Using Artificial Intelligence in the COVID-19 Pandemic: A Systematic Review

Gözde Özsezer[1], Gülengül Mermer[2]

[1] *Department of Public Health Nursing, Faculty of Health Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey*
[2] *Department of Public Health Nursing, Faculty of Nursing, Ege University, İzmir, Turkey*

***Received:* 13 Oct. 2021; *Accepted:* 18 May 2022**

Abstract- Artificial intelligence applications are known to facilitate the diagnosis and treatment of COVID-19 infection. This research was conducted to investigate and systematically review the studies published on the use of artificial intelligence in the COVID-19 pandemic. The study was conducted between April 25 and May 6, 2020 by scanning national and international studies accessed in "Web of Science, Google Scholar, Pubmed, and Scopus" databases with the keywords ("Coronavirus" or "COVID-19") and ("artificial intelligence" or "deep learning" or "machine learning"). As a result of the scanning process, 1495 (Google Scholar: 1400, Pubmed: 58, Scopus: 30, WOS: 7) studies were accessed. The studies were first examined according to their titles, and 1385 studies, which were not related to the research topic, were not included in the scope of the research. 50 articles, which did not meet the inclusion criteria, were excluded. The abstract and complete texts of the remaining 60 studies were scanned for the study's inclusion and exclusion criteria. A total of 10 studies, consisting of reviews, letters to the editor, meta-analysis studies, animal studies, conference presentations, studies not related to COVID-19, and incomplete studying protocols, were excluded. There were 50 studies left. 9 articles with duplication were identified and excluded. The remaining 41 studies were examined in detail. A total of 26 studies were found to meet the criteria for the systematic review study. In this systematic review, AI applications were found to be effective in COVID-19 diagnosis, classification, epidemiological estimates, mode of transmission, distribution, the density of lesions, case increase estimation, mortality/mortality risk, and early scans.

Acta Med Iran 2022;60(7):387-397.

Keywords: Coronavirus disease 2019 (COVID-19); Pandemic; Artificial intelligence; Deep learning; Machine learning

Introduction

Today, the COVID-19 pandemic seen all over the world and in our country is an important public health problem (1). More than 6,000,000 cases have been reported globally. The United States is the country with the highest number of cases, and Turkey ranks tenth in the world with a number of 165555 cases, whereas it ranks sixth in Europe (2). According to the data of the Ministry of Health of the Republic of Turkey, 165555 cases and 4585 deaths have been reported (3).

During the pandemic, hospitals were closed to routine visits, and the fear of cross-contamination in hospitals led the public to seek different access routes to health services, such as health care offered by smartphones and online healthcare staff. With the pandemic, a real ground for testing digital health in the field has been established (4). At the same time, with this global crisis, the need for research on developing digital healthcare practices has increased, and artificial intelligence (AI) has been seen as a powerful tool in the fight against the COVID-19 pandemic (5).

AI is used in many areas of health care. These fields can use applications such as Machine Learning (ML), Natural Language Processing (NLP), Computer Vision, Deep Learning (DP), Data Visualization, and Big Data to create patterns, descriptions, and predictions with computers (6,7). The existence of estimated computing tools and their use in health care globally has led to significant transformations in medical interventions,

Corresponding Author: G. Özsezer
Department of Public Health Nursing, Faculty of Health Sciences, Çanakkale Onsekiz Mart University, Çanakkale, Turkey
Tel: +905077548552, Fax: +902862181379, E-mail address: gozsezer@comu.edu.tr

individual medicine, and epidemiology. These applications are expected to continue to develop sensitivity, especially in diagnosis accuracy (8). AI prediction tools are used in the recruitment and evaluation of healthcare staff in many countries and are increasingly strengthened day by day. It is thought that AI is a strong way to be prepared for the future, and it is also expected to promote the creation of new health policies (9).

The use of AI-based algorithms for the early detection of pandemics is increasing. In addition to predicting pandemics, it is believed that, through the use of different AI tools such as machine learning in individual medicine and predictive patient outcome applications, it will be easier to quickly diagnose and treat global outbreaks (10). It is also thought that AI applications might be useful in the diagnosis and prediction of COVID-19 infection (11). In this regard, BlueDot and Metabiota companies continue their AI studies to predict the COVID-19 pandemic accurately. Nine days before the official announcement of the COVID-19 pandemic, based on the air travel data of Wuhan, BlueDot correctly predicted the pandemic and the cities at high risk of suffering from the pandemic (12). Based on the power of AI and ML, Metabiota then uses this data to make predictions about how pandemics affect human behavior and the levels of fear they have caused (13). AI is also used in the prediction of the regions where COVID-19 is locally dense. In this way, the future course and re-emergence of the disease can be predicted (14,15).

By combining artificial intelligence and mathematical modeling, an excellent set of data is obtained. This data set provides real-time monitoring of the pandemic and helps to restructure its early epidemiological features (16). In the studies conducted, websites, social networks, and news reports related to health care in China have been monitored and observed at the population level. The causes that have been effective in the spread of this pandemic have been identified (16,17). Data sets and data flows provide information about the creation and implementation of effective public health precautions. Accordingly, it has been emphasized that public health authorities should also pay attention to the data accuracy, modeling, and analysis of big data (16).

COVID-19 can be diagnosed more easily with AI applications. With blockchain technology, one of the AI applications, a number of operations can be performed, such as recording, verification, and confirmation of data. Block-chain technology contains a high level of security. Apart from being a cryptography-based computer program, it offers patient-centered healthcare services, advanced public health surveillance, management of pandemics, and a quick and efficient decision-making process (18,19). AI also helps in diagnosing COVID-19-infected cases with the help of medical imaging technologies such as computed tomography (CT) and magnetic resonance imaging (MRI) (14,20).

AI is also used for drug research for COVID-19. This technology helps to significantly accelerate this process since standard tests take a lot of time. With the help of AI, real-time drug testing can be performed at a speed that cannot be performed by a human being (21). With AI, vaccination and treatment are being developed much faster than usual. It is also stated that it is useful for clinical trials during the development process of the vaccine (15,20).

Due to a sudden and large increase in the number of patients during the COVID-19 pandemic, the workload of health staff has also increased. Therefore, AI is used to reduce the workload of healthcare workers (15,22). It offers the best education to medical and nursing students about this new disease by helping to make the diagnosis at an early stage through the use of digital approaches and decision science (23). It is believed that AI will affect patient care and reduce the workload of health staff in the future. In accordance with these arguments, the purpose of the systematic review is to review the published studies on the use of artificial intelligence in the COVID-19 pandemic and to systematically examine the data obtained from these studies. In accordance with this plan, the systematic review will seek an answer to the following question: "What are the areas of utilization and the effects of Artificial Intelligence in the COVID-19 pandemic?"

Materials and Methods

In this study, in order to determine the areas of utilization and the effects of artificial intelligence used in the COVID-19 pandemic, a literature scan was conducted in "The web of Science, Google Scholar, Pubmed, and Scopus" databases. The scan was carried out between April 25 and May 6, 2020, by two researchers using the keywords ("Coronavirus" or "COVID-19") and ("artificial intelligence" or "deep learning" or "machine learning") and examining the related publications. It aimed to reach all the studies related to the subjects by scanning the databases. The titles and abstracts of all the relevant publications reached by means of the electronic search were reviewed independently by the researchers. The publications were subjected to a quality assessment using the Preferred Reporting Items for Systematic

Reviews (PRISMA) checklist.

The criteria for inclusion in the study were determined as such: examining the use of AI during the COVID-19 process; focusing on early detection of COVID-19-related infection; addressing the use of AI on topics such as monitoring treatment, developing medicines and vaccines, reducing the workload of healthcare workers, and preventing disease; the language of publication being in English, and having full text available online. On the other hand, those studies which were published in another language other than English and which were more like summaries were excluded.

As a result of the scan, 1495 (Google Scholar: 1400, Pubmed: 58, Scopus: 30, WOS: 7) studies were accessed. The studies were first examined according to their titles, and 1385 studies not related to the research topic were not included in the scope of the research. 50 articles that did not meet the inclusion criteria were excluded. The abstract and complete texts of the remaining 60 studies were scanned for the study's inclusion and exclusion criteria. A total of 10 studies, consisting of reviews, letters to the editor, meta-analysis studies, animal studies, conference presentations, studies not related to COVID-19, and incomplete studying protocols, were excluded. There were 50 studies left. 9 articles with duplication were identified and excluded. The remaining 41 studies were examined in detail. They were separated according to the discussion way of COVID-19 and AI. A total of 26 studies were found to meet the criteria for the systematic review study. The research selection process of the systematic review is shown in the PRISMA flow diagram in Figure 1 (24).

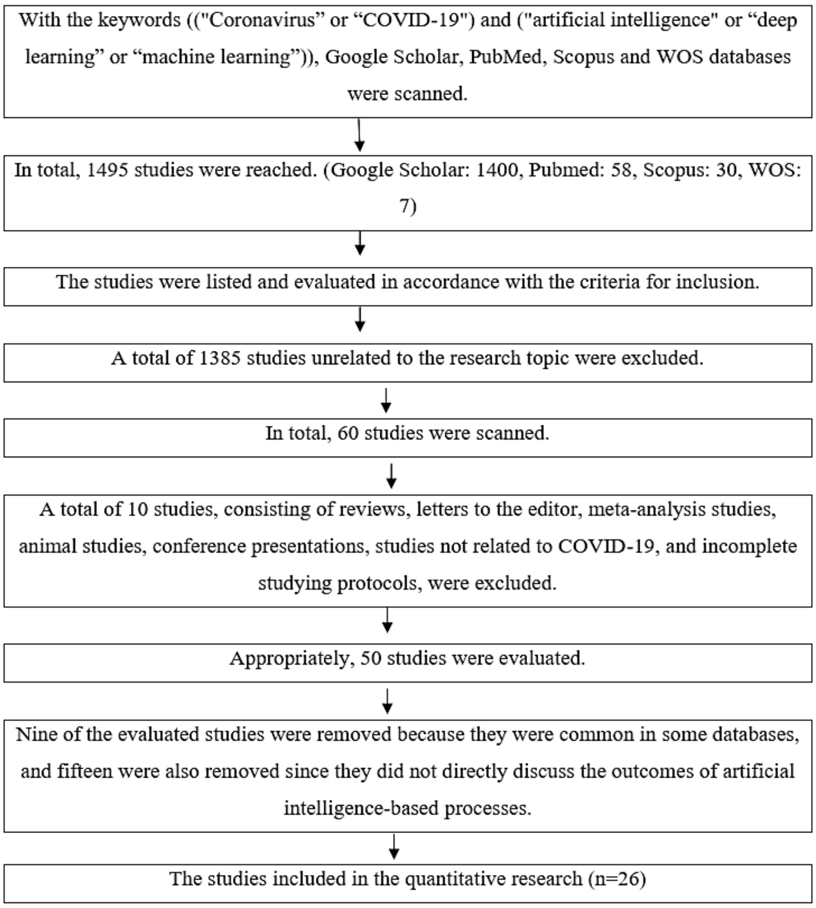

Figure 1. Systematic review process steps/process of determining the sample

Based on the results obtained, a standard data abstraction form was developed for the analysis of the data. The data analysis form included information such as authors of the study; publication year of the study; the AI model used; samples, inputs, outputs, and statistical methods used; and conclusions reached by authors.

In the study, the research articles included in the sampling did not require ethical permission since they were taken from open-access electronic databases and search engines. All the stages of the study were carried out in accordance with the principles contained in the Helsinki Declaration.

Results

Among the researches included in the systematic review, one is cross-sectional (25), fifteen are retrospective multicentre (26,28-31,36,37,39,41,44-48,50), nine are retrospective (27,32,33,34,38,40,42,43,49), and one is methodological (35) (Table 1). Ten of the researches included in the study were conducted in China (26,32,33,35,37,39,44,46,47,49); one in Brazil (25), one in China, Japan, South Korea and Italy (50), one in Switzerland (27), one in Egypt (29), one in Italy (38) and one in Spain (45).

Table 1. Characteristics of the studies included in the review

Authors	AI Model Used	Sampling	Inputs	Outputs	Statistical method Used	Results
Soares et al., 2020 (25)	SVM	n=5644 Patients Laboratory testing (n=108)	CT Laboratory testing	Diagnosis, classification	AUC	A new method called ER-CoV using artificial intelligence in the emergency room, which was proven for the detection and classification of COVID-19 patients with simple and rapid blood tests, was demonstrated.
Feng et al., 2020 (26)	LR Decision Tree	Exposure to COVID-19 (n=164)	Demographic information, comorbidities, exposure to COVID-19, life signs, blood tests, clinical symptoms, infection-related biomarkers, influenza viruses (A + B) test	Diagnosis	AUC, F-1 score, precision, specificity, sensitivity	With AI, it can be diagnosed in triage without CT scans.
Marini, Chokani, & Abhari, 2020 (27)	Simulation and ML AI-Assisted EnerPol software (Big Data) (Algorithm not specified)	The entire population of Switzerland (n=8,57 million)	Switzerland highway networks (1,1 million connections and 0,5 million nodes) Public transportation vehicles (30000 stops and 20000 routes) Private vehicles in Switzerland (n=3,5 million)	Prediction of individual contacts and possible ways of transmission	Sensitivity	AI is effective in predicting individual contacts and ways of transmission.
Pourhomayoun & Shakibi, 2020 (28)	SVM ANN, Random Forest Decision Tree LR KNN	COVID-19 positive data set from 76 countries (n= 117000)	Age, gender, country and city travel background, comorbidities, symptoms, CT	Mortality risk prediction	AUC, specificity, sensitivity, ROC, Confusion Matrix	AI is effective in the prediction of mortality risk.
Hassanien et al., 2020 (29)	ANN SVM	COVID-19 symptoms are positive (n=108)	Age, gender, city, province, country, latitude, longitudinal, geographical resolution, history of initial symptoms, hospital admission date, date of approval of symptoms, exposure report, presence of chronic disease, death or discharge, and travel history	Diagnosis	Linear Regression	AI makes accurate diagnoses.

Cont. table 1

Jiang et al., 2020 (30)	KNN Decision tree Random forest SVM	COVID-19 positive (n=53)	Age, gender, clinical symptoms, comorbidities, laboratory testing, CT	Diagnosis	Logistic Regression	AI is effective in diagnosing.
Mei et al., 2020 (31)	CNN SVM Random forest	COVID-19 positive (n=905)	Age, gender, CT, clinical symptoms, exposure background, laboratory testing	Diagnosis	AUC, specificity, sensitivity	AI is effective in diagnosing.
Hu, Ge, Li, Jin, & Xiong, 2020 (32)	MAE	COVID-19 positive (n=51986)	COVID-19 positives	Prediction of transmission dynamics between the cities and the end time of the pandemic	Cluster analysis	AI makes accurate predictions in determining the dynamics of intercity transmission.
Du, Gao, & Zhang, 2020 (33)	AI-assisted InferRead™ CT Pneumonia software (Algorithm not specified)	COVID-19 recovered (n=135)	CT	Diagnosis, classification	Mann-Whitney U test, Wilcoxon signed rank test, Friedman test	AI analysis results are compatible with imaging features and changes. It probably serves as an objective indicator for disease monitoring and discharge. However, it is not enough. It needs to be worked with larger data.
Martin et al., 2020 (34)	Chatbot	COVID-19 positive (n=1142)	Age, gender, comorbidities, COVID-19 symptoms, risk factors	Diagnosis	Specificity, sensitivity	AI application "Symptoma" accurately diagnoses COVID-19 in %96,32 of the clinical cases.
Zeng et al., 2020 (35)	DL (Algorithm not specified)	COVID-19 positive (n=49)	CT	Distribution, density, and severity of pneumonia lesions	Multiple Linear Regression	AI-based CT quantitative measurements can provide more precise information about the distribution and the severity of lesions to predict clinical outcomes.
Bai H. X. et al., 2020 (36)	LR, CNN	COVID-19 positive (n=521)	CT	Diagnosis	Precision, specificity, sensitivity, AUC, ROC	With AI, COVID-19 pneumonia can be distinguished from non-COVID 19 pneumonia.
Li et al., 2020 (37)	CNN	COVID-19 positive (n=3322)	CT	Diagnosis	AUC, specificity, sensitivity	AI is effective in diagnosing.
Castiglioni et al., 2020 (38)	CNN	COVID-19 positive (n=250) COVID-19 non-infected (n=250)	CXR	Diagnosis	AUC, sensitivity	Although trained in a limited number of cases, a CNN-based AI system applied to CXR in patients suspected of COVID-19 infection was shown to have a sensitivity of 0.80 sensitivity and 0.81 specificity in a patient. Its performance can be improved by providing training on multi-enterprise datasets.

Cont. table 1

Xiaowei et al., 2020 (39)	CNN	COVID-19 positive (n=110) 219 CT samples, Influenza-A viral pneumonia (n=224) Healthy individual (n=175) Total 618 CT samples	CT	Establishing an early screening model to distinguish COVID-19 pneumonia from Influenza-A viral pneumonia and healthy cases	Noisy-or Bayesian function	Deep learning models are effective in the early diagnosis of COVID-19 patients. It has been shown as a promising complementary diagnostic method.
Ucar & Korkmaz, 2020 (40)	CNN	COVID-19 positive (n=76) Pneumonia (n=4290) Healthy individual (n=1583)	CXR	Diagnosis	Deep Bayes-SqueezeNet	With AI models, early-stage detection of COVID-19 cases can be made.
Ozturk et al., 2020 (41)	CNN	COVID-19 positive (n=127)	CT	Diagnosis	Specificity, sensitivity	AI quickly makes accurate diagnoses.
Salman, Abu-Naser, Alajrami, Abu-Nasser, & Ashqar, 2020 (42)	CNN	COVID-19 positive (n=130) Healthy individual (n=130)	CXR	Diagnosis	F-1 score, precision, specificity, sensitivity, PPV, NPV	AI is effective in diagnosing.
Guegium Kana et al., 2020 (43)	CDNN	Bacterial or viral pneumonia infected (n=2507) Healthy individual (n=2487) COVID-19 positive (n=161)	CXR	Diagnosis	MV	The model makes similar predictions to experts with the ability to recognize the pixels of icy areas as distinctive features of COVID-19 and to distinguish them from other viral and pneumonia-infected lungs.
Jin C. et al., 2020 (44)	CDNN	COVID-19 positive (n=496) Healthy individual (n=260)	Age, gender, CT	Diagnosis	AUC, specificity, sensitivity	AI is effective in diagnosing.
Prieto, Baltas, Rios-Pena, & Rodriguez, 2020 (45)	DNN	COVID-19 positive (n=140510) Mortality (n=13798) Admitted to ICU (n=7069)	Number of COVID-19 positives in each province, ICU cases by region, cases requiring hospitalization, cases that need to be admitted to ICU, mortality, and recovered cases.	Prediction of case increase	SIR	SIR model is effective in the prediction of case increase.
Jin S. et al., 2020 (46)	DNN	N=1136 COVID-19 positive (n=723)	CT	Diagnosis	AUC, specificity, sensitivity	AI quickly makes accurate diagnoses.

Cont. table 1

Yang et al., 2020 (47)	RNN, LSTM	People in Zhejiang province (n=57 million), Guangdong province (n=113 million) and Hubei province (n=60 million) in China	Railway, airway and highway traffic	Individual contacts and predictions of possible ways of transmission, recovery and mortality prediction of the cases	SEIR	SEIR model is effective in predicting COVID-19 pandemic peaks and dimensions.
Kolozsvari et al., 2020 (48)	RNN, LSTM	COVID-19 positive data set from 150 countries	Number of daily cases	Prediction of case increase	Square root of error mean squares	AI-based predictions are useful in pandemic epidemiology.
Bai X. et al., 2020 (49)	LSTM, MLP	COVID-10 positive (n=133)	CT, Clinical and laboratory data	Diagnosis	AUC, precision, specificity, sensitivity	AI is effective in diagnosing.
Pirouz, Haghshenas, Haghshenas, & Piro, 2020 (50)	GMDH	Total population in China, Japan, South Korea and Italy	Age, gender, maximum and minimum and average temperature, the density of a city, relative humidity, and wind speed	Number of the positive cases of COVID-19	Regression, binary classification	AI and relative humidity, and maximum daily temperature were found to have the highest impact on confirmed cases.

ANN: Artificial Neural Networks, AUC: Area Under Curve, CDNN: Convolutional Deep Neural Network, CNN: Convolutional Neural Network, CXR: Chest X-Ray, DL: Deep Learning, DNN: Deep Neural Network, GMDH: Group Method of Data Handling, KNN: K-Nearest Neighbor, LR: Logistic Regression, LTSM: Long-Short-Term-Memory, MAE: Modified Auto-Encoders, MLP: Multi-layer Perceptron, MV: Machine Vision, NPV: Negative Prediction Value, PPV: Positive Prediction Value, RNN: Recurrent Neural Network, SEIR: Susceptible-Exposed-Infectious-Removed, SIR: Susceptible-Infected-Recovered, SVM: Support Vector Machine

The data taken from the hospitals (26,28-33,35-40,44-47,49,50) were used in nineteen of the studies; the railway, airway, and highway data (27) were used in one study; the BMJ data (34) were used in one study; the data from the WHO and John Hopkins University (48) were used in one study; the GitHub data (41) were used in one study; the GitHub and Kaggle data (42) were used in one study; the Kaggle data (25) were used in one study, and the data taken from any data store (43) were used in one study (Table 1).

When the samples of the studies are examined, it is seen that only COVID-19 positive individuals were included in thirteen studies (25,28,30-32,34-37,41,46,48,49); that healthy individual with COVID-19 positive pneumonia was included in three studies (39,40,43); that COVID-19 positive and healthy individuals were included in three studies (38,42,44); that the population-based data were included in three studies (27,47,50); that only people exposed to COVID-19 were included in one study (26); that people with positive symptoms of COVID-19 were included in one study (29); that individuals who recovered from COVID-19 were included in one study (33); and that COVID-19 positive individuals, mortality rate and people admitted to ICU (45) were included in one study (Table 1).

In general, it was determined that classification, determination of the distribution and intensity of pneumonia lesions, screening, possible ways of transmission, risk of mortality, prediction of the end time of the pandemic and the case increase, and ML and DL algorithms from artificial intelligence applications were used in the diagnosis of COVID-19. It was found that ten studies were conducted using ML, whereas sixteen were conducted with DL algorithms. It was observed that the most applied algorithms were CNN with 8 studies and SVM with 5 studies, respectively. The other algorithms were identified as 3 LR, 3 LSTM, 3 Random Forest, 3 Decision Tree, 2 ANN, 2 KNN, 2 RNN, 2 DNN, 2 CDNN, 1 GMDH, 1 MLP, 1 chatbot, and 1 MAE. In addition, it was found that in 3 studies, the algorithms were not specified (Table 1).

It was observed that %66 (n=17) of the articles were conducted for diagnostic purposes and that such input variables as CT, CXR, laboratory tests, demographic information, comorbidities, travel history, and exposure background were included (25,26,29-31,33,34,36-38,40-44,46,49). In %7 (n=2) of the studies regarding the prediction of ways of transmission, the highway, airway, and railway data were used (27,47). It was determined that %7 (n=2) of the articles were conducted to predict mortality and that these studies used demographic data, comorbidities, COVID-19 symptoms, and traffic transmission data for prediction (28,47). %7 (n=2) of the articles consisted of case increase predictions. It was seen that the number of daily cases was used as input for predictions (45,48). It was determined that %3 of the studies, which focused on the prediction of transmission dynamics between cities and the end time of the pandemic, used COVID-19 positive cases as input (32). It was determined that %3 of the studies (n=1) were about the detection of the distribution, intensity, and severity of pneumonia lesions. It was seen in the study that CT findings were included as input (35). The early screening study, in which CT findings were used as input, constituted the %3 (n=1) of the articles (39). In %3 (n=1) of the studies conducted to detect the COVID-19 positive cases, it was determined that demographic data was used to predict daily maximum, minimum, and average temperature, urban density, relative humidity, and wind speed (50). In the studies, each sample was discussed from different perspectives and with different statistical methods; thus, it was difficult to construct a correlation between the studies. When the studies were examined, it was determined that AUC, specificity, and sensitivity were the most commonly used statistical methods (Table 1).

When the results of the study were examined, it was concluded that 17 diagnostic studies evaluated AI as an effective method for diagnosis (25,26,29-31,33,34,36-38,40-44,46,49). In the studies conducted to predict the ways of transmission, AI was concluded as an effective method in determining individual contacts and predicting the ways of transmission (27,47). When the studies using AI in the prediction of mortality and mortality risk were examined, it was seen that the models used were effective in predicting the mortality risk and pandemic peaks and dimensions (28,47). The study regarding transmission dynamics between cities and the end time of the pandemic using AI showed that it made accurate predictions (32). In a study using AI in case increase predictions, the SIR model was found to be effective in case increase predictions (45), whereas, in another study, AI-based predictions were found to be useful in pandemic epidemiology (48). In a study in which AI was based for the purpose of determining the distribution, intensity, and severity of pneumonia lesions, it was determined that the prediction results provided accurate information (35). In a study conducted to distinguish COVID-19 pneumonia from Influenza-A viral pneumonia by establishing an early screening model, it was found that AI was effective in early screening and was expressed as a promising diagnosis model (39). In another study investigating the impact of temperature, city density, relative humidity, and wind speed on COVID-19 by using AI applications, AI was found to predict that relative humidity and maximum daily temperature variables increased COVID-19 positive cases (50) (Table 1).

Discussion

This study, which includes the use of AI applications in the COVID-19 pandemic, diagnosis of COVID-19, classification and distribution of pneumonia lesions and determination of its intensity, screening, possible ways of transmission, risk of mortality and mortality, and prediction of the end time of the pandemic and the case increase were examined. Almost all 26 studies that met the determined criteria showed that AI applications were effective. The limited number and limited variety of data inputs and AI applications occupy a rather small place in the literature related to the COVID-19 pandemic. It was stated that the results are promising to help with the decision-making process for the COVID-19 pandemic.

In all 17 diagnostic studies conducted to diagnose COVID-19, AI was evaluated as an effective method for diagnosis. In these studies; variables, such as CT, CXR, laboratory tests, demographic data, comorbidities, travel history, and exposure background, were used as input (25,26,29-31,33,34,36-38,40-44,46,49).

Prediction of the ways of transmission was carried out in two studies. Highway, airway, and railway data were used as input. AI was evaluated as an effective method for determining individual contacts and predicting the ways of transmission (27,47).

In two studies, the mortality and the risk of mortality were predicted. As input, demographic data, comorbidities, COVID-19 symptoms, and traffic transmission data were used. When the studies using AI were examined, it was seen that the models used were effective in predicting mortality risk and pandemic peaks and dimensions (28,47).

In one study, transmission dynamics between cities and the end time of the pandemic were predicted using AI. The number of positive cases of COVID-19 was used as input. In the conducted study, it was stated that AI made accurate predictions (32).

COVID-19 positive case numbers were used as data in the inputs of two studies using AI in case increase predictions. In the study conducted by Prieto and his colleagues, the SIR model was determined to be effective in case increase predictions (45). In the study conducted by Kolozsvari and his colleagues, AI-based predictions were found to be helpful in pandemic epidemiology (48).

One study involved the distribution, density, and severity of pneumonia lesions. CT data were used as input. In the study, it was stated that the prediction results provided precise information (35).

One study included an early screening model to distinguish COVID-19 pneumonia from Influenza-A viral pneumonia and healthy cases. CT data were used as input. It was stated that AI was effective in early screening and was also a promising diagnostic method (39).

In one study, the effects of maximum, minimum, and average daily temperature, urban density, relative humidity, and wind speed on COVID-19 cases were evaluated. AI predicted that relative humidity and maximum daily temperature variables increased COVID-19 positive cases (50).

It is an indisputable fact that computers are faster and more efficient than people. However, the fear that machines will replace people is unfounded. Machines are only developed and will continue to be developed merely to help people. AI applications have been adapted to daily life. Additionally, it will also be used in the diagnosis and treatment of diseases, epidemiological predictions, hospitalization duration, reduction of cost, and nursing care. As artificial intelligence applications are rapidly advancing today, people are in a race with machines and fear that computers will take the place of health staff, and assume that nurses must also keep pace with the era.

New algorithms and new application methods will enable more accurate decisions. Another innovation that AI applications will bring is to help nurses to find new ways of care. Diagnosis, treatment, and nursing care algorithms with daily parameters will be replaced by complex algorithms equipped with big data; therefore, developing and using new algorithms for nursing care will enhance the effect over time.

Limitations

The absence of *P* in all of the studies and, therefore, the difficulty of comparing all the studies are the limitations of this study. In addition, information on the applications of various ML/DL techniques to detect COVID-19 is still insufficient. ML/DL approaches require large amounts of data for computational models to discover and obtain information that is very limited in the case of COVID-19.

In this systematic review, AI applications were found to be effective in COVID-19 diagnosis, classification, epidemiological estimates, mode of transmission, distribution, the density of lesions, case increase estimation, mortality/mortality risk, and early scans. Today, along with technological developments, the importance of using artificial intelligence in the field of health is increasing. AI techniques, such as machine learning and deep learning, can be applied for preparedness and feedback activities to tackle critical situations worldwide. For example, machine learning applications can be used to develop the most efficient robotics and automated setup for drug delivery and patient care in hospitals. In this context, it is inevitable for nurses and all health professionals to keep pace with technology. It is thought that it is important and necessary to benefit from AI applications in preventive, therapeutic, and rehabilitating health services and to develop algorithms for complex situations.

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