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Knowledge, Attitudes, and Perceptions of Dental Students, Intern and Dentists Regarding the Use of Artificial Intelligence in Fixed Prosthodontics in Qassim, Saudi Arabia

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ABSTRACT

Background: Artificial intelligence (AI) innovation in dentistry special in fixed prosthodontics is developing at a rapid speed. As a result, it is difficult for people to decide that they completely recognize it.

Aim: The aim of this study was to assess dental students', interns', and dentists' knowledge, attitudes, and perceptions of AI in fixed prosthodontics in Saudi Arabia.

Materials and Methods: An online-based questionnaire will be given to dental students, interns, and dentists in Qassim, Saudi Arabia for a cross-sectional study. Google Forms were used to create the questionnaire for this research.

Results: About 65.6% participants acquainted with the notion of AI and its applications in fixed prosthodontics. About 71% agree that AI has valuable applications in the area of fixed prosthodontics. About 40.3% possess any insights about the use of AI in fixed prosthodontics. About 91.4% interested in using a software or program that can assist in the planning of fixed prosthodontic treatments. About 21.3% concur that the planning capacity of AI surpasses the clinical expertise of a professional in fixed prosthodontics 76.9% advise other practitioners to include AI into their clinical practice. About 85.5% concur that AI will assist in assessing intricate aspects of fixed prosthodontic treatment planning that are sometimes overlooked by practitioners. About 65.2% agree that AI might be used in future fixed prosthodontic treatment planning. About 76% believe that AI has a prospective role in the field of dentistry in Saudi Arabia.

Conclusion: Dental students, interns, and dentists in Saudi Arabia possess a high level of knowledge, positive attitudes, and accurate views on the use of AI in fixed prosthodontics.

Keywords: Artificial intelligence, dentistry, fixed prosthodontics

Introduction

AI models are efficient for streamlining the process of selecting the appropriate shade of teeth, automating the design of dental restorations, mapping the precise location of the finishing line during preparation, and optimizing the processes for making dental casts. For individuals who use detachable prostheses, it helps anticipate changes in face structure and aids in the creation of removable partial dentures (RPDs). Various dental professions have used AI models.[1,2] AI has been used in restorative dentistry to improve the detection of dental cavities by the analysis of bitewing and periapical radiographs. It can also predict the likelihood of restoration failure and identify vertical tooth fractures by analyzing cone-beam computed tomography or periapical radiographic data.[3-8] AI has been used in implant dentistry to identify the kind of implant using panoramic and periapical radiographs. It has also been used in periodontics to enhance the detection of periodontal disease.[9-12] AI has been used in the field of endodontics to accurately detect periapical lesions and locate the apical foramen.[13,14] AI models are used in prosthodontics for various functions, such as mapping the finishing line of tooth preparation and assisting in identifying tooth anatomy to create computer-aided dental restorations using computer-aided design methods.[15,16] In addition, AI models were developed to forecast the optimal parameters for casting a metal

framework and to assist in selecting the appropriate shade for teeth, as well as recommending a porcelain option to achieve shade matching.[17,18] RPDs are a cost-effective and less invasive option for tooth replacement, since they may be supported by either natural teeth or dental implants.[19] The design of the many components of a RPDs is a crucial stage in the creation of the prosthesis. However, there is a lack of agreement on the optimal design, as shown by conflicting opinions in the literature.[20,21] Artificial intelligence (AI) algorithms have also been developed to assist in the creation of RPDs. It is currently unclear how helpful and advanced AI applications are in the field of prosthodontics. Therefore, it is necessary to assess the development, effectiveness, and limitations of AI applications specifically designed for prosthodontic objectives.

Materials and Methods

This research was done at a dental clinic and college of dentistry in Qassim, Saudi Arabia from February 2022 to October 2023. It was a prospective and cross-sectional study. The research obtained responses from 221 individuals using a questionnaire. This research included all dentistry students, interns, and dentists in Qassim, Saudi Arabia. The research excluded dental students, interns, and dentists outside of of Qassim region, as well as patients and medical students. Convenient sampling technique was carried out for a minimum sample size of 221. Anticipated population proportion = 58% = 0.58, confidence level = 95%, and relative precision (53% - 63%) = 10% of 58% = 0.10.

This cross-sectional study included the distribution of an online-based questionnaire to dentistry students, interns, and dentists in Qassim, Saudi Arabia. The study used Google Forms as the questionnaire. This study aimed to examine the knowledge, attitudes, and perspectives of dentistry students, interns, and dentists about the use of AI in fixed prosthodontics. This cross-sectional study included administering an online-based questionnaire to dentistry students, interns, and dentists in Qassim, Saudi Arabia. Before initiating this investigation, the researchers secured an ethical certificate from the National Committee of Bio and Medical Ethics. The purpose of this study was to enhance the participants' general knowledge, attitudes, and perceptions while respecting their dignity. It aimed to promote charity, justice, and individual and societal rights, in line with Islamic principles and the cultural traditions of the Kingdom of Saudi Arabia.

The survey was conducted using Google Forms and sent through various media channels such as WhatsApp, Twitter, and Email to a total of 221 individuals, including dentistry students, interns, and dentists throughout Qassim region. In addition, a questionnaire barcode was provided to the students and dentists in person for scanning purposes. The survey was composed in the English language. The study's objective was explicitly mentioned in the questionnaire, and a concise explanation of AI was provided in the preface of the questionnaire.

The questionnaire was divided into four overarching categories: sociodemographic factors, knowledge, attitudes, and future. The first segment of the questionnaire inquired about sociodemographic attributes, including gender, nationality, education, health sector affiliation, and specialization in fixed prosthodontics. During the second part of the survey, participants were presented with four questions regarding their fundamental comprehension of AI. The survey's final segment had four inquiries about participants' perspectives on AI in fixed prosthodontics. The last component of the poll included of seven questions about the future possibilities of AI in fixed prosthodontics.

Data analysis

Data were gathered and subjected to statistical analysis using SPSS (statistical software) to see whether there is a correlation between certain demographic factors and the provided replies. The Chi-square test was used to ascertain the outcomes in the form of pie and bar charts.

Results

Figure 1 displays the gender breakdown and distribution of participants with different qualifications. Table 1 displays distribution based on year of study, specialization, and health sector.

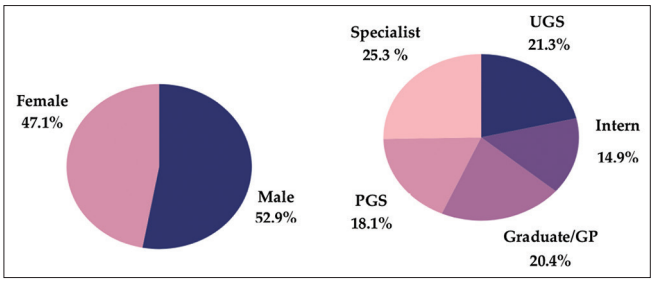

Figure 1: Demographic data of the studied group (gender and qualifications) UGS: Under graduate students, PGS: Post-graduate student, GP: General practitioner

Table 1: Distribution based on year of study, specialization, and health sector

Variable	Frequency	Percentage
Year of study		
Third year	14	6.3
Forth year	19	8.6
Final year	14	6.3
Not applicable	174	78.7
Specialization in prosthodontics		
Yes	38	17.2
No	147	66.5
In progress	36	16.3
Health sector		
Government	59	26.7
Private	64	29.0
Academic	67	30.3
None	31	14.0

Responses for the following questions were as follow: Are you acquainted with the notion of AI and its applications in fixed prosthodontics? The results indicate that 145 individuals, or 65.6% of the total, responded positively, while 76 individuals, or 34.4%, were unsure. Do you agree that AI has valuable applications in the area of fixed prosthodontics? The distribution of responses is as follows: 157 individuals (71.0%) answered "Yes," 52 individuals (23.5%) answered "May be," and 12 individuals (5.4%) answered "Not sure." Do you possess any insights about the use of AI in fixed prosthodontics? The results are as follows: Yes received 89 votes, accounting for 40.3% of the total; No received 42 votes, accounting for 19.0%; and May be received 90 votes, accounting for 40.7%. Are you interested in using a software or program that can assist in the planning of fixed prosthodontic treatments? The results show that 202 individuals, or 91.4%, responded positively, while 19 individuals, or 8.6%, responded with uncertainty. Do you concur that the planning capacity of AI surpasses the clinical expertise of a professional in fixed prosthodontics? The percentages are as follows: Yes – 21.3%, No – 17.6%, and May be – 61.1%. Would you advise other practitioners to include AI into their clinical practice? The percentages for the responses are as follows: Yes – 170 (76.9%), No – 4 (1.8%), and Maybe – 47 (21.3%). Do you concur that AI will assist in assessing intricate aspects of fixed prosthodontic treatment planning that are sometimes overlooked by practitioners? The results are as follows: 189 respondents (85.5%) answered "Yes," 1 respondent (.5%) answered "No," and 31 respondents (14.0%) answered "May be." Do you agree that AI might be used in future fixed prosthodontic treatment planning? The response distribution is as follows: Yes with 144 responses, representing 65.2% of the total; No with 5 responses, representing 2.3% of the total; and May be with 72 responses, representing 32.6% of the total. Do you believe that AI has a prospective role in the field of dentistry in Saudi Arabia? The results indicate that 168 individuals, accounting for 76.0% of the total, responded with "Yes." On the other hand, 5 individuals, representing 2.3% of the total, responded with "No." In addition, 48 individuals, making up 21.7% of the total, responded with "Maybe."

Do you believe that AI will assist novice dentists in the process of diagnosing and making decisions? The percentages are as follows: Yes – 42.1%, No – 20.4%, and Maybe – 37.6%. What are the benefits of using AI in fixed prosthodontics, in your opinion? Enhances efficiency in fixed prosthodontic procedures and minimizes mistakes. 37, which represents 16.7% of the total. Capable of providing substantial quantities of clinically significant, top-notch data instantaneously (at a rate of 4.1%), devoid of any emotional fatigue, or physical constraints. Seven individuals, representing 3.2% of the total, selected the first option. The remaining 168 individuals, accounting for 76.0% of the total, selected all of the above. If there is a discrepancy between the judgment of your fixed prosthodontic professional and the judgments made by AI, whose judgment will you adhere to? The specialist's view accounted for 34.4% (76), the AI's opinion accounted for 24.0% (53), and 41.6% (92) were unsure. Which specific discipline of dentistry do you believe will benefit the most from the use of AI? The breakdown of responsibilities is as follows: 28 (12.7%) for making a diagnosis, 62 (28.1%) for making treatment choices, 30 (13.6%) for interpreting difficult fixed prosthodontic situations, and 101 (45.7%) for direct treatment planning. Which specific area within the healthcare industry do you predict will be the first one to adopt and use AI for commercial purposes? The distribution of healthcare facilities is as follows: specialized clinics account for 64.7% (143), university hospitals make up 0.9% (2), public health centers represent 5.4% (12), and primary care is provided in private clinics at a rate of 29.0% (64).

Responses for the following questions displays the correlation between dental students, interns, postgraduates, and experts in terms of their knowledge, perception, and attitude toward the use of AI in fixed prosthodontics. Do you have knowledge of the notion of AI and its applications in fixed prosthodontics? Among the undergraduate students, 20 (42.6%) responded yes and 27 (57.4%) responded no. For interns, 15 responded yes and 18 responded no. Among graduate and general practitioners, 32 responded yes and 13 responded no.

Postgraduate students had 32 yes responses and 8 no responses. Finally, among specialists, 46 responded yes and 10 responded no.

Do you agree that AI might be used in future fixed prosthodontic treatment planning? There are 34 undergraduate students who answered "yes" and 12 who said "maybe." There is 1 certain intern, 20 interns who have confirmed, and 12 interns who may or may not be attending. Among the graduate general practitioners, 1 responded negatively, 24 responded positively, and 20 responded with uncertainty. As for postgraduate students, 1 responded negatively, 26 responded positively, and 13 responded with uncertainty. Among specialists, 1 responded negatively, 40 responded positively, and 15 responded with uncertainty.

Do you concur that the planning capability of AI surpasses the clinical expertise of a fixed prosthodontic specialist? The survey results indicate that there were 11 affirmative responses, 10 negative responses, and 26 responses that were uncertain or ambiguous. There are five certain yes responses, eight definite no responses, and 20 uncertain responses. Out of the respondents, five agreed, seven disagreed, and 33 were uncertain. A postgraduate student received 11 yes responses, four no responses, and 25 maybes. In addition, a specialist received 15 yes responses, 10 no responses, and 31 maybes.

Would you advise other practitioners to include AI into their clinical practice? The undergraduate student received 27 affirmative responses, three negative responses, and 17 uncertain responses. The intern received 24 affirmative responses, 0 negative responses, and 9 uncertain responses. The survey results for the Graduate/GP category indicate that 36 respondents answered "yes," 0 respondents answered "no," and 9 respondents answered "may be." For the post-graduate student category, 36 respondents answered "yes," one respondent answered "no," and three respondents answered "may be." In the specialist category, 47 respondents answered "yes," 0 respondents answered "no," and 9 respondents answered "may be."

Do you believe that AI will assist novice dentists in diagnosing and making decisions? The survey results for undergraduate students are as follows: 31 responded yes, 1 responded no, and 15 responded maybe. For interns, 17 responded yes, eight responded no, and eight responded maybe. For graduate/GP students, 15 responded yes, 11 responded no, and 19 responded maybe. A total of 11 postgraduate students said "yes," 10 answered "no," and 19 answered "maybe." Among the specialists, 19 answered "yes," 15 answered "no," and 22 answered "maybe."

Discussion

The current research included an equal number of participants from both genders, with males accounting for 52.9% (117) and females accounting for 47.1% (104). In contrast, Yüzbaşıoğlue *et al*. performed research where 59% (650) of the participants were female and 41% (453) were male. In separate research carried out in Germany, the female participants accounted for the majority, with 63.8% (166), while the male participants constituted 36.2%.[22] Our research found an equal distribution across both genders. In addition, the study done by Pinto *et al*. showed a higher distribution among females.[22] Out of the dental students in their third year, just 6.3% participated in this survey, making them the group with the lowest participation rate.[23] However, according to research done by Yüzbaşıoğlu, the majority of participants were 6th year dentistry students, accounting for 8.8%.[22] The current investigation yielded an almost evenly divided result regarding the possession of fundamental understanding of the operational principles of AI, with 65.6% of participants responding negatively and 34.4% responding affirmatively, representing a mere one participant discrepancy. In the Turkish survey conducted by Yüzbaşıoğlu in 2020, the results showed an almost equal distribution of responses, with 51.6% answering "no" and 48.4% answering "yes." Nevertheless, a survey performed on dental professionals in India revealed that 68% of them were acquainted with the idea of AI and its applications (Sur *et al*.).[24] It is evident that our research and the Turkish study are almost identical in terms of possessing fundamental understanding of AI. This suggests that this issue is not very popular in any community. The Indian research found that dental professionals had a greater level of knowledge, indicating that they were more aware of the notion of AI compared to dentistry students in general.[24]

In contrast, the Indian research found that 42% of participants have a rudimentary comprehension of how to use AI into the field of dentistry.[24] Both our research and the Indian study found that most people are unaware of the applications of AI in dentistry. This lack of awareness may be attributed to the absence of seminars, conferences, and educational lectures focused

on AI. On the other hand, the Turkish research had individuals who attended a greater number of seminars and scientific conferences specifically focused on the applications of AI in dentistry. When questioned about the potential use of AI as a tool for treatment planning in dental diagnosis, the majority of students responded affirmatively. In the Turkish study, 44.2% (187) of students agreed, while in the Indian study, 57.2% (631) chose the same response. Furthermore, in the Indian study, 72% (181) of participants agreed that AI can be effectively utilized in treatment planning. In response to the question about the usage of a software or program that aids in fixed prosthodontic treatment planning, 91.4% of participants in the current research expressed a positive inclination, whereas 51% (562) of participants in the Yüzbaşıoğlu *et al* study concurred that AI may be a promising tool to use. Interestingly, 38.4% (101) of the study participants in the research done by Pinto *et al*. expressed disagreement, maybe stemming from a lack of enthusiasm toward using AI in their professional work and concerns about being supplanted by technological advancements.[23]

Across all of the research, the participants were informed about AI through social media, given the widespread use of smartphones and social media platforms in contemporary society. In addition, AI ideas and applications are often shared on social media platforms. In our research, as well as in the Yüzbaşıoğlu *et al* study, most participants were unaware of AI through magazines or newspapers, since these sources of information have declined in popularity within both groups. On the other hand, research done by Pinto *et al*. found that most participants were informed about AI through newspapers and magazines. This suggests that the general populace still relies on conventional sources for their everyday information.[23]

In this research, 65.2% of participants expressed agreement with the use of AI for fixed prosthodontic treatment planning in the future. In contrast, study conducted by Yüzbaşıoğlu *et al*. and Pinto *et al*., only 46.5% and 56.3% of participants agreed, respectively.[22,23] Our survey found that just 42.1% of the participants felt that AI may be utilized as a conclusive diagnostic tool for illnesses. This suggests that although the students are aware of AI, their understanding of its purposes and working principles is limited. In the survey done by Yüzbaşıoğlu *et al*., 36.1% of the participants expressed disagreement. Both our research and the study done by Yüzbaşıoğlu, *et al*, found that participants agreed on the potential of AI as a predictive tool for predicting illness progression and assessing the likelihood of recovery. Furthermore, our research and the study done by Yüzbaşıoğlu *et al*. reached a consensus that AI may be used for the radiographic diagnosis of dental caries. Similarly, both sets of participants in the research concurred when questioned about the potential utility of AI for radiographic detection of periodontal diseases.[22]

Do you concur that the planning capacity of AI surpasses the clinical expertise of a professional in fixed prosthodontics? The percentages are as follows: Yes – 21.3%, No – 17.6%, and May be – 61.1%. Would you advise other practitioners to include AI into their clinical practice? The percentages for the responses are as follows: Yes – 170 (76.9%), No – 4 (1.8%), and Maybe – 47 (21.3%). Do you concur that AI will assist in assessing intricate aspects of fixed prosthodontic treatment planning that are sometimes overlooked by practitioners? The results are as follows: 189 respondents (85.5%) answered "Yes," 1 respondent (0.5%) answered "No," and 31 respondents (14.0%) answered "May be." Do you agree that AI might be used in future fixed prosthodontic treatment planning? The response distribution is as follows: Yes with 144 responses, representing 65.2% of the total; No with 5 responses, representing 2.3% of the total; and May be with 72 responses, representing 32.6% of the total. Relationship between qualification and level of knowledge, attitude, perception (Figure 2).

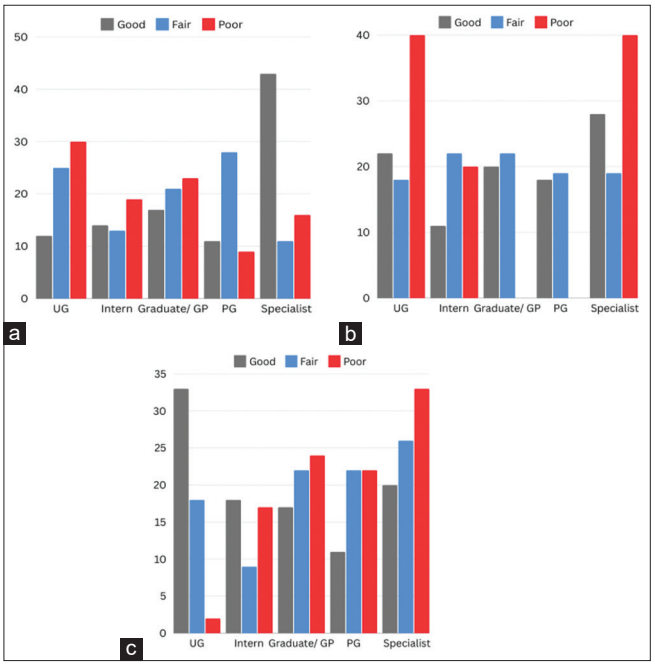

Figure 2: (a) Responses to knowledge, (b) attitude, and (c) perceptions of different qualifications regarding using artificial intelligence in fixed prosthodontic

In research done by Yüzbaşıoğlu *et al*., 52.1% (575) of the participants felt that AI may be used in the field of forensic dentistry. The participants were surveyed on the inclusion of AI applications in undergraduate dentistry training. Both our research and the study conducted by Yüzbaşıoğlu, 2020, found agreement on this matter.[22] Undergraduate dental students may be motivated to acquire knowledge about emerging dental technology to enhance the efficacy of dental treatments.

Conclusion

Our findings indicate that dental students, interns, and dentists in Saudi Arabia possess a high level of knowledge, positive attitudes, and accurate views on the use of AI in fixed prosthodontics. The current investigation unveiled that dental students, interns, and dentists in Saudi Arabia are enthusiastic about using AI into fixed prosthodontics. They anticipate that this technology will assist them in their treatment and diagnostic endeavors in the near future. Dental academic curriculums have to include additional lectures on this subject to educate dental students about the applications of AI in their everyday clinical work.

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Data Availability Statement

All data generated or analyzed as part of this study are included in this published article.

Conflicts of Interest

Declare: The authors have no potential conflicts of interest related to the publication of this paper. The authors state that there are no financial and personal relationships with other people or organizations that could inappropriately influence their work.

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