

Original Article

ChatGPT applications in medical, dental, pharmacy, and public health education: A descriptive study highlighting the advantages and limitations

Malik Sallam^{1,2,3*}, Nesreen A. Salim^{4,5}, Muna Barakat⁶ and Ala'a B. Al-Tammemi⁷

¹Department of Pathology, Microbiology and Forensic Medicine, School of Medicine, The University of Jordan, Amman, Jordan; ²Department of Clinical Laboratories and Forensic Medicine, Jordan University Hospital, Amman, Jordan; ³Department of Translational Medicine, Faculty of Medicine, Lund University, Malmö, Sweden; ⁴Department of Prosthodontic, School of Dentistry, The University of Jordan, Amman, Jordan; ⁵Department of Prosthodontic, Jordan University Hospital, Amman, Jordan; ⁶Department of Clinical Pharmacy and Therapeutics, Faculty of Pharmacy, Applied Science Private University, Amman, Jordan; ⁷Migration Health Division, International Organization for Migration (IOM), The UN Migration Agency, Amman, Jordan

*Corresponding author: malik.sallam@ju.edu.jo

Abstract

Since its public release in November 2022, ChatGPT has gained a widespread attention and received mixed responses in the academia. Promising applications of ChatGPT in university education has been suggested; however, several concerns were raised. The aim of this descriptive study was to investigate the pros and cons of ChatGPT use in medical, dental, pharmacy, and public health education. Based on expert panel discussion and review of the existing literature, specific and concise ChatGPT prompts were constructed and the responses were generated on 25 February 2023. Out data suggested that in medical education, ChatGPT benefits included the possibility of improving personalized learning, clinical reasoning and understanding of complex medical concepts. The benefits listed in the context of dental education included improved skills through step-by-step instructions and interactive content, with instant feedback on student techniques. In pharmacy education, the advantages included possible explanations of complex subjects and the deployment of interactive tools aiding to develop skills for patient counselling. In public health education, the listed benefits included providing explanations and case scenarios, besides improved skills in data analysis and literature review. The limitations listed based on ChatGPT-generated content were common across all of the investigated healthcare disciplines and included data privacy issues, risk of generating biased and inaccurate content, and the risk of deterioration of critical thinking and communication skills among healthcare students. The ChatGPT-generated content in the context of healthcare education was deemed partially helpful by the expert panel. However, several important points regarding the pros and cons of ChatGPT use in medical, dental, pharmacy and public health education were missed by ChatGPT-generated content including: the risk of plagiarism, copyright issues, the risk of academic dishonesty, and the lack of personal and emotional interactions necessary for developing proper communication skills in healthcare education. In conclusion, despite the promising prospects of ChatGPT in healthcare education, several drawbacks should be addressed with implementation of guidelines for proper use to ensure exploiting the benefits of this innovative technology.

Keywords: Artificial intelligence, machine learning, education, technology, healthcare



Introduction

The launching of ChatGPT by OpenAI (OpenAI, L.L.C., San Francisco, CA, USA), marks a new era of widespread adoption and applicability of artificial intelligence (AI) [1, 2]. ChatGPT represents a conversational chatbot that is based and developed on a type of neural network architecture designed to process and understand natural language [1, 3]. Trained on massive dataset that comprises billion of words, the deployment of ChatGPT allows the instantaneous generation of responses in an interactive manner [1].

The benefits that come with application of ChatGPT as a revolutionary AI-based large-scale language model (LLM) include several transformative aspects of human life, a few of which are presented as follows. First, ChatGPT can be a helpful chatbot in customer service through generation of prompt human-like responses [4]. Second, ChatGPT can help to create content for news articles, blogs and social media posts that can be viewed as unique and versatile with little risk of plagiarism [5]. Third, ChatGPT utility is highly valuable in prompt language translation generating a translated text while preserving the meaning and context of the translated text [1, 2]. Fourth, in scientific research, ChatGPT can be a valuable and effective way of generating literature reviews and summaries, writing programming codes, and analyzing huge clinical and genomic datasets [2]. Fifth, ChatGPT applicability can transform healthcare practice in terms of optimizing workflow and reduce the burden of documentation with subsequent reduction in costs and shift towards personalized medicine [2, 6]. Sixth and importantly, the application of ChatGPT in education, particularly in healthcare disciplines can be described as a paradigm shift mandating the revision of traditional assessment tools and creating novel opportunities to focus on improving critical thinking and problem-based learning [2, 7].

In spite of all the aforementioned benefits, the applicability of ChatGPT comes with several risks that should be studied carefully [2]. These risks entail the issue of generating biased content that is related to the quality of datasets used for ChatGPT training [8]. In addition, credible ethical concerns arose with ChatGPT and other LLMs including the issues of lack of transparency, data privacy concerns, risk of manipulation to generate malicious content with possibility of creating infodemics and cyberwars as well as the issue of generating biased or discriminatory content [2, 7, 9-11]. Moreover, legal concerns in the context of ChatGPT use are worrisome considering the ambiguity of accountability and copyright issues [2, 12-14]. Furthermore, ChatGPT is prone to a phenomenon known as “hallucination” which involves the generation of scientifically false content that appears sound to non-experts [2, 15, 16]. Other limitations of ChatGPT include the lack of certain attributes of human intelligence (e.g., critical and logical thinking, understanding of abstract concepts, emotional intelligence, etc.), limited knowledge based on the training dataset to the period prior to September 2021, risk of academic dishonesty, research fraud, declining dependence on human intelligence and expertise in exploring psychological, social and economical problems [1, 2, 17].

Several recent studies showed the applications of ChatGPT in education, especially in the context of healthcare education as reviewed recently [2]. These studies showed the capabilities of ChatGPT to pass exams like the United States Medical Licensing Examination (USMLE) [18], ophthalmology examination for postgraduates [19], parasitology exam for medical students [20], and the life support exam by the American Heart Association (AHA) [21]. The performance of ChatGPT in the aforementioned exams (e.g., USMLE) revealed the current limitations of the assessment tools in healthcare education that mainly focus on memorization rather than the evaluation of adaptiveness, flexibility, as well as critical thinking and problem-solving skills [22-24].

Therefore, this study aimed to describe ChatGPT content generated in response to prompts crafted to elucidate the pros and cons of ChatGPT use in medical, dental, pharmacy and public health education. Additionally, the study objectives included the assessment of ChatGPT content by a panel of experts who are involved in medical, dental, pharmacy and public health education.

Methods

A descriptive study was conducted using a search strategy that utilized ChatGPT (default model) from OpenAI (OpenAI, L.L.C., San Francisco, CA, USA) on February 25, 2023 [1]. The prompts that were administered to ChatGPT, were generated based on a panel discussion among the authors who are involved in medical, dental, pharmacy and public health education and research. The expertise of the panel is also related to the administrative posts of two authors (NAS and MB) who served as Assistant Deans in their faculties during the study period. The discussions specifically addressed the following points: (1) the potential advantages of ChatGPT in each healthcare discipline; (2) the possible risks/concerns that could emerge with the application of ChatGPT in each healthcare discipline; and (3) the possible strategies to address the challenges that could emerge with the application of ChatGPT in the educational process in each healthcare discipline. Ethical approval was not applicable for this study, because it did not involve humans or animals.

Following the expert panel discussion, and based on a recent systematic review [2, 6], the prompts were constructed in the four subjects as follows:

- A. ChatGPT use in medical education:
 1. Scientifically list the potential use of ChatGPT to provide personalized learning experience in medical education in fewer than 50 words.
 2. Scientifically and concisely elaborate on ChatGPT use to improve medical students' clinical reasoning and problem-solving skills in fewer than 50 words.
 3. Scientifically discuss the abilities of ChatGPT to assist medical students to understand complex medical concepts in their courses in fewer than 50 words.
 4. Scientifically list all the potential concerns and challenges that could be associated with ChatGPT incorporation into medical education in fewer than 50 words.
 5. In fewer than 50 words, how can the potential concerns and challenges that come with ChatGPT integration into medical education be mitigated?
- B. ChatGPT use in dental education:
 1. Scientifically list the potential use of ChatGPT to facilitate teaching of complex dental procedures in fewer than 50 words.
 2. Scientifically elaborate on ChatGPT utility to create interactive educational content for dental students in fewer than 50 words.
 3. Scientifically elaborate on ChatGPT use to improve dental students' basic knowledge to enhance their diagnostic and treatment planning skills in fewer than 50 words.
 4. Scientifically elaborate on ChatGPT utility to assist dental students in developing effective communication skills with patients and colleagues in fewer than 50 words.
 5. Scientifically list all the potential concerns and challenges that could be associated with ChatGPT incorporation into dental education and how these concerns can be mitigated in fewer than 50 words.
- C. ChatGPT use in pharmacy education:
 1. Scientifically list the potential use of ChatGPT in pharmacy education to help in teaching of pharmacology, pharmacokinetics, and drug interactions in fewer than 50 words.
 2. Scientifically discuss the utility of ChatGPT to assist in development of patient counseling, and medication management skills among pharmacy students in fewer than 50 words.
 3. Scientifically elaborate on ChatGPT application to facilitate interprofessional education between pharmacy students and other healthcare professionals, such as physicians, nurses, and allied health practitioners in fewer than 50 words.
 4. Scientifically list all the possible concerns and challenges associated with ChatGPT use in pharmacy education in fewer than 50 words.
 5. Scientifically discuss how to address ChatGPT's limitations in pharmacy education to ensure patient safety and confidentiality in fewer than 50 words.

D. ChatGPT use in public health education:

1. Scientifically list the potential use of ChatGPT in teaching of epidemiology, biostatistics, and health policy to public health students in fewer than 50 words.
2. Scientifically elaborate on ChatGPT utility to assist public health students in developing skills to conduct literature reviews, analyze data, and synthesize evidence for public health practice and policy in fewer than 50 words.
3. Scientifically discuss the ability of ChatGPT to facilitate interprofessional education and collaboration between public health students and other healthcare professionals, policymakers, and community stakeholders in fewer than 50 words.
4. Scientifically discuss the concerns and challenges that could be associated with ChatGPT use in public health education in fewer than 50 words.
5. Scientifically elaborate on how to address ChatGPT's limitations in public health education with regards to data privacy, data security, and potential bias in fewer than 50 words.

For each response, a follow up prompt was constructed as follows: Provide three specific examples with less than 20 words each.

The responses were then evaluated and scored by each member of the expert panel independently followed by a group discussion to reach a verdict regarding correctness (accuracy of the content), clarity (being understandable and coherent), and conciseness (the degree to which all information is delivered) based on the previous approach [7]. The scoring system was as follows: if the response was deemed as completely correct, clear and concise, then the response was scored as "4"; if the response was almost correct, clear and concise, then the response was scored as "3"; if the response was partially correct, clear and concise, then the response was scored as "2"; and if the response was completely incorrect, unclear or lacked conciseness, then it was given a score of "1" [7].

The assessment of the overall inter-rater agreement was conducted using the Fleiss Multirater Kappa through IBM SPSS v26.0 for Windows, with Kappa=0.81–1.00 indicating very good agreement, Kappa=0.61–0.80 indicating good agreement, Kappa=0.41–0.60 indicating moderate agreement, Kappa=0.21–0.40 indicating fair agreement, and Kappa<0.20 indicating poor agreement.

Results

In medical education, ChatGPT listed the following pros of its integration in the educational process: (1) improve personalized learning; (2) improve clinical reasoning; and (3) assist to understand complex medical concepts. For the limitations, the following were listed: (1) privacy concerns; (2) the risk of bias and inaccurate content; and (3) risk of declining skills in communication and critical thinking (**Table 1**). Measures to address these issues included: (1) human oversight; (2) implementing privacy and security measures; and (3) promoting critical analysis of the generated content.

Table 1. ChatGPT output in relation to expert panel queries regarding medical education

Prompt	ChatGPT exact response
Scientifically list the potential use of ChatGPT to provide personalized learning experience in medical education in fewer than 50 words.	ChatGPT has the potential to provide personalized learning experiences in medical education by generating tailored responses to student queries, recommending relevant learning resources, and adapting content to their individual learning needs. <i>*Examples:</i> Generating personalized quiz questions based on student's learning progress Recommending additional resources based on student's knowledge gaps Adapting explanations to match student's preferred learning style.
Scientifically and concisely elaborate on ChatGPT use to improve medical students' clinical reasoning and problem-solving skills in fewer than 50 words.	ChatGPT can improve medical students' clinical reasoning and problem-solving skills by providing immediate feedback on their reasoning process, generating case scenarios for practice, and identifying knowledge gaps to inform future learning. <i>*Examples:</i> Generating feedback on student's diagnostic and treatment plans

Prompt	ChatGPT exact response
Scientifically discuss the abilities of ChatGPT to assist medical students to understand complex medical concepts in their courses in fewer than 50 words.	<p>Creating practice cases with varying levels of complexity Identifying knowledge gaps and recommending learning resources to address them.</p> <p>ChatGPT can assist medical students to understand complex medical concepts by generating natural language explanations, simplifying complex language, providing additional examples and analogies, and linking to relevant resources to deepen their understanding.</p> <p><i>*Examples:</i> Generating explanations of complex physiological processes Simplifying medical jargon into layman's terms Providing additional examples or analogies to clarify difficult concepts.</p>
Scientifically list all the potential concerns and challenges that could be associated with ChatGPT incorporation into medical education in fewer than 50 words.	<p>Potential concerns and challenges associated with ChatGPT incorporation into medical education include privacy and security risks, limited ability to recognize bias or errors, overreliance on technology, lack of social interaction and communication skills, and potential for reduced critical thinking and creativity.</p> <p><i>*Examples:</i> Privacy concerns related to use of student and patient data Lack of opportunities for in-person communication and teamwork Possibility of bias or inaccuracy in generated responses due to limitations in training data.</p>
In fewer than 50 words, how can the potential concerns and challenges that come with ChatGPT integration into medical education be mitigated?	<p>Potential concerns and challenges associated with ChatGPT integration into medical education can be mitigated by developing ethical guidelines for its use, integrating human oversight and feedback, providing instruction in critical thinking and communication skills, ensuring privacy and security measures, and monitoring for bias and errors.</p> <p><i>*Examples:</i> Providing regular training and oversight for human supervisors Implementing privacy and security measures to protect sensitive information Encouraging critical thinking and analysis of ChatGPT-generated responses.</p>

*Examples were based on the follow up prompt "Provide three specific examples with less than 20 words each."

The responses with regard to dental education are presented in **Table 2**. Briefly, ChatGPT applications in dental education include enhancing basic and diagnostic skills through step-by-step instructions, providing interactive educational content, enhancing communication skills and prompt feedback on student techniques and decision-making skills. Limitations included data privacy, bias declining creativity and critical thinking. Measures to address these limitations included human feedback and supervision, and implementing ethical guidelines for use.

Table 2. ChatGPT output in relation to expert panel queries regarding dental education

Prompt	ChatGPT exact response
Scientifically list the potential use of ChatGPT to facilitate teaching of complex dental procedures in fewer than 50 words.	<p>ChatGPT can facilitate teaching of complex dental procedures by generating step-by-step instructions, providing visual aids and simulations, answering student questions, and offering immediate feedback on their technique and decision-making.</p> <p><i>*Examples:</i> Generating 3D visualizations of complex dental procedures Providing detailed instructions for performing each step of the procedure Giving immediate feedback on the student's technique and decision-making.</p>
Scientifically elaborate on ChatGPT utility to create interactive educational content for dental students in fewer than 50 words.	<p>ChatGPT can create interactive educational content for dental students by generating quizzes, flashcards, and interactive simulations, as well as generating natural language explanations of dental concepts and linking to relevant resources.</p> <p><i>*Examples:</i> Generating interactive simulations of dental procedures and techniques Creating personalized flashcards for students to review key concepts and terminology Linking to relevant resources, such as textbooks and research articles.</p>
Scientifically elaborate on ChatGPT use to improve	<p>ChatGPT can improve dental students' basic knowledge and enhance their diagnostic and treatment planning skills by generating case scenarios and</p>

Prompt	ChatGPT exact response
dental students' basic knowledge to enhance their diagnostic and treatment planning skills in fewer than 50 words.	providing immediate feedback on their reasoning process, as well as generating natural language explanations of dental concepts and linking to relevant resources to deepen their understanding. <i>*Examples:</i> Generating case scenarios with different dental conditions and patient histories Providing feedback on student's diagnostic and treatment plans Recommending learning resources to address knowledge gaps.
Scientifically elaborate on ChatGPT utility to assist dental students in developing effective communication skills with patients and colleagues in fewer than 50 words.	ChatGPT can assist dental students in developing effective communication skills by generating simulated patient interactions, providing feedback on communication techniques, and generating natural language responses to common patient and colleague questions and scenarios. <i>*Examples:</i> Generating simulated patient interactions to practice communication techniques Providing feedback on student's communication skills Generating natural language responses to common patient questions and concerns.
Scientifically list all the potential concerns and challenges that could be associated with ChatGPT incorporation into dental education and how these concerns can be mitigated in fewer than 50 words.	Potential concerns and challenges associated with ChatGPT incorporation into dental education include reliability and accuracy of generated content, potential for overreliance on technology, limited ability to recognize bias or errors, privacy and security risks, and potential for reduced critical thinking and creativity. These can be mitigated by integrating human oversight and feedback, developing ethical guidelines for use, providing instruction in critical thinking and communication skills, and ensuring privacy and security measures. <i>*Examples:</i> Providing regular training and oversight for human supervisors Implementing privacy and security measures to protect sensitive information Encouraging critical thinking and analysis of ChatGPT-generated responses.

*Examples were based on the follow up prompt "Provide three specific examples with less than 20 words each."

The views of ChatGPT regarding pharmacy education are illustrated in **Table 3**. Advantages included providing explanations of the complex pharmacy subjects, and the use of interactive tools to aid in learning and developing skills needed for patient counseling. Concerns included privacy risks, inaccurate ChatGPT content, overreliance on technology, and reduced critical thinking. Mitigation strategies included the implementation of human oversight, ethical guidelines, and privacy measures.

Table 3. ChatGPT output in relation to expert panel queries regarding pharmacy education

Prompt	ChatGPT exact response
Scientifically list the potential use of ChatGPT in pharmacy education to help in teaching of pharmacology, pharmacokinetics, and drug interactions in fewer than 50 words.	ChatGPT can assist in pharmacy education by generating natural language explanations of pharmacology, pharmacokinetics, and drug interactions, providing examples and case scenarios, generating flashcards and quizzes, and linking to relevant resources. <i>*Examples:</i> Generating natural language explanations of drug mechanisms and interactions Providing interactive drug interaction simulations Generating personalized quizzes based on student's progress.
Scientifically discuss the utility of ChatGPT to assist in development of patient counseling, and medication management skills among pharmacy students in fewer than 50 words.	ChatGPT can assist in the development of patient counseling and medication management skills by generating simulated patient interactions, providing feedback on communication and counseling techniques, and generating natural language responses to common patient questions and scenarios. <i>*Examples:</i> Generating simulated patient interactions to practice counseling techniques Providing feedback on student's counseling skills Generating natural language responses to common patient questions and concerns.
Scientifically elaborate on	ChatGPT can facilitate interprofessional education by generating case

Prompt	ChatGPT exact response
ChatGPT application to facilitate interprofessional education between pharmacy students and other healthcare professionals, such as physicians, nurses, and allied health practitioners in fewer than 50 words.	scenarios and natural language explanations of different healthcare professions' roles, as well as providing opportunities for collaboration and communication with other healthcare professionals to enhance understanding of their respective roles in patient care. <i>*Examples:</i> Generating case scenarios that involve collaboration between different healthcare professions Generating natural language explanations of different healthcare professions' roles and responsibilities Providing opportunities for collaboration and communication between different healthcare professions.
Scientifically list all the possible concerns and challenges associated with ChatGPT use in pharmacy education in fewer than 50 words.	Possible concerns and challenges associated with ChatGPT use in pharmacy education include privacy and security risks, reliability and accuracy of generated content, potential for overreliance on technology, limited ability to recognize bias or errors, and potential for reduced critical thinking and creativity. <i>*Examples:</i> Accuracy and reliability of generated drug information Potential for over-reliance on ChatGPT-generated responses Limited ability to recognize errors or inaccuracies in generated content.
Scientifically discuss how to address ChatGPT's limitations in pharmacy education to ensure patient safety and confidentiality in fewer than 50 words.	To address ChatGPT's limitations in pharmacy education and ensure patient safety and confidentiality, it's essential to integrate human oversight and feedback, develop ethical guidelines for use, ensure privacy and security measures are in place, and regularly monitor for potential errors or biases. <i>*Examples:</i> Providing regular training and oversight for human supervisors Implementing privacy and security measures to protect sensitive information Encouraging critical thinking and analysis of ChatGPT-generated responses.

*Examples were based on the follow up prompt "Provide three specific examples with less than 20 words each."

In public health education as illustrated in **Table 4**, the listed benefits included ChatGPT providing explanations, case scenarios, and quizzes, and facilitating interprofessional education. Additionally, the benefits included developing skills for data analysis and literature review. Concerns included overreliance on technology, privacy risks, risk of bias, and limitations in ignoring the social determinants of health. Addressing these concerns was suggested through implementing privacy measures, ethical guidelines, human oversight, monitoring of bias and compliance with regulations for data protection.

Table 4. ChatGPT output in relation to expert panel queries regarding public health education

Prompt	ChatGPT exact response
Scientifically list the potential use of ChatGPT in teaching of epidemiology, biostatistics, and health policy to public health students in fewer than 50 words.	ChatGPT can assist in public health education by generating natural language explanations of epidemiology, biostatistics, and health policy concepts, providing case scenarios and examples, generating flashcards and quizzes, and linking to relevant resources. <i>*Examples:</i> Generating natural language explanations of epidemiology and biostatistics concepts Providing interactive policy simulation scenarios Generating personalized quizzes based on student's progress.
Scientifically elaborate on ChatGPT utility to assist public health students in developing skills to conduct literature reviews, analyze data, and synthesize evidence for public health practice and policy in fewer than 50 words.	ChatGPT can assist public health students in developing skills to conduct literature reviews, analyze data, and synthesize evidence by providing guidance and feedback on search strategies and statistical methods, generating summaries of research findings and implications, and linking to relevant resources. <i>*Examples:</i> Generating natural language explanations of systematic review methods Providing interactive data visualization tools for analyzing public health data Generating personalized quizzes based on student's progress in data analysis.
Scientifically discuss the	ChatGPT can facilitate interprofessional education and collaboration by

Prompt	ChatGPT exact response
ability of ChatGPT to facilitate interprofessional education and collaboration between public health students and other healthcare professionals, policymakers, and community stakeholders in fewer than 50 words.	generating case scenarios and natural language explanations of different healthcare and public health professions' roles, as well as providing opportunities for collaboration and communication with other healthcare professionals, policymakers, and community stakeholders to enhance understanding of their respective roles in public health practice and policy. <i>*Examples:</i> Generating case scenarios that involve collaboration between different healthcare professionals, policymakers, and community stakeholders Providing opportunities for communication and collaboration between different healthcare professionals, policymakers, and community stakeholders Generating natural language explanations of different healthcare professions' roles and responsibilities in public health practice and policy.
Scientifically discuss the concerns and challenges that could be associated with ChatGPT use in public health education in fewer than 50 words.	Concerns and challenges with ChatGPT use in public health education include potential for overreliance on technology, privacy and security risks, limited ability to recognize bias or errors, potential for reduced critical thinking and creativity, and limitations in recognizing the social determinants of health. <i>*Examples:</i> Accuracy and reliability of generated public health information Potential for over-reliance on ChatGPT-generated responses Limited ability to recognize errors or inaccuracies in generated content.
Scientifically elaborate on how to address ChatGPT's limitations in public health education with regards to data privacy, data security, and potential bias in fewer than 50 words.	To address ChatGPT's limitations in public health education, it is essential to ensure that privacy and security measures are in place, develop ethical guidelines for use, integrate human oversight and feedback, regularly monitor for potential errors or biases, and ensure compliance with relevant data protection regulations and policies. <i>*Examples:</i> Implementing secure storage and access controls to protect sensitive information Encouraging human oversight to ensure accuracy and reliability of generated content Regularly monitoring for bias and errors to ensure fair and unbiased representation of public health information.

*Examples were based on the follow up prompt "Provide three specific examples with less than 20 words each."

The ChatGPT-generated content was evaluated by the expert panel and the subjective evaluation revealed that the content can be described as almost correct with a mean score across the four raters of 3.96 ± 0.19 . The ChatGPT-generated content was deemed to be partially clear based on a mean score across all raters of 2.96 ± 0.19 . Additionally, the ChatGPT-generated content showed a partial lack of conciseness, with a mean score across the four raters of 2.56 ± 0.50 , with redundant content at times, as well as missing relevant and important aspects that included: (1) lack of referencing; (2) missing the copyright issues; and (3) risk of increased burden needed to evaluate the generated content, by the inclusion of overdetailed excessive content. The inter-rater agreement was good based on the overall Fleiss Multirater Kappa value of 0.681.

Discussion

The current study was conducted during a heated debate regarding the applicability of ChatGPT as an AI-based LLM in education including healthcare education [2, 6, 25]. Therefore, we aimed to evaluate the utility of ChatGPT in healthcare education taking a dual approach of ChatGPT-generated responses and subjective evaluation of this response based on the opinions of the authors involved in healthcare education. Thus, the current study assessed the potential transformative potential of ChatGPT as an example of LLMs as an innovative tool to address the current challenges in healthcare education.

The proverb "if it aint broken don't fix it" does not currently seem to be applicable in the context of healthcare education, due to the various challenges and shortcomings that should be addressed properly, and the availability of novel innovative AI-based tools such as ChatGPT can be helpful in this regard [26]. These challenges facing healthcare education are enormous, a few

of which include: (1) in several countries, a rapid increase in the number of healthcare students was not met by contemporaneous improvements in the number and quality of healthcare faculties; (2) the rapid changes in the landscape of healthcare settings with changes in societal expectations and demands regarding healthcare services; (3) the exponential growth and availability of healthcare-related knowledge; (4) the rapid evolution of technological advancements and innovations needed to be incorporated in healthcare; (5) the need to improve training that involves communication skills that are essential for health professionals; and (6) the continuous need to refine healthcare students' assessment methods to reach credible, fair and valid results that are considered as integral aims of curricula in higher education [27-31]. Therefore, aspiring for continuous improvements in healthcare education appears of an utmost value.

The advantages of digital education (e-learning) as well as the benefits of incorporating digital literacy in healthcare education has been advocated for years [32-35]. The benefits include preparing the students to have up-to-date information in terms of swift and massive evolution of health-related topics [36]. Additionally, digital literacy can help the students be prepared to recognize and challenge polluted information sources [36, 37]. Moreover, the development of healthcare curricula based on digital literacy is important to prepare health professionals able to effectively implement online technologies in patient care [36, 38].

The findings of this study indicated the promising potential of ChatGPT as an example of LLMs based on the ChatGPT-generated listed benefits in healthcare education as follows: First, the integration of ChatGPT as an example of LLMs' Chatbots, in medical education could have several advantages. Personalized learning (student-centered learning) can be a promising benefit of using ChatGPT, enabling the tailoring of both educational content and assessment tools to the specific needs and learning styles of different students. Such an approach can help in achieving a holistic learning experience, with an opportunity for interactive tools that can be helpful to improve the achievement of intended learning outcomes [39]. Personalized learning has been shown to enhance healthcare students' engagement and enrich their learning outcomes [40]. Additionally, AI-based technologies might be helpful in enhancing the clinical reasoning skills through providing medical students with realistic case scenarios with instantaneous feedback on their diagnostic and treatment decisions [41]. Thus, ChatGPT can help medical students to practice and refine their clinical skills through simulation in a safe and controlled environment, minimizing the risk of harm to real patients [42]. Furthermore, ChatGPT's usefulness in medical education can be related to the ability to simplify complex medical concepts and jargon to elements that become easier to comprehend reinforced with interactive explanations and demonstrations [43]. In this study, ChatGPT responses based on the evaluation of the expert panel, correctly listed the benefits of integrating such technology among other LLMs in medical education, which could represent a valuable tool to improve learning and assessment, ultimately leading to improved learning outcomes [44].

Second, in dental education, the utility of ChatGPT can be promising. In recent years, dental education has increasingly utilized technology to develop a meaningful, yet enjoyable learning experience among dental students [45]. In particular, the adaptation of Chatbots' technology in dental education has been suggested to be valued highly by the students via providing an engaging and personal experience [46]. This experience can be achieved by providing interactive content and step-by-step instructions much needed in dental education [47]. Additionally, the use of ChatGPT among other Chatbots can have an economic value with reducing the costs and the spaces needed for dental students' training [46]. The value of ChatGPT is of particular relevance in clinical training of dental students enabling them to practice their techniques in a controlled environment, with subsequent improvement in their skills [45, 48]. Additionally, Chatbots providing virtual reality experience with immediate feedback on dental students' techniques, allow the students to have opportunities for tailored personalized dental training [46]. Thus, ChatGPT can offer promising opportunities to dental education, providing personalized and cost-effective learning experiences [47].

Third, recent studies showed the potential benefits of integrating Chatbots, such as ChatGPT, in pharmacy education [49]. One of the main advantages of using ChatGPT in

pharmacy education is the ability to provide easier explanations of complex subjects and medical jargon to aid the students to understand complex pharmaceutical and medical concepts [50, 51]. Moreover, ChatGPT among other AI-based educational tools can offer interactive platforms that may enhance the development of essential skills for patient counseling, such as facial expression and emotional communication [52]. Thus, the integration of AI-based tools such as ChatGPT in pharmacy education may offer an effective approach to enhance the achievement of intended learning outcomes, aiding to develop essential skills for pharmacy professionals, that could contribute to more positive healthcare outcomes.

Fourth, in public health education, ChatGPT is advantageous in the delivery of explanations and case scenarios that facilitate learners' understanding of complex public health issues [53]. Chatbots including ChatGPT can provide students in public health domain the opportunity to develop essential skills needed in data analysis and comprehensive review of literature, which are fundamental aspects of public health education and research [54]. In turn, the value of ChatGPT can help public health students to address real-world public health problems and challenges [55]. Therefore, ChatGPT can be viewed as a promising tool in public health education offering valuable tools to develop and enhance essential skills of data analysis and tackling complex and evolving public health scenarios [56, 57].

An important point that was investigated in this study is the challenges and worries of using ChatGPT in healthcare education and how to address these possible concerns. As with any new technology, there are limitations that must be addressed to ensure that the benefits of using this innovation will outweigh the associated risks [6].

One significant limitation of Chatbots in healthcare education is the issue of breaching data privacy [2, 58]. Healthcare education involves the use of sensitive patient information; thus, ChatGPT among other AI-based tools must be strictly regulated with full protection of data privacy to maintain patients' confidentiality, and prevent any deleterious implications of breaching data privacy (e.g., insurance, job opportunities, and personal relationships) [59, 60]. Therefore, the utility of ChatGPT in healthcare education should be considered in light of the possible severe consequences for both the patients and the health professionals which may entail legal liability issues [2].

Another limitation of ChatGPT listed across different healthcare educational disciplines in this study was the potential for generating biased, outdated, or inaccurate content [2, 61]. The inadvertent generation of incomplete, inaccurate, or biased content in the context of healthcare education could undermine the quality of education and ultimately result in a negative impact on healthcare quality [62]. Thus, it is important to consider that ChatGPT ability to generate accurate and unbiased content and the possible limitations to maintain the integrity of healthcare education [57].

Importantly, a significant limitation of ChatGPT use is the potential for suppressing the development of critical thinking and communication skills among healthcare students through discouraging the engagement of students in critical evaluation of study material [63]. Furthermore, ChatGPT among other AI-based educational tools may compromise the ability to develop skills needed for human interaction and communication, which are critical skills for health professionals [64]. These skills are indispensable for effective communication with patients and their families, as well as for ideal communication with other healthcare workers, needed to make informed decisions that could impact patient care [65].

Based on the aforementioned points, all the stakeholders involved in healthcare education must balance the application of ChatGPT among other LLMs with traditional learning methods to reach the maximum benefits of such an approach [66]. The importance of promoting the continuous need of developing critical thinking and communication skills among healthcare students should be emphasized with integration of active learning and independent thinking.

Finally, the current study results must be carefully interpreted in light of the following shortcomings: (1) despite the evaluation of ChatGPT responses by an expert panel comprising authors involved in healthcare education, the few number of authors and the subjective nature of assessing ChatGPT responses should be considered as potential sources of bias in the assessment of the advantages and disadvantages of ChatGPT use in healthcare education; (2)

the ChatGPT prompt construction was done with a clear instruction regarding the word count to be generated by ChatGPT, which was done to address the issue of overdetailed content; however, this may have caused missing of important or relevant information regarding the queries; and (3) the lack of evaluation of some healthcare related disciplines (e.g., nursing, medical technology) should be considered in any future work aiming to evaluate the ChatGPT utility in healthcare education.

Conclusions and future prospects

The adoption of ChatGPT and other LLM-based technologies in medical, dental, pharmacy, and public health education can have promising prospects. However, this should be guided by evidence-based results of further studies to address the potential shortcomings of implementing LLMs such as ChatGPT in the process of healthcare education [6]. These studies should focus on the ethical among other transparency and bias issues, as well as the copyright issues and the possibility of inaccurate or misleading content, especially in certain subject areas (e.g., parasitology) [17, 20, 67, 68].

The integration of ChatGPT as an example of AI-based LLMs in healthcare education can offer several advantages; however, it is essential to consider the possible limitations associated with this innovative technology. Faculties in healthcare education must carefully weigh the benefits and the risks/concerns of ChatGPT and proactively attempt to mitigate its potential risks. Thus, ChatGPT can provide healthcare students with personalized, interactive, and effective learning tools that could enhance the positive development of skills in healthcare education, ultimately improving patient care. Integration of the traditional methods with AI-based methods including ChatGPT can be advantageous. The issues of data privacy, besides the possibility of generating inaccurate and biased information should be considered. Thus, a careful embrace of this innovative technology can be beneficial if cautiously regulated.

Ethics approval

Not required. Ethical approval was not applicable for this study, because it did not involve humans or animals.

Acknowledgments

We are deeply thankful for OpenAI (OpenAI, L.L.C., San Francisco, CA, USA), which allowed free access to ChatGPT.

Conflict of interest

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

How to cite

Sallam M, Salim NA, Barakat M, Al-Tammemi AB. ChatGPT applications in medical, dental, pharmacy, and public health education: A descriptive study highlighting the advantages and limitations. *Narra J* 2023; 3 (1): e103 - <http://doi.org/10.52225/narra.v3i1.103>.

References

1. OpenAI. OpenAI: Models GPT-3. Available from: <https://beta.openai.com/docs/models>. Accessed: 14 January 2023.
2. Sallam M. The Utility of ChatGPT as an example of large language models in healthcare education, research and practice: systematic review on the future perspectives and potential limitations. medRxiv 2023. DOI: 10.1101/2023.02.19.23286155.

3. Radford A, Narasimhan K, Salimans T, *et al.* Improving language understanding by generative pre-training. Preprint 2018. Available from: <https://paperswithcode.com/paper/improving-language-understanding-by>. Accessed: 2 March 2023.
4. Nagarhalli TP, Vaze V, Rana N. A review of current trends in the development of chatbot systems. In: 2020 6th International conference on advanced computing and communication systems (ICACCS): 2020: IEEE; 2020: 706-710.
5. Atlas S. ChatGPT for higher education and professional development: a guide to conversational AI. College of Business faculty at the University of Rhode Island 2023. 1-2023. Available from: https://digitalcommons.uri.edu/cba_facpubs/548. Accessed: 2 March 2023.
6. Sallam M. ChatGPT utility in health care education, research, and practice: Systematic review on the promising perspectives and valid concerns. *Healthcare* 2023; 11(6):887.
7. Sallam M, Salim NA, Al-Tammemi AB, *et al.* ChatGPT output regarding compulsory vaccination and COVID-19 vaccine conspiracy: A descriptive study at the outset of a paradigm shift in online search for information. *Cureus* 2023; 15(2):e35029.
8. Dale R. GPT-3: What' s it good for? *Nat Lang Eng* 2021; 27(1):113-118.
9. Marchandot B, Matsushita K, Carmona A, *et al.* ChatGPT: The next frontier in academic writing for cardiologists or a pandora's box of ethical dilemmas. *Eur Heart J Open* 2023:oead007.
10. De Angelis L, Baglivo F, Arzilli G, *et al.* ChatGPT and the rise of large language models: The new AI-driven infodemic threat in public health. *SSRN* 2023; DOI: 10.2139/ssrn.4352931.
11. Liebreuz M, Schleifer R, Buadze A, *et al.* Generating scholarly content with ChatGPT: ethical challenges for medical publishing. *Lancet Digit Health* 2023. DOI: 10.1016/s2589-7500(23)00019-5 (In press).
12. Stokel-Walker C, Van Noorden R. What ChatGPT and generative AI mean for science. *Nature* 2023; 614(7947):214-216.
13. Biswas S. ChatGPT and the future of medical writing. *Radiology* 2023:223312.
14. Lin Z. Why and how to embrace AI such as ChatGPT in your academic life. *PsyArXiv* 2023; DOI: 10.31234/osf.io/sdx3j.
15. Deng J, Lin Y. The benefits and challenges of ChatGPT: An overview. *Front Comput Intell Systems* 2023; 2(2):81-83.
16. Shen Y, Heacock L, Elias J, *et al.* ChatGPT and other large language models are double-edged swords. *Radiology* 2023:230163.
17. Borji A. A categorical archive of ChatGPT failures. *arXiv preprint* 2023; DOI: 10.48550/arXiv.2302.03494.
18. Kung TH, Cheatham M, Medenilla A, *et al.* Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. *PLOS Digital Health* 2023; 2(2):e0000198.
19. Antaki F, Touma S, Milad D, *et al.* Evaluating the performance of ChatGPT in ophthalmology: An analysis of its successes and shortcomings. *medRxiv* 2023; DOI: 10.1101/2023.01.22.23284882.
20. Huh S. Are ChatGPT' s knowledge and interpretation ability comparable to those of medical students in Korea for taking a parasitology examination?: a descriptive study. *J Educ Eval Health Prof* 2023; 20:1.
21. Fijačko N, Gosak L, Štiglic G, *et al.* Can ChatGPT pass the life support exams without entering the American Heart Association course? *Resuscitation* 2023; DOI: 10.1016/j.resuscitation.2023.109732 (In press).
22. Epstein RM. Assessment in medical education. *N Engl J Med* 2007; 356(4):387-396.
23. Hatem CJ, Searle NS, Gunderman R, *et al.* The educational attributes and responsibilities of effective medical educators. *Academic Medicine* 2011; 86(4).
24. Patel VL, Yoskowitz NA, Arocha JF, *et al.* Cognitive and learning sciences in biomedical and health instructional design: A review with lessons for biomedical informatics education. *J Biomedl Inform* 2009; 42(1):176-197.
25. Taecharungroj V. "What Can ChatGPT Do?" ; Analyzing early reactions to the innovative AI Chatbot on Twitter. *Big Data Cog Comput* 2023; 7(1):35.
26. Mennin S. Ten global challenges in medical education: Wicked issues and options for action. *Med Sci Educ* 2021; 31(1):17-20.
27. Rosenbaum ME. Dis-integration of communication in healthcare education: Workplace learning challenges and opportunities. *Patient Educ Couns* 2017; 100(11):2054-2061.
28. Hou J, Michaud C, Li Z, *et al.* Transformation of the education of health professionals in China: progress and challenges. *Lancet* 2014; 384(9945):819-827.
29. Guze PA. Using technology to meet the challenges of medical education. *Trans Am Clin Climatol Assoc* 2015; 126:260-270.

30. Frenk J, Chen L, Bhutta ZA, *et al.* Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. *Lancet* 2010; 376(9756):1923-1958.
31. Tabish SA. Assessment methods in medical education. *Int J Health Sci (Qassim)* 2008; 2(2):3-7.
32. Holland Brown TM, Bewick M. Digital health education: the need for a digitally ready workforce. *Archives of Disease in Childhood - Education and Practice* 2022. DOI: 10.1136/archdischild-2021-322022 (In press).
33. Kyaw BM, Posadzki P, Paddock S, *et al.* Effectiveness of digital education on communication skills among medical students: Systematic review and meta-analysis by the digital health education collaboration. *J Med Internet Res* 2019; 21(8):e12967.
34. Kyaw BM, Saxena N, Posadzki P, *et al.* Virtual reality for health professions education: Systematic review and meta-analysis by the digital health education collaboration. *J Med Internet Res* 2019; 21(1):e12959.
35. Dunleavy G, Nikolaou CK, Nifakos S, *et al.* Mobile digital education for health professions: Systematic review and meta-analysis by the digital health education collaboration. *J Med Internet Res* 2019; 21(2):e12937.
36. Mesko B, Gyórfy Z, Kollár J. Digital literacy in the medical curriculum: A course with social media tools and gamification. *JMIR Med Educ* 2015; 1(2):e6.
37. Haleem A, Javaid M, Qadri MA, *et al.* Understanding the role of digital technologies in education: A review. *Sustain Oper Comput* 2022; 3:275-285.
38. Isidori V, Diamanti F, Gios L, *et al.* Digital technologies and the role of health care professionals: Scoping review exploring nurses' skills in the digital era and in the light of the COVID-19 pandemic. *JMIR Nurs* 2022; 5(1):e37631.
39. Bhutoria A. Personalized education and artificial intelligence in the United States, China, and India: A systematic review using a Human-In-The-Loop model. *Comput Educ* 2022; 3:100068.
40. Rojanasart S, Milone A, Balestrieri R, *et al.* Personalized learning in an online drugs and US health care system controversies course. *Am J Pharm Educ* 2018; 82(8):6391.
41. Grunhut J, Wyatt ATM, Marques O. Educating future physicians in artificial intelligence (AI): An integrative review and proposed changes. *J Med Educ Curric Dev* 2021; 8:23821205211036836.
42. Datta R, Upadhyay K, Jaideep C. Simulation and its role in medical education. *Med J Armed Forces India* 2012; 68(2):167-172.
43. Sapci AH, Sapci HA. Artificial intelligence education and tools for medical and health informatics students: Systematic review. *JMIR Med Educ* 2020; 6(1):e19285.
44. Kaur A, Singh S, Chandan JS, *et al.* Qualitative exploration of digital chatbot use in medical education: A pilot study. *Digit Health* 2021; 7:20552076211038151.
45. Zitzmann NU, Matthisson L, Ohla H, *et al.* Digital undergraduate education in dentistry: A systematic review. *Int J Environ Res Public Health* 2020; 17(9):3269.
46. Suárez A, Adanero A, Díaz-Flores García V, *et al.* Using a virtual patient via an artificial intelligence chatbot to develop dental students' diagnostic skills. *Int J Environ Res Public Health* 2022; 19(14):8735.
47. Thurzo A, Strunga M, Urban R, *et al.* Impact of artificial intelligence on dental education: A review and guide for curriculum update. *Educ Sci* 2023; 13(2):150.
48. Hassani H, Amiri Andi P, Ghodsi A, *et al.* Shaping the future of smart dentistry: from artificial intelligence (AI) to intelligence augmentation (IA). *IoT* 2021; 2(3):510-523.
49. Hope DL, Grant GD, Rogers GD, *et al.* Virtualized gamified pharmacy simulation during COVID-19. *Pharmacy* 2022; 10(2):41.
50. Hsu M-H, Chan T-M, Yu C-S. Termbot: A chatbot-based crossword game for gamified medical terminology learning. *Int J Environ Res Public Health* 2023; 20(5):4185.
51. Rooson D, Chok J, Baskys A, *et al.* PGxKnow: a pharmacogenomics educational HoloLens application of augmented reality and artificial intelligence. *Pharmacogenomics* 2022; 23(4):235-245.
52. Nakagawa N, Odanaka K, Ohara H, *et al.* Communication training for pharmacy students with standard patients using artificial intelligence. *Curr Pharm Teach Learn* 2022; 14(7):854-862.
53. Jungwirth D, Haluza D. Artificial intelligence and public health: An exploratory study. *Int J Environ Res Public Health* 2023; 20(5):4541.
54. Wilson L, Marasoiu M. The development and use of chatbots in public health: Scoping review. *JMIR Hum Factors* 2022; 9(4):e35882.
55. Giansanti D. Artificial intelligence in public health: Current trends and future possibilities. *Int J Environ Res Public Health* 2022; 19(19):11907.

56. Lomis K, Jeffries P, Palatta A, *et al.* Artificial intelligence for health professions educators. *NAM Perspect* 2021; 2021.
57. World Health Organization. Ethics and governance of artificial intelligence for health: WHO guidance. Available from: <https://apps.who.int/iris/handle/10665/341996>. Accessed: 4 March 2023.
58. Mijwil M, Aljanabi M, Ali A. ChatGPT: Exploring the role of cybersecurity in the protection of medical information. *Mesopotamian Journal of CyberSecurity* 2023:18–21.
59. Hasal M, Nowaková J, Ahmed Saghair K, *et al.* Chatbots: Security, privacy, data protection, and social aspects. *Concurrency and Computation: Practice and Experience* 2021; 33(19):e6426.
60. Gerke S, Minssen T, Cohen G. Chapter 12 - Ethical and legal challenges of artificial intelligence-driven healthcare. In: Bohr A, Memarzadeh K (eds). *Artificial Intelligence in Healthcare*. Academic Press. 2020: 295-336.
61. Tili A, Shehata B, Adarkwah MA, *et al.* What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learn Enviro* 2023; 10(1):15.
62. Marcelin JR, Siraj DS, Victor R, *et al.* The Impact of unconscious bias in healthcare: How to recognize and mitigate it. *J Infect Dis* 2019; 220(Supplement_2):S62-S73.
63. Cotton D, Cotton P, Shipway J. Chatting and cheating. Ensuring academic integrity in the era of ChatGPT. *EdArXiv* 2023; Preprint. DOI: 10.35542/osf.io/mrz8h.
64. Brown JEH, Halpern J. AI chatbots cannot replace human interactions in the pursuit of more inclusive mental healthcare. *SSM - Mental Health* 2021; 1:100017.
65. King A, Hoppe RB. "Best practice" for patient-centered communication: a narrative review. *J Grad Med Educ* 2013; 5(3):385-393.
66. Eysenbach G. The role of ChatGPT, generative language models and artificial intelligence in medical education: Sconversation with ChatGPT - and a Call for Papers. *JMIR Med Educ* 2023. DOI: 10.2196/46885 (In press).
67. Aljanabi M, Ghazi M, Ali A, *et al.* ChatGpt: Open possibilities. *Iraqi J Comp Sci Math* 2023; 4:62–64.
68. Benoit J. ChatGPT for clinical vignette generation, revision, and evaluation. *medRxiv* 2023. DOI: 10.1101/2023.02.04.23285478.