TECHNOLOGICAL REVOLUTION IN BREAST CANCER DIAGNOSIS: BENEFITS OF ARTIFICIAL INTELLIGENCE IN IMAGE ANALYSIS

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ABSTRACT

Artificial Intelligence (AI) has revolutionized breast cancer imaging diagnosis, contributing to early and accurate detection of the disease. This study, conducted through an integrative literature review, aimed to understand the impact of AI on breast cancer imaging diagnosis. The review was carried out between February and March 2023, with searches conducted in the BVS, LILACS, and SciELO databases. The health descriptors used were:

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Physiotherapy, Facial Paralysis, Oral Health, and Neurology. A total of 46 articles were found, but only 8 comprised the final sample. AI-based tools, such as machine learning algorithms and neural networks, support radiologists by reducing diagnostic errors and optimizing analysis time. Despite advancements, challenges such as database quality, ethical issues, and integration into healthcare systems need to be addressed. With continuous investment and responsible use, AI can transform cancer care, promoting more effective and accessible diagnoses for patients.

Keywords: Breast Cancer, Women's Health, Radiology, and Artificial Intelligence.

INTRODUCTION

Cancer is a complex disease characterized by the uncontrolled proliferation of abnormal cells. Among the various types, breast cancer stands out as one of the most prevalent, defined by the formation of tumors with the potential for local invasion and metastatic spread to other organs (Trayes; Cokenakes, 2021). According to the National Cancer Institute (INCA) in Brazil, this neoplasm represents a significant challenge for the public health system, being the second most frequently diagnosed type of cancer, surpassed only by non-melanoma skin cancer. This reality underscores the urgency of implementing effective strategies for early detection and proper management of the disease (INCA, 2023).

As noted by Atty and Tomazelli (2018), cancer has become a public health issue requiring increasingly comprehensive policies aimed at improving the quality of life of cancer patients. These policies should prioritize promotion, prevention, early detection, and timely treatment, considering the risk factors associated with the development of certain types of cancer. Additionally, breast cancer stands out as one of the leading causes of mortality among women, especially in cases diagnosed late or when there is a delay of more than three months between the onset of symptoms and the start of treatment (Ramirez; Martins, 2023).

The intersection of technology and healthcare has driven significant advancements, particularly through the incorporation of AI in radiology. The development of computational systems has enabled innovative solutions that not only simplify routine tasks but also enhance the accuracy and efficiency of medical diagnoses. AI, in particular, stands out as an essential element in this context, enabling the analysis of radiological images with levels of precision that often surpass human capabilities. This progress becomes even more relevant given the exponential growth in the volume of imaging exams, which increases the workload of radiologists and highlights the need for tools to assist in the interpretation of complex data (Costa et al., 2024).

Despite significant advancements, AI still faces relevant challenges. Transparency and accountability in the use of AI systems have become growing concerns, requiring the implementation of clear regulatory policies to mitigate potential risks. The future of AI points to profound societal transformations, with advancements in areas such as interpretable AI, which seeks to make systems more understandable to humans, and decentralized AI, which promotes the distribution of computational power to local devices. Furthermore, the

integration of AI with other emerging technologies, such as quantum computing and the Internet of Things (IoT), opens the door to disruptive innovations in various spheres of human life. These interactions have the potential to contribute to the development of emotional intelligence, enhance social skills, and promote paradigm shifts, especially in the educational field (Barros, 2024).

This study, conducted through an integrative literature review, sought to understand the impact of AI on breast cancer imaging diagnosis.

METHODOLOGY

This research was conducted through an integrative literature review with an exploratory approach, aiming to investigate, based on previously published articles, relevant information capable of answering the guiding question. To support the development of this study, the methodology proposed by Mendes, Silveira, and Galvão (2008) was adopted, following these sequential steps: 1) definition of the topic and formulation of the research question; 2) establishment of inclusion and exclusion criteria; 3) extraction and systematization of information from selected studies; 4) analysis of the included studies; 5) interpretation of the results; and 6) presentation of the synthesized knowledge.

The guiding question defined was: What are the implications of diabetes in oral surgeries?

The integrative literature review facilitates the consolidation of knowledge by grouping different ideas on the same topic and implementing the results obtained. It is a fundamental approach for evidence-based practice, as it clearly defines the problem, uses critical analysis to search for research in the field, and identifies the application of the findings. This review method is more comprehensive, as it can incorporate both experimental and non-experimental studies, making the analyses more complete and robust (Souza; Silva; Carvalho, 2010).

Searches were conducted in the Latin American and Caribbean Health Sciences Literature (LILACS) and Scientific Electronic Library Online (SCIELO) databases, using Health Sciences Descriptors (DeCS) with the Boolean operator AND. The terms used for the search were: Breast Cancer, Women's Health, Radiology, and Artificial Intelligence.

To ensure the eligibility of the results, the selected articles followed these inclusion criteria: free and full availability, Portuguese language, publication within the last three

years, and relevance to the proposed objective. The exclusion criteria were: incomplete articles, duplicates in more than one database, and abstracts.

RESULTS AND DISCUSSION

The analysis of the selected studies, they were organized in Table 1, including relevant information for better reader comprehension. The structure includes data such as study title, author, year of publication, and objectives.

Table 1 – Sample of Selected Studies

N	TITLES	AUTHOR	YEAR	JOURNAL	OBJECTIVE
1	FROM MACHINE TO EMOTION: PERCEPTIONS OF AI IN DEVELOPING EMOTIONAL INTELLIGENCE IN EDUCATIONAL ENVIRONMENTS	Barros et al	2024	Revista Tópicos	This article analyzes the potential of AI to contribute to the development of emotional competencies, as well as the challenges and opportunities emerging from this intersection between technology and education.
2	AI IN CLINICAL DECISION-MAKING: IMPACTS, ETHICS, AND EFFICIENCY	Dantas et al	2024	Comprehensive Healthcare: Challenges and Vulnerabilities	This study explores how the integration of AI in the clinical setting can impact healthcare efficiency and address disparities among different populations, age groups, and socioeconomic strata.
3	THE ROLE OF PHYSIOTHERAPY IN BREAST CANCER TREATMENT	Mota; Raimundo	2024	JRG Journal of Academic Studies	Through a literature review, this study highlights physiotherapy as an essential pillar in multidisciplinary cancer care, from early detection to palliative support.
4	THE IMPACT OF AI IN RADIOLOGY: ADVANCES IN DIAGNOSTIC EFFICIENCY AND TREATMENT PERSONALIZATION	Da Silva et al	2024	Ibero-American Journal of Humanities, Sciences, and Education	To understand the applications of AI in radiology, analyzing potential impacts and contributions, enabling the integration of the tool as an ally in various health fields.
5	AI IN RADIOLOGY	Ibero-American Journal of Humanities, Sciences, and Education	2024	Ibero-American Journal of Humanities, Sciences, and Education	To understand the importance of this technology in radiology through a systematic review of scientific literature.
6	USE OF AI TOOLS IN IMAGING DIAGNOSIS	Gonçalves et al	2024	Research, Society, and Development	To investigate how the implementation of AI technologies can impact

					the accuracy and reduction of imaging diagnosis time, as well as evaluate treatment efficacy.
7	INTEGRATING AI INTO MAMMOGRAPHY: A COMPLEMENTARY APPROACH TO BREAST CANCER DIAGNOSIS	Guerreiro et al	2024	Ibero-American Journal of Humanities, Sciences, and Education	To review the use of AI as an essential complement to mammography, exploring its applications, benefits, and challenges in clinical practice.
8	THE ROLE OF NURSES IN BREAST CANCER PREVENTION - LITERATURE REVIEW	Ramirez; Martins	2024	Archives of Health Sciences, UNIPAR	To demonstrate the importance of nurses in breast cancer prevention, sensitization, and awareness among women.

Source: Authors (2024)

Breast cancer, according to INCA 2023, is a complex disease with significant incidence and mortality rates both in Brazil and globally. It results from the disordered multiplication of abnormal cells in the breast, which can invade other organs and present varying development rates. It is important to note, as stated in the document, that "most cases respond well to treatment, especially when diagnosed and treated early," emphasizing the importance of early detection and proper management of the disease (Mota; Raimundo, 2024).

According to the Ministry of Health, the gold standard for breast cancer screening is mammography, recommended every two years for women aged 50 to 69. Breast self-examination, widely recommended in the past, has not proven effective for early tumor detection and may generate false reassurance, doubts, and excessive invasive exams. Therefore, it should not be encouraged as a method of lesion recognition. However, women should be aware of their bodies, and healthcare professionals should consider the complaints presented by patients (Brasil, 2016).

The use of AI in mammography offers several advantages. Studies by Sun et al. (2022) and Yom & Kim (2021) demonstrate that deep learning systems can significantly improve the early detection of structural changes and microcalcifications in mammograms, many of which might otherwise be overlooked. Additionally, Taylor et al. (2023) state in their research that, when used appropriately and in conjunction with clinical evaluation, AI can increase diagnostic accuracy, improving sensitivity and contributing to better clinical outcomes in breast cancer treatment (Guerreiro et al., 2024).

Zhang et al. (2023) compared traditional diagnostic methods with AI-assisted techniques, considering time and accuracy. The experimental data indicated that the average time required for traditional diagnosis was 3.623 minutes, with an accuracy rate of 83.72%. In contrast, the AI-assisted method had an average time of 0.744 minutes and an accuracy rate of 97.73%, demonstrating a clear advantage in terms of speed and precision. However, the study also highlighted that, despite the high diagnostic sensitivity of AI, false positives still occur. For example, the system identified 132 cases of lung lobe infection, while the second round of diagnosis confirmed 129 real cases. Such errors can cause patient anxiety and impact subsequent treatment plans (Gonçalves et al., 2024).

The implementation of AI in clinical decision-making highlights a significant duality between efficiency and ethical complexity. These systems, integrating advanced algorithms and machine learning, offer healthcare professionals tools that can predict treatment outcomes and disease progression with high precision, optimizing clinical decisions and resource management. However, the growing reliance on automated systems raises profound ethical questions, particularly regarding transparency, patient consent, and the potential for bias in AI algorithms. Additionally, while the operational effectiveness of these technologies is undeniable, their ability to adapt to individual patient characteristics remains a concern. Therefore, the development of AI in medicine must be accompanied by rigorous ethical guidelines and continuous evaluation of its impact on the doctor-patient relationship, ensuring that humanization of care remains a priority in medical practice (Dantas et al., 2024).

Through AI, healthcare professionals can perform a variety of functions related to radiological techniques, including the acquisition of medical images and the application of ionizing radiation in treatments such as radiotherapy and nuclear medicine. AI can also be used in imaging procedures across different fields, such as industrial radiology, magnetic resonance imaging, and veterinary radiology. Furthermore, the technology can be employed in monitoring, quantifying, and optimizing the production of radiological waste, as well as supervising radiographic techniques. AI facilitates the coordination of teams in diagnostic imaging services and supports the development, implementation, management, and supervision of quality control and radiation protection programs. It also enables the performance of quality control tests in imaging services and the issuance of technical opinions in radiology (MEC, 2016).

With the advancement of AI, radiology professionals face the challenge of adapting and incorporating these technologies into their daily practice. AI offers the ability to perform a wide range of tasks, from acquiring medical images to applying ionizing radiation in radiotherapy and nuclear medicine treatments. Additionally, radiologists must be trained to use AI-based protocols for conducting exams in various specialties, including industrial and veterinary radiology. The supervision of radiographic techniques, as well as the management of quality control and radiation protection programs, are also areas where AI can be applied to optimize processes and ensure procedural safety. Thus, continuous training of radiology professionals becomes essential for the effective use of AI, transforming clinical practice and promoting better patient outcomes (Costa et al., 2024).

CONCLUSION

The application of artificial intelligence in breast cancer imaging diagnosis represents a milestone in the development of diagnostic medicine, promoting precision, speed, and efficiency in the early detection of the disease. It has been demonstrated that AI-based tools improve diagnostic accuracy, reduce false positives and negatives, and optimize healthcare professionals' time.

However, significant challenges remain, including the need for more comprehensive and diverse databases, the ethical and secure integration of technology into healthcare systems, and the training of professionals to use these tools effectively.

With continuous advancements and interdisciplinary collaboration, AI has the potential to transform cancer care, not only improving clinical outcomes but also promoting a more personalized and human approach to patient care. Therefore, investments in research, regulation, and technological infrastructure are essential to ensure that this innovation benefits everyone equitably.

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