Review Article

A comparison of artificial intelligence algorithms in diagnosing and predicting gastric cancer: a review study

Hamed Mazreati [1], Reza Radfar [2]*, Mohammad-Reza Sohrabi [3] **, Babak Sabet Divshali [4], Mohammad Ali Afshar Kazemi [5]

[1] Department of Information Technology Management, Science and Research Branch, Islamic Azad University, Tehran, Iran.
[2] Department of Industrial Management, Science and Research Branch, Islamic Azad University, Tehran, Iran.
[3] Department of Community Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[4] Department of Surgery, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[5] Department of Industrial Management, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

***Corresponding author and reprints: Reza Radfar,** Islamic Azad University, Science and Research Branch, Ferdos Blvd, Universi-ty Blvd, Hesarak, Tehran, Iran.
Email: r.radfar@srbiau.ac.ir
**** Co-Corresponding author: Mohammad-Reza Sohrabi** 8th Floor, Bldg No.2 SBUMS, Arabi Ave, Daneshjoo Blvd, Velenjak, Teh-ran, Iran.
Email: m.sohrabi@sbmu.ac.ir

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Abstract

Today, artificial intelligence is considered a powerful tool that can help physicians identify and diagnose and predict diseases. Gastric cancer has been the fourth most common malignancy and the second leading cause of cancer mortality in the world. Thus, timely diagnosis of this type of cancer could effectively control it. This paper compares AI (artificial intelligence) algorithms in diagnosing and predicting gastric cancer based on types of AI algorithms, sample size, accuracy, sensitivity, and specificity. This narrative-review paper aims to explore AI algorithms in diagnosing and predicting gastric cancer. To achieve this goal, we reviewed English articles published between 2011 and 2021 in PubMed and Science direct databases. According to the reviews conducted on the published papers, the endoscopic method has been the most used method to collect and incorporate samples into designed models. Also, the SVM (support vector machine), convolutional neural network (CNN), and deep-type CNN have been used the most; therefore, we propose the usage of these algorithms in medical subjects, especially in gastric cancer.

Keywords: **Artificial Intelligence; Neural Networks, Computer; Stomach Neoplasms; Support Vector Machine.**

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Introduction

Descartes believed humans could validate their existence through experience-formed thought processes, while animals merely follow prefix plans. In other words, AI researchers are the children of Descartes because they trust absolute logic and mathematics (1). AI is one of the expert systems that emerged in the mid-1950s as a field of computer sciences (2). This field is related to all the cognitive aspects of problem-solving and creating systems that learn and think like humans. In other words, this field is a combination of cognitive and computer sciences .(3) Hence, AI is a branch of applied computer sciences in which computer algorithms are taught to perform tasks that are commonly related to human intelligence .(4)

AI is computer knowledge that works on a similar pattern of human behavior with machine capabilities (5). Based on AI applications, this method has two virtual and physical branches (6). Today, the current AI is a specific type of AI that intellectually performs in an area called the personal area and does not perform all the human brain functions .(7)

AI was introduced to many clinical fields like radiology .(8) Accordingly, AI is on the frontline of medical innovations, and field researchers believe that trust has a determining role in successfully using this technology in medicine .(9) In the healthcare system, AI helps the healthcare practices of patients using a huge amount of healthcare data. AI extracts the data from a large pool of patients data and issues the necessary warnings regarding the patient's health status.(10) Physicians and other medical professionals use intelligent computer applications to make difficult medical decisions. They are a well-established component of medical technology because they help reduce time and reduce the risk of errors in medical procedures (11). AI is becoming one of the main elements of many medical programs in the healthcare sector, including drug discovery, remote monitoring of patients, medical diagnosis and imaging, risk management, wearable gadgets, virtual assistants, and hospital management.(8)

Cancer has a heterogeneous nature; each cancer can have several subsets that machine learning methods can effectively help identify and prevent (12). Also, it should be noted that rapid developments in technology, machine learning, and AI applications in recent years have led to success and significant progress in predicting cancer (13). Gastric cancer is the fourth most common malignancy, the second leading cause of cancer mortality globally (14), and the most common type of cancer in the last century so East Asia is at high risk of this cancer .(15) Studies indicate that gastric cancer has an uptrend in Iran, especially in the north and northwest of the country .(16) On the other hand, preventing the disease is critical because gastric cancer patients have a five-year average survival rate (17).

Neural networks are advanced and effective methods in AI that can improve the classification and prediction accuracy of gastrointestinal cancer .(18) The purpose of using these models is to identify individuals exposed to a higher risk of having a particular disease (19). Jin et al.(20), Yu et al.(21), and many researchers reviewed AI applications in gastric cancer. But, They didn't compare the performance of AI algorithms in diagnosing and predicting gastric cancer.

Thus, this paper aims to conduct a review study on the published papers in AI algorithms to diagnose and predict gastric cancer. Moreover, we compared artificial intelligence algorithms based on four factors: accuracy, sensitivity, specificity, and the number of samples.

Methods

This paper is considered a narrative-review paper. The papers between 2011 – 2021 were incorporated into the study to find the documents associated with AI algorithms to diagnose gastric cancer. The search was conducted using an English search strategy from March 2021 to April 2021. The search strategies are as below:

The used databases include: PubMed, Science direct

The used keywords are as follows: gastric cancer, machine learning, AI, and neural network.

The search queries are as follows on PubMed:

(Stomach cancer) AND (machine learning); (Stomach cancer) AND (artificial intelligence); (Stomach cancer) AND (neural network).

The search query is as follows on Science direct:

(Stomach cancer OR gastric cancer) AND (machine learning OR artificial intelligence OR neural network).

Publications were selected based on inclusion and exclusion criteria.

The study's inclusion criteria are full-text publications and papers that have been published in the English language.

The exclusion criteria are duplicated papers, and the ones providing asymmetric data with a focus on AI algorithms in diagnosing gastric cancer were excluded. The results of the inclusions and exclusions search are shown in fig.1.

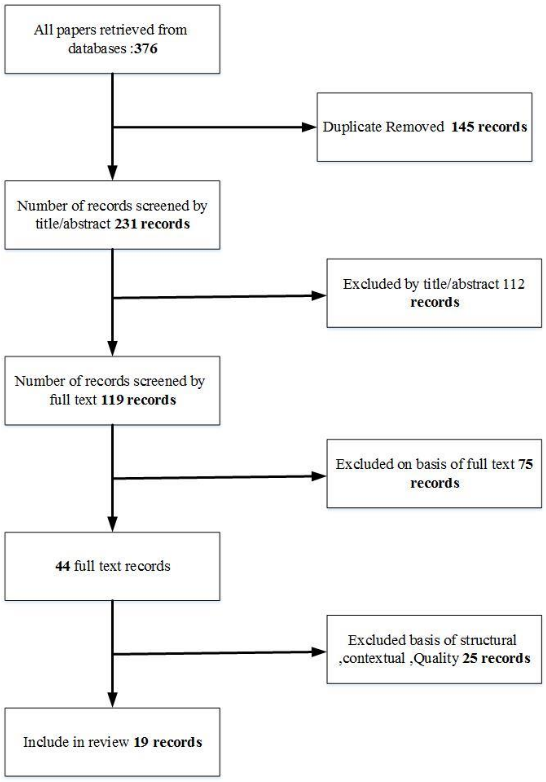

Fig.1. inclusion/exclusion criteria flow chart

Based on the following conditions, published articles on the application of artificial intelligence in gastric cancer have been identified. AI algorithms in diagnosing and prediction of gastric cancer are compared based on the purpose, method, sample size, accuracy, sensitivity, and specificity in table 1 and table 2.

1. Results

Three hundred seventy-six papers were extracted by searching related databases. However, through a complete title review, 145 repetitive studies were removed. Finally, after conducting a comprehensive review of the remaining papers, 19 studies had the inclusion criteria. The selected study information is provided in table 1 and table 2.

The AI algorithms' subject matter is considered a method to diagnose and predict gastric cancer presented in table 1 and table 2 in the sections of the algorithm, aim, method, sample size, accuracy, sensitivity, and specificity.

The AI algorithms in diagnosing and predicting cancer are categorized in the algorithm section. The goals of the paper's author to develop a specifically related algorithm are discussed in the purpose section. The type of algorithm for diagnosing and predicting gastric cancer is defined in the method section. The used sample sizes for teaching and developing AI algorithms are determined in the sample section. The ability of the model to proper segregation of healthy cases and cases with gastric cancer from other cases is explored in the accuracy section. The ability of the model to find cancer cases is reviewed in the sensitivity section, and ultimately, the ability of the model to find healthy cases is shown in the specificity section. These sections can be seen in table 1 and table 2.

Each section of table 1 and table 2 regarding the 19 selected papers is reviewed in this section.

1.1. Algorithm

Different algorithms were used to diagnose gastric cancer. According to the extracted paper, each segregated algorithm is shown in fig.2.

Table 1: Comparison of artificial intelligence algorithms in the diagnosis of gastric cancer

No.	Algorithm	Aim	Method	Sample	Accuracy	Sensitivity	Specificity	Ref.
1	Support Vector Machines (SVM)	Classification of unknown samples through pattern recognition method	Pathology	54	92.2%	100%	83.3%	(22)
2	Decision Tree (DT)	Using highly accurate two-gene signature to diagnose stomach cancer	Gen	216	98.4%	96.30%	95.65%	(23)
3	Support Vector Machines (SVM)	Automatic detection of cancerous tissue	transmission time-domain terahertz spectroscopy	14	100%	100%	100%	(24)
4	Support Vector Machines (SVM)	Creating a new computer-aided method for detecting images of cancerous lesions	Endoscopy	1330	95.20%	95.60%	94.80%	(25)
5	Multilayer Perceptron (NN)	Using classification models to diagnose the disease	Endoscopy and breath test analysis	245	79.6%	66.7%	86%	(26)
6	Support Vector Machines (SVM)	Determination of transcribed biomarkers of saliva for early detection of gastric cancer	Gen	349	99%	98%	100%	(27)
7	Support Vector Machines (SVM)	Early detection of gastric cancer through screening methods	Endoscopy	176	87%	91%	82%	(28)
8	Convolutional neural network	Design of an auto-diagnostic model based on a convolutional neural network to help diagnose gastric cancer in endoscopic images	Endoscopy	228	87.6%	80%	94.8%	(29)
9	Support Vector Machines (SVM)	Use of new biomarkers to diagnose early-stage gastric cancer	Gen	24	90.45%	94%	82%	(30)
10	Support Vector Machines (SVM)	Application of fluorescence hyperspectral imaging technology to detect gastric cancer in its early stages	Pathology	76	96.4%	97.7%	93.6%	(31)

No.	Algorithm	Aim	Method	Sample	Accuracy	Sensitivity	Specificity	Ref.
11	GRAIDS=Gastrointestinal Artificial Intelligence Diagnosis System	Development and validation of gastrointestinal artificial intelligence diagnostic system for diagnosis of gastrointestinal cancers through analysis of endoscopic imaging data	Endoscopy	4532	92.8%	94.2%	92.3%	(32)
12	deep convolution neural network (DCNN)	Establish a system using a deep convolutional neural network to diagnose early-stage gastric cancer	Endoscopy	24549	92.5%	94%	91.3%	(33)
13	Convolutional neural network	Establishment of a diagnostic system based on a convolutional neural network based on endoscopic images to determine the invasion depth and screening patients	Endoscopy	993	89.16%	76.47%	95.56%	(34)
14	Convolutional neural network	Development of a new system based on a convolutional neural network for the analysis of gastric mucosal lesions	Endoscopy	2088	90.91%	91.18%	90.64%	(35)
15	deep convolution neural network (DCNN)	Increase the chances of successful treatment of gastric cancer through early and accurate histological diagnosis	Pathology	3,212	87.3%	99.6%	80.6%	(36)
16	deep convolution neural network (DCNN)	Establish and validate a deep convolutional neural network system in a real-time manner for early detection of gastric cancer	Endoscopy	45,240	91.2%	95.5%	90.3%	(37)
17	Convolutional neural network	Create an intelligent image-based diagnostic system	Pathology	1880	88.8%	91.9%	86.0%	(38)

Table 2: Comparison of artificial intelligence algorithms in the prediction of gastric cancer

No.	Algorithm	Aim	Method	Sample	Accuracy	Sensitivity	Specificity	Ref.
1	Convolutional neural network	Testing of new artificial intelligence systems in predicting the depth of gastric cancer invasion	Endoscopy	16,557	95.5%	94.5%	94.3%	(39)
2	Gradient boosting decision tree(GBDT)	Develop a predictive model for the diagnosis of gastric cancer with high accuracy and based on non-invasive features	Pathology	709	83%	87%	84.1%	(40)

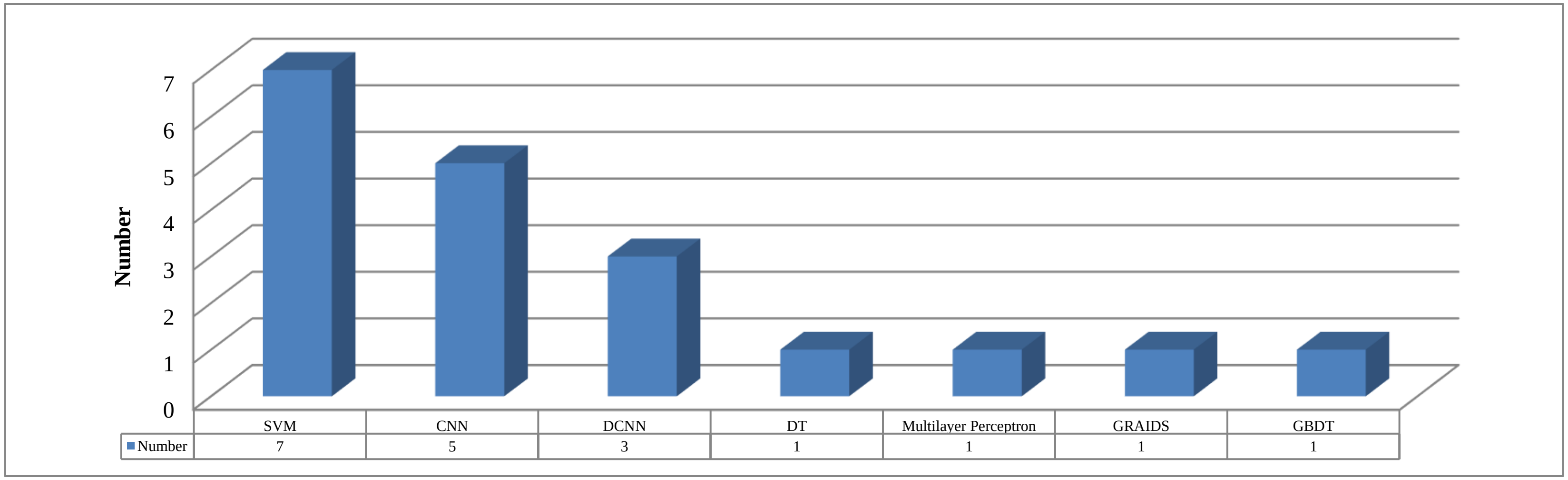

Fig.2. AI algorithm segregation in diagnosing and predicting gastric cancer

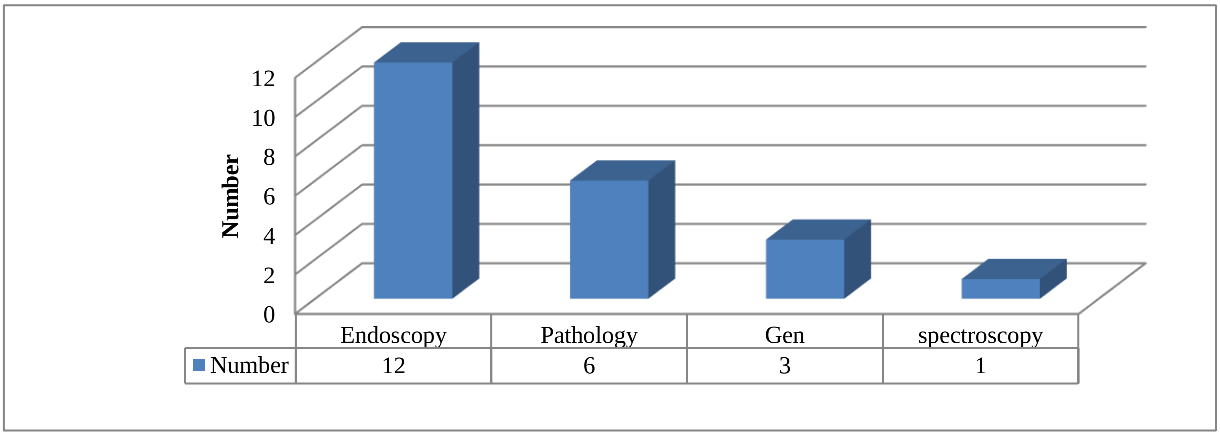

Fig.3. method segregation to collect samples

The data in fig.1 indicate that SVM and then CNN are the most used algorithms to diagnose and predict gastric cancer.

1.2. Aim

The reviewed papers indicate that their purpose is to develop AI algorithms to diagnose and predict gastric cancer in different stages.

1.3. Methodology

Various methods were used to collect samples and incorporate them into each model. The method segregation is shown in fig.3 based on extracted papers.

According to the data provided in fig.2, endoscopy is the most used method to collect samples and incorporate them into the gastric cancer diagnosis models, and the least used one is spectroscopy. Endoscopy is a safe and effective tool in disease diagnosis and various gastrointestinal disorder treatments .(41) This tool was first used by the optic engineer Charles Chevalier on February 7, 1855 .(42)

1.4. Sample size

Sample size determination in AI algorithms like neural networks is not subject to a specific rule, and most of them are defined experimentally .(43) According to the provided data in table 1 and table 2, to teach and implement the model, the minimum sample size is 14, and the maximum is 45240. The high sample sizes are used in cases in which the medical images were used to diagnose and predict cancer.

1.5. Accuracy, sensitivity, and specificity

Various tests were used to diagnose the disease, including lab tests, imaging, etc., and generally, the test with the lowest error and highest accuracy is the most suitable. In other words, the test with 100% accuracy is the most suitable, although it is not feasible in real life .(44) Therefore, each accuracy, sensitivity, and specificity index is important based on the disease and the desired conditions.

Of course, in medicine, the application of diagnostic tests in segregating sick individuals from healthy ones is recognized through statistical concepts of sensitivity, specificity, PPV, and NPV that these indices are affected by the disease prevalence in society .(45) PPV (Positive Predictive Value) entails the cases whose test result is positive, and they are truly sick, and NPV (Negative Predictive Value) entails the cases whose test result is negative and are truly healthy .(44)

On the other hand, none of these two indices solely guarantee the proper model performance because in a case the model sensitivity is 100%, it indicates that all the samples were diagnosed as sick, and in turn, it has diagnosed all the healthy samples as sick, and the specificity index becomes 0%. So, the best case is that both sensitivity and specificity indices are close to 100% .(45)

According to the conducted review in table 1 and table 2 and regardless of the number of samples, we can see that the SVM algorithm has higher accuracy, sensitivity, and specificity than other algorithms. After that, deep CNN has the best situation compared to other algorithms.

Conclusion

Today, the application of expert and intelligent systems such as AI algorithms are rapidly growing in various industries, one of which is the medical industry. Thus, physicians have significantly reduced their medical errors by using these systems as their assistants.

Diagnosing and predicting diseases, including non-contagious diseases like cancer, is one of the critical medical issues. Since gastric cancer has been the fourth most common malignancy, the second leading cause of cancer mortality globally, and the most common type of cancer in the last century, using AI algorithms to diagnose this type of cancer has become more important than ever.

According to the reviews conducted on the published papers, the endoscopic method has been the most used method to collect and incorporate samples into designed models. Also, the support vector machine (SVM), convolutional neural network (CNN), and deep-type CNN have been used the most; so, we propose the usage of these algorithms in medical subjects, especially in gastric cancer.

Since most expensive methods (e.g., endoscopy) have been used in the reviewed papers, which can impose adverse effects on an individual's health, the critical point is the lack of attention to the risk factors of people's lifestyle and collecting samples through studying their lifestyle before diagnosing gastric cancer, which could be a research topic for future studies.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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