

The Role of Generative Artificial Intelligence in Pediatric Healthcare Professions Education: A Narrative Review

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ABSTRACT

The advent of generative artificial intelligence (GenAI), particularly Large Language Models (LLMs), presents transformative potential for pediatric healthcare professions education. This narrative review explores the current applications, educational opportunities, and inherent risks associated with integrating GenAI into the training of future pediatric healthcare professionals, including nurses, medical imaging technicians, and physiotherapists. Current applications range from informal student use for study synthesis and query resolution to structured curriculum implementations involving simulated clinical scenarios and AI-assisted learning. LLMs offer significant educational opportunities by enabling personalized learning, providing immediate access to information, simulating complex or rare cases, and reducing linguistic barriers. However, critical risks such as informational hallucinations, algorithmic biases, cognitive dependency, and ethical concerns necessitate a cautious approach. The review highlights the crucial need for a robust, integrated, and supervised educational model. This model should emphasize AI literacy, structured integration of GenAI tools with low-risk applications initially, followed by more complex simulations, ethical decision-making modules, and collaborative curriculum co-design. The essential role of faculty training and ongoing systematic evaluation of effectiveness is underscored. Ultimately, the successful and safe integration of GenAI in pediatric healthcare education hinges on a balanced approach that amplifies humanistic qualities of care, such as empathy and critical reasoning, rather than replacing them, ensuring the formation of competent and ethically grounded professionals prepared for the future of pediatric healthcare.

INTRODUCTION

The advent of generative artificial intelligence (GenAI) represents one of the most significant transformations in the contemporary technological landscape, with particularly relevant implications for the healthcare and education sectors. Large Language Models (LLMs), language models based on transformer architectures, constitute the core of this technological revolution [1]. These systems are trained on vast text corpora and possess the ability to generate coherent and contextually appropriate textual content through probabilistic prediction mechanisms of linguistic sequences [2].

Generative artificial intelligence is distinguished from traditional artificial intelligence systems by its capacity to create new content rather than being limited to analyzing existing data. In the medical context, LLMs have demonstrated remarkable performance in various applications, from generating scientific texts to assisting in diagnosis and supporting professional training [3]. Their neural architecture, based on multi-head attention mechanisms, allows them to process and correlate complex information while maintaining semantic and contextual coherence over long textual sequences.

In the panorama of pediatric healthcare education, the emergence of these tools is generating increasing interest accompanied by fundamental questions about their safe and effective integration into educational curricula. Pediatric healthcare professions, including pediatric nursing, pediatric medical imaging

technicians (TSRM), and pediatric physiotherapy, are characterized by the need for highly specialized skills and the crucial importance of continuous education based on updated scientific evidence.

The relevance of generative artificial intelligence in the field of pediatric healthcare education is manifested through multiple dimensions. Wu [4] highlighted how AI technologies, including machine learning, deep learning, natural language processing, and GenAI, are rapidly transforming the educational landscape, improving both teaching and learning processes. The ability of these systems to provide immediate and personalized answers to student questions, generate simulated clinical scenarios, and support self-directed learning represents a paradigmatic potential in medical pedagogy [5].

However, the integration of such technologies in the training of professionals who will work with pediatric patients requires a thorough critical analysis of the benefits, risks, and associated ethical implications. Buchanan et al. [6] conducted a systematic review identifying the urgent need for curricular reforms in nursing education programs to prepare nurses and students to practice safely and efficiently in the era of AI.

The importance of critically analyzing the impact of LLMs on pediatric healthcare professions students emerges from the consideration that these future professionals will need to operate in contexts characterized by patient vulnerability and clinical complexity. Pediatric training requires not only



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specialized technical skills but also the development of relational, ethical, and critical clinical reasoning abilities that could be influenced by interaction with artificial intelligence systems [7].

This article aims to provide a systematic summary of the educational applications of generative artificial intelligence in the context of pediatric healthcare professions, critically analyze the emerging risks, and propose an integrated and supervised educational model for the safe and effective use of these tools. Through the examination of recent scientific literature identified via PubMed and arXiv databases with focus on LLMs and nursing education, this work aims to outline a conceptual framework that can guide educators, educational institutions, and policymakers in the responsible implementation of generative artificial intelligence technologies in pediatric healthcare training pathways.

Current Applications of GenAI in Pediatric Healthcare Education

The analysis of scientific literature reveals a rapidly evolving landscape of artificial intelligence applications in healthcare education, with particular interest in its potential within the pediatric field. Usage modalities are primarily divided into two categories: informal use by students and structured implementation within educational curricula.

The informal use of LLMs by pediatric healthcare professions students has emerged as a spontaneous and widespread phenomenon. Gunawan et al. [8], through a systematic textual network analysis, identified that 48% of evaluations on the integration of ChatGPT in nursing education expressed positive sentiments, highlighting four main thematic clusters: academic writing, health simulation, data modeling, and personal development. Negative evaluations accounted for 31%, and neutral evaluations for 21%. Ostick et al. [9] conducted an integrative review demonstrating generally positive attitudes towards the use of AI in nursing education among 2,430 participants from five countries, although the need to compare student and faculty perceptions emerged. Students predominantly use these tools for the synthesis of complex teaching material, the resolution of specific clinical queries, and the generation of self-assessment quizzes. Metersky et al. [10] explored the implications of evaluating AI-generated assignments versus those created by students, highlighting critical issues for assessing student work in nursing. This informal application, while widespread, features autonomy and a lack of expert supervision, raising significant questions about the quality and reliability of the processed information.

In a structured context, the implementation of LLMs in pediatric healthcare education has shown promising results in various application areas. Sun et al. [11] developed an AI-driven framework specifically oriented towards nursing and geriatrics, imple-

menting incremental pre-training and supervised fine-tuning techniques on a dedicated Chinese dataset. This approach demonstrated significant improvements in model performance for specialized tasks, opening prospects for similar applications in the pediatric field.

Regarding pediatric nursing, specific applications primarily focus on the simulation of complex care plans and support for communication practices with patients and families. Castonguay et al. [12] highlighted how ChatGPT can be used to create realistic clinical scenarios that allow students to practice diagnostic reasoning and develop care plans in simulated settings, while also emphasizing the need for a critical and informed use of the tool to avoid over-reliance and ensure alignment with evidence-based practices. Lebo and Brown [13] described the innovative use of an AI virtual patient that ages with students throughout their nursing program progression, enabling skill development through increasingly complex scenarios.

The implementation of AI-based simulations has shown particularly promising results. Simsek-Cetinkaya and Cakir [14] evaluated the effectiveness of AI-assisted interactive simulations for breast self-examination, demonstrating an innovative approach in nursing education. Liaw et al. [15] conducted a mixed-methods study on AI-powered virtual reality simulations for interprofessional communication training, highlighting significant potential but also implementation challenges.

One of the most innovative applications is represented using GenAI for creating pre-simulation materials. A pilot study by Reed and Dodson [16] investigated the use of AI-generated backstories as a pre-simulation strategy, reporting positive pedagogical outcomes, including reduced anxiety, increased preparatory knowledge, and a greater emotional connection to the patient's history.

Evidence related to TSRM's courses is still limited in the literature. However, promising applications are emerging in guided interpretation of reports and understanding of pediatric-specific imaging protocols. The use of LLMs for generating educational material on pediatric radiological techniques and for simulating clinical cases represents an area of particular interest, considering the specificity of procedures and dosimetric considerations in the pediatric field.

In pediatric physiotherapy, current applications focus on the simulation of complex neuromotor cases and support for evidence-based updating. Liu et al. [17] systematically analyzed the applications of ChatGPT in nursing education, highlighting potential that can also be extended to other healthcare professions. The ability of LLMs to process and synthesize large amounts of scientific literature is particularly useful for pediatric physiotherapists, who must stay updated on evolving therapeutic approaches for various neuromotor conditions. As highlighted by Lowe

[18], these models can assist physiotherapy students and professionals in accessing and digesting current scientific knowledge, facilitating a more dynamic and evidence-informed approach to clinical decision-making in neuromotor rehabilitation contexts. A specific example of structured implementation is represented by the work of Yang et al. [19], who developed PediatricsGPT, the first Chinese LLM assistant specifically designed for pediatric applications. The system, based on a corpus of over 300,000 multi-task instructions derived from pediatric textbooks, guidelines, and knowledge graph resources, demonstrated superior performance compared to existing Chinese medical LLMs in specific pediatric diagnostic tasks.

Ongoing international initiatives include pilot projects in various academic institutions exploring the controlled integration of LLMs into healthcare training curricula. Bumbach [20] described how nursing educators can leverage ChatGPT to enhance the student educational experience, while acknowledging the technology's current limitations. Bumbach et al. [21] also described a practical application in the education of DNP (Doctor of Nursing Practice) students, highlighting that students attempting to develop simple tools for non-complex patients had more success with the technology.

Current evidence suggests that the implementation of LLMs in pediatric healthcare education is still in an exploratory phase, characterized by promising experiments but not yet by standardized and validated protocols. Topaz et al. [22] emphasized the importance of a proactive approach to curriculum development and the need for global collaboration and standardization in AI education to address the diverse evolving needs of the healthcare sector. The necessity of developing specific frameworks for the pediatric field clearly emerges from the literature, considering the clinical, ethical, and educational peculiarities that characterize this sector of medicine.

Educational Opportunities Offered by LLMs

The analysis of the educational potential of LLMs in pediatric healthcare education reveals a range of opportunities that could significantly transform traditional didactic paradigms. Learning personalization represents one of the most promising dimensions of this technological transformation. Safranek et al. [23] highlighted how LLMs can adapt to different individual learning styles, providing personalized explanations and educational support calibrated to each student's specific learning needs, also facilitating brainstorming in differential diagnoses and providing multiple-choice questions tailored to the case under study. Almansour and Alfheid [24] conducted a narrative review demonstrating how generative AI can personalize healthcare professional education, adapting content and methodologies to students' individual needs.

Continuous and immediate access to information constitutes another significant advantage offered by LLMs. Tam et al. [25] emphasized how conversational AI can support education by being constantly accessible and adaptable to learners' needs. In nursing education, AI-Chatbots such as ChatGPT have been employed to assist in drafting course materials, facilitate self-paced learning, and support problem-based activities, while raising concerns related to over-reliance, plagiarism, and reduced critical thinking, thus requiring clear pedagogical guidance. Kim [26] provided a comprehensive narrative review of AI chatbot applications, including ChatGPT, in education, highlighting promising prospects for supporting continuous learning.

The possibility of simulating rare or interdisciplinary cases represents one of the most innovative applications of LLMs in pediatric healthcare education. Holmes et al. [27] evaluated the performance of different LLMs in pediatric ophthalmology, demonstrating that GPT-4 achieves performance comparable to that of specialist physicians, while ChatGPT and PaLM2 surpass medical students. This evidence suggests that LLMs can be used to generate complex and realistic clinical scenarios, allowing students to engage in situations they might not frequently encounter during traditional clinical internships.

Support for interprofessional teaching emerges as an area of particular interest, considering the multidisciplinary nature of pediatric care. LLMs can facilitate understanding of different professional perspectives and promote collaboration among students from various healthcare disciplines. Srinivasan et al. [28] provided a comprehensive overview of the pedagogical implications of AI and chatbots in nursing education, highlighting the potential for improving interprofessional collaboration through shared access to specialized knowledge.

The reduction of linguistic and cognitive barriers represents an often underestimated but crucial aspect of LLMs' potential. These tools can support students with linguistic or learning difficulties by providing simplified explanations, real-time translations, and adaptations of technical-scientific language. In the international context of healthcare education, this capability can foster inclusivity and accessibility of specialized education. Luo et al. [29] conducted a web-based survey among Chinese nursing students, highlighting how ChatGPT can support employability and cognitive skills of students in the AI era.

The value for students in geographical areas with fewer educational resources represents a significant opportunity for educational equity. Abd-Alrazaq et al. [30] identified significant benefits in using LLMs for generating educational content, formative assessment, and simulating patient-professional interactions, particularly relevant for contexts with limited resources. LLMs can provide access to specialized knowledge and scientific updates that may not be easily available in contexts with limited avail-



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lability of specialized faculty or library resources.

Innovative applications also extend to the creation of advanced educational content. Sekhar et al. [31] described a use case for generative AI in medical education, demonstrating how these tools can assist in creating flashcards and personalized study materials. The ability to automatically generate educational content tailored to specific curricular needs represents significant potential for educational efficiency.

AI-supported medical simulations offer particularly promising opportunities. Lebo and Brown [13] described the implementation of AI virtual patients that evolve over time, allowing students to develop longitudinal competencies through progressively more complex scenarios. This innovative approach overcomes the limitations of traditional static simulation models.

Generative AI also demonstrates significant potential in supporting research and professional development. Reading Turchioe et al. [32] described the implementation of programs to increase generative AI competency among students enrolled in doctoral nursing research courses, highlighting the potential for improving research skills and digital literacy.

Support for problem-based learning (PBL) represents another promising area of application. LLMs can generate complex clinical cases, provide immediate feedback, and guide students through structured clinical reasoning processes. This capability is particularly relevant in the pediatric context, where case complexity and physiological variability require flexible and adaptive educational approaches.

A critical analysis of the available evidence reveals that the educational opportunities offered by LLMs are real and significant but require careful and methodologically rigorous implementation. Learning personalization, immediate access to information, and the simulation of complex cases represent undeniable advantages; however, their effective realization depends on the quality of integration with existing teaching methods and the ability to maintain high educational standards while preserving the fundamental aspects of healthcare education.

Risks and Limitations of GenAI Use

The implementation of generative artificial intelligence in pediatric healthcare education presents significant criticalities that require in-depth and methodologically rigorous analysis. Informational hallucinations represent one of the most concerning risks associated with the use of LLMs in healthcare training contexts. Alkaissi and McFarlane [33] systematically documented the phenomenon of hallucinations in ChatGPT, highlighting how the system can generate seemingly plausible but factually erroneous content with a level of confidence that can mislead less experienced users.

Chelli et al. [34] conducted a comparative analysis

of hallucination rates in ChatGPT and Bard when conducting systematic reviews. The results showed that Bard (Google) generated fabricated references in 91.4% of cases, while GPT-3.5 and GPT-4 had hallucination rates of 39.6% and 28.6% respectively. These data highlight a high incidence of significant errors in the references produced by the models, underscoring the need for careful verification by researchers before using LLMs for academic purposes. Mugaanyi et al. [35] extended this analysis through a cross-disciplinary study, confirming significant limitations in generating reliable citations and references. In the context of pediatric training, where the accuracy of clinical information is crucial for the safety of future patients, this aspect takes on particularly critical dimensions.

The problem of hallucinations also extends to the scientific writing sector. Teixeira da Silva and Tsigraris [36] highlighted how ChatGPT can generate fraudulent but seemingly authentic references in medical scientific articles, opening significant ethical and legal issues. Masters K. [37] identified the first ChatGPT reference hallucinations in Medical Teacher, emphasizing the need for editorial vigilance and specific training for faculty and reviewers.

Biases and stereotypes embedded in training data constitute another critical dimension that warrants particular attention. Ito et al. [38] conducted a systematic study to evaluate the presence of racial and ethnic biases in GPT-4 for clinical diagnosis and triage. Using 45 typical clinical scenarios, the study compared the performance of GPT-4 with that of specialist physicians. The results showed that GPT-4's diagnostic and triage accuracy was comparable to that of physicians and did not vary significantly based on the race or ethnicity of the patients represented in the clinical cases. These data suggest fair behavior of the model, at least in the analyzed experimental context. Deb and Rodman [39] analyzed the behavior of advanced language models (GPT-4 and Gemini Pro) in pain assessment in Black and White patients, replicating a validated experimental paradigm. Although no significant differences in pain assessment emerged between racial groups, the study highlighted that Gemini Pro showed greater adherence to false biological beliefs about race compared to GPT-4 and medical trainees. These results raise concerns about the possibility that some AI models may internalize and reproduce racial stereotypes, with potential implications for health equity. In the pediatric context, where cultural and socioeconomic considerations play a decisive role in care, the presence of algorithmic biases can perpetuate and amplify existing health inequalities. Porter and Foronda [40] emphasized the need to improve AI literacy in nursing education to combat embedded biases, highlighting the importance of specific training on the risks of algorithmic discrimination. Cognitive dependency and student passivity represent emerging risks that could compromise the

development of critical skills essential for clinical practice. Nguyen [41] introduced the concept of "automation bias" in medical education, describing the tendency of students and physicians to rely uncritically on AI-provided results without developing independent evaluation skills. This phenomenon is particularly concerning in pediatric training, where complex clinical reasoning and the ability to adapt to unforeseen situations are fundamental skills.

Choudhury and Chaudhry [42] explored the systemic implications of integrating LLMs into healthcare, focusing on two critical dynamics: the self-referential learning loop, where AI-generated content feeds back into model training, reducing information diversity and potentially reinforcing biases; and the phenomenon of deskilling, i.e., the progressive loss of diagnostic and analytical skills by clinicians due to excessive delegation of decision-making to AI. The authors emphasize that uncritical trust in LLMs may compromise the quality of care and the training of healthcare professionals, especially if not accompanied by critical human oversight. Furthermore, the work highlights the need to also address the ethical-legal implications related to the use of LLMs in medicine, highlighting the need for strategic and ethically grounded integration policies that safeguards the active and competent role of the clinician. Difficulties in evaluating the reliability and clinical relevance of LLM-generated responses represent a significant methodological challenge. Giuffrè et al. [43] evaluated the accuracy, reliability, and comprehensiveness of ChatGPT's responses to medical questions, highlighting concerns regarding hallucinations and the lack of quantification of variability across outputs. The authors emphasize that in clinical contexts, even partially incorrect responses may have harmful consequences, and call for more rigorous methodologies to assess the degree of inaccuracy and acceptable limits of variation in AI-generated content. Unstructured information overload represents a commonly underestimated yet potentially substantial risk. LLMs can produce vast volumes of text without clear prioritization or clinical relevance, complicating the identification of essential practice elements. Recent guidelines suggest that designers of LLM enabled educational tools should implement safeguards to avoid information overload in asynchronous learning environments [44]. Ethical concerns also extend to academic integrity issues. Cervantes et al. [45] investigated the relationship between the use of generative AI and academic integrity, highlighting that 97% of faculty express concerns about cheating on homework assignments and 95% about the tendency to generate false information. O'Connor [46] examined open AI platforms in nursing education, questioning whether they represent tools for academic progress or for abuse.

Implications for patient safety represent a critical dimension often overlooked. Busch et al. [47] explo-

red the biomedical ethical aspects of implementing AI in medical education, identifying specific recommendations based on the principles of autonomy, justice, non-maleficence, and beneficence. The use of inaccurate or inappropriate information generated by LLMs in training contexts can translate into potentially dangerous clinical practices.

The issue of professional responsibility emerges as a crucial element in the AI era. Weidener and Fischer [48] proposed a principles-based approach to teaching AI ethics in medical education, emphasizing the need to clarify professional responsibilities when using AI tools. In the pediatric context, where clinical decisions have long-term implications for patients' development and quality of life, clarity of responsibilities becomes even more critical.

The analysis of available evidence converges in identifying the need for methodologically rigorous approaches to managing the risks associated with the use of LLMs in pediatric healthcare education. Specific training for educators, development of systematic verification protocols, and implementation of qualified supervision systems emerge as essential elements for mitigating the identified risks, while simultaneously maintaining the potential benefits of these innovative technologies and preserving educational integrity and the safety of future patients.

Towards an Integrated and Supervised Educational Model

The development of an educational framework that effectively integrates generative artificial intelligence into pediatric healthcare education requires a systematic and multidimensional approach that balances technological innovation with educational safety and learning quality. The analysis of scientific literature allows for the identification of key elements for constructing an integrated and supervised educational model.

Initial training in the critical use of artificial intelligence emerges as a fundamental element for the safe and effective implementation of LLMs in educational curricula. Blomquist et al. [49] proposed the use of the National Council of State Boards of Nursing's "five Rights of delegation" framework to teach students the appropriate use of LLMs in healthcare and educational settings. This systematic approach provides a methodological structure for evaluating the validity and reliability of AI-generated information, documenting its use, and appropriately referencing sources.

Busch et al. [47] proposed a comprehensive ethical framework based on the four fundamental principles of biomedical ethics—autonomy, justice, non-maleficence, and beneficence—to guide the integration of AI in medical education. The implementation of specific introductory courses should include modules on LLM architecture and functioning, algorithmic limitations and biases, fact-checking methodologies,



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and critical thinking principles applied to AI. Simms [50] emphasized the urgency of integrating generative AI literacy into nursing education, identifying it as a core requirement to prepare students for a technologically advanced healthcare landscape. This literacy involves the ability to critically assess AI-generated content, an essential understanding of the underlying technologies, and awareness of ethical considerations in clinical application. The article calls for proactive curriculum development and highlights the need for nurse educators to adapt teaching strategies accordingly. The presence of qualified human facilitators represents an indispensable element for ensuring educational quality and training safety. Sun and Hoelscher [51] emphasized the critical importance for faculty to become familiar with ChatGPT's capabilities and limitations to promote effective, ethical, and responsible use, while also preparing students for the rapidly evolving technological landscape in the healthcare sector.

Ichikawa et al. [52] conducted a cross-sectional descriptive survey on policies and training related to generative AI in US osteopathic medical schools, highlighting the need to develop specific training programs for faculty. Facilitators must possess specific competencies in both the pediatric clinical domain and the use and evaluation of AI systems, acting as guides in the critical navigation of generated information and its appropriate clinical contextualization. Structured curriculum integration requires a gradual and methodologically validated approach. Srinivasan et al. [28] provided a comprehensive overview of the pedagogical implications of AI and chatbots in nursing education, highlighting the need for progressive integration that respects the developmental timeline of students' critical competencies. Summers et al. [53] conducted a descriptive qualitative study to explore nursing students' perspectives on the integration of generative AI in higher education, identifying six distinct themes, including educational impact, equitable learning environment, and ethical considerations.

Implementation should follow logical progression, starting with low-risk supportive applications, such as guided literature searches and synthesis of teaching material, to gradually evolve towards more complex applications like clinical simulation and support for diagnostic reasoning. Shimizu et al. [54] conducted a qualitative study in a Japanese medical school to develop curriculum reform strategies in response to the impact of generative AI. Through a SWOT analysis and workshops with faculty and students, three integration directions emerged: learning about GAI (literacy and ethics), with GAI (efficiency and access to information), and beyond GAI (critical thinking and communication). The study proposes practical approaches for systematic and shared adoption in educational settings. Systematic evaluation of educational effectiveness constitutes a crucial element for continuous refinement of the educational

model. Veras et al. [55] developed a protocol for a randomized crossover-controlled study to evaluate the usability and effectiveness of AI chatbots for health sciences students. This rigorous methodological approach provides a model for objectively assessing the impact of LLMs on learning, including quantitative metrics such as academic performance and learning times, and qualitative measures such as student satisfaction and perceived self-efficacy.

Shin et al. [56] conducted a quasi-experimental study to evaluate the effects of AI-assisted learning on ethical decision-making and clinical reasoning of nursing students in pediatric care. The results showed that the control group outperformed the experimental group in ethical standards and with a better clinical reasoning, highlighting the need for hybrid approaches that combine AI and traditional methods.

AI ethics education represents a fundamental dimension often overlooked in implementation models. Migdadi et al. [57] conducted a cross-sectional study of nursing students in Jordan, finding moderate levels of AI ethical awareness, attitudes, anxiety, and usage intention. The analysis revealed significant correlations between ethical awareness, positive attitudes, and usage intention, suggesting that greater ethical understanding can foster more conscious technology use. Kwak et al. [58] analyzed the influence of AI ethical awareness, attitude, anxiety, and self-efficacy on nursing students' behavioral intentions, highlighting that a positive attitude towards AI and high self-efficacy are significant predictors of usage intention. The study emphasizes the importance of targeted educational interventions to strengthen these dimensions in nursing education.

Yang [59] investigated factors influencing AI ethical awareness among nursing students, identifying moral sensitivity as a key factor ($\beta = 0.23$, $p = 0.042$) with an explanatory power of 14.0%. The curriculum should include specific modules on data privacy, informed consent in the digital age, professional responsibility in AI use, and ethical considerations specific to the pediatric field.

The integrated framework should incorporate continuous feedback mechanisms and dynamic adaptation based on emerging evidence. Zhang et al. [60] conducted a narrative review on the evolution of chatbot use in nursing education, highlighting a rapid increase in publications in recent years and a predominance of theoretical or editorial studies. The study identifies geographical and methodological trends in literature and emphasizes the need for original research, recommending ethically conscious and evidence-adaptable implementation. Interprofessional collaboration in the design and implementation of the educational model emerges as an essential element for the success of integration. The combined expertise of educators, pediatric clinicians, biomedical informaticians, and AI experts is necessary to develop approaches that are simulta-

neously technologically advanced, clinically relevant, and pedagogically effective. The practical implementation of the model should follow a pilot methodology that allows for gradual testing and iterative refinements. Lane et al. [61] proposed strategies for guiding and regulating the use of generative AI in nursing education, emphasizing the importance of clear ethical guidelines, the development of AI literacy, and active faculty supervision. Among the recommended strategies, the creation of simulated environments where students can experiment with LLM use under direct supervision emerges as an effective approach to maximize educational opportunities and minimize risks associated with improper or uncritical use of technology. Preiksaitis et al. [62] conducted a systematic review identifying opportunities and limitations of generative AI in medical education, proposing three key areas of investigation: developing student skills to critically evaluate AI, rethinking assessment metho-

by trained educators. Table 2 summarizes the phases of the integrated and supervised educational model, highlighting for each level the teaching objectives, application modalities, and main bibliographic references that support its validity. This progressive sequence allows for calibrating the introduction of generative artificial intelligence in a manner consistent with students' educational level, fostering the development of advanced digital skills without sacrificing the centrality of critical thinking, clinical reasoning, and professional ethics. The adoption of a supervised and scalable model represents a key strategy for combining the transformative potential of LLMs with the safety and effectiveness of pediatric education.

CONCLUSION

The integration of generative artificial intelligence in the education of pediatric healthcare professions represents an educational frontier that requires a

Table 2. Progressive Levels of the Supervised Educational Model for LLM Integration in Pediatric Healthcare Education

Level	Description	Learning Objective	Usage Context	Examples from Literature
1. AI Literacy	Technical and ethical introduction to LLM use	Critical understanding of functioning, biases, and hallucinations	Introductory courses, theoretical modules	Blomquist et al. [49], Simms [50]
2. Low-Risk Applications	Supervised use for synthesis, quizzes, literature searches	Support for individual study and updating	Classroom, personal study with tutoring	Bumbach et al. [20], Gunawan et al. [8]
3. Interactive Clinical Simulations	LLM-generated scenarios, simulated interactions with virtual patients	Development of clinical reasoning and communication skills	Laboratories, simulated environments	Castonguay et al. [12], Lebo and Brown [13]
4. Ethics and Decision-Making Modules	AI-assisted discussion of ethical dilemmas	Promotion of critical thinking and decision-making autonomy	Interdisciplinary courses, tutorial sessions	Shin et al. [56], Busch et al. [47]
5. Curricular Co-design	Collaboration between faculty, students, and AI in content construction	Pedagogical innovation and adaptation to emerging needs	Curriculum design, formative assessment	Ichikawa et al. [52], Lane et al. [61]

dologies, and training educators. These controlled environments allow for data collection on educational effectiveness and the identification of best practices transferable on a larger scale. Based on the literature, the proposed educational pathway for integrating LLMs into pediatric healthcare education can be schematized into five progressive levels, each characterized by distinct learning objectives, specific usage contexts, and a gradual increase in complexity and educational risk. This breakdown allows for guiding the adoption of generative models in a pedagogically sound manner, avoiding uncritical automation drifts and ensuring constant accompaniment

balanced approach between technological innovation and pedagogical rigor. This review highlights how LLMs offer significant potential for learning personalization, democratic access to specialized knowledge, and the simulation of complex clinical scenarios, elements that could profoundly transform traditional educational paradigms. However, critical analysis of the literature has revealed substantial criticalities that cannot be overlooked. Informational hallucinations, algorithmic biases, the risk of cognitive dependency, and the potential compromise of critical thinking represent challenges that require methodologically rigorous



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mitigation strategies. Convergent scientific evidence suggests that generative artificial intelligence cannot and should not replace human educators or automate the learning process, but it can serve as an amplifier of educational capabilities when integrated into structured and supervised frameworks.

LLMs can significantly contribute to making clinical learning more accessible and dialogic, facilitating access to specialized knowledge and supporting skill development through interactive simulations. However, this potential is fully realized only when implementation occurs within structured educational contexts, characterized by qualified supervision, continuous critical evaluation, and integration with traditional interprofessional pedagogical approaches. The urgency of developing a shared strategy among educators, clinicians, and AI technology developers emerges clearly from the analysis of available evidence. This multidisciplinary collaboration is essential to ensure that the use of LLMs in pediatric healthcare education is simultaneously clinically safe, pedagogically effective, and implementation-wise sustainable. The development of standardized guidelines, evaluation protocols, and ethical frameworks specific to the pediatric field represents a priority that the scientific and educational community must

address with determination and methodological rigor.

Prospects outline scenarios of progressive integration of LLMs into e-learning systems, on-the-field training, and university curricula for pediatric healthcare professions. However, the success of this integration will depend on the ability to keep the human dimensions of pediatric care at the center of the educational process: empathy, critical clinical reasoning, situational adaptability, and relational competence with patients and families. Generative artificial intelligence, when used appropriately, can amplify these fundamental human skills rather than replace them, contributing to the training of more competent, informed pediatric healthcare professionals prepared for the challenges of the future.

The path towards effective and safe implementation of generative AI in pediatric healthcare education requires significant investment in research, faculty training, and the development of adequate technological infrastructure. However, commitment in this direction represents a strategic investment in the future quality of pediatric care and in the preparation of professionals capable of effectively navigating the growing intersection between technology and medicine.

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