



AI-Powered Clinical Decision Support Systems in Disease Diagnosis, Treatment Planning, and Prognosis: A Systematic Review

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Received: 12 Feb 2025

Published: 16 Jun 2025

Abstract

Background: Artificial intelligence (AI) is transforming healthcare with applications that can surpass human performance in prevention, detection, and treatment. This systematic review aimed to collect and assess the impact and success of AI technologies across various healthcare domains.

Methods: A systematic search of major databases (including PubMed, Scopus, and ISI) was conducted for articles published up to 2023. Keywords related to AI-driven disease detection, classification, and prognosis were used. Non-English articles or those with inaccessible full texts were excluded. Data was extracted by two researchers, and the quality of selected articles was evaluated based on the strengths and limitations stated by the authors.

Results: In total, 123 articles were included. AI contributions were categorized into three areas. For disease detection (n=75), Coronavirus disease 2019 (COVID-19) was the most frequent topic (n=18), followed by oncology. Chest X-rays were the most common input (n=15). In disease classification (n=23), oncology (especially breast cancer) was the most researched field (n=7), primarily using breast imaging. For prediction and prevention (n=25), oncology was again the most studied category, with clinical and laboratory parameters being the most utilized input (n=12).

Conclusion: AI-driven clinical decision support systems (CDSS) exhibit strong diagnostic and prognostic accuracy in imaging and laboratory settings. However, many models function as "black boxes," which limits interpretability and clinician trust. Data bias and challenges in integrating AI tools into practice also persist. The findings suggest that future work should focus on explainable AI and rigorous real-world validation to safely implement these tools in healthcare.

Keywords: Artificial Intelligence, Clinical Decision Support Systems, Diagnosis, Treatment, Prognosis, Disease, Prediction

Conflicts of Interest: None declared

Funding: None

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Cite this article as: xxxxx. AI-Powered Clinical Decision Support Systems in Disease Diagnosis, Treatment Planning, and Prognosis: A Systematic Review. *Med J Islam Repub Iran*. 2025 (16 Jun);39:81. <https://doi.org/10.47176/mjiri.39.81>

Introduction

Artificial Intelligence (AI) is a multidisciplinary study that aims to create a machine capable of perceiving data, inferring information, reaching intelligence, wisdom, cognition, and ultimately making decisions. AI aims to assist human beings in their decision-making by preparing a framework for processing all data at the same time, and presenting logical thinking and problem-solving (1). These machines are designed to handle vast, complex tasks without limitations in time or accuracy (2).

According to the literature, AI is applied in a broad range of applications, technologies, and facilities, from software programs to robots. Like the other services and jobs, using AI in medical care is inevitable today (3). AI could compensate for some care delivery deficiencies, such as a lack of manpower and time-consuming tasks (2). Generally, AI is used in prevention, early detection of disease, and personalized and targeted therapy. Using a variety of computational tools, AI can process different types of data, such

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↑What is "already known" in this topic:

Artificial intelligence (AI)-powered clinical decision support systems (CDSS) demonstrate high diagnostic and prognostic accuracy in imaging and laboratory settings. However, challenges such as the "black-box" nature of models, dataset biases, and integration barriers into clinical workflows limit their widespread adoption and trust among healthcare providers.

→What this article adds:

This systematic review provides a focused analysis of AI-powered CDSS across diagnosis, treatment, and prognosis, addressing architectural suitability (eg, CNNs for imaging, RNNs for temporal data). It critically examines limitations, proposes strategies for explainability and bias mitigation, and highlights ethical and workflow considerations for real-world deployment.

as laboratory, clinical, images, signals, et cetera, to find irregular patterns of disease, perform estimation, and prediction. The ability to work with multimodal data creates a holistic view for physicians to make quick and precise decisions.

Studies show that AI may enable better disease prevention, diagnosis, and treatment. Among the main fields of disease that use AI tools, we can mention basic interventions in the fields of cancer, neurology, cardiology, and diabetes (4-6). For instance, many studies in radiologic diagnosis of different types of lung disease find the remarkable diagnostic value of various types of AI methods (7-9). However, there is a need for research to comprehensive study and address the effect of AI applications on healthcare. Therefore, here, we systematically reviewed the evidence to find the effect of different AI methods usage on the medical interventions classified as prevention, diagnosis, and treatment.

Methods

Study Design

Search Strategy and Study Screening Process: This systematic review was conducted in 2024. Iran University of Medical Sciences approved the study (IR.IUMS.REC.1401.711). To select appropriate and relevant studies, an extensive electronic search was conducted. For this purpose, PubMed, ISI, Cochrane, Scopus, Embase,

Science Direct, and Elsevier databases were searched. Articles published until 2023 were searched. To select studies, by applying Mesh term strategy we used keywords such as "AI powered," "AI powered," "AI- powered," "AI assisted," "AI assisted," "AI based," "AI based," "AI enabled," "AI enabled," "AI aided," "AI aided," "Machine learning powered," "Machine learning assisted," "Machine learning based," "Machine learning enabled," "Machine learning aided," "Deep learning powered," "Deep learning assisted," "Deep learning based," "Deep learning enabled," "Deep learning aided," "Neural Network Computer," "Computer based," "Computer assisted," "Computer enabled," "Computer aided," "Computer powered," "System based," "System assisted," "System enabled," "System aided," "System powered," "AI," "Deep learning," "Machine learning," "Clinical Decision Support Systems," and "Clinical Decision Support". Based on the main purpose of the study, the keywords of prevention, classification, and diagnosis (detection) were also used to search for studies. The types of included studies were intervention clinical trials, randomized controlled trials, case-control, prospective and retrospective cohort, and cross-sectional. Also, references to the selected articles were searched manually. For an extensive search, 3 researchers conducted the resource search process separately and eventually coordinated the selected studies.

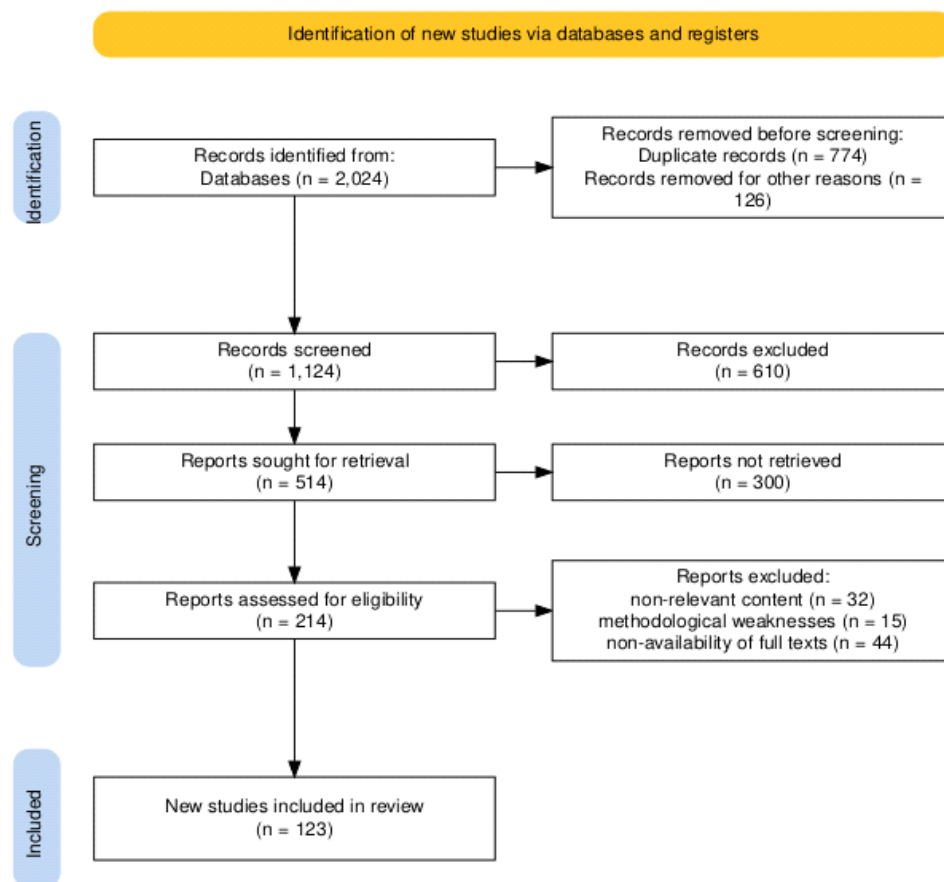


Figure 1. Finding and screening flowchart

In the first search phase, 2024 articles were selected. Duplicated articles were detected by 1 researcher and supervised by a subsequent researcher using EndNote (X17) software, and 1250 articles were removed. The criteria used for duplication detection were similar in the titles, first author name, and the year of publication. Here, we focus on the open-access journals and those publicly available for the possibility of further investigation. A total of 126 articles were excluded due to full-text unavailability. The number of remaining articles after this process reached 648. Subsequently, the titles and abstracts of articles were evaluated based on inclusion criteria, and 243 articles met the inclusion criteria. Using a full-text review, 120 articles were excluded due to inappropriate content. Finally, 123 eligible studies were reviewed. The finding and screening flowchart was plotted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram tool (10) and reported in Figure 1.

Inclusion and Exclusion Criteria

We considered all studies with any study design as eligible for inclusion if they examined PICO as a tool (Table 1) for developing a search strategy for identifying potentially relevant studies. We applied other restrictions in this review, such as studies related to the English language. Also, for quality assessment, we used evaluation criteria that are usual in artificial intelligence in medicine journals, including accuracy, precision, et cetera. We evaluate AI-based systems rather than the process of diagnosis. The articles whose full texts were not accessible were excluded.

Data Extraction

A standard checklist was developed for data collection and extraction. The design of the checklist was done under the supervision of the AI expert of the project. The designed checklist included the information of the extracted articles, such as the name of authors, year of publication, the country where the study took place, the type of AI model, the type of disease, the type of data processed, the AI performance measures and the limitations that mentioned in the manuscripts. To evaluate the quality of the selected articles, the strengths and limitations expressed in the articles by the authors were used as a proxy for the quality evaluation tool of the selected studies. Data extraction was done by 2 researchers of the study under the supervision of an AI expert. Any ambiguities and disagreements were listed and discussed in a session by these 2 researchers. If any problem remained after the discussion, it was investigated and resolved by the third person in the study. In the data-extracting process, the effort was to ensure that there was no missing data.

The methodological quality and potential for bias of the selected studies, particularly those evaluating diagnostic accuracy, were assessed using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool. This tool evaluates studies across 4 key domains: patient selection, index test, reference standard, and flow and timing. Each domain was assessed for risk of bias, and the first 3 domains were also evaluated for concerns regarding applicability.

Results

This review included studies published until 2023. Through a systematic search of electronic databases and manual screening of references, 123 articles were identified. The findings of this review indicated that AI has made significant contributions to the field of medicine in various areas, including diagnosis, prognosis, and classification. Based on these findings, our included articles were classified into these three parts, presented in Tables 2 to 4.

Application of Artificial Intelligence in the Detection of Diseases

Our review identified a total of 75 studies that employed AI algorithms for the early detection and diagnosis of medical conditions. The details of each study, including the AI model used, performance measurement, data types, and study limitations (if available), are shown in Table 2. These studies have covered a wide range of conditions, with respiratory infections, including COVID-19 disease, being the most commonly studied topic (in 18 out of the 75 studies).

The second most researched field in this category was oncology, with a focus on gastrointestinal and skin cancers.

AI was used in various applications for detection, ranging from the interpretation of medical images to the analysis of clinical and laboratory data. In this category, chest X-ray images were the most frequently used inputs (in 15 of the 75 studies), followed by CT scan images (in 9 of the 75 studies). It is worth noting that AI-based systems demonstrated high accuracy and efficiency in detecting abnormalities.

In this category, out of 75 studies reviewed, 37 studies (49.3%) have employed “deep learning methods,” while 22 studies (29.3%) utilized “machine learning methods.” This demonstrates a significant reliance on deep learning algorithms for the accurate detection and diagnosis of medical conditions.

Classification

In the domain of classification, our review identified 23 studies that employed AI techniques to categorize medical data into distinct classes.

Table 1. Description of the PICO Components

Population or Problem	Intervention	Comparison	Outcome
Studies of any study design that have investigated the use of AI in the diagnosis, classification, and prediction of diseases.	Any type of applied AI models	Investigating the efficacy of AI models compared to existing standard medical methods	sensitivity, specificity, accuracy, etc.

Table 2. AI in the detection and diagnosis of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurement	Country	limitation
Abbasi, 2022 (11)	machine-learning	XGBoost random forest SVM	COVID-19	6710	chest X-ray	F1 score: 0.90 ROC curve: 0.96	Pakistan	N/A
Abdelhamid, 2022 (12)	deep-learning	transfer-learning TensorFlow `optimization algorithm: RMSprop	COVID-19	7395	chest X-ray	accuracy: 99.3 sensitivity: 99 specificity: 99 F1-Score: 99.3	online dataset	N/A
Akgün, 2021 (13)	Deep Learning	VGG19, ResNet50V2, Dense-Net121, and MobileNet	COVID-19	460	cough sound	accuracy: 86.42%	Cambridge data	N/A
Ali, 2022 (14)	convolutional neural networks		COVID-19 (Omicron virus)	915	chest X-ray	ROC: 0.9888 Sensitivity: 96.2 Accuracy: 98 Precision: 100	Egypt	N/A
Alotaibi, 2022 (15)	Deep Learning	Long-term and short-term memory CNN-bidirectional LSTM CNN-LSTM	Ischemic Stroke	48	MRI	F1 score: 75.3 Accuracy: 70.2 Precision: 68.1 F1 score: 94.2 Accuracy: 94.2 Precision: 94.5 F1 score: 93.8 Accuracy: 93.8 Precision: 96.5	online dataset	N/A
Aponte-Hao, 2021 (16)	machine learning	XGBoost model	frailty	5,466	Clinical Frailty Scale (CFS)	sensitivity: 78.14 specificity: 74.41	Canada	N/A
Babukarthik, 2022 (17)	Deep Learning	Genetic Deep Learning Con- volutional Neural Net- work (GDCNN) Particle Swarm Optimization	COVID-19	5071	chest X-ray	accuracy: 97.23 sensitivity: 98.62 specificity: 97.0 precision: 93.0	publicly availa- ble datasets	N/A
Balgetir, 2021 (18)	deep learning	VGG16, VGG19, ResNet, DenseNet, MobileNet, NasNetMobile, and NasNetLarge.	multiple sclerosis	105	images showing plantar pressure distribution	accuracy: 89.23 sensitivity: 89.65 specificity: 88.88		N/A
Baz, 2022 (19)	deep learning	deep learning model dubbed Parallel Convolution Neuron Net- works (PCN2)	COVID-19	328	chest X-ray	accuracy: 99.9 F1-score: 0.99	online dataset	N/A

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Bendifallah,2022 (20)	Machine learning	ML models such as Logistic Regression (LR), Random Forest (RF), Decision Tree (DT), eXtreme Gradient Boosting (XGB), and hard/soft Voting Classifier are considered ensemble learning techniques	endometriosis	8000	features about diagnosis, symptoms, imaging, medical treatment, fertility and surgical treatments, and follow-up.	sensitivity: 1 specificity: 80 F1-score: 88	online dataset	N/A
Bhargava, 2022 (21)	machine learning	K-NN	COVID-19	31,454	chest X-ray / CT images	Accuracy: 91.70 Sensitivity: 90.69 Specificity: 88.70	nine distinct datasets	N/A
		SRC				Accuracy: 94.40 Sensitivity: 72.00 Specificity: 86.00		
		ANN				Accuracy: 96.16 Sensitivity: 91.20 Specificity: 97.40		
		SVM				Accuracy: 99.14 Sensitivity: 92.86 Specificity: 99.86		
Bozkurt, 2020 (22)	machine learning	Decision Tree, Support Vector Machines, k-Nearest Neighborhood Algorithm and Ensemble classifiers.	Obstructive Sleep Apnea	10	ECG	Accuracy: 85.12 Sensitivity: 85 Specificity: 86	Turkey	N/A
Chen, 2019 (23)	deep learning	receptive field block, dense up sampling convolution	Prostate cancer	50	MRI	Recall: 90.82 Precision: 85.53 F1-score: 88.10	dataset from MICCAI Grand Challenge	small sample size
Chen, 2022 (24)	multiple learning	deep attention-based MIL	Lung cancer	1018	Chest CT images	Recall: 87 accuracy: 80 PPV: 92 NPV: 59 AUC: 84	Lung Image Database Consortium (LIDC-IDRI)	being depended on preexisting or human expert segmentation
Choi, 2021 (25)	Deep learning	Deep learning-based CAD algorithm (DCAD)	thoracic abnormalities	244	chest X-ray	AUC: 0.9112	Korea	the algorithm covered only 3 major thoracic lesions

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Deperlioglu, 2020 (26)	Deep learning	Autoencoder Neural Networks (AEN)	Cardiovascular diseases	449 409	heart sounds	Accuracy: 100 Sensitivity: 100 Specificity: 100 Accuracy: 99.8 Sensitivity: 99.65 Specificity: 99.13	PASCAL dataset PhysioNet dataset	Potential interruptions in wireless communication and negative user experiences
Ding, 2021 (27)	convolutional neural network	algorithm named 'HRNet'	oral and maxillofacial disease	912	facial images		China	Lower accuracy for abnormal group compared to normal group
Asmare, 2021 (28)	machine learning	support vector machine classifier	Rheumatic Heart Disease	170: 124 cases 46 controls	heart sound	F1-score: 96.0 ± 0.9 recall: 95.8 ± 1.5 precision: 96.2 ± 0.6 specificity: 96.0 ± 0.6	in-house collected data with data from a freely available public database	N/A
Padmavathi Kora, 2017 (29)	Neural Network	Particle Swarm Optimization	Myocardial Infarction	1806	ECG Signals	99.3% accuracy, sensitivity of 99.97%, and specificity of 98.7%		N/A
Yuan Liu, 2020 (30)	deep learning	deep convolutional neural network	skin diseases	16114	Skin Image	accuracy: 0.66	USA	N/A
Zhiyong Liu, 2021 (31)	deep learning	ResNet-101 and RPN networks	prostate cancer		ultrasound image		China	N/A
Erito Marques de Souza Filho, 2022 (32)	Machine Learning	Logistic Regression (LR), KNearest-Neighbors (KNN), Classification and Regression Tree (CART), AdaBoost (AB), Gradient Boosting (GB), Extreme Gradient Boosting (XGB), Random Forests (RF) and Support Vector Machine (SVM)	Depression	100	clinical-laboratory and sociodemographic data	accuracy> .85	Brazil	Low socio-economic information and data
Muhammed, M, 2021 (33)	deep learning	Alex Net is the CNN model	COVID-19		chest X-ray	accuracy of 97.97%	Nigeria	N/A

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Ju Gang Nam, 2019 (34)	deep learning	deep learning-based automatic detection algorithm	Malignant Pulmonary Nodules	600	chest X-ray	specificity of 100%	South Korean	only included malignant nodules - small nodules
Alvaro D. Orjuela-Cañón, 2022 (35)	Machine Learning	algorithm-in-the-loop	tuberculosis	233	smear sample	accuracy 78%, sensitivity 90% , specificity 33%	Colombia	high incidence of TB in the data set, selection bias
ChunSu Park, 2022 (36)	deep learning	N/A	bone marrow edema	73	MRI	sensitivity (79%) specificity (90%)	Korea	n/A
Hatice Catal Reis, 2022 (37)	Deep Learning	InceptionResNetV2, InceptionV3, Mobile Net, ResNet-101, DenseNet-169, NASNetMobile, Efficient-NetB0 algorithms	Covid-19	2400	CT and Chest X-Ray images	96.58 % sensitivity	Turkey	a small dataset - jpeg format
Prottoy Saha, 2021 (38)	Deep Neural Network	convolutional neural network(, EMCNet)	COVID-19	4600	chest X-ray	98.91% accuracy	Bangladesh	misclassify some COVID-19-positive cases as negative
Arkaprabha Sau, 2019 (39)	Machine Learning	CatBoost, Logistic Regression, Naïve Bayes, Random Forest	anxiety and depression	470	online public data	accuracy 82.6 % and precision 84.1%	India	N/A
Vijendra Singh, 2022 (40)	Deep Neural Network	Support Vector Machine (SVM), K-Nearest Neighbor (KNN), Logistic regression, Random Forest, and Naïve Bayes classifier	Chronic Kidney Disease	N/A	lab features	accuracy 100%	usa	small data sets
Fu M, 2018 (41)	Deep Learning	Multi-layer up-sampling structure	pancreas cancer	236	CT images	Precision: 77.36 ± 17.96, Recall:79.12 ± 16.27, DSC: 76.36 ± 14.34, JAC-CARD: 63.72 ± 17.05	China	N/A
Ghazal TM, 2022 (42)	Deep Learning	AlexNet , MATLAB 2020a	Skin cancer	2400	image	Accuracy: 87.1% Sensitivity: 89.0% Specificity: 94.2% PPV: 93.2% NPV:82.5%	Malaysia UAE Pakistan	N/A

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Gopalakrishnan T, 2022 (43)	Deep Learning	Synergic Deep Learning (SDL) method with extreme Gradient Boosting (XGBoost), called SDL-XGBoost	Muscular dystro-phy		MRI images	Accuracy: 96.18 Precision:87.60 Sensitivity: 97.92% Specificity: 95.64% F-Score: 92.44 Kappa:0.1800	India KSA Saudia Arabia Yemen	N/A
Hemanth DJ, 2020 (44)	Deep Learning	CNN model with eight layers: image input layer, convolutional layer, ReLU layer, cross-channel normal-ization layer, max pooling layer, fully connected layer, softmax layer, and classifica-tion layer.	diabetic retinopa-thy	400	retinal fundus images	ShuffleNet	India Turkey	N/A
Hsu FR, 2022 (45)	Deep Learning	ShuffleNet	Biliary atresia (BA)	1976	ultrasound images	Accuracy: 90.57% Precision:85.08% Sensitivity: 67.83% Specificity: 96.76% F-Score: 75.48% AUC: 92.62%	Taiwan	the size of the US image database, the doubt of over fitting, and more requirements of test sets for verifi-cation. In addition, the overdiagnosis of BA by ShuffleNet was an issue
Hu S, 2020 (46)	Deep Learning	Portable Handheld Slit-Lamp Based on a Smartphone Camera	cataract	N/A	N/A	N/A	China	N/A
Huang C, 2022 (47)	Deep Learning	Deep Transferred Efficient-Net with SVM (DTE-SVM)	Tuberculosis	N/A	CT images	Accuracy: 94.62±1.00 Precision: 95.30±1.24 Sensitivity: 93.89±1.96 Specificity: 95.35±1.31 F-Score: 94.62±1.00	China	N/A
Hussain L, 2020 (48)	Machine learn-ing	Decision Tree (DT), Naïve Bayes (NB), SVM Gaussian, SVM RBF and SVM Polynomial	congestive heart failure	72	RR time series inter-val data	Sensitivity (93.06%), Specificity (81.82%), Accuracy (88.79%), AUC (0.95)	Saudi Arabia Pakistan	N/A

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Hussain W, 2019 (49)	Machine learning	a new entropy index Permutation Fuzzy Entropy (PFEN)	Epileptic Seizure	21	EEG	accuracy of 98.72%, sensitivity of 98.82%, specificity of 98.63%	China Japan	N/A
Hwang EJ, 2019 (50)	Deep Learning	deep learning-based automatic detection algorithms (DLADs)	Active Pulmonary Tuberculosis	65548	chest X-ray	classification performance of 0.977–1.000, localization performance of 0.973–1.000, Sensitivities and specificities for classification were 94.3%–100% and 91.1%–100%	Korea	N/A
Jia X, 2022 (51)	Machine learning	WOA-SVM model	Breast Cancer	683	clinical data of breast cancer	Accuracy: 99%	China	N/A
Jia Yj, 2022 (52)	convolutional neural network	convolutional neural network VGG16 and gradient enhanced tree model	Lung Disease		Chest sonography	Accuracy: 0.415 F-value: 0.452 Recall:0.496	China	N/A
Jo Y,2017 (53)	Deep Learning	HoloConvNet	optical screening of anthrax spores		holographic imaging	Accuracy:96.3%	Korea	N/A
Kaiume M, 2021 (54)	Deep Learning	a software based on a deep convolutional neural network (DCNN)	Rib fracture	256	CT images	Sensitivity: 0.645 (0.586–0.703) , PPV:0.793 (0.738–0.848)	Japan	N/A
Khan T,2019 (55)	Deep Learning	a deep learning classifier with 8 layers	Snoring	1000	sound	Accuracy: 0.96	USA	N/A
Khurana Y, 2022 (56)	Deep Learning	ResNet-50, EfficientNetB0, VGG-16 and a custom convolutional neural network (CNN)	COVID-19	8000	chest CT & X-ray	Precision:99.8% Specificity: 99.8% F1-Score: 98.7% Recall: 97.6%	India	N/A
N. Toda, 2023 (57)	Machine Learning	N/A	detecting pulmonary nodules, masses	453	chest X-ray	mean wAFROC FOM score: 93	Japan	small and designed datasets, CT not used for ground truth labeling, US FDA guideline instead of Japanese guidelines are used.
S. Toften, 2021 (58)	neural network	N/A	sleep apnea	40	Somnofy and pulse oximetry signal	Cohen's kappa: 0.81	Norway	small data

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S. Toraman, 2020 (59)	convolutional neural network	N/A	COVID-19		chest X-ray	accuracy:97.24	Turkey	small data
S. Trajanovski, 2021 (60)	deep learning	N/A	tongue squamous cell carcinoma	N/A	hyperspectral imaging (HSI)	average dice coefficient=0.891±0.053 area under the ROC-curve=0.924±0.036	China	N/A
K. E. Trinkley, 2021 (61)	Machine Learning	N/A	drug-induced long QT syndrome	7510	Electronic health record	N/A	United States	more analytical approaches, more types of data
L. M. Tseng, 2020 (62)	deep learning	N/A	Ventricular fibrillation	N/A	ECG	recall: 99 accuracy: 97	Taiwan	N/A
A. S. Vatian, 2022 (63)	Deep Learning	N/A	acute myocardial infarction		ECG	accuracy:85 F-scores : 74	Russian	N/A
J. Verdu-Diaz, 2020 (64)	Machine Learning	N/A	Genetic diagnosis of muscular dystrophies	976	MRIs	accuracy: 95.7 sensitivity : 92.1 specificity: 99.4	Russian	N/A
R. Verma, 2023 (65)	Machine Learning	N/A	glaucoma		fundus images	Precision: 97.2 Recall: 97.3 accuracy: 97.1	India	N/A
M. Viscaino, 2021 (66)	Deep Neural Network	based on convolutional and recurrent neural networks for video otoscopy analysis.Long Short-term Memory	Ear disorders	875	video otoscopy	accuracy: 98.15 precision : 91.94 sensitivity : 91.67 specificity : 98.96 F1-score : 91.51	Chile	N/A
M. Viscaino,, 2022 (67)	convolutional neural network	N/A	otologic diagnosis		images	accuracy: 92 sensitivity: 85 specificity: 95 precision: 86 F1-score : 85	Chile	N/A
H. Wang, 2022 (68)	Deep Learning	N/A	Brown adipose tissue	368	PET/CT images	average DICE coefficient (DSC): 0.9057 average Hausdorff distance: 7.2810	United States	small data
J. Wang, 2021 (69)	convolutional neural network	N/A	Congenital heart disease	1308	five-view echocardiograms video records	accuracy: 93.9	china	small data
X. Y. Wu, 2022 (70)	Machine Learning	N/A	Coronavirus disease	21	CT imaging	accuracy: 59 Sensitivity: 91.2 Specificity: 18.5 false-positive rate: 81.5	China	single center, data type, and AI model

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Y. Xiang, 2021 (71)	Deep Learning	(DenseUnet composed of encoder module , context extraction module and decoder module was established)automatic segmentation model based on the magnetic resonance image	N/A	19	MRI images	accuracy: 81	China	small data
C. N. Xu, 2022 (72)	convolutional neural network		glioma	470	MR images	Dice coefficient: 0.81 intraclass correlation coefficients: 0.75 area under the curve: 0.958		computational resources
L. Yan., 2021 (73)	convolutional neural network	feature selection module based on attention mechanisms	cervical lesions	1400	colposcopy image	sensitivity: 74.6 accuracy: 85.5 specificity : 95.7 AUC :0.909	China	N/A
Z. H. Yao, 2021 (74) S. L. Yi, 2022 (75)	deep learning Machine Learning	(ResLab) N/A	bacterial vaginosis rectal cancer	1078<	image ultrasound images	accuracy: 82.19 accuracy: 94.66 precision: 94.7 recall: 94.65 F1 values : 94.67 accuracy: 0.773	china china	N/A N/A
T. Yin, 2022 (76)	Machine Learning	upport vector machine (SVM)	functional dyspepsia	745	FD patients were collected from two clinical trials		china	N/A
W. Zeng, 2022 (77)	convolutional neural network	N/A	Fetal head circumference	999	ultrasound images	mean absolute difference: 1.97(± 1.89) Dice similarity coefficient: 97.61	china	N/A
Y. Zeng, 2020 (78)	Deep learning	N/A	colorectal cancer	26000	optical coherence tomography (OCT)	sensitivity: 100 specificity: 99.7 AUC: 0.998	United States	small traing data
Q. Zhang, 2019 (79)	Deep learning	N/A	hyperlipidemia	446	physiological information and doctors' diagnosis results	accuracy: 91.49 sensitivity: 87.50 specificity: 93.33 precision: 87.50 N/A	china	all factors not consider
X. N. Zhang, 2022 (80)	Clinical decision support systems	N/A	Type 2 diabetes		State-University Partnership Learning Network		United States	N/A

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Z. Zhang, 2022 (81)	Deep Learning	N/A	meibomian gland dysfunction	2420	Image	sensitivity: 88 specificity 81	China	N/A
C. Zhao, 2021 (82)	convolutional neural network	N/A	Melanoma	2420	mei-bography images	Jaccard index: 86.84	china	N/A
A. E. Zhdanov, 2023 (83)	machine learning	N/A	retinal dystrophy		signal	N/A	Romania	N/A
J. Zhou, 2022 (84)	N/D	N/A	espiratory function evaluation	220	spirometers signal	accuracy: 68	China	N/A
X. J. Zhou, 2022 (85)	convolutional neural network	N/A	dental	210 patients with one or more caries and 94 patients without caries	panoramic radiographs	accuracy: 0.8272 precision: 0.8538 recall: 0.8770 F1 score: 0.8652 AUC: 0.9005	china	N/A

Table 3. AI in classification of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurement	Country	limitation
Abdalla, 2020 (86)	conventional neural network	N/A	Arrhythmia		ECG		Dataset from Physionet, MIT	N/A
Alzubaidi, 2021 (87)	Deep Learning	N/A	breast cancer	400	H&E-stained breast biopsy images	Accuracy: 93.2	BACH 2018 Grand Challenge dataset	N/A
			diabetic foot ulcers	754	foot skin images	precision: 95.1 recall: 94.5 F1 score: 94.8	DFU 2 dataset	N/A
			wound types	783	wound images	precision: 88.1 recall: 84.8 F1 score: 86.4 accuracy: 87.94 Recall: 0.9990 Precision: 0.9990 F1-Score: 0.9990 Accuracy: 0.9990	a combination of Google search images and DFU 2 dataset	N/A
Ara, 2022 (88)	Deep Learning	VGG network CNN models	Diabetic Macular Edema (DME), Choroidal Neovascularization (CNV), Drusen	84,000	Optical Coherence Tomography Images		publicly available dataset	N/A
Badawy, 2021 (89)	fuzzy logic and deep learning	Eight CNN based SS models have been utilized: FCN-AlexNet, UNet, SegNet-VGG16, SegNet-VGG19, and DeepLabV3+(ResNet18, ResNet50, MobileNet-V2, and Xception.	breast cancer	1200	breast ultrasound images	accuracy: 95.45 intersection over union: 78.70 F1- score: 68.08	MT_small_dataset.	N/A
Bajaj, 2017 (90)	NNLS classifier	CoHOG and Eig(Hess)-CoHOG	Alcoholism	120	alcoholic EEG signals	Accuracy: 95.83 Sensitivity: 100 Specificity: 91.67 accuracy: 95	Online dataset	N/A
Basha, 2021 (91)	quasi-reflection-based learning procedure	swarm intelligence-driven convolutional neural network	brain tumor	16000	Brain MRI		Online dataset	N/A
Burlina , 2017 (92)	deep learning	transfer learning and universal features derived from deep convolutional neural networks (DCNN).	age-related macular degeneration	5664	fundus images	accuracy: 79.4, 81.5, 93.4 for different classifications	NIH AREDs dataset	N/A

Table 3. AI in classification of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurment	Country	limitation
Hua Li – 2019 (93)	deep learning	DenseNet-II neural network m	Breast cancer	2042	mammogram images	accuracy of 94.55%	China	
Eduardo Ramirez, 2019 (94)	neural networks and fuzzy systems	type-1 and type-2	2-lead cardiac arrhythmias	N/A	electrode signals or leads	92.90% and 92.70% of classification	Mexico	N/A
Xinbo Ren, 2023 (95)	deep learning	lock-SegNet (DBSegNet)	cardiovascular	22210	optical coherence tomography (OCT) images	91.81%	China	N/A
Dr. K. SRI-DHAR, 2022 (96)	Deep Neural Network	ResNet and DenseNet, CNN	Leukemic Cells	N/A	blood cell counts	accuracy of 95.59%	India	N/A
Gholami E, 2021 (97)	convolutional neural network	deep non-parametric transfer (DNPT), DeepRF	Gastric cancer	970	tongue images	Accuracy: 73.78	Iran	the size of the input network
Gite S, 2023 (98)	deep learning	U-Net ++	TB or other pulmonary lung diseases	662	X-ray images	Dice: 0.9796 Specificity: 0.9932 Mean-iou: 0.9598 Sensitivity: 0.9753 Recall: 0.9838 Precision: 0.9685 Accuracy: 0.9874 accuracy: 83.49	India	N/A
Y. Tashtoush (99)	convolutional neural networks	CNN that is augmented with convolutional block attention modules (CBAM)	Lung cancer	N/A	CT lung		United States	small data
C. M. Vasile, 2021 (100)	deep learning ensemble method	that fused two deep learning models, one based on convolutional neural network and the other based on transfer learning (5-CNN, VGG-19)	thyroid disorders	N/A	ultrasound images	accuracy: 97.35 specificity: 98.43 Sensitivity: 95.75 positive predictive value: 95.41 negative predictive value: 98.05 N/A		need representative images, small data
W. Y. Wang, 2023 (101)	Deep Learning	PointNet++	knee arthroplasty	N/A	Image		China	N/A
T. Wongsiricho, 2018 (102)	hybrid ASSC technique, Multi-Layer Hybrid Machine Learning Model	Decision Tree (DT) and Support Vector Machine	sleep disorder	100	polysomnographic data signal	accuracy: 0.694±0.22 in subject-specific classification and 0.942±0.02 in subject-independent classification.	Thailand	N/A

Table 3. AI in classification of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurment	Country	limitation
L. Yi, L. Zhang, 2022- (103)	multi-label soft-max loss (MLSL)	N/A	lung nodules	N/A	image	AUC: 82.78	china	N/A
J. B. Zang, 2022 (104)	deep residual network model	N/A	Cardiovascular disease	152	ECG	accuracy : 97.89	china	N/A
V. Zarikas, 2015 (105)	Bayesian networks (BNs)	N/A	pulmonary infections	N/A	lab data	sensitivity: 90	Austria	N/A
J. Zech, 2018 (106)	Natural Language Modeling	bag-of-words (BOW), word embedding, and Latent Dirichlet allocation-based approaches		96 303	CT reports text	AUC: 0.966 Sensitivity: 92.59 specificity : 89.67	United States	N/A
X. Zhang, 2021 (107)	decision support systems with team-based care	decision support systems with team-based care	type 2 diabetes		clinical data	online survey agree: 80	United States	N/A
Q. Zhao, 2023 (108)	deep learning	N/A			ECG	accuracy: highly consistent	china	N/A

Table 4. AI in determining prognosis of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurment	Country	limitation
Amyar,2022 (109)	multi-task multi-scale learning framework	multilayer perceptron and convolutional neural network (CNN)	lung cancers esophageal cancers	195	PET images PET images	area under the ROC curve:77 area under the ROC curve:71	France	N/A
Burdick, 2020 (110)	machine learning	XGBoost Classifier	COVID-19	197	clinical parameters	AUC: 0.86 Sensitivity: 0.90 Specificity: 0.58 LR+: 2.15 LR-: 0.17 DOR: 12.57	US	N/A
chicco, 2020 (111)	Machine learning	Random forests Gradient boosting SVM radial	heart failure	299	clinical parameters	F1 score: 0.754 Accuracy: 0.585 F1 score: 0.750 Accuracy: 0.585 F1 score: 0.720 Accuracy: 0.543 accuracy: 90	Pakistan	small size of the dataset
Bailoor , 2021 (112)	computational hemodynamic models	linear discriminant classifier	transcatheter aortic valve replacement	29	heart sound	accuracy: 90	United States	N/A
Shaline Jia Thean Koh1- 2022 (113)	deep learning	Inception-ResNet-v2 (Gradient Class Activation Map)	Covid-19	795	PCR	Accuracy:98.13%, sensitivity:97.7% specificity :99.1%.	Public open dataset	N/A
Renu Narain, 2016 (114)	Neural Network	quantum neural network	Cardiovascular	689	symptoms	98.57% accuracy	India	N/A
Roberto Negro,2020 (115)	machine learning	N/A	benign Thyroid Nodule	402	needle aspirations	accuracy:85% - sensitivity: 0.70; specificity: 0.99	Italian	criteria used for nodule classification - number of noduels
Nathan Orlando, 2020 (116)	deep learning	N/A	prostate segmentation		ultrasound images			
Uvais Qidwai, 2022 (117)	Machine Learning-Adaptive Neuro-Fuzzy Inference System	N/A	Age-related macular-degeneration	58	clinical examination data	accuracy (>92%)	united kingdom	low sample size
Xavier Rafael-Palou, 2022 (118)	Neural Network	hierarchical generative and probabilistic network	Lung Nodule		Lung Nodule image	accuracy of 84%	Spain	low sample size, segmentations were generated semi-automatically,our method relied on a single axial slice of the tumour

Table 4. AI in determining prognosis of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Perfomance, Measurment	Country	limitation
Göltepe Y, 2021 (119)	Machine learning	RF(Random forest); k-NN(k-nearest neighbors); NB(Naïve Bayes); LR(Logistic regression); DT(Decision tree); SVM(Support vector machine)	lung cancer	56	Images	Z-score Accuracy :0.83	Turkey	N/A
Han X, 2021 (120)	Deep Learning	LDDMM-based Registration Network	pancreatic cancer	40	CT and CBCT images	improved segmentation accuracy	USA	N/A
Hasimbegovic E, 2021 (121)	Machine learning	ML-based approaches for understanding complex clinical decision-making processes	Severe Symptomatic Aortic Stenosis	692	The cohort registry data	Area under the receiver operator char acteristics curve: 0.91 Accuracy:92% Sensitivity: 92% Specificity: 90%	Austria	N/A
Hossain MM, 2022 (122)	Fuzzy convolutional neural network (fuzzy CNN)	QUANTITATIVE FEATURE EXTRACTION MACHINE PSO BASED FINE-TUNED FUZZY CNN	Ultrasound Image Quality Identification	2600	Ultrasound Image	Accuracy (99.62%), Precision (99.62%), Recall (99.61%), F1-score (99.61%)	Bangladesh Saudi Arabia Australia	N/A
Jung JW, 2022 (123)	Machine learning	Extreme Gradient Boosting algorithm (XGBoost) model as a machinelearning classiier	postoperative delirium following knee arthroplasty	3980	Clinical data	AUC score was 0.82 (95% CI: 0.80 – 0.83) and the sensitivity, speciicity was 0.72 and 0.73 respectively.	Korea	N/A
Işık AH, 2013 (124)	Neural Network	BP-ANN-based Mobile Information Device Applet application is developed with the Java 2 Micro Edition environment.	Chronic Pulmonary Disease	486	Spirometry Data	Accuracy: 98.7% , Specificity: 97.83% , Sensitivity: 97.63% , Correlation values: 0.946	Turkey	N/A

Table 4. AI in determining prognosis of medical conditions

Study	AI Model	AI Mode details	Disease	Sample size	Data Type	AI Performance, Measurment	Country	limitation
G. Sumana, 2021 (125)	Neural Networks	N/A	renal syndromes		laboratory data	expert evaluation assessment	India	N/A
J. Tang, 2023 (126)	machine learning	including Backpropagation artificial neural network (BP-ANN), random forest (RF), support vector machine (SVM), and naive Bayes classifier (NBC)	Adrenocortical carcinoma	825	clinical data	5-year AUROCs=0.890, 0.847, and 0.854	China	small data
A. Vodenčarevic, 2018 (127)	machine learning	N/A	Rheumatoid Arthritis (RA), a chronic inflammatory disease		laboratory and pharmacy data	AUC value: 80	Netherlands	N/A
Y. J. Wang, 2022 (128)	Deep Learning	N/A	Alzheimer's Disease	127	dCDT images	accuracy: 85	China	small data
G. T. Werneburg, 2022 (128)	machine learning	kernel techniques	overactive bladder treatments OnabotulinumtoxinA (OBTX-A) injection and sacral neuromodulation (SNM). chronic kidney disease		clinical data	accuracy: 95	United States	N/A
C. H. Wu, 2015 (129)	neural network models fuzzy rule-based expert system	N/A	chronic kidney disease		clinical and lab data	accuracy: 88.40		N/A
I. Y. Zhang, 2023 (130)	machine learning	N/A	malignant tumor		clinical value	(for pediatric, adolescent, and young adult) average C-index = 86.8%, 85.2%, and 88.6% [average time-dependent AUC = 76.5%, 88.1%, and 99.0%	United States	not available data,
C. J. Zimmermann, 2021 (131)	feedback and adapted the tool	N/A	ill older adult trauma	48	trauma clinicians in Wisconsin, Texas, and Oregon	qualitative content analysis	United States	N/A
A. Vallée, 2022 (132)	N/A	N/A	human immunodeficiency virus (HIV)	8180	electronic medical record (EMR)	N/A	France	A patient with a previous HIV diagnosis was included, did not compare rates of HIV testing during the study

Table 3 presents the details of each study. These studies covered a wide range of medical conditions, with oncology (specifically breast cancer) being the most studied topic in 7 of 23 studies. Another widely researched area was cardiovascular diseases, which were addressed in 4 of 23 studies. AI algorithms demonstrated remarkable capabilities in accurately classifying patients based on various data, with breast images (ultrasound or mammograms) being the most used items.

Out of 23 articles reviewed in this category, 11 studies (47.8%) have utilized “deep learning methods.” In addition, 4 studies (17.4%) have utilized “neural networks,” further highlighting the versatility and effectiveness of AI in classifying medical conditions.

Prognosis and Prevention

In the domain of prognosis and prevention, our review identified 25 studies that leveraged AI methodologies to predict the progression and outcomes of medical conditions, as shown in Table 4. These studies covered a wide spectrum of diseases, ranging from heart failure to neurological disorders. Oncology again was the most studied field in this category. AI-based prognostic models exhibited impressive predictive performance, enabling clinicians to anticipate patient outcomes with greater accuracy and foresight. The category's most frequently used items were clinical and laboratory parameters, including PCR, used in 12 out of 25 articles. Furthermore, AI algorithms demonstrated the ability to identify prognostic factors that might otherwise go unnoticed, thereby facilitating early intervention and risk mitigation strategies.

Out of 25 articles reviewed in this category, 14 studies (56%) have utilized “machine learning methods” for prognosis and prevention tasks. However, deep learning methods were only employed in 4 articles (16%).

Comparing the 3 Classes

Furthermore, we evaluated research in the 3 classes based on sample size, AI models, and data type.

Figure 2 shows the comparison from the aspect of sample size. As the result shows for the classification, the AI-based system required a larger sample size. Also, detection and diagnosis need a larger sample size than prognosis. Considering the AI models, we first investigated the AI-based model as presented in Figure 3. The most used model is DL. Then, we analyzed them in each of the 3 classes. The most used model in detection-diagnosis and classification is the deep learning model, with about 49.3% and 47.8 %, respectively, and prognosis uses ML, with 56%. These results indicate that for detection and classification, deep learning is the most used model, while in prognosis, in which there is a need to find patterns among data, ML is the most used model that uses a smaller sample size than the deep learning model.

We further evaluated the classes from the aspect of data type in AI-based systems. As the results in Tables 2 to 4 indicate, in detection-diagnosis and classification, different modalities of images and signals are the 2 most used data types. More than 75% and 60% are images, and more than 15% and 26 % are signals in those 2 classes. Also, the most used data type in prognosis is laboratory data, with more than 53% usage. These results show that for detection and classification, images and signals carry proper information,

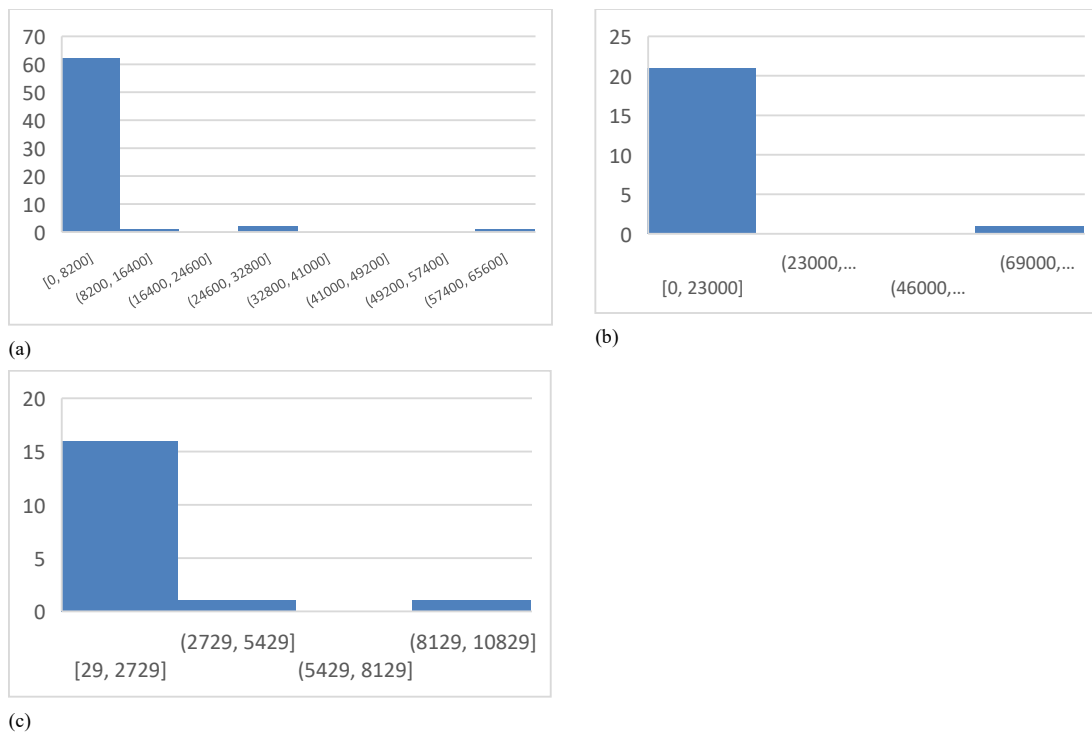


Figure 2. (A) Detection and Diagnosis, (B) classification, and (C) prognosis

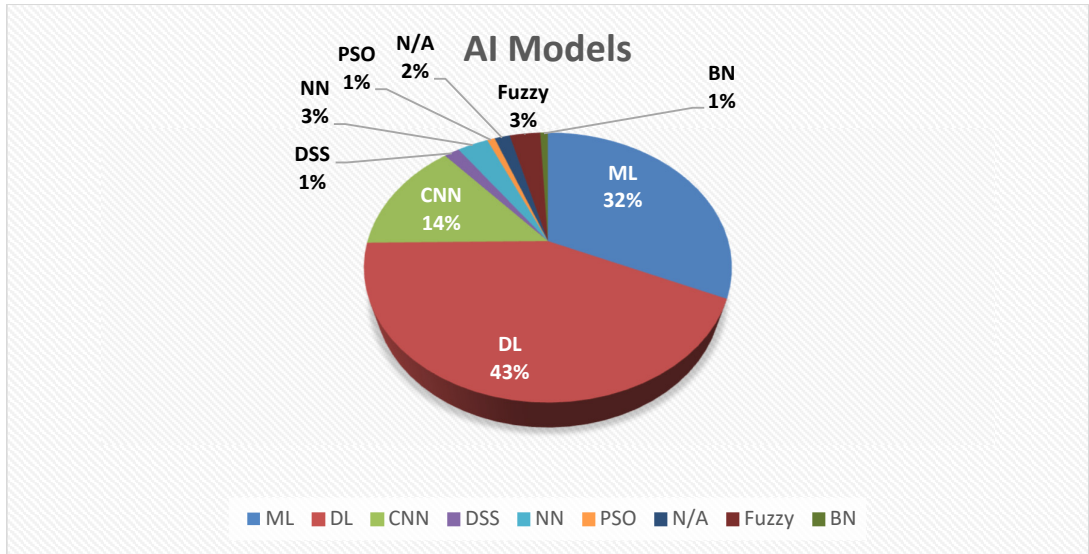


Figure 3. AI-based models in studies. Neural networks (NN), convolutional neural networks (CNN), and deep learning (DL) stand for 3 types of network-based ML algorithms, and ML class stands for the rest of the ML algorithms.

Table 5. Methodology checklist: the QUADAS-2 tool components for risk of bias assessment the selected studies (questions)

1. Was a consecutive or random sample of patients enrolled? (Yes / No / Unclear)
2. Was a case-control design avoided? (Yes / No / Unclear)
3. Did the study avoid inappropriate exclusions? (Yes / No / Unclear)
4. Could the selection of patients have introduced bias? (Risk: Low / High / Unclear)
5. Is there concern that the included patients do not match the review question? (Concern: Low / High / Unclear)
6. Were the index test results interpreted without knowledge of the results of the reference standard? (Yes / No / Unclear)
7. If a threshold was used, was it pre-specified? (Yes / No / Unclear)
8. Could the conduct or interpretation of the index test have introduced bias? (Risk: Low / High / Unclear)
9. Is there concern that the index test, its conduct, or interpretation differ from the review question? (Concern: Low / High / Unclear)
10. Is the reference standard likely to correctly classify the target condition? (Yes / No / Unclear)
11. Were the reference standard results interpreted without knowledge of the results of the index test? (Yes / No / Unclear)
12. Could the reference standard, its conduct, or its interpretation have introduced bias? (Risk: Low / High / Unclear)
13. Is there concern that the target condition as defined by the reference standard does not match the review question? (Concern: Low / High / Unclear)
14. Was there an appropriate interval between index test(s) and reference standard? (Yes / No / Unclear)
15. Did all patients receive a reference standard? (Yes / No / Unclear)
16. Did patients receive the same reference standard? (Yes / No / Unclear)
17. Were all patients included in the analysis? (Yes / No / Unclear)
18. Could the patient flow have introduced bias? (Risk: Low / High / Unclear)

while in prognosis, laboratory data analysis leads to extracting early signs of disease.

The specific signaling questions used for the methodological quality and potential for bias of the selected studies assessment, adapted from the standard QUADAS-2 checklist, are provided in Table 5. The summary of the risk of bias and applicability judgments for the diagnostic accuracy studies included in this review (as listed in Table 2) is presented in Figure 4.

Discussion

The information obtained from studies was analyzed from several aspects, including the applied AI models, the investigated disease, sample size, data type, and measurement criteria. Most studies used structures based on DL in the model section. The most used methods were deep learning, ML, CNN, hybrid fuzzy-based learning systems,

classical neural networks (NN), decision support systems (DSS), Bayesian network (BN), and particle swarm optimization (PSO). ML algorithms consist of two classes of non-network-based ML algorithms, such as random forest, and network-based ML algorithms, such as NN. Here, for precise classification, we separate each type of network-based algorithm of NN, CNN, and DL, which are mostly used in papers, and consider the rest of the ML algorithms as ML class.

From the point of view of diseases, the two top investigated diseases were COVID-19 and cancer. Also, in terms of data type, various medical data types such as images, signals, clinical data, and geographical data were used in studies. However, medical images were used as the data investigated in most of the studies.

In the sample size section, the largest data volume included 96,303 CT image samples, and the smallest included 19 MRI image samples. It shows that the proper sample size

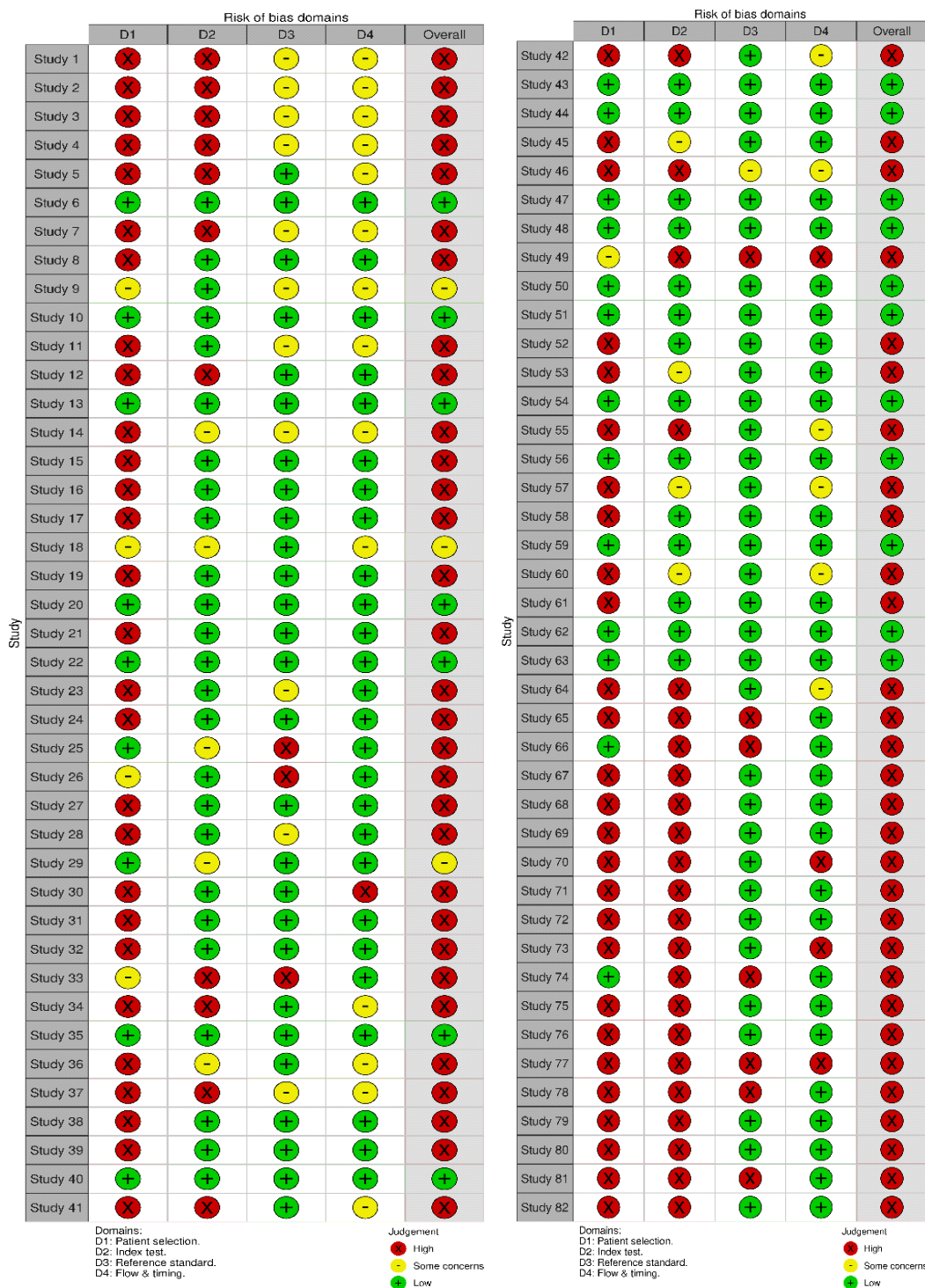


Figure 4. Methodology checklist: the QUADAS-2 tool for studies of diagnostic test accuracy (listed according to table 2)

depends on the applied model. Besides, it should be noted that this sample size variation might affect results. Moreover, on the measurement criteria, accuracy, specificity, F1-score, and area under the curve were among the most used criteria in studies, and the accuracy of the model was at the

top. The highest accuracy value of the models is equal to 99.9% in the diagnosis of COVID-19 using deep learning and 328 data points related to chest radiography, and also in the classification of diabetic macular edema using deep learning and 84000 tomographic images.

Risk of bias domains					
	D1	D2	D3	D4	Overall
Study 83	✗	✗	✗	+	✗
Study 84	✗	✗	✗	+	✗
Study 85	✗	✗	+	+	✗
Study 86	✗	✗	+	+	✗
Study 87	✗	✗	+	+	✗
Study 88	✗	✗	+	+	✗
Study 89	✗	✗	+	+	✗
Study 90	✗	✗	+	+	✗
Study 91	✗	✗	+	+	✗
Study 92	✗	✗	+	+	✗
Study 93	✗	✗	+	+	✗
Study 94	✗	✗	+	+	✗
Study 95	✗	✗	✗	✗	✗
Study 96	+	✗	+	+	✗
Study 97	✗	✗	+	✗	✗
Study 98	✗	✗	+	+	✗
Study 99	✗	✗	✗	✗	✗
Study 100	+	✗	+	+	✗
Study 101	✗	✗	+	+	✗
Study 102	✗	✗	+	+	✗
Study 103	✗	✗	✗	✗	✗
Study 104	✗	✗	+	+	✗
Study 105	✗	✗	+	+	✗
Study 106	✗	✗	+	+	✗
Study 107	✗	✗	+	+	✗
Study 108	✗	✗	+	+	✗
Study 109	✗	✗	+	+	✗
Study 110	✗	✗	+	+	✗
Study 111	✗	✗	+	+	✗
Study 112	✗	✗	+	+	✗
Study 113	+	✗	+	+	✗
Study 114	✗	✗	+	✗	✗
Study 115	✗	✗	+	+	✗
Study 116	✗	✗	+	✗	✗
Study 117	✗	✗	+	+	✗
Study 118	✗	✗	+	+	✗
Study 119	✗	✗	+	+	✗
Study 120	+	✗	+	+	✗
Study 121	✗	✗	✗	✗	✗
Study 122	+	✗	+	+	✗

Domains:
D1: Patient selection.
D2: Index test.
D3: Reference standard.
D4: Flow & timing.

Judgement
✗ High
+ Low

Figure 4. Methodology checklist: the QUADAS-2 tool for studies of diagnostic test accuracy (listed according to table 2)

Architectural Suitability and Domain Characteristics

CNNs are particularly well-suited to high-dimensional imaging tasks because their convolutional filters and pooling layers efficiently learn and aggregate spatial features,

such as edges, textures, and anatomical structures, across multiple scales. In contrast, RNNs (and LSTM variants) excel at modeling temporal dependencies in sequential data, such as time-series laboratory values or vital signs, by maintaining an internal state that captures information

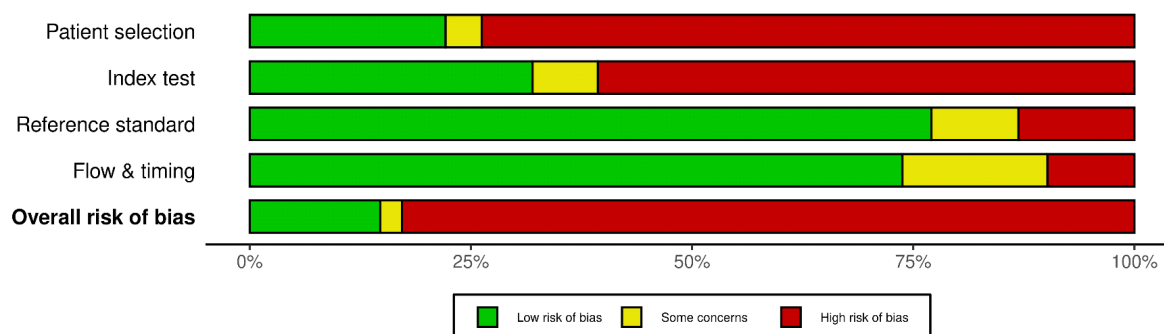


Figure 4. Methodology checklist: the QUADAS-2 tool for studies of diagnostic test accuracy (listed according to table 2)

across prior time steps. The nature of the input modality further dictates model choice and hyperparameter tuning: structured clinical data (eg, tabular lab results, demographics) often employ fully connected networks or tree-based models with feature engineering and regularization parameters (eg, learning rate, tree depth) optimized for tabular distributions, whereas unstructured imaging data require convolutional architectures with appropriately chosen filter sizes, depths, and spatial dropout rates to balance representational power and overfitting risk. Finally, hybrid CNN-RNN pipelines enable multimodal integration—first extracting spatial embeddings from images via CNNs, then modeling their temporal evolution or combining them with sequential clinical measurements in RNN layers—thereby capturing both spatial and temporal patterns for more comprehensive clinical predictions.

Limitations

A key strength of this study is its comprehensive and systematic approach, as it analyzed a wide range of studies from multiple reputable databases, ensuring a thorough review of AI applications in medical diagnosis, classification, and prognosis. Additionally, the study highlighted AI's significant contributions across different medical fields, particularly in disease detection and prediction, providing valuable insights for future research. However, a notable weakness is the lack of emphasis on the speed and efficiency of AI models, as the study primarily focuses on accuracy without discussing the practical implications of AI adoption in clinical settings. Another limitation is its exclusion of non-English studies and studies with inaccessible full texts, which may introduce selection bias and limit the generalizability of its findings. Furthermore, while the paper categorizes AI applications effectively, it does not critically assess the challenges of AI implementation, such as ethical concerns, data biases, and real-world integration hurdles. Finally, considering the interpretability and data requirements, we should explain that DL models, compared to ML models, are less interpretable and need more data. However, using explainable artificial intelligence (XAI) techniques, this problem can be solved. Also, the mentioned limitations in the studies include lack of data, having small datasets that can be solved using data augmentation

or federated learning, asymmetry of data, dependence on the data labeling process, incomplete or inaccurate data that lead to data bias, and the need for an expert's opinion in the data labeling process.

Moreover, many high-performance DL models remain “black boxes,” limiting clinician trust; integrating XAI methods such as saliency mapping or SHAP can partially mitigate this but adds complexity. The reliance on English-language, publicly accessible datasets may also introduce geographic and demographic biases, and small sample sizes exacerbate overfitting; strategies like data augmentation and federated learning could improve generalizability. Practical integration into clinical workflows remains challenging due to workflow disruption, interoperability issues with electronic health records, and regulatory uncertainties, underscoring the need for clinician-AI-AI codesign. Finally, ethical and regulatory concerns, including patient privacy, accountability for AI-driven decisions, and the lack of standardized approval pathways—must be addressed to ensure safe and compliant deployment.

Conclusion and Future Work

AI-based methods with a variety of approaches can be used in different areas of medicine, such as automated triage systems or real-time imaging analysis, based on the type of data and the amount of available data. DL, as the most popular strategy, has multiple processing layers in the network. They are used in many medical applications with high accuracy. In medical diagnoses, classification, and prognoses, the focus has been on the use of AI methods, which increase the accuracy, and criteria for selecting methods that increase the speed of diagnoses, classification, and prognoses were not provided. This may be a suggestion for future investigation. Also, the efficiency of AI-based methods compared with manual ones is discussed in most studies, which indicates the willingness to use AI in the medical industry. Also, with the human in the loop in medicine and medical staff duty, all AI-based applications are assistants, and the final choice is made by the human expert who uses such AI-based aid.

As a result, no work is focused on replacing clinical professionals with AI. This demonstrates the complementarity and aid of artificial intelligence in medical services. It is

indicated that in the future, it will be explored in which medical services AI may be fully implemented, as well as how human presence will be involved. Robotic surgery is one relevant example in this subject. Robotic surgery is one relevant example in this subject.

Authors' Contributions

M.N. and E.B. conceptualized the study. N.R.R., Z.R., and M.R.B. conducted the literature search and data extraction. N.R.R. and M.S. contributed to data analysis and manuscript revision. All authors reviewed and approved the final manuscript.

Ethical Considerations

This study was approved by the Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1401.711).

Acknowledgment

The authors would like to thank the Iran University of Medical Sciences for their support.

Conflict of Interests

The authors declare that they have no competing interests.

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