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Research Article

Use Of Artificial Intelligence in Diagnosis Of Various Autoimmune Disease, A Comprehensive Literature Review About Current Situation & Future Directions

Jawad K. Abbas[1*], Karrar Kareem Hatem[2], Wisam Ali Hussein[3],

[1*]Department of internal medicine, Faculty of Medicine, University of Kufa, Najaf, Iraq. Email: jawadk.alchallabi@uokufa.edu.iq
[2]Department of surgery, Faculty of Medicine, Jabir ibn Hayyan University for Medical & pharmaceutical Sciences, Najaf, Iraq. email: Karrarkareem84k@gmail.com
[3]University of Kufa-College of Medicine, Department of Surgery. Email: wisam.allami@uokufa.edu.iq

***Corresponding Author:** Jawad K. Abbas.
jawadk.alchallabi@uokufa.edu.iq

Abstract
Artificial Intelligence (AI) has arisen as a genuine tool in diagnosing and managing of various medical problems including autoimmune diseases. This comprehensive review focused on the possible applications, approaches, and future leaderships of AI skills in the diagnosis of autoimmune diseases, including rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), ankylosing spondylitis (AS), psoriatic arthritis (PsA), systemic sclerosis (SSc), Sjögren's syndrome (SjS), and Behcet's disease. The review shows that AI-based algorithms, including artificial neural networks (ANNs), support vector machines (SVMs), convolutional neural networks (CNNs), and random forests, have attained noteworthy results and statistics. For example, RA diagnosis achieved an excellent accuracy by incorporating clinical, serological, and radiological data, whereas LASSO-LR and clustering techniques have been utilized in SLE diagnosis with an accuracy reached to 94.8%. Likewise, AI techniques recognized early AS with an accuracy of 91.8%. The PsA risk prediction models successfully predicted disease commencement up to four years before clinical diagnosis. Imaging techniques, such as X-rays, MRIs, and ultrasounds, incorporated with AI have a proven efficacy in distinguishing structural damages and aids disease diagnosis. Multi-omic approaches combining genomics, proteomics, and metabolomics promote tailored medicine, as represented in SSc and SjS, where specific or unique biomarker recognition and disease categorization have considerably improved. Despite these talented results, challenges still seen, including data shortage, models interpretability, and ethical issues regarding privacy and bias. High lightening these problems is fundamental for AI's wide-ranging implementation in clinical practice. Future directions warrant the establishment of multi-modal AI themes, mixing clinical, imaging, and molecular data, besides instituting concerted databases for training models. Real-time diagnostic techniques and AI-based decision-support systems are dignified to redefine autoimmune disease management. In conclusion, AI proposed a considerable prospect to facilitate the early recognition, diagnosis, and management of various medical problems including autoimmune diseases.

Key Words: Artificial Intelligence• Autoimmune disease • Axial spondyloarthritis

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Introduction :
Artificial intelligence (AI) techniques are encouraging fields of research in medicine nowadays especially after the huge application of AI in other life aspects with great & promising results . Intelligence is best described as the capability to acquire and perform proper skills to answer questions and reach aims that are compatible with certain situations . AI consists of machine learning (ML) and deep learning (DL) . ML is widely used to help both patients & health care providers . Principally , ML models used a 'training set,' and adjusted via a 'validation set' and then reviewed & compared to a 'testing set,' to get an ultimate, fair extent of the model's expectation skills [2].

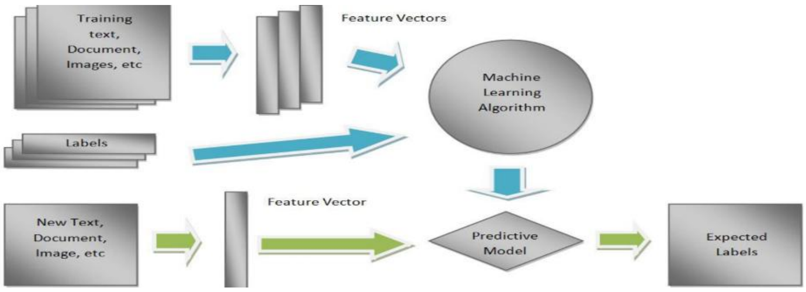


Figure 1 : supervised learning algorithm [3]

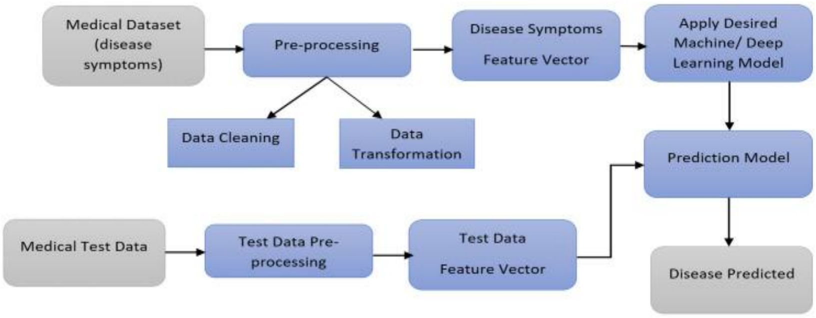


Figure 2 : Framework for disease detection system[4]

Deep Learning is best defined as the usage of enormous layers of artificial neural networks that work out with actual amount of representations, just mimicking the organization of nerve cells in brains of humans . Now , DL is considered as a popular ML tool , operating for most styles of ML . A large beneficial data gained from relatively limited or small amounts of via DL [1]. The observed assistances of deep learning methods are seen with formless data commonly found in rheumatology, such as patients images or slides and texts, where traditional machine learning methods have writhed to crack an abundance of data within these formats formats [5].

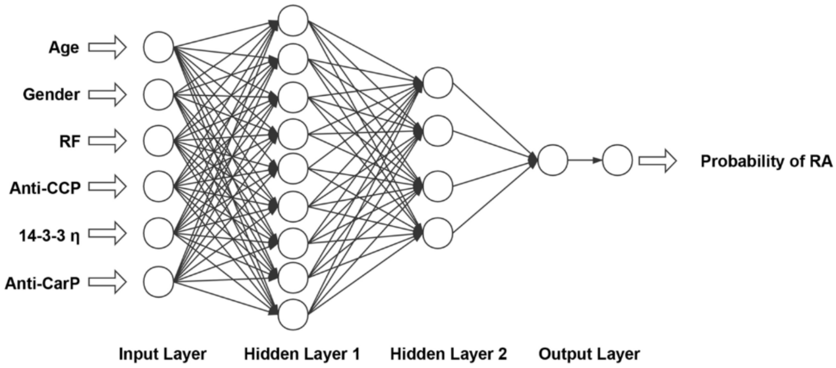


Fig. 4 : Example of Computational structure of the artificial neural network (ANN) [6].

Omic data which are best defined as patients' genomic, transcriptomic and proteomic profiles are progressively used by AI to give the accurate diagnosis & specific treatment depending on the genetic issues of the disease which may minimize the side effects of medications and achieve highly targeted therapy , and present more comprehensive representation of auto-inflammatory diseases with better & new understandings. Artificial intelligence systems have the ability to recognize significant findings or patterns among plenty of data, solving previously difficult questions .The ability to classify patients with autoimmune diseases via these data will influence their care, from assessment of such diseases risk to whole process of disease management and guessing the outcome[7].

Electronic diagnosis

The Online electronic diagnosis systems are commonly utilized by the public and health-care workers . Most of these systems are symptom checkers based on simple decision trees. Usually , They are based on textbook information , where group of symptoms will formulate a differential diagnosis. One study revealed that in about 65 % of cases, the exact diagnosis is within a list of the first twenty diagnoses listed and inflammatory arthritis is properly spotted in less than 20% . Nowadays, symptom checkers have forward-thinking in communication with patients. Chatbot systems can manage and reply to user's ideas effectively . Symptom checkers come to be more potent as they move to experience-based, deep learning models [8]. Till now , AI application in the scope of rheumatology has been comparatively little with regards to other medical aspects . AI has the ability to deeply improve the process of diagnosis and management plans of various rheumatological diseases . This review will highlights the advancements in AI techniques , the performance of various algorithms, and the integration of multimodal data for diagnosing of various autoimmune diseases . the ability of AI in analysis of radiological tests related to such diseases also will be reviewed . As well, it will discusses the challenges associated with AI utilizations , such as data limitations, interpretability, and ethical concerns .

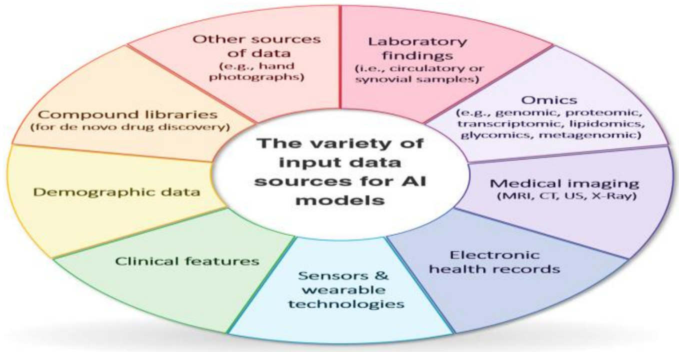


Fig.4 : The sources of input data for AI models [9].

Methodology:

This literature review was conducted by systematically searching databases for studies concentrating on the use of AI in diagnosing autoimmune diseases. Keywords included "artificial intelligence, machine learning, deep learning," and the names of particular autoimmune diseases. Data sources included peer-reviewed journals, clinical trials, and reviews. Studies were chosen considering its relevance, methodological accuracy and the availability of performance metrics such as accuracy, sensitivity, and specificity. The findings were categorized by each disease separately and AI techniques used.

Rheumatoid arthritis (RA):

Rheumatoid arthritis is a common autoimmune diseases and most of other diseases in this field related to RA in a way or another whether in the similarity of clinical features, elevations of inflammatory markers or options of treatment. The diagnosis of rheumatoid arthritis mainly is clinical supported in sometimes by positivity of certain autoantibodies , rises of inflammatory markers and universal x ray findings especially when the disease last more than 2 years. One classification criteria collected such data and recommend to exclude the mimics to put the patient in the category of RA [10] . automated systems have been widely utilized to establish RA diagnosis using AI systems such as artificial neural networks, random forest and support vector machine. AI algorithms have the ability to ease searching and recognition of likely diseased patients , diagnosing them using clinical, imaging , omics , sensor data and picking of the suspected diseased people within the electronic health record (EHR) systems [11]. AI has a significant prospective uses in different aspects of RA management to achieve optimal outcomes for such patients [12]. AI algorithms have shown promise in RA diagnosis. A study comprised an arrangement of patient's personal data and serology panels to aiming for accurate spotting of patients with RA via ANN . This project attained an AUROC 0.95 and F1 score of 0.916 , which refers to a great degree of accuracy [2]. Shiezadeh *et al.* achieved RA diagnosis on a group of ~2500 patients visit a rheumatology department in Iran. They used a group of decision trees and matched them with *k*-nearest neighbors and SVM systems. The accuracy of this model about 85% and sensitivity/specificity of 44%/74%. One study used random forests to isolate patients with RA via the clinical codes in the EMR . An accuracy of 92% was achieved , with very good sensitivity & specificity . Chin *et al.* worked for early-disease possibility of RA patients by using an EMR . The aim was to discern concealed factors and launch an assessment models using SVM. RA in the early stage was identified with good sensitivity and specificity [8]. O'Neil et al. used patient's blood proteome to detect patients who may develop RA (i.e., progressors) in the future within families of confirmed cases especially first-degree relatives [11]. Numerous ribonucleic acid (RNAs) within the blood of patients were searched to launch a precise diagnosis of RA using ML techniques. A study evaluated gene expression maps of blood cells in RA patients and recognized several differentially expressed genes , nine of them were identified as a hub genes with fundamental effects in RA pathogenesis [11].

Regarding radiological issues , AI techniques could efficiently recognize structural changes suggestive of certain diseases like rheumatoid arthritis (RA) & psoriatic arthritis aiding in establishing diagnosis of such diseases . AI can execute scoring system depending on radiological tests and give measurements rapidly.

Hand X-ray which is simple and inexpensive test can be used as an input data to diagnose RA patients with an accuracy touch 95% . One study created a model using hand X ray and CNNs to detect RA with an accuracy of 73% . MRI and ultrasound considered as good tests in spotting subtle soft tissue alterations . AI-based models are used in the recognition of bone attritions , synovial inflammation , edema of bone marrow and joint space reduction [11].

AI can examine CT images of metacarpophalangeal joints and spotting arthritis. One study had created a two-dimensional array images that can distinguish RA patients from clinical data. The results had a good agreement by a group of rheumatologists . Extracted features from lymphocyte pictures created by an automated image sensor had high accuracy for RA grouping. Of note , automated devices could translate optical pictures into a useful electronic data . Bardhan et al. established a unique classification system in RA patients appropriately tagging nearly 3/4 of the knee thermograph scans via thermograms [11].

Nowadays , ultrasound is commonly used tool to diagnose and monitor disease activity in RA . It is used to detect inflamed synovium and stage activity index with a great accuracy compared with an expert rheumatologist . Cartilage damage also can be assessed in patients with RA as done by Fiorentino et al. which benefit from CNNs to detect the cartilage boundaries and accurately measure the thickness. The prospect of ultrasound in rheumatology will utilize AI models to empower instantaneous image exploration and readings [2]. MRI of the hand with contrast enhancement can classify the image intensities into normal and inflamed synovium & measure degree of inflammation. This will facilitate automatic image recording and then classify the intensity as opposed to time curves with the resulting perfusion maps can be used to detect synovitis and quantify their extent [13]. The utilization of CNNs could lessen the effort by reducing the time for analysis and permitting computerized records examination [14].

Systemic Lupus Erythematosus :

Systemic Lupus Erythematosus (SLE) is an autoimmune disease with multi-systemic involvement. It is very diverse with regards to clinical & immunological representations . This complexity would result in a time lapse to reach the diagnosis with long-term consequences. The updated EULAR/ACR criteria in 2019 state that the presence of ANA positivity is an essential element for diagnosis . In the most recent era , a lot of studies have been made about the ability of ML to reach the diagnosis , subtyping of disease variants, predicting the course and possible complications and suggestion of management plan of SLE patients .

The value of plasma lipidome in diagnosis of SLE was assessed by Matthiensen and colleagues and showed a good results in segregating such patients from those with atherosclerosis . A study intended at evaluating the accuracy of 2019 EULAR/ACR criteria in SLE diagnosis by using a LASSO-LR model . The observed accuracy was about 94.8% in detecting SLE patients. Also, they established a predictive score termed SLERPI with a score more than seven achieve an excellent accuracy . Guthridge and colleagues have combined information from plasma, serum and RNA with clinical and immunological profiles. This facilitate identification of different disease groups according to molecular summary including the expression of interferon and disease activity . Another study act similarly & identify four SLE categories that are diverse in terms of the autoantibody summary , HLA type , immunological , clinical presentations & lymphocyte subsets. Lu and colleagues recognized four groups of SLE that contrasted in terms of clinical expressions . Reynold and colleagues were able to segregate SLE patients according to cytokine profile by using cluster analysis into three separate groups [15].

For the detection of LN & NPSLE , several vital biomarkers was identified using genomic and genetic expression datasets. Proteomics using cerebrospinal fluid could distinguish NPSLE from SLE controls (non-NPSLE). Others have used single-cell RNA sequencing data comparing biomarkers for NPSLE to multiple sclerosis and vascular dementia . A heavy work about the role of ML in detection of SLE patients are the in meta-analysis phases with valuable and promising results [16].

Using ML , A range of images from patients with SLE were evaluated including MRI of brain for the recognition of features related to NPSLE, retinal images to evaluate for retinopathy and skin images for various skin manifestations of SLE [17]. Mass spectrometry and magnetic beads were utilized to search for serum protein biomarkers from patients with SLE. A machine-learning model efficaciously anticipated SLE depending on several presumed biomarkers [18].

Ankylosing spondylitis

Axial spondyloarthritis or spondyloarthropathy (axSpA), a group of enduring diseases manifested by inflammation in the joints of axial skeleton preferentially involving sacroiliac joint . Ankylosing spondylitis is one of this group of diseases characterized by radiographic sacroiliitis . The expected interval between symptoms onset in a given patient and conclusion that these symptoms due to ankylosing spondylitis is around 13 years with resultant substantial bad effects on the patients, caretakers and community . The usual method for axSpA documentation in its early stages had a little performance. Aiming for this , they advanced ML models to expect the diagnosis . Using AI , the positive predictive value was five times greater in contrast to that of a clinical model . The EMR centered ML model recognized patients with axSpA with high accuracy up to 91.8% . The immediate and long-term results for such patients will be improved by using these models. The utilization of AI in radiology have a great future in diagnosing axSpA with some models perform similarly or best than radiologists in identifying inflammation of sacroiliac joint . The developments in imaging modalities & techniques allowed the scientists to identify a lot of people with non-classical axSpA especially when these data have integrated with useful clinical information [18]. One AI model was established to perceive sacroiliac inflammation manifested by bone marrow edema on MRI in patients suspected to have axSpA with about 100% specificity but 56% sensitivity [19],[20].

Utilizing AI techniques ; the prediction , diagnosis & expecting the prognosis of the AS patients are possible. A real-time intelligent diagnosis is possible by using a smartphone-captured photos . ML techniques were used by Deodhar et al. for feature selection prompting the diagnosis of AS. The data of over 182 million patients applied in multiple models for AS classification. Their model had achieved a good predictive value as compared to classical models of diagnosis. Kennedy et al. developed a model to guess who is probable to be diagnosed with AS in future with good predictive values was achieved around 70–80 %. Walsh et al. suggested clinical expert snippet-based classification for the three different identified axial SpA models with an excellent accuracy. Li et al. generated a smart model for AS diagnosis . They utilized X ray of sacroiliac joint for AS diagnosis. Using MRI , Tas et al. recommended a DL-based AS diagnosis approach depending on fine signs from datasets of MRI scans [21].

A multi-omic approach to reach AS diagnosis based on transcriptome and cell surface proteins assessment was done with excellent performance. Similarly. Han et. al used ML technique to find AS-specific mRNA biomarkers. Thirteen key feature mRNAs were identified . Li et al. used ML for searching about differentially expressed pyroptosis-related genes (DE-PRGs) for AS diagnosis. They identified key genes with respectable diagnostic capability having AUC reaching 0.881especilly GZMB. Newly, researchers used DL models for early identification of AS by using spectroscopy on dried serum samples [21]. Ye *et al* collect large group of patients diagnosed with axSpA pooling clinical risk factors with sacroiliac MRI radiomics . The incorporation of clinical radiomics had enhanced clinical diagnostic value as suggested by the AUC that was achieved approached 0.9 . In conclusion , ML can ease early AS diagnosis by integration of patient's clinical data, laboratory findings , imaging records , molecular and biological data [22]. The ML algorithm proved to have a great degree of precision and accuracy in the diagnosis of suspected cases of axSpA, which may be worthwhile in minimizing the time before securing the diagnosis [23].

Psoriatic arthritis

Psoriatic arthritis (PsA), it is a long lasting inflammatory arthritis causing joint disease in about 20% of those with skin psoriasis with nearly similar frequency in both genders . The average elapsed time from the onset of symptom to final diagnosis is 2.5 years. Timely diagnosis is important because as any hesitation in treatment initiation can cause joint attritions with consequent deformity and resultant affection of health related quality of life especially concerning of the association of PsA and cardiovascular issues . The usual standards for diagnosis of PsA is Classification Criteria (CASPAR) needs incorporation of data from physicians, laboratory results and radiology . A novel tool named PredictAI™, utilized ML models for quick recognition of patients with a high possibility of inflammatory disorders like PsA. The diagnosis of PsA within the first 4 years before the settlement of true provisional diagnosis was evaluated using PredictAI™ . Notably, this instrument does not need doctors or patient participation. This system precisely recognized up to half of them one to four years before a clinician's diagnosis [24].

One case-control study used convolutional neural network to predict the risk of PsA for a certain patients with psoriasis in the next 6 months. The results advocate that the risk prediction model can find patients with psoriasis at a high risk of PsA. . The genetic signature was used to catch the differences between PsA and cutaneous psoriasis with good results [25].

The genetic aspect of musculoskeletal features in psoriasis and AS was studied by Zhang et al. where PUM1 and ZFP91 were identified as important biomarkers [27].

Systemic sclerosis

Systemic sclerosis (SSc) is a rare autoimmine disease that can affect different body systems with heterogeneous features and well known delayed diagnosis . ML can be utilized to classify SSc patients and recognize those at threat of problems related to disease complications . ML may be worthwhile in the timely detection of organ involvement. ML could help physicians predict organ involvement and allow a tailored treatment according to genetics, autoantibody profile and organ involvement . Also, ML help in finding new biomarkers that could affects the follow-up [28]. The ACR/EULAR 2012 classification criteria have been used to diagnose SSc , progresses in AI can be used to improve the accuracy in diagnosis, prognosis and treatment outcomes. Several studies attempting to diagnose SSc patients with accuracy ranged from 85.4% to 87.7% . In one study, AI technique was used to allocate histological images of SSc to subsets of disease and relate them to specific genetic biomarkers to assess disease severity . One of these studies used random forest and GLMnet to identify interstitial lung disease (related to SSc) progression from a set of high-resolution computed tomography (HR-CT) images. All of the studies were able to utilize ML in talented ways with high level of accuracy in identifying SSc subtypes [29].

Jamian and colleagues used ML techniques to detect SSc from the Electronic Health Record with an excellent accuracy . Franks and colleagues evaluate skin biopsy to classify patients with SSc depending on molecular subsets with good result using ML techniques . Huang and colleagues integrate ML tools with gene set enrichment analysis (GSEA) to classify ILD patients depending on flow cytometry, . This may aid earlier diagnosis of interstitial lung disease in SSc patients and guide their management accordingly thereby improving the outcome [30].

Recently , a shared work to assess the capacity of AI to detect patterns of microangiopathy in nailfold capillaroscopy (NFC) images of patients with SSc via a Vit system . About the classification of NFC into presence and absence of scleroderma pattern, the human observers reached a dense agreement of 81%. In conclusion, the ViT is simple to use and trustworthy tool for evaluating NFC images and could be of assistance in detecting NFC changes [31]. One study to look for efficacy of AI in efficiently interpret the HRCT image details of SSc-ILD. The study demonstrate that specific lesions of ILD could change after treatment [32]. As well , analysis of gene expression data in such patients was done using ML. Samples taken from peripheral blood of those patents with SSc-ILD with a 92.2% accuracy in identifying about 172 genes that might be related to the disease. Beside to the differentiation between control and patients, the proposed algorithm was capable to discriminate between different variations of the illness [33].

The face identification of possible patients with SSc by utilizing AL was attempted with good accuracy through automated pre-processing. Face images of 60 SSc pts from the websites were compared to a group of age and sex matched control faces. They were able to recognize SSc typical facial appearance with range of specificity and sensitivity [34] .

Sjögren's syndrome (SjS) :

It is an inflammatory disorder manifested by sicca symptoms affecting any mucosal surface including eyes , mouth & vagina as the main clinical features. With the aid of the DL system , the US has high diagnostic ability for SjS when the static images were carefully chosen by an experienced radiologist. Therefore, this advocates that DL is clinically worthy [35]. DL could have an excellent diagnostic ability for recognition of SjS on CT as done by well-trained radiologists [36].

The integrations of ML and metabolomics can perfectly differentiate those with pSS. The 2-Hydroxypalmitic acid, L-carnitine and cyclic AMP as a potential targets and biomarkers are confirmed to have a close correlation with the development of pSS with good accuracy [37].

The use of classic healthcare data to classify patients as having pSS was trialed using ML techniques with possible development of standard CDSS for detection of pSS in primary care units [38]. In this scope , one study utilizing ML algorithms based on several genes was conducted. They were well designed and attained an overall AUCs of more than 0.972 in the training and testing datasets. The immune microenvironment of pSS were also described in this study in specific details & the results were promising in providing new bases and ideas about pSS diagnosis [39].

Behcet disease :

Behçet's disease (BD) is a long-lasting autoimmune vasculitis of unknown cause affecting several body systems . It is characterized by recurrent oral and genital ulcerative lesions, skin and ocular problems . Eye complications seen in about 50 % of BD patients with poor visual outcome . Detection of those at risk for visual loss permits commencement of proper management plan to avoid further problems . ML keep the potential to improve patient categorization , expect outcome and predict treatment response . ML techniques were used to highlight the misclassification rate of BD-uveitis among large number of cases of panuveitis with an excellent accuracy . Guler and Ubeyli created a model for the recognition of ocular Behcet's disease basing on Doppler signals of ophthalmic artery with great results. Image analysis using AI algorithm showed good results and it is practical for the supportive diagnosis of Behcet's disease concerning those with uveitis and may aid in clinical diagnosis and treatment in the near future [40].

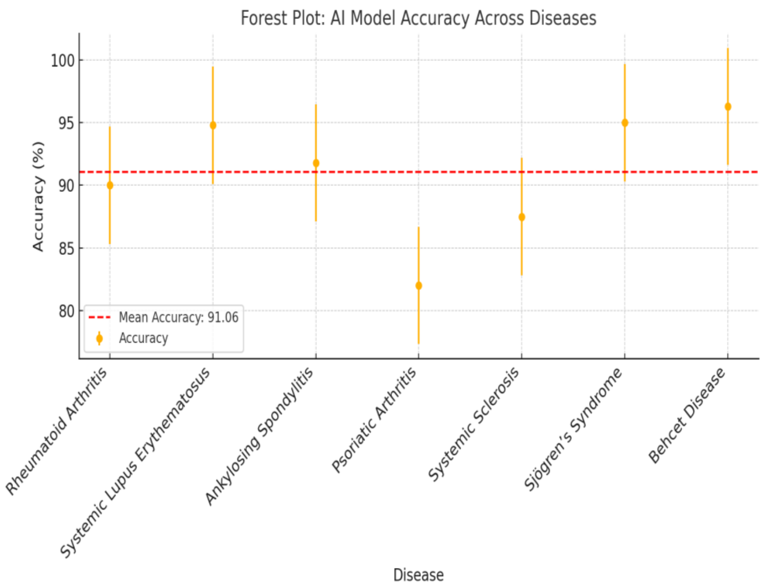
Results :

The results of this review has been summarized with the aid of AI in (table 1) where the results of each disease are discussed regarding the AI models used , the accuracy being achieved , the data sources and the practical applications of these results .

Disease	AI Models/Methods	Key Metrics (Accuracy)	Data Sources	Applications
Rheumatoid Arthritis	ANN, SVM, Random Forest, CNNs	85-95% (varied by study)	EHR, Imaging (X-ray, MRI, Ultrasound)	Diagnosis, Prognosis, Drugs Development
Systemic Lupus Erythematosus	LASSO-LR, Clustering, CNNs	94.8% (LASSO-LR), AUC: 0.95	Genomics, Clinical profiles, Imaging	Subtype Classification, Disease Course Prediction
Ankylosing Spondylitis	SVM, Radiomics, DL (CNNs)	91.8% (ML model), AUC > 0.95	MRI, Radiomics, Transcriptomics	Early Diagnosis, Prognosis
Psoriatic Arthritis	PredictAI™, CNNs	82% (ML-based models)	Genomics, Clinical Data	Risk Prediction, Diagnosis

Systemic Sclerosis	Random Forest, GLMnet, CRF	85-90% (varied by study)	HRCT, Genomics, Capillaroscopy	Subtype Identification, Early Detection
Sjögren's Syndrome	DL, ML-based metabolomics	AUC > 0.972	Ultrasound, CT, Metabolomics	Diagnosis, Biomarker Discovery
Behcet Disease	Delta-bar-delta algorithm, AI image analysis	Accuracy: ~96%	Doppler, Imaging	Diagnosis, Treatment Response

Table 1 : AI applications in Autoimmune Disease Diagnosis



Metric	Value
Mean Accuracy	91.05714285714285
95% CI Lower	86.38084340342334
95% CI Upper	95.73344231086236

Figure 4 showed the meta-analysis for accuracy which has been summarized in the above table and visualized in a forest plot.

The mean accuracy of AI models across these autoimmune diseases is approximately **91.06%**, with a 95% confidence interval of **86.38% to 95.73%**.

Discussion

The AI utilizations is best performing in analyzing difficult and huge datasets, joining the dots in early diagnosis and aiding in the design of suitable predictive model. The use of Artificial Intelligence (AI) in the diagnosis and management of autoimmune diseases has displayed substantial potential, as shown by this literature reviewed. AI models suggest a noteworthy tools that incorporate imaging, clinical, and molecular data together and then analyze & present them again in a simple and understandable manner. Through several autoimmune diseases, AI models prove notable accuracy, sensitivity, and specificity, with several models beating classical diagnostic methods. The findings underscore the potential of AI to improve autoimmune diseases diagnosis through improved diagnostic accuracy, timely disease recognition, and tailored managements plans.

Performance Trends

The meta-analysis shows that AI techniques attain a mean accuracy around **91.06%** through the studied autoimmune diseases. The Convolutional Neural Networks (CNNs) and remaining deep learning techniques do best in image-based diagnosis , with accuracies often exceeding **90%** for diseases like Rheumatoid Arthritis (RA), Ankylosing Spondylitis (AS), and Systemic Lupus Erythematosus (SLE). Likewise , Random Forests and Support Vector Machines (SVMs) have showed robust performance in the interpretation of structured data, such as electronic health records (EHRs) and genomic profiles.

Challenges and Limitations

Despite these great and promising results of AI utilizations , a lot of obstacles may be faced including :

Data availability : most AI systems depends on big , high-quality datasets for training, which may not be feasible in every clinical settings. For rare autoimmune diseases like Systemic Sclerosis (SSc), data heterogeneity and scarcity limit model performance.

Interpretability: The black-box nature of many deep learning models, such as CNNs, raises concerns about the transparency and interpretability of diagnostic decisions.

Ethical issues : especially when dealing with peoples privacy, data security, and possible faults in model training.

Generalizability: The performance of AI models often depends on the population and setting in which they are trained. Ensuring the generalizability of models across diverse populations is crucial.

Future Directions

Multi-Modal AI Models: Upcoming researches should focus on incorporating multiple data sources, such as clinical, imaging, and genomic data, to force diagnostic accuracy and permits individualized management plans.

Instantaneous Diagnostics: Innovations in real-time AI tools, such as PredictAI for Psoriatic Arthritis, can revolutionize early disease detection and risk prediction.

Collaborative Databases: Establishing large, collaborative databases of autoimmune disease cases can improve model training and validation, particularly for rare diseases

Conclusion

In summary , the reached conclusion of this review is that AI denotes a transformative potency in the diagnosis and management of autoimmune diseases. The improvements in AI techniques , radiomics, and multi-omics integration, AI models offer superior accuracy, early detection abilities, and individualized solutions. High lightening the challenges and fences such as data scarcity, model interpretability, and ethical issues will be serious in ensuring the clinical application of AI technologies. By promotion novelty, cooperation, and clearness, AI has the ability to re-shape the prospect of autoimmune disease care.

Refernces:

[1] C. Manning, “Artificial Intelligence Definitions,” *HAI Stanford Univ.*, no. September, p. 2020, 2020.

[2] V. J. Gilvaz and A. M. Reginato, “Artificial intelligence in rheumatoid arthritis: potential applications and future implications,” *Front. Med.*, vol. 10, no. November, pp. 1–7, 2023, doi: 10.3389/fmed.2023.1280312.

[3] D. Ucar-Comlekoglu, A. Fox, and H. N. Sen, “Gender differences in Behçet’s disease associated uveitis,” *J. Ophthalmol.*, vol. 2014, no. doi.org/10.1155/2014/820710 Review, 2014, doi: 10.1155/2014/820710.

[4] A. L.-A., F. A.M., and O. R.N., “Medication adherence and persistence in patients with autoimmune rheumatic diseases: A narrative review,” *Patient Prefer. Adherence*, vol. 12, pp. 1151–1166, 2018, doi: 10.2147/PPA.S165101 LK - http://resolver.ebscohost.com/openurl?sid=EMBASE&issn=1177889X&id=doi:10.2147%2FPPA.S165101&atitle=Medication+adherence+and+persistence+in+patients+with+autoimmune+rheumatic+diseases%3A+A+narrative+review&stitle=Patient+Preference+Adherence&title=Patient+Preference+and+Adherence&volume=12&issue=&spage=1151&epage=1166&aulast=Anghel&aufirst=Laura-Alexandra&auinit=L.-A.&aufull=Anghel+L.-A.&coden=&isbn=&pages=1151-1166&date=2018&auinit1=L&auinitm=-A.

[5] C. McMaster *et al.*, “Artificial Intelligence and Deep Learning for Rheumatologists.,” *Arthritis Rheumatol. (Hoboken, N.J.)*, vol. 74, no. 12, pp. 1893–1905, Dec. 2022, doi: 10.1002/art.42296.

[6] L. Bai, Y. Zhang, P. Wang, X. Zhu, J. W. Xiong, and L. Cui, “Improved diagnosis of rheumatoid arthritis using an artificial neural network,” *Sci. Rep.*, vol. 12, no. 1, pp. 1–7, 2022, doi: 10.1038/s41598-022-13750-9.

[7] I. S. Stafford, M. Kellermann, E. Mossotto, R. M. Beattie, B. D. MacArthur, and S. Ennis, “A systematic review of the applications of artificial intelligence and machine learning in autoimmune diseases,” *npj Digit. Med.*, vol. 3, no. 1, 2020, doi: 10.1038/s41746-020-0229-3.

[8] M. Hügle, P. Omoumi, J. M. van Laar, J. Boedecker, and T. Hügle, “Applied machine learning and artificial intelligence in rheumatology.,” *Rheumatol. Adv. Pract.*, vol. 4, no. 1, p. rkaa005, 2020, doi: 10.1093/rap/rkaa005.

[9] S. Momtazmanesh, A. Nowroozi, and N. Rezaei, “Artificial Intelligence in Rheumatoid Arthritis: Current Status and Future Perspectives: A State-of-the-Art Review.,” *Rheumatol. Ther.*, vol. 9, no. 5, pp. 1249–1304, Oct. 2022, doi: 10.1007/s40744-022-00475-4.

[10] J. Kay and K. S. Upchurch, “ACR/EULAR 2010 rheumatoid arthritis classification criteria.,” *Rheumatology (Oxford).*, vol. 51 Suppl 6, pp. vi5-9, Dec. 2012, doi: 10.1093/rheumatology/kes279.

[11] R. Rokutanda, M. Kishimoto, and M. Okada, “Update on the diagnosis and management of Behçet ’ s disease,” *Open Access Rheumatol. Res. Rev.*, vol. 7, pp. 1–8, 2015.

[12] D. Zhang *et al.*, “Research hotspots and trends of artificial intelligence in rheumatoid arthritis: A bibliometric and visualized study.,” *Math. Biosci. Eng.*, vol. 20, no. 12, pp. 20405–20421, Nov. 2023, doi: 10.3934/mbe.2023902.

[13] B. Stoel, “Use of artificial intelligence in imaging in rheumatology-current status and future perspectives,” *RMD Open*, vol. 6, no. 1, pp. 1–10, 2020, doi: 10.1136/rmdopen-2019-001063.

[14] M. Yahalom, L. Bloch, K. Suleiman, B. Rosh, and Y. Turgeman, “Cardiovascular Involvement in Behçet Disease: Clinical Implications,” *Int. J. Angiol.*, vol. 25, no. 5, pp. e84–e86, 2016, doi: 10.1055/s-0035-1551796.

[15] F. Ceccarelli *et al.*, “Application of Machine Learning Models in Systemic Lupus Erythematosus.,” *Int. J. Mol. Sci.*, vol. 24, no. 5, Feb. 2023, doi: 10.3390/ijms24054514.

[16] Y. Zhou, M. Wang, S. Zhao, and Y. Yan, “Machine Learning for Diagnosis of Systemic Lupus Erythematosus: A Systematic Review and Meta-Analysis.,” *Comput. Intell. Neurosci.*, vol. 2022, p. 7167066, 2022, doi: 10.1155/2022/7167066.

[17] K. Zhan, K. A. Buhler, I. Y. Chen, M. J. Fritzler, and M. Y. Choi, "Systemic lupus in the era of machine learning medicine," *Lupus Sci. Med.*, vol. 11, no. 1, pp. 1–13, 2024, doi: 10.1136/lupus-2023-001140.

[18] J. A. Walsh, M. Rozycki, E. Yi, and Y. Park, "Application of machine learning in the diagnosis of axial spondyloarthritis," *Curr. Opin. Rheumatol.*, vol. 31, no. 4, pp. 362–367, 2019, doi: 10.1097/BOR.0000000000000612.

[19] A. Bordner *et al.*, "A deep learning model for the diagnosis of sacroiliitis according to Assessment of SpondyloArthritis International Society classification criteria with magnetic resonance imaging," *Diagn. Interv. Imaging*, vol. 104, no. 7, pp. 373–383, 2023, doi: https://doi.org/10.1016/j.diii.2023.03.008.

[20] S. Lee *et al.*, "Artificial intelligence for the detection of sacroiliitis on magnetic resonance imaging in patients with axial spondyloarthritis.," *Front. Immunol.*, vol. 14, p. 1278247, 2023, doi: 10.3389/fimmu.2023.1278247.

[21] S. Dhall, A. Vaish, and R. Vaishya, "Machine learning and deep learning for the diagnosis and treatment of ankylosing spondylitis- a scoping review," *J. Clin. Orthop. Trauma*, vol. 52, no. January, p. 102421, 2024, doi: 10.1016/j.jcot.2024.102421.

[22] Y. Chen, H. Liu, Q. Yu, X. Qu, and T. Sun, "Entry point of machine learning in axial spondyloarthritis," *RMD Open*, vol. 10, no. 1, pp. 1–7, 2024, doi: 10.1136/rmdopen-2023-003832.

[23] R. Sengupta *et al.*, "P261 Early and accurate diagnosis of patients with axial spondyloarthritis using machine learning: a predictive analysis from electronic health records in the United Kingdom," *Rheumatology*, vol. 61, no. Supplement_1, p. keac133.260, May 2022, doi: 10.1093/rheumatology/keac133.260.

[24] J. Shapiro *et al.*, "Evaluation of a machine learning tool for the early identification of patients with undiagnosed psoriatic arthritis – A retrospective population-based study," *J. Transl. Autoimmun.*, vol. 7, p. 100207, 2023, doi: https://doi.org/10.1016/j.jtauto.2023.100207.

[25] L. T.-J. Lee, H.-C. Yang, P. A. Nguyen, M. S. Muhtar, and Y.-C. J. Li, "Machine Learning Approaches for Predicting Psoriatic Arthritis Risk Using Electronic Medical Records: Population-Based Study.," *J. Med. Internet Res.*, vol. 25, p. e39972, Mar. 2023, doi: 10.2196/39972.

[26] M. Köhm *et al.*, "POS0273 A MACHINE LEARNING ALGORITHM BASED ON AUTOMATICALLY EXTRACTED IMAGE FEATURES AND CLINICAL DATA ON MORNING STIFFNESS CAN DISTINGUISH PSORIATIC ARTHRITIS PATIENTS FROM CONTROLS IN CLINICAL ROUTINE CARE," *Ann. Rheum. Dis.*, vol. 83, no. Suppl 1, pp. 375 LP – 376, Jun. 2024, doi: 10.1136/annrheumdis-2024-eular.5205.

[27] Y. P. Zhang *et al.*, "Osteoarticular Involvement-Associated Biomarkers and Pathways in Psoriasis: The Shared Pathway With Ankylosing Spondylitis," *Front. Immunol.*, vol. 13, no. March, pp. 1–11, 2022, doi: 10.3389/fimmu.2022.836533.

[28] F. Bonomi *et al.*, "The Use and Utility of Machine Learning in Achieving Precision Medicine in Systemic Sclerosis: A Narrative Review.," *J. Pers. Med.*, vol. 12, no. 8, Jul. 2022, doi: 10.3390/jpm12081198.

[29] E. P. McMullen, R. S. Grewal, K. Storm, L. Mbuagbaw, M. R. Maretzki, and M. J. Larché, "Can machine learning assist in systemic sclerosis diagnosis and management? A scoping review," *J. Scleroderma Relat. Disord.*, pp. 1–7, 2024, doi: 10.1177/23971983241253718.

[30] G. Murdaca *et al.*, "A Machine Learning Application to Predict Early Lung Involvement in Scleroderma: A Feasibility Evaluation.," *Diagnostics (Basel, Switzerland)*, vol. 11, no. 10, Oct. 2021, doi: 10.3390/diagnostics11101880.

[31] A. Garaiman *et al.*, "Vision transformer assisting rheumatologists in screening for capillaroscopy changes in systemic sclerosis: an artificial intelligence model," *Rheumatol. (United Kingdom)*, vol. 62, no. 7, pp. 2492–2500, 2023, doi: 10.1093/rheumatology/keac541.

[32] J. Zhao *et al.*, "sclerosis - interstitial lung disease imaging features," *Rheumatol. Int.*, no. 0123456789, 2024, doi: 10.1007/s00296-024-05681-7.

[33] G. Alfonso Perez and R. Castillo, "Identification of Systemic Sclerosis through Machine Learning Algorithms and Gene Expression," *Mathematics*, vol. 10, no. 24, 2022, doi: 10.3390/math10244632.

[34] A. Fryxelius, "Pos0202-Pare Chronically Active - a Patient Empowerment Program With Peer Support," pp. 326.1-327, 2023, doi: 10.1136/annrheumdis-2023-eular.2159.

[35] Y. Kise *et al.*, "Usefulness of a deep learning system for diagnosing Sjögren's syndrome using ultrasonography images.," *Dentomaxillofac. Radiol.*, vol. 49, no. 3, p. 20190348, Mar. 2020, doi: 10.1259/dmfr.20190348.

[36] Y. Kise *et al.*, "Preliminary study on the application of deep learning system to diagnosis of Sjögren's syndrome on CT images.," *Dentomaxillofac. Radiol.*, vol. 48, no. 6, p. 20190019, Sep. 2019, doi: 10.1259/dmfr.20190019.

[37] K. Wang, J. Li, D. Meng, Z. Zhang, and S. Liu, "Machine learning based on metabolomics reveals potential targets and biomarkers for primary Sjogren's syndrome," *Front. Mol. Biosci.*, vol. 9, no. September, pp. 1–12, 2022, doi: 10.3389/fmolb.2022.913325.

[38] J. T. Dros *et al.*, "Detection of primary Sjögren's syndrome in primary care: developing a classification model with the use of routine healthcare data and machine learning," *BMC Prim. Care*, vol. 23, no. 1, pp. 1–10, 2022, doi:

10.1186/s12875-022-01804-w.

[39] K. Yang, Q. Wang, L. Wu, Q. C. Gao, and S. Tang, "Development and verification of a combined diagnostic model for primary Sjögren's syndrome by integrated bioinformatics analysis and machine learning," *Sci. Rep.*, vol. 13, no. 1, pp. 1–11, 2023, doi: 10.1038/s41598-023-35864-4.

[40] Y. Ji *et al.*, "Research Progress of Artificial Intelligence Image Analysis in Systemic Disease-Related Ophthalmopathy," *Dis. Markers*, vol. 2022, 2022, doi: 10.1155/2022/3406890.