THE USE OF ARTIFICIAL INTELLIGENCE AS A TRAINING MECHANISM IN MEDICAL EDUCATION IN REMOTE AREAS OF GOIÁS: A PERSPECTIVE OF SOCIAL DEVELOPMENT

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ABSTRACT

The growing demand for skilled healthcare professionals in remote areas presents significant challenges, particularly in the training of doctors. The use of Artificial Intelligence (AI) is able to offer an innovative solution to overcome access barriers and improve professional training in isolated regions, such as remote areas of Goiás. This article sought to explore the application of AI-based tools in medical education, highlighting the benefits, challenges, and implications of this approach. The research uses a quantitative/qualitative methodology, including a literature review based on case studies to highlight the effectiveness and opportunities for integrating AI in the training of health professionals. The results indicate that AI can provide realistic simulations, instant feedback, and expanded accessibility, contributing to more robust and efficient training.

Keywords: Artificial Intelligence. Technology. Medical training.

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INTRODUCTION

The training of health professionals in remote areas faces significant challenges that compromise the effectiveness of training programs and, consequently, the quality of care offered to the population. These difficulties are particularly pronounced in regions such as Goiás, a Brazilian state that, despite its vast territorial extension, has one of the lowest population densities in the country (Oliveira *et al.*, 2017). Within this scenario, the State of Goiás has areas very far from its capital, such as the city of Cavalcante, where it is possible to verify the complexity of the obstacles faced in the training of health professionals (Takahashi and Alves, 2015). The scarcity of educational resources and the difficulty of access to specialized training centers are pressing issues, and professionals in training do not have access to adequate infrastructure, such as well-equipped laboratories and clinical simulation centers. The long distances to urban centers and the precariousness of transport routes aggravate the situation, making commuting an additional barrier, and this reality not only limits the training of new professionals, but also perpetuates a cycle of lack of qualification and deficiency in medical care (Van Stralen *et al.*, 2016).

In this context, Artificial Intelligence (AI) emerges as an innovative and promising solution to face these difficulties as pointed out by Aruda (2024). With the ability to create interactive simulations and provide real-time feedback, AI can overcome many of the physical and logistical limitations faced in remote areas. The training of doctors allows professionals or interested people in the community to acquire direct or indirect, theoretical or practical experience and advanced knowledge without the need to constantly travel to specialized centers (Nascimento & Gasparello, 2023). The application of AI in professional training offers the possibility of developing virtualized learning environments, which reproduce clinical scenarios and emergency situations, providing an essential practical experience for training. In addition, AI can provide detailed analysis of student performance, adjusting content and complexity according to individual needs, which is crucial for personalized and effective training.

Therefore, exploring and implementing AI technologies in remote areas of Goiás represents a significant opportunity to overcome the traditional challenges of training health professionals. This approach can expand access to quality training and also improve the preparation of professionals to deal with the specificities and demands of health services in rural and isolated regions. Thus, this article aimed to examine how AI can be effectively integrated in remote areas, highlighting its potential and implications for medical education in the State of Goiás and regional development.

METHODOLOGY

This is a descriptive and exploratory study with a quantitative/qualitative approach, which according to (Hedler, Moresi and Vieira, 2022), the study in question sought to research the use of AI in medical training in remote areas of Goiás. The methodology was divided into 3 stages: in the first stage, the most relevant articles for this research were selected, the second stage was an analysis of places with a shortage of health professionals, in which we sought to analyze the aspects that influence this situation; and in the third and final stage, the region to be studied and what would be the potential for the use of AI in medical training was defined.

This article proposed through this approach, to explore information in databases on specialized websites, academic studies and scientific papers, using the following steps: research design; data collection and compilation; bibliometric analysis, and a qualitative analysis. This approach allowed us to explore the indicators available in the Lens.org and google scholar databases, in order to support a critical analysis of the panoramas found.

The first stage of the research is the design of what is intended. Thus, it is necessary to define the guiding question and choose an appropriate bibliometric method to answer it (Hedler, Moresi, and Vieira, 2022). The metadata in the Lens database was explored, in the search for academic works with the initial text "The use of artificial intelligence", which returned 985 documents, as the number of journals was quite vast, another filter was carried out using the connector "and" with the term "artificial intelligence in remote areas", which returned 12 articles and finally, with the same connector "and" and the term: "medical training and artificial intelligence", and 7 scientific papers were selected. I emphasize that for each search filter, as shown in table 1, the most relevant and current articles were selected for the periods from 2014 to 2024, according to the author's criterion regarding the construction of this work and its possibility of application in the final objective.

Table 1: Literature search (Base Lens)

Search Keywords	Connectors	No. of citations
"The use of artificial intelligence"	and	985
"Artificial intelligence in remote areas"	and	12
"Medical training and artificial intelligence"	and	7

Source: The Authors

In the Google Scholar database, the theme "the use of artificial intelligence" was demanded, which returned 4,940 documents, then the search was delimited with the connector "and" the theme: "the use of artificial intelligence in remote areas" which returned 21 scientific articles, in an attempt to further delimit the search, the connector "and" was

used with the theme: "the use of artificial intelligence in medical training" which returned 8 papers and finally, the connector "and" was kept and the term "the use of AI in medical training" was used which returned 4 journals. Thus, the author selected, according to table 2, the most current and relevant articles, according to the relevance of what is intended.

Table 2: Literature search (Google Scholar)

	Search Keywords	Connectors	No. of citations
1	"The use of artificial intelligence"	and	4.940
2	"The use of artificial intelligence in remote areas"	and	21
3	"The use of artificial intelligence in medical training"	and	8
4	"the use of AI in medical training"	and	5

Source: The Authors

In the research on the "use of AI in medical training" were 5 articles from the year 2024 were selected, which were published in journals such as Revista USP, from the University of São Paulo, with the article "Artificial intelligence in health", by the authors Amaro. And; Nakaya, H and Rizzo, L (2024), authors with several studies in the area of *Big Data*, AI and immunology, and *Electronic Journal Collection Health*, with the article "The use of artificial intelligence in medicine: the benefits and challenges of the human-technology partnership in health" by the authors Gomes, S; Montanini, J and Sobrinho, M (2024).

Franco (2024) in his article on "Artificial intelligence in medicine: advances and challenges", published by the Multidisciplinary Journal of the Northeast of Minas Gerais, highlights the importance of AI in medical transformations, presenting its fundamentals, historical evolution, and learning from machines and neural networks. Ogata & Bosba (2024) in the article "The use of artificial intelligence systems for the personalization of the patient experience: the perception of technology and innovation managers of hospitals associated with ANAHP" published by Original Article, highlight the perception of managers in the areas of technology and innovation of Brazilian private hospitals about the use of artificial intelligence in health.

RESULTS AND DISCUSSION

THE ORIGIN OF ARTIFICIAL INTELLIGENCE (AI) AND ITS USE IN MEDICINE

For Spadini (2023, apud FRANCO, 2024, p.5), AI refers to the ability of an organizational system or machine to mimic human intelligence to perform tasks that would normally require human intervention. For the same author, among the various definitions for AI, Artificial Intelligence is the field of computer science that focuses on the development of computer systems and programs that normally require human intelligence,

such as visual perception, natural language processing, learning, reasoning, problem-solving, and decision-making.

According to Morais (2020, apud GOMES, MONTANINI and SOBRINHO, 2024, p.2), John McCarthy was the first to use this term, in 1956, during the Dartmouth Conference. Thus, today it is possible to perceive a transformation of AI that was initially described as "the science and engineering of creating intelligent machines, allowing a technological evolution, with the development of machines, tools, software, and applications that have revolutionized several areas of human existence, such as medicine (KAUL V, et al., 2020).

However, Gomes, Montanini, and Sobrinho (2024) argue that, despite the existing benefits of AI in medicine, such as the speed of diagnoses, the compilation of medical records, telematics, and remote training, a study conducted with patients from hospitals in Michigan, New York, and Miami in the United States found an inefficient applicability of some AI tools in medicine, such as Raman historiology and deep convolutional neural networks in the diagnosis of tumors in comparison with traditional pathologists.

Despite this, Borba and Ogata (2024), in a study carried out with technology and innovation managers from the National Association of Private Hospitals – ANAHP, found that there is a certain acceptance of this public regarding the use of AI in public health and that of the 122 associated hospitals, 30 returned the questionnaires in full, that is, 25%. Among the knowledge acquired about the types of artificial intelligence platforms in the health area, the use of health chatbots prevailed with 76%, demonstrating that dialogue-based approaches are more common in health, possibly with tips and answers to frequently asked questions and in use for training, as shown in Table 3.

Table 3: Knowledge about the types of artificial intelligence platforms in healthcare

Plata **Artificial intelligence platforms**	**No. of replies**	**% of responses**
Health Chatboots	23	76,67%
Medical Data Analysis	21	70,00%
Virtual assistance	14	46,67%
Computer-Aided Diagnostics	12	40,00%
Remote monitoring	6	23,33%
Treatment Personalization	7	20,00%

Source: Borba and Ogata (2024)

Among the existing concerns, despite the benefits of integrating AI with medicine are the possible loss of jobs due to automation, data privacy issues, misuse of autonomous systems, and the fear that AI may become uncontrollable, due to its superintelligence, in addition to ethical issues and regulatory policies are essential for maximizing and mitigating risks FILHO (2024). Despite the existing fears, since the 1st

Industrial Revolution it is natural that the work process evolves with adaptations to new technologies.

NEED FOR MEDICAL TRAINING AND ITS CHALLENGES IN REMOTE AREAS

Vocational training in remote areas faces significant challenges that directly impact the quality and effectiveness of training in these regions in Goiás. First, geographical distance and the scarcity of educational infrastructure limit access to courses and specializations, resulting in inadequate training for potential professionals (Van Stralen, 2016). For Olímpio (2015), in isolated regions, the lack of training centers and the difficulty of travel make access to academic resources and clinical practices extremely difficult. In addition, the lack of advanced technology and high-quality internet exacerbates the problem, preventing the implementation of digital and *e-learning* solutions that could help mitigate physical barriers.

The low attractiveness of these areas for instructors and specialists also contributes to the lack of local qualification, perpetuating a cycle of deficiency in training (Bauer, Cassettari and Oliveira, 2017). The absence of support networks and continuous updates in the professional field also represents an obstacle, since medical and paramedical knowledge is constantly evolving. Thus, it is essential to develop innovative strategies and adaptable technologies to overcome these limitations and ensure that the training of professionals in remote areas is robust and effective, such as the use of satellite internet, promoting quality service for local communities.

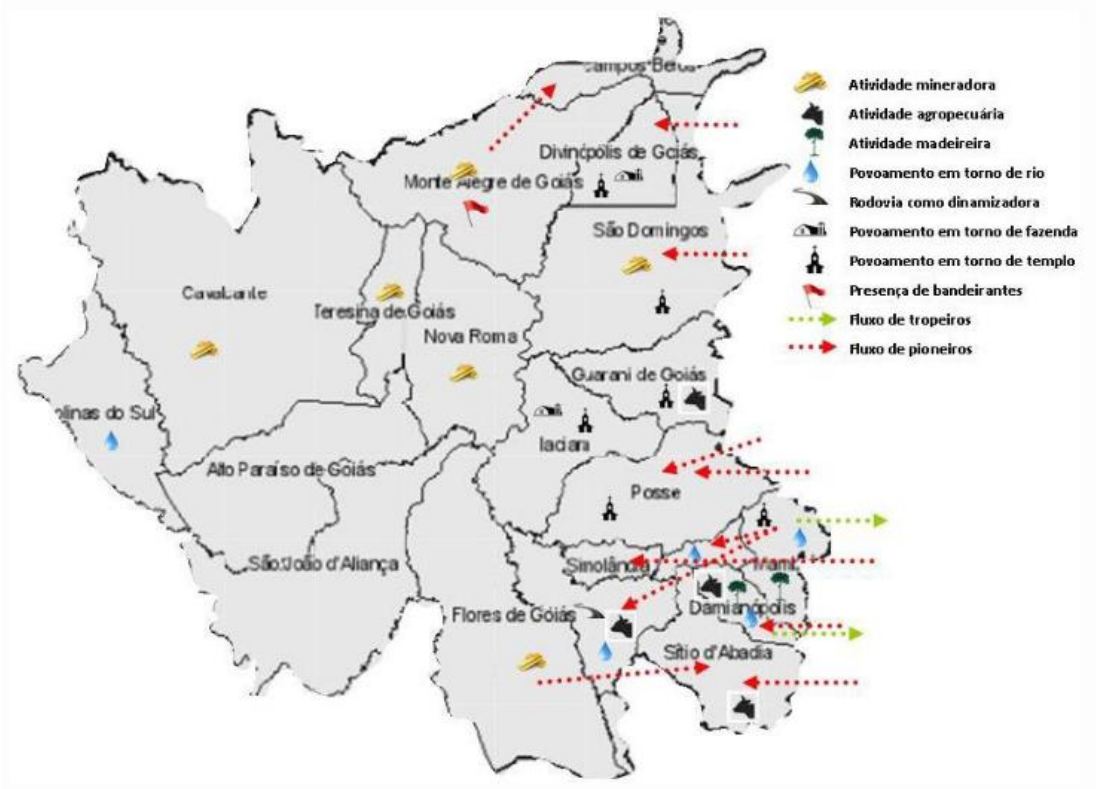
The shortage or low distribution of doctors in an equal way in the various geographic regions of Goiás would be almost impossible, since not all cities have the financial and structural conditions to maintain these professionals. Having the ability to assess the needs of physicians to attract these professionals to work in remote areas is not an easy task. In the study published by EPSM, in December 2012, there was an index of shortage of doctors in more than 1,304 Brazilian municipalities (EPSM, 2012 apud Van Stralen, 2016).

According to academic studies, it is possible to verify a lack of public policies and integration of education and health practices in remote regions with low population density, as in the case of the city in the northeast of the state such as Cavalcante (Takahashi and Alves, 2015). In a study carried out by (Silva, 2014) on the origin and factors of the urban evolution of the northeast of Goiás, it was found that since its occupation, this region has not developed as much as the southern region, southern region of Goiás, due to the first exploratory penetrations that took place from São Paulo and naturally made the first occupied regions develop rapidly, as shown in Figure 1.

It is important to emphasize that it is not enough to have AI models, even in places of better development, as is the case of Goiânia, which is the capital of the state, according to (Amaro, Nakaya and Rizzo, 2024) AI, in addition to depending on the quantity and quality of data, also lacks training for a better interpretation of the data so that, according to the authors, the so-called "artificial stupidity" is avoided.

Thus, even in remote areas there is a need for health professionals, experimental scientists, and AI experts to work together for research and training in the health area, as Johns Hopkins University announced in 2023 with the creation of a new department in AI.

Figure 1: Historical synthesis of the municipalities of northeastern Goiás



Source: Brazil, 2013a. Prepared by Silva (2014)

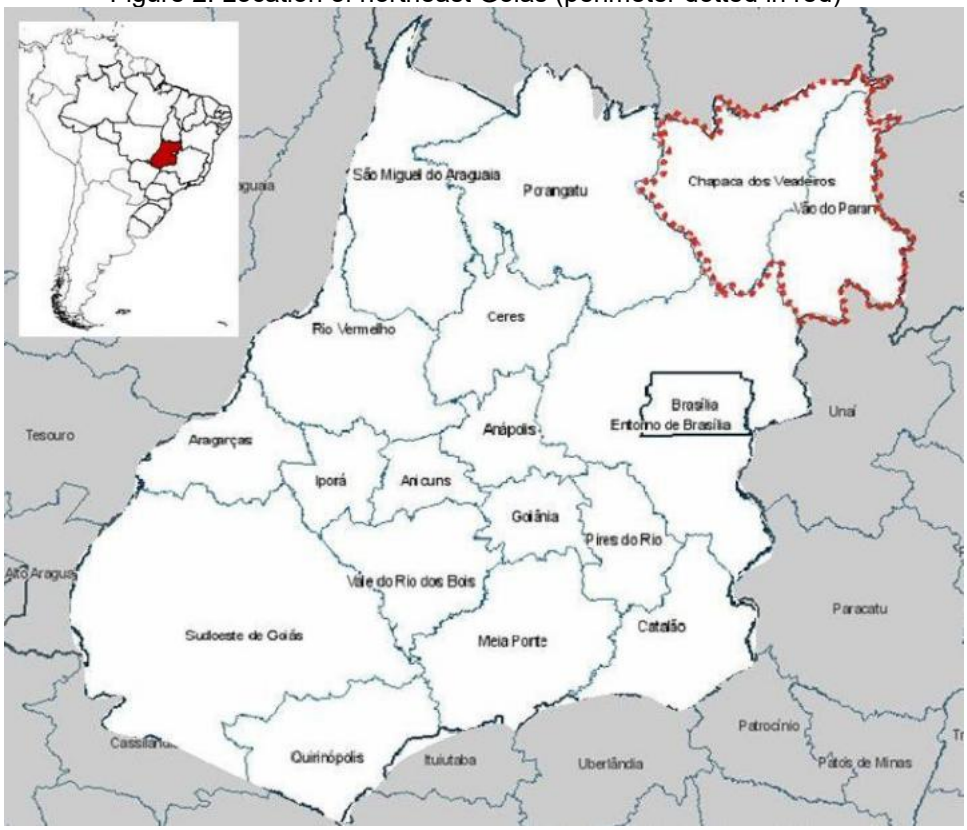
And due to the lack of basic structures, it is possible to infer that it directly affects regional development, since it hinders access to quality services.

REMOTE AREAS OF GOIÁS

The State of Goiás, located in the Midwest region of Brazil, is one of the most extensive states in the country, covering approximately 340,000 km², with 246 municipalities and the state of Goiás is notoriously diverse in terms of geography and population density, presenting a combination of urban areas and extensive rural regions. Many of these rural areas are located in remote and isolated regions, from rural regions in cities neighboring Goiânia to more distant municipalities in the north or northeast of the

state, where population density is low and infrastructure is limited, as shown in figure 2 (Silva, 2014). One of the main difficulties faced by the state is access to high-quality internet in these areas, which negatively impacts access to educational resources and health services. Telecommunications infrastructure often does not keep pace with the development of digital technologies, resulting in poor connectivity and low internet speed, which restricts the implementation of advanced technological solutions, such as *e-learning* and telemedicine platforms, which could immensely benefit local communities and improve the quality of services provided in remote regions. Thus, geographical distance and lack of infrastructure limit the ability of health professionals in training to access educational resources and face-to-face training.

Figure 2: Location of northeast Goiás (perimeter dotted in red)



Source: BRASIL, 2013b.

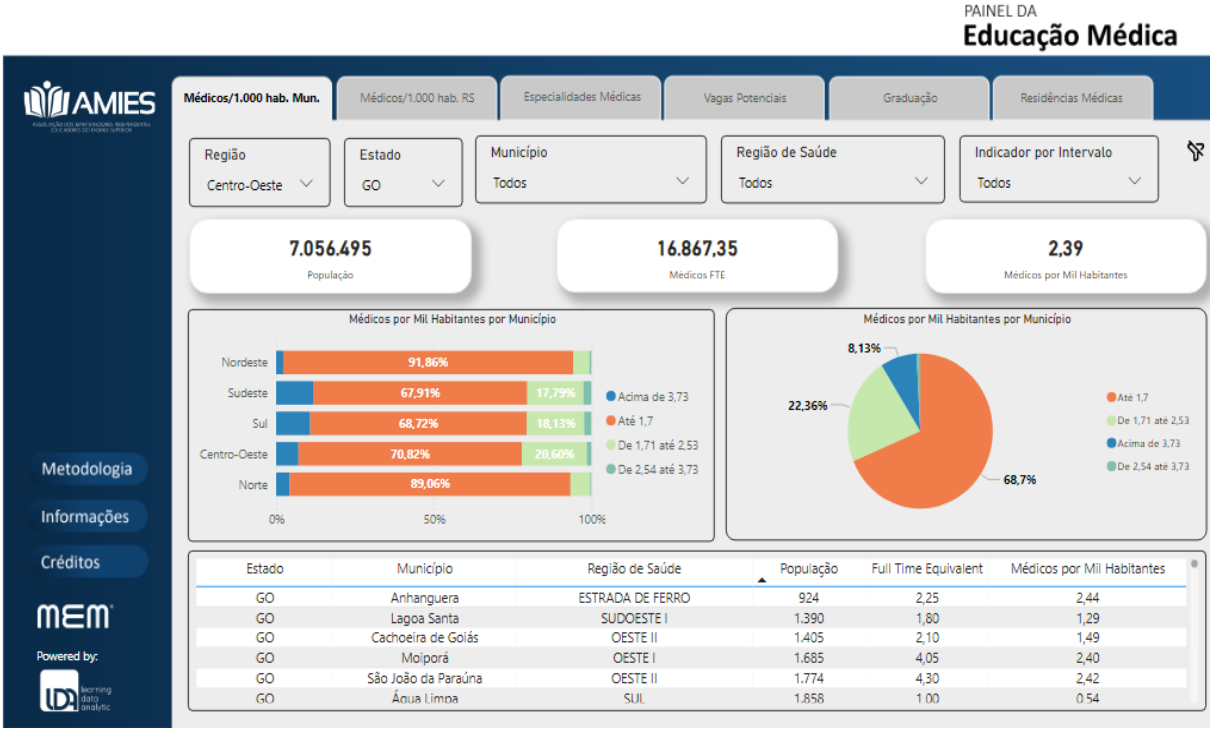
DEFICIENCY IN THE NUMBER OF PROFESSIONALS

The lack of qualified doctors in remote regions of the state of Goiás compromises quality care for the local population (Scheffer, Almeida, Cassenote, 2023). In the survey carried out by the IBGE, in 2023, according to the "Medical Demography in Brazil" Radar, the country has 2.4 doctors per thousand inhabitants, behind countries such as Spain with about 4.5 doctors per thousand inhabitants, the United States with 2.6 and Australia with 3.8. These data suggest that there are indications of a possible shortage of physicians in

Brazil, which allows existing professionals to have more freedom to choose their workplace due to the high demand for their services and the lack of sufficient professionals. This situation can lead to a concentration of physicians in more urban areas or more economically developed regions that offer other attractions such as leisure and services for physicians and their families (Girardi *et al.,* apud Van Stralen *et al*., 2015).

The geographic distribution of physicians in the state of Goiás, as in many other regions of Brazil, is more concentrated in urban areas, especially in the capital, Goiânia, and in larger cities, to the detriment of rural areas and smaller cities, as shown in Table 4. Medium-sized cities, such as Anápolis, Rio Verde and Aparecida de Goiânia, also have a significant number of doctors, but still in a smaller proportion compared to the capital. Inland regions and rural areas, especially those farther from large urban centers, face a shortage of doctors, since many professionals prefer to work in places with greater infrastructure and better working conditions (Scheffer, Almeida, Cassenote, 2023).

Table 4: Medical Education Panel – physicians/1,000 inhabitants. Mun (Goiás)



Source: Medical Education Panel.

Although incentive programs such as "More Doctors" created in October 2013, under the government of Dilma Rousseff, had the objectives of guaranteeing access to doctors in needy regions; the strengthening of primary health care; investment in medical training and the improvement of the infrastructure of basic health units (UBS) (BRASIL, 2014) and other initiatives to internalize health have been implemented to reduce the

inequality in the distribution of doctors in the State of Goiás, a definitive solution has not yet been achieved.

The shortage of doctors is not a problem exclusive to Brazil. Canada, for example, implemented the Underserved Area Program (UAP), a program aimed at the redistribution of health professionals, with the aim of alleviating the concentration in large urban centers. Van Stralen, (2015) Government policy thus seeks to direct doctors to regions with greater need, promoting a balance in the supply of health services. The North American government, on the other hand, has the Health Professional Shortage Area (HPSA) program with the objective of allocating professionals and programs aimed at improving medical care in places that lack hospital care (Gao, 2006). And, in Brazil, the government has developed policies and programs similar to these countries in terms of a better geographical distribution of health professionals, such as the Program for the Interiorization of Health Actions (PIASS) and the implementation of rural boarding schools in undergraduate courses in the health area (Maciel Filho, 2007; Girardi et al., 2011).

In a study carried out by the Labor Market Signals Research Station (EPSM, 2012), 1,304 Brazilian municipalities with a shortage of doctors were identified and, based on this study, the municipalities that make up the so-called "scarcity route" in the five regions of the country were listed. The North and Northeast regions had a greater number of routes due to their greater territorial extension and consequently greater difficulty in locomotion, regardless of the type of vehicle used (water, air or land), so 10 routes were identified in 36 municipalities. It is important to note that within this survey, the state of Goiás stands out as one of the federation units that has a shortage of doctors as shown in table 5.

Table 5: Number of routes, municipalities and interviews of the scarcity routes by geographic region.

Region	No. of Routes	UF	No. of Municipalities	Number of Physicians interviewed
North	3	Amazonas (AM), Pará (PA), Rondônia (RO)	10	13
Northeast	3	Bahia (BA), Ceará (CE), Maranhão (MA), Pernambuco (PE), Piauí (PI)	12	17
Southeast	1	Minas Gerais (MG) (Jequitinhonha Valley)	3	3
South	1	Rio Grande do Sul (RS), Santa Catarina (SC)	5	5
Midwest	2	Mato Grosso (MT), Mato Grosso do Sul (MS), Goiás (GO)	6	13
Total	**10**	**14**	**36**	**51**

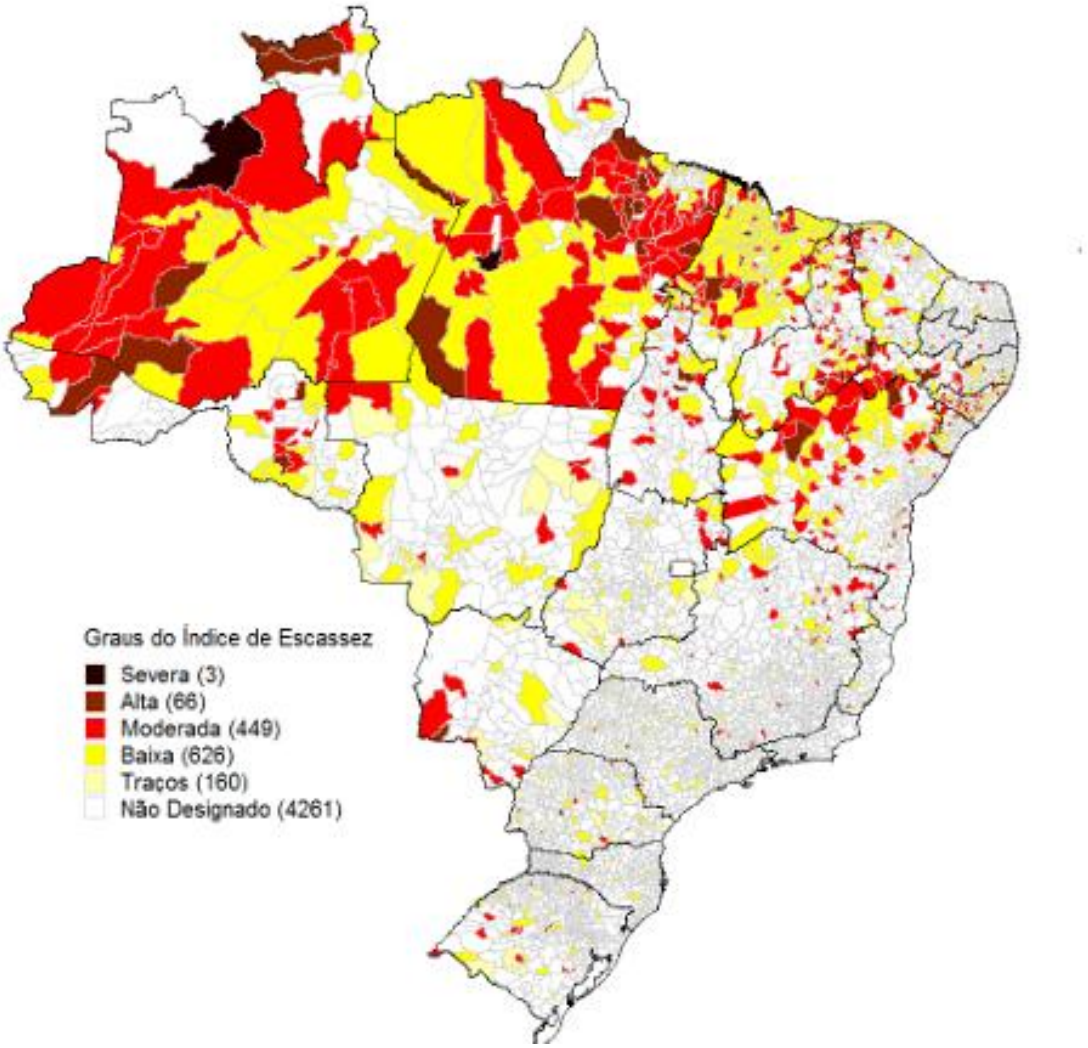
Source: EPSM/NESCON/FM/UFMG, 2015.

According to the survey "Construction of the Shortage Index of Health Professionals to Support the National Policy for the Promotion of Health Care Security:

In total, 1,280 municipalities were designated based on the above criteria and these had the shortage index of doctors calculated. To this end, the three indicators were classified, each gradually, from 0 to 5 according to the intensity of the occurrence of the event, as described in Table 2. The sum from the scores in each of the indicators is the value of the index, which varies from 0 to 15. The closer to one, the lower the degree of scarcity, the closer to 15, the higher. Thus, the values were divided into five categories, each combining three degrees of the index, identifying the municipalities according to scarcity, low, moderate, high and severe traits.

Based on the study in question, it is possible to verify, as shown in figure 3, that the State of Goiás has a shortage of moderate-grade physicians in its northeast region, indicating a greater need for these professionals in these places.

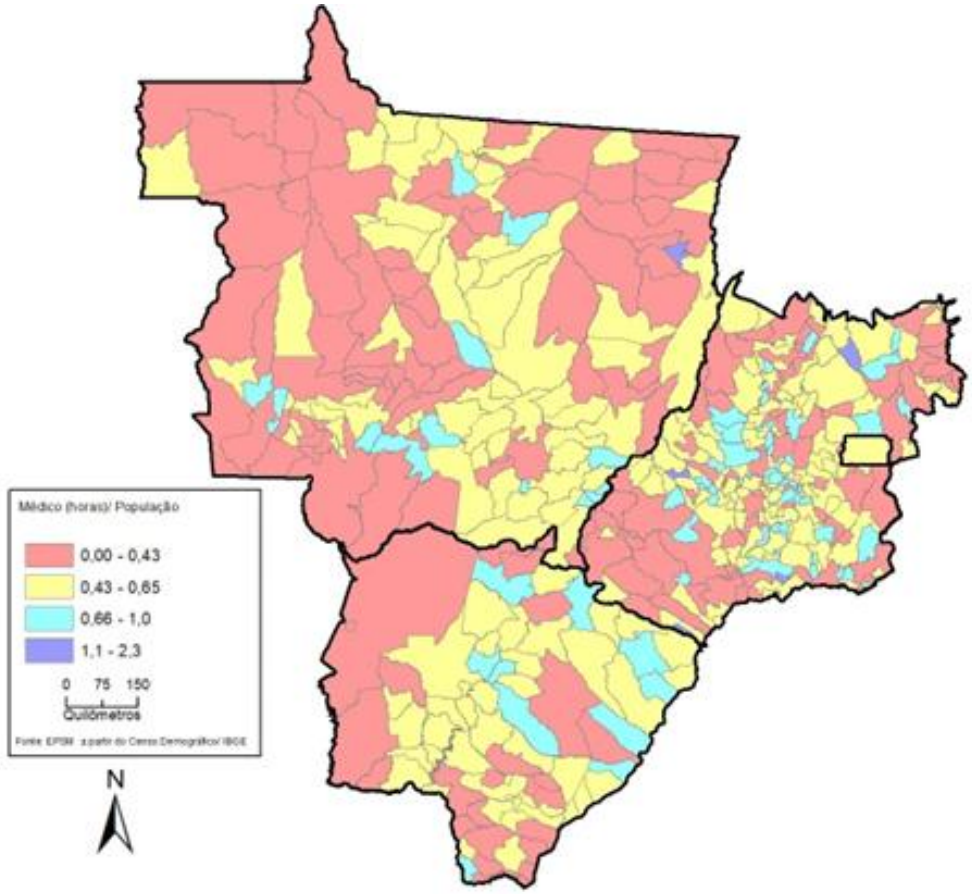
Figure 3: Map of the shortage of physicians in primary care – Brazil, December 2010.



Source: Human Resources Observatory Market Signals Research Station (EPSM/NESCON/FM/UFMG) from the National Registry of Health Establishments of the Ministry of Health (CNES/MS), Ministry of Social Development and Fight against Hunger (MDS) and National System of Live Births (SINASC).

In the regional analysis, it can be seen that the State of Goiás has, in remote areas, a distribution of primary care physicians of 0.00 – 0.43 for every 1,000 inhabitants, a small value as shown in figure 4.

Figure 4: Map of the municipal distribution of primary care physicians per 1,000 inhabitants – Midwest, December 2010.



Source: EPSM/NESCON/FM/UFMG, 2015.

The research carried out by Van Atralen *et al*., (2015), demonstrated that among the factors that influence the low density of physicians, especially in Goiás, are remuneration, employment relationship, working conditions, professional factors, local factors, and personal factors. Knowing how to combine different incentives, financial and non-financial, for a better regional distribution is not an easy task. Thus, having a policy that encompasses a good part of these variables would already be a way to encourage health professionals to work in these places.

The World Health Organization (WHO) recommends that to improve the retention of physicians in rural areas, a combination of sustainable financial incentives such as housing, food and transportation assistance is needed (Who, 2010). Because these motivational factors can contribute to the choice of places further away from urban centers.

The choice of physician to work in a given region is dependent on motivational factors such as training/updating and graduate studies through specialization courses and medical residency (ESM, 2012). Since they may have more time to train, since in urban centers the flow of care is greater and there is greater competition in these trainings.

Given this scenario, a possibility of distance training with the use of AI is based on this article as a way to mitigate the problems arising from a shortage of health professionals or even give a possibility to encourage managers to better distribute doctors in remote locations.

MEDICAL TRAINING PROTOCOLS

The Federal Council of Medicine – CFM, recommends that the doctor seek, according to training protocols, to update himself continuously. On the page, the CFM, in a generic way, suggests training protocols and it is possible to notice that both for doctors or paramedics there are the so-called refresher courses or continuing education that must be observed.

Traditional Medical Teaching Protocols

- Undergraduate Medical Curriculum: Includes theoretical classes, clinical practices, hospital internships, and simulation activities. The goal is to provide a solid foundation in basic sciences, clinical skills, and medical ethics.
- Medical Residency: Specialized training in a specific area of medicine, with variable duration. It involves intensive training in clinical and research settings.

Clinical Simulation Protocols

- High-Fidelity Simulators: Use of manikins and simulators to recreate realistic clinical scenarios and emergency situations, allowing clinicians to practice technical and decision-making skills.
- Simulation of Specific Procedures: Training in procedures such as intubation, sutures, and medication administration using models and simulators.

Continuing Education Protocols

- Refresher Courses: Participation in courses and workshops to stay up-to-date with the latest practices and advances in medicine.
- Certifications and Recertifications: Obtaining additional certifications and recertifications in specialized areas such as advanced life support (ALS) and basic life support (BLS).

Evaluation Protocols

- Clinical and Theoretical Examinations: Regular assessments to measure the knowledge and skills of physicians, both in practical and theoretical contexts.
- 360-Degree Feedback: Assessments that include feedback from colleagues, supervisors, and patients to promote ongoing professional development.

As recommended by the CFM, the doctor should whenever possible update himself with regard to medical care, new research, new procedures and new technologies.

NEED FOR TECHNOLOGICAL SOLUTIONS WITH THE USE OF AI

In the face of the technological evolution we are experiencing, in which space and time make long journeys unnecessary, artificial intelligence (AI) emerges as a transformative tool, which plays an essential role in the reconstruction of knowledge, innovating by creating new data from the analysis of repetitive patterns (Ray, 2023). According to Spaidni apud Franco (2024), AI refers to the ability of a computer system or machine to mimic human intelligence to perform tasks that would traditionally require human intervention. Acemoglu and Restrepo (2019) define AI as the study and development of machine-like software algorithms that simulate human intelligence interacting with its environment.

The fascinating progression of ideas, technological advances, and intense periods of research over several decades since the advent of the computer led to the creation of the term "Artificial Intelligence" by John McCarthy in 1956. At that time, computer programs such as *Logic Theorist* of Newell and Simon who was able to prove mathematical theorems (Franco, 2024).

Between the 1970s and 1980s, the so-called "Artificial Intelligence Winter" took place, a period marked by the slowdown of progress in the area, with the decrease in expectations and the significant reduction in funding for AI projects. In the 1990s, interest in AI resurfaced, driven by increased computing power and the efficient use of algorithms. During this period, techniques such as artificial neural networks (ANN) and genetic algorithms emerged, which, through the analysis of large volumes of data, are able to generate new knowledge from past information. In addition, the first facial and voice recognition systems emerged, as well as advances in data analysis (Franco, 2024).

It is precisely in the year 2020 that advanced language models such as OpenAI's GPT-3 and Google's BERT demonstrate near-human capabilities in text generation and natural language understanding, and currently Deep Leaning or deep language has been

used in several areas such as finance, health, and education (Ferreira, 2024). Thus, advances are taking place in deep AI (*deep learning*), which takes advantage of deep neural network architectures for pattern recognition, natural language processing, computer vision, among other innovations such as virtual assistants and self-driving cars Fernandes and Filho (2018).

APPLICATIONS OF AI IN THE DOCTOR'S ROUTINE

Franco (2024) states that among the applications of AI in medicine are the ability to analyze exam images, patient history, and clinical information that can help health professionals identify diseases, interpret results, and suggest treatments. In view of this information, the so-called personalized medicine or precision medicine emerges, which aims to adapt prevention, diagnosis, and treatment based on the individual characteristics of each patient. Artificial intelligence plays an important role in this field, especially in the analysis of genomic and molecular data. With AI, it is possible to analyze large volumes of genomic data, identify biomarkers, and provide more accurate diagnoses and treatments. In this way, the use of technology is applied in new treatment modalities, such as predictive medicine, which is a contemporary practice that emerged from scientific and technological advances in the 90s and that uses AI and other technologies to detect possible genetic alterations in advance, such as the Genome project (Albernaz, 2023), thus preventive medicine can make it possible with the help of technology to predict individual risks, allowing early interventions to prevent or treat specific conditions more effectively.

For (Benner, 2023 apud Silva et al, 2024) technologies have brought new ways to improve quality of life and solve health problems, creating tools, techniques, and methods, contributing to continuous advancement and the well-being of the population. Another significant application in medicine is telematics, as it facilitates the provision of medical services remotely, through communication technologies that enable diagnoses and treatments, widely used with the help of *chatterbots*, which help interact with patients, provide information, and provide guidance on medical care (Nogaroli and Dantas, 2019). According to the same author, the Federal Council of Medicine (CFM) issued Resolution No. 1,643/2002, which defined some parameters in the provision of health services at a distance, developing new information and communication techniques that facilitate the exchange of information between physicians and between them and patients. Therefore, the idea is to expand the practice of telemedicine in Brazil through remote consultations, diagnoses, and surgeries (BRASIL, 2024).

The application of artificial intelligence techniques in education, especially in distance training, is a relatively new topic. With the emergence of the internet, educational technologies have transformed the search for knowledge, enabling virtual interactions and offering greater flexibility in schedules. This allows adaptation to the individual pace of the students, making learning more accessible and personalized (Viana and Nascimento, 2010).

Chatterbots such as Junior and Cybelle are experimental conversational bots used in education that work through the same code (programmed in Perl). It is a very simple engine (Reichel, 2000). From the user inputs captured in a *form*, the words typed with those available in the robots' "brain" are valuable tools in distance education, employing intelligent agents designed to simulate conversations through the exchange of text messages. A pioneering example in this area was ELIZA, an operating system that uses natural language processing (NPL) for commercial and educational applications. Thus, due to their characteristics, *chatterbots* have great potential as pedagogical agents, offering autonomy and the ability to guide conversations in a natural and adaptive way (Viana and Nascimento, 2010).

Belloni (1999) highlights that the new information and communication technologies offer new possibilities of digital interaction between teachers and students, allowing a rich interactivity with high quality and diverse materials. On the other hand, Viana and Nascimento (2010) point out a growing trend in the use of *chatterbots* in education, since this form of artificial intelligence has a unique and effective methodology for using interactive resources.

TEACHING PLATFORMS AND EDUCATIONAL RESOURCES

In 2021, it has become evident that educational institutions need to adapt to the technologies that will shape distance education in the context of the "new normal". Educational digital platforms emerge as crucial tools, providing an online learning environment that simulates the characteristics of a face-to-face classroom. These platforms are equipped with essential features that not only optimize the teaching process but also increase student engagement, highlighting the importance of adaptive platforms and *e-learning* (Pearson Higher Education, 2022).

These technological solutions transform virtual interactions into digital classrooms, allowing direct communication between students and teachers, team collaboration, information exchange, learning management, the application of assessments, and the monitoring of activities in real time (SILVA et al, 2024).

A significant example of a digital platform is the Learning Management System (LMS). Its primary function is to manage distance learning environments, facilitating interaction between students and teachers (Pearson Higher Education, 2022).

In this way, technological platforms such as *e-learning* and Adaptive platforms can adjust content and difficulty based on student performance, having virtualized educational resources for access to study materials, videos, and tutorials developed with AI support for more efficient learning (Albernaz, 2023).

BENEFITS, CHALLENGES AND FUTURE OF INTEGRATING AI IN THE TRAINING OF HEALTH PROFESSIONALS

Coelho (2024) points out that AI has become a powerful ally in improving patient care and the effectiveness of health systems. It should be noted that the expansion of artificial intelligence has occurred in several areas, including medicine. The use of this technology has helped to process large volumes of health data, such as patient information, population data, and records from wearable devices such as *smartwatches* that monitor blood pressure.

The use of telemedicine is a technological innovation that allows medical services at a distance, breaking down geographical barriers and facilitating health services, especially in remote or hard-to-reach areas (Barbosa., et al, 2024). The combination of technologies has enhanced medical care in an efficient and personalized way, adjusting to individual needs (*Filho et al*., 2021).

The incorporation of AI in medical education presents relevant opportunities to improve the quality of teaching and prepare future health professionals in an increasingly digital world. Among the main benefits highlighted in the analyzed research is the ability of AI to make medical training more effective, productive, economical, and accessible (Silva, Quadros and Cãmara, 2024).

CASE STUDY: THE QUILOMBOLA COMMUNITY – KALUNGA, IN CAVALCANTE

The Quilombola community is located in the northeast of the State of Goiás, just over 320 km from Brasília, where approximately 5,000 people live. This region is considered one of the poorest regions of Goiás with about 237,0000 hectares and is recognized as a historical and cultural heritage of humanity (Takahashi and Alves, 2015).

Cavalcante is a municipality in the north of Chapada dos Veadeiros, about 500 km from Goiânia, with approximately 9,583 people and a territorial area of 6,948,780 km², demographic density of 1.38 inhabitants/km², municipal human development index of 0.584

and an infant mortality rate of 13.7 deaths per thousand live births, in addition to having the second largest Quilombola community in the country (IBGE, 2024). From these data, it is possible to infer that although the population of Cavalcante is almost 10,000 people, there is a relevant percentage of people who consider themselves Kalunga and that according to the human development index table of the UNDP (United Nations Development Program) the city of Cavalcante has a medium/low percentage, as shown in Figure 5.

However, the absence of doctors, nurses and other health professionals hinders access to basic services such as consultations, exams and follow-up of patients Takahashi and Alves (2015). This shortage is compounded in more remote areas and rural communities, where the population faces even more difficulties in receiving medical care. In addition, the lack of hospital beds and adequate equipment limits the capacity of care and prevents the performance of more complex procedures.

This problem is not exclusive to Cavalcante, being common in several cities in the interior of Brazil. The lack of investment in public health, the low remuneration of professionals, and the difficulty in attracting and retaining talent in more remote areas are some of the factors that contribute to this situation.

Despite the challenges, the population of Cavalcante has sought alternatives to meet health needs, such as the organization of joint efforts and the search for partnerships with other institutions. In addition, the work of professionals engaged and committed to the community has been fundamental to ensure access to basic health services Takahashi and Alves (2015).

It is important to emphasize that health is a fundamental right and that the population of Cavalcante deserves to have access to quality services and qualified professionals. Overcoming challenges in the health area requires a joint effort by society, the government, and other institutions, aiming to ensure access to health for all citizens.

Figure 5: Human Development Index Table

Source: UNDP, 2024.

It is important to emphasize that the reality described by elderly quilombolas, based on the methodology of Yves Durand (1988), reveals that they face significant deficiencies as well as in terms of health. And this absence of public policies in the community became evident due to the lack of qualified professionals, the absence of attractions such as

adequate salaries and the lack of opportunities for basic structure or the possibility of specialized training (Takahashi and Alves, 2015).

As the Kilombola community is far from urban centers, in a place of difficult access and few roads, it is not in the habit of the people of that place to come into contact with new technologies or professionals with better training for specialized care, which makes the inhabitants of that place seek non-scientific methods to solve their problems.

According to Takahashi and Alves (2015), plants often serve as a response to calls for help, since nature has been the main guarantee of survival in health matters. This shows that the lack of health policies in remote regions continues to be a persistent problem in Brazil. This seems to reflect on the case where government inaction leads people to seek support and meaning in other areas of their lives. When public policies fail to meet the needs of the community, it is common for people to turn to family, nature, faith, and religiosity as sources of support and hope. These spheres can offer a form of resistance and resilience in the face of adversity and gaps left by the lack of public policies.

According to the CNES (National Registry of Health Establishments), the municipality of Cavalcante has 4 basic health units (UBS) and 1 (one) municipal hospital according to table 6, however it was verified that the first registered health unit is deactivated and the third unit (BS 2 center) has a doctor from the more doctors program in the shift from (Monday to Thursday), In addition, the second unit has 1 (one) doctor hired by the city hall who attends basic consultations (40 hours per week) and 1 (one) pediatrician who attends 20 hours per week. The fourth unit has 2 (two) physicians attending basic consultations (40 hours per week) and the hospital has a physician on duty every 12 hours, that is, it has one physician per 12-hour shift, theoretically with medical coverage 24 hours/week/month, in addition to a radiologist who works in a special regime (reports radiographs by telemedicine), the latter case, corroborating the use of AI as a way to mitigate the gap for medical health in that place.

Table 6: Information on health facilities in Cavalcante/GO.

‘	Municipality	CNES	Trade Name	Legal Nature	Management	Meets SUS
GO	RIDING MAN	9429476	BASIC FAMILY HEALTH UNIT IV	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	6304613	UBS III POVOADO ENGENHO	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	2440946	UBS II CENTRO	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	2769417	UBS I MORRO ENCANTADO	PUBLIC ADMINISTRATION	M	YES

GO	RIDING MAN	6425690	7MUNICIPAL HEALTH DEPARTMENT OF CAVALCANTE	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	2382709	HOSPITAL MUNICIPAL DE CAVALCANTE	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	9364595	MUNICIPAL BASIC PHARMACY OF CAVALCANTE	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	9794697	QUINCA FERREIRA PSYCHOSOCIAL CARE CENTER	PUBLIC ADMINISTRATION	M	YES
GO	RIDING MAN	7981333	MORRO ENCANTADO HEALTH ACADEMY	ADMINISTRATION PUBLIC	M	YES

Source: CNES (2024).

FINAL CONSIDERATIONS

The integration of Artificial Intelligence in the training of doctors in remote areas in the state of Goiás represents a significant opportunity to overcome historical challenges in professional training. AI technologies offer innovative solutions that can expand access to education and improve the quality of training in order to qualify professionals to face the reality in remote areas. However, the successful implementation of these tools requires attention to infrastructure, training of instructors, and continuous adaptation to new technologies. In remote areas, in the State of Goiás, the population faces significant challenges, such as the scarcity of training centers, access difficulties and technological limitations. AI emerges as an innovative tool to help with these difficulties, allowing professionals in training to participate in clinical simulations and obtain high-quality theoretical and practical training without the need to travel frequently to specialized centers.

The benefits of implementing AI are evident: the ability to create virtual learning environments and provide detailed analyses of student performance can significantly improve the quality of training and, consequently, the service offered to the population. However, challenges such as the need for adequate technological infrastructure and the training of instructors to effectively use these tools still need to be addressed.

The case study of the Quilombola community of Kalunga, in Goiás, reports the critical need to integrate technologies such as AI and to implement effective government policies to address health challenges in isolated regions. The use of AI can provide essential support in training health professionals and improving care, while government actions can ensure the necessary infrastructure and policies that adequately respond to the needs of the

community. Together, these approaches can help overcome limitations and promote a better quality of life for residents in these areas.

Therefore, the integration of AI in the training of healthcare professionals in remote regions not only offers a solution to the problems of access and resources, but also represents a significant advance in the modernization of medical training. The adoption of these technologies can help mitigate regional inequalities and promote more equitable and effective care, positively impacting the quality of health services in isolated and needy communities. The research suggests that, despite the challenges, AI has the potential to revolutionize professional training in remote areas and substantially improve health care in adverse contexts.

REFERENCES

1. Albernaz, H. (2024). Saiba o que é medicina preditiva. Recuperado em 30 de outubro de 2024, de https://portaltelemedicina.com.br/medicina-preditiva

2. Antonini, L. M. (2024). O uso da inteligência artificial na educação: uma revisão. Editora e-Publicar – Tecnologia, inovação e inclusão: Desafios e Possibilidades para a educação, 1. https://doi.org/10.47402/ed.ep.c2402117522843

3. Aruda, E. P. (2024). Inteligência artificial generativa no contexto da transformação do trabalho docente. EDUR – Educação em Revista, 40, e48078. https://doi.org/10.1590/0102-469848078

4. Barbosa, T. M. S., et al. (2024). Integração da telemática com Inteligência Artificial: o futuro da assistência médica personalizada. Studios Publicações e Editora Ltda.

5. Bauer, A., Cassettari, N., & Oliveira, R. P. (2017). Políticas docentes e qualidade da educação: uma revisão da literatura e indicações de política. Ensaio: Avaliação de Políticas Públicas em Educação, 25(97), Oct-Dec. https://doi.org/10.1590/S0104-40362017002501010

6. Borba, F. A. K., & Ogata, A. J. N. (2024). O uso de sistemas de inteligência artificial para a personalização da experiência do paciente: a percepção de gestores de tecnologia e inovação de hospitais associados à ANAHP. Jornal Brasileiro de Economia da Saúde, 16(2), 108-120. https://doi.org/10.21115/JBES.v16.n2.p108-120

7. Brasil. (2002). Portaria nº 1.643 de 26 de agosto de 2002. Ministério da Saúde, Conselho Federal de Medicina.

8. Brasil. (2024a). Cidades@. Instituto Brasileiro de Geografia e Estatística. Recuperado em 29 de outubro de 2024, de http://cidades.ibge.gov.br/xtras/home.php?lang=

9. Brasil. (2024b). Programa Mais Médicos. Recuperado em 29 de outubro de 2024, de https://www.gov.br/secom/pt-br/acesso-a-informação/lista-de-acoes-e-programas/programas-mais-medicos

10. Campos, M. S. M., & Natos, M. A. E. (2024). A inteligência artificial como prática educativa na educação profissional e tecnológica. Editora Científica Digital Ltda., 9-19. https://doi.org/10.37885/240115534

11. Costa, E. J. (2022). Inteligência artificial na educação médica: tendências e perspectivas. Revista Brasileira de Educação Médica, 46(1), 25-40.

12. Dantas, E., & Nogaroli, R. (2021). O consentimento informado do paciente frente às novas tecnologias da saúde: telemedicina, cirurgia robótica e inteligência artificial. Revista de Direito Médico e da Saúde(21).

13. Fernandes, F. T., & Filho, A. D. P. C. (2018). Perspectivas do uso de mineração de dados e aprendizado de máquina em saúde e segurança no trabalho. Revista Brasileira de Saúde Ocupacional. https://doi.org/10.1590/2317-6369000019418

14. Ferreira, J. (2024). Deep learning: Da teoria à prática e rumo à inteligência artificial avançada. Recuperado em 30 de outubro de 2024, de https://www.objective.com.br/insights/deep-learning/

15. Filho, C. O. B. (2024). A inteligência artificial e o médico. Revista APMED, 3(1).

16. Filho, R., et al. (2021). Formulação de um sistema de informação baseado em inteligência artificial e telemedicina para suporte a diagnósticos de radiologia. Repositório Unichristus. Recuperado em junho de 2021, de https://repositorio.unichristus.edu.br/jspui/handle/123456789/1177

17. Franco, G. M. O. (2024). Inteligência artificial na medicina: Avanços e desafios. Revista Multidisciplinar do Nordeste Mineiro, 5.

18. Gomes, A. G., Montanini, J. F., & Sobrinho, H. M. R. (2024). O uso da inteligência artificial na medicina: os benefícios e desafios da parceria homem-tecnologia na saúde. Revista Eletrônica Acervo Saúde.

19. Hedler, H. C., Moresi, E. A. D., & Vieira, J. A. D. (2022). O impacto da governança de tecnologia da informação no desempenho organizacional: um estudo bibliométrico. 19th Contecsi – International Conference on Information Systems and Technology Management.

20. Instituto Brasileiro de Geografia e Estatística – IBGE. (2024). Cidades e estados: Cavalcante. Rio de Janeiro: IBGE. Recuperado em 8 de janeiro de 2024, de https://www.ibge.gov.br/cidades-e-estados/go/cavalcante.html

21. Kaul, V., et al. (2020). History of artificial intelligence in medicine. Gastrointestinal Endoscopy, 92(4), 807-812.

22. Nascimento, R. R., & Gasparello, V. A. (2023). O potencial da inteligência artificial e tecnologia na área da saúde. Anais do IV Congresso Nacional de Inovações em Saúde.

23. Oliveira, A. P. C., Gabriel, M., Poz, M. R. D., & Dussalt, G. (2017). Desafios para assegurar a disponibilidade e acessibilidade à assistência médica no Sistema Único de Saúde. Ciência & Saúde Coletiva, 22(4), 1165-1180. https://doi.org/10.1590/1413-81232017224.31382016

24. Scheffer, M. C., Almeida, C. J., & Cassenote, A. J. F. (2023). Radar da Demografia Médica no Brasil. Informe Técnico (1), setembro de 2023. São Paulo, SP: FMUSP, AMB.

25. Silva, J., & Quadros, S. (2024). Integração da inteligência artificial na formação educacional médica: Oportunidades e desafios. VI Seven International Multidisciplinary Congress. https://doi.org/10.56238/sevenVImulti2024-029

26. Takahashi, F. G. M. (2015). Imagens representacionais das políticas públicas à educação e à saúde, no imaginário de um grupo de idosos da comunidade Quilombola – Kalunga, de Monte Alegre de Goiás. Ensaio: Avaliação de Políticas Públicas em Educação, 23(88), 567-592.

27. Van Stralen, A. C., et al. (2017). Percepção de médicos sobre fatores de atração e fixação em áreas remotas e desassistidas: rotas de escassez. Physis Revista de Saúde Coletiva, 27(1), 147-172. https://doi.org/10.1590/s0103-73312017000100008

28. Viana, T. A. M. N., & Nascimento, S. G. (2010). Aplicação de técnicas de inteligência artificial na educação: O uso de chatterbots na educação à distância. Revista Virtual das Faculdades Integradas Barros Melo.