiology provide critical insights into how the human body functions during physical activity and how disease conditions alter these responses. Through coordinated interactions among multiple physiological systems, the body adapts to the increased metabolic demands imposed by exercise. Understanding these mechanisms allows clinicians and researchers to design effective exercise interventions that promote health, enhance performance, and aid in disease prevention and rehabilitation. As sedentary lifestyles become increasingly prevalent worldwide, the role of exercise as medicine will continue to expand within modern healthcare systems.

Figures

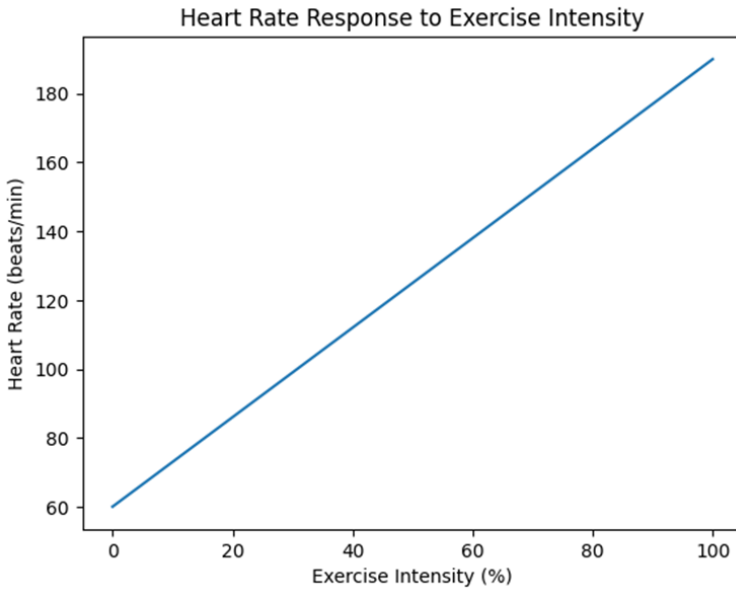


Figure 1. Heart rate response to exercise intensity.

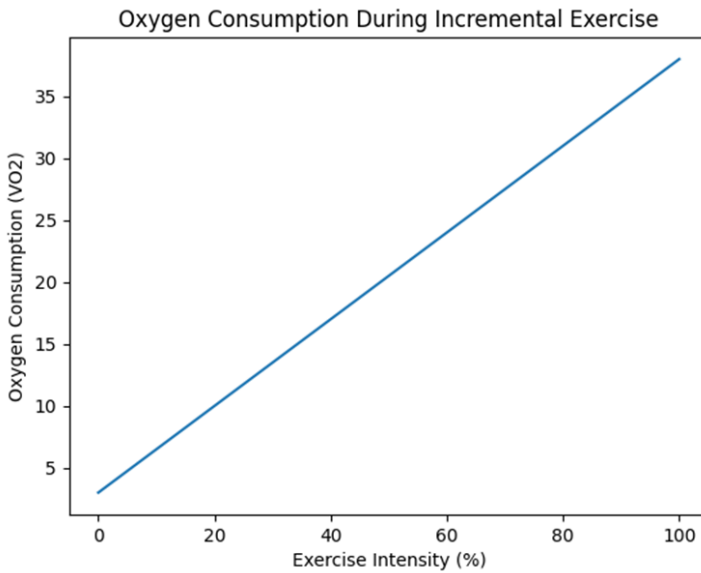


Figure 2. Oxygen consumption during incremental exercise

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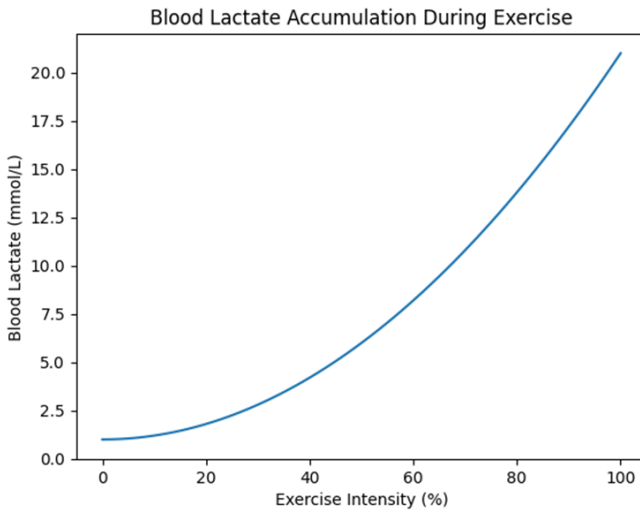


Figure 3. Blood lactate accumulation during exercise.

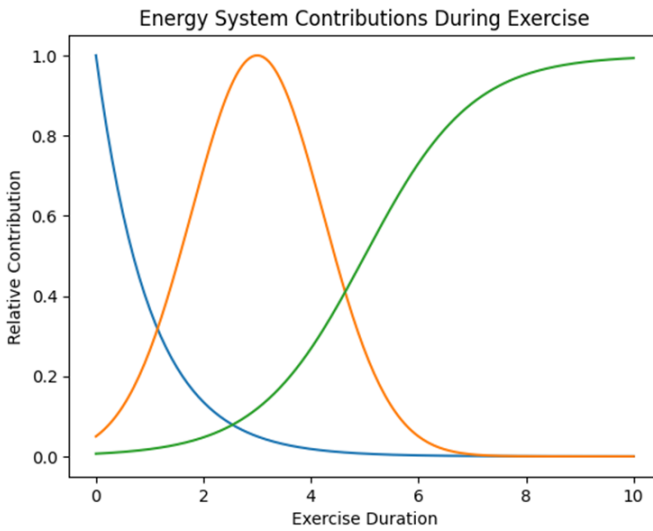


Figure 4. Relative contributions of energy systems during exercise

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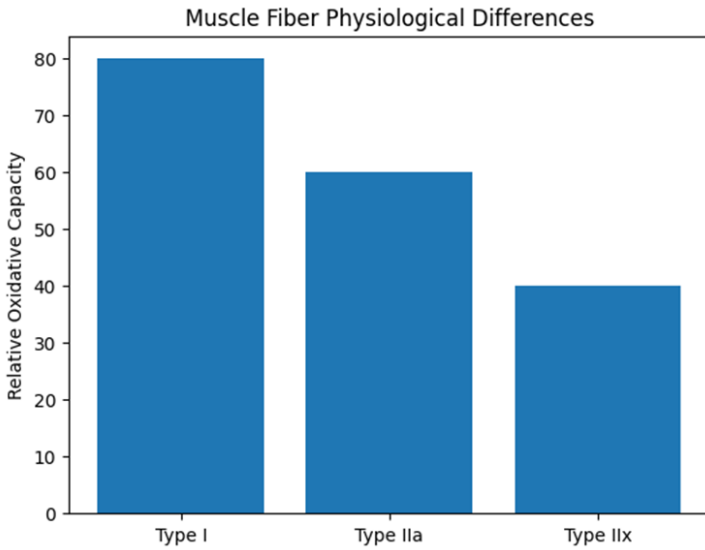


Figure 5. Comparison of skeletal muscle fiber physiological properties.

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CHAPTER 2
CLINICAL FEATURES-BASED REVIEW OF
MACHINE LEARNING FRAMEWORKS IN
PREDICTING SKIN DISEASES

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INTRODUCTION

Skin disease is a common ailment but could be deadly like diabetes or cardiovascular disorders. People who are geographically dispersed in region with excessive temperature or occasionally induced hot weather are highly prone to risk of skin diseases at the instance of climatic change. Classification of skin diseases where cases are associated with influencing factors is such a crucial task; hence, identifying appropriate and optimum features for skin disease classification from the large quantity of health sector data is somehow difficult (Ayeni et al., 2020).

Recent studies in health informatics have shown the extensive application of computational intelligence or machine learning techniques in computer assisted disease diagnosis based on the series of peculiar symptoms for various diseases. Optimal use of healthcare applications in telemedicine during global lockdown, particularly in the tensed year 2020 due to COVID-19 pandemic, brings about motivation for continuous development of computer assisted diagnostic technologies or prognostic application in healthcare and medical domain (Usman et al., 2023).

At times, global warning and sudden change in climate might be notable incidences which can cause skin diseases or some irritating skin rashes (Rangaswamy et al., 2024). The combination of solar inwards and outwards thermal radiation is not far-fetched from atmosphere when earth revolves. Certain gases, radiation, carbon dioxide, wind patterns, methane, fossil flues, and ocean currents are also attributed to factors influencing climate change and occasioned warming of the planet (Chauhan, 2020). The suffering of people from different diseases had been alleviated through automated disease diagnosis and technological solution such as pre-trained predictive models of supervised classification techniques (Sariyah et al., 2023; Meena et al., 2023).

Preventive measure and treatment of disease in timely manner is very important in modern dispensation, unlike the high number of preventable deaths being recorded in previous century due to the lack of accurate diagnosis of symptoms in patients thereby threaten the patients' lives.

Effective and timely diagnosis of any health associated problem is of utmost importance, which necessitates standard diagnostic and clinical recovery for serious illness (Karwa et al., 2022).

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As much as classification algorithms and data mining techniques plays vital role in grouping labelled or unlabeled data based on shared characteristics or similar attributes into predefined classes; yet the size and quality of data is also germane (Zhang et al., 2024; Ibrahim et al., 2023).

The use of machine learning embedded functions in prominent data analytic tools helps in automating some computational processes, like model building and validation, to maintain the sensitivity of clinical dataset (Sheety et al., 2022; Ayeni, 2021).

Availability of medical data in real time is not directly usable for clinical analysis because larger proportion of the medical data requires pre-processing before the feature selection. Combining the efficacy of neural network and fuzzy logic to optimize functional perspective of hybridized architecture, brings an enhanced edge with machine leaning techniques toward fundamental understandings and experimental analysis of clinical data (Ummature et al., 2023).

As much as large proportion of the medical data are needed to increase training cycle for model improvement, yet pre-processing before the application of feature extraction technique is germane. Pre-processing phase could involve filling the missing values, conversion of the fixed data to nominal value; and changing of label for medical data analysis (Hatem, 2022). Selecting the most preferred techniques for recent machine learning frameworks in detection of skin disease, and their empirical comparison is the focus of this study; discovering the hidden but relevant patterns in dermatological data for proper fitting of classification model, through relative parameters and the target variable to improve sensitivity and accuracy of every classifier.

1. RELATED LITERATURES

Rangaswamy et al. (2024) provided a framework for classifying skin disease using deep learning technique which incorporates convolutional neural network (CNN). The focus codenamed two different networks as V3 and VGG16, which were trained and evaluated with seventeen thousand (17,000) images; as well as thirteen (13) classes.

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Image pre-processing was also done to validate the input data, before experimenting with the dense layers of CNN model, because understanding the epidemiological pattern of medical images as shown in figure 1 is very crucial. Accuracy of classification algorithm was optimized; nevertheless, the study outcome provides insight to automation of dermatological system that could be adapted to other areas of medical informatics.



Figure 1. Lesion for Clinical Stages of Skin Disease

(Raut et al., 2022)

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Investigative and exploratory study of Sariyar (2023) juxtaposed the application of formal methods for data processing data, preservation and analysis for cause and effect relationship in clinical decision support; with conjectural proposition of health informatics.

Provision of appropriate principles, theories and methods helps to substantiate scientific notion of health or medical informatics; though, uncertain perception of underlying philosophy is yet to align totally with interdisciplinary justification.

Saran et al. (2023) conducted a descriptive survey which aimed to explore the impact of health transformation policy on access equity to the usage of medical imaging service in Lorestan communities, western region of Iran. Annual growth of imaging devices was computed, while equity assessment of medical imaging distribution was determined for target population close to hundred thousand (100,000).

Their results revealed tremendous increase in the number of imaging devices through cumulative distribution of imaging devices, and the cumulative population ratio. However, access equity to these fundamental health technologies is still diminishing despite the increase in these facilities. Policymakers were advised to allocate medical equipment based on the specific health needs of various regions in Iran.

Meena et al. (2023) proposed a novel method for predicting skin diseases using supervised classification techniques. Their work explored machine learning algorithms of K-nearest neighbour (KNN), support vector machine (SVM) and random forest (RF) for the selection of significant attributes and removal of irrelevant features affecting predictive model performance. Experimental analysis shows intensified effort to increase the accuracy of data mining method in feature selection with ensemble of techniques to avoid model over fitting.

However, comparative analysis with other predictive models or methods of similar system was not provided, coupled with the fact that the work is a trial and error benchmark of raw skin data. Usman et al. (2023) provided a mathematical approach of epidemic modeling with fear of viral infection. Numerical simulation of the proposed model leverage on forward bifurcation to stabilize free virus equilibrium in dynamical study of COVID-19.

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Meanwhile, the risk level was not completely evaluated for concentration of virus toward target population of infected humans. Multi disease prediction system was developed using machine learning techniques, implemented by application prototyping to forecast transiting stages of various diseases since the data corpus for knowledge representation is based on individual symptoms (Karwa et al., 2022).

Though, several localized diseases have specific features in various places, thereby making disease outbreak prediction somehow difficult. Nevertheless, high fidelity, accuracy and computational speed of multi disease predictive model is a great improvement.

Raut et al. (2022) applied machine learning algorithms on the classification of skin diseases using decision tree and support vector machine (SVM). Diagnostic accuracy was improved with scalability of medical decision support system. Meanwhile, expanding learning strategies for data pre-processing and hybridized techniques were identified as areas of further study.

Ayeni (2021) also developed clinical prognostic system for disease classification using fuzzy cluster means. The designed model for clinical prognosis used computational intelligence for handling ambiguity and imprecision in medical data, towards clinical classification and predictive projection of every ailment.

The predictive tendency of proposed system was based on mathematical model and/or clustering algorithm for data mining. It made an enhanced classification framework for clinical prognostic system, which has given room to multi class prediction, especially with large datasets in quantitative and developmental research.

Chauhan (2020) implemented a diagnostic system for disease prediction using machine learning. The study focused on association of relevant attributes with the target for predicting several diseases to the advantage of human expert for smart decision support models. Medical information management and/or health informatics revolves around decision support models application and diagnosis of various illnesses. Though, delay in the diagnosis and treatment of serious ailment like diabetes and kidney failure could pose high risk to one's life.

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Goswami et al. (2020) also conducted an image survey of skin disease classification in descriptive and comparative perspective, which reveals how the classifier's efficiency depends largely on selected features. Many skin diseases have highly similar visual attributes, which add more difficulties to the selection of useful features from image. Adaptation of pre-trained model with transfer learning brings augmentation to existing approach.

2. COMPARISON REVIEW OF SELECTED FRAMEWORKS

Advanced technologies of computing like deep learning and machine learning algorithms makes it possible to predict skin disease of various types. Accuracy of the results seem improving when predictions and analysis are carried out especially with machine learning methods like Support Vector Machine (SVM), Random Forest (RF), Neural Network (NN), Fuzzy Logic and others. Though, sometimes the accuracy of the predictive model may appear biased or otherwise.

Data mining algorithms yields the functional framework and the results of developed solution system showed that Probabilistic Neural Networks (PNN) works better in prediction performance for determining severity stage in chronic kidney disease, when compared with three other algorithms. However, diagnostic and specificity error in treatment was only observed in Probabilistic Neural Networks (PNN).

Skin disease identification system using deep learning. Ensemble of data mining techniques helps to handle extracted features of principal component, while logistic regression was used for training and testing the medical images. However, some difficulties were seen in the prediction process due to rough areas, irregular skin tones, the scar and other factors which are peculiar to image resolution and appearance.

Machine learning approach to the disease prediction in vulnerable patients in probabilistic nature of support vector machine (SVM) and k-nearest neighbour (KNN) were dependants of statistical learning for clinical feature. Support vector machine (SVM) and fuzzy logic had been previously used together for accurate estimation of classification (Ibrahim et al., 2023).

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For instance, the yardstick for searching related instances in clinical database or knowledge base in diagnostic decision support is similar to that of other systems. Comparative survey for analysing the existing algorithms for clustering and classification has been explored as well.

Essential parameters for regulating inference system from graphical user interface; to handle input/output elements, membership functions; the rule and to monitor behaviour of specific rules for improving system performance with multi-layer inference or multi faceted adaptive system as shown in figures 2 to 5.

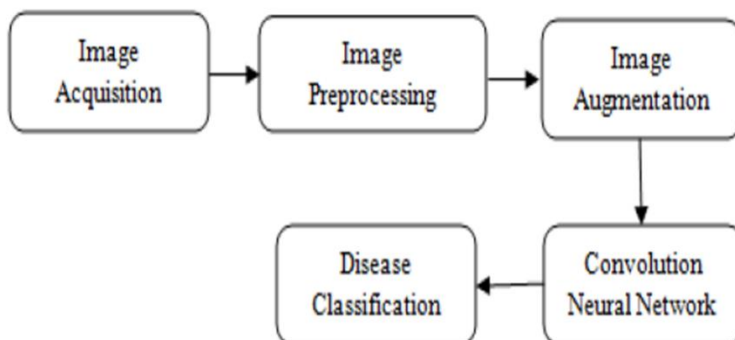


Figure 2. Workflow of Machine Learning classifier (Goswami et al., 2020)

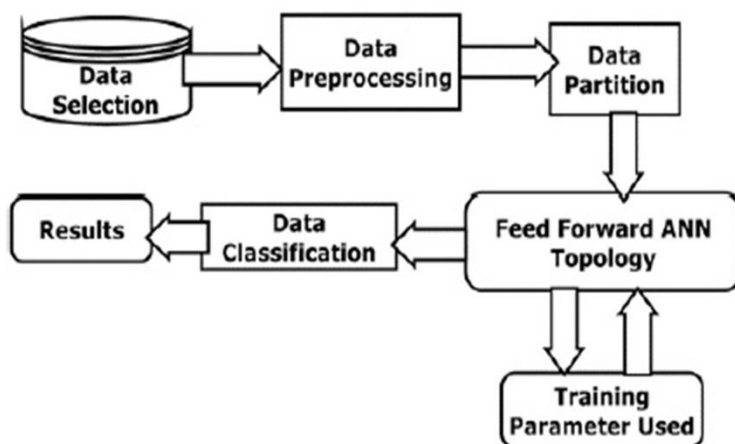


Figure 3. ANN-PSO Model for Feature Selection (Ahammed et al., 2022)

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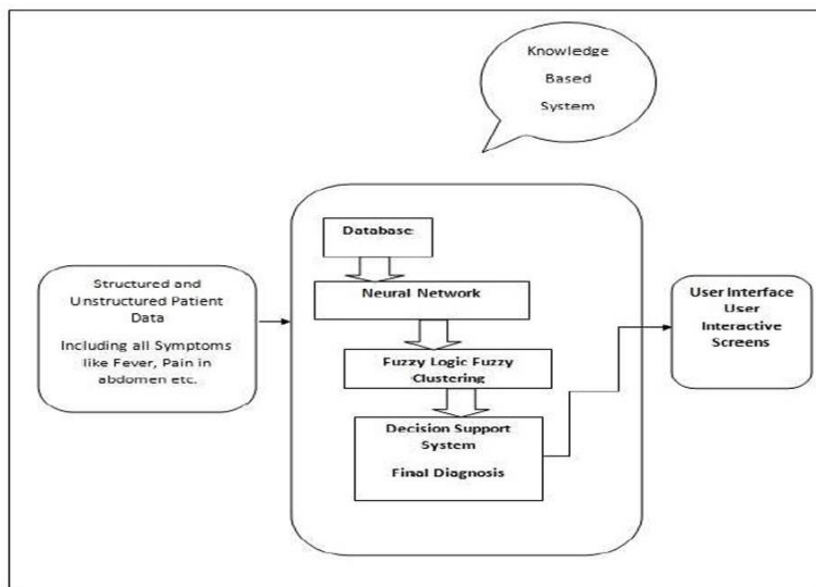


Figure 4. Neuro Fuzzy System for Diagnostic Support (Sayyad et al., 2022)

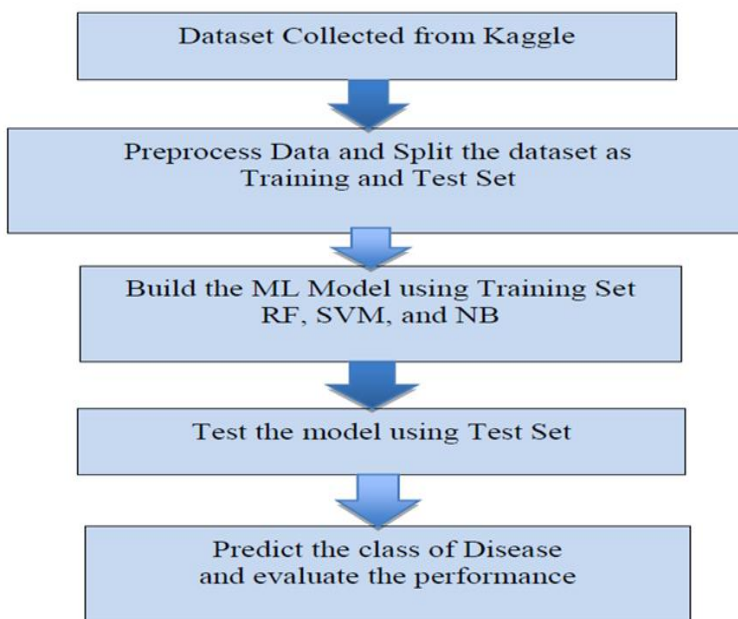


Figure 5. Multi disease prediction workflow (Karwa et al., 2022)

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Evaluating patients' data and clinical decision for diagnostic support is very germane to application of computational intelligence for classifying chronic diseases because classification methods helps to prevent errors due to fatigue or lack of human expertise. Therapeutic dataset is subjected to dissection by quite a number of varying elements and restorative factual information. Computer Aided Diagnosis blueprint makes it possible to gather the liver dataset from various herpetologists. Anomalies and imbalanced biomedical data is targeted with efficient implementation of predictive model (Barin & Guraskin, 2022).

Feature selection methods are essential tools for model optimization and fitting in machine learning. Optimal paradigm for selecting essential subset of features is needed to actualize overall performance when parameter tuning of algorithms is significant.

A model based diagnostic system ensures a high degree of confidence because a model can capture the essential features and structure of clinical domain. It reasons from first principles so that it knows the system internal processes and uses that knowledge to determine which state of the device matches actual observations. However, the main disadvantage of this approach is the computational inefficiency. (Saifan & Jubair, 2022).

Dermatological characteristics and skin related features were used to define independent variables (input), as well as their membership function for fuzzy inference mechanism while skin status is being identified as the target variable (output) by reasoning, which does not only classify instance of skin data into normal and diseased but can explicitly create multi clusters and target groups by partitioning the clinical data to indicate the kind of skin disease being diagnosed. Validation can be performed by segmenting clinical data for training and testing, with operational peculiarities of different techniques as summarized in table 1.

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Table 1. Summary of Functional Techniques for Selected Frameworks

Applied Methods	Streight (s)	Weakness (es)
Deep learning technique	Accuracy of CNN and optimization of disease classifier	Need to automate dermatological system for adaptation
KNN, SVM and RF supervised technique	Selection of significant for model accuracy	Irrelative qualities and raw format of real time health data
Mathematical modeling approach	Numerical solution to infection stability	Risk level of infected human N/A
Empirical analysis	Emerging principles and theories within health informatics	Wrong perception of the underlying science philosophy
Descriptive survey	HTP influence on access usage of medical imaging	Lack of suitable data for analyzing the impact factor
Ensemble of machine learning techniques	High speed for disease prediction	No performance analysis/comparison
Decision tree C4.5 and Support vector machine	Scalability of decision support for diagnostic	Expansion of learning strategies after pre-processing
Feed forward neural network	Multi label clustering of clinical data	Limited parameter for model training
Neural network and fuzzy cluster means	Optimality in decision support	Lack of implementation guide
Computer aided disease diagnosis	Error prevention in system anomaly	Lack of scientific/ analytical experiment
Fuzzy cluster means	Multi class clinical data and prediction	Medical imaging not fully explored
Descriptive study and comparative survey	Adaptation of pre-trained model with transfer learning	Insight into classification dependency on data
Hybridized machine learning algorithms	Improved precision in diagnosis support	Lack of evaluation and comparison

CONCLUSION

Machine learning approach reduces the problems that conventional systems have such as limited coverage in symptom and cause relationships and poor performance of the system when dealing with problems which lies on the periphery of its knowledge.

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Consequently, two categories of output or independent variables have been the common classification target of existing systems as normal and diseased, presence or absence, healthy and non-healthy without estimating the intensity level. Hence, mathematical model with computational intelligence method of neuro-fuzzy is more projected for increased efficiency in prognostic performance due to deep learning and scalability tendency, to inculcate the reasoning potential of machine learning technique in unique predictive framework.

Multi-layer inference system was incorporated in adaptive neuro-fuzzy technique for classifying dermatological data; though its prediction reliability for illness of the skin was not evaluated. Machine learning algorithm had been widely used in the past for disease classification in comparison manner; its projection of hybridized method is expected to produce perfect prediction with effectiveness.

Paucity of dermatological data in health sector especially the data samples on skin diseases from clinical history of concentrated out-patients is also a drawback; and when available contains too many irrelevant features or appears in unreadable form with hidden patterns, whereas classification efficacy of any algorithm depend majorly on the dataset and selected features.

Machine learning algorithms are heavily dependent on the qualitative data available to them and quantitative design for learning and validation process to improve model's behaviour; towards estimation of certainty in the target variable. Therefore, the given benchmark of raw medical data needs continuous enhancement of classification model to adapt to contagious skin diseases.

Conflict Of Interest

Authors declare that no conflict of interest exist or competing interest among the authors

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CHAPTER 3
AI DERIVED PERSONALISED MEDICINE

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INTRODUCTION

A long-standing goal in the healthcare industry is personalized medicine, which tailors therapy to each patient based on their individual characteristics. Through technical developments, artificial intelligence (AI) has made this goal a reality and promises to enhance diagnosis and treatment. In terms of diagnosis, treatment, patient care, and expedited drug discovery, artificial intelligence has significantly transformed the healthcare industry. AI has the ability to revolutionize customized care, but there are still ethical issues. In order to improve overall clinical outcomes, this post aims to clarify how developments in AI technology are revolutionizing the field of personalized medicine, improving diagnostics, customizing therapy planning, and drug discovery.

1. THE ROLE OF ARTIFICIAL INTELLIGENCE IN PERSONALIZED MEDICINE

Personalized medicine is revolutionizing the healthcare industry, and the integration of artificial intelligence (AI) is fueling this transformation. AI technologies have significantly advanced our ability to analyze vast amounts of complex data, leading to improved diagnosis and treatment outcomes. In this article, we will explore the pivotal role that AI plays in revolutionizing personalized medicine, its impact on disease detection, diagnosis, and the future of healthcare. Beyond the technology that makes it possible, the idea of personalized medicine that medical care can be tailored to an individual's genomic and molecular profile has broad ramifications. Healthcare infrastructure, diagnostic and pharmaceutical business models, government and private payer payment policies, and a new regulatory oversight approach will all need to alter. Additionally, personalized medicine will redefine the roles of both the doctor and the patient and shift medical practices from reactive disease treatment to proactive healthcare management, including screening, early treatment, and prevention. In a sector that has a long history of antipathy toward information technology, it would increase reliance on electronic medical records and decision support systems.

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Artificial intelligence (AI) can play a crucial role in the development of personalized medicines at all pertinent stages of clinical development and implementation of new personalized health products, from identifying appropriate intervention targets to testing their utility, given the significance of data-intensive assays in revealing appropriate intervention targets and strategies for personalizing medicines. In order to maintain people's health, personalized medicine uses specific medical data to create methods and treatments for diagnosing and treating diseases. In order to make precise diagnoses and create customized treatment plans in line with those findings, physicians in this kind of practice integrate all available patient data, including symptoms, conventional test results, the patient's medical and family history, and some genomic data.

Health information management (HIM) specialists, who are responsible for managing patient data, will be crucial to this customized healthcare model that supports the significance of AI. In a recent National Academy of Medicine report on the state of AI in healthcare today and in the future, the authors highlighted "unprecedented opportunities" to supplement specialists' care as well as the help AI offers in overcoming human limitations like fatigue and inattention as well as the dangers of machine error. Crucially, the article highlights that although these technologies need to be handled carefully, they have a lot of potential. However, the difficulty of evaluating vast volumes of data to create individualized treatment plans is the issue that AI in personalized medicine seeks to address. Due to the difficulty of interpreting the enormous volumes of data required to develop a customized treatment plan, traditional personalized medicine approaches are limited. But these limitations can be overcome by using AI to identify patterns and correlations in data, which can then be used to create more precise and effective individualized treatment plans.

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Figure 1. Role of AI in Personalised Medicine

2. THE EVOLUTION OF PERSONALIZED MEDICINE: FROM TRADITIONAL APPROACHES TO AI INTEGRATION

Conventional medical methods frequently assumed a one-size-fits-all approach to therapy. Nonetheless, it is becoming more and more evident that a person's response to treatment is greatly influenced by individual differences in genetics, lifestyle, and environment. This insight led to the development of personalized medicine, a strategy that customizes medical treatments to each patient's particular needs. By acknowledging the significance of individual variability in treatment outcomes, customized medicine has completely transformed the healthcare sector. Healthcare practitioners can now create focused interventions that are more likely to be successful by taking into account a patient's genetic composition, lifestyle decisions, and environmental factors. In addition to improving patient outcomes, this move toward individualized treatment has made healthcare more patient-centered. Artificial intelligence (AI) integration has unlocked the full potential of personalized medicine. In order to develop individualized treatment regimens, AI algorithms are capable of processing vast amounts of patient data, including genetic information, medical records, and lifestyle factors. AI can uncover hidden insights and forecast treatment outcomes with previously unheard-of precision by examining patterns and connections in this data. The use of AI in customized medicine has created new opportunities for study and therapy advancement.

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Artificial intelligence (AI) algorithms can find minor patterns and relationships that might otherwise go undiscovered since they can examine large amounts of data quickly. New biomarkers, genetic variations, and therapeutic targets have been found as a result, opening the door to more accurate and successful treatments. Preventive care could be improved by AI-powered tailored medicine. Artificial intelligence algorithms are able to identify people who are more susceptible to specific diseases by examining their genetic predispositions, lifestyle choices, and environmental factors. Early detection enables medical practitioners to carry out interventions and preventive actions, lowering the burden of illness and enhancing general population health.

The capacity to continuously learn and adapt is another important benefit of integrating AI into customized medicine. Treatment plans can be improved and optimized thanks to AI algorithms' real-time analysis of patient responses and treatment results. Over time, better patient outcomes result from this iterative process, which guarantees that interventions are continuously evolving and improving. The difficulties and moral issues surrounding the use of AI in customized medicine must be acknowledged. To guarantee the ethical and responsible application of AI in healthcare, a number of difficulties must be addressed, including algorithm bias, data security, and privacy concerns. To reduce these dangers and guarantee that AI integration in customized medicine benefits everyone, transparency, accountability, and strong regulatory frameworks are crucial. The healthcare sector has undergone a transformation thanks to the development of personalized medicine from conventional methods to AI integration. Personalized medicine has improved patient outcomes and moved toward a more patient-centered approach by taking individual differences in genetics, lifestyle, and environment into account. The accuracy and effectiveness of customized medicine have been further improved by the incorporation of AI, which has made it possible to create focused interventions and uncover novel insights. However, in order to guarantee ethical and responsible healthcare practices, it is imperative to address the ethical issues related to AI integration.

3. UNDERSTANDING ARTIFICIAL INTELLIGENCE: A PRIMER FOR PERSONALIZED MEDICINE

It is essential to comprehend the fundamentals of artificial intelligence before digging further into AI's function in customized medicine. Fundamentally, artificial intelligence (AI) is the creation of computer systems that can carry out tasks like problem-solving, decision-making, and pattern recognition that normally need human intelligence. Computer programs can learn from data and gradually improve their performance without explicit programming thanks to machine learning, a subset of artificial intelligence. Healthcare is one of the many industries that this ground-breaking technology has revolutionized. Large volumes of patient data, such as genetic information, medical history, and lifestyle characteristics, can be analyzed using machine learning algorithms in the context of personalized medicine in order to spot trends and forecast a person's health outcomes. One piece of the puzzle is machine learning. Deep learning is a more sophisticated type of machine learning that is especially useful for customized medicine since it makes use of neural networks to examine intricate relationships in data. These neural networks can process and interpret data in a manner similar to human cognition since they are modeled after the structure and operation of the human brain. Deep learning algorithms are particularly good at tasks like speech recognition, natural language processing, and image recognition. These algorithms can be trained in customized medicine to examine medical pictures, such pathology slides or MRI scans, and spot minute patterns or abnormalities that might point to a particular illness. Healthcare practitioners can create individualized treatment programs that are specific to each patient's needs and make more accurate diagnoses by utilizing deep learning.

Healthcare professionals can predict patient outcomes and choose the best interventions with the help of AI-powered technologies. Artificial intelligence (AI) algorithms can produce insights that assist physicians in making well-informed treatment decisions by examining sizable datasets that contain data about patients with comparable traits and medical histories. In addition to improving patient outcomes, this maximizes the distribution of healthcare resources, making sure that those who most need them receive them.

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It's crucial to remember that, despite its enormous potential for customized medicine, AI is not without its difficulties. To guarantee the ethical and responsible application of AI in healthcare, ethical issues like algorithmic bias and data privacy must be properly addressed. Healthcare practitioners, data scientists, and regulatory agencies must work together to develop standards and recommendations for the application of AI in clinical practice. Personalized medicine could undergo a revolution thanks to artificial intelligence, especially machine learning and deep learning. Healthcare practitioners may use AI to evaluate enormous volumes of data, spot trends, and forecast outcomes that lead to more precise diagnoses and individualized treatment regimens. However, privacy, bias, and legal frameworks must be carefully taken into account for the ethical and responsible application of AI in healthcare. The future of customized medicine appears bright with ongoing developments in AI technology and interdisciplinary cooperation.

4. AI IN DISEASE DIAGNOSIS

It has been observed that a number of AI techniques, particularly machine learning and deep learning algorithms, improve diagnostic efficiency. AI can identify patterns and connections that a clinician would miss by using information from a patient's medical history, genetics, and other data inputs. AI in image recognition, for instance, can help diagnose cancer, heart conditions, and neurological issues by spotting minute variations in images taken by X-rays or MRIs. An additional advantage of AI is its ability to analyze and integrate the enormous amount of data collected from several sources.

AI can identify some biomarkers linked to a particular disease by fusing genetic and clinical data, which will aid in the patient's accurate diagnosis and therapy. This integration improves diagnosis accuracy, which can assist prevent incorrect conclusions and enable early treatment initiation.

The application of AI to the diagnosis of diseases like cancer, heart disease, and Alzheimer's has been studied. In comparison to traditional methods, Kumar et al. showed that using AI to diagnose these conditions produced better results in terms of prediction rate, accuracy, sensitivity, and specificity.

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The use of AI in healthcare has proven essential for disease diagnosis in a number of domains, including disease detection, disease classification, and decision-making processes.

This has led to improved treatment choices and, eventually, longer lifespans. AI is being used to diagnose illnesses more accurately. Chen et al. evaluated the use of AI in urologic problem diagnosis, therapy, and outcome prediction by a comprehensive review and meta-analysis. They showed that AI had more benefits than traditional models and techniques. They found that AI was reportedly 71.8% better at diagnosis and outcome prediction. The ability of retinal specialists to identify retinal fluid in spectral domain OCT scans of eyes with age-related macular degeneration was evaluated by Keenan and his colleagues. They contrasted their output with an artificial intelligence algorithm. When it came to recognizing retinal fluid, retinal experts showed less sensitivity and less accuracy. While AI-based detection achieved improved accuracy, sensitivity, specificity, and precision, this was particularly applicable to intraretinal fluid and difficult cases.

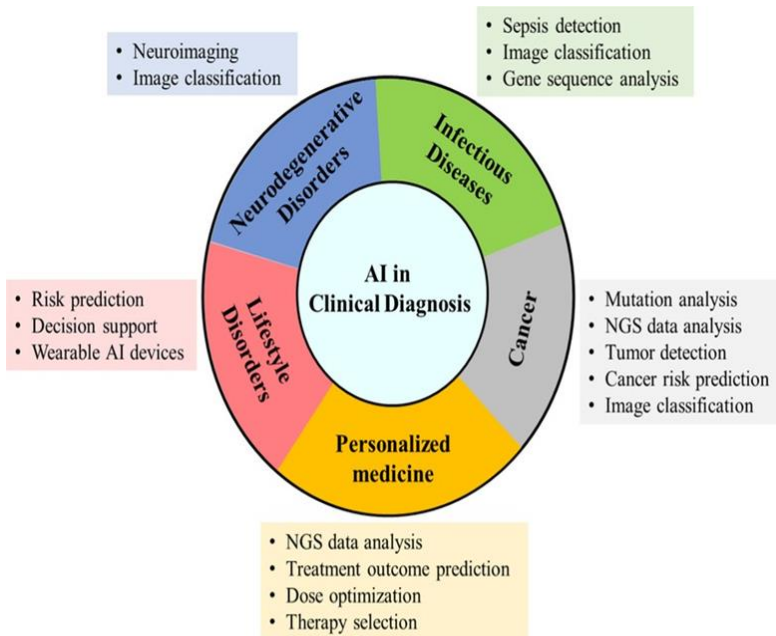


Figure 2. AI in disease diagnosis

5. AI IN DISEASE TREATMENT

AI is useful not only for diagnosing illnesses but also for treating them appropriately. AI methods are frequently used to assess how a patient responds to a particular treatment and choose the best course of action based on the patient's genetic and clinical characteristics. Because AI may help choose the best chemotherapy or immunotherapy treatment based on the genomic features of the tumor, this can be especially significant in oncology. Additionally, it can track how the patient responds to particular therapy and care strategies and modify them to achieve the desired results with the fewest possible negative effects. For instance, the AI algorithms might monitor the patient's condition and suggest modifications to the treatment plan using data from the wearable and other digital health information. All of these might be viewed as a means of attaining therapy optimization, which is regarded as one of the significant advancements in the field of personalized medicine that can lead to better patient outcomes and a higher standard of living. The growing importance of AI in healthcare, particularly in radiotherapy and clinical decision-making, is highlighted by a recent study.

AI applications span a number of medical specialties, including as radiology, gastroenterology, and cardiology, and they provide chances to improve patient outcomes, treatment plans, and illness identification. During preclinical and clinical trials, artificial intelligence (AI) technologies like artificial neural networks (ANN), deep learning models, and support vector machines have proven helpful in disease identification, diagnosis, and therapy optimization. AI has successfully analyzed genomic data, drug reactions, and phenotypes in oncology, achieving high precision in customized treatment plans. Using insights from oncology, Krittanawong et al.'s clinical trials showed that the application of AI in cardiovascular care is as promising.

The standardization and aggregation of genetic and health data, the use of multi-modal data, cooperation with disease specialists, clinical community scrutiny of AI findings, and comprehensive clinical trials to validate AI-derived insights are all crucial components in maximizing the benefits of AI in personalized medicine. These advancements point to a shift in treatment paradigms from curative to preventative.

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All things considered, AI has significantly altered the medical field in terms of patient care, diagnosis, and therapy. In order to identify illnesses including cancer, heart disease, and neurological disorders, medical diagnosis applies deep learning models to pictures such as artificial networks (ANN), magnetic resonance imaging (MRIs), computed tomography (CT) scans, and X-rays. AI models foresee the disease's beginning using patient data, enabling early treatment. AI is used in personalized medicine, where it evaluates clinical and genetic data to recommend the best course of action.

Robots guided by artificial intelligence improve surgical procedures' accuracy and precision. AI is used by surgical systems like the da Vinci to increase the precision of minimally invasive procedures like those performed in the urology and gynecological fields. These apps show how AI is being used in the healthcare sector.

6. ETHICAL CONCERNS

Even while AI has the potential to revolutionize personalized treatment, there are still certain ethical issues. Since the data is gathered from various sources and contains patient personal information, data privacy is a significant issue that should be brought up. To guarantee the proper handling and security of patient data, reliable data management solutions must be put in place. Adoption of AI is expensive, involving human and facility investments as well as training healthcare workers on its application. Healthcare organizations must include AI into their frameworks, and clinicians must learn how to use technology and comprehend its outcomes.

The availability of high-quality, thorough, and carefully annotated medical data is essential to the use of AI in customized medicine. Problems arising from poor data quality could include biases, missing numbers, or inaccuracies, which could result in incorrect forecasts and suggestions. Medical AI algorithms must be accurate and designed to function across a range of patient demographics, medical conditions, and healthcare settings. Particularly in vital medical applications, it is imperative to concentrate on the dependability of AI systems and the possible risks they can present. Some AI models, especially deep learning systems, have interpretability problems that make them "black boxes," making it difficult to use them in therapeutic settings.

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The use of AI in personalized medicine may expand significantly since it can improve medication development, therapy options, and diagnostic precision. The use of AI in the provision of healthcare services can be used to give each patient individualized attention to improve their health state while also lowering costs. It is crucial to promote cooperation between engineers, doctors, academics, and regulators given the trend for future advancements in AI in the healthcare sector. By working together, we can advance the application of AI in the provision of tailored medicine, which will ultimately improve patient outcomes globally.

7. THE FUTURE OF PERSONALIZED MEDICINE: AI'S ROLE IN TRANSFORMING HEALTHCARE

Although the application of AI in customized medicine has already demonstrated great promise, its full potential is still far off. AI will continue to be crucial in changing healthcare in a number of areas. AI algorithms will get more precise as more data becomes available, resulting in individualized treatment regimens that maximize patient results. Precision medicine will continue to grow because to AI technologies, which will allow for customized treatments for a variety of ailments. real-time data gathering will be made easier by the integration of AI with wearable technology and remote patient monitoring, allowing medical professionals to continuously monitor patients outside of conventional clinical settings. The healthcare industry is changing as a result of AI's role in personalized medicine. Healthcare practitioners can give more focused therapies, lower diagnostic errors, and enhance patient outcomes by utilizing AI. AI's impact will only increase as it develops further, bringing in a new era of individualized healthcare.

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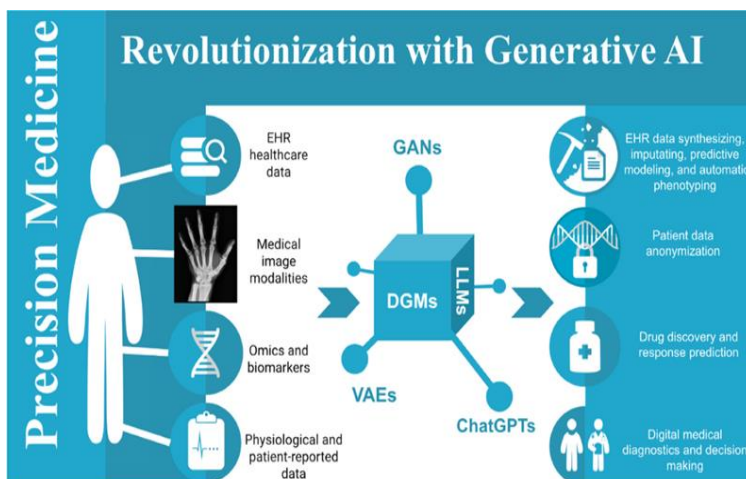


Figure 3. The Future of Personalised Medicine

8. CURRENT AND FUTURE TRENDS OF ARTIFICIAL INTELLIGENCE IN MEDICINE

In the field of medicine, artificial intelligence has already emerged as a key component. Artificial intelligence is already used in the majority of human health subfields. One of the most important medical innovations in the world is the implementation of artificial intelligence hospital systems. Healthcare will undergo significant changes as a result of artificial intelligence technology, which will eventually become essential for an increasing number of institutions. Gastroenterology, dermatology, cancer, surgery, and more fields currently employ it. Additionally, artificial intelligence facilitates the creation of novel medications, enhances the standard of healthcare services, and streamlines clinical workflow, all of which lower costs associated with these services.

The "Food and Drug Administration" in the United States authorized the first use of an artificial intelligence algorithm for diagnostic purposes in 2018. The program automatically examines fundus photos to help screen for diabetic retinopathy. With a variety of implications in pathological anatomy, imaging, cardiology, and other areas, the use of artificial intelligence in healthcare is still expanding. However, in order to deliver safer, more economical, and more effective medical care, medical professionals across all specialties must engage with these technologies.

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The use of artificial intelligence in healthcare has grown significantly on a global scale. The United States of America, China, Japan, the United Kingdom, Germany, and France are among the nations that are currently heavily utilizing artificial intelligence in the medical field. These nations have made great strides in using artificial intelligence to a wide range of medical applications, including patient monitoring, medical diagnosis, medical data analysis, individualized medicine, and more. To improve the caliber and effectiveness of medical services, numerous other nations, especially those in Central and Eastern Europe, are working to integrate artificial intelligence into their healthcare systems.

Private companies spent billions of dollars on healthcare during the first quarter of 2022. The integration and advancement of artificial intelligence, one of the most promising areas in medicine, received one-third of this sum.

Some Models of Using Artificial Intelligence In Medicine

- **Medical diagnosis:** Artificial intelligence can assist in diagnosing conditions and identifying symptoms. Artificial intelligence tools can be trained to identify patterns and symptoms that point to specific illnesses, assisting in the quick and accurate diagnosis process.
- **Patient monitoring:** In the critical care unit or cardiology, for instance, artificial intelligence can be used to keep an eye on patients' circumstances and identify any changes in their health statuses.
- **Personalized therapy:** Based on a patient's genetic profile and medical history, artificial intelligence can be utilized to develop customized treatments. By lowering the possibility of adverse effects and boosting therapeutic effectiveness, this can assist in selecting the optimal treatments for patients.
- **Workflow optimization:** By lowering wait times and boosting the effectiveness of medical procedures, artificial intelligence can be utilized to optimize hospital workflow. Currently, most medical professionals are dubious about using artificial intelligence in routine practice. The technology should inspire its use on an ascending scale and persuade the patient and the physician to have complete confidence. Artificial intelligence now carries out specific jobs.

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It provides us with binary responses, such as present or absent and benign or malignant. Lamellae visualization in pathological anatomy or tumor genesis in dermatology are two examples. Currently, experts are attempting to show physicians the better sensitivity and specificity of artificial intelligence. Target areas in radiotherapy are the subject of another ongoing investigation. Combining medical imaging with radiotherapy for precision that is beyond the capabilities of a physician appears to yield excellent results. However, a trained radiotherapist now makes the final decision, and it will likely take years for the paradigms to shift.

Artificial intelligence could also be used in areas with poor medical resources. Software evaluates lung radiological images and provides results with extremely high sensitivity and specificity in regions where pulmonary tuberculosis is highly prevalent. A breakthrough in artificial intelligence may potentially help with difficult diagnoses and illnesses with high present fatality rates. Examples include septic shock and sepsis, where mortality rates can approach 63% and 50%, respectively; these rates have not significantly dropped in recent years. Another benefit of precision medicine is artificial intelligence, which has already begun to gain traction and is developing at a faster rate. Artificial intelligence has limitless potential; it can synthesize a patient's electronic file with all biomarkers and related pathologies and provide a customized medication at the appropriate moment, which will also play a significant role in preventive medicine.

CONCLUSION

The future of AI in personalized medicine is promising, with the potential to revolutionize the way healthcare is delivered. Future research should prioritize the development of more accurate and efficient AI algorithms, the improvement of data quality and access, and the resolution of ethical and privacy concerns. AI has the ability to greatly enhance patient outcomes and overall healthcare quality if these problems and constraints are overcome. In this discipline, the IBM Watson system is a pioneer. The system, which contains both ML (Machine Learning) and NLP (Natural Language Processing) modules, has shown encouraging results in oncology. In a cancer study, for example, 99% of Watson's therapy suggestions agree with medical conclusions.

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In addition, Watson worked with Quest Diagnostics to provide the AI Genetic Diagnostic Analysis. Furthermore, the system began to have an impact on actual clinical practices. Watson, for example, successfully detected a rare secondary leukemia caused by myelodysplastic syndromes in Japan by studying genetic data. One prototype for connecting an AI system with front-end data input and back-end clinical actions is the cloud-based CC-Cruiser. More specifically, when patients arrive, their demographic information and clinical data (pictures, EP results, genetic results, blood pressure, medical notes, and so on) are collected into the AI system with their permission. The AI algorithm then uses the patients' data to provide healthcare recommendations. These recommendations are delivered to clinicians to help them make clinical decisions. Feedback on the ideas (whether correct or incorrect) will also be recorded and put back into the AI system so that it can continue to improve accuracy.

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