ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

ARTIFICIAL INTELLIGENCE AND ETHICS IN HEALTHCARE: A BIBLIOMETRIC ANALYSIS[*]

SAĞLIK HİZMETLERİNDE YAPAY ZEKA VE ETİK: BİR BİBLİYOMETRİK ANALİZ

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ABSTRACT

The rapid proliferation of artificial intelligence (AI) in healthcare services has underscored the importance of ethical considerations. This development highlights the need to examine ethical implications, debates, concerns, and thoughts from diverse and broad perspectives. In this context, the study focuses on the ethical dimensions of AI in the healthcare domain. AI is increasingly being used in various healthcare applications, but this usage brings along ethical challenges. The aim of the research is to identify themes, trends, and critical points related to AI ethics in healthcare. Through literature review and bibliometric analyses, it is observed that AI ethics research in healthcare revolves around fundamental concepts such as ethics, AI, machine learning, healthcare services, and privacy. Additionally, the leading countries, authors, and institutions in the field are examined. The intensity of collaboration and knowledge sharing in the literature is steadily increasing. In conclusion, considering the potential benefits and challenges of AI use in healthcare, addressing ethical issues, ensuring data security, and enhancing transparency in AI decision processes are crucial. The study aims to provide a deeper understanding of AI ethics topics in the existing literature and guide future research.

Keywords: Artificial Intelligence (AI), Healthcare, Medical Ethics, Privacy, Bibliometric Analysis.

JEL Classification Codes: O33, I1, I18, D82, C18.

ÖZ

Sağlık hizmetlerinde yapay zekanın hızla yaygınlaşması, etik ilgili tartışma, kaygı, düşüncelerin önemini farklı ve geniş bir perspektifte değerlendirmesini gerekli kılmaktadır. Bu gelişme, sağlık alanında yapay zeka uygulamalarının artan etkisini ve beraberinde getirdiği etik sorunları daha yakından inceleme gerekliliğini ortaya koymaktadır. Bu bağlamda tasarlanan bu çalışma, sağlık alanındaki YZ'nin etik boyutlarına odaklanmaktadır. YZ, sağlık alanında çeşitli uygulamalarda kullanılmakta ve bu kullanım etik zorluklarını beraberinde getirmektedir. Araştırmanın amacı ise sağlık alanındaki YZ etiği ile ilgili temaları, eğilimleri ve önemli noktaları belirlemektir. Literatür incelemesi ve bibliyometrik analizler sayesinde, sağlık alanındaki YZ etiği araştırmalarının etik, YZ, makine öğrenimi, sağlık hizmetleri ve mahremiyet gibi temel kavramlar etrafında büyüdüğü görülmektedir. Ayrıca, bu alanda öncü rol oynayan ülke, yazar ve kurumların analizi yapılmıştır. Literatürdeki işbirliği ve bilgi paylaşımının yoğunluğu giderek artığı gözlemlenmiştir. Sonuç olarak, sağlık alanındaki yapay zeka kullanımının potansiyel faydaları ve karşılaşılan zorluklar göz önüne alındığında, etik meselelerin, veri güvenliğinin ve yapay zeka karar süreçlerinin şeffaflığının ele alınması gerekmektedir. Bu çalışma, mevcut literatürdeki yapay zeka etiği konularında daha derinlemesine anlayış sağlamak ve gelecekteki araştırmalara yol göstermek amacıyla yapılmıştır.

Anahtar Kelimeler: Yapay Zeka (YZ), Sağlık Hizmetleri, Tıbbi Etik, Mahremiyet, Bibliyometrik Analiz.

JEL Sınıflandırma Kodları: O33, I1, I18, D82, C18.

GENİŞLETİLMİŞ ÖZET

Amaç ve Kapsam:

Yapay zekâ (YZ), doğrudan insana özgü yetenekleri taklit etme yeteneği ile diğer teknolojik yeniliklere kıyasla önemli bir etki kazanmış ve geniş uygulama alanı bulmuştur. İnsana özgü sayılabilecek yetenekler arasında akıl yürütme, hesaplama becerileri, algoritma oluşturma ve örüntülü bağlantılardan anlamlı sonuçlar çıkarma yer almaktadır. YZ, bu yetenekleri hızla uyarlayabilir ve büyük verileri çok kısa sürelerde analiz ederek anlamlı sonuçlar çıkarabilmektedir. YZ bu yetenekleri sayesinde son zamanlarda, alan veya sektör fark etmeksizin çeşitli alanlarda daha geniş bir kullanım alanı bulmuştur. Bu alanlardan biri de tıptır. Tıp literatüründe tanınan tıbbi etik ilkeler, klasik tıbbi uygulamadaki etik konuların anlaşılmasına ve yorumlanmasına önemli katkı sağlar. Ancak yapay zekanın sağlık hizmetlerine entegrasyonu, göz ardı edilemeyecek yeni etik sorunların ortaya çıkmasına yol açmaktadır. Bu yeni etik sorunların kökeni, YZ algoritmalarından gelmekte ve toplumların farklı kalıtsal yapıları, fiziksel yaşam koşulları, önyargılar, değerler gibi birçok değişkene bağlı olarak şekillenmektedir. Yapay zekâ temelini oluşturan sağlık veri kümeleri, bu yeni etik sorunlarının ortaya çıkmasında kritik bir rol oynamaktadır. Bu nedenle bu yeni etik sorunlar, çeşitlilikleri, kapsamları ve genişlikleri dikkate alınarak kapsamlı bir şekilde ele alınmalıdır. Bu, sağlık alanında yapay zekâ kullanımının etik boyutlarını anlamak ve etkili çözümler üretmek için önemli bir adımdır. Bu çalışmanın amacı, sağlık alanında Yapay Zeka'nın (YZ) etik boyutlarına odaklanan bir bibliyometrik analiz yapmaktır. Araştırma, sağlıkta YZ etiği ile ilgili temaları, trendleri ve önemli noktaları belirlemeyi amaçlamaktadır.

Yöntem:

Çalışmada, sağlıkta yapay zekâ etiği ile ilgili bir bağlantı bulan yayınlar üzerinde bibliyometrik ağ analizi uygulanmış ve bu yayınlar Scopus veri tabanından alınmıştır. Bibliyometrik analiz, bilimsel yayınların yazar, konu, kaynak, ülke ve alıntı gibi yayın ayrıntılarını ortaya çıkararak eğilimleri değerlendirmek veya araştırma performansını artırmak için kullanılan bir araçtır. Çalışmada "sağlık" ve "yapay zekâ" kavramları seçilerek ve ardından "tüm alanlar" seçilerek "etik" anahtar kelimesi ile yapılan araştırmada 281 sonuç elde edilmiştir. Yıllara göre, farklı disiplinler/alanlardan 257 makale ve 24 kitap bölümüne ulaşılmış; çalışmaya dahil edilen dokümanlar yıl sınırı olarak 2018'den 2023'e kadar ki aralık seçilmiştir. Elde edilen veriler, yazar-alıntı-dergi-ülke-kurum-anahtar kelime ve özet analizi yoluyla incelenmiştir. Ancak yine de bu çalışma sınırsız değildir. Örneğin, çeşitli araştırmalarda farklı veri kümeleri kullanılıyor olabilir. Bu çalışmaya sadece Scopus veri tabanı kullanılmıştır. Dil olarak yalnızca İngilizce seçilmiştir. Farklı dillerde yürütülen araştırmalar olabilir. Kavram olarak da "sağlık", "yapay zekâ" ve "etik" ile sınırlar çizilmiştir. Başka çalışmalarda daha fazla kavram tanıtılabilir ve daha farklı değerlendirmeler olabilir.

Bulgular:

Son yıllarda, sağlıkta YZ etiği ile ilgili yayınların önemli ölçüde arttığı gözlemlenmiştir. Bu alandaki önde gelen dergiler arasında "Journal of Medical Internet Research", "Journal of Medical Ethics", "Frontiers in Digital Health" ve "International Journal of Environmental Research and Public Health" yer almaktadır. Belirtilen üretken yazarlar arasında Carter, S.M. ve Ienca, M. bulunmaktadır. En çok çalışma yapılan alanlar, Tıp, Sosyal Bilimler, Bilgisayar Bilimi, Hemşirelik, Sanat ve Beşerî Bilimlerdir. Yaygın olarak kullanılan anahtar kelimeler arasında etik, yapay zekâ, makine öğrenimi, sağlık hizmetleri, mahremiyet ve büyük veri gibi kavramlar olduğu bulunmuştur. Anahtar kelime kümelerinin analizi, algoritmalar, özerklik, önyargı, veri, eşitlik, yönetişim, sağlık hizmetleri, düzenleme, güvenlik ve şeffaflık gibi tematik konsantrasyonları ortaya koymaktadır. Ortak yazarlık ağları, ülkelerin ve kuruluşların alıntıları, alandaki iş birliği çabalarını ve önde gelen yazarların katkıları gösterilmiştir. Bu çalışmada ayrıca, 2018-2023 yılları arasında literatürde en üretken ve referans gösterilen yazarlar olarak beş yayınla "Carter, S.M." ve dört yayınla "Ienca, M." belirlenmiştir. Ülke bağlamında en az bir yayın ve bir atıf alınması kriterine dayalı olarak ülkeler arası atıfların bir ağ haritasını çıkarmayı amaçlamaktadır. Analiz, bu kriteri karşılayan 56 gözlem birimi kullanılarak gerçekleştirilmiştir. Toplam 8 küme, 260 bağlantı ve 446 toplam bağlantı gücü tespit edilmiştir. En fazla atıf alan ülkeler Amerika Birleşik Devletleri (1821 atıf), Birleşik Krallık (1329 atıf) ve İsviçre'dir (645 atıf).

Sonuç ve Tartışma:

Çalışma sağlık sektöründe yapay zekâ kullanımının arttığını göstermektedir, özellikle YZ'nın teşhis ve tedavi süreçlerinde önemli bir rol oynadığı belirlenmiştir. Bu kullanımın, erken hastalık teşhisi, tedavi planlaması ve hasta izlemi gibi alanlarda önemli faydalar sağladığı gözlemlenmektedir. Ancak, bu artış bazı zorlukları da beraberinde getirmektedir. Özellikle yapay zekâ karar alma süreçlerinde şeffaflık, etik konular ve veri gizliliği gibi önemli hususlar olarak öne çıkmaktadır. Ayrıca, hasta sağlık verilerinin doğru şekilde korunması ve yapay zekâ tarafından üretilen sonuçların anlaşılabilirliği de kritik öneme sahiptir. Ayrıca çalışma, sağlık alanındaki yapay zekâ etiği üzerine yapılan çalışmaların temel temalarını ve gelişen desenlerini belirlemektedir. Literatür taraması ve bibliyometrik analizler yoluyla, sağlıkta yapay zekâ etiği üzerine yapılan araştırmalardaki artışı ve bu alandaki anahtar kavramları vurgulamaktadır. Özellikle, etik, yapay zekâ, makine öğrenimi, sağlık hizmetleri ve mahremiyet gibi kavramlar üzerinde odaklanıldığı gözlemlenmiştir. Sonuç olarak, sağlık alanındaki yapay zekâ kullanımının potansiyel faydaları ve karşılaşılan zorluklar göz önüne alındığında, etik meselelerin, veri güvenliğinin ve yapay zekâ karar süreçlerinin şeffaflığı ele alınması gerekmektedir. Bu çalışma, mevcut literatürdeki yapay zekâ etiği konularında daha derinlemesine anlayış sağlamak ve gelecekteki araştırmalara yol göstermek amacıyla yapılmıştır.

1. INTRODUCTION

Artificial intelligence (AI), with its ability to directly mimic human-specific abilities and capabilities, has gained significant impact and found broad applications compared to other technological innovations. Among the abilities that can be considered human-like are reasoning, computational skills, algorithm creation, and deriving meaningful results from patterned connections. AI can rapidly adapt these abilities. Over time, AI has found wider usage across various domains, regardless of industry or sector. One such domain is the healthcare sector. Given that the healthcare sector encompasses numerous decision-making mechanisms that directly or indirectly affect human life, it is highly sensitive to technological innovations. AI has the potential to influence decision-making mechanisms in healthcare by altering or transforming facts, perceptions, methods, and techniques. In this context, artificial intelligence-assisted decision support systems can assist healthcare professionals by providing real-time recommendations for diagnoses and therapeutic decisions. These systems can be useful in understanding complex structures such as healthcare management, patient cycles, information accuracy, and big data, as well as solving problems encountered in these areas (Alowais et al., 2023; Güzel et al., 2022).

Factors such as long working hours and non-ergonomic conditions contribute to physicians in the healthcare field making incorrect, incomplete, or erroneous decisions under intense stress and heavy workloads. This situation particularly increases the risk of physicians making incorrect decisions in clinical settings. AI can develop systems, methods, and techniques that can address these issues and provide high-accuracy assistance to physicians. Among the most effective branches of these solutions are deep learning algorithms, which offer successful architectures and models for solving complex problems. Additionally, these algorithms can support optimal decision-making by performing high-accuracy data analysis. Accurate decisions, especially in the medical dimension of healthcare services, are closely associated with the knowledge, experience, and abilities of physicians who are at the core of the decision-making process. While correct or incorrect decisions made by physicians are crucial for patients' health problems, diagnostic errors in the healthcare sector can lead to costly and fatal consequences. AI provides various methods and techniques that can assist physicians in making accurate decisions (Shah et al., 2023).

In recent times, especially with the support of deep learning, artificial intelligence has gradually been integrated into daily medical applications, leading to significant advancements in medical image processing (Ahmad et al., 2019; Ardila et al., 2019; McKinney et al., 2020). It is also utilized in medical education, process optimization, medical diagnosis and various other application domains (Bellini et al., 2020; Dias & Torkamani, 2019; Gutierrez, 2020; Kehl et al., 2021; Oliveira, 2019; Van Der Niet & Bleakley, 2021). While the use of artificial intelligence in clinical settings has positively impacted disease diagnosis and patient outcomes, it also raises ethical concerns, challenges, and dilemmas (Freitas, 2023).These challenges include accountability for physicians and developers, transparency and limitations of clinical performance, justice for marginalized populations, and autonomy for patients and clinicians (Herington et al., 2023). In many cases (Cresswell et al., 2023) artificial intelligence systems trained on specific datasets do not perform well when applied to other datasets and different contexts, reducing model portability. This can lead to loss of predictive ability/reliability for underrepresented segments and algorithmic bias. A classic example of this is Google's dermatology application trained on light skin, which fails to detect melanoma on dark skin (Feathers, 2021).

The purpose of this research is to identify frequent and developing themes and patterns in the literature that scholars have published on AI ethics in the field of health. In this instance, bibliometric network analysis was applied to publications that found a connection between AI and ethics in health and were retrieved from the Scopus database. Bibliometric analysis is a tool that can be used to assess trends or enhance research performance by exposing publication details of scientific publications, including author, subject, source, country, and citation (Polat et al., 2013; Small, 2003). One popular technique in bibliometric analysis is citation analysis (Sun et al., 2012). Many academics from various disciplines have used bibliometric analysis to highlight the patterns of studies in their subject (Celik et al., 2021).

In order to comprehend the responses to the following questions, bibliometric analysis was used in the research.

- How has research on AI ethics in health evolved over time, and which topics have become prominent?

- Which countries, organizations, and institutions are leading the research on AI ethics in health, and who are the key contributors?

- What disciplines or areas of expertise are most involved in AI ethics in health research?

- What ethical principles or concepts are most prominent in AI ethics in health research, and how are they being addressed?

2. LITERATURE REVIEW

This section includes a literature review on the definitions and related concepts related to the concept of AI ethics in health.

2.1. Ethics in Healthcare and Artificial Intelligence

Ethics is a branch of philosophy that examines the values created by humans and interprets them as "good" or "bad", "right" or "wrong". Medical ethics is a set of rules that define how doctors should behave ethically and guide them in their behavior. Principles of Medical Ethics stands out as one of the important academic works conducted by Tom L. Beauchamp and James F. Childress. These researchers talk about four different basic medical principles in their book Principles of Biomedical Ethics (Aydın & Ersoy, 1995; Erdemir, 2005; Laçin, 2024) :

- Beneficence: Physicians should work for the good of patients and protect their health.
- Respect for Autonomy: Patients' right to make their own health decisions must be respected. Informed consent is part of this principle.
- Non-Maleficence: Physicians should refrain from harming their patients.
- Justice: Health services should be distributed fairly.

These principles, which form the basis of medical ethics, guide physicians in their professional practice and imply an ethically respectful interaction in the patient-physician relationship. However, AI is replacing some tasks previously performed by doctors, which will undoubtedly change the relationship between doctors and patients and cause a dilemma in the sharing of ethical responsibility (Zhang & Zhang, 2023). In other words, who will be responsible for a wrong decision based on artificial intelligence? The physician? The software developer? The health institution? These and similar questions are very difficult to answer. In addition, there are potential risk and threat areas directly related to the design and use of AI, such as data quality, algorithmic bias, opacity, privacy, trust and attribution of responsibility. In this context, even at a basic level, unethical behaviors related to AI such as uncertainty, misprediction, bias have negative impacts on both people and organizations. Non-compliance can lead to job losses, reduced organizational respect and credibility, and a decline in overall morale and productivity. (Khogali & Mekid, 2023).

There is an important relationship between ethical principles and legal standards for medical treatment. However, AI is challenging these standards and introducing new challenges to medical practice. For example, a study conducted in South Africa concluded that it is unclear whether the operational use of AI in radiology is covered by existing ethical and legal standards and that, given the unique ethical and legal challenges posed by AI, specific legislation is needed to support the responsible and ethical use of AI in the South African healthcare system. (Sihlahla et al., 2023).

A study (Fournier-Tombs & McHardy, 2023) on Chatbots, one of the popular applications of artificial intelligence in the field of medicine, identified an intense set of ethical and risk factors. These are risks such as discrimination, stereotyping and exclusion, as well as risks of misleading patients (Hamdoun et al., 2023). It has been emphasized that factors such as gender, lifestyle or ethnicity affect this situation and at the same time, privacy and data management are very important when interacting with patients' health data. Furthermore, chatbots carry fault tolerance and trust issues; it has been found that misunderstandings or incorrect advice can lead to patients being directed to the wrong treatments. In addition, it was warned that chatbots cannot replace human communication and may reduce trust in healthcare professionals. Technological analysis (Miner et al., 2020) suggested that human doctors cannot be replaced and therefore should be collaborated with, and that ethics and well-designed algorithms should be used to manage these risks. It was also suggested that the use of chatbots plays a critical role in informing and guiding patients.

While the use of artificial intelligence (AI) in healthcare is acknowledged to have the potential to improve clinical practice, there are growing concerns that these developments risk reducing clinical skills. A qualitative study found that many professional stakeholders involved in the development, acquisition, regulation, and implementation of AI technologies in the healthcare industry are evaluating the impact of AI on clinical skills (Aquino et al., 2023).

But stakeholders have different views on how to address the potential loss of clinical skills due to AI-driven automation. It also turns out that there are conflicting views on the extent to which AI-powered automation should be incorporated into healthcare; from utopian to dystopian visions regarding the risk of skill loss from AI automation; and the values that should underpin health efforts.

The ethical principles of medicine recognized in the literature contribute significantly to the understanding and interpretation of ethical issues in classical medical practice. However, the integration of AI into healthcare leads to the emergence of new ethical issues, which is becoming a challenge that cannot be ignored in the literature. The origins of these new ethical issues come from the training of AI algorithms, which are linked to many variables such as societies' different hereditary structures, physical living conditions, prejudices, values and so on. Health datasets, which form the basis of AI, play a critical role in the emergence of these new ethical problems. Therefore, these new ethical issues need to be addressed comprehensively, taking into account their diversity, scope and breadth. This is an important step to understand the ethical dimensions of the use of AI in healthcare and to generate effective solutions.

3. RESEARCH FINDING

In this section, information about the data used in the study will be given.

3.1. Data and Analysis

On 31.12.2023, 281 results were reached in the research conducted by selecting the concepts of "health" and "artificial intelligence" and then selecting "all fields" with the keyword "ethics". According to the years, 257 articles and 24 book chapters from different disciplines/fields were reached, with the oldest being 2018 and the newest being 2023. The data obtained were analyzed through author-citation-journal-journal-country-institution-keyword and abstract analysis. The contents indexed in Scopus were used as the database. The limitations are as follows; only Scopus was selected as the database. Only English was selected as the language. In document type, only articles and book chapters were selected. The concept of "artificial intelligence ethics in health" was selected as the concept.

Table 1. Publication Trend of Publications Included in the Study

Year ↓	Documents ↑
2023	90
2022	53
2021	65
2020	45
2019	18
2018	7
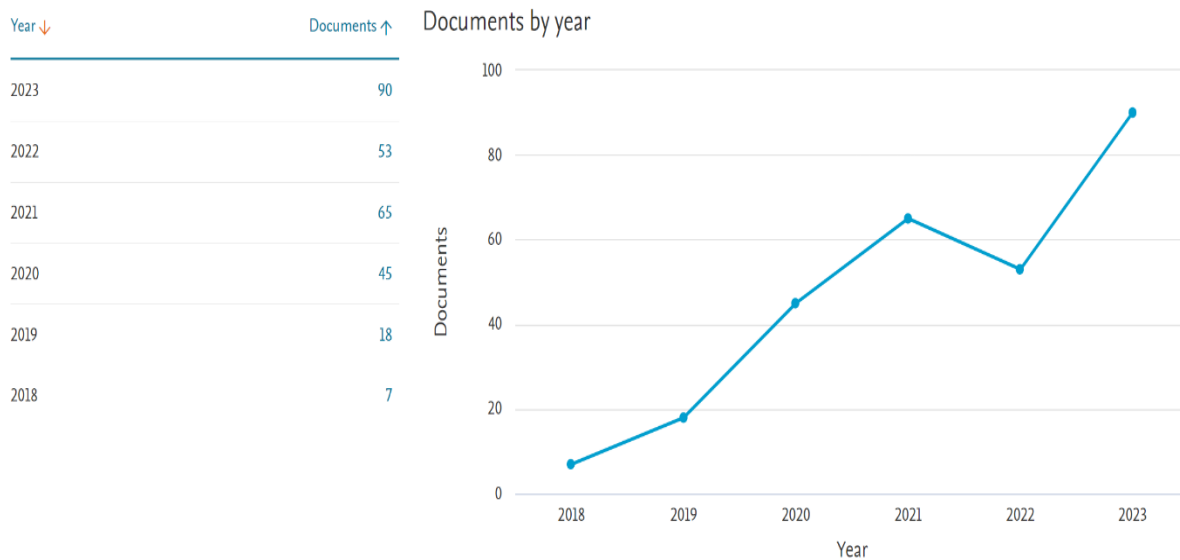
In the time period determined for this study, the highest number of publications was published in 2023 with 91 publications. Looking at the trend of the study between 2018 and 2023, it is observed that the number of publications has increased almost continuously. One of the biggest reasons for this increase can be said to be due to the significant popularization of artificial intelligence in the last five years.

Table 2. Platforms and Journals Where the Journal and Book Chapters Selected for the Study Were Published the Most
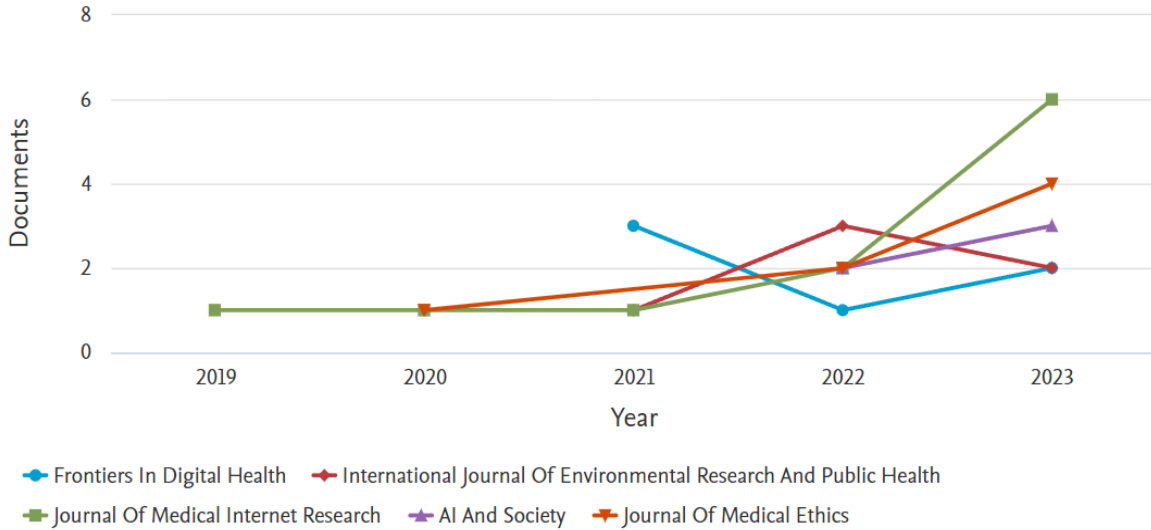
In the source list of the studies included in the study, the five journals with the highest number of publications are as follows: "Journal of Medical Internet Research" was identified as the leading source in this field with 11 studies. In second place is the "Journal of Medical Ethics" with 7 studies. Among other journals, "Frontiers in Digital Health" and "International Journal of Environmental Research and Public Health" were identified as an important source with 6 publications respectively. The journal "AI and Society" has made an important contribution in this field with 5 publications.

Table 3. The 10 Most Productive Authors in This Field
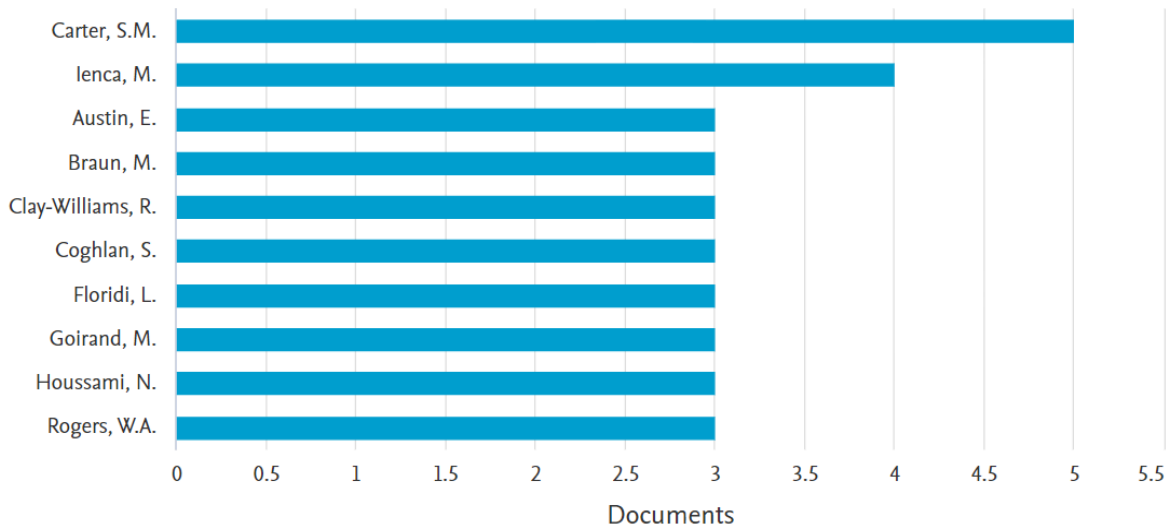
In this study, "Carter, S.M." and "Ienca, M." with five and four publications, respectively, were identified as the most productive and reference authors in the literature between 2018 and 2023. When the citation and content analysis of the works of these two authors were analyzed, it was concluded that they should be taken into consideration by those who will conduct research on this subject.

Table 4. Fields of Publications Included in the Study
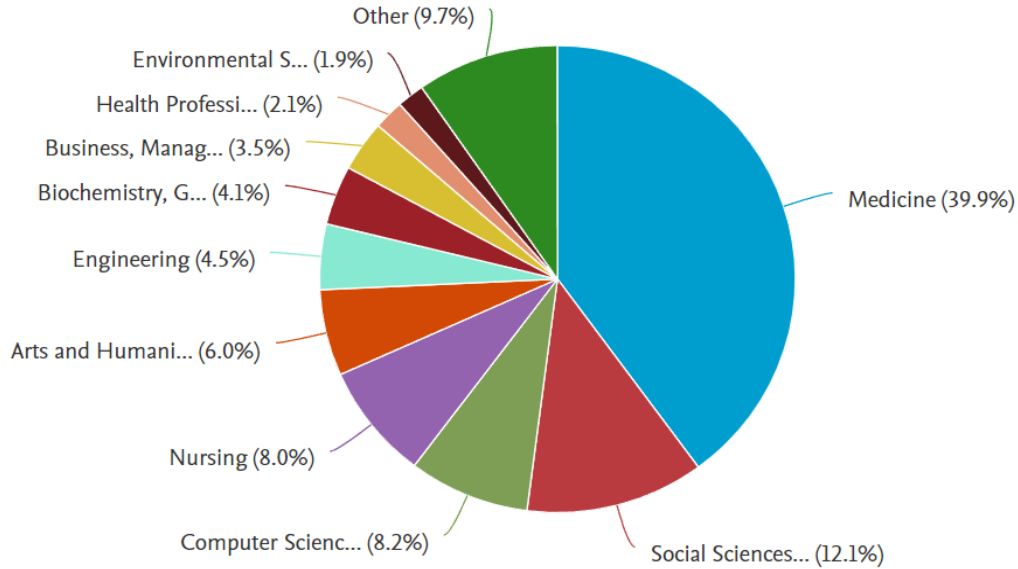
When the fields of the publications included in the study are analyzed, "Medicine" is the field with the highest number of studies with 194 publications. Other leading fields are "Social Sciences" in second place with 59 publications, "Computer Science" in third place with 40 publications, "Nursing" in fourth place with 39 publications and "Arts and Humanities" in fifth place with 29 publications.

3.2. Co-occurence of All Keywords

In publications related to the ethics of artificial intelligence (AI) in healthcare, the most frequently used keywords are as follows: ethics (172 occurrences), artificial intelligence (148 occurrences), machine learning (43 occurrences), healthcare (19 occurrences), privacy (16 occurrences), and big data (14 occurrences). In terms of total link strength, the most powerful concepts include ethics (379), artificial intelligence (317), machine learning (118), healthcare (59), privacy (56), and big data (42). An analysis conducted with 843 observation units that appeared at least 4 times and had relationships among them resulted in a total of 7 clusters, 241 connections, and a total link strength of 813.

Figure 1. Most Frequently Used Keyword Links
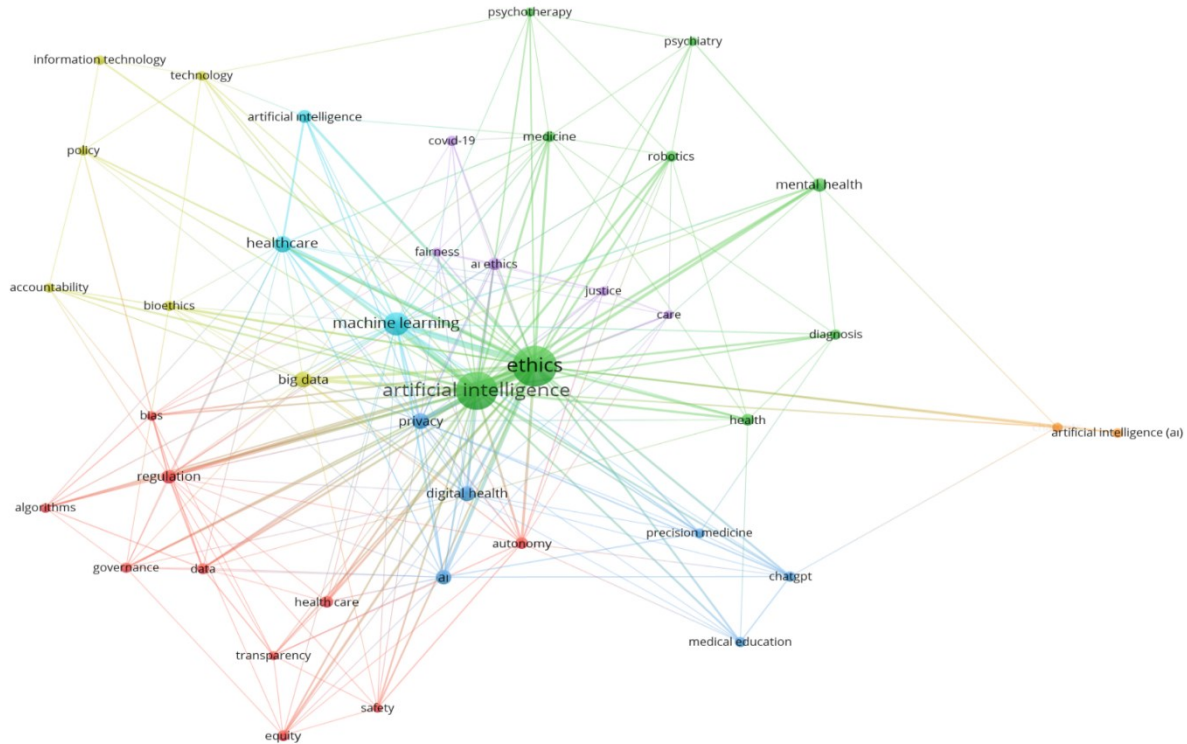
Keyword analysis and clustering methods are important tools used to understand research areas more accurately and to create network maps (Kulak et al., 2019). Therefore, the results indicate how common or limited keywords are in the analyzed documents. An example visualization of the clusters created with VOSviewer is shown in Figure 1 and Figure 2.

In Figures 1 and 2, the keywords are analyzed in relation to the concepts used within their respective clusters, revealing the areas of concentration in the studies. Cluster 1 (highlighted in red) consists of 10 related keywords: algorithms, autonomy, bias, data, equity, governance, healthcare, regulation, safety, and transparency. These keywords demonstrate various relationships between AI ethics in healthcare: Algorithms: When applied to the healthcare industry, artificial intelligence algorithms can offer patients recommendations for diagnosis, care, or therapy. From an ethical perspective, it is imperative to guarantee the accuracy and dependability of algorithms since flawed or erroneous algorithms may have negative effects on patient health. Autonomy: Patients' autonomy may be impacted by AI systems. For example, patients' right to communicate their treatment preferences and choices should be respected while using AI to make medical decisions. Bias: Prejudices found in training data can be learned by AI systems and reflected in them. An example of biassed behavior in a healthcare application could be a diagnostic algorithm that favors some ethnic or gender groups over others. This circumstance may go against equality ideals and present ethical questions. Data: AI systems in the medical field require a lot of data. There may be ethical questions about this data's gathering, storing, usage, and dissemination. In particular, it is vital to follow ethical guidelines for patient privacy, data security, and data access.

Equity: Using AI technologies in healthcare in a fair manner is crucial. For instance, AI-supported diagnostic and treatment choices should guarantee equal access and opportunity for people from various socioeconomic backgrounds. Healthcare disparities might worsen otherwise. Governance: It's critical to supervise and control AI use in healthcare in an ethical manner. Healthcare facilities, regulatory agencies, and ethics committees must all take part in this. In order to guarantee the equitable, dependable, and moral implementation of AI applications, governance mechanisms are required. Healthcare: Establishing ethical boundaries and developing and improving healthcare services depend heavily on AI ethics. Patient safety should come first when using AI systems in healthcare, and this should be in line with ethical principles. Regulation: The application of AI in healthcare must

be governed by both legal and ethical guidelines. These rules ought to guarantee that AI systems are applied in a way that upholds ethical standards for justice, security, privacy, and other areas. Safety: There may be concerns to patient safety when using AI systems in healthcare. As a result, AI systems' capacity for risk management, dependability, and safety is crucial. Ethically, patient safety and the provision of high-quality healthcare services depend on safety. Transparency: AI systems in healthcare should have clear decision-making procedures and guiding principles. Healthcare providers and patients alike must be able to trust the decisions made by AI systems and comprehend how they operate. From an ethical perspective, this is significant because accountability and dependability are fundamentally dependent on transparency.

Figure 2. Clustering of the Most Frequently Used Keyword Links with Various Colors

Nine linked keywords make up Cluster 2 (Green): robotics, diagnostics, ethics, health, medicine, mental health, psychiatry, and psychotherapy. These keywords cover a broad spectrum of AI applications in the medical and health domains. In medical diagnosis and treatment, words like "robotics", and "artificial intelligence" are becoming more and more common. These technologies help therapy approaches during treatment (such as psychotherapy and psychiatry) and can analyze data during diagnosis processes. But it's crucial to remember that these developments have an ethical component as well. Evaluations of the application of these technologies and the protection of patient privacy and safety are required by the word "ethics." Furthermore, since their implementation may change the way that emotional and mental health services are provided, the effects of AI and robotics in "mental health" should be investigated.

Six keywords that are connected to one another were found within cluster 3 (blue). AI, ChatGPT, digital health, precision medicine, medical education, and privacy are some of these terms. The function and significance of digital technology in the health industry are highlighted by these keywords. In order to improve healthcare, artificial intelligence technologies like "ChatGPT" and "AI" are being developed for use in medical diagnosis and treatment. The delivery of healthcare services via digital channels and the digital preservation of medical records are referred to as "digital health" practices. This can facilitate access and aid in more efficient patient care management. The focus of "medical education" is on preparing the upcoming generation of medical professionals on digital technologies and how to incorporate them into healthcare. "Precision medicine" describes the practice of personalized medicine, which includes creating unique plans for illness prevention and treatment that take into

consideration a person's genetic, biological, and other characteristics. Ultimately, the concept of "privacy" is critical to safeguarding patient confidentiality and health data, and it is an ethical consideration when utilizing digital health technologies. These keywords suggest that advancements in digital health are concentrated on enhancing healthcare and resolving privacy and ethical concerns.

Six related terms were found in cluster 4 (yellow). Accountability, big data, bioethics, information technology, policy, and technology are these keywords. These keywords highlight the management of these technologies as well as the consequences of their use in the healthcare industry. The enormous volumes of data gathered and examined in the health industry are referred to as "big data" and "information technology" respectively. By aiding in the identification and treatment of illnesses, this data can enhance medical services. The word "accountability" describes responsibility and openness in the processes of making decisions on the application of health technologies. This means that those who create technology and those who administer healthcare must accept accountability for the results of their choices and actions. "Policy" describes the norms and regulations established for the control and administration of health technology. Finally, "bioethics" evaluates the ethical problems and moral principles surrounding the application of health technology and their effects on human life and health. These terms highlight how crucial it is to address data management, policy-making, and ethical issues pertaining to the use of technology in healthcare.

Five terms that are connected to one another were found within cluster 5 (purple). AI ethics, caring, COVID-19, justice, and fairness are these keywords. The ethical aspect of AI in healthcare is highlighted by the terms in Cluster 5. Words like "fairness" and "AI ethics" highlight how crucial moral principles and justice are to the creation and application of AI systems. These ideas stress how important it is to follow moral standards and justice principles in order to guarantee that AI technologies be applied to human care in an efficient manner, particularly in light of the COVID-19 epidemic.

There were three related terms found inside cluster 6 (turquoise). Artificial intelligence (AI), machine learning, and healthcare are these terms. The significance of AI and machine learning technology in healthcare is emphasized by the keywords in Cluster 6. Artificial intelligence (AI) technologies are used in healthcare in fields like data analysis and disease diagnosis. Terms like "artificial intelligence" and "machine learning" describe these applications. Moreover, the word "healthcare" highlights the use of AI technology in healthcare as well as its advancement.

Two keywords that are connected to one another have been found within cluster 7 (orange). Artificial intelligence (AI) and chatbots (charbots) are these terms. Cluster 7's keywords highlight the significance of chatbot and artificial intelligence technology. The terms "chatbots" and "AI (artificial intelligence)" allude to the growing usage of AI-based software in communication and healthcare. Healthcare can be provided more efficiently and more widely by utilizing these technologies in patient care and information retrieval procedures.

3.3. Co-authorship of Authors

According to the co-authorship analysis of authors, an author network map was created by setting the criteria of at least one publication and at least one citation to identify the most connected and collaborative authors out of 1090 authors. A total of 860 authors met these criteria. Within the four clusters with the highest connections, an analysis of the names reveals that nine authors are united in a single cluster, with a total of 99 connections. Interestingly, the most cited authors (Luciano Floridi with 514 citations and Mariarosaria Taddeo with 284 citations) are not among the most connected authors. Additionally, the most prolific authors in terms of publications do not appear among the most connected authors (specifically, Stacy M. Carter and Marcello Ienca).

Figure 3. Co-Authorship Network Showing Collaborations Between Authors
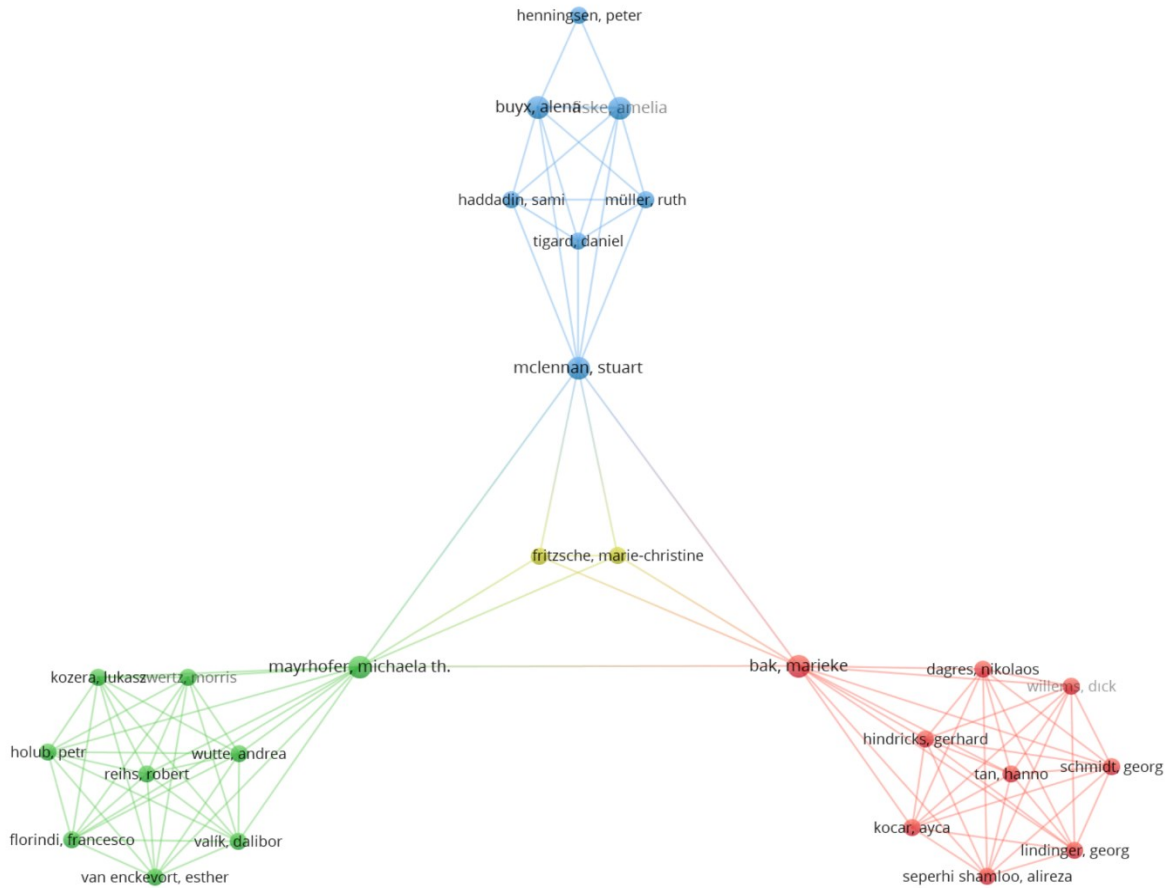
3.4. Citation of Countries

This analysis aims to create a network map of inter-institutional citations based on the criterion that at least one publication and one citation must be received from a country. The analysis is conducted using 56 observation units that meet this criterion. A total of 8 clusters, 260 connections, and a total link strength of 446 were identified. The countries receiving the highest number of citations are the United States (1821 citations), United Kingdom (1329 citations), and Switzerland (645 citations). In terms of total link strength, the top three countries are the United States, United Kingdom, and Germany. Regarding the number of publications, the ranking is as follows: United States (101 publications), United Kingdom (47 publications), and Australia (34 publications).

Figure 4. Citation of Countries
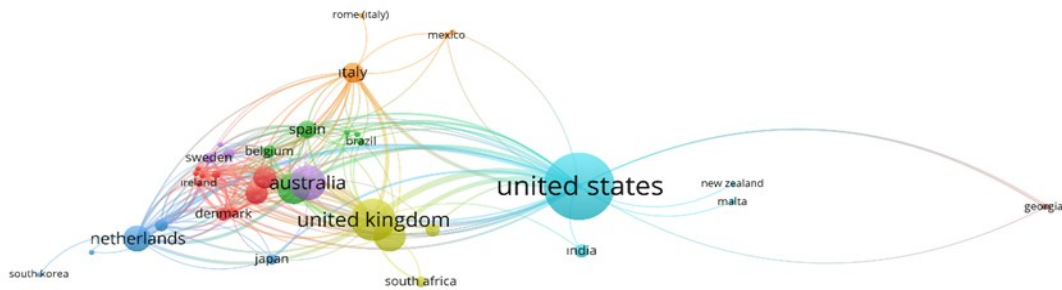
3.5. Citation of Organizations

In an analysis conducted based on the criterion that a minimum of one publication and one citation must be received from an institution to create a network map of inter-institutional citations, a total of 722 observation units were considered out of 901 institutions that met this criterion. The Stanford University School of Medicine (with 10 publications), University of Toronto (with 9 publications), and University of Oxford (with 9 publications) are represented in this network. Among the publications, the institutions receiving the highest number of citations are The Alan Turing Institute (with 305 citations) and the Oxford Internet Institute (with 282 citations).

Figure 5. Citation of Organizations
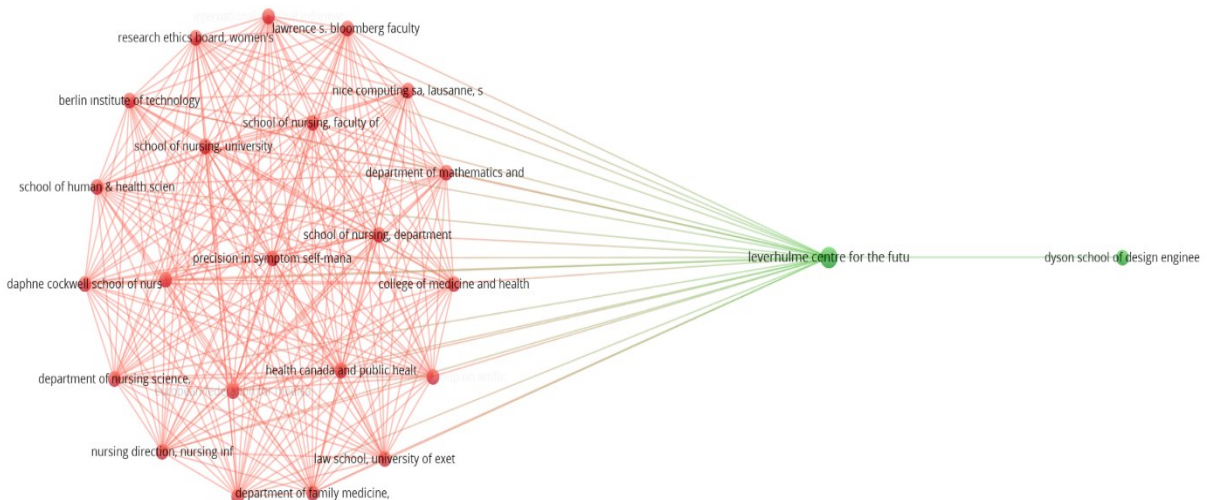
3.6. Bibliographic Coupling of Documents

The term "bibliographic coupling" describes the circumstance in which two separate sources both cite the same work. Based on an analysis involving 183 units and a minimum of 10 citations, 7 ties, 9379 linkages, and a total link strength of 37958 were identified. Cath (2018), Vayena (2018), and Watson (2019) have the highest bibliographies, with 282 citations, 278 citations, and 230 citations, respectively. The works Siale (2022), Zhang (2023), and Mclennan (2022) have the strongest links.

Figure 6. Bibliographic Coupling of Documents
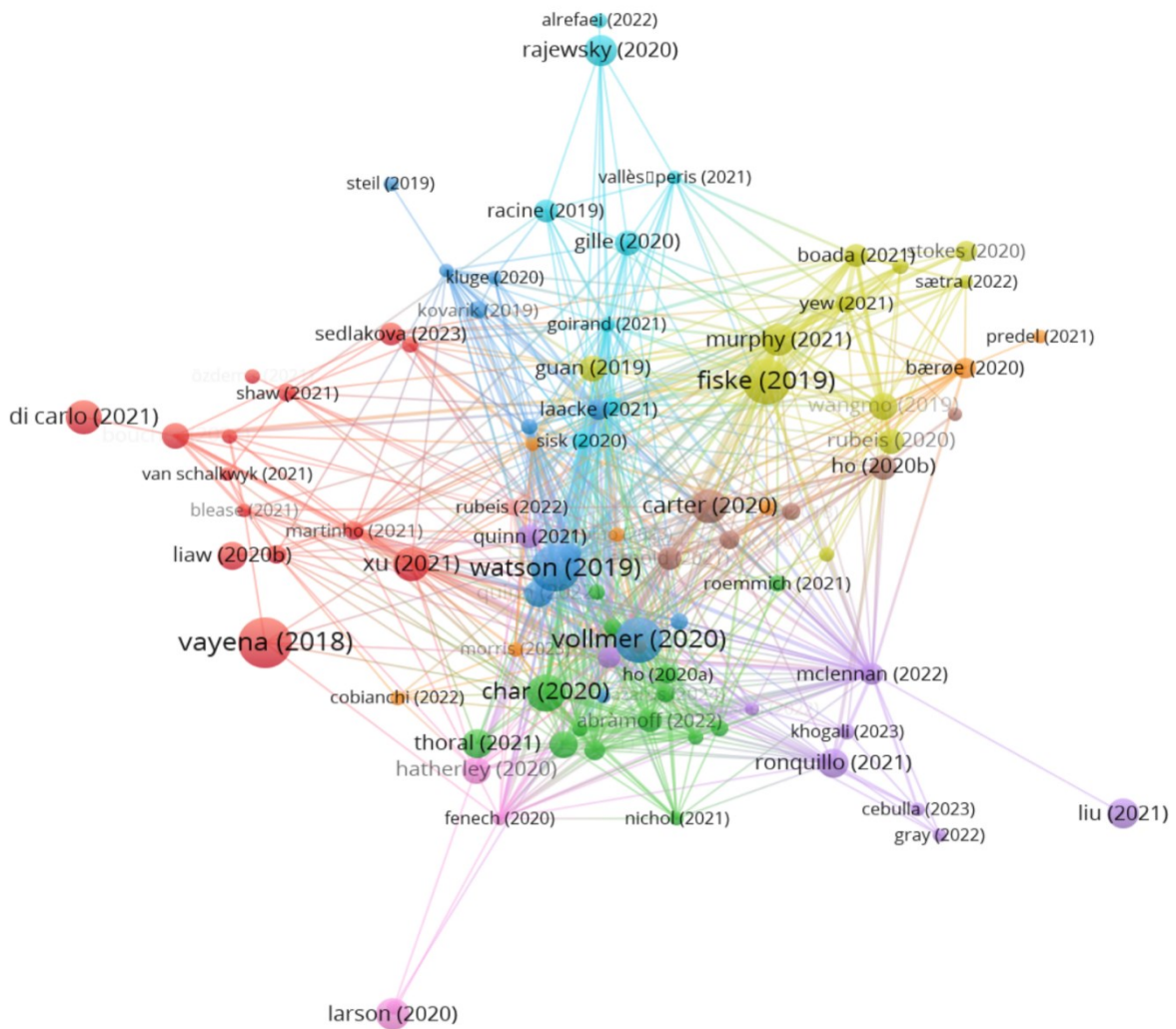
3.7. Co-citation of Co-authors

In a publication, co-citations refer to different sources that are referenced through citations. In an analysis with at least 10 citations across all 183 units, 7 clusters were found, 9379 connections were found, and total link strength was 37958. The authors with the most co-citations were Floridi (105) (Vayene (80) Ienca (59)).

Figure 7. Co-citation of Co-authors
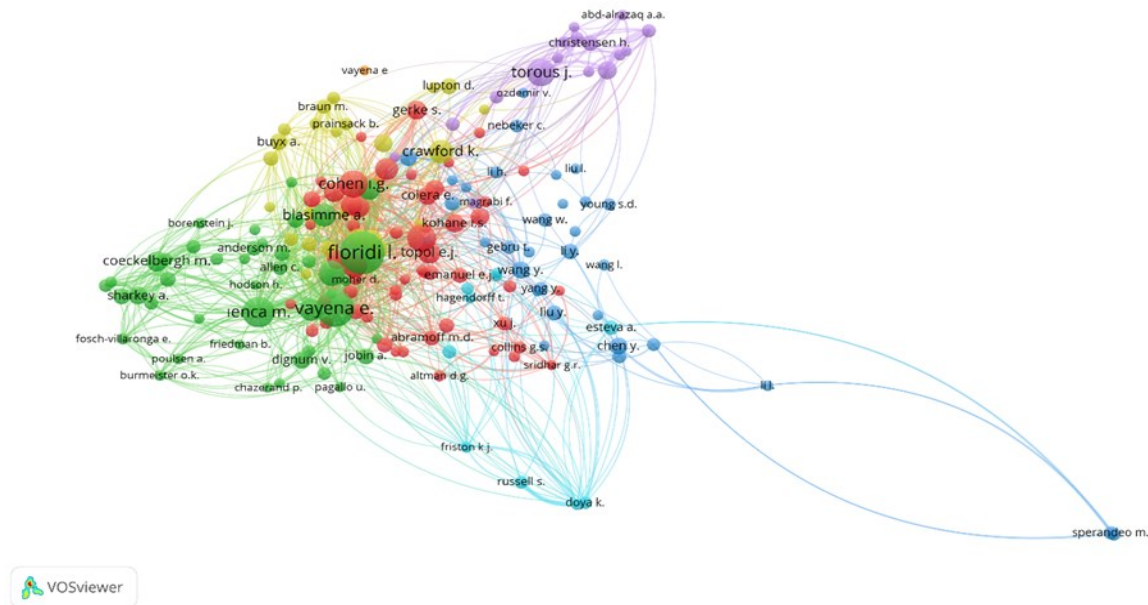
4. CONCLUSION

In recent years, it has been emphasized in many studies that the use of current technology in the field of health has gained momentum. Despite this interest, comprehensive studies are lacking to systematically review and analyze the existing literature on this topic (Agac et al., 2023). Seeing how ethics and AI research evolves over time can help us predict future trends (Chuang et al., 2022). The healthcare industry is seeing an increase in the use of artificial intelligence (AI). Artificial intelligence is an important component of healthcare delivery, especially in the diagnostic and treatment stages. Artificial intelligence (AI) applications offer significant potential in early detection of diseases, treatment planning and patient monitoring with the help of big data analytics and machine learning techniques. This can lead to more accurate and timely patient care. However, using artificial intelligence in the healthcare sector also has its difficulties. Transparency, ethical issues, and data privacy are crucial factors in the AI decision-making process. Ensuring appropriate protection of patient health data and understanding the implications of AI is also crucial.

A systematic scoping survey of the ethical sustainability of AI in healthcare; It has been determined that there are ethical principles such as respect for human autonomy, reporting harm, justice, accountability, and confidentiality. Additionally, a review of lifespan ethics found that practical tools for testing and supporting AI-based technologies largely lack detailed information, with a variety of multiple perspectives largely present (Karimian et al., 2022). The results of this study overlap with the results of our study at several points.

There is disagreement about the effects of AI-powered decision support systems on medical professionals. While some argue that artificial intelligence can increase accuracy and reduce medical workload, others emphasize the importance of human interaction. More research is needed to determine how doctors should evaluate AI recommendations and how they affect treatment protocols. Moreover, artificial intelligence has an impact on the healthcare industry that goes beyond doctors. It is very important for patients to communicate and trust artificial intelligence-supported systems. Patient happiness depends largely on the accurate processing of medical data from patients and the clear dissemination of recommendations generated by artificial intelligence. It is critical to consider both the potential and challenges associated with the increasing use of AI in healthcare. To guarantee efficient and reliable use in the healthcare sector, issues related to doctor-patient relationships, data protection and ethical norms, and openness in AI decision-making processes need to be addressed.

5. DISCUSSION

According to a meta-analysis by Jobin et al, ethical principles for ai consist of the following ten things: transparency, justice, equality, fairness, privacy, trust, responsibility, accountability, benevolence, sustainability, and solidarity (Jobin et al., 2019). In this study, according to the key idea analysis, the main study topics in this field are ethics, artificial intelligence, deep learning, healthcare, and privacy. These ideas bring to light important issues that are frequently raised and need to be carefully explored in the context of AI ethics.

A study on artificial intelligence and ethics found that it accounts for 61% of the most published research articles in the United States and the United Kingdom; these articles are pioneering research in ethics and machine learning (Chuang et al., 2022). Information obtained in a bibliometric study on the ethics and privacy of artificial intelligence found that English-speaking countries such as the USA, UK, Australia and Canada are the main contributors to research on ethical issues related to AI (Zhang et al., 2021). The United States continues to lead this field in terms of publications and citations, according to analyses done at the national and institutional levels. Nonetheless, nations like the UK, Switzerland, and Germany have made substantial contributions to artificial intelligence ethics and have prominent positions in this field.

To better understand the ethical implications of artificial intelligence (AI) in the healthcare industry, this study will look for themes, trends, and key points in the literature. Evaluation of the literature and bibliometric studies, regarding the ethical implications of artificial intelligence (AI) in the healthcare industry, this study seeks to uncover the major themes, patterns, and takeaways from the literature. The literature review and bibliometric analyses reveal an increasing number of studies on AI ethics in health, with common themes revolving around ethics, AI, machine learning, healthcare services, and privacy. Additionally, the analysis examines which countries and institutions play a leading role in this field. The bibliometric analyses indicate a nearly continuous rise in the number of studies related to AI ethics in healthcare between 2018 and 2023. This increase likely parallels the growing importance and popularity of AI in the healthcare sector. Notably, recent advancements in AI-assisted decision support systems for healthcare providers and progress in medical image processing have contributed to the surge in research on AI ethics. Furthermore, the analysis highlights that prominent publications in this area often appear in journals such as "Journal of Medical Internet Research," "Journal of Medical Ethics," "Frontiers in Digital Health," and "International Journal of Environmental Research and Public Health." Researchers are encouraged to follow these journals as they serve as significant resources for AI ethics in healthcare.

This study is not without limits, though. For instance, several datasets might be employed in various research projects. There may be research conducted in different languages. Lastly, more concepts might be introduced. In the end, this study emphasizes the importance of conducting additional research to comprehend and resolve the ethical issues surrounding AI in the healthcare sector. This work can guide future research in this field by assisting scholars in comprehending themes and patterns pertinent to AI ethics in the body of existing literature.

DECLARATION OF THE AUTHORS

Declaration of Contribution Rate: The authors have equal contributions.

Declaration of Support and Thanksgiving: No support is taken from any institution or organization.

Declaration of Conflict: There is no potential conflict of interest in the study.

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