



ETHICAL CHALLENGES AND TRANSFORMATIVE POTENTIAL: EXAMINING THE IMPACT OF ARTIFICIAL INTELLIGENCE ON PATIENT CARE, DATA SECURITY, AND THE HEALTHCARE WORKFORCE IN ROMANIA

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Abstract: *The integration of artificial intelligence (AI) into healthcare holds immense potential for transforming diagnostic, prognostic, and therapeutic approaches, particularly in addressing challenges faced by Romania's strained medical system. This study conducts an in-depth literature review to explore the opportunities and risks associated with implementing AI technologies in Romanian healthcare. Relevant research has evaluated the impact of AI on patient quality of life, highlighting both positive outcomes, such as improved disease management and personalized treatment, as well as potential concerns, including algorithmic bias, data privacy issues, and workforce displacement. This review underscores the need for a balanced approach that maximizes the benefits of AI while mitigating associated risks through robust governance frameworks, ethical guidelines, and stakeholder collaboration. Ultimately, the responsible integration of AI could revolutionize healthcare delivery in Romania, enhancing access, efficiency, and overall patient well-being. However, a comprehensive assessment of socioeconomic and ethical implications is crucial to ensure a smooth and equitable transition toward AI-driven healthcare.*

Keywords: *Artificial Intelligence, Romanian Healthcare, Patient Quality of Life, Ethical Implications, Data Privacy, Workforce Transformation*

Introduction

Artificial intelligence (AI) is a surprise for many fields without being able to know its real limits; if it exists, it has a vast range of applications in various sectors, including the

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medical field (Topol, 2019). Within the difficult and very well-known situation in the Romanian healthcare system, AI can be perceived as a promising alternative to improve the processes of diagnosis, prognosis, and therapeutic approach to treating diseases but also in terms of the long string of Romanian bureaucratic processes. Using AI in healthcare would have positive consequences, at least as we suspect from many other studies, such as improving the quality of patients' lives (T'symbal et al., 2018). Application of artificial intelligence methods for imaging of spinal metastasis. *Cancers*, 14(16), 4025) but also negative ones, e.g., discrimination (Char et al., 2018), technical errors (Wang et al., 2021), hacking or more or less voluntary cracking of IT systems (Dittrich & Himma, 2006), overtechnologists (Meskó et al., 2018), lack of training of technical staff (Longhurst et al., 2019), replacement of medical staff (Jiang et al., 2017), etc.

AI technologies have the undeniable potential to radically change the medical field because they can process enormous volumes of data from the BigData universe and medical information and deliver results at a light speed (Bean, 2021). As emphasized by Ahmed et al., using AI in 2023 has the potential to revolutionize healthcare, as it can rapidly process vast amounts of data. For the reasons listed above, I believe that introducing AI in human medicine is currently a controversial topic from several perspectives, especially because of concerns about safety and efficacy (Ahuja, 2019), as well as job loss in the medical sector (Igou, Power, Brosnan, & Heavin, 2023). According to a recent survey, over 50% of Romanian doctors believe that AI will lead to massive layoffs in the healthcare system in the coming years (Association for the Development of Artificial Intelligence in Romania, 2019). Briciu et al. also emphasized that integrating AI and COVID-19 effects is reshaping the labor market, leading to automation in various sectors and causing upskilling of the workforce (Briciu et al., 2020). These fears are justified, given the ability of AI to perform some medical tasks better and more efficiently than humans, such as interpreting medical images or making diagnoses (Dimoglo, 2023). It is therefore important that the adoption of AI in medicine is gradual, with the active involvement of medical staff and, in a way that enhances, not replaces, their work. Although there is a wealth of research and applications showing the potential of AI to improve patient diagnosis, treatment and monitoring, these topics have not yet been sufficiently evaluated through rigorous clinical trials (Ahmer et al., 2023; AlZaabi et al., 2023; Alexandru & Coardos, 2016; Bisdas et al., 2021; Dijmarescu, 2021;rescu &rescu, 2018; Fotea et al., 2019; Krittanawong & Kaplin, 2021; Micu et al., 2021; Pană et al., 2021; Qurashi et al., 2021; Săniuță & Filip, 2021; Sit et al., 2020; Sunarti et al., 2021). There is a welcome optimism of AI in our lives, and this optimism must be treated with the realism of a skeptical researcher, asking: to what extent should we rejoice and to what extent should we worry about this unexpected and fulminating development? Therefore, can we get a full picture? It is essential to consider the ethical issues associated with the application of AI in medicine, such as protecting patient data and the implications for medical practice. There is a need to ensure that the technology is used in a responsible and respectful way so as not to compromise the quality of patients' lives or the integrity of the already precarious medical system in Romania. Therefore, in this article, I will review the literature selected for this purpose, the potential of AI in medicine, and the impact, challenges and concerns that need to be addressed to ensure the responsible use of this technology in the development of new methods of patient care.

Background and review of the literature on the impact of artificial intelligence (AI) on patients' quality of life is crucial to deepen our understanding of this issue and to develop viable solutions. According to the literature, AI can diagnose conditions faster and more accurately than traditional methods (Ojha, 2022). For example, some researchers have shown that advanced machine learning (ML) algorithms can identify certain heart diseases with significantly greater accuracy than can expert cardiologists (Shameer et al., 2017). In parallel, AI can help accurately predict disease progression and therapeutic outcomes based on the complex integration of a patient's multiple medical parameters, improving personalized care planning (Dautenhahn, 2007). However, there are potential issues related to the use of AI in healthcare; therefore, a rigorous evaluation of the medium- and long-term effects is needed to determine the impact of AI on patients' quality of life, considering these issues and solutions.

In principle, the chapter focuses on a detailed exploration of how AI influences patients' quality of life in the Romanian medical context, a sector with distinctive characteristics. From this perspective, there is a distinction between the contributions of AI in medicine globally and its particularities in Romania, highlighting specific opportunities and risks. A literature review allows not only an understanding of the impact of AI on the diagnosis and treatment of diseases but also an assessment of the uncertainties and challenges brought about by its implementation in a medical system with multiple difficulties.

The implementation of AI in Romanian medicine is a potential catalyst for improving diagnostic and treatment processes, given the ability of AI to process large volumes of data quickly and efficiently. Significant benefits are foreseen, such as optimizing disease management by personalizing treatments and improving diagnostic accuracy. AI can provide solutions to the systemic problems of health bureaucracy. However, optimism must be balanced with realism and a keen awareness of negative repercussions, such as discrimination, technical errors, and vulnerabilities to cyber attacks. Implementing AI can lead to ethical and professional dilemmas, including the marginalization of healthcare professionals. While AI promises to bring significant transformations to Romanian medicine, a sociological perspective is important for understanding the complexity of this evolution. Therefore, a thorough assessment and monitoring of the impact of AI on patients' quality of life is needed to maximize the benefits and minimize the associated risks. The contribution of this chapter is therefore to provide a comprehensive and contextualized picture of the potential and limitations of AI in healthcare in Romania, with a vision toward a future where technology and humanity can complement each other to improve patients' health and quality of life.

Method

To meet these goals, I vetted academic resources that discuss the influence of artificial intelligence (AI) on the welfare of patients in Romania from October 2023 to December 2023. The research process included exploring digital databases (PubMed, Scopus and Web of Science) to identify relevant publications from the last decade. In the analysis, I incorporated studies that were closely aligned with the topic, published within a specific

time period, and possessed unique publication-related attributes. The selected studies were analyzed using a qualitative approach involving synthesis and critical evaluation of the findings from each study. The analysis focused on identifying opportunities and challenges associated with implementing AI-led technologies in the Romanian healthcare system.

Search Strategy and Databases

The search terms included ("artificial intelligence" OR "machine learning" OR "deep learning") AND ("health" OR "medicine" OR "medical") AND "Romania*"). As the Romanian scientific community primarily uses English databases, the search terms were constructed in English only.

Inclusion and Exclusion Criteria

Inclusion criteria: a. Studies that focused on implementing AI in the Romanian healthcare system. b. Studies that have explored the potential benefits and challenges of AI in healthcare. c. Articles that focus on AI in medicine and are written by Romanian experts/authors. d. Articles published in English or Romanian.

Exclusion criteria: a. Studies that did not specifically address the Romanian health care system, e.g., studies focused on AI applications in health care outside Romania and not referring to Romania or Romanians. b. Editorials, opinion pieces and conference abstracts.

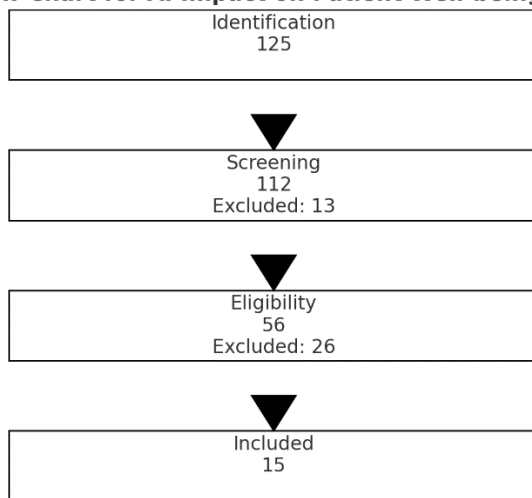
The three selected scientific databases were filtered using the MESH system to make an initial selection of relevant articles. By using the specified search terms, I found 125 articles that applied to the research topic. To narrow this number, a three-step selection process was adopted, focusing on keyword relevance, publication date, study type, methodological rigour, data quality, and full-text accessibility. For example, for the PubMed database, the search string "(((Artificial Intelligence*) AND (Health)) AND (Perception*)) AND (Student*)" resulted in 26 articles. The remaining articles, up to 125, were selected from three other databases: Scopus, Web of Science and Google Scholar.

Step 1: Initial screening

Out of the original 125 articles, I eliminated duplicates, leaving 112 records for screening. After applying the inclusion and exclusion criteria, 56 articles remained for further evaluation.

Fig. 1. Number of publications for each reason at each level

PRISMA Flow Chart for AI Impact on Patient Well-being in Romania



Note. Flow Chart according to PRISMA (Moher et al., 2009)

Step 2: Relevance and Methodological Rigour

At this level, the articles were assessed for relevance and methodological rigor. Following this evaluation, 30 articles were retained for the final selection stage.

Stage 3: Quality Assessment and Final Selection

In the final stage, a detailed evaluation of the remaining articles focused on data quality and full-text accessibility. Fifteen articles were ultimately selected for the literature review. This rigorous selection process ensured a comprehensive and high-quality presentation of the impact of AI on health. I critically examined these articles, identifying common themes, trends, and areas where the literature is lacking. The findings helped us infer the ramifications of AI for patients' quality of life in Romania, including the opportunities and risks associated with implementing AI in the healthcare system. Recommendations were made to improve AI usage in medicine, aiming to enhance the Romanian healthcare system and patient well-being.

Data extraction and synthesis

Data were extracted from the included studies using a standardized form, which captured the study design, sample size, main findings, and implications for the Romanian health

system. A narrative synthesis was conducted, grouping the results into relevant themes and categories (see Appendix 1 for details).

Analyzing and interpreting the data

To understand how AI influences the quality of life of patients in Romania, I examined data from 15 articles and identified common themes, emerging trends, and gaps in the literature. The thematic analysis method was used to organize the findings into distinct categories and subcategories. The following specific areas of qualitative analysis were included:

- a. An overview of AI's status in the Romanian healthcare system.
- b. Perceived pros and cons of incorporating AI into Romanian healthcare.
- c. Obstacles and potential risks of integrating AI in the Romanian healthcare system.
- d. Suggestions and approaches to maximize AI use in health care while managing potential negative effects.

During my discussion, I focused on the primary findings of the selected articles, shedding light on the prospects and difficulties linked to AI in the Romanian healthcare system while considering the credibility of the evidence.

The ethical and social considerations outlined in the selected qualitative articles apply to integrate AI in the Romanian healthcare system. Data protection issues, patient independence and potential biases in AI algorithms are crucial factors to consider for the conscious integration of AI in healthcare in Romania. For example, the possibility of unequal treatment resulting from bias in AI algorithms is an issue that could influence patient care in Romania. Therefore, it is vital to address these considerations during the design and implementation of AI in the Romanian healthcare system to ensure that patient care is not adversely affected.

The selected literature also examined the impact of AI on the health workforce in Romania. Some studies have highlighted the potential of AI to streamline workflows and reduce the burden on healthcare professionals by up to 20% (Ahmer et al., 2023; Qurashi et al., 2021), while others have raised concerns about the displacement of healthcare workers due to increased automation (Fotea et al., 2019). These diverse findings highlight the need for further exploration and discussion of the impact of AI on healthcare professionals, as well as the formulation of tactics to mitigate potential negative consequences. The quality assessment revealed a moderate risk of bias in these studies, warranting further research to clarify the impact of AI on the health workforce.

Interpretation of results and comparison with literature

A review of the relevant literature suggests that integrating AI into medical practices could potentially benefit the Romanian healthcare system. These findings are consistent with the literature, which highlights that AI can foster innovation, optimize resource

allocation, and improve healthcare services (AlZaabi et al., 2023; Pană et al., 2021). The involvement of multiple parties, such as technology developers, public health officials, commercial enterprises, and academic bodies, was not explored comprehensively in the analysis of this study. However, their collaboration could be critical in cultivating the growth and introduction of innovative solutions designed to simplify administrative work, refine approaches in healthcare, and improve diagnostic and treatment procedures. A literature review revealed that AI has considerable potential for improving the quality of life of patients in Romania. AI technologies can be applied in healthcare, with many examples of collaborations between technology companies and healthcare institutions. These technologies are useful in diagnosis, treatment protocol development, personalized medicine and patient monitoring. Ethical and safety considerations related to the use of AI in medicine, such as protecting patient data and implications for medical practice, need to be addressed.

Implications of the findings: The digitization process in the Romanian health sector plays a vital role in ensuring that reliable information reaches citizens while also improving the level of interaction between those providing and those seeking health services. It is essential to understand that, although different from AI, E-health still holds importance—it uses communication technologies to enable seamless transfer, documentation and protection of health data. It is necessary for Romania to cultivate the development and application of such digital innovations, ensuring that they are tailored to meet the unique requirements of its health infrastructure and patient population.

Upon examining the chosen publications, I observed several areas where the research field could be strengthened. These include the necessity for a more rigorous methodological framework, a greater focus on the application of AI in the medical field, and an increased number of studies exploring the long-term effects of AI on patients' quality of life in Romania. Moreover, I recognize the limitations of this study, which include focusing only on articles published in English or Romania, considering a specific time frame for the selected publications, and the potential for overlooking relevant studies due to the constraints of the search strategy. To address these gaps and limitations, I suggest future research directions: to carry out several empirical studies to assess the real impact of AI on patients' quality of life in Romania; investigating the ethical, legal and social implications of the use of AI in health; exploring the potential of AI in addressing health disparities and improving access to health in Romania; examining the role of AI in workforce development and health education.

In conclusion, this review of selected literature provided valuable insights into the impact of AI on the quality of life of patients in Romania. My research focused on evaluating the opportunities, risks, and challenges involved in integrating AI into the healthcare system in Romania. As a result, I suggested recommendations to optimize the use of AI in medicine, with the goal of enhancing patients' quality of life and mitigating any adverse consequences.

The impact of AI in Romanian and international medical environments

Artificial intelligence (AI) and deep learning (DL) are sophisticated technologies in the medical context that explore connections between prevention, treatment, and patient testing. They are used in diagnostics, therapeutic protocol development, drug creation, personalized medicine, and patient surveillance (Dobrescu & Dobrescu, 2018). Butaru et al. highlighted a unique challenge in medical AI, where datasets often display class imbalances, especially in rare diseases, challenging the typical deep learning assumption of class equality. Nasser and Yusof (2023) provided an extensive review of deep learning techniques for breast cancer detection, highlighting their effectiveness in early diagnosis and increased survival chances. They noted that deep learning, compared to traditional machine learning, requires less human intervention for feature extraction, making it a more efficient tool in medical diagnostics. In Romania and other countries, technology companies collaborate with medical and academic institutions to tailor DL technologies to healthcare. Examples include Google Deep Mind's collaboration with the NHS in the UK for cancer detection through medical image analysis and Microsoft's Hanover Project with the Oregon Health & Science University Cancer Institute for cancer treatment estimation. Other initiatives involve evaluating medical images of tumor progression and creating programmable cells (Dobrescu & Dobrescu, 2018).

Artificial intelligence has become a key element in healthcare worldwide, including in Romania, with a significant impact on the quality of services and the efficiency of resources, especially in regions with restricted access to medical resources. Technologies such as healthcare robots and unmanned aerial vehicles can be integrated with computer vision techniques to enable a wide range of innovations in healthcare. An example would be the use of computer vision for remote diagnosis of parasitic infections or tuberculosis, after which delivery of needed medicines can be made using unmanned aerial vehicles (Krittana Wong & Kaplin, 2021). This app includes Romania in addition to Swahili to support people in Romania and East Africa who have restricted access to medical resources. Introducing Romania into the app facilitates access and usefulness for the Romanian population, providing them with a digital tool for assessing health status and making informed healthcare decisions. This highlights the ability of artificial intelligence to improve healthcare in resource-constrained countries, such as Romania.

In Pană and collaborators' 2021 research, the authors explored the possibility of developing a noninvasive system capable of predicting worsening heart failure in Romania by voice analysis. The central aim of the study was to analyze patients' vocal characteristics and use the identified variations as input for a machine learning-based method using artificial intelligence (AI) technologies. Sixteen patients, 9 men and 7 women aged 65 to 91 years who were hospitalized for acute cardiogenic pulmonary edema, participated in the present study. Patients' voice recordings were made twice a day using the same smartphone device, Lenovo P780, from admission to discharge, when their clinical condition stabilized. These voice recordings were subsequently used in the machine learning algorithm. Different machine learning techniques have been applied for classification, such as artificial neural networks (ANNs), support vector machines (SVMs) and K-nearest neighbors (KNNs), to determine which best fit the dataset and can serve

as a starting point for future developments. After integrating information from 15 patients, the algorithm correctly classified the 16th patient into NYHA (New York Heart Association Functional Classification) stage three on admission and NYHA stage two on discharge, based solely on voice recording. The KNN algorithm achieved the highest classification accuracy, with a value of 0.945. As Varela et al. (2023) highlighted, integrating AI in medical applications, particularly in areas requiring rapid and accurate diagnosis, is becoming increasingly vital. Their study emphasized the potential of AI to revolutionize traditional diagnostic methods, offering new avenues for early detection and treatment strategies. Preliminary research has shown that voice could be an accessible and simple means of monitoring the health status of heart failure patients. The algorithm used for voice analysis provided highly accurate results. The authors' goal is to obtain larger datasets and develop more sophisticated voice analysis algorithms to validate the results. In terms of the practical applicability of the study, the researchers plan to develop a smartphone app in the future that works in the background by performing voice analysis of heart failure patients. If the app identifies signs of heart failure decompensation, patients will be referred to medical services. This could prevent severe acute heart failure requiring hospitalization and emergency treatment. This study provides a new perspective on the applicability of artificial intelligence in medicine and proposes a noninvasive approach for monitoring and preventing worsening heart failure.

The theme of digitization in the Romanian health system addresses a major problem, examining the lack of digitization and its effects on public health. These difficulties include high morbidity and mortality rates for cardiovascular diseases and malignancies and a low birth rate (Dijmarescu, 2021). Implementing digitization in the healthcare system is crucial both to provide accurate information to the population and to simplify the interaction between doctors and patients, facilitating the achievement of medicine's primary goal—protecting health. The concept of e-health encompasses all these aspects and refers to the use of communication technologies to support the transmission, recording and storage of medical information (Dijmarescu, 2021). Certainly, a national database would provide important benefits in Romania, improving and facilitating health services and providing a complete medical history. The applications of e-health are varied and are attracting increasing attention from doctors and patients, who are providing services such as telemedicine, e-health education, information storage through electronic health records and various useful tools in the medical field. The COVID-19 pandemic has highlighted the importance of digitization in healthcare and telemedicine in maintaining social distance. In addition, telemedicine facilitates the remote monitoring of patients through smart home technologies and devices, thus contributing to increased quality of life for some patients.

Health organisations need to optimize their use of health data and distribute it to other institutions to increase the quality and efficiency of the services provided and to stimulate learning opportunities (Alexander & Coardos, 2016). Big Data can centralize patient information, making it easier to analyze and predict outcomes. This paper describes the concept and characteristics of Big Data, the data in healthcare, and the major challenges of Big Data and Big Data Analytics in Romania.

Some applications of Big Data in Romania include the following:

- ✓ The Integrated Electronic Health Record System (SIUI) is a computer system of the National Health Insurance House (CNAS) that integrates county health insurance houses (CJASs) and medical service providers under the coordination of the CNAS. The SIUI has been fully operational since 2008;
- ✓ The electronic prescription information system (SIPE) aims to provide an essential component of the Romanian Health Insurance Information Platform and became operational on 1 July 2012;
- ✓ Armonia®sanita—a hospital IT system successfully adopted by some of the largest healthcare providers in Romania and available in the Cloud. This system helps to improve the efficiency and quality of healthcare services (Alexandru & Coardos, 2016);
- ✓ An Integrated Emergency Services System coordinates emergency services at the national level and supports the response activities of operational units. It handles approximately 1.4 million victims every month and, due to the technologies implemented, has reduced the time needed to locate victims on the map and increased the response capacity of search teams throughout Romania;
- ✓ The National Registry of Rheumatoid Arthritis Patients - Romanian Rheumatic Diseases Registry Association and Ymens Cloud have developed and implemented a cloud-based solution for the Romanian public health sector. The system focuses on automating the flow of rheumatoid arthritis patient records and received the EuroCloud Romania award in 2014;
- ✓ StarVaulte-Health is a platform that allows physicians and medical centers to interact with patients in a secure and user-friendly environment, facilitating the constant exchange of medical information between health systems, patients, and physicians. It also received the EuroCloud Romania award in 2015 (Alexandru & Coardos, 2016).

All these examples illustrate the potential of Big Data to revolutionize healthcare in Romania by integrating and centralizing information, thus facilitating access to data and improving the healthcare services offered. It is important to consider the challenges related to data security and confidentiality of information, as well as the need to develop technological solutions and infrastructures adapted to the specific Romanian healthcare system. Big Data refers to data collected throughout the entire diagnostic and treatment process and has the potential to transform medical practices, guiding specialists in the delivery of efficient and high-quality healthcare services (Murdoch & Detsky, 2013). The benefits of Big Data include prevention of some conditions (Bates et al., 2014), minimization of errors in the medical process (Groves et al., 2013), ensuring access to the right treatment at the right time (Wang et al., 2021) and improving therapeutic outcomes (Raghupathi & Raghupathi, 2014). In healthcare, specific Big Data challenges include managing and analyzing unstructured data (Wang et al., 2021), real-time data processing (Andreu-Perez et al., 2015), maintaining confidentiality and protecting patient information (Baro et al., 2015).

Big Data Analytics opens new opportunities for combining health knowledge with data analytics, providing valuable insights into decision making and health system

transformation (Murdoch & Detsky, 2013). The use of big data analytics in population health monitoring (Bates et al., 2014) and healthcare quality assessment (Wang et al., 2021) is experiencing rapid growth. By using Hadoop technology, efficient patient care management can be achieved by providing data-driven services and meeting patient needs (Gupta et al., 2014).

In Romania, the adoption of big data technologies and approaches in the health and medical sector has had a positive impact on the quality of healthcare services, optimized processes and improved patient access to high-quality treatment and care. By implementing these innovative solutions, the Romanian healthcare system aligns with international trends and ensures better adaptation to patient and community needs (Alexandru & Coardos, 2016).

Artificial intelligence (AI) is being integrated into many aspects of life. In the age of technology, companies are turning to AI to increase productivity, better understand consumer behavior or provide services through robots. Successful businesses exist through the development of European and Romanian AI startups and the factors that determine their success, such as product development team expertise, core team commitment and business strategy (Săniuță, A., & Filip, S. O., 2021). Recent research has also explored clinical research on AI in the treatment of cancer and underlined its integration challenges and opportunities in the European Union (EU) health sector (Popescu, Geantă, & Brand, 2022).

At present, there are few studies documenting the relationship between AI and business in Romania. For example, Micu et al. (2021) investigated AI algorithms in e-commerce, noting significant interest at the management level in implementing AI in online stores, although the actual adoption of AI is still low. Enhancing the cybersecurity measures of new-age startups is facilitated by artificial intelligence, which offers advanced solutions for detecting threats and assessing vulnerabilities (Dasawat & Sharma, 2023). In short, in Romania, there is an interest in AI and a wide recognition of its potential, but the development of AI remains rather slow compared to that of other European countries in different fields, including business (Săniuță & Filip, 2021). As a result, there has been a noticeable increase in the adoption of AI-based educational solutions across different countries, including less-developed areas, as evidenced by the increased use of intelligent platforms (Pantelimon, Bologa, Toma, & Posedaru, 2021).

Radiography of AI development in the Romanian medical environment

In Romania, AI technologies are being applied in the healthcare system for various purposes, such as diagnosing conditions, managing patient cases and optimizing the quality of healthcare. Thus, AI has become an essential tool for identifying diseases. For example, a team of researchers at the University of Medicine and Pharmacy "Carol Davila" in Bucharest has developed an AI algorithm that facilitates the diagnosis of brain tumors and is capable of accurately identifying even the smallest tumors (Univ. Professor Gheorghe Iana, 2021). These results have led to notable improvements in the accuracy

and efficiency of diagnosis of this condition, contributing to saving lives and reducing medical costs. AI is also proving to be of great use in patient care in Romania. These technologies can monitor patients in real time, especially those with chronic diseases such as diabetes or chronic obstructive pulmonary disease (Ionescu, 2020). An example of this is the patient monitoring system successfully developed by a team of researchers at the University of Medicine and Pharmacy "Grigore T. Popa" in Iasi (Ionescu, 2020). The system continuously tracks patients' vital parameters using sensors and monitoring technology, alerting doctors in real time if problems occur. Each example shows the potential of AI in improving the healthcare system in Romania, contributing to early diagnosis of conditions, personalized patient care and overall optimization of healthcare quality. As new technologies continue to develop and integrate into healthcare, it is expected that these applications will become increasingly widespread and bring significant benefits to both patients and healthcare professionals. However, it is essential to pay particular attention to protecting patient data and privacy, as well as addressing ethical and legal issues related to the use of AI in medicine. In the long term, the adoption and integration of AI in the Romanian healthcare system could lead to better efficiency and optimal distribution of resources, contributing to increased accessibility and quality of healthcare services offered to the population. Similarly, investment in AI research and the development or training of specialists and medical staff in using these technologies could have a significant impact on the health and well-being of the Romanian population.

AI can also improve the quality of patient care. A team of researchers at the "Iuliu Hațieganu" University of Medicine and Pharmacy in Cluj-Napoca has developed an AI-based medical data analysis system that can help doctors make better decisions regarding the diagnosis and treatment of patients (Faculty of Dental Medicine UMF Cluj, n.d.). The system uses advanced machine learning algorithms to identify patterns in medical data and provide personalized suggestions and recommendations for individual patients. Similarly, Tătaru (2022) highlights that the use of AI in pharmacies has great potential to improve pharmaceutical processes, but it is crucial to carefully address legal aspects, including data security and liability. However, with great care, the use of AI in medical and patient care should always be supervised by qualified professionals to ensure that it is used in an ethical and responsible way. Data security and privacy concerns also need to be considered when implementing AI-based systems.

Medical imaging has developed greatly in Romania. In this respect, there are various examples of the use of AI in radiology, computed tomography, and magnetic resonance imaging. For example, the Romanian Society of Radiologists and Medical Imaging is developing AI software that can analyze medical images and help detect tumors and lesions quickly and accurately (SRIMR, 2023). Syncro Soft in Cluj-Napoca has also created an artificial intelligence platform that can analyze medical images and help diagnose respiratory diseases such as pneumonia or tuberculosis (Sync.ro, n.d.). Another example of the use of AI in Romanian medicine is in the treatment of cancer patients. A team of researchers at the Bucharest Oncology Institute has developed an AI system that can analyze patients' medical data and help choose the most effective treatment for each individual patient (Dr. Minea, 2023). This system is now helping to improve treatment and increase the survival rate of cancer patients. In addition, AI is also used in patient and medical data management. For example, SoftNet Consulting in Bucharest has

developed an AI platform that can help manage patients' medical data and increase efficiency in managing complex medical cases (Tomescu, 2023). The platform can help improve communication between doctors and provide more efficient and accurate treatment for patients. Gradually and surely, AI has been increasingly used in the Romanian medical field, having a significant impact on the diagnosis and treatment of diseases, as well as on the management of patients and medical data.

Risks and opportunities in implementing AI in medicine.

There are obviously several risks that come with the benefits, requiring a careful assessment of what is already happening but also an inference of what might follow. In academia, we are seeing an increasing number of students who seem familiar with AI technology as regular users of social networks with a high level of knowledge of information technology. We need to evaluate whether this level of technological expertise is sufficient to adequately prepare these young individuals for employment. A study by Kuleto et al. (2022) showed that Serbian K-12 teachers recognize the benefits of AI in education, viewing it as a tool for improving teaching and learning processes. According to the authors' research, professionals are becoming more optimistic about how AI can contribute to their professional aspirations, and they primarily rely on the media and the internet for information. Although AI is perceived positively in personal interactions, respondents show distrust in using AI in education, especially in the process of teaching in front of a class. Therefore, it is essential that the educational process helps students gain knowledge of AI without becoming experts but rather to take advantage of the opportunities arising from this technological revolution (Fotea, S., Fotea, I., & Țundrea, E., 2019).

There are also several international studies on the same subject that show, on a broad scale, what students' attitudes and perceptions are about this phenomenon. Tănculescu et al. (2023) reported that Romanian dental students are positive about AI in dentistry, particularly valuing AI-based virtual simulations for skill enhancement. They also highlighted concerns about the limited role of online learning in practical fields such as dentistry and the challenges of keeping students engaged in such settings. Students perceive AI as a partner rather than a competitor and believe that AI will revolutionize medicine and dentistry. Most students believe that AI development will make medicine and dentistry more interesting, and that AI should be part of medical training. In Romania, medical and dental students have positive attitudes toward AI and are eager to integrate it into their future practice. However, the study identified the need to include AI in the curricula of medical and dental schools, as only one-third of respondents reported university education as a source of information about AI. This suggests that students are currently seeking information about AI on the internet to satisfy this demand. Another important aspect to consider is the impact of AI on human interactions in medicine and dentistry. Most students (61.86%) expressed concerns that as the role of AI increases in these fields, human interaction with patients may decrease. It is essential that the foundation of medicine and dentistry, based on communication, empathy, and a close relationship with patients, is maintained as AI is integrated into medical practice.

In Romania, introducing AI into healthcare can offer obvious opportunities to develop and improve healthcare services. However, it is important that students and health professionals be properly trained to understand and use such power effectively and responsibly for the benefit of patients.

Regarding the risks, one of the major concerns is that AI will replace many jobs in healthcare, such as radiology. We do not yet have dedicated studies on this topic in Romania, but we have some relevant studies internationally. In a study by Qurashi et al. (2021), researchers investigated the perceptions of radiology staff in Saudi Arabia on implementing artificial intelligence (AI) in their field. Most respondents (70%) agreed or strongly agreed with the usefulness of AI in clinical decision-making, setting scanning protocols, improving patient care, and saving time. Although AI is a relatively new technology in radiology, most participants had a good basic understanding of it. However, radiologists' level of confidence in machine learning's ability to analyze data for decision-making purposes was quite limited. The literature suggests that AI should not play the ultimate role in image interpretation but should facilitate real-time workflow management and prioritization of urgent examinations. An important issue related to implementing AI in radiology is the impact on workplaces. In the present study, only one-third of participants thought that AI would replace their jobs in the future. However, almost half of the participating students felt threatened by AI applications. In a UK study (Sit et al., 2020), it was found that students were less likely to consider a career in radiology because of AI. Despite these concerns, approximately 95% of participants showed interest in AI education. This highlights the importance of introducing AI education into future study programmes. The study also revealed that most respondents will implement AI technology in clinical practice.

AI can transform healthcare by enhancing diagnosis, prevention, and treatment while also increasing cost effectiveness and promoting equal access to healthcare services. Despite the potential benefits, several challenges and risks must be addressed when implementing AI in healthcare. The benefits of integrating AI into healthcare include better patient management, reduced referrals, cost savings, and time efficiency. AI can also contribute to a fairer overall healthcare system by supporting health facilities in rural and deprived areas. Despite these benefits, there are several barriers to the adoption of AI in healthcare. These challenges include the need for early adoption and sustainable implementation in the healthcare system, consideration of the user perspective, and optimization of the use of technology in the public health sector (Sunarti et al., 2021). Ethical concerns arise as AI is increasingly integrated into clinical practice. Concerns include the risk of bias in AI algorithms, lack of transparency, privacy issues related to the data used to train AI models, security vulnerabilities, and accountability for implementing AI in clinical settings (Sunarti et al., 2021). To address these challenges, a robust governance framework must ensure fairness, transparency, trust, and accountability in AI applications. Such a project should involve multiple stakeholders, including software developers, government officials, healthcare providers, physicians, and patient advocacy groups. Some specific issues that need to be addressed include data bias¹, privacy², ethical double effects³ and ethical principles related to research and biomedical medicine⁴. Ensuring that artificial intelligence models are trained on representative and unbiased data is crucial to avoid misleading predictions, adverse events

and discrimination. Confidentiality is another significant concern, as healthcare data are highly sensitive and must be protected to respect patient autonomy and privacy. Finally, AI applications in healthcare should respect biomedical ethical principles such as autonomy, beneficence, nonmaleficence and justice (Sunarti et al., 2021). As in other countries, implementing AI in medicine and healthcare in Romania comes not only with benefits but also with several risks that need to be assessed with caution. In an academic context, it is imperative to assess whether the level of technological competence of young people is adequate to adapt to the demands of the changing labor market. According to the literature review, the following risks and challenges may arise in implementing AI in the Romanian healthcare system:

Job displacement: AI could displace certain jobs in healthcare, such as radiology, which could lead to increased unemployment among healthcare professionals (Qurashi et al., 2021).

Insufficient training of health professionals: Studies have shown that the level of knowledge of AI among young Romanians is low to medium (Fotea, S., Fotea, I., & Țundrea, E., 2019). Thus, it is essential that the educational process adapts to provide AI knowledge without imposing expertise but rather to take advantage of the opportunities arising from this technological revolution.

The need to include AI in medical and dental school curricula: International studies reveal the need to include AI in curricula to prepare future health professionals for the use and understanding of AI (Bisdas et al., 2021).

Reduced human interaction: The integration of AI into the medical and dental fields could lead to a decrease in human interaction with patients, thus affecting the basis of medicine, which is based on communication, empathy, and close relationships with patients.

Ethical and privacy issues: There are concerns about bias in AI algorithms, lack of transparency, privacy issues related to the data used to train AI models and security vulnerabilities.

Need for educational adaptation: Educational programmes need to adapt to include AI training and prepare future health professionals to take advantage of the opportunities this technology offers.

Create a robust governance framework: To address the challenges and risks associated with implementing AI in healthcare, it is necessary to establish a governance framework that ensures fairness, transparency, trust, and accountability in AI applications. This framework should involve multiple stakeholders, including software developers, government officials, healthcare providers, physicians, and patient advocacy groups.

Ensuring correct training of AI models: It is essential that AI models are trained on representative and unbiased data to avoid misleading predictions, adverse events, and discrimination.

Implementing artificial intelligence in healthcare in Romania remains a dilemma, bringing opportunities for progress but also significant risks that can affect the human relationship

between patients and healthcare professionals. It is crucial to adapt education and strengthen the governance framework to assimilate this technology responsibly and equitably without compromising ethics and confidentiality but cultivating the skills needed to navigate the wave of transformation in 21st century medicine.

Discussions

The Romanian health system faces challenges such as insufficient funding and discrepancies between the number of insured people and the beneficiaries of health services. Using artificial intelligence (AI) can improve the quality of this system by stimulating innovation, streamlining resource allocation, and improving healthcare services. Collaboration between AI developers, the Ministry of Health, business, and academia is essential for the development and implementation of intelligent applications to reduce bureaucracy, boost marketing strategies and optimize the diagnosis and treatment process.

A literature review revealed that AI has significant potential to improve the quality of life of patients in Romania. AI technologies are applied in healthcare, with many examples of collaboration between technology companies and medical institutions. These technologies can be used in diagnostics, treatment protocol development, personalized medicine, and patient monitoring. However, ethical and safety issues related to the use of AI in medicine, such as protecting patient data and the implications for medical practice, need to be considered.

Digitization of the Romanian healthcare system is important for providing reliable information to the population and simplifying interactions between doctors and patients. The concept of e-health is defined as the use of communication technologies to support the transmission, recording and storage of medical information. In Romania, there is a need to develop and implement technologies adapted to the specificities of the healthcare system and the needs of patients.

There are examples of successfully implemented information systems and technologies in Romania, such as the Electronic Prescription Information System (SIPE), Armonia@sanita, a hospital information system, the Integrated Emergency Services System, and the National Registry of Rheumatoid Arthritis Patients. All these systems have shown significant benefits in improving the quality of life and the efficiency of the healthcare system.

Using AI as a marketing tool in the Romanian healthcare system implies responsibility and respect for patients and the healthcare system. The development and implementation of AI technologies must be adapted to the specifics of the Romanian healthcare system and to the needs of patients, considering privacy issues and protecting patient data. The use of speech analytics to predict heart failure exacerbation (Pană et al., 2021) is an example of the use of AI in medicine, which can significantly improve patients' quality of life. In this context, it is essential to address issues of privacy and protection of patient data and the responsible and respectful use of technology so as not to affect the quality of patients' lives or the integrity of the healthcare system.

Conclusions

In this chapter, we analyzed the use of artificial intelligence in healthcare and assessed the effects of risks and challenges for patients and healthcare staff in Romania. Considering the current crisis in the Romanian healthcare system, AI could be considered a promising solution for improving the diagnosis, prognosis, and treatment of diseases. Implementing this technology in the healthcare system can generate both positive and negative consequences. AI can process large volumes of medical data, ranging from medical images and laboratory analyses to patient medical histories. Using AI can facilitate the identification of patterns and trends relevant for early diagnosis and prediction of disease progression. Rapid and accurate results can save more lives and improve therapeutic approaches. AI can also increase the efficiency of medical staff by reducing the time needed to check and update patient information, process medical images, and interpret laboratory analyses.

In terms of the impact on patients in Romania, artificial intelligence in healthcare can bring several benefits, including improved quality of life. Early diagnosis and accurate prognosis facilitate prompt treatment of conditions, preventing or reducing complications and reducing the length of hospitalization. In addition, AI can help tailor treatments to patients' individual medical data. However, there are risks. Discrimination can occur if learning algorithms use datasets affected by bias and human error. Another risk is the overreliance of doctors and patients to make coparticipatory decisions with AI, which can lead to the neglect of atypical signs and symptoms or the underestimation of risks. Additionally, where AI generates errors, establishing the causes can be difficult. Another relevant issue concerns the security and protection of patient data. Medical data, sensitive being, require adequate safeguards against unauthorized access or theft. Implementing artificial intelligence may amplify the risk of data compromise, especially with security vulnerabilities in systems using this technology. As a result, the use of artificial intelligence in medicine carries great benefits as well as potentially substantial risks for the future, and it is essential to address these issues to develop technologies and practices that minimize potential dangers and maximize benefits for patients and healthcare professionals. Thus, artificial intelligence represents an innovative and promising tool in the transformation of the Romanian medical system, with the potential to revolutionize diagnostic, prognostic, and therapeutic approaches. Under these circumstances, a balanced, responsible approach and long-term preparation of legislation and citizens before implementing the technology are imperative, considering both the benefits and the associated risks.

Following all these analyses, I believe that in the long term, collaboration between the different actors involved in the health system and the development of AI technologies can lead to a better quality of life for the population and an increase in life expectancy in Romania. AI technologies and digitization support the transmission, recording, and storage of health information. The creation of a national database can facilitate access to health information, monitoring of patients and rapid identification of needs and opportunities for health system improvement.

List of abbreviations

AI - Artificial intelligence

DL - Deep learning

ML - Machine Learning

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Appendix 1: Topics covered in the 15 selected articles.

Article	Subject	Study sample and results
(Briciu & Briciu, 2021)	Influence and Future Perspectives of Artificial Intelligence on the Labor Market	The authors analyze the impact of COVID-19 and AI on the labor market. The study sample includes a range of industries affected by AI, focusing on how job roles are developing. Key results show a shift toward automation, with AI replacing certain jobs while creating new opportunities in others. The study emphasizes the need for reskilling and upskilling in the workforce to adapt to these changes. It also highlights the growing importance of AI literacy and interdisciplinary skills in the future job market. The article concludes with a discussion of the socioeconomic implications of these trends.
(Butaru et al., 2022)	COVID-19 Influence and Future Perspectives of Artificial Intelligence on the Labor Market. BRAIN. Broad Research in Artificial Intelligence and Neuroscience	Artificial Neural Networks (ANNs) was used to analyze data from Hepatitis C screenings. The ANNs were trained to identify high-risk individuals for Hepatitis C from the screening data. Two ANN models were developed and tested for their effectiveness. These models aimed to enhance the efficiency of identifying individuals at higher risk for Hepatitis C, improving resource management in screening programs. The results showed varying degrees of success in using AI for predictive analysis in public health screening.
Tătaru (2022)	Inteligența Artificială și industria farmaceutică: duet pentru inovație	This study examines the integration of AI in Romania's pharmaceutical sector, focusing on enhancing processes like research, clinical testing, production, and drug promotion. It underscores AI's benefits in streamlining these activities but also highlights legal risks, such as data misuse, confidentiality breaches, and product liability. The article delves into the implications of AI in pharmaceuticals, addressing personal data processing risks and the need for responsible AI application to mitigate potential legal issues. This exploration is crucial for understanding AI's role in advancing pharmaceutical practices while ensuring legal compliance.

Article	Subject	Study sample and results
Tănculescu et al. (2023)	Perception of Remote Learning by Fixed Prosthodontic Students at a Romanian Faculty of Dentistry	The article presents the findings of a study conducted in Romania, focusing on the perceptions of dental medicine students regarding the quality and effectiveness of clinical training using AI during the COVID-19 pandemic. The study sample included 259 clinical year students, and the results showed that most students preferred a learning sequence involving teaching, individual study, and discussions. Clear and understandable content was identified as a key factor in improving the quality of clinical training in online settings.
Dijmarescu (2021)	Entrepreneurship in medicine and digitization of the medical system in Romania	The article examines the increasingly close relationship between entrepreneurship and medicine, particularly through the use of technology, including AI and digitization in healthcare. It highlights the potential benefits of digitization, such as information systems, robotics, automation, and AI, with a special emphasis on the role of telemedicine and collaborative platforms, as stressed by the COVID-19 pandemic. However, it also notes the existing gaps in Romania's healthcare digital infrastructure and its implications for public health. The article includes a comprehensive list of 18 references to e-health, covering various aspects like service delivery impact, opportunities, challenges, and efficiency in enhancing treatment adherence. Overall, it suggests that technology and digitization could significantly improve healthcare and ease strains on the health system.
Dobrescu & Dobrescu (2018)	Artificial intelligence (Ai)-the technology that shapes the world. Global economic observer	The article summarizes trends, analyses, and perceptions regarding artificial intelligence (AI) and its integration across various socioeconomic aspects of life. It discusses AI's positive societal impact and its potential to address societal challenges. Concerns about AI's risks, such as mass unemployment and global destabilization, are also noted. The article highlights AI's application in health, military, and economic sectors, and mentions regulatory approaches by the European Commission and the UN, China's rise as a key global AI player, and Romania's

Article	Subject	Study sample and results
		prioritization of AI in its national research, development, and innovation program for 2016-2020.
Kuleto et al. (2019)	The Attitudes of K-12 Schools' Teachers in Serbia toward the Potential of Artificial Intelligence	Kuleto et al. conducted a study in the provided document. focuses on the perspectives and attitudes of K-12 school teachers in Serbia toward integrating Artificial Intelligence (AI) in education. The sample comprised 109 teachers who expressed their opinions on AI's utility in various educational processes. Key findings reveal a general positive attitude toward AI in teaching, with teachers acknowledging AI's potential to automate and enhance certain educational tasks. The study also discusses the teachers' readiness to implement AI in their schools, reflecting on the opportunities and challenges AI presents in the educational sector.
Varela et al. (2023)	Artificial intelligence in retinal disease: clinical application, challenges, and future directions	This research addresses retinal diseases, a leading cause of blindness in developed countries. It emphasizes the need for specialized clinicians to interpret multimodal retinal imaging and discusses the potential delays in diagnosis and intervention. The study reviews the development of artificial intelligence (AI) software to facilitate rapid data processing in this field. It focuses on decision support for the diagnosis, classification, monitoring, and treatment of retinal diseases using AI, particularly diabetic retinopathy, age-related macular degeneration, inherited retinal disease, and retinopathy of prematurity. The review expresses cautious optimism about integrating these AI algorithms into routine clinical practice, which could improve access to treatments, enhance healthcare system efficiency, and assist clinicians in managing the increasing volume of multimodal data.
Ahmed et al. (2023)	A Systematic Review of the Barriers to the Implementation of Artificial	In this literature review explores the challenges hindering the integration of artificial intelligence (AI) into the field of medicine. It delves into how AI holds the promise of improving medical practices through its capacity to enable early disease

Article	Subject	Study sample and results
	Intelligence in Healthcare	detection, streamline administrative tasks, facilitate drug development, personalize medical and cancer treatments, and continuously monitor individual health metrics. Despite the long-standing recognition of AI's potential in healthcare, the review highlights the slow and uneven adoption of AI technologies in the medical sector. It identifies obstacles across six critical domains: ethical considerations, technological constraints, liability and regulatory concerns, workforce readiness, societal factors, and patient safety issues. Grasping the nuances of these impediments is essential for healthcare professionals and leaders as they strive to surmount these challenges and seamlessly incorporate AI solutions to the advantage of both patients and medical practitioners.
Dasawat & Sharma (2023)	Cyber Security Integration with Smart New Age Sustainable Startup Business, Risk Management, Automation and Scaling System for Entrepreneurs: An Artificial Intelligence Approach	This article examines the impact of Artificial Intelligence (AI) and cybersecurity on the growth and sustainability of modern startup enterprises. It highlights the capabilities of AI in identifying and thwarting cyber threats, as well as in uncovering potential security weaknesses. The paper delves into the potential risks linked to the use of AI and cybersecurity, including the likelihood of data breaches and ethical dilemmas. It proposes robust security protocols to mitigate these risks.
Pană et al. (2021)	Reducing the heart failure burden in Romania by predicting congestive heart failure using artificial intelligence: Proof of concept	The study sample comprised 16 patients with heart failure. It used vocal recordings containing specific keywords linked to the New York Heart Association's functional classification to categorize the heart failure stages of the patients. The algorithm accurately identified the 16th patient as being in the third NYHA stage based solely on the vocal recording. The study concluded that voice is a cost-effective and simple method for monitoring a patient's health status. However, for a larger dataset, a more computationally efficient algorithm might be necessary. This study was presented at the ESC Congress 2021 - The Digital Experience.

Article	Subject	Study sample and results
Nasser & Yusof (2023)	Deep Learning Based Methods for Breast Cancer Diagnosis: A Systematic Review and Future Direction	In their study, Nasser and Yusof (2023) thoroughly review the application of deep learning methods in the detection of breast cancer, emphasizing the significant advancements these techniques bring to the field. They highlight the superior accuracy of Convolutional Neural Networks (CNNs) in identifying breast cancer, outperforming traditional machine learning models. The review emphasizes the efficiency of breast cancer diagnostics by highlighting the minimal need for human intervention in feature extraction when deep learning is employed. Various datasets used for breast cancer detection are explored in the study, and different metrics for performance assessment are evaluated. The authors conclude by discussing the challenges in the field and suggesting future research directions, positioning deep learning as a pivotal tool in improving breast cancer diagnosis and patient outcomes.
Săniuță & Filip (2021)	Overview of the European and Romanian startup landscape for AI and factors determining their success	Aiming to identify critical success factors for AI startups across various industries, the study analyzed a sample of 10 European artificial intelligence startups from Romania. According to the key findings of the pilot research, pivotal factors influencing business success in the AI industry were identified as the core team's expertise, commitment, product development, and business strategy. The study also revealed that internal factors appeared more crucial for a business's success than external ones. The research identified areas where AI is still underdeveloped, such as education, transportation, entertainment, and human resources, suggesting these as potential avenues for further business development in the AI sector.
Pantelimon, Bologa, Toma, & Posedaru (2021)	The evolution of AI-driven educational systems during the COVID-19 pandemic. Sustainability	This study discusses the significant impact of COVID-19 on education, particularly emphasizing the shift toward digital, remote learning methods. The transition from traditional resources like paperback books to digital formats, and from in-person classes to

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		<p>online platforms, has been notable. This shift has been accompanied by the adoption of artificial intelligence (AI)-driven systems that use adaptive learning techniques by both educators and students. The paper presents a statistical analysis of the use of an adaptive learning system in Romania, both before and during the pandemic, based on data collected during a pilot project. This data includes the number of students enrolled in a course, the percentage of successful completions, and demographic information, such as age, location, and primary interest areas. The study concludes that the use of AI in education has escalated during the pandemic, and the data supports the growing popularity and effectiveness of AI-driven tools in the educational process.</p>
Popescu, Geantă & Brand (2022)	Mapping of clinical research on artificial intelligence in the treatment of cancer and the challenges and opportunities underpinning its integration in the European Union health sector	<p>This study conducts a systematic review to map clinical research on artificial intelligence (AI) in cancer treatment and explores integration challenges and opportunities in the European Union (EU) healthcare sector. It encompasses 44 clinical trials between 2010 and 2020, focusing on three research areas: AI with medical imaging, robotic surgery, and clinical decision-making. While 21 studies were interventional and nine observational, 14 did not specify the study type, exhibiting significant heterogeneity. Interestingly, only a small fraction of studies occurred in the EU, likely influenced by socioeconomic, political, and technological factors. Addressing these challenges causes tailored strategies to leverage AI in EU healthcare fully.</p>