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Assessing the impact of ChatGPT on enhancing learning in preclinical and clinical dental education

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ABSTRACT

BACKGROUND & OBJECTIVE: Artificial intelligence (AI) is transforming not only education but also healthcare. ChatGPT offers new opportunities for interactive learning. This study assessed the benefits, challenges, and applications of this approach in pre-clinical and clinical dental education.

METHODOLOGY: A cross-sectional, questionnaire-based survey was conducted among 300 undergraduate dental students (preclinical and clinical) in Lahore. A validated self-administered questionnaire assessed knowledge, perceptions, and practices. Data were analyzed using SPSS v25.0; the chi-square test was applied with significance set at $p \leq 0.05$.

RESULTS: Awareness of ChatGPT was high (96%). Active use as a learning tool was reported by 86%, with higher use among clinical students (95%) compared to preclinical students (76%) ($p<0.001$). While 94% expressed interest in integrating ChatGPT into future education, challenges included lack of formal training (49%), difficulties in usage (97%), and skepticism about its relevance to clinical dentistry (46%). Although 89% recognized its role in providing current literature, 72% reported unreliable or inadequate information regarding clinical dentistry.

CONCLUSION: ChatGPT is widely adopted as a learning adjunct among dental students, particularly in clinical years. Despite its potential to enhance communication and evidence-based learning, concerns regarding accuracy, reliability, and ethical integration remain. Careful incorporation into curricula is necessary to maximize benefits while addressing limitations.

KEYWORDS: Deep Learning, ChatGPT, Dental Education, Artificial Intelligence.

INTRODUCTION

Various sectors, including finance and healthcare, are being rapidly reshaped by the advancement of artificial intelligence [1]. The integration of artificial intelligence (AI) within the field of natural language processing (NLP) is fundamental and relies on it for the advancement of intricate language models capable of generating text responses that are akin to human-like expressions [2]. The COVID-19 pandemic has further accelerated the adoption of AI-driven tools in education when face-to-face interaction was reduced to almost zero [3]. At the forefront of the technological revolution, an innovative AI creation powered by advanced deep learning algorithms called ChatGPT stands. This groundbreaking invention specializes in crafting tailored outputs suitable for a wide range of contexts. A recent milestone has been marked with the integration of AI with

NLP, sparking transformative advancements across various domains such as healthcare and education [4].

Extensive discourse has been noted regarding the utilization of ChatGPT and similar AI-driven tools within educational environments, particularly in relation to pedagogical approaches [5,6]. ChatGPT offers a valuable tool for enhancing educational outcomes, nurturing critical thinking among both practicing professionals and students engaged in clinical dental sciences, and bolstering information retention. The retention of knowledge within the realm of clinical dental sciences can be significantly improved by this technology [7]. ChatGPT provides a comprehensive knowledge of oral biology, including anatomy, physiology, histology, microbiology, and other dental sciences. Dentists rely on a comprehensive grasp of these fundamental dental sciences to effectively diagnose and address diverse oral health conditions [8–11].

A study has also shown that problem-based learning is enhanced by ChatGPT through the provision of clinical scenarios and case studies, fostering critical thinking skills, and applying theoretical knowledge to real-world situations [12]. Similarly, students who engage with their lecture notes, textbooks, or online materials find ChatGPT to be a valuable tool for studying. ChatGPT supports enduring learning and boosts memory retention. Through ChatGPT, students gain access to educational resources on demand, empowering them to take charge of their learning journey. The freedom to explore subjects of interest and seek clarification at any time is provided, enhancing the learning process and making it more dynamic and engaging [13]. Engaging with ChatGPT can help students improve their communication and language skills. Effective communication with patients, coworkers, and healthcare professionals requires certain abilities. Students can receive assistance from ChatGPT in preparing for tests and evaluations. It provides review materials, quizzes, and practice questions. Because educational support is available to students around the clock, it is incredibly adaptable and accessible at any time [14,15].

Clinical dental sciences are vital for providing high-quality patient care, promoting preventive dentistry, treatment planning, pain management, restorative dentistry, oral surgery, periodontal care, pediatric dentistry, endodontic therapy, orthodontics, and prosthodontics. Various studies have documented that artificial intelligence, including ChatGPT, is revolutionizing clinical dental education and practice by enhancing learning experiences, optimizing clinical workflows, and improving patient care. Key roles include interactive learning, virtual patient simulations, personalized learning paths, decision support systems, automated grading and assessment, research and data analysis, patient communication and education, quality assurance and peer review, and patient empowerment [16,17].

Moreover, research has also indicated that AI algorithms can adjust interventions, adjust instructional materials, and provide evidence-based advice to dental professionals by analyzing student performance, patient data, and diagnostic pictures [18]. Furthermore, AI tools such as NLP and ChatGPT can analyze vast amounts of scientific literature and clinical records, thereby enhancing data interpretation, literature reviews, and hypothesis development, and ultimately accelerating dental research innovation [19].

This study examines the role of ChatGPT in pre-clinical and clinical dental education. The objectives are: (1) Assessing central students' familiarity, usage, and perception of ChatGPT, (2) Investigating its impact on theoretical knowledge and practical skills, (3) Identifying challenges in AI integration in dental education, and (4) Exploring its effectiveness in providing evidence-based literature assisting in diagnosis and treatment planning and supporting interactive learning. This research aims to provide insights into the benefits and limitations of ChatGPT in enhancing dental education.

METHODOLOGY

To evaluate undergraduate dental students' knowledge, perceptions, and attitudes regarding ChatGPT and its potential uses in the field of dentistry, a cross-sectional questionnaire-based study was conducted among Bachelor of Dental Surgery (BDS) students at three private dental colleges in Lahore.

The Institutional Research and Ethics Committee provided ethical approval with reference to UCD/ERCA/24/197. A non-probability convenience sample technique was utilized to collect data from 300 participants for this cross-sectional observational study. Participants of first-, second-, third-, and final-year undergraduate students who consented to participate in this study were included. The house officers and postgraduate residents were excluded from the study. First and second-year BDS students were categorized as pre-clinical whereas third and final-year, BDS students as clinical students. The sample size was calculated with a 95% confidence level and, a 5% margin of error, and by taking the expected percentage of familiarity with ChatGPT as 63.8% [19]. The sample size was calculated using the formula

$$n = \frac{z_{1-\alpha/2}^2 P(1-P)}{d^2}$$

The research project was carried out between March 2024 and August 2024. A pre-validated, self-administered questionnaire was modified for use in the study [19]. The questionnaire consisted of three sections, each containing closed-ended questions: four questions on knowledge, three questions on attitude, and four questions on practice. The purpose of the response was to use a 3-point Likert scale (Yes, No, Maybe) to represent the respondents' degree of agreement with the statement. The questionnaire was disseminated via email and social media sites, using a Google Forms link format. Participants were only permitted to complete the form once, at any time, and their answers were only collected after they had given their permission, expressed their willingness to participate in the study, and been informed that their information would remain anonymous. To maintain confidentiality, no personal information was collected, and responses remained anonymous. The data was securely stored and only accessible to authorized researchers for analysis.

The collected data were analyzed using SPSS version 25. Descriptive statistics were used to present qualitative variables, including frequencies and percentages. The Chi-square test assessed associations between categorical variables with a significance level set at $p \leq 0.05$. Statistically significant p-values will indicate meaningful differences, guiding interpretations of ChatGPT's impact on dental education.

RESULTS

A total of 300 undergraduate dental students participated in the study, with females comprising 68% (n=203) and males 32% (n=97) of the participants. The majority of the students were in their final year (29%, n=87), followed by second year (26%, n=78), first year (24%, n=72) and third year (21%, n=63). The participants were divided into two categories, preclinical students (50%, n=150) and clinical students (50%, n=150).

Table-I: Dental Students' Knowledge, Attitudes, and Practices Regarding ChatGPT.

Questions	Respones		
	Yes n(%)	No n(%)	Not Sure n(%)
Are you familiar with the concept of ChatGPT?	288(96)	12(4)	0(0)
Do you have any idea about how ChatGPT might be used in dentistry?	89(30)	41(14)	170(57)
Do you currently use ChatGPT in your dental studies?	257(86)	31(10)	12(4)
Do you think ChatGPT is essential in the field of clinical dentistry?	268(89)	20(7)	12(4)
Would you like to know more regarding different versions of ChatGPT on iOS and android platforms?	178(59)	70(23)	52(17)
Did you encounter any challenges while using ChatGPT app?	290(97)	10(3)	0(0)
Can ChatGPT be used as a tool to assist in diagnosis and treatment planning in clinical dentistry?	253(84)	24(8)	23(8)
ChatGPT useful in providing current literature/evidence-based literature pertaining to clinical dentistry?	139(46)	124(41)	37(12)
Have you been successful in receiving adequate knowledge regarding clinical dentistry by using ChatGPT app?	73(24)	215(72)	12(4)
Was it easy for you to use ChatGPT?	148(49)	48(16)	104(35)
Would you like to use ChatGPT in the future?	280(94)	10(3)	10(3)

Table-II: Comparison of ChatGPT awareness and usage between preclinical and clinical students.

Variables	Respones	Preclinical n(%)	Clinical n(%)	P-Value
Are you familiar with the concepts of ChatGPT?	Yes	142(94.70)	146(97.30)	0.239
	No	142(94.70)	4(2.70)	
	Not sure	8(5.30)	0(0.00)	
Do you have any idea how ChatGPT might be used in dentistry?	Yes	0(0.00)	32(21.30)	0.005
	No	0(0.00)	25(16.70)	
	Not sure	57(38.0)	93(62.0)	
Do you currently use ChatGPT in your current dental studies?	Yes	16(10.7)	143(95.30)	<0.001
	No	77(51.3)	2(1.30)	
	Not sure	114(76.0)	5(3.30)	
Do you think ChatGPT is essential in the field of clinical dentistry?	Yes	29(19.3)	139(92.70	0.068
	No	7(4.70)	5(3.30)	
	Not Sure	12(86.0)	6(4.00)	
Would you like to know more about different versions of ChatGPT on iOS and Android platforms?	Yes	15(10.0)	84(56.00)	0.346
	No	6(4.00)	40(26.70)	
	Not Sure	6(4.00)	26(17.30)	
Did you encounter any challenges while using the Chat GPT app?	Yes	94(62.7)	146(97.30)	0.520
	No	29(19.3)	4(2.70)	
	Not Sure	26(17.3)	0(0.000)	
Can ChatGPT be used as a tool to assist in diagnosis and treatment in clinical dentistry?	Yes	144(96.0)	126(84.00)	0.755
	No	6(4.00)	11(7.30)	
	Not Sure	0(0.00)	13(8.70)	
Is Chat GPT useful in providing current literature/evidence-based literature about clinical dentistry?	Yes	12(84.70)	75(50.00)	0.443
	No	13(8.70)	58(38.70)	
	Not Sure	10(6.70)	17(11.30)	
Have you been successful in receiving adequate knowledge regarding clinical dentistry by using the ChatGPT app?	Yes	38(25.3)	35(23.30)	0.174
	No	103(68.7)	112(74.70)	
	Not Sure	9(6.00)	3(2.00)	
Was it easy for you to use ChatGPT?	Yes	77(51.3)	71(47.30)	0.735
	No	22(14.70)	26(17.30)	
	Not sure	51(34.0)	53(35.30)	
Would you like to use ChatGPT in the future?	Yes	140(93.3)	140(93.30)	0.670
	No	4(2.70)	6(4.00)	
	Not sure	6(4.00)	4(2.70)	

Based on the survey findings, 96% of undergraduate students were knowledgeable about ChatGPT. When asked about ChatGPT's potential applicability in dentistry, 57% of the participants were not sure, while 30% acknowledged its potential to assist in treatment planning and educational purposes. The majority of participants exhibited positive responses towards using ChatGPT in dental education, with 86% actively using it as an adjunct learning tool and 59% eager to learn more about the different versions available on various platforms.

However, 97% of participants encountered problems while using the application, and 49% of the participants found it difficult to use ChatGPT due to a lack of formal training. A total of 89% of participants agreed to the use of ChatGPT in providing current/evidence-based literature, while 46% expressed reservations about its use in clinical dentistry. Despite the positive attitude towards ChatGPT, 72% of the participants failed to receive reliable and accurate information about clinical dentistry from the application. Ninety-four % of the participants expressed an interest in integrating the use of ChatGPT in their future endeavors. The results are summarized in Table-I.

Table-II compares the perception and usage patterns of ChatGPT between preclinical and clinical dental students; both groups revealed a favorable response, with 95% of preclinical and 97% of clinical participants reporting familiarity with ChatGPT. 51.3% of the preclinical and 62% of the clinical participants reported being unsure about the use of ChatGPT in dentistry (p = 0.005). Seventy-six % of preclinical and 95% of clinical students were currently using ChatGPT for educational purposes (p < 0.001). Although 51% of the preclinical and 47% of the clinical students reported ease when using ChatGPT, both sets of participants encountered problems, with 95% of the preclinical and 97% of the clinical students reporting difficulties when using the application. When asked if they would like to know about the different versions available across different platforms, both groups showed enthusiasm, with 62% of preclinical and 56% of clinical students responding affirmatively. 84% of both parties concurred with the use of ChatGPT as a diagnostic tool in clinical dentistry.

Furthermore, 86% of preclinical and 93% of clinical students expressed favorable responses when asked about using ChatGPT to access current, evidence-based literature. However, when queried about its relevance to clinical dentistry, 44% of the preclinical students responded negatively, whereas 50% of the clinical students provided positive feedback. 69% of preclinical and 75% of clinical students failed to receive dependable clinical dentistry information when using the application. The resulting data were deemed insignificant (p-value > 0.05). 94% of preclinical students and 94% of clinical students expressed interest in the potential future use of the software. (Table 2)

DISCUSSION

Recent advancements in AI technologies in dental education have led to the development of ChatGPT as a promising tool for enhancing interactive learning environments and meeting the evolving needs of dental students and professionals [20]. In our study, the majority of participants from both preclinical and clinical years were well aware of ChatGPT, with 94.7% and 97.3%, respectively. A study conducted in the US also showed that a majority of students (90%) were well aware of ChatGPT [21]. However, a study by Hagde found this to be 63.8% among dental graduates, which seems quite low when compared to our study [20].

In our study, we found that dental students from preclinical (86%) and clinical (92.7%) years believe that ChatGPT is essential for dentistry, which aligns with a study from India (93.3%) [20]. When asked if they use ChatGPT in their dental studies, a whopping 95.3% of clinical year participants said yes, compared to 76% from preclinical years. This difference was quite significant, with a p-value of <0.001. Interestingly, this adoption rate is significantly higher than the 37.7% reported in a study by Hagde [20]. A study compared traditional lecture-based training to the use of ChatGPT. The results showed that students who interacted with ChatGPT-generated comments showed higher levels of engagement and knowledge retention. This suggests that in therapeutic settings, ChatGPT may enhance active learning and promote deeper conceptual understanding [15].

In academic writing and assignments, ChatGPT demonstrates a notable advantage by accelerating the process of concluding, surpassing human capabilities in information processing and connection-making. Our study revealed that 62.7% of preclinical and 56% of clinical students expressed interest in learning about updated versions of ChatGPT. This disparity may stem from preclinical students recognizing the increasing reliance on online resources in their future studies, as indicated by 51.3% of them expressing interest in using ChatGPT in the future, compared to 62% of the students from the clinical year (p = 0.05). Additionally, research in computer science majors found that GPT-4 led to a 17% increase in exam scores compared to GPT-3.5, highlighting the potential benefits of newer versions of ChatGPT for students' academic endeavors. Notably, a study on dental undergraduates reported that 84.8% of students were interested in using ChatGPT in the future, recognizing its ability to expedite and simplify tasks such as summarizing papers and aiding academic writing [22].

ChatGPT can assist medical researchers and scientists in various ways, including writing, conducting literature research, summarizing data, organizing content, suggesting citations and titles, and even generating an initial draft of a paper. In our study, we found that both preclinical and clinical participants (84.7% and 84.0%, respectively) agreed that ChatGPT is helpful in diagnosis and treatment planning, which is consistent with findings from a study in India. Nevertheless, there are concerns regarding the sufficiency and uniformity of the solutions provided by ChatGPT, along with questions about its novelty, confidentiality, accuracy, bias, and legality [23].

When participants were surveyed about the usefulness of ChatGPT in providing current literature and evidence-based search, 44% of preclinical students felt it did not offer up-to-date information, whereas half of the clinical students disagreed. While the difference wasn't significant, preclinical years may prioritize textbook knowledge, whereas clinical years rely more on online resources for assignments, prompting the development of more effective search strategies. Another study found that 42.9% of dental undergraduates shared a similar perspective[19]. The effectiveness of ChatGPT in promoting critical thinking skills and evidence-based relevance among medical students was examined in a study conducted by Jamal et al., who concluded that AI should be embraced as an opportunity to enhance the field of medical and dental education[16]. However, a study concluded that 33% believed ChatGPT provided incorrect information, with 80% noting false references. This should be kept in mind to avoid using information without verifying it with other sources[24].

ChatGPT has emerged as a valuable tool for undergraduate students in various academic fields. However, its reliance on algorithms presents certain challenges and limitations. Many students struggle with concepts requiring algorithmic reasoning, such as matrix factorization, when using ChatGPT[25]. Similarly, in dentistry, dental image processing or treatment planning can cause similar problems. In our study, we found similar results, where students found it difficult to retrieve specific, adequate knowledge regarding their assignments, particularly in preclinical (68.70%) and clinical (74.7%) years. While ChatGPT excels in delivering theoretical knowledge effectively, its reliability for problem-solving and diagnosing cases remains relatively limited at present[26]. Dentists should be responsible for making conclusive decisions in diagnosis and treatment planning.

Additionally, another study examined the use of ChatGPT as a virtual instructor for students, offering them individualized clinical procedural instruction and feedback. The results showed that improvement in procedural skills and confidence was observed in students who were engaged with ChatGPT, highlighting the utility of AI-powered tutoring programs in Medical Education[14]. However, despite the potential benefits, challenges are posed in dental education by the integration of ChatGPT, including ethical concerns, data privacy, and validation procedures. Thoughtful design and implementation strategies are required to ensure accessibility and inclusivity for diverse student populations.

Ultimately, the potential for revolutionizing clinical dentistry education, patient care, and practice lies in Artificial Intelligence (AI) tools, such as ChatGPT. They offer advanced solutions and instruments that simplify clinical workflows, enhance learning opportunities, and improve student and patient outcomes.

LIMITATION OF THE STUDY AND FUTURE DIRECTION:

This study has limitations such as a relatively small sample size, potential selection and response biases, and absence of long-term assessment. Future research should explore larger, more diverse populations and assess the long-term impact of ChatGPT on dental education and practice. There is a need to evaluate the accuracy of ChatGPT-generated clinical information and its real-world applicability in dental practice. Future research should also investigate the ethical and professional implications of AI integration in clinical decision-making, ensuring that such tools support rather than compromise patient care.

CONCLUSION

This study highlights a widespread awareness and positive perception of ChatGPT among dental students of various years, with the majority actively incorporating it into their educational practices. Clinical students demonstrated a higher adoption rate than in preclinical years. This indicates a greater inclination towards integrating AI-based tools in their advanced learning stages. However, despite its popularity, a significant proportion of students encountered difficulties due to a lack of formal training, and many expressed concerns about the reliability of ChatGPT in providing clinical dentistry information.

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Tayyaba Nayab: Substantial contributions to the conception and design of the work.

Malik Adeel Anwar: Drafting the work.

Ammara Chaudhry: Analysis and interpretation of data for the work.

Annam Imtiaz: Reviewing critically for important intellectual content.

Gulrez Amin: Final approval of the version to be published.

Nimra Meraj: Acquisition of data for work.