Research Article

Bibliometric Analysis of Artificial Intelligence Revolutions in Health-related Sustainable Development Goals

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Abstract

Background: In line with the advancement of Artificial Intelligence (AI), innovative solutions have been designed to improve health-related Sustainable Development Goals (SDGs). Accordingly, there is an increasing trend in the realm of AI and SDG research areas.

Objectives: This study aimed to analyze the trends and patterns of AI research in health-related SDGs using bibliometric analysis.

Methods: The bibliometric approach facilitated the identification of key terms and countries from previous research. We used VOSviewer to map and analyze data obtained from three databases: Scopus, Web of Science, and PubMed.

Results: Our findings illustrated that research on health has been a popular area of study in recent years. In particular, we observed a significant increase in research on AI in health-related SDGs during 2015 - 2022.

Conclusions: This study provides insights into the trends and patterns of AI research in health-related SDGs using bibliometric analysis. The findings can guide future research by identifying key terms that require further investigation.

Keywords: Artificial Intelligence; Revolutions; Health; Sustainable Development Goals

1. Background

Artificial Intelligence (AI) and Sustainable Development Goals (SDGs) have received much attention in the last few years (1). The definition of AI is evolving, but currently, it is defined as the ability of computers to solve complex cognitive problems associated with human intelligence, assist people through smartphones or healthcare, and recognize problems and create solutions for the benefit of technology, people, and society (2). Artificial intelligence is a field within computer science that focuses on simulating intelligent behavior in computers (3).

Artificial intelligence has become a reality of everyday life in our modern high-tech societies (2). The advanced capabilities of machines and robotics with deep learning have brought about both disruptive and enabling impacts on businesses, governments, and society (4). Artificial intelligence has the potential to positively impact humans and SDGs by solving problems that can lead to advancements in creativity, productivity, and a more equitable society (5). In other words, AI is causing a revolution with increasing impacts on the people, the planet, and prosperity (6). With its increasing capacities, AI has become a crucial factor in achieving SDGs by utilizing large datasets and novel analytical methods that rely on such data for SD (7, 8). Despite being in its early stages, AI tools and techniques have proven beneficial in providing comprehensive insights into individual health and predicting population health risks. As a result, their use in medicine and public health is expected to increase significantly in the near future (9).

2. Objectives

The utilization of AI has the potential to revolutionize SD efforts through various applications. The academic community plays a crucial role in informing future leaders and policymakers to address the challenges and opportunities presented by AI and its impact on advancing global goals (2). Numerous studies have explored the intersection of AI and SDGs, yet none have specifically examined the impact of AI on health-related targets and indicators within the SDG framework. To address this gap, a comprehensive study is necessary to guide future researchers in their exploration of AI's potential contributions to health-related SDGs, especially the areas that are currently underutilized. Therefore, this study aimed to determine the revolutions of AI research on health-related SDGs using VOSviewer software to map data.

3. Methods

VOSviewer is a software tool for creating maps based on network data and for visualizing and exploring these maps. The functionality of VOSviewer can be summarized as follows: (1) Creating maps based on network data and (2) Visualizing and exploring maps (10). Unlike most computer programs that are used for bibliometric mapping, VOSviewer pays special attention to the graphical representation of bibliometric maps. The functionality of VOSviewer is especially useful for displaying large bibliometric maps in an easy-to-interpret way (11). VOSviewer can be used for analyzing all kinds of bibliometric network data, for instance, citation relations between publications or journals, collaboration relations between researchers, and co-occurrence relations between scientific terms (12).

The study involved analyzing articles from databases using predetermined keywords. Bibliometric maps were created using VOSviewer to visualize and analyze trends, including country maps and keyword maps based on networks or relationships between existing items. A term map is a map that visualizes the structure of a scientific field by showing the relations between important terms in the field (13). We adapted the list of health-related SDG targets and indicators proposed by three studies (14-16) as the keywords. Studies published in English from the period of 2000 to 2023 were included.

4. Results

The research criteria yielded a total of 856 articles from three databases: 402 from Scopus, 334 from Web of Sciences, and 120 from PubMed. Table 1 provides the searched keywords used in the study. The results were divided into two parts: Bibliometric analysis of the topic area and country of research study across all three databases.

Table 1. Search Queries Used for Target Databases

Databases and Query	Initial Results
SCOPUS (TITLE (SDG) OR TITLE ("Sustainable development goals") OR TITLE (Poverty) OR TITLE (Disaster) OR TITLE (Hunger) OR TITLE ("Road Injuries") OR TITLE (Economic) OR TITLE (Social) OR TITLE (Environmental) OR TITLE ("Communicable diseases") OR TITLE (NCD) OR TITLE ("NON communicable diseases") OR TITLE ("Food security") OR TITLE (Nutrition) OR TITLE (Death) OR TITLE (Chemicals) OR TITLE ("Air pollution") OR TITLE ("Water pollution") OR TITLE ("Air quality") OR TITLE (" Soil pollution ") OR TITLE (YLLS) OR TITLE (GBD) OR TITLE (Violence) OR TITLE (Disasters) OR TITLE ("Air quality") OR TITLE (DALY) OR TITLE (QALY) OR TITLE ("Disability-adjusted life-year") OR TITLE ("Disability adjusted life year") OR TITLE ("Quality-Adjusted Life Year") OR TITLE ("Quality Adjusted Life Year") OR TITLE (Deaths) OR TITLE ("Municipal management") OR TITLE (Agriculture) OR TITLE (Water) OR TITLE (Sanitation) OR TITLE (Hygiene) OR TITLE (Pollution) OR TITLE (Suicide) OR TITLE (Employment) OR TITLE (Wash) OR TITLE (Sustainability) OR TITLE (War) OR TITLE ("Climate change")) AND (((TITLE ("Big data") OR TITLE ("Data mining") OR TITLE ("Internet of things") OR TITLE ("Deep learning") OR TITLE ("Artificial intelligence") OR TITLE ("Machine learning")))) AND (LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English"))	402
Web of Science (TI=(SDG)) OR TI=("Sustainable development goals")) OR TI=(Poverty)) OR TI=(Disaster)) OR TI=(Hunger)) OR TI=("Road injuries")) OR TI=(Economic)) OR TI=(Social)) OR TI=(Environmental)) OR TI=(" Communicable diseases")) OR TI=(NCD)) OR TI=("NON communicable diseases")) OR TI=("Food security")) OR TI=(Nutrition)) OR TI=(Death)) OR TI=(Chemicals)) OR TI=("Air pollution")) OR TI=("Water pollution")) OR TI=("Air quality")) OR TI=("Soil pollution")) OR TI=(YLLS)) OR TI=(GBD)) OR TI=(Violence)) OR TI=(Disasters)) OR TI=("Air quality")) OR TI=(DALY)) OR TI=(QALY)) OR TI=("Disability-adjusted life-year")) OR TI=("Disability adjusted life year")) OR TI=("Quality-Adjusted Life Year")) OR TI=("Quality Adjusted Life Year")) OR TI=(Deaths)) OR TI=("Municipal management")) OR TI=(Agriculture)) OR TI=(Water)) OR TI=(Sanitation)) OR TI=(Hygiene)) OR TI=(Pollution)) OR TI=(Suicide)) OR TI=(Employment)) OR TI=(Wash)) OR TI=(Sustainability)) OR TI=(War)) OR TI=("Climate change")) (TI= ("Artificial intelligence")) OR TI= ("Machine learning")) OR TI= ("Data mining")) OR TI= ("Deep learning")) OR TI= ("Big data")) OR TI= ("Internet of things")	334

PubMed		
(SDG[Title]) OR ("Sustainable development goals"[Title])) OR (Poverty[Title])) OR (Disaster[Title])) OR (Hunger [Title])) OR ("Road injuries"[Title])) OR (Economic [Title])) OR (Social [Title])) OR (Environmental [Title])) OR ("Communicable diseases" [Title])) OR (NCD [Title])) OR ("NON communicable diseases" [Title])) OR ("Food security" [Title])) OR (Nutrition [Title])) OR (Death [Title])) OR (Chemicals [Title])) OR ("Air pollution" [Title])) OR ("Water pollution" [Title])) OR ("Air quality" [Title])) OR ("Soil pollution" [Title])) OR (YLLS [Title])) OR (GBD [Title])) OR (Violence [Title])) OR (Disasters [Title])) OR ("Air quality" [Title])) OR (DALY [Title])) OR (QALY [Title])) OR ("Disability-adjusted life-year" [Title])) OR ("Disability adjusted life year" [Title])) OR ("Quality-Adjusted Life Year"[Title])) OR ("Quality Adjusted Life Year" [Title])) OR (Deaths [Title])) OR ("Municipal management" [Title])) OR (Agriculture [Title])) OR (Water [Title])) OR (Sanitation [Title])) OR (Hygiene [Title])) OR =(Pollution [Title])) OR (Suicide [Title])) OR (Employment [Title])) OR (Wash [Title])) OR (Sustainability [Title])) OR (War [Title])) OR ("Climate change"[Title])) AND (Review[Filter] OR Systematic review[Filter])) AND ((((((("Artificial intelligence"[Title])) OR ("Machine learning"[Title])) OR ("data mining"[Title])) OR ("Deep learning"[Title])) OR ("Big data"[Title])) OR ("Internet of things"[Title])) AND (Review[Filter] OR Systematic Review[Filter]))	120	

4.1. Web of Science

In the Web of Science database, we used VOSviewer to analyze the data with a minimum of two terms for relationships. Of a total of 987 keywords, 67 keywords met the minimum threshold of 3 occurrences of a keyword. The results were divided into 15 clusters that represented different relationships between the terms. VOSviewer offers three different visualizations: Network visualization (Figure 1), overlay visualization (Figure 2), and density visualization (Figure 3). Colored circles label keywords, with larger circles indicating more frequent occurrences in article titles. The size of letters and circles is determined by keyword frequency.

Using this data, we can identify research on AI revolutions related to health-related SDGs. Figure 1 highlights that agriculture, precision agriculture, social media, and air pollution are the most commonly researched keywords. Research related to environmental monitoring, public health, and river water quality is still rarely conducted or published in this database.

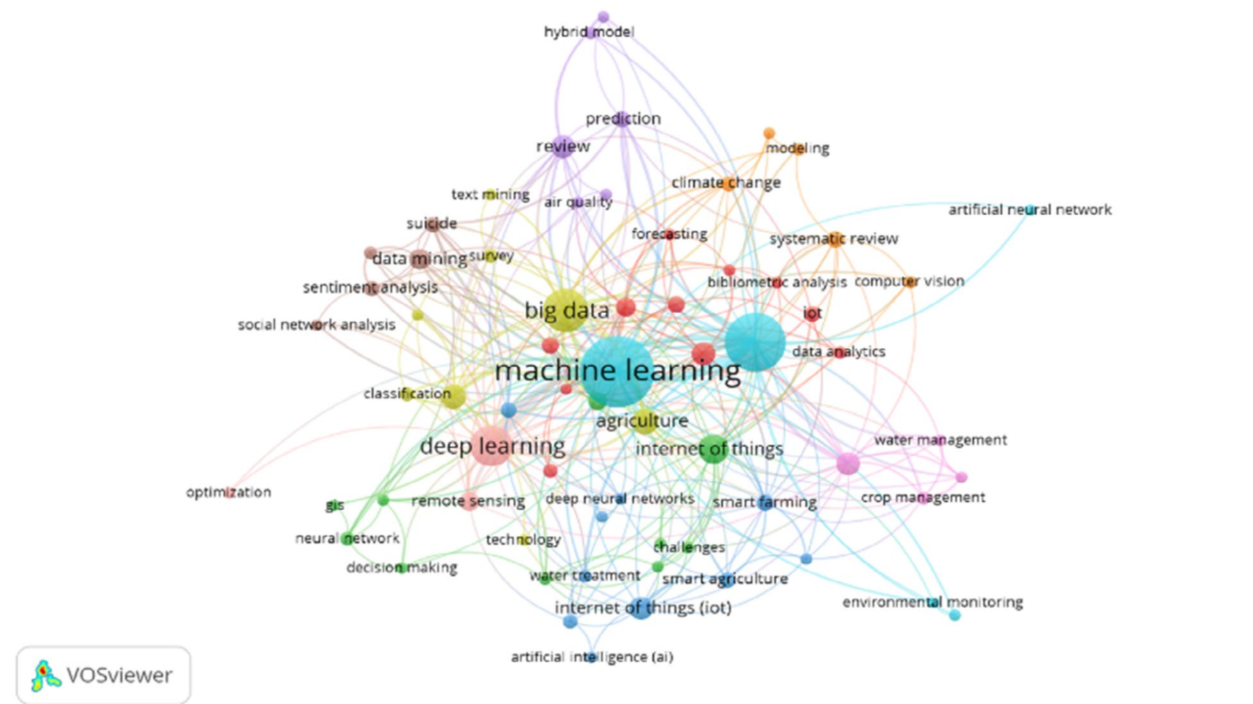

Figure 1. Network visualization of AI revolutions in health-related SDGs in the Web of Science

4.1.1. Network Visualization of AI Revolutions in Health-related SDGs in the Web of Science

The network visualization presented in Figure 1 provides an overview of the research conducted on AI revolutions in health-related SDGs in the Web of Science database.

The relationship between terms is illustrated in Figure 1 through network visualization, which displays a line connecting one term to another. Figure 1 shows the clusters in each of the researched topic areas. The figure also showcases the clusters within each researched topic area. These clusters are shown in Table 2.

Table 2. Clusters of Researched Topic Areas in the Web of Science

Clusters	Topic Areas
Cluster 1 (11 items)	AI, Air pollution, Bibliometric analysis, Big data analytics, Data analytics, Disaster management, Forecasting, IOT, Smart cities, Sustainability, sustainable development goals
Cluster 2 (10 items)	Challenges, Decision-making, GIS, Internet of things, Neural networks, Online social networks, Social internet of things, Social networking (online), Systematic literature review, Trust management
Cluster 3 (10 items)	Artificial intelligence (AI), Artificial neural networks, Deep neural Networks, Internet of things (IOT), QSAR, Smart agriculture, Smart Farming, Sustainable agriculture, Water quality, Water treatment
Cluster 4 (8 items)	Agriculture, Big data, Classification, Social media, Survey, Technology, Text mining, Twitter
Cluster 5 (6 items)	Air quality, Hybrid model, Prediction, Public health, Review, River water quality
Cluster 6 (5 items)	Artificial intelligence, Artificial neural network, Environmental monitoring, Machine learning, Metagenomics
Cluster 7 (5 items)	Climate change, Computer vision, Data science, Modeling, Systematic review
Cluster 8 (5 items)	Data mining, Sentiment analysis, Social network analysis, Social networks
Cluster 9 (4 items)	Crop management, Precision agriculture, Soil management, Water management,
Cluster 10 (3 items)	Deep learning, Remote sensing, Optimization

4.1.2. Overlay Visualization of AI Revolutions in Health-related SDGs in the Web of Science

The overlay visualization presented in Figure 2 provides an overview of the research on AI revolutions in health-related SDGs in the Web of Science database.

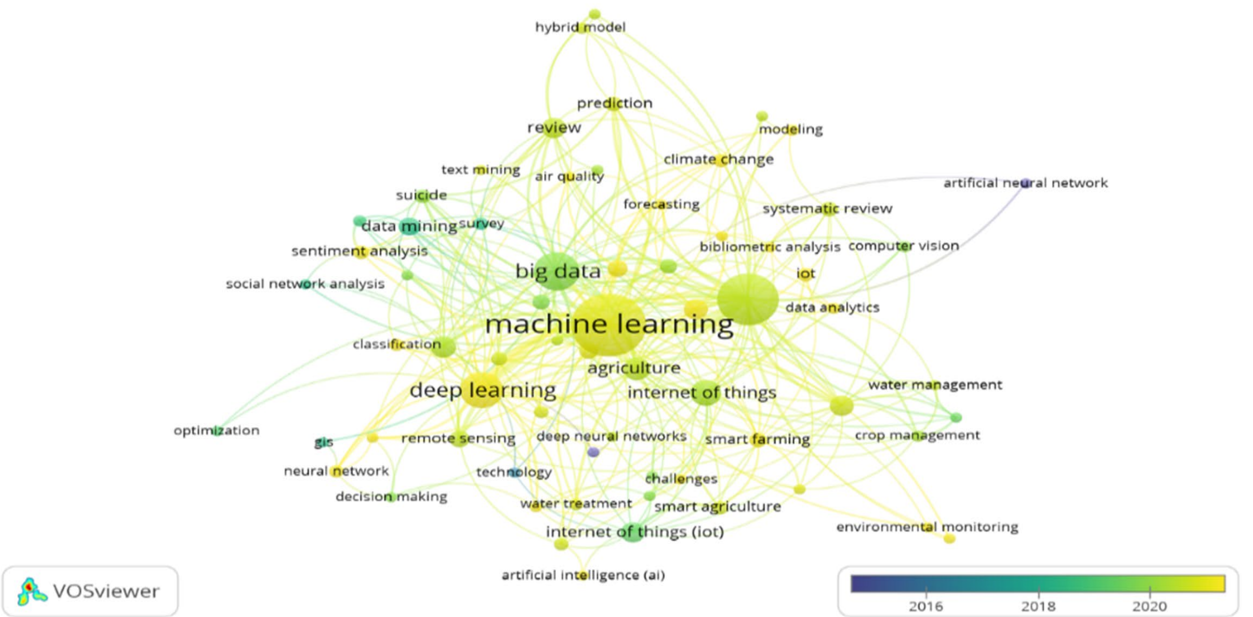

Figure 2. Overlay visualization of AI revolutions in health-related SDGs in the Web of Science

Figure 2 shows the trend from year to year related to AI research on health-related SDGs during 2015 – 2022.

4.1.3. Density Visualization of AI Revolutions in Health-related SDGs in the Web of Science

The density visualization presented in Figure 3 provides an overview of the research conducted on AI revolutions in health-related SDGs in the Web of Science database.

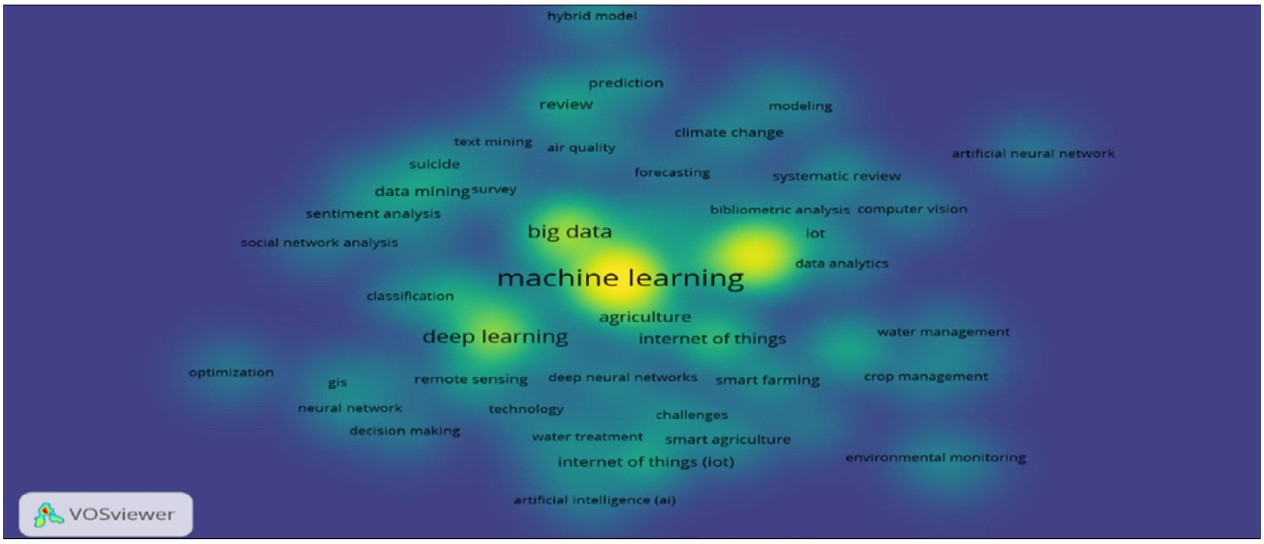

Figure 3. Density visualization of AI revolutions in health-related SDGs in the Web of Science

The visualization in Figure 3 displays the density of research on AI revolutions in health-related SDGs in the Web of Science database. The darker yellow color and larger circle diameter indicate higher keyword density, which signifies an increase in research frequency. Conversely, fading colors blending with the green background indicate a decrease in the studies.

4.1.4. Country of Research Study

Furthermore, the bibliometric analysis examined the countries involved in this research area. Figures 4, 5, and 6 illustrate the bibliometric analysis of the country of research. The study involved 69 countries, out of which 55 met the minimum threshold of 2 articles per country. The results were divided into 9 clusters that represent different relationships between the terms. The USA, China, India, England, and Australia contributed significantly to relevant journal publications. Figures 4, 5, and 6 also depict the relationships between these countries as follows:

4.1.5. Network Visualization of the Country of Research on AI Revolutions in Health-related SDGs in the Web of Science

The Network visualization presented in Figure 4 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Web of Science database.

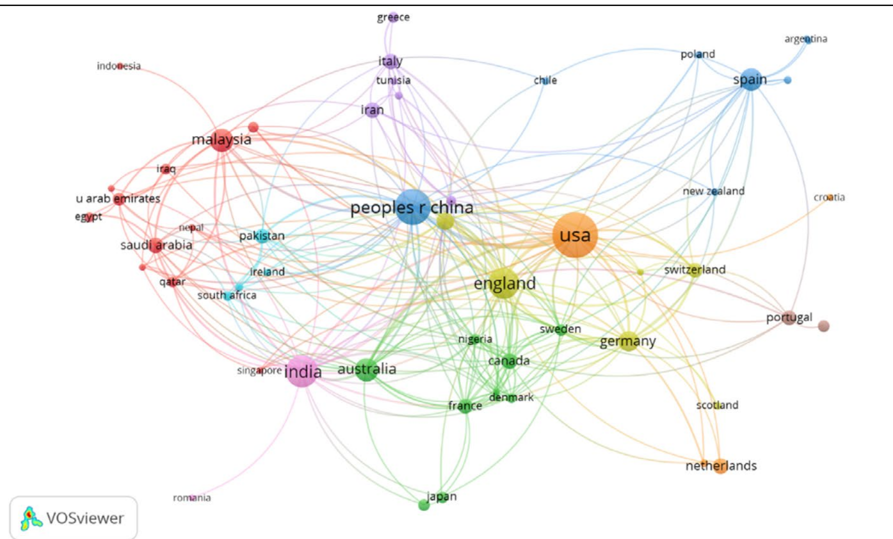

Figure 4. Network visualization of the country of research on AI revolutions in health-related SDGs in the Web of Science

The relationship between countries is illustrated in Figure 4 through network visualization, which displays a line connecting one country to another. Figure 4 shows the clusters in each of the countries. The figure also showcases the clusters within each country. Table 3 shows these clusters.

Table 3. Clusters of the Country of Research in the Web of Science

Clusters	Countries
Cluster 1 (12 items)	Algeria, Egypt, Indonesia, Iraq, Malaysia, Nepal, Qatar, Saudi Arabia, Singapore, Taiwan, U Arab Emirates, Wales
Cluster 2 (10 items)	Australia, Canada, Denmark, France, Hungary, Japan, Nigeria, Russia, Sweden, Thailand
Cluster 3 (8 items)	Argentina, Chile, Colombia, New Zealand, China, Poland, Spain, Vietnam
Cluster 4 (6 items)	England, Germany, Luxembourg, Scotland, South Korea, Switzerland
Cluster 5 (6 items)	Austria, Greece, Iran, Italy, Tunisia, Turkey,
Cluster 6 (4 items)	Ireland, North Ireland, Pakistan, South Africa
Cluster 7 (4 items)	Belgium, Croatia, Netherlands, USA
Cluster 8 (2 items)	Brazil, Portugal
Cluster 9 (2 items)	India, Romania

4.1.6. Overlay Visualization of the Country of Research on AI Revolutions in Health-related SDGs in the Web of Science

The overlay visualization presented in Figure 5 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Web of Science database.

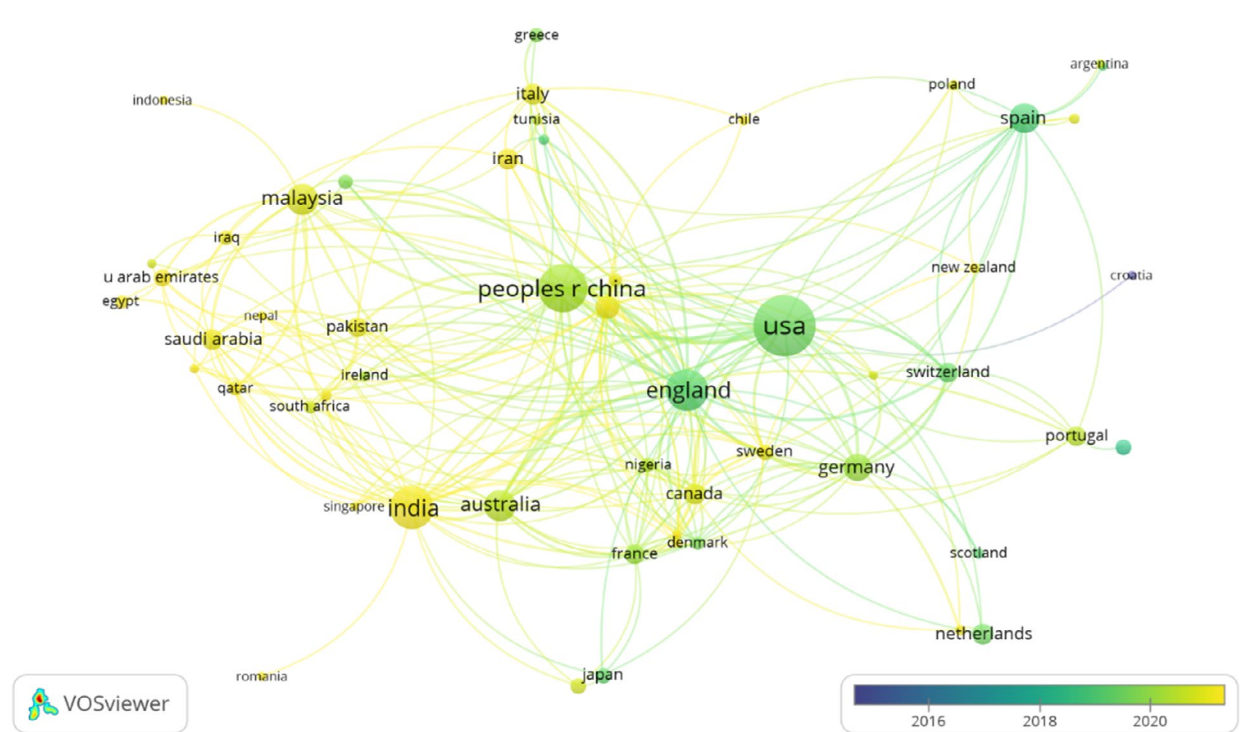

Figure 5. Overlay visualization of the country of research on AI revolutions in health-related SDGs in the Web of Science.

Figure 5 shows the trend from year to year in countries related to AI research on health-related SDGs during 2015 – 2022.

4.1.7. Density Visualization of AI Revolutions in Health-related SDGs Across Various Countries in the Web of Science

The density visualization presented in Figure 6 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Web of Science database.

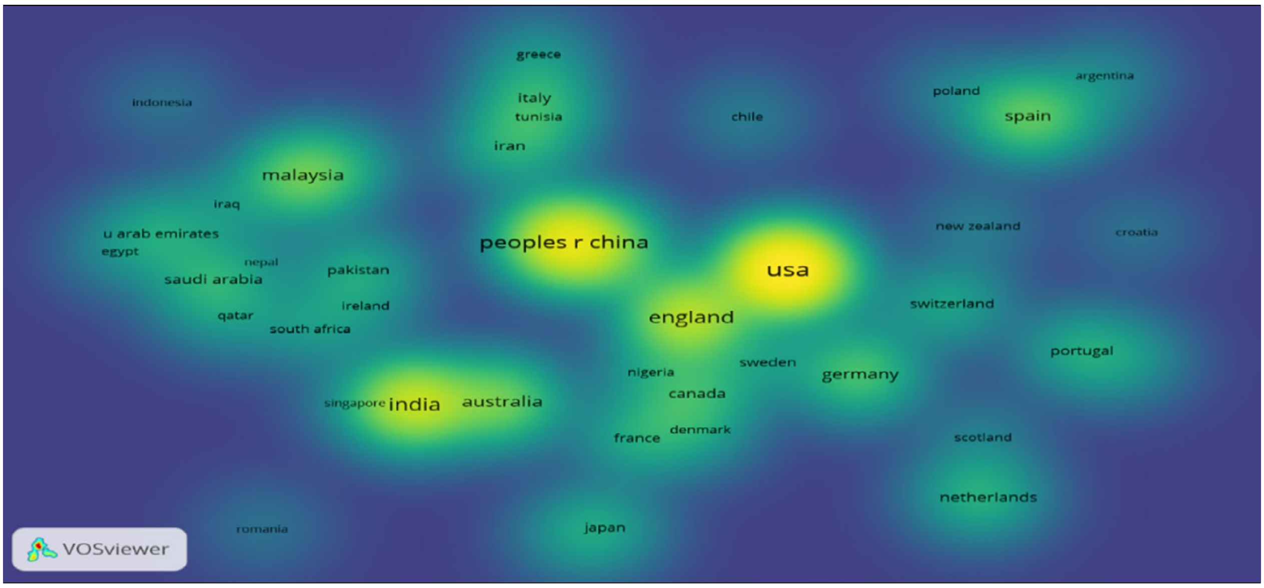

Figure 6. Density visualization of AI revolutions in health-related SDGs across various countries in the Web of Science

The density visualization depicted in Figure 6 indicates that the intensity of research on this topic is higher when the yellow color is darker, and the circle diameter is larger. Conversely, if the color fades and blends with the green background, it suggests a decrease in research activity.

4.2. Scopus

To analyze the relationships between terms related to AI revolutions in health-related SDGs further, we used VOSviewer software. Of a total of 1,105 keywords, 78 met the minimum threshold of 3 occurrences of a keyword. The results were divided into 10 clusters that represent different relationships between the terms. VOSviewer can display bibliometric mappings in three types of visualizations: Network visualization (Figure 7), overlay visualization (Figure 8), and density visualization (Figure 9). In these visualizations, keywords are represented by colored circles whose size corresponds to their frequency in titles. Thus, larger circles and letters indicate more frequent occurrences of keywords.

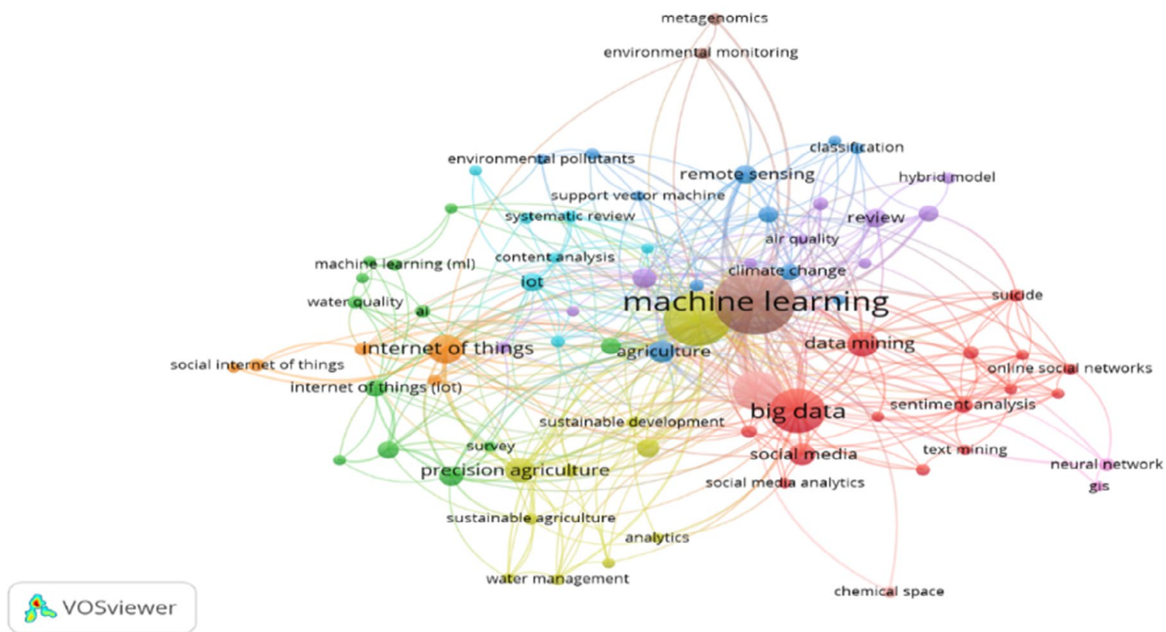

Figure 7. Network visualization of AI revolutions in health-related SDGs in Scopus

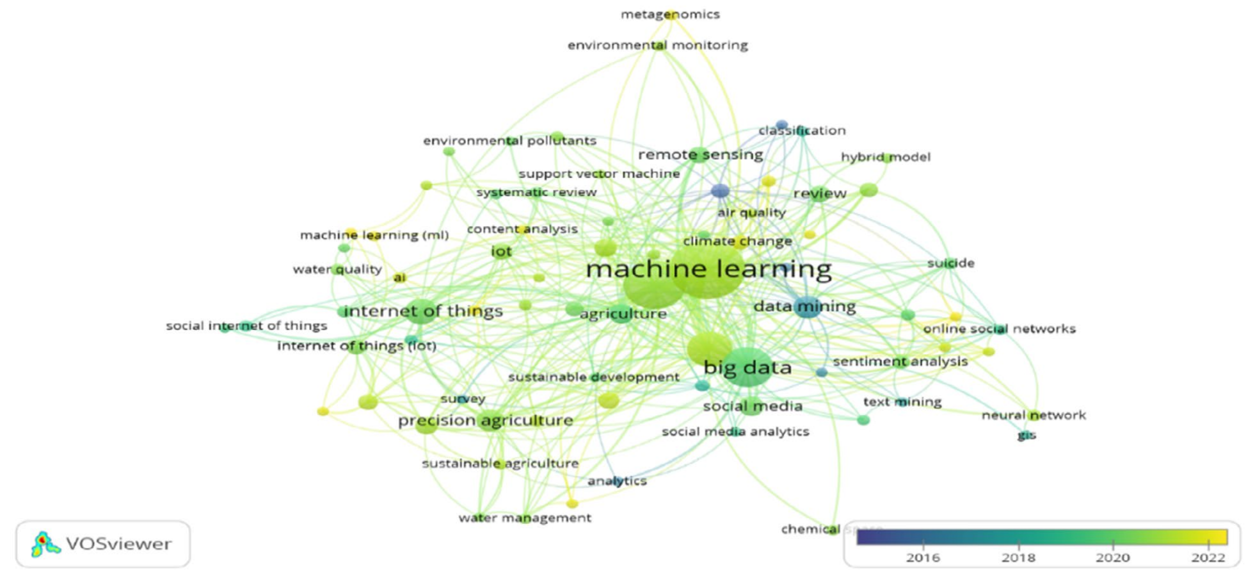

Figure 8. Overlay visualization of AI revolutions in health-related SDGs in Scopus

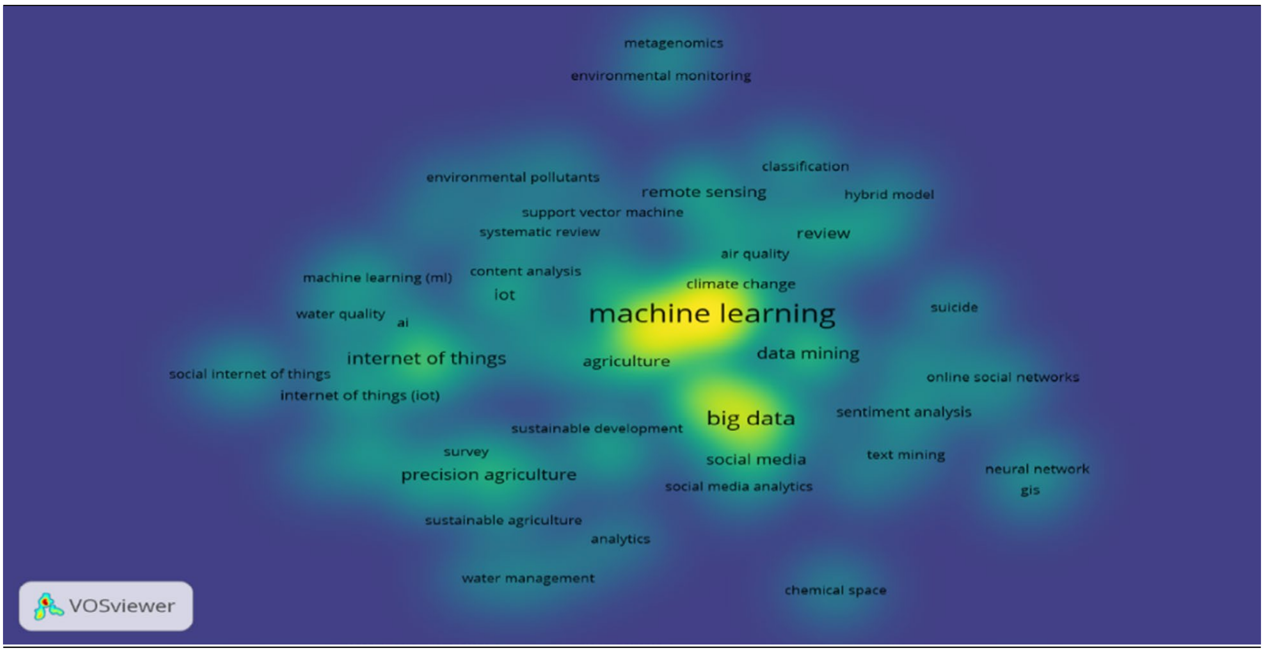

Figure 9. Density visualization of AI revolutions in health-related SDGs in Scopus

Figure 7 highlights that precision agriculture, agriculture, social media, and air pollution are the most commonly researched keywords. Research related to depression, air quality, environmental management, crop management, sustainable development, and indoor air quality is still rarely conducted or published in this database.

4.2.1. Network Visualization of AI Revolutions in Health-related SDGs in Scopus

The network visualization presented in Figure 7 provides an overview of the research conducted on AI revolutions in health-related SDGs in the Scopus database

The relationship between terms is illustrated in Figure 7 through network visualization, which displays a line connecting one term to another. Figure 7 also shows the clusters in each of the researched topic areas and within each researched topic area. These clusters are listed in Table 4.

Table 4. Clusters of Researched Topic Areas in Scopus

Clusters	Topic Areas
Cluster 1 (15 items)	Big data, Big data analytics, Data mining, Depression, Feature extraction, Information technology, Knowledge discovery, Natural language processing, Online social networks, Sentiment analysis, Social media, Social media analytics, Social network analysis, Suicide, Text mining
Cluster 2 (11 items)	AI, Artificial intelligence (AI), Disaster management, Internet of things (IOT), Machine learning (ML), Smart agriculture, Smart farming, Survey, Water quality, Water treatment, Wireless sensor network
Cluster 3 (11 items)	Agriculture, Artificial neural network, Artificial neural networks, Classification, Climate change, Environmental pollutants, Optimization, Regression, Remote sensing, Support vector machine, Systematic literature review
Cluster 4 (11 items)	Analytics, Artificial intelligence, Crop management, Data analytics, Environment, Precision agriculture, Sustainable agriculture, Sustainable development, Water management
Cluster 5 (10 items)	Air pollution, Air quality, COVID-19 Forecasting, Hybrid model, Indoor air quality, Prediction, Public health, Review, Sensors
Cluster 6 (7 items)	Computer vision, Content analysis, Environmental management, IOT, Irrigation, Smart cities, Systematic review
Cluster 7 (5 items)	Cloud computing, Internet of things, Social internet of things, Trust management, Wireless sensor networks
Cluster 8 (3 items)	Environmental monitoring, Machine learning, Metagenomics
Cluster 9 (2 items)	GIS, Neural network
Cluster 10 (2 items)	Chemical space, Deep learning

4.2.2. Overlay Visualization of AI Revolutions in Health-related SDGs in Scopus

The overlay visualization presented in Figure 8 provides an overview of the research conducted on AI revolutions in health-related SDGs in the Scopus database

Figure 8 shows the trend from year to year related to AI research on health-related SDGs during 2015 - 2022.

4.2.3. Density Visualization of AI Revolutions in Health-related SDGs in Scopus

The density visualization presented in Figure 9 provides an overview of the research conducted on AI revolutions in health-related SDGs in the Scopus database.

The visualization in Figure 9 depicts the density of research on AI revolutions in health-related SDGs in Scopus. The darker shade of yellow and larger circle diameter indicate higher keyword density, which implies an increase in research frequency. Conversely, a fading color blending with the green background suggests a decrease in studies.

4.2.4. Country of Research Study

Apart from analyzing the topic area as bibliometric, we also examined the country where the research was conducted. Figures 10, 11, and 12 present a bibliometric analysis of the study country. The study involved 101 countries, out of which 50 countries met the minimum threshold of 2 articles per country. The results were divided into seven clusters that represent different relationships between the terms. The United States, India, China, the United Kingdom, and Australia contributed significantly to relevant journal publications. Figures 10, 11, and 12 also depict the relationships between these countries as follows:

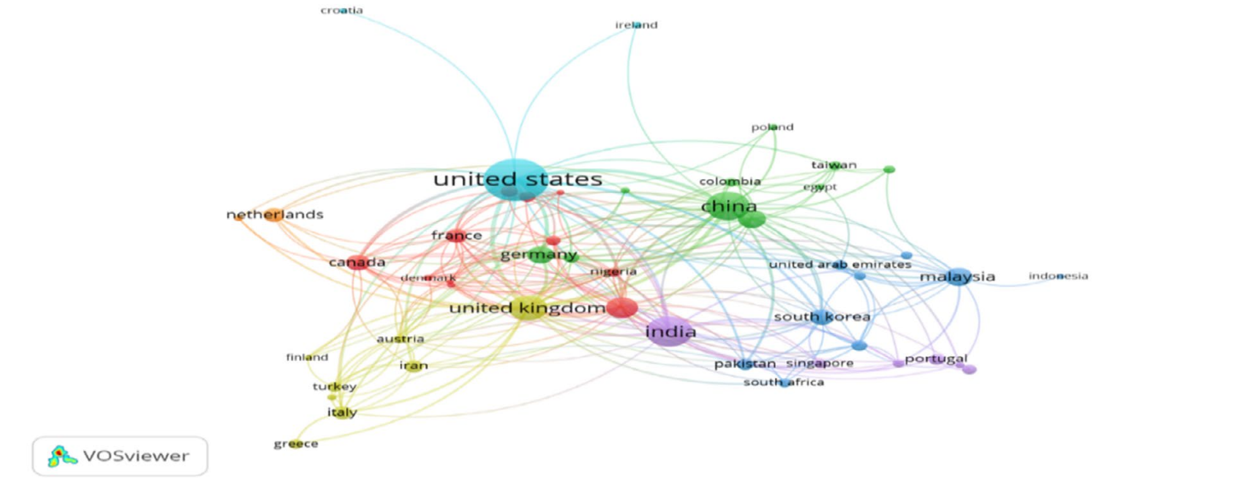

Figure 10. Network visualization of the country of research about AI revolutions in health-related SDGs in Scopus

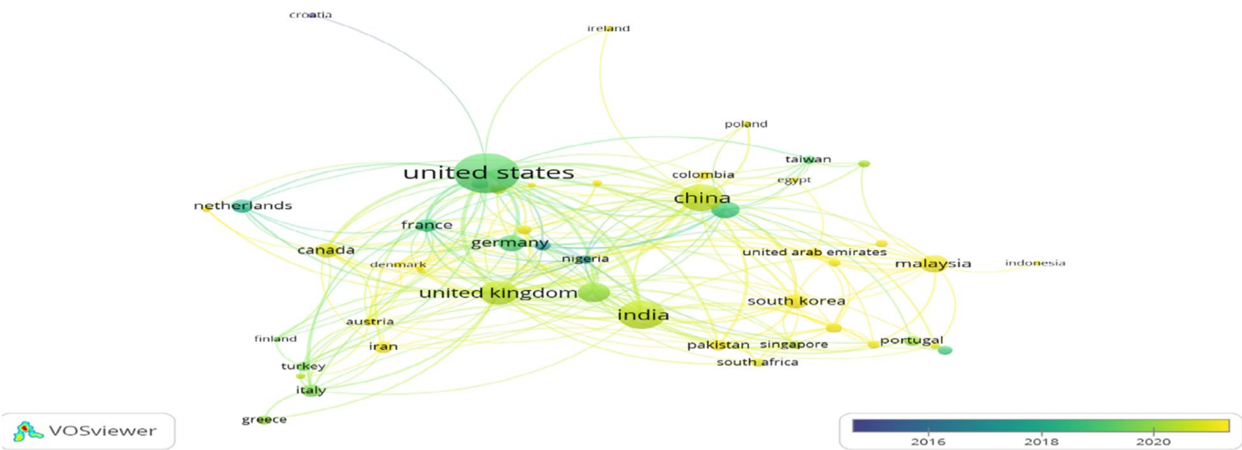

Figure 11. Overlay visualization of country research on AI revolutions in health-related SDGs in Scopus

4.2.5. Network Visualization of the Country of Research on AI Revolutions in Health-related SDGs in Scopus

The network visualization presented in Figure 10 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Scopus database.

The relationship between countries is illustrated in Figure 10 through network visualization, which displays a line connecting one country to another.

Figure 10 also shows the clusters in each of the countries and within each country. The following is a list of these groups (Table 5).

Table 5. Clusters of Country of Research in Scopus

Clusters	Countries
Cluster 1 (11 items)	Australia, Canada, Denmark, France, Hungary, Israel, Japan, Mexico, Nigeria, Russian Federation, Sweden
Cluster 2 (10 items)	China, Colombia, Egypt, Germany, Hong Kong, New Zealand, Poland, Spain, Switzerland, Taiwan
Cluster 3 (9 items)	Chile, Indonesia, Iraq, Malaysia, Pakistan, Saudi Arabia, South Africa, South Korea, United Arab Emirates
Cluster 4 (8 items)	Austria, Finland, Greece, Iran, Italy, Tunisia, Turkey, United Kingdom
Cluster 5 (6 items)	Algeria, Brazil, India, Portugal, Qatar, Singapore
Cluster 6 (3 items)	Croatia, Ireland, united states
Cluster 7 (2 items)	Belgium, Netherlands

4.2.6. Overlay Visualization of Country Research on AI Revolutions in Health-related SDGs in Scopus

The overlay visualization presented in Figure 11 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Scopus database.

Figure 11 shows the trend from year to year in countries related to AI research on health-related SDGs during 2015 – 2022.

4.2.7. Density Visualization of AI Revolutions in Health-related SDGs Across Various Countries in Scopus

The density visualization presented in Figure 12 provides an overview of the research conducted on AI revolutions in health-related SDGs across various countries, as indexed in the Scopus database.

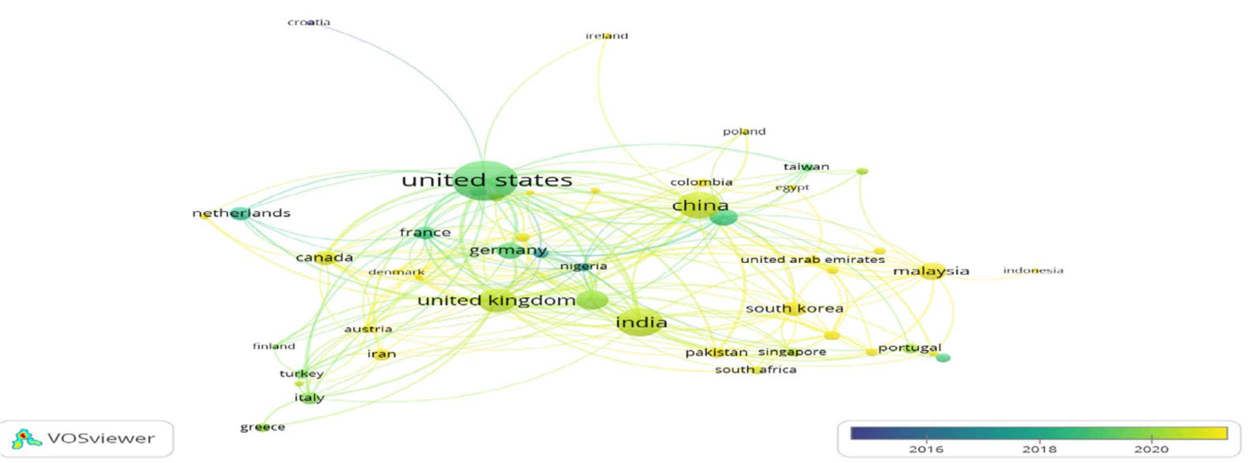

Figure 12. Density visualization of AI revolutions in health-related SDGs across various countries in Scopus

The density visualization depicted in Figure 12 indicates that the intensity of research on this topic is higher when the yellow color is darker, and the circle diameter is larger. Conversely, if the color fades and blends with the green background, it suggests a decrease in research activity.

4.3. PubMed

For further analysis of the relationships between terms related to AI revolutions in health-related SDGs, we used VOSviewer. There were a total of 344 keywords, out of which 48 met the minimum threshold of 2 occurrences of a keyword. The results were divided into 10 clusters that represent different relationships between the terms. VOSviewer can display bibliometric mappings in three distinguished visualizations: Network visualization (Figure 13), overlay visualization (Figure 14), and density visualization (Figure 15). Keywords are labeled with colored circles. In these visualizations, keywords are represented by colored circles, whose size corresponds to their frequency in titles. Thus, larger circles and letters indicate more frequent occurrences of keywords.

Figure 13. Network visualization of AI revolutions in health-related SDGs in PubMed

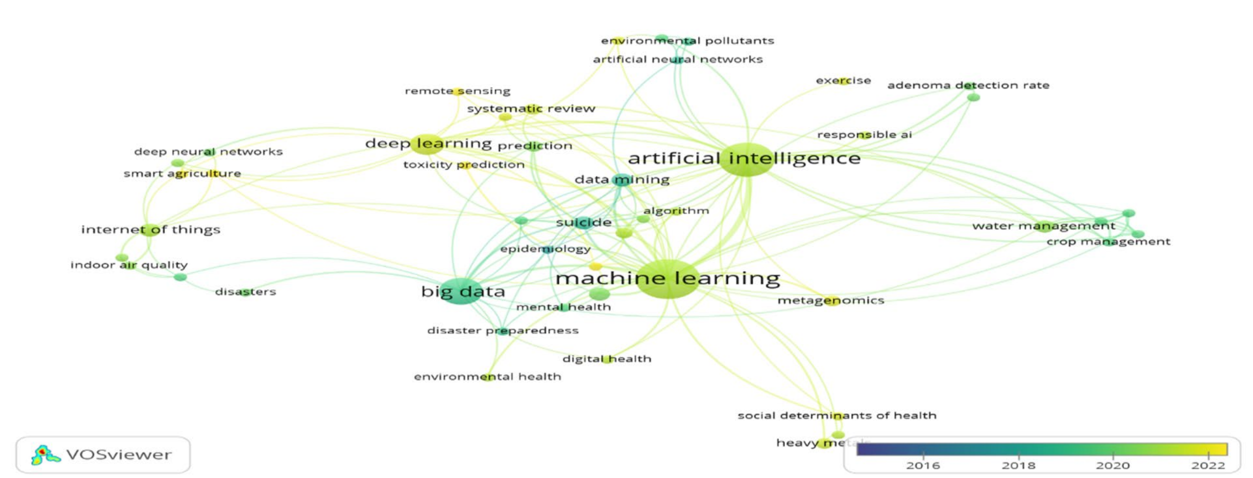

Figure 14. Overlay visualization of AI revolutions in health-related SDGs in PubMed

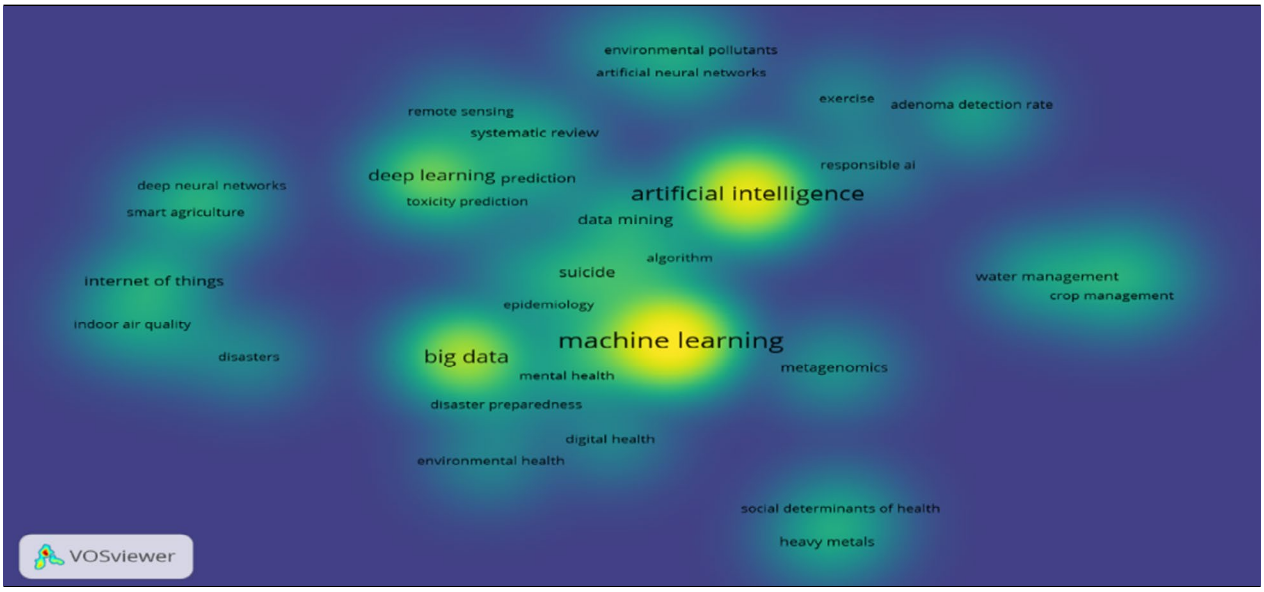

Figure 15. Density visualization of AI revolutions in health-related SDGs in PubMed

From this data, we can look for AI revolutions in health-related SDGs. Figure 13 highlights that suicide, social media, water management, and metagenomics are the most commonly researched keywords. Research related to crop management, livestock management, precision agriculture, soil management, and air pollution is still rarely conducted or published in this database.

4.3.1. Network Visualization of AI Revolutions in Health-related SDGs in PubMed

The network visualization presented in Figure 13 provides an overview of the research conducted on AI revolutions in health-related SDGs in the PubMed database.

Figure 13 shows the relationship between the terms. Relationships in network visualization are depicted in a network or line that comes from one term to another. The figure also showcases the clusters within each researched topic area. These groups have been listed in Table 6.

Table 6. Clusters of Researched Topic Areas in PubMed

Clusters	Topic Areas
Cluster 1 (11 items)	Air pollution, Algorithm, Data mining, Depression, Epidemiology, Machine learning, Mental health, Sentiment analysis, Social media, Social networks, Suicide
Cluster 2 (9 items)	Deep neural networks, Disasters, Indoor air quality, Internet of things, Monitoring systems, Protected agriculture, Public health, Smart agriculture, Smart farming

Cluster 3 (6 items)	Deep learning, Prediction, Remote sensing, Sudden cardiac death, Systematic review, Toxicity prediction
Cluster 4 (5 items)	Crop management, Livestock management, Precision agriculture, Soil management, Water management
Cluster 5 (4 items)	Artificial neural networks, Environmental pollutants, Literature review, Water treatment
Cluster 6 (4 items)	Big data, Digital health, Disaster preparedness, Environmental health
Cluster 7 (3 items)	Artificial intelligence, Exercise, Responsible AI
Cluster 8 (3 items)	Heavy metals, Review, Social determinants of health
Cluster 9 (2 items)	Adenoma detection rate, Water exchange
Cluster 10 (1 items)	Metagenomics

4.3.2. Overlay Visualization of AI Revolutions in Health-related SDGs in PubMed

The overlay visualization presented in Figure 14 provides an overview of the research conducted on AI revolutions in health-related SDGs in the PubMed database.

Figure 14 shows the trend from year to year related to AI research on health-related SDGs during 2015 – 2022.

4.3.3. Density Visualization of AI Revolutions in Health-related SDGs in PubMed

The density visualization presented in Figure 15 provides an overview of the research conducted on AI revolutions in health-related SDGs in the PubMed database.

According to Figure 15, the darker shade of yellow and larger circle diameter indicate higher keyword density, which implies an increase in research frequency. Conversely, a fading color blending with the green background suggests a decrease in studies.

5. Discussion

Among 17 SDGs, SDG 3 is particularly focused on ensuring healthy lives and promoting well-being for all people of all ages. As known, AI can play both a positive and negative role in achieving SDGs (2, 17). This study aimed to illustrate AI applications' potential for achieving health-related SDGs (6).

Our findings indicated a significant increase in research assessing the impact of AI on health-related SDGs (18). Additionally, the analysis of keywords in published articles revealed the key research areas and threads in different databases. In this regard, the common areas of study include agriculture, precision agriculture, social media, and air pollution in the Web of Science, precision agriculture, agriculture, social media, and air pollution in Scopus, and suicide, social media, water management, and metagenomics in PubMed. Bibliometric analysis of the study country showed that the United States, India, China, the United Kingdom, and Australia in the Scopus database and the USA, China, India, England, and Australia in the Web of Sciences database contributed significantly to relevant journal publications.

There are immense potential benefits to sustainable development that can be addressed by the applications of AI if associated risks are managed meaningfully. The benefits include cost reduction, risk mitigation, increasing consistency and reliability, and enabling new solutions to tackle complex problems. Also, AI can help human development by enabling creative and productive activities over repetitive tasks that can enhance fair and procedural decision-making processes (5). By using AI, countries are capable of overcoming population health challenges-especially regarding maternal and child health and communicable and non-communicable diseases (19).

Additionally, to enhance the condition of ecosystems, AI applications can play a vital role in achieving SDGs related to environment, society, and economic targets (17), as well as making public services more readily available (4). The emergence of AI and its potential for addressing SDGs can help national and international institutions face the challenge of sustainability by expanding the scope of innovations and improving the use of evidence-based policies (4). Artificial intelligence will not only change our lives but also bring about revolutionary transformation (20). Effective policy design, implementation, and monitoring of AI strategies are essential to efficient AI integration across different domains (4). Artificial intelligence plays a role as a powerful enabler of the global effort to promote economic development and address the impact of our production and consumption on societies, governance systems, and the environment. Innovators, activists, and global champions of development who use AI-enabled applications are the frontier of sustainable development. Their innovations have improved the efficiency of industries and sectors, helped conserve valuable non-renewable resources, disseminated knowledge and expertise, bridged global gaps in resources and technology, and fostered multi-sector partnerships involving governments, the private sector, civil society, and citizens in the pursuit of global sustainability (2). If designed with a focus on sustainable development, AI has the potential to serve opportunities for human beings (5), as well as address and mitigate global problems such as poverty (21).

Our findings illustrated a lack of comprehensive published studies in terms of environmental monitoring, public health, depression, air quality, environmental management, crop management, sustainable development, and air pollution in the databases. Therefore, there is a need for innovative applications to advance these areas and help mitigate health risks in the unpredictable, multifaceted, and ambiguous world, thus ensuring significant progress toward health-related SDGs (22). Many of these challenges go beyond technological solutions and require a comprehensive understanding of the underlying dynamics of these problems and their solutions (23). Therefore, particularly in emerging economies, governments must invest more in the use of AI and increase the SDGs' research related to innovation, infrastructure development, and poverty (21). We advocate an evidence-based approach to employ the decision-making and implementation of AI in health by applying appropriate laws and policies to guide the application of AI in all settings (19).

5.1. Conclusions

Artificial intelligence is enveloping our world and changing our ecosystem. The way we manage the evolution of AI will impact our way of life, which will result in healthier people by making the world healthier. Artificial intelligence has to be governed by embracing a paradigm shift in the process of institutional strategies.

This study provides a holistic view of existing studies on the intersection of AI and health-related SDGs. Our findings will hopefully encourage international and national institutions to recognize the importance of AI, develop a higher level of responsiveness, and motivate them to address the challenges of health-related SDGs through AI advancements. Further, this analysis provides insight into the global research landscape of AI revolutions in health-related SDGs. Despite AI being fairly well-attended in health-related SDGs, researchers must do more research related to these areas. We advocate future studies to address SDGs by considering related factors and focus on exploring how AI can be used to achieve specific SDGs related to health.

At the global level, politicians, institutions, and researchers are coming together to develop common legislation to ensure that all AI technologies are applied responsibly. Global and national institutions need a strategy to design and implement key interventions through regulatory standards, physical infrastructures, and digital systems capable of improving the benefits of AI for SDGs while avoiding the numerous potential pitfalls of political issues. Above all, we encourage knowledge management and sharing tools to promote dialogue between man and machine, involving decision-making processes directly. In this way, AI becomes the tool to achieve health-related SDGs by enhancing the potential of human beings. These insights may enhance health by improving policy-making and optimizing decisions, all to the end of producing higher life expectancy.

Footnotes

Authors' Contributions:

AT and MR conceived the study. AT supervised all phases of the study and contributed to the drafting and improvement of the manuscript. AT is the guarantor. MR drafted the manuscript. HRR provided feedback on the result and edited the manuscript. MR and AB analyzed data and created descriptions. SS edited the manuscript. All authors read and approved the final manuscript.

Conflict of Interests:

The authors declare that they have no competing interests.

Data Reproducibility:

All data generated or analyzed during this study are included in this published article.

Ethics Approval:

This study received ethical approval from the Ethics Committee of the Tehran University of Medical Sciences under the ethical code of: IR.TUMS.SPH.REC.1401.063. (https://ethics.research.ac.ir/EthicsProposalView.php?id=266708)

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