Student and Faculty Perspectives on AI in Health Education: An Exploratory Systematic Review.

Students and Teachers perspective about AI in Healthcare Education: Scoping Review.

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Abstract: The teaching and learning process in Medical Education evolves with technological advances. Artificial Intelligence (AI) has become an increasingly used tool in student learning. However, its implementation is questioned by teachers and students of careers related to the health field. In this exploratory systematic review (scoping review), the perceptions, opportunities and challenges of undergraduate students of health careers in relation to the implementation of AI were examined. Following the PRISMA guidelines, searches were performed in MEDLINE/PubMed, Scopus and ISI/Web of Science for relevant articles; duplicate articles were eliminated and selected according to our eligibility criteria. Of the 121 studies selected, 14 were included in the study; A thematic analysis based on categories of the selected studies has been performed. Most of the findings show a good perception, interest and willingness of students regarding the implementation of AI in the medical curriculum. However, the lack of knowledge about the usefulness of AI stands out as a challenge, coupled with resistance to change due to fear of replacing professional work. Likewise, the dehumanization of medicine has been raised as an ethical challenge. The main limitation is the research topic that is still in development, with available literature still in the initial stages of research.

Keywords: Artificial Intelligence; Medical education; Perception; Students; Teachers.

Abstract: The teaching and learning process in Medical Education evolves with technological advancements. Artificial Intelligence (AI) has become an increasingly used tool in student learning. However, its implementation is questioned by both faculty and students in health-related fields. In this scoping review, the perceptions, opportunities, and challenges of undergraduate health students regarding AI implementation were examined. Following PRISMA guidelines, searches were conducted in MEDLINE/PubMed, Scopus, and ISI/Web of Science for relevant articles; Duplicate articles were removed and selected according to our eligibility criteria. Of the 121 studies selected, 14 were included in the review; a thematic analysis was conducted based on categories from the selected studies. Most findings show good perception, interest, and willingness from students regarding the implementation of AI in the medical curriculum. However, the lack of understanding of AI's usefulness, along with resistance to change due to fear of job replacement,

stands out as a major challenge. Furthermore, the ethical challenge of the dehumanization of medicine is also raised. The main limitation is that the research topic is still developing, with the available literature still in its early stages.

Keywords: Artificial intelligence, Medical education, perception, Students, Teachers

1. Introduction

Medical education has undergone significant transformations in recent decades, driven by emerging technological advances that seek to improve the various dimensions that education presents, such as the development of clinical skills, diagnostic accuracy, personalization of learning (1) and the need to adapt teaching methods to a constantly evolving environment (2). In this context, artificial intelligence (AI) has emerged as a support tool for the academic training and clinical practice of health professionals, particularly in aspects related to patient care (3) and decision-making (4). However, the incorporation of AI into the educational curriculum and clinical practices has been questioned by students themselves and their teachers. These concerns have focused on the deficit of professional training, particularly related to the fulfillment of the essential competencies of professional training, as well as clinical reasoning and the doctor-patient relationship (5), with its implications for the ethical principles of medical care (6-7).

The present study aims to address how students and teachers of health careers perceive the impact of AI on their training and professional practice. The main objective of the study is to systematize recent findings that show and identify the different perceptions of students and their teachers of health careers regarding this new tool implemented in the educational process. Likewise, it seeks to identify opportunities and challenges in the integration of these new technologies as tools for educational and professional development in health. To meet these objectives, a scoping review has been carried out , focused on the PRISMA methodology. This approach has allowed us to offer a broad view of the subject, exploring the variety of existing approaches, because the application of AI in medical education and the perception of this by students and teachers is a field still in development, and the available evidence is still in an initial stage of research.

2. Methods

To carry out this study, the methodology proposed by Arksey and O'Malley (8) was used, which allows a comprehensive and flexible approach to the research topic. This approach is particularly suited to the objective of the study, as it facilitates the identification of the main areas of interest, gaps in the literature and possible lines of future research, optimally adapting to the specific characteristics of the study.

Step 1: Identify the research question

As a first stage of this review, the following research question was defined: "How do students and teachers of health careers perceive the impact of AI on their training and professional practice?"

Step 2: Identify relevant literature

Searches were conducted in PubMed/MEDLINE, Scopus and ISI/Web of Science on 16 August 2024, focusing on peer-reviewed articles published between 2014 and August 2024. The focus of the search was the innovative use of AI-based technologies among university students and teachers in undergraduate and professional practice health courses, as well as the growing ethical and moral debate on the use of these technologies as tools in professional training. The search strategy used used the following Boolean operators and Medical Subject Headings (MeSH): ("Artificial Intelligence"[Mesh] OR "AI" OR "Machine Learning") AND ("Perception" OR "Attitudes" OR

"Views" OR "Opinions") AND ("Teachers"[Mesh] OR "Faculty" OR "Educators" OR "Instructor" OR "Tutor" OR "Professor" OR "Lecturer" OR "Facilitator" OR "Teacher") AND ("Education"[Mesh] OR "Training" OR "Professional Practice" OR "Clinical Practice") AND ("health professions" OR "health careers" OR "medical education" OR "nursing education" OR "health sciences education").

On the other hand, the selection criteria for the review of studies are structured into two main categories: inclusion and exclusion (Table 1). Original peer-reviewed studies published between 2014 and 2024, accessible in English or Spanish, that investigate the perceptions of students and teachers of health careers on the use of artificial intelligence in education are included. Qualitative, quantitative or mixed-method designs are accepted, as long as the articles are available in recognized databases such as PubMed/MEDLINE, Scopus or ISI/Web of Science. Systematic reviews, meta-analyses, opinion articles, editorials, clinical case reports and grey literature without academic rigor are excluded. Likewise, studies that examine applications of artificial intelligence outside the health education field are excluded, as well as those that do not prioritize the direct analysis of the perceptions of students and teachers on this topic.

Step 3: Selecting appropriate items

The identified articles were examined in a comprehensive review, following the inclusion and exclusion criteria previously established by all authors. It was systematically and rigorously ensured that each selected article was related to the research question and the objective of the study. To optimize a collaborative selection, the Rayyan tool was used. Each member of the team evaluated the selected articles, and articles in disagreement were discussed.

Stage 4: Data Extraction, Mapping and Graphing

A data organization framework has been developed for the collection and synthesis of extracted information. The extracted data were recorded in two tables specifically designed to organize both the characteristics of the reviewed studies and their main findings. These tables are available in the Annexes section. Table 2 records key details of each study, including the authors and year of publication, country/center of conduct, study design, participants, objectives, methods, and the AI tools studied. In addition, it systematizes the basic information of the studies and standardizes the variables of interest. Table 3 summarizes the results of the studies in relation to the impact of AI on the academic training and professional practice of students and teachers of health careers. The columns include general perceptions, identified opportunities, challenges and barriers, ethical aspects discussed, and conclusions of the study. In this way, a thematic mapping has been guaranteed that allows identifying patterns, opportunities, and challenges in the integration of AI in the educational and professional field of health.

Step 5: Summary and presentation of results

Most of the articles included in this study are observational and descriptive surveys, so the results obtained detail not only the perceptions and attitudes of participants regarding the impact of AI on their academic and professional training, but also the opportunities, barriers, challenges and ethical considerations associated with its implementation. The qualitative nature of the results presents a reflexive narrative approach, allowing us to interpret not only general trends, but also the individual and collective experiences of the respondents. This approach has facilitated a more holistic and contextualized understanding of participants' perceptions, as well as the opportunities, challenges and ethical considerations related to the use of AI in the health field.

Step 6: Consult with experts

Although the original proposal by Arksey and O'Malley for scoping studies includes five stages, several authors have highlighted the flexibility of this methodological approach (9-10), allowing adjustments to more effectively address the specific objectives of each review. In this case,

a sixth stage, consultation with experts, was added to enrich the analysis and strengthen the validity of the review process. The decision to include this stage was based on two main reasons: First, the review addressed an emerging topic, such as the use of artificial intelligence in health education, which combines disciplines such as medical education, technology, and ethics. Thus, the participation of an expert allowed for the integration of an interdisciplinary perspective, ensuring that the interpretations were consistent with the complexities of the topic. Second, the guidance provided by the expert contributed to the structuring of the review protocol, the definition of inclusion/exclusion criteria, and the interpretation of findings. This stage also helped to identify key gaps in the literature, ensuring that the study remained aligned with quality methodological standards.

3. Results

The article selection process has been described in Figure 1, following the PRISMA diagram. In total, 121 studies were identified, of which 25 duplicates were excluded. The remaining 96 articles were subjected to an evaluation of titles and abstracts, applying the inclusion and exclusion criteria previously described, which considered original studies on the perceptions of the use of AI in the training of undergraduate students, professionals in practice and teachers in health areas, between 2014 and 2024. After this process, only 33 articles were included for an exhaustive review. Finally, 14 articles were selected in this study for their relevance to the research objectives. The main characteristics are summarized in Table 2, while the main results are in Table 3.
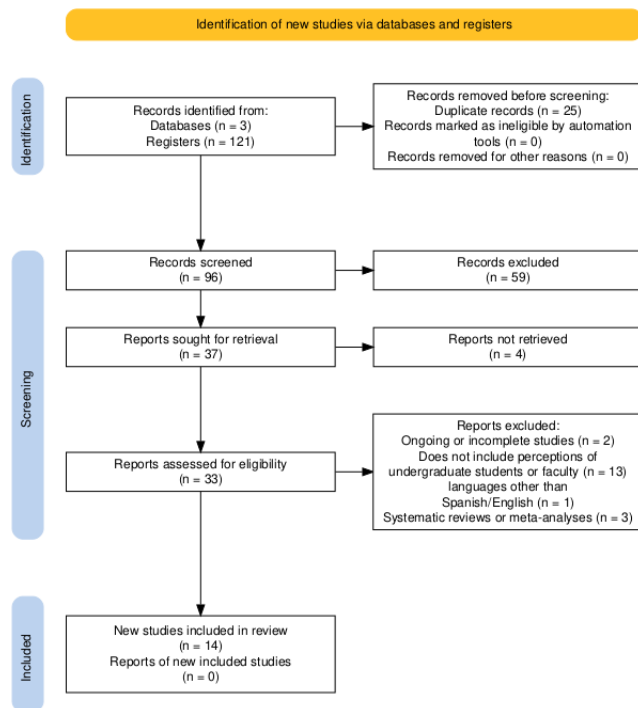

Figura 1. El diagrama de flujo PRISMA muestra el proceso de identificación, selección, elegibilidad e inclusión de artículos sobre las percepciones de estudiantes y docentes de carreras de la salud acerca de la IA.

To answer the research question, the results were organized into five categories, by mode in the selected articles. This approach has allowed structuring the analysis for later discussion. The categories were: General Characteristics of the Selected Studies, Attitudes towards Artificial Intelligence, Implementation Opportunities, Challenges and Barriers, and Ethical Considerations.

3.2. General Characteristics of the Selected Articles

The selected articles originate from diverse regions, including Europe, Asia, North America and the Middle East, providing an international perspective on the perceptions of students and teachers of health care disciplines regarding the impact of AI on their training and professional practice. The designs of the articles are mostly descriptive and cross-sectional observational, based on surveys directed at undergraduate students, practitioners and teachers of health disciplines. The sample sizes vary widely between articles, from smaller groups of 173 participants, to multinational studies including up to 4492 respondents, providing a wide range of perceptions and attitudes towards the use of AI in the educational and professional field. The time frame of the selected articles spans from 2021 to 2024. Within this period, the analyzed studies do not show significant differences in the results given. In general, a limited level of knowledge is observed regarding the use of AI in medical education. However, the studies highlight the relevance of this new tool for its future incorporation in education and healthcare.

The geographical distribution of the articles includes a diverse representation, with research conducted in countries such as Greece, the United States, India, Malaysia, Sudan, and Vietnam, among others. The perceptions collected not only detail a specific context, but also allow for the identification of possible cultural or regional differences in the integration of AI in health education. It should be noted that various AI implementations are presented in the analyzed studies. For example, in the article by Alkhaaldi (11) and Pallivathukal (12), they direct the surveys according to the knowledge that students have regarding large-scale language model artificial intelligence, which has the ChatGPT application as an example. On the other hand, the studies by Truong (13), Santos (14), and Jaber (15) approach their studies from the clinical perspective of the application of AI in various specialties, such as radiology, histopathology, dermatology, among others. However, it is noted that the authors mostly presented the "ChatGPT" application as an example of artificial intelligence in medical education within the questions implemented in the surveys. In most of the articles, online surveys of quantitative and qualitative nature were used, often combined with open questions about perceptions and attitudes regarding the use of AI in the educational development of health faculty students. No standardized survey methods are evident, so it is deduced that they originated from the authors themselves.

3.3. Attitudes towards Artificial Intelligence in Professional Training and Practice

Attitudes towards AI in Professional Training and Practice detail several trend lines among the articles. The first trend shows a general positive attitude towards AI in the respondents of most of the studies. Bonacaro et al. (2024) (16) mention that between 50% and 60% of students and teachers have positively valued training in AI. On the other hand, Yalcinkaya et al. (17), Buabbas et al. (18) and Allam et al. (19) have reported a positive attitude towards AI in more than 80% of their respondents. Likewise, Jebreen et al. (20) has described a positive perception, specifically oriented towards the improvement of medicine in relation to AI. Finally, Pallivathukal et al. (12), Alkhaaldi et al. (11) and Fitzek and Choi (21) have qualitatively shown a positive perception of the participants.

The second trend relates to AI being a useful tool for training and educational improvement, which has been observed in four different studies. More specifically, Boncaro et al. (16) showed that 40.1% of participants considered the implementation of AI useful in their simulations, 28.4% in teaching activities, and 16.2% in personalized learning environments. This positive opinion is consistent with the results of Wood et al. (22), Hashish and Alnajjar (23), and Truong et al. (13).

In the third trend, responses related to the impact and consequences that the use of AI would have in training and clinical practice are observed. The results observed by Wood et al. (22), Jaber et al. (15), Jebreen et al. (20), and Fitzek and Choi (21) have determined that students and teachers consider that AI will revolutionize medical practice and its development. In addition, it was shown that, in one of the articles, 77.2% of respondents agreed that AI could be used in public health and epidemic prevention (13), furthermore, 99.1% consider that it will play an important role in the health system (18).

The fourth trend determines the lack of knowledge about the existence and use of AI, where it was observed that 30% of students and 50% of teachers had knowledge of it, and that 36% of teachers and 18% of students do not have a basic understanding of it (22). This observation coincides with Sharma et al. (24), who have recorded that 19.3% of their respondents do not understand AI, as well as with Allam et al. (19) and Jaber et al. (15), where more than 80% of respondents have shown a low level of knowledge on the subject, and more than 90% have stated that they have not received formal training on AI. Finally, Blease et al. (25) has detailed that 66.5% state that they have not received information or training on the subject during their career.

The fifth trend expresses the concerns generated by AI by the respondents. In total, four articles mention results regarding this topic. On the one hand, Sharma et al. (24) have detailed that 41% of their respondents considered the impact of AI on the future of medicine as something unpredictable, while Pallivathukal et al. (12) have evidenced concerns mainly oriented towards the accuracy of the answers and the ethics of the use of AI. On the other hand, the results of Jebreen et al. (20) and Fitzek and Choi (21) have agreed that the respondents consider it unlikely that AI will end up replacing doctors totally or partially in the future.

Finally, the sixth trend is oriented towards the curricular implementation of AI in health careers. Sharma et al. (24) and Blease et al. (25) have shown that 46.8% and 78.6% of their respondents, respectively, have considered its implementation in the curricular training of the medical career. On the other hand, as stated by Yalcinkaya et al. (17), 89.3% of the participants in their survey have considered that AI should be applied within the future curriculum of the nursing career.

3.4. Opportunities in the Implementation of Artificial Intelligence

The selected articles have identified various opportunities for the implementation of AI in educational and clinical settings. In particular, seven articles have indicated that the incorporation of teaching about AI in the curricular training of health careers could offer benefits for their professional training (13, 15, 17-19, 23, 25). In particular, Yalcinkaya et al. (17) have detailed that 83.2% of the interviewed nursing students have been in favor of the inclusion of AI in the curriculum, while 89.3% have considered it necessary to integrate AI-based tools in education.

Furthermore, ten studies have concluded that AI contributes to the optimization of decision making and to the improvement of the accuracy and efficiency of diagnostic processes in the clinic (17)(18)(13, 15, 19-22, 24-25). In recent studies, (19-20) it is suggested that AI could revolutionize practices in medicine and radiology, becoming a commonly used tool in clinical contexts. However, a concern is pointed out; in the study by Allam et al. (19) it was revealed that 1620 students (36.1%) believe that, as a result of the implementation of AI in clinical spaces, there could be a decrease in the need for radiologists.

Finally, the perception of benefit regarding the inclusion of AI to improve the education of health career students is seen in five studies (11, 16-17, 22-23). Among these, the study carried out by Bonacaro et al. (16) stands out, where participants report that AI is a beneficial tool for practical simulations (40.1%), in teaching activities (28.4%) and in the development of personalized learning

(16.2%). According to Pallivathukal et al. (12), 36.6% of participants have used this tool, specifically ChatGPT, in order to complete academic activities, and 65.9% perceive that it allows reducing the time to complete activities and assignments assigned by health careers. This result is complemented by the research by Alkhaaldi et al. (11) where 60% of participants showed interest in the new versions of AI, and 53.2% consider that it will improve their learning.

3.5. Challenges and Barriers to Artificial Intelligence Integration

Challenges and barriers hinder the integration of AI into the academic training of health students. The most common impediment was the basic lack of knowledge of AI as a useful tool in clinical practice and undergraduate education, which was present in 11 studies, where the most common factor was the lack of training and teaching regarding AI (11, 13, 15, 17-23, 25). Particularly, Fitzek, S., and Choi, K. (21) raise the need to develop basic teaching in the use of AI for the training of health students. On the other hand, professional resistance to change is also a barrier to the integration of AI, which was present in 7 studies, the most common reasoning was the fear of the substitution of medical tasks by technologies such as AI, however, it does not explain the exact proportion of those participants (13, 15-19, 23).

Other challenges and barriers that were less present were the limited resources in the implementation of AI were present in 5 studies (13, 16-18, 24), where the latter has highlighted the insufficient educational infrastructure for the integration of AI, in addition Truong, N., et al (13) has raised the possible inequalities in its implementation in the different regions of Vietnam, which could be replicated in other underdeveloped countries. On the other hand, the concern about the accuracy of the information delivered by AI has been present in 3 studies (11-12, 23), where the latter two have questioned digital knowledge and precision when making clinical decisions. Finally, the least common factor has been the concern about the dependence on the use of AI was present in 2 studies (12, 24), however, they have not explained their reasons.

3.6. Ethical Considerations in the Use of Artificial Intelligence

Regarding ethical considerations, the main concern is the dehumanization of medicine by AI. Specifically, Alkhaaldi, S., et al, (11) have detailed that 63.4% of students believe that the use of AI could diminish the humanity of medicine, as well as reduce patients' trust in healthcare professionals (59%). Similar results have been found in the study by Fitzek, S., and Choi, K. (21).

Bonacaro, A., et al., (16) has determined that 30.4% of nursing students are afraid of losing the interaction between interns and patients, an essential component within nursing. On the other hand, Truong, N., et al, (13) has shown that participants consider difficulties of AI in relation to empathy (75%) and psychological counseling (59%). Likewise, 43% of the students in the results of Sharma, V., et al(24) have affirmed the lack of empathy that AI would have.

Another ethical issue is the concern for patient data privacy (37%) (13, 18, 24-25). Likewise, Hashish et al (23) have stated that information security and privacy are important obstacles to the formal implementation of AI; the patient's right to determine how their data is used and to prevent unwanted access to it being fundamental according to Jebreen, K., et al (20).

4. Discussion

The results of this review show a clear trend towards positive opinions from students and teachers in health careers, which are accompanied by the need to include standardized curricular training on AI in health careers. The great lack of knowledge and some important ethical considerations involved in the implementation of AI were raised. The results obtained will be discussed below in relation to the observations present in the literature.

Positive attitudes of students and teachers towards AI in the training and practice of health careers are consistent with what has been reported in the literature. However, most of the available information focuses on students' perceptions, while data on teachers are limited or non-existent. For example, the systematic review by Sun et al. (26) has highlighted that students' opinions, especially in medicine, are mostly positive regarding AI. This is consistent with the findings of the review by Mousavi et al. (27), which concluded that in 76% of the reviewed studies, health career students showed positive attitudes towards AI, highlighting their motivation to apply these technologies both in their training and in their future professional practice. Likewise, the results presented by Amiri et al. (28) have corroborated this trend, showing a predominance of positive opinions among students of medicine, dentistry and nursing.

On the other hand, both Mousavi et al. (27) and Amiri et al. (28) have highlighted that negative attitudes towards AI were more prevalent in low- and middle-income countries. These authors have suggested that socioeconomic differences could significantly influence students' perceptions. In their review, Mousavi et al. (27) have observed that most negative attitudes originate in contexts where access to technology and education around AI are limited. Similarly, Amiri et al (28) have stated that students from developing countries tend to be more skeptical, which could be contributing to a higher prevalence of negative opinions in this group. Taken together, these evidences highlight the need to explore how socioeconomic context can shape attitudes towards AI in health education, suggesting that future research should focus on this dimension to better understand variations in students' perceptions.

In addition to perceptions about AI, the reviewed literature has also highlighted its increasing application in clinical education. Several authors have analyzed the benefits of AI in this field, pointing out its ability to improve practical simulation and personalized learning. Bonacaro et al. have mentioned that respondents find the use of AI beneficial in practical simulations (40.1%), in teaching activities (28.4%) and in developing personalized learning (16.2%). Similarly, Alkhaaldi et al. (11) have reported that although only 20.4% have used AI to complete a written assessment, 63.4% have planned to use this technology during their future training in order to explore new medical topics and research. These findings are consistent with the exploratory systematic review by Gordon et al. (29), which has shown the potential benefit of using AI as a learning tool in areas such as histopathology and neuroanatomy in 12 of 33 articles analyzed. Furthermore, 5 studies have recognized that AI is beneficial for the practice of medical simulations when combined with an intelligent tutoring system (ITSs). This combination could form simulated patients from AI that answer the questions asked by the trainee, facilitating the training of the various components of the clinical reasoning process. The implementation of these new technologies not only encourages dynamic learning, but also allows the development of the student's educational training by providing personalized feedback, showing correct and incorrect reasoning and suggesting different bibliographies aimed at reinforcing the weaknesses presented by the trainee. Therefore, as indicated by Sun et al. (26), it is possible to observe how several institutions from different regions and countries are adopting the use of these technological innovations in the training of future health professionals.

Along the same lines, a positive trend has been observed regarding the impact that AI can provide in clinical practice, especially in optimizing decision-making and improving diagnostic accuracy and efficiency. This is consistent with the systematic review by Chen et al. (30), which reported that the studies analyzed perceive benefits in the use of AI in clinical practice, by promoting efficiency, quality, and improving standardization in the interpretation of results. Similarly, the study by Amiri et al. (28) has shown that students recognize the potential of AI for improving diagnostic accuracy, increasing access to health care, and reducing work overload. In addition to these benefits reported in the educational field, where AI has demonstrated its ability to improve practical simulation and personalized learning, the various studies reviewed in this

exploratory systematic review have referred to the growing skepticism of health students regarding the possible dehumanization of health care that can be generated by the use of AI in clinical contexts.

The literature has also pointed out these ethical and human challenges associated with its use in health practice. One of the main critical aspects is the possible dehumanization of medical care, as the findings observed in the results coincide with the literature found. Various authors have stated that AI can fundamentally alter the way in which empathy, compassion and trust are built in healthcare (31). Likewise, from the perspective of patients (32) and their perception of AI, it has been found that they feel the inability to empathize as their main weak point, compared to the experience with human professionals. Addressing both aspects, linked to dehumanization and lack of empathy, we promote education on the complementary use of AI as an educational tool, reinforcing that it does not replace empathy or human clinical judgment. Following this line, we recommend the use of AI in clinical simulations, which would allow the development of not only technical skills, but also enhance empathy and interpersonal skills. These perspectives are reinforced in the use of Virtual Reality, through tests that simulate patients' illness experiences, helping health professionals to understand diseases, generating more empathetic behaviors and more positive attitudes towards patients (31).

On the other hand, the literature has supported the findings focused on patient data privacy, mentioning how ethical issues have always been of public concern, fearing privacy breaches and the stigma that some sensitive data may cause. Likewise, it has been suggested that these concerns are due to the lack of unified standards and norms on AI technology, giving rise to skepticism in the public (29). Addressing this ethical discussion, we recommend that encryption and solid software be used on sensitive patient information, in addition to implementing strict access and transparent policies that protect said information. An example of such technology is Blockchain, software that allows storing and managing health data, preventing unauthorized access and possible data breaches (33). Likewise, patients must be informed about how their data will be used and protected, giving way to informed consent, thus promoting trust and confidentiality. Proof of this is the General Data Protection Regulation (GDPR) (34) present in the European Union, which establishes standards for data protection, allowing users to exercise their rights, both by allowing the use of their information, as well as deleting it if they wish.

This skepticism towards AI not only affects the confidence in its use in clinical practice, but also, as demonstrated in the results, in its application in the educational field. As mentioned by Sun L. et al (26), although educational technology has accelerated modern medical education, there are still relatively few medical students who are familiar with AI. These findings are also consistent with Amiri et al (28) and Chen et al (30), who have suggested that most studies report students' lack of knowledge, but have a positive but reserved attitude towards its implementation. One of the ways to remedy the lack of knowledge is the implementation of teaching about the uses of AI in medical education, which is consistent with Amiri et al (28), Pupic et al (35) and Iqbal et al (2021) (36), where they have indicated the inadequate preparation of teachers and the need for the integration of AI within curricular training.

Another relevant finding has been the resistance to change in the face of AI, which is also a challenge for implementation in medical education due to the fear of the substitution of medical tasks. This is partially consistent with Jussupow et al (37) and Lambert et al (38), where, however, resistance to change has been related to the loss of the status of medical work and the autonomy of the health professional. However, these premises have been mainly associated with the lack of knowledge of the usefulness of AI, since knowledge of AI among students and teachers is very low and insufficient for the development of future health students, according to what Grunhut et al (7) mentions.

Given this lack of knowledge, the preparation of future health professionals in the use of AI has become a central topic in recent debates. Several authors within the present scoping review have emphasized the preparation of future health professionals on this new tool, highlighting the importance of including teaching about AI in the curricula.

The main recommendation is to carry out training courses for students in the health area, seeking to educate them on the use of AI and avoid the stigmatization of this tool, focusing on students from low- and middle-income countries, who were more skeptical about the use of AI (26, 28). This is consistent with what was presented in the study by Pupic et al. (35), where the consensus among recent publications on the need to integrate AI training into education plans for health students has been pointed out. It is worth mentioning that we also recommend a gradual implementation of the use of AI, with the aim of reducing the perception of replacement and dehumanization on the part of students (37-38), thus mitigating resistance to change. After these actions, we suggest prioritizing the use in practical simulations, clinical reasoning and personalized learning, given the greater acceptance and positive perceptions that these practices have received in the literature (16). The above is reflected in the study carried out by Sapci et al. (39), where the authors have recommended familiarizing and introducing students to the use of AI in clinical situations, as well as emphasizing the importance of understanding AI to validate the clinical algorithm generated by this tool.

Limitations and biases of this review

One of the main limitations of this review is the emerging research topic, where the present findings are still articles in the early stages of research. Other limitations are the biases associated with the design of the studies that have been analyzed during this review. For example, cross-sectional studies such as (6-8, 12, 16-20) that, although they allow identifying attitudes, opportunities, challenges and barriers oriented to the use of AI, do not imply that these remain intact over time; moreover, they are highly volatile in the face of the rapid technological evolution that AI is experiencing. Therefore, they make it difficult to plan and use the recommendations described in this review.

On the other hand, it is also possible to identify biases in the methods used by the studies (1-5, 7-8, 12, 16-20) through surveys or (6, 20) through interviews, since the authors have not specified a standardized or formally validated structure, in addition to mostly representing individual and subjective perceptions by the respondents, which are highly variable, especially for those groups that do not have adequate knowledge about AI. Therefore, the recommendations described in this review should be relevant to the reality and public opinion of students, professors and other academic professionals at universities on the matter.

Finally, there are certain limitations associated with geographical differences between studies. For example, in high-income countries, attitudes tend to be more positive due to access to advanced technologies and adapted curricula. In contrast, in developing countries, greater skepticism is observed associated with limitations in infrastructure and training. In contexts where AI is better integrated, such as in universities in Europe (1)(12, 18) and the United States (2), a greater understanding and willingness to use it is reported. In contrast, in regions such as Africa (16) there is less formal training in AI, which affects the perception and implementation of these technologies. In Europe (6, 12) and the United States (2), progress has been made in integrating AI into medical curricula. This includes the use of tools such as AI-based simulations and customized platforms for autonomous learning. In regions such as the Middle East and Asia (3)(4-8, 16-17, 19-20), although there is a notable interest, the curricular implementation is limited by factors such as the lack of resources or the lack of knowledge about its educational potential. Therefore, the cultural and

economic differences of each country must be considered as a factor to consider when making the recommendations established in this review.

5. Conclusions

- In this scoping systematic review, the transformation of healthcare careers in the AI era is analyzed. Relevant studies were selected for a comprehensive analysis and their main findings have been synthesized.

- Although the studies do not report a great variability of information, they have shown a good perception of new technologies based on AI within medical education by undergraduate students and teachers at different universities. However, there are still challenges that must be faced when implementing AI in the curriculum within health careers, such as the lack of knowledge of its usefulness within education and clinical practice, and the commitment to ethical attitudes that focus on the dehumanization of medical practice.

- Because the era of AI within health careers is still in development, this study recommends studying the socioeconomic differences between countries that could hinder the formal and standardized implementation of AI within the curricular training of health careers and even the age differences of the perceptions and attitudes of the participants who are included in the studies, from recent undergraduate students to long-standing academic teachers.

- It is also important to highlight that the education of health students about these new technologies must be carried out by a multidisciplinary team trained with the appropriate knowledge to achieve their efficient use, and thus enhance the optimal development of knowledge of future health professionals.

Declaration of conflict of interest : The authors declare that they have no conflict of interest.

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Table 2. Characteristics of the studies selected in the review on the perception of artificial intelligence in health education.

No.	Authors and Year	Country/Center	Study Design	Participants	Goals	Methods	AI Tools Studied
1	Bonacaro, A., et al. (2024)	Greece/ University of West Attica	Descriptive observational (survey)	N = 176 (nursing students, nurses and educators)	Exploring the impact of AI in healthcare and nursing education	Online survey (multiple choice and Likert)	General use of AI in education and health
2	Wood, E., et al (2021)	USA/Medical College of Georgia	Descriptive observational (survey)	N = 173 participants (121 medical students, 52 clinical teachers)	Assessing attitudes towards AI in the medical curriculum	15-question online survey	AI in medicine (radiology, oncology, etc.)
3	Sharma, V., et al (2023)	India/College of Medical Sciences	Descriptive observational (survey)	N = 730 (medical students)	Assessing AI acceptance in medical education	Cross-sectional survey (Google Forms)	Using AI in medical education
4	Pallivathukal, R., et al (2024)	Malaysia/ Manipal University College Malaysia	Descriptive observational (survey)	N = 443 (medical and health sciences students)	Evaluate knowledge and use of ChatGPT in education	Online survey (Google Forms)	ChatGPT in academic education
5	Hashish, A. and Alnajjar, H. (2024)	College of Nursing, Jeddah, King Saud bin Abdul-Aziz University for Health Science	Descriptive correlational study	266 (3rd and 4th year undergraduate nursing students)	Assess perceived knowledge, attitudes and skills regarding digital transformation	6-section structured survey. No platform specified.	AI in healthcare digitalization
6	Yalcinkaya, T. et al (2024)	Türkiye	Descriptive cross-sectional study	N = 291 (nursing students)	Determine the attitude of nursing students towards AI	Face-to-face interviews using three scales.	Implementation of AI in education
7	Truong, N., et	Pham Ngoc	Descriptive, cross-	N = 1142 (medical and	Assess knowledge, attitudes and	Online survey	Use of AI in the

	al (2023)	Thach University of Medicine in Ho Chi Truong City, Vietnam	sectional, observational, quantitative and analytical study	chemistry and pharmacy students)	perspectives on AI and its consequences,	(Google Forms)	medical and pharmaceutical profession
8	Buabbas, A., et al (2023)	Kuwait	Cross-sectional study	N = 352 (medical students from the Faculty of Medicine at Kuwait University)	Investigating students' perceptions regarding medical education	Online survey	Using AI in medical education
9	Allam, A., et al (2024)	Libya, Egypt, Iraq, Jordan, Syria, Sudan, Algeria, Palestine and Yemen.	Multinational and multicenter cross-sectional study	N = 4492 (Students from Middle Eastern and North African countries)	To assess students' knowledge, attitude and perception of AI in medicine.	Online survey (Google forms)	Use of AI in medicine, with a focus on radiology.
10	Jaber, M., et al (2024)	Sudan	Cross-sectional study	N = 762 (medical students)	Assess the current state of knowledge, perceptions and practical experiences in AI.	Online survey (Google forms)	General knowledge of AI, both for learning and the medical field
11	Blease, C., et al (2022)	Ireland	Cross-sectional study	N = 252 (Final year medical students from three different Medical Schools in the country)	To assess students' experiences and opinions on their exposure to AI and machine learning (AI/ML) during their medical training.	Physical survey	Using AI and Machine Learning in medical training.
12	Alkhaaldi, S., et al (2023)	Khalifa University College of Medicine and Health Sciences and Sheikh Khalifa Medical	Cross-sectional study	N = 265 (Newly graduated medical students in the United Arab Emirates)	To understand students' experiences and perspectives on using ChatGPT and AI in their medical training.	Online survey	Using AI and ChatGPT in medical training.

		City					

13	Jebreen, K., et al (2024)	Palestine/Various public and private universities in Palestine	Cross-sectional study	N = 349 (Undergraduate medical students)	To identify undergraduate medical students' attitudes towards AI in medicine, explore current AI-related training opportunities, investigate the need for AI in medical curricula, and determine preferred methods for teaching AI programs.	Online survey and face-to-face interview	Use of AI in medical curricular training.
14	Fitzek, S., & Choi, K. (2024)	Germany, Austria and Switzerland/Medicine and Dentistry Programs	Cross-sectional study	N = 409 (undergraduate medical (57%) and dentistry (43%) students)	Identify the AI literacy gap among medical and dental students and improve the preparation of future healthcare professionals for the ethical and effective use of AI	Online surveys (Google Forms)	Using AI in medical and dental training
15	Magalhães, S., and Cruz-Correira, R. (2024)	Porto					

Table 3. Perceptions, opportunities and challenges related to the implementation of artificial intelligence in health education and professional practice

No.	Authors and Year	Attitudes towards Artificial Intelligence	Opportunities Identified	Challenges and Barriers	Ethical debate	Conclusions of the Study
1	Bonacaro, A., et al. (2024)	50-60% value AI training; 89.7% are inclined to use it; 40.1% find it useful in simulations; 28.4% find it useful in teaching activities; 16.2% in personalized learning	Cost reduction, gender equality, improved education	Limited resources, professional resistance	Positive impact on nursing, need for ethical training Less interaction and care with patients,	AI perceived positively, but research is needed to ensure ethical use
2	Wood, E., et al (2021)	30% of students and 50% of teachers are aware of AI; 36% of teachers and 18% of students have no basic	It will revolutionize medical practice and education. However, the potential	Lack of basic understanding of AI in teachers (36%) vs students	Students and teachers do not consider AI to be a	Interest in AI as a tool in healthcare; greater AI literacy needed

		understanding of AI. Students and teachers agree that AI will revolutionize medical practice and improve education	opportunities it offers are not specified.	(18%)	threat to their careers	
3	Sharma, V., et al (2023)	80.7% understand AI; 46.8% believe it should be part of the curriculum; 41% consider the impact of AI in medicine to be unpredictable.	Clinical diagnoses, protocol management	Lack of resources, over-reliance on AI,	Concerns about privacy, costs, accessibility and lack of empathy	Great interest in AI, teacher and curriculum training needed
4	Pallivathukal, R., et al (2024)	Positive attitude towards ChatGPT, concerns about accuracy and ethics	Improvement in academic tasks	Concerns about accuracy and dependencies, differences between races	Ethics on the use of AI in academic tasks (plagiarism, integrity)	Limited but positive knowledge about ChatGPT; research needed on risks.
5	Hashish, A. and Alnajjar, H. (2024)	Students perceive high usefulness, good impact and ease of use of digital technologies.	Integrating digital skills into university education, developing AI skills to improve clinical decision-making, and improving digital health literacy.	Disparities in digital skills in terms of the level of digital knowledge and skills, lack of specific training in AI, and resistance to change.	Concern about increasing digitalisation in patient care that may lead to dehumanisation of care. Questioning of data privacy and security. Inequitable access to technology.	Students have a generally positive attitude towards digital transformation and the use of AI in healthcare, but there is a lack of awareness of it and of digital skills.
6	Yalcinkaya, T. et al (2024)	83.2% of students have a positive attitude towards the integration of AI in the educational training of nursing students. 89.3% of participants want AI to be applied in the future curriculum of the nursing career.	Improving educational curricula, developing specific skills with AI and interdisciplinary collaboration with AI experts	Lack of awareness and training, resistance to change in healthcare and limited resources to implement AI education

Replacing human labor | Privacy and data management, and inequality in access | Students recognize the potential of AI implementation in healthcare, but there is a lack of preparation and adequate knowledge for its implementation. |
| 7 | Truong, N., et al (2023) | 77.9% of the surveyed students agree that AI can be beneficial for their careers, and 77.2% agree that this innovation will be used in public health and epidemic | Expanding AI training and its need in health sciences education, improving diagnostic accuracy and personalizing treatment. | Lack of knowledge about AI, inequality in implementation in different regions of the country, and fear of | Possible alterations to privacy and data management. Fear of dehumanization of care | In general, students have a positive attitude towards AI and recognize its potential, but there is a significant |

		prevention.		replacing human professionals, unequal access to technology	lack of knowledge and training in its use.
8	Buabbas, A., et al (2023)	99.1% agree that AI will play an important role in the healthcare system. 83.5% agree that the use of AI in their education will be beneficial. 82.1% agree with teaching the use of AI to healthcare students.	Inclusion of AI in the medical curriculum. Use of AI as a clinical support and diagnostic tool. Machine learning and medical simulations.	Lack of preparation and knowledge of AI by students. Insufficient educational infrastructure for the integration of AI. Resistance to its adoption due to fear of being replaced.	Dehumanization of the practice of medicine. Alteration of privacy and security of patient data. Alteration of the traditional role of the physician and his professional responsibility by delegating critical decisions to machines.	Participating students agree that the use of AI has positive potential for clinical practice. However, they mention a great lack of knowledge and preparation for integrating it into medical education.
9	Allam, A., et al (2024)	92.4% of students surveyed have not received formal training on AI. 87.1% show a low level of knowledge in this field. Despite this, 84.9% of students have a positive perception about the use of AI.	Key tool for automated diagnosis of pathologies.	Lack of information and formal knowledge about AI Concern about possible replacement of doctors, mainly radiologists	Maintaining human clinical judgment.	The value of AI in medicine is recognized, however there is a large gap in training and knowledge. The integration of AI into the medical curriculum is supported.
10	Jaber, M., et al (2024)	87.1% showed a low level of knowledge about AI, and 92.4% had not received formal training in AI; despite low knowledge, 84.9% of students believed that AI would revolutionize medicine and radiology.	Curricular integration. Improved diagnostic accuracy.	Lack of AI training. Concern about the replacement of doctors.	Medical liability, use of AI in a complementary manner	Insufficient knowledge and training in AI. Positive attitude towards AI, highlighting the need to incorporate it into formal education.
11	Blease, C., et al (2022)	66.5% report not having received any training on these topics during their careers, and 43.4% had never	Improvement in digital training and creation of interdisciplinary courses.	Lack of formal education and general lack of knowledge about digital	Patient privacy with the use of AI/ML; education on	Students have received little or no training on AI/ML throughout their

		heard of machine learning. 78.6% agreed that discussion of AI/ML should be included in their medical training.		tools.	algorithmic biases.	education, however there is interest in learning more about AI/ML, considering it as part of the curriculum.
12	Alkhaaldi, S., et al (2023)	Only 20.4% of students used Chat GPT to assist with written assessments and less than 10% used it in clinical settings. Positive attitudes are collected towards GPT and AI chat.	Using AI to enhance learning. Support in personalized education (GPT Chat).	Limited experience; ambiguity in using AI for clinical use (decision making)	Possible dehumanization of medicine; distrust in the doctor-patient relationship. Regulations on the use of AI and GPT Chat.	Optimistic perceptions were found about the future of Chat GPT and AI in medical education and healthcare. Development is required structured curricula, policies and formal guidelines on the use of AI.
13	Jebreen, K., et al (2024)	65.9% of students have the perception that AI has improved and benefited medicine, while 67.9% believe that it will become common in medicine, drive the future of medicine (67.0%) and revolutionize medical fields (68.7%). On the other hand, 74.2% believe that it will not completely or partially replace doctors.	70.2% believe that AI generates a cost-effective benefit and 68.8% believe that it optimizes medical services. However, they do not specify these benefits.	Lack of knowledge is the main problem that hinders the understanding of AI in medicine.	It mentions ethical problems, but does not specify them.	Many students do not receive formal education on AI, so they have difficulties in implementing it during medical training, which is why it is necessary to incorporate AI into medical training curricula.
14	Fitzek, S., & Choi, K. (2024)	Most students strongly agree that AI has the potential to revolutionize medical practice (mean 4.76), that its development (mean 4.64) will improve medicine (mean 4.74) and that it will become part of medical education (mean 4.17). However, a minority is afraid of the development of AI (1.76) and that it	The increase in the use of AI in diagnosis and treatment plans.	Need to develop basic training in the use of AI and the desire to integrate it into the study plans.	Dehumanizing potential of health care.	Medical education curricula must adapt to the digital age, where they must improve technological competence and provide reliable information on AI to foster more receptive attitudes

will possibly replace all doctors in
the future (mean 2.14).

towards AI in
healthcare.