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The Impact and Implication of Artificial Intelligence on Thematic Healthcare and Quality of Life

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ABSTRACT

Artificial intelligence (AI) in healthcare is utilized to define the application of machine learning (ML) technologies or algorithms to replicate human cognitive abilities regarding the understanding, presentation, and analysis of sophisticated medical procedures and healthcare information. This article discusses the impacts and implications of AI on QoL and healthcare. The thirty-two articles included in the dataset for this study were algorithmically retrieved through a systematic search on four multidisciplinary databases, including PubMed, JSTOR, ScienceDirect, and Medline. This thematic analysis identified and discussed the following themes: AI and sustainability; the potential risk of automation bias; healthcare ethics; AI and quality of life regarding security and safety; and bias in artificial intelligence technologies. Impact-related graphs of the different AI systems and healthcare dynamics are also included in the narrative. Population safety, security, racial bias, and proactive systems are identified as potential and perpetual challenges.

KEYWORDS

AI Applications, Bias, Bioethics, eHealth, Ethics, Machine Learning, Telehealth, Telemedicine

INTRODUCTION

The phrase artificial intelligence (AI) in healthcare is used to define the application of machine learning (ML) technologies or algorithms to replicate human cognitive abilities regarding the understanding, presentation, and analysis of sophisticated medical procedures and healthcare information. AI was primarily introduced in the healthcare industry to enable clinicians and other healthcare practitioners to accurately and efficiently analyze the association between patient outcomes and clinical techniques and help improve those techniques. Various studies demonstrate that AI has considerably affected the healthcare industry and the QoL in several positive and negative ways. Its impacts on the healthcare industry are evident in cardiovascular, telemedicine, telehealth, electronic health records, dermatology, gastroenterology, infectious diseases, primary care, psychiatry, and pathology (Davenport & Kalakota,

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2019). The significance of AI in humanity's QoL is witnessed in such areas as music and streaming services, banking, credit fraud elimination, navigation and travel, transportation, social media, chatbots, education, digital assistants, and security and surveillance.

Nonetheless, various studies demonstrate the negative impacts of AI on the healthcare industry, QoL, and current and future generations (Bohr & Memarzadeh, 2020). This article discusses AI technology and the mechanisms underlying its workability. We employ quantitative and qualitative research techniques to identify various themes evident in different studies regarding the impact of AI on QoL and the healthcare industry.

The Concept of AI

AI has received enormous attention from various disciplines and stakeholders, including healthcare, engineering, manufacturing, philosophy, economy, and politics. AI is a science of human intelligence that aims to study the understanding, knowledge, and nature of human intelligence. AI strives to make machines similar to human beings by enabling them to comprehend complex mental processes during the thinking process and perform complex calculations. As a result, machines can simulate human behavior and carry out various tasks that could have been performed only by human beings in the past (Davenport & Kalakota, 2019). To understand the concept of AI and its impact on healthcare and QoL, it is essential first to know the types or stages of AI and the mechanisms underlying each type or stage.

Artificial Narrow Intelligence (ANI)

ANI is also known as weak AI. This type of AI involves computerized machines that can carry out only a narrowly defined set of particular activities. At this stage, the AI enabled-machine cannot process any activity that requires thinking and can perform only a set of predefined actions. Numerous examples of weak AI include Google Assistant, self-driving automobiles, Alexa, and Alpha-Go.

Artificial General Intelligence (AGI)

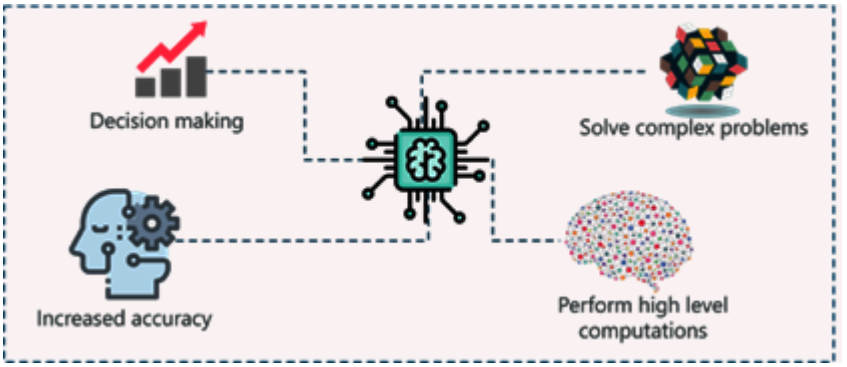
AGI is also known as strong AI. It is the stage in the development of AI where computerized machines are predicted to possess the capacity to think like humans and make informed decisions. Currently, there are no examples of AGI, but various stakeholders believe that humanity will soon develop machines that are intelligent as humans. However, some researchers, such as McLean et al. (2021), believe that strong AI will pose a substantial threat to the existence of humanity. According to Cellan-Jones (2014), Stephen Hawking stated that the development of AGI could mean the distinction of society because strong AI might take off on its own and reprogram and reproduce itself at an alarming rate. Their population would surpass humanity's because humans are limited by slow biological evolution and would not match AGI.

Artificial Super Intelligence (ASI)

ASI is the stage of AI development where computerized machines' intelligence and thinking capacity will surpass human beings. Currently, ASI is only hypothetical and often depicted in science fiction movies and books. Vaast (2022) states that, based on technological advancement, ASI will probably become a reality in a few decades. The rate of technological advancement and AI development is incredibly fast. Besides healthcare, AI is used in various fields, such as scientific research, learning, and daily activities. AI can also be categorized based on its functionalities in multiple areas. Figure 1 shows the functionalities of AI in different fields.

The types of AI based on functionality include reactive machines AI, limited memory AI, self-aware AI, and theory-of-mind AI. Reactive machines AI involves machines that use present data for their operations and consider the current situations only when performing their functionalities. These machines cannot form inferences from data; hence, they cannot use the present data to evaluate future events or activities. Reactive machines AI can carry out only a narrow range of predefined

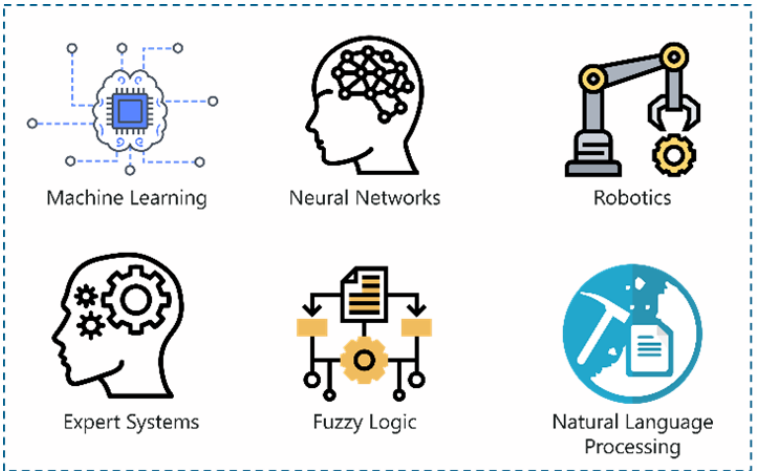
Figure 1.
The functionalities of AI (Zulaikha Lateef, 2019)



duties. Limited memory AI is better than reactive machines AI because it can make better and more informed decisions by making inferences based on past data available in its memory. It can also evaluate future events and activities. However, its memory is temporary and short-lived; hence, it can store only a limited volume of past data and experiences. An excellent example of limited memory AI is self-driving automobiles, which employ information gathered in the recent past to make immediate decisions. The theory-of-mind AI is more advanced than limited memory AI and reactive machines AI. It performs a significant role in psychology and majorly focuses on emotional intelligence. As of 2022, the theory-of-mind AI has yet to be fully achieved, but rigorous studies are being conducted toward its development (Rong et al., 2020). Self-aware AI is more advanced than the previous three types of AI, but it is currently just a theory. This type of AI is believed to have its consciousness and is self-aware.

Literature on the applications of AI in healthcare and QoL shows that there are six branches of AI techniques that significantly transform medical practice and curl the path of QoL. The branches include machine learning, deep learning, natural language processing, robotics, expert systems, and fuzzy logic. Figure 2 depicts the six branches.

Figure 2.
Pictorial depiction of the branches of AI (Zulaikha Lateef, 2019)

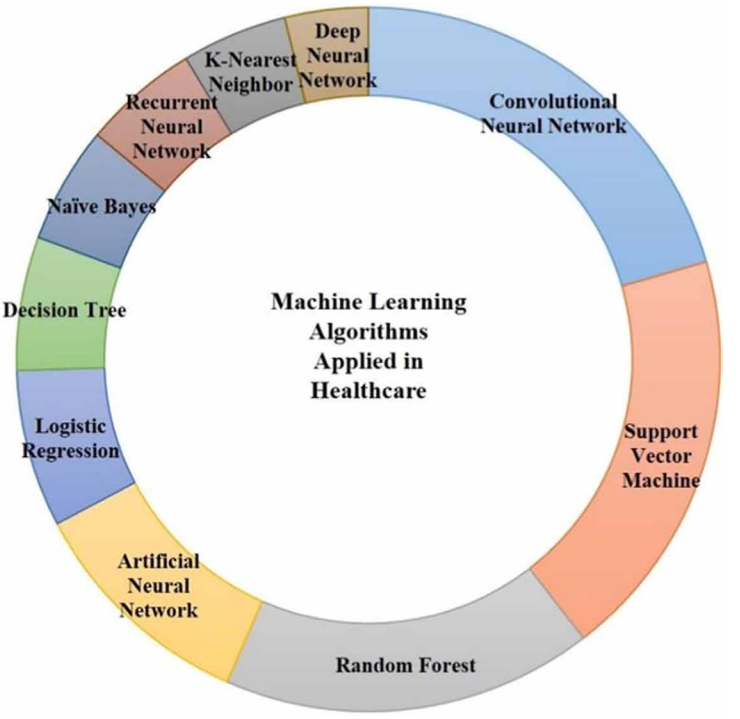


ML is the science of enabling computerized machines to understand, process, and examine data to solve real-world issues. The impact of ML in improving the QoL and healthcare is evident in various studies. Habehh & Gohel (2021) state that some of the applications of ML in healthcare include the identification and diagnosis of illnesses, discovery and manufacturing of pharmaceuticals, medical imaging diagnosis, personalized medication, innovative health records, clinical trials and studies, modification of behavior, crowdsourced data gathering, enhanced radiography, and prediction of disease outbreaks. Figure 3 is a pie chart showing ML algorithms used in the healthcare industry and their relative frequency of application.

Deep learning is the second branch of AI widely applied in healthcare and daily activities. It is the method of embedding neural networks on high-dimensional information to acquire procedure solutions and insights. It is more advanced than ML and can provide solutions to more advanced life of health issues. According to Miotto et al. (2018), some of the applications of deep learning in the healthcare industry include curbing insurance fraud, developing drugs, imaging in medicine, early detecting of Alzheimer's disease, responding to patient inquiries, researching mental health, and auditing prescriptions. Nonetheless, deep learning in healthcare and improving QoL is still at its earliest stages, and its impact is expected to increase rapidly in the coming years.

The impacts of natural language processing (NLP) are also evident in daily activities and the healthcare industry. The science of scrutinizing natural human language to draw significant insights enables communication with machines. For instance, Twitter filters out offensive and unacceptable language in their users' tweets, and Amazon relies on NLP to gain insights into customer reviews to enhance user experience. Wang et al. (2020) state that NLP applications in healthcare include clinical assertation modeling, clinical deidentification modeling, financial contract entity recognition, clinical relation extraction modeling, and clinical named entity recognition general modeling.

Figure 3.
ML algorithms applied in healthcare and their relative frequency of application (Mehta et al., 2019)



Robotics has wholly transformed the healthcare industry and the quality of human life. This branch of AI focuses on various applications and categories of robots. AI robots are artificially intelligent agents that carry out multiple activities and tasks in a real-world environment. The most famous AI robot is Sophia the humanoid. Robotics offers surgical assistance in operation theaters, performs disinfection and cleaning tasks, transports food and supply support to patients and healthcare workers, stores and distributes medications, and carries out administrative and logistical tasks, saving healthcare providers from the burden of performing routine, tiresome tasks. Expert systems have made it easier to make informed clinical decisions. It is the branch of AI that uses computer systems to learn and emulate the decision-making ability of a highly trained human expert. It employs if-them logical notions to offer solutions to complex issues in healthcare and daily activities (Bini, 2018). Expert systems do not require conventional procedural programming, making them widely applicable in medical facilities, virus detection, data management, and loan analysis.

LITERATURE REVIEW

AI generally involves computer system technologies that imitate human intelligence elements, such as sensory comprehension, engagement, thinking, adaptation, and deep learning. According to Hamid (2016), some AI-enabled computer devices can perform roles that usually encompass decision-making and human understanding. AI techniques are interdisciplinary, making them applicable in various fields, including medicine, scientific research, business, healthcare, manufacturing, and cybersecurity. Burton et al. (2019) state that AI has been present in medicine and healthcare since the early 1950s, when a group of healthcare practitioners first attempted to enhance disease diagnosis through computer-aided applications. Since the first attempts in the early 1950s, the applications of AI in healthcare and clinical practice have increased steadily. Padole et al. (2022) claim that advances and interest in healthcare AI uses have risen dramatically in recent decades owing to the substantial growth of computing technologies and big data. AI is progressively transforming medical practice because numerous medical fields, such as surgical, clinical, and diagnostic, heavily rely on AI techniques.

Furthermore, AI has significantly affected critical areas of medical practice, including disease diagnosis and clinical decision-making. According to Cho et al. (2020), AI technologies can autonomously take in, scrutinize, and report substantial volumes of information across various modalities to discover illnesses and guide healthcare practitioners in clinical decisions. Hamid (2016) and Shortliffe and Sepúlveda (2018) believe that AI applications can handle large volumes of data collected from various healthcare fields and find insightful information that would otherwise stay unknown. These technologies are also used in the pharmaceutical industry to identify and develop new medications for the treatment of patients and the management of health services. The substantial use of AI in the healthcare industry is evident owing to the vast literature available in primary research databases. Meskó et al. (2017) established that AI technologies would significantly decrease repetitive clinical operations and healthcare costs by focusing the medical profession's attention on clinical creativity and critical thinking.

Nonetheless, Doyle et al. (2020) and Cho et al. (2020) believe that the application of AI in healthcare is exciting. Still, new research is necessary to determine the applications and efficacy of AI in the healthcare sector and various dimensions of QoL. These studies depict multiple themes concerning the implications of AI on healthcare and QoL and the gaps in the current literature.

Previous research on the impact of AI on healthcare and QoL has majorly concentrated on themes of privacy, inequality, ethics, and security. Chapuis (2022) demonstrates that these themes depict AI's negative and positive impacts on QoL and healthcare. Healthcare and QoL researchers and experts have employed various research techniques to gain significant insights into the subject matter. The widely applied methods include systematic literature review, randomized controlled trials, case studies, qualitative research, and epidemiology. However, there is a significant gap in research because only a few studies analyze the themes arising from the impact of AI on QoL and healthcare. The reason

for this gap is because the application of AI in the two fields has risen exponentially in the last seven years. Most studies are still trying to figure out its impact on various sectors and dimensions of QoL and healthcare rather than the themes arising from those impacts. Therefore, there is a need for this study and future studies to pay more attention to the themes emerging from these impacts and how those themes can help put AI-based technologies on the right trajectory. This study will contribute to the current literature on the themes arising from the subject matter.

OBJECTIVE OF THE STUDY

The general objective of this study is to identify the different themes demonstrated in the literature focusing on the impact and implications of AI on healthcare and QoL.

RESEARCH QUESTIONS

Given the significant impact of AI on QoL and healthcare, there is an apparent necessity to comprehend better the body of literature concerning the subject matter. A thematic analysis of the existing peer-reviewed scholarly articles enables us to understand the emergent themes, identify the research gaps, establish the strength and weaknesses of the topic, and find out the prospective future research themes. Our thematic analysis focuses on the following research questions:

- Which scientific disciplines are involved in the study of the impacts of AI on QoL and healthcare?
- Are the studies associated only with health and technology sciences, or are other disciplines involved?
- What are the common themes of the studies being carried out?
- Does the topic have a well-founded empirical methodology and theoretical framework? What are the practical methodologies and theoretical framework being used in research (in case they exist)?

A well-founded research topic has well-defined theoretical frameworks with original empirical methods. Conversely, a less mature research topic has numerous articles carrying out pilot analyses and deliberating suitable frameworks.

METHODOLOGY

Collection of Data

We chose to use secondary data for various reasons. First, secondary data allows for completeness and convenience because they are publicly available and freely accessible on multiple online platforms, databases, and libraries of learning institutions. The availability and ease of access enable us to compare information easily. Second, secondary data offers the viewpoints of healthcare practitioners, healthcare organizations, AI experts, and scientists, among other stakeholders, allowing for a significantly diversified view concerning the subject matter. The data used in this article consisted of only reports and articles published in English. We adopted a thematic analysis and a systematic exploration to scrutinize the peer-reviewed scholarly articles on the impact of AI on healthcare and QoL.

The initial step in the data collection process was establishing the relevant keywords to enable us to retrieve the most relevant studies that apply to the subject matter. The article retrieval keywords include artificial intelligence, healthcare, QoL, ML, thematic analysis, eHealth, telehealth, and telemedicine. We explored 10 certified academic research databases, including Medline, Web of Science, PubMed, ScienceDirect, and JSTOR. We chose the four databases as the data sources for our research because they cover a wide range of scientific and academic fields of study, offering us inclusive sources for our thematic analysis. We designed a search strategy and employed it on each

of the six databases. We keyed in the keywords and customized the search engines to retrieve only articles published between 2010 and October 10, 2022. Setting the time frame limits allowed us to obtain current, up-to-date peer-reviewed scholarly articles on the topic of study.

First, we keyed in the keywords one by one in the search box in each database and retrieved 7,313,888 articles as shown in Table 1. In the second step, we narrowed the search process by combining the keyword artificial intelligence with the keywords healthcare, QoL, eHealth, telehealth, and telemedicine to enable us to obtain the most relevant studies as shown in Table 2. This is because the central theme of this study was AI. We got 133,536 articles in the second step. In the third step, we filtered the articles based on the publication date to obtain only articles published between 2010 and October 10, 2022. We got 20,215 articles in this step. In the fourth step, we filtered the articles based on the publication language to retrieve only articles published in English. In this step, we retrieved 10,554 articles. In the fifth step, we cross-checked the articles retrieved from the four databases, removed the duplicates, and identified the most cited papers. In this step, we retrieved only 523 articles. In the final step, we read the abstracts of each article to pick out the most relevant ones. Finally, only 32 articles were included in the final dataset used in coding. Figure 4 shows the flow chart of data of the article retrieval process.

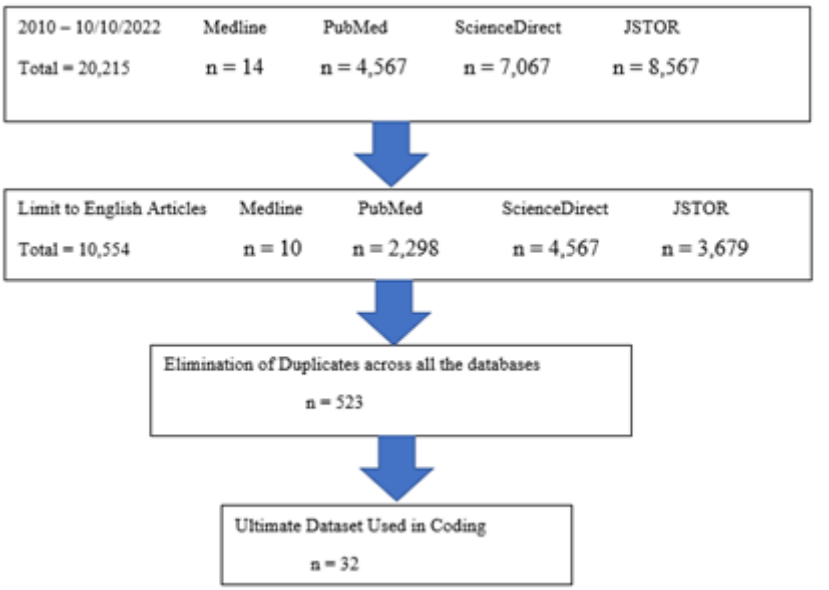
Table 1.
The number of articles retrieved in the first step

Keyword	Medline	PubMed	ScienceDirect	JSTOR
Artificial intelligence	n = 50	n = 182,365	n = 215,847	n = 116,314
Healthcare	n = 3,092	n = 1,650,914	n = 685,354	n = 159,870
QoL	n = 1771	n = 505,753	n = 1,000,000	n = 1,691,339
Machine learning	n = 222	n = 197	n = 354,573	n = 209,406
eHealth	n = 122	n = 59,592	n = 5,165	n = 1,164
Thematic Analysis	n = 0	n = 46,620	n = 97,124	n = 170,619
Telehealth	n = 316	n = 57,423	n = 13,922	n = 1836
Telemedicine	n = 316	n = 53,090	n = 26,091	n = 3421
Total	**n = 5889**	**n = 2,555,954**	**n = 2,398,076**	**n = 2,353,969**
	n = 7,313,888			

Table 2.
Combining the keyword artificial intelligence with other keywords

Artificial intelligence +	Medline	PubMed	ScienceDirect	JSTOR
Healthcare	n = 6	n = 12, 007	n = 18,621	n = 2,385
Telehealth	n = 6	n = 2,022	n = 1,079	n = 42
eHealth	n = 0	n = 2,208	n = 824	n = 42
Telemedicine	n = 6	n = 1,924	n = 2,677	n = 158
QoL	n = 11	n = 2,664	n = 50,622	n = 36,232
Total	**n = 29**	**n = 20,825**	**n = 73,823**	**n = 38,859**
	n = 133,536			

Figure 4.
Data collection flow chart



FINDINGS

After keenly reading each article and coding the prospective themes, we identified the following themes: AI and sustainability, the potential risk of automation bias, healthcare ethics, AI and QoL regarding security and safety, and bias in AI technologies.

DISCUSSION

AI and Sustainability

The dataset also showed that AI has significantly contributed to the sustainability of the modern world. Allam and Dhunny (2019) state that cities rapidly adopt specialized technologies to handle various social and ecological problems. The emergence of the Internet of Things (IoT) has made it possible to incorporate big data and sensors with the aid of the emerging concept of smart cities (Sobnath et al., 2019). The rapid increase in the volume of data in smart cities has opened up new dimensions in the management and design of these cities. Smart cities have considerably enhanced various dimensions of QoL, including increased public safety, improved health of city residents, enhanced civic participation, social connections, reduced cost of living, and better jobs. The application of AI-based technology to process big data in these cities has significantly contributed to sustainability and the urban fabric. Essoussi (2019) states that AI is widely recognized for substantial contributions to fundamental changes in various levels of human civilization. He adds that it has contributed to sustainability in various fields, leading to the well-being of humankind (Xiang et al., 2021). Robotics is being used to carry out dangerous tasks that people lost their lives carrying out before the rise of AI.

The Potential Risk of Automation Bias

According to various studies used in coding themes, different researchers and AI experts have identified biased algorithms and data as a considerable threat to bioethics and safety regarding the application

of AI in the healthcare industry. Nonetheless, another type of bias, automation bias, is gradually arising owing to the rapid incorporation of AI-based technologies in healthcare. Sunarti et al. (2021) say that humans are naturally vulnerable to cognitive mistakes resulting from inadequate knowledge, defective heuristics, and situational or affective influences. For several decades, the healthcare industry has recognized these cognitive errors as they lead to incorrect diagnoses, patient injury or harm, delayed diagnoses, and numerous medical errors. Healthcare practitioners are susceptible to automation bias when they employ AI-based technologies in clinical practice. Automation bias occurs when healthcare practitioners accept automated systems' decisions and stop seeking confirmatory evidence. In essence, they transfer the decision-making responsibility onto the AI-based clinical tool. In addition, healthcare providers who employ highly reliable AI-based technologies might become content and fail to identify potential errors.

In some cases, automation bias occurs as a result of the risk homeostasis theory. The risk homeostasis theory claims that people adjust their attitudes and behaviors based on the perceived risk in a given situation. Healthcare providers are more careful when activities seem unsafe and become less careful when actions seem safe (Bajwa et al., 2021). AI-based technologies introduce a perceived degree of infallibility and precision, making clinicians more likely unable to act autonomously without the guidance of automated systems, and consequently, clinicians are more likely to make errors of commission or accept incorrect decisions. The issue of "black-box" algorithms, discussed in another section, makes the automation bias more alarming (Secinaro et al., 2021). It is not appropriate for clinicians to rely heavily on ML technologies without explicit knowledge of how the systems work, how they arrive at their decisions, and their level of accuracy and reliability (Alugubelli, 2016). The situation worsens with the change in time. As healthcare standards and illness patterns shift over time, AI-based technologies can become ineffective as weak AI cannot acquire and adapt to new data. This issue poses considerable threats to the safety and well-being of patients, especially when clinicians fail to identify and eliminate these discrepancies (Tai, 2020).

Healthcare Ethics

According to Gerke et al. (2020), the application of AI in the healthcare industry has substantial potential to enhance operations, but it raises many ethical questions. Imaging, surgery, and diagnostics are numerous clinical procedures that have significantly benefited from health AI applications because they have transformed the clinician-patient relationship. However, the situation raises the ethical question: How will the use of health AI applications to aid in the enhancement of patient care affect the ethical principles of informed consent? Answering this question is very challenging, especially in situations where AI-based technology carries out activities using black-box algorithms, which are noninterpretable ML methods that most healthcare practitioners can find very difficult to understand. An excellent instance of a black-box algorithm is Corti's, which sends emergency dispatchers signals that a patient is experiencing a cardiac arrest. Even the inventor of Corti's algorithm does not understand how the application makes its decisions (Bennett & Hauser, 2013). This lack of knowledge is a source of worry for most healthcare practitioners.

The other application of AI-based technology in the healthcare industry that raises many bioethical questions is chatbots and apps. Chatbots and apps gather information through wearable sensors, enhance medication adherence, assess patient health, and guide diet. The user agreements and the association of these apps and chatbots to patients' informed consent. Most people need more time to go through user agreements, and others ignore them because they are frequently updated, making it difficult for patients to keep track of the terms and conditions of services they have accepted (Tai, 2020). Numerous bioethical questions regarding the subject matter remain unanswered, including the following ones:

- What information should developers offer users before agreeing to use the applications?
- What should a bioethically responsible user agreement resemble in the context of chatbots and apps?
- Do users adequately comprehend that using health apps and chats may rely on accepting future changes in terms of use?

These questions are currently very challenging, but the situation worsens as the data obtained from these chatbots and apps are applied in clinical decision-making.

AI and QoL: Security and Safety

Chapuis (2022) states that at the beginning of the second millennium, several international organizations invested many funds in AI, and academic literature on AI rose rapidly within the decade. The implications of AI on QoL began in the late 2000s, with researchers paying more attention to people's motivation and attitudes regarding AI's applications in different fields. They also studied the practices and behaviors of using AI and non-use that people engaged in. Since then, several studies, such as those conducted by Goralski and Tan (2020) and Jannani et al. (2021), have drawn the attention of various stakeholders to the prospective advantages of the applications of AI and the potential drawbacks. Some benefits of AI are already evident in multiple sectors, including automation of repetitive processes, convenience, fostering economic development, safety at individual and social levels, and security. Nonetheless, the various issues arising from its application include fraud, identity theft, declining privacy, increasing surveillance, and increasing profiling and spamming.

One of the most important critical factors of QoL is freedom. The rise of AI coincided with the rapid growth of the Internet and related digital technologies, effectively overcoming the barriers created by physical borders that limited the freedom of interaction and communication (Lee et al., 2020). The implications of AI on QoL are unquestionable, as technological growth in recent decades has created new necessities for the average person, and researchers and developers have consistently come up with new applications of AI to meet those needs (Lăzăroiu & Harrison, 2021). There are still gaps in the literature regarding the social effect of the rise of AI, especially the attitudes and beliefs regarding AI and its actual applications. There is a significant difference between popular belief and attitude about AI applications and how it is applied in various fields. Deshpande et al. (2021) believe that AI is gradually becoming a primary factor in QoL mainly because of the emotional reactions it provokes among its users and nonusers. Its development has paved the way for a substantial volume of highly receptive, ground-breaking personalized uses and services. Nevertheless, it is a considerable risk driver, especially in individual safety and security.

Several malicious actors, such as hackers, pose severe threats to individuals' safety and security, making it necessary to protect sensitive personal information in any environment with the widespread application of AI-based technologies. Companies and organizations that use AI-based technologies have made data protection an object of constant attention. Recent scandals and issues in the healthcare industry, such as those discussed by Choudhury and Asan (2022) and Dutt (2020), indicate the prevalence of threats to individuals' security and safety regarding the use of AI may increase considerably in the future. For instance, Chapuis (2022) states that the cyber-attack carried out in May 2017, using the Wannacry virus, infected at least 200,000 personal computers in more than 150 countries. This data implies that the application of AI is likely to affect the QoL of most individuals considerably owing to its security and safety concerns. Chapuis (2022) recommends that more studies be conducted to analyze individuals' practices and behaviors regarding AI applications to mobilize AI users properly. Once the relevant stakeholders comprehend the current behaviors and practices, they can focus on vigilance and awareness to enable individuals to enhance their security and safety and realize improved QoL outcomes.

The issue of individuals' safety and security extends to the application of AI-based technologies in the healthcare industry. Habli et al. (2020) and Kelly et al. (2019) demonstrate that scenarios of a

patient being harmed by the decisions made by an AI-based medical tool are a situation that current medical practices of safety and accountability have not yet adjusted. These authors focus on two elements of clinical AI in decision-making: safety assurance to guard patients against harm and moral responsibility for any damage that befalls a patient. The applications of AI-based technologies in healthcare challenge the standard clinical practices of assigning blame to responsible healthcare practitioners and ensuring safety. For such reasons, researchers such as Ghassemi et al. (2021) believe that the current AI technologies in healthcare involve many false hopes that could severely impact the industry. Habli et al. (2020) demonstrate that clinical officers and safety engineers do not understand and have no knowledge of how AI-based clinical tools reach decisions and have little control over those decisions. As a result, holding anybody accountable for the harm to a patient is difficult—especially if the damage results from a decision made by an AI-based clinical tool.

Bias in Artificial Intelligence

Some of the scholarly articles included in the dataset discuss the concerns of various stakeholders regarding the unintentional impacts of AI on inequality and social bias (Shuaib et al., 2020). Various scholars, government officials, political leaders, and academic officials have voiced concerns over gender and racial bias evident in numerous AI-based technologies (Krishnamoorthy et al., 2022). Some of the most famous social biases evident in AI-based technologies include AI algorithms to forecast the risk of felonious behavior and search engines. Parikh et al. (2019) state that companies such as Microsoft and IBM declared war against this type of social bias and have promised to de-bias their AI-based technologies. However, companies such as Amazon have raised their concerns regarding the fight by mounting numerous public campaigns criticizing it.

Delgado et al. (2022) demonstrate the extent of bias in AI-based technologies by studying the algorithms of the AI systems developed to help in the fight against COVID-19. These researchers identified racial disparities as one of the biases of the AI systems designed for digital contact tracing (DCT) and triage for COVID-19. They also identified biased data, socioeconomic disparities, and unequal accessibility. Heavily relying on AI may give relevant stakeholders a misinformed sense of equality and objectivity (Sarker et al., 2021). This false sense makes the stakeholders fail to design and implement mitigation strategies and hinders the adoption of other measures and tools with the substantial potential of enhancing patients' outcomes. Regarding socioeconomic disparity, Delgado et al. (2022) state that DCT is effective only if the patient has adequate personal wealth and can afford to stay at home for as long as necessary.

During the fight against the COVID-19 pandemic, ML produced and spread risk through the community, enabling researchers and healthcare providers to study risk and identify its uneven distribution in those communities. Most of the predictive surveillance algorithms employed in DCT control pay attention to communities with much bias—for instance, low-income or highly racialized communities. Using ML in this manner is unethical, but epidemiologically effective. The bias in AI-based technologies is more evident in unequal accessibility. Various researchers and political leaders recommend that the globe implement an AI-based health initiative because some countries with limited resources cannot access or afford AI-based technologies (Malik et al., 2020). Unequal accessibility leaves some populations at risk. The problem exists even in developed countries because some countries lack adequate Internet access. Germany is an excellent example of this case. Despite the bias of AI applications in healthcare, however, it has significantly transformed various clinical activities. Trivedi & Patel (2020), Hashimoto et al. (2018), and Ellahham (2020) demonstrate that AI-based technologies have significantly decreased waiting times in healthcare facilities, enhanced surgical operations, and improved outcomes of diabetes patients, respectively. These developments helped improve patient outcomes and saved lives that could have been lost when patients were waiting for services. Figure 5 summarizes AI's themes and impact on healthcare identified in the 32 articles.

Figure 6 shows the overall applications of AI-based technologies that have significantly affected various dimensions of QoL and their relative frequency of use in daily economic and social activities.

Figure 5.
A summary of the themes, applications, impacts, opportunities, and challenges of AI in healthcare (Rajpurkar et al., 2022)

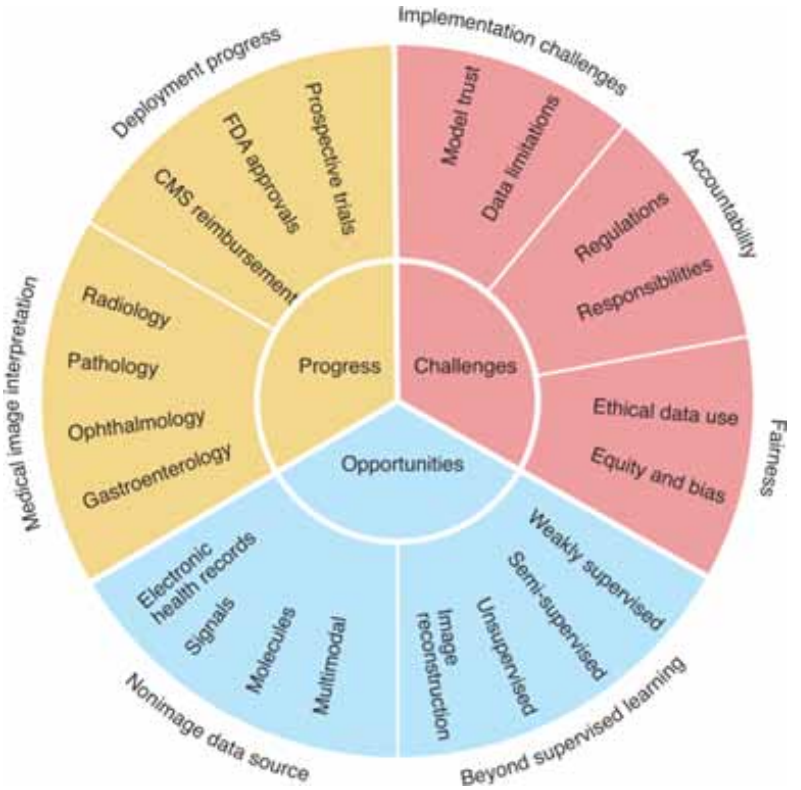
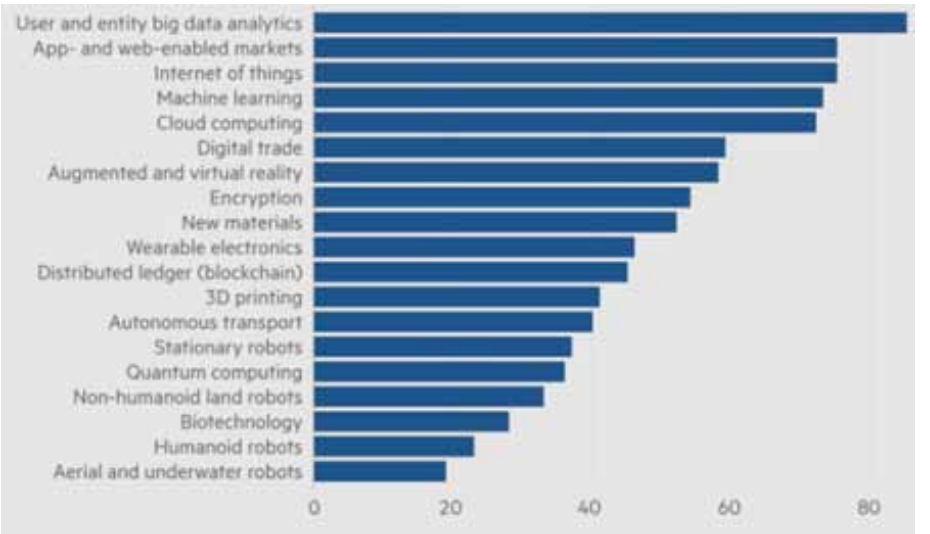


Figure 6.
Overall applications of AI-based technologies that have significantly impacted various dimensions of QoL (Colback, 2020)



CONCLUSION

In conclusion, research demonstrates that AI has substantially affected the QoL of humans and the healthcare sector. Some studies show that the positive impacts of AI outweigh its adverse effects; hence, they call for more research on AI to enable humanity to overcome the challenges experienced in AI-based technologies. This thematic analysis identified and discussed the following themes: AI and sustainability, the potential risk of automation bias, healthcare ethics, AI and QoL regarding security and safety, and bias in AI technologies. Generally, AI has a significant potential to improve QoL and enhance patient outcomes, but more research must be done to overcome the setbacks and issues. The ubiquity of AI and its application in different thematic areas continue to improve people's QoL in several forms. The quick and positive response of digital strategies contributed significantly to mitigating the potentially devastating effects of COVID-19. However, the challenges that lie ahead also need to be highlighted. ML has progressed substantially, with its ability to transform data and generate outcomes outside the available data continuing to present enormous inadequacies that may be addressed with yet-to-discovered technologies. Advancing current achievements with "creative" systems with holistic abilities remains essential, necessary, and compelling.

COMPETING INTERESTS

The authors of this article declare there are no competing interest.

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