

The role of artificial intelligence in colonoscopy imaging and colonic diseases: A scientometrics analysis and visualization study

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Abstract

Introduction: Artificial intelligence (AI) has made a big difference and is used in many different sectors also in medicine. We sought to identify the areas of interest and potential future directions for AI in the field of colonoscopy imaging and colonic diseases by utilizing bibliometrics to analyze the previous 50 years' worth of changes on this topic.

Material and methods: Using the Web of Knowledge (WOS) database, we searched for articles published from 1970 to 2021 using the keywords related to colonoscopy imaging/colonic diseases and AI. The retrieved articles were analyzed with bibliometric methods.

Results: A total of 278 documents were analyzed in this study. The earliest article was published in 1997 and the vast majority of the documents were published in 2021 (n=81). There was a growth in publications number in the last 5 years. The documents were cited 3054 times in total and had 10.99 citations per document. The main Hirsch (H) index of the documents was 27. A total of 41 countries contributed to the literature. The United States of America (USA), the People's Republic of China, and England were the leading countries on this topic. Also, England had the highest number of citations (total of 974 citations, 31.42 per document) and the USA publications had the highest H index.

Discussion: Artificial intelligence facilitates diagnosis and treatment possibilities, especially in the field of health. Especially the use of artificial intelligence in colonoscopic imaging reduces the risk of missing a possible polyp or a mucosal pathology. The integration of artificial intelligence into imaging methods has been the most in the last 5 years. Most studies on this subject have been done in the USA.

Conclusion: Our research may offer a historical perspective on the development of AI in colorectal diseases. The documents were limited to some developing countries.

Key words: artificial intelligence, colorectal diseases, colon, colonoscopy, machine learning, bibliometric analysis

Introduction

The definition of artificial intelligence (AI) is an intelligence displayed by machines as opposed to the natural intelligence exhibited by humans and other animals [1]. It was made of leather, wood, and artificial organs [2]. AI is projected to fill a number of jobs currently filled by humans [1].

There are two key applications of AI in medicine: both imaginary and physical. Firstly, AI has increased and continues to encourage advancements in genetics and molecular offering machine learning algorithms and

knowledge administration [3]. AI and its use in medicine have advanced significantly since 2010 [4]. The use of AI-based medicine in gastroenterology practice is anticipated in the near future [1]. In gastroenterology, AI is being investigated for endoscopic lesion analyzed, cancer detection, and for making it easier to analyze inflammatory lesions or gastrointestinal bleeding using wireless capsule endoscopy. It is challenging to compare the findings of various research due to variations in performance indicators. AI appears to be especially useful for endoscopy, where it might improve the identification

of inflammatory lesions, small-bowel hemorrhage, malignant and premalignant lesions, and pancreaticobiliary illnesses [4-6]. Additionally, these studies may be able to forecast the onset of GI illness before symptoms appear, increasing the likelihood of prevention or pre-treatment. Additionally, computer vision offers the intriguing possibility of automated lesion detection during endoscopy and colonoscopy [7,8].

An accepted colonoscopy quality indicator is the adenoma detection rate. For instance, a 1 % increase in the adenoma diagnosis rate was linked to a 3 % decrease in the risk of interval colorectal cancer [8]. A prior meta analysis, however, revealed that about 26% of neoplastic diminutive polyps were missed during a single colonoscopy [9]. Blind spots and human mistakes are thought to be two variables that influence this rate. A wide-angle scope or distal attachments might address the first issue, but human error is difficult to eliminate. AI has drawn interest as a way to alleviate human mistakes [10,11]. Systems that use a computer's capacity to learn and carry out certain tasks include computer-aided detection (CADE) and computer-aided diagnostic (CADx). Machine learning and deep learning advancements have made it possible for computers to learn and carry out certain endoscopic activities that were previously the duty of the endoscopist. CADE and CADx have the potential to change endoscopy, albeit in its early stages. The use of CADE and CADx during colonoscopy, with an emphasis on three main points: (1) the effectiveness of the mucosal inspection, (2) the identification of polyps, and (3) ocular biopsy. Imaging, robotic surgery, and genomics are just a few of the numerous possible uses for CADE and CADx in the healthcare industry [10].

We sought to identify the areas of interest and potential future directions for AI in the field of colonoscopy imaging and colonic diseases by utilizing bibliometrics to analyze the previous 30 years' worth of changes on this topic.

Materials and methods

In this retrospective bibliometric design study, the Web of Science (WoS) database was used to gain the dataset. Subscribers to the WOS database gain access to a range of databases that offer comprehensive citation data for a wide range of academic disciplines. It was originally developed by the Institute for Scientific Information (ISI). It is currently owned by Clarivate, formerly known as the Intellectual Property and Science division of Thomson Reuters. The Scientific Information Institute (ISI) initially developed the service, which is now run by Clarivate Analytics [12].

There are two search options available for this database: a simple search and an advanced search, which enables users to construct intricate and comprehensive search queries to accomplish the desired objective. Customers can access words in the database's titles, abstracts, journal/author names, and affiliations [13]. In this study, authors, affiliations, nations, publication numbers, journals, H-index, and citation bursts were only a few of the parameters that were noted.

We used the keywords related to AI (artificial intelligence; computer-aided detection; computer-aided diagnosis; convolutional neural network, deep learning; machine learning; computer-aided diagnostic; computer-aided detection) and colonic diseases or colonic diagnostic methods (colonoscopy; colonic diseases; colon; colonic diseases, colonoscopy, colonic polyps) in the "title" as a search item in our study.

The following were the exclusion criteria: (1) Articles written in languages other than English; (2) Articles covering a variety of topics but not only colorectal diseases.

The WOS database's maximum timeframe for searches was June 25, 2022, so this was the timeframe covered. In order not to cause bias, the search in the study was carried out in a single day. The information was gathered on June 26, 2021, by pre-analyzing retrieval outcomes from the core collection's online version in the WOS database. All published documents were examined without making any distinction between documents.

Finally, the collected information was extensively studied for its applicability to the research presented in the study.

Statistical analysis

Microsoft Word and Microsoft Excel were used to create the tables and graphs, respectively. Based on the frequency of keywords in titles and abstracts, data visualization was done using the VOSviewer 1.6.18 software (Leiden University, Leiden, The Netherlands) approach to produce scientific networks and landscapes.

Results

A total of 278 documents were analyzed in this study. Regarding study type, there were articles (n=100), meeting abstracts (n=75), proceedings papers (n=42), reviews (n=32), editorial materials (n=23), early access (n=5), letters (n=4), news items (n=3), corrections (n=2) and book chapters (n=1). There were no guidelines, respectively. Most of them were from gastroenterology/hepatology (53.957%) and surgery (15.827%) research areas (Table 1).

Table 1	Publishing Categories	
Web of Science Categories	Record Count	% of 278
Gastroenterology Hepatology	150	53.957
Surgery	44	15.827
Engineering Biomedical	24	8.633
Robotics	21	7.554
Radiology Nuclear Medicine Medical Imaging	20	7.194
Engineering Electrical Electronic	17	6.115
Automation Control Systems	16	5.755
Medicine General Internal	14	5.036
Computer Science Artificial Intelligence	13	4.676
Engineering Mechanical	12	4.317

Showing 10 out of 47 entries

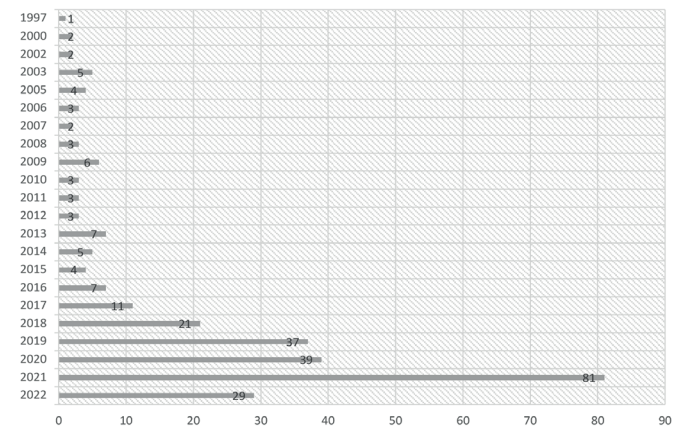


Figure 1 - The number of published documents by the years

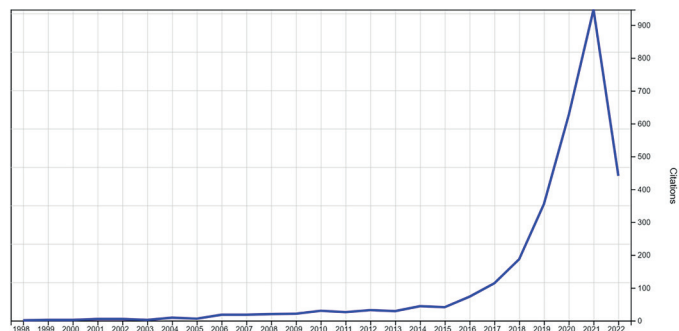


Figure 2 - The number of citations of the documents by the years

The earliest article was published in 1997 and the vast majority of the documents were published in 2021 (n=81). There was a growth in publications number in the last 5 years (Figure 1). The documents were cited 3054 times in total and had 10.99 citations per document. The main Hirsch (H) index of the documents was 27. Figures 1 and 2 display the number of papers and citations per year (Figure 1,2). The article had the highest citation number published by Sirinukunwattana et al. [13] in 2016. This article [17] was cited 563 times.

The European Commission (n=9), the National Institutes of Health Nih United States of America (USA) (n=9) and, the United States Department Of Health Human Services (n=9) were the leading funding agencies (Figure 3).

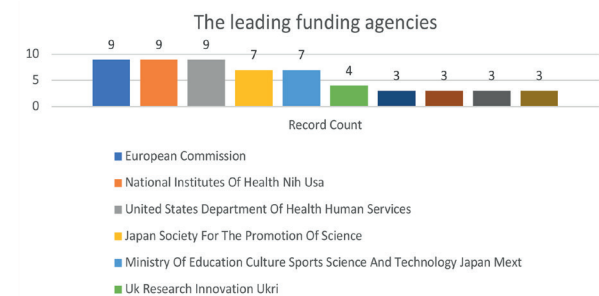


Figure 3 - The leading funding agencies
*Showing 10 out of 133 entries;196 record(s) (70.504%) do not contain data in the field being analyze

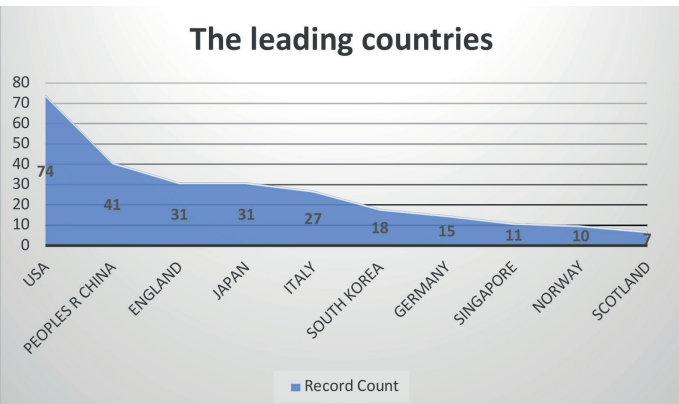


Figure 4 - The leading countries on the AI&colon literature
*Showing 10 out of 41 entries

A total of 41 countries contributed to the AI&colon literature. The USA, the Peoples’ Republic of China, and England were the leading countries in the AI&colon literature (Figure 4). Also, England had the highest number of citations (total of 974 citations, 31.42 per document) and the USA publications had the highest H index (Table 2).

Table 2

The number of citations and H indexes according to countries

Ranking	Country	Total citations	Mean of citations per document	H index
1	The USA*	689	9.31	14
2	The Peoples Republic of China	278	6.78	8
3	England	974	31.42	10
4	Japan	846	27.29	11
5	Italy	429	15.89	12

*USA: United State of America

Table 3

The leading institutions

Name of institutions	n	% of 278
SHOWA UNIVERSITY	18	6.475
MAYO CLINIC	11	3.957
UNIVERSITY OF LONDON	11	3.957
NAGOYA UNIVERSITY	10	3.597
UNIVERSITY OF OSLO	10	3.597
KOREA AEROSPACE UNIVERSITY	9	3.237
UNIVERSITY COLLEGE LONDON	9	3.237
SCUOLA SUPERIORE SANT ANNA	8	2.878
UNIVERSITY OF CALIFORNIA SYSTEM	8	2.878
POLIAMBULATORIO NUOVO REGINA MARGHERITA	7	2.518

Table 4

Journals in which the AI&colon articles were published

The publishing journal	n	% of 278
GASTROINTESTINAL ENDOSCOPY	41	14.748
ENDOSCOPY	15	5.396
AMERICAN JOURNAL OF GASTROENTEROLOGY	14	5.036
GASTROENTEROLOGY	13	4.676
GUT	9	3.237
ENDOSCOPY INTERNATIONAL OPEN	7	2.518
LANCET GASTROENTEROLOGY HEPATOLOGY	7	2.518
JOURNAL OF GASTROENTEROLOGY AND HEPATOLOGY	6	2.158
PROCEEDINGS OF SPIE	6	2.158
SURGICAL ENDOSCOPY AND OTHER INTERVENTIONAL TECHNIQUES	6	2.158
DIGESTIVE AND LIVER DISEASE	5	1.799
WORLD JOURNAL OF GASTROENTEROLOGY	5	1.799
CANCERS	3	1.079
DIAGNOSTICS	3	1.079
DIGESTIVE ENDOSCOPY	3	1.079
IEEE ROBOTICS AND AUTOMATION LETTERS	3	1.079
2003 IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION VOLS 1 3 PROCEEDINGS	2	0.719
ADVANCED MATERIALS RESEARCH	2	0.719
ANNALS OF INTERNAL MEDICINE	2	0.719
ANNALS OF TRANSLATIONAL MEDICINE	2	0.719
APPLIED SCIENCES BASEL	2	0.719
CLINICAL ENDOSCOPY	2	0.719
COLOPROCTOLOGY	2	0.719
COMPUTERS IN BIOLOGY AND MEDICINE	2	0.719
IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION	2	0.719

Showing 25 out of 149 entries

With regard to institutions, the Showa University from Japan (n=18), The Mayo Clinic from the USA (n=11), and the University of London (n=11) published the largest number of documents (Table 3).

Showing 10 out of 452 entries; 35 record(s) (12.590%) do not contain data in the field being analyzed.

The vast majority of the articles (n=41) were published in the Gastrointestinal Endoscopy journal (Table 4). The summary of the journals were given in Table 4.

Mapping

Figures 5-9 define the mapping of co-authorship analysis between authors (Figure 5), keyword analysis (Figure 6), citation analysis among countries (Figure 7), co-citation analysis among authors (Figure 8), and bibliographic coupling among countries (Figure 9).

Discussion

Recent years have seen an upsurge in the prevalence of colorectal disorders across the world, particularly inflammatory bowel disease and colorectal cancer [15]. One of the most prevalent cancers in the world is colon cancer, which often begins as localized changes in the colon epithelial tissue that progress to a malignant polyp as a result of genetic abnormalities that accumulate over the course of cancer development [15,16]. As an outcome, several studies on colorectal illnesses have been conducted in the fields of pathophysiology, epidemiology, genetics, and immunology [17]. The abundance of information may overwhelm researchers, making it challenging to identify areas of interest for further study. Therefore, there is a pressing need to investigate strategies for facilitating researchers' efficient access to relevant papers in their areas of study [15]. However, no research on colorectal diseases has examined the relationship between AI and colonic diseases. To do this, we used bibliometrics to examine the developments over the preceding 30 years in the field of colonoscopy imaging and colonic disorders to determine the areas of interest and potential future avenues for AI.

The bibliometric analysis has been used by several medical disciplines to determine the most significant papers in their area [18-30]. In the past few years, a wide range of bibliometric analysis techniques have begun to appear in the medical literature, and techniques like mapping and graphing can enhance analysis research on this topic. These studies can be conducted using a variety of techniques, including content analysis, comparisons of scientific productivity across years, nations, and citation counts. Databases that offer quick and thorough data analysis, such as Pubmed, EBSCO, Scopus, ProQuest, and Web of Science, are often used for the bibliometric study.

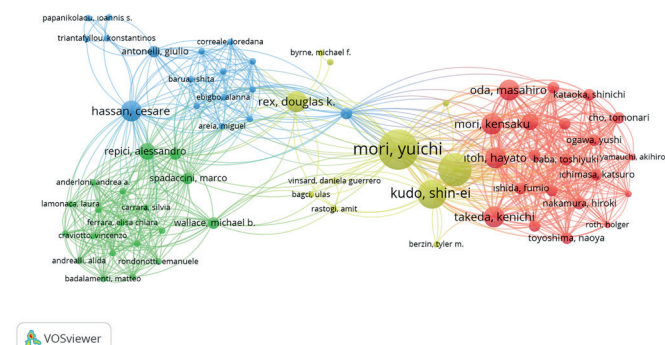


Figure 5 - Co authorship analysis between authors
*Author with 1 article

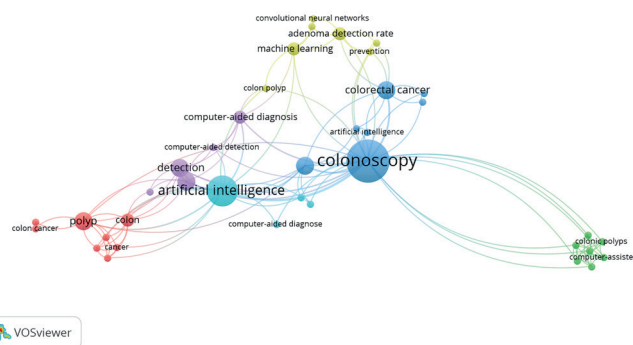


Figure 6 - Keyword analysis
*41 keywords total with 1 occurrence

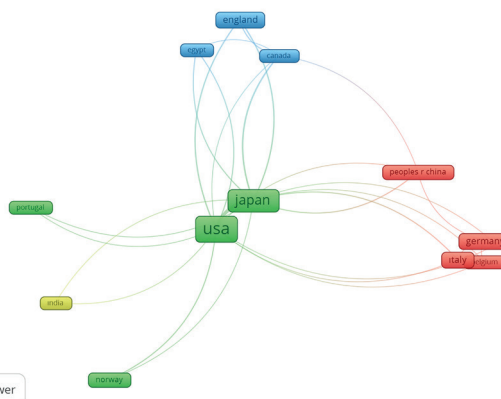


Figure 7 - Citation analysis among countries

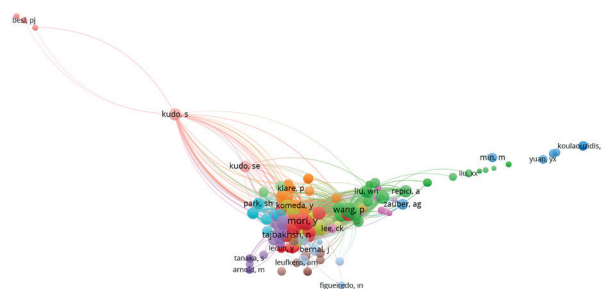


Figure 8 - Co-citation analysis among authors

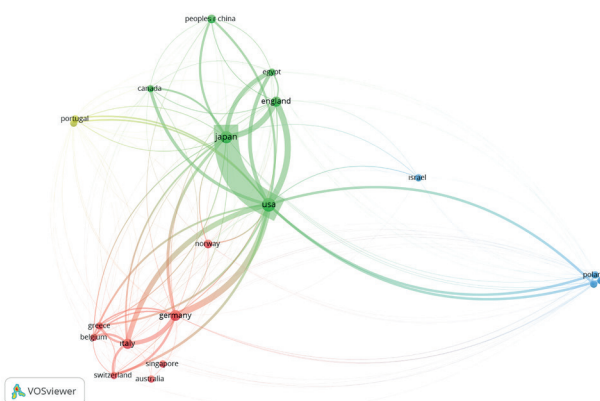


Figure 9 - Bibliographic coupling among countries

But other sources, including any database, theses, journals, conferences, etc., can also be examined using this technique [18-30]. In our study, we preferred the WOS database as this database indexes highly quality studies. And our findings revealed that scientific output was rising, especially in the last 5 years. Leading nations, journals, and funding agencies were found to be the main contributors to the discipline. The top contributing nations were the United States, the People's Republic of China, England, Japan, Italy, South Korea, Germany, Singapore, Norway, and Scotland.

The bibliometric method refers to the quantification of general trends and the identification of links or relationships that may be concealed in vast amounts of data [22-25]. In this current study, the mapping results stated the co-authorship analysis between authors (Figure 5), citation analysis among countries (Figure 7), co-citation analysis among authors (Figure 8), and bibliographic coupling among countries (Figure 9).

The thickness of the links and the size of the node reflect the degree of international collaboration; the larger the node, the more important the country or area, and the thicker the line, the tighter the cooperation ties between the countries/regions/authors (Figure 5-9). In our study, it was determined that there was an intense bibliographic coupling between USA and Japan (Figure 9).

An article's impact and legitimacy are shown by how many times it has been cited, and the number of citations also reflects the author's academic success [31]. Also, H-index is an author-specific statistic that measures a scholar's publications in terms of productivity and citations. It is also known as the Hirsch index or Hirsch number [32]. Jorge Hirsch made the initial suggestion to measure the relative academic contribution of different theoretical physicists [33]. England had the highest number of citations (total of 974 citations, 31.42 per document) and the USA publications had the highest H index.

Analysis of keywords offered a special hint about this field's potential future directions (Figure 6). Over this time, there was a clear dynamic change in the top terms with burst citations, showing a transfer of research resources and interests.

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Misawa et al. studied AI using 546 short videos from 73 full-length videos, which were divided into two groups of training data (105 polyp-positive videos and 306 polyp-negative videos) and test data (50 polyp-positive videos and 85 polyp-negative videos). The researchers showed the possibility of the automate detection of colonic polyps in real time, and the sensitivity and specificity were 90.0% and 63.3%, respectively [34].

Urban et al also used a AI to identify colonic polyps. They used 8641 hand-labeled images and 20 colonoscopy videos in various combinations as training and test data. The AI model detected polyps in real time with an AUROC of 0.991 and an accuracy of 96.4% [35].

This study has certain limitations. The data were obtained from a single database (WOS), thus there may have been some missing articles and the number of citations was inflated, although the authors think this is unlikely. The content analyses weren't put into practice enough. This manuscript's biggest flaw is the likelihood of many sorts of prejudice, which might bias the findings. Disproportionate citation can be caused by institutional prejudice, linguistic bias, self-citation, or bias against powerful people. Additionally, older journals might get more citations. The restriction to just first and senior writers, as well as the first author's institution, is another one. Several of the first writers could have contributed to additional studies.

Conclusion

Our research may offer a historical perspective on the development of AI in colorectal diseases. The documents were limited to some developing countries.

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