

KNOWLEDGE AND PERCEPTION OF RIYADH-BASED DENTISTS REGARDING THE ROLE OF ARTIFICIAL INTELLIGENCE IN PROSTHODONTICS: A CROSS-SECTIONAL STUDY

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Abstract

Introduction: The study investigates the perceptions of dental professionals in Riyadh regarding the use of artificial intelligence (AI) in prosthodontics. Previous research has shown AI's potential in various dental procedures, but its application in prosthodontics is relatively new.

Aims of the study: The study aims to assess the current perceptions of Saudi-based dental professionals and their knowledge of AI in implant prosthodontics, CAD/CAM, and maxillofacial prostheses.

Materials and methods: A cross-sectional study design was used, and data were collected using a pre-validated questionnaire. The sample consisted of 357 dentists contacted via email and social media. The results showed that both male and female participants viewed AI positively in dentistry and medicine.

Conclusion: While there were some differences in opinion between genders and work positions, overall, both general dentists and specialists recognized the potential of AI in dentistry and medicine. Further research and development are needed to address skepticism and ensure the effective integration of AI into clinical practice.

Keywords: artificial intelligence, prosthodontics, digital dentistry, case control studies

Introduction

Artificial intelligence (AI) is considered to be one of the most significant scientific and technical developments of the contemporary period (Schwendicke et al., 2020; Yüzbaşıoğlu, 2020). It is best to understand Kaplan and Haenlein's definition of artificial intelligence as "the system's ability to correctly interpret external data, to learn from such data, and to use them to achieve specific goals and tasks through flexible adaptations" (Kaplan et al., 2018), despite the fact that there are many definitions of the term. Artificial intelligence is employed in many facets of our daily lives these days. Moreover, a lot of people are not aware that artificial intelligence is included in the majority of the products they use on a daily basis. For example, AI is essential to autonomous parking and driving. We may also mention the intelligent maps we use every day to get to our many places and the intelligent email answers we receive. Due to a process called machine learning (ML), humans have become the most intelligent creatures to date, despite the fact that

robots are believed to be better than humans in pattern identification since they can employ several data dimensions (Schwendicke et al., 2020). Learning is facilitated by the neurons that comprise the human brain's network (Schwendicke et al., 2020).

Furthermore, the field of neural networks (NN) investigates whether it is possible to replicate the composition and operations of the human brain in order to provide robots with cognitive abilities (Schwendicke et al., 2020). Moreover, the technique of employing these deeper and more complex networks to comprehend challenging ideas is known as deep learning (DL) (Schwendicke et al., 2020). Artificial intelligence (AI) is becoming increasingly important in the medical and dental industries these days. It is well recognized to be helpful in a number of sectors where cutting-edge technology may support and assist experts. Improved efficiency, accuracy and precision, better monitoring, and time economy are the advantages of this course (Chen et al., 2020; Khanna et al., 2017).

Prosthodontics is a sophisticated and multifaceted area of dentistry, and frequent use of AI technologies may have several advantages. Prolonged success is contingent upon the abutment teeth' good prognosis in all areas of operative, endodontic, periodontal, and reconstructive principles. Patient-specific factors include load circumstances, individual medical problems, and supportive care (Bernauer et al., 2021; Alshaddi et al., 2023).

Lerner et al. (2020) examined the implications of AI in fixed prosthodontics. They found that using a fully digital workflow, AI is a reliable method for restoring single implants with monolithic zirconia crowns cemented on custom-made hybrid abutments. Mahrous et al. (2022) researched to assess the quality of removable partial denture manufacturing utilizing artificial intelligence (AI) vs. traditional techniques. Results indicated that when dental students were preparing RPDs for their pre-clinical training, AI-related approaches improved their general abilities and perception.

Furthermore, Kusu (2023) supported prosthodontics' use of AI for shade modification of prosthetic teeth. He presented promising results in terms of color correction from the use of AI in prosthodontic dentistry. Furthermore, Chau et al.'s comprehensive evaluation from 2023 showed that the use of AI-supported 3D scanning greatly improves the creation of full dentures.

Aim of study:

The purpose of this study is to ascertain how dentists feel about using artificial intelligence (AI) in prosthodontics.

- To find out how much dentists know about the relationship between AI and CAD/CAM, maxillofacial prosthesis, and implant prosthodontics.
- To find out how dentists feel about the ethical implications and technical constraints of AI.

The rationale for the study: Although artificial intelligence (AI) has been around for decades, prosthodontics is one of the more recent dental specialties to benefit from AI. Thus, it's important to find out how Saudi dental professionals now feel about using AI in certain prosthodontic treatments.

Materials and Methods:

Survey design: A closed-ended, pre-validated questionnaire was used to perform this cross-sectional survey among dentists in Riyadh.

Techniques for Gathering Data: The study used a closed-ended questionnaire that first asked participants about their demographics before moving on to questions on their understanding and perspective of artificial intelligence (AI) and its application in prosthodontics.

Sample Characteristics: Emails and social media pages/groups were used to reach a sample of 357 dentists for this study.

Table 1: Sample size

Margin of error	5%
Confidence level	95%
Population size	5000
Recommended sample size	357

Survey administration: Google Forms was used to administer the survey.

Study preparation: Initially, a pilot study was conducted among 20 participants to determine the reliability of the questionnaire (Chronbach's alpha .789). Validity was also tested by sending the questionnaire to experienced researchers in REU.

Statistical methods: Statistical Package for Social Sciences (SPSS) version 22 was used to analyze the collected data. Demographics were presented in the form of frequencies, with knowledge and perception being compared between subgroups (experience, gender) using an Independent samples t-test.

Ethical Considerations: This proposal was submitted to the REU research center and ethical review board to receive ethical approval before beginning data collection.+

Results:

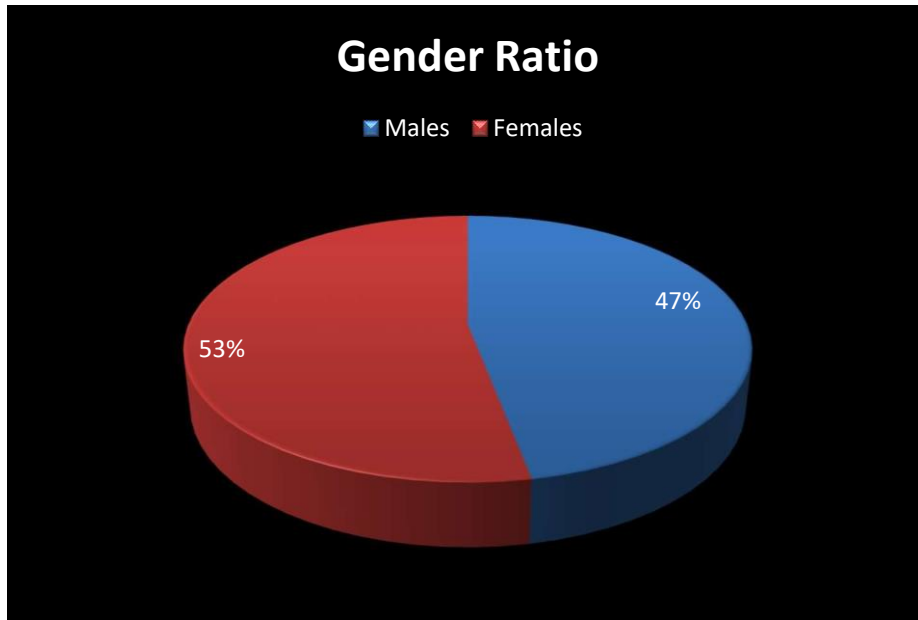


Figure 1: Gender ratio of the study participants

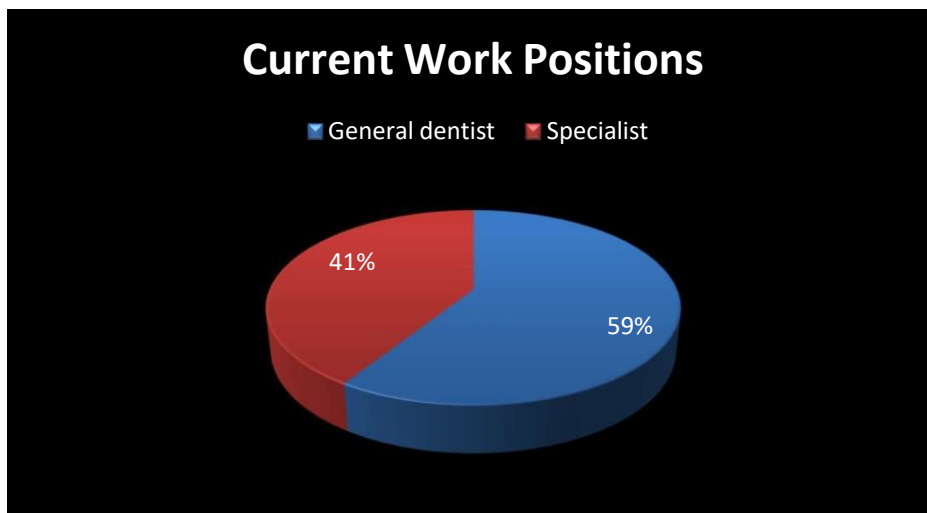


Figure 2: Current work positions of the study participants

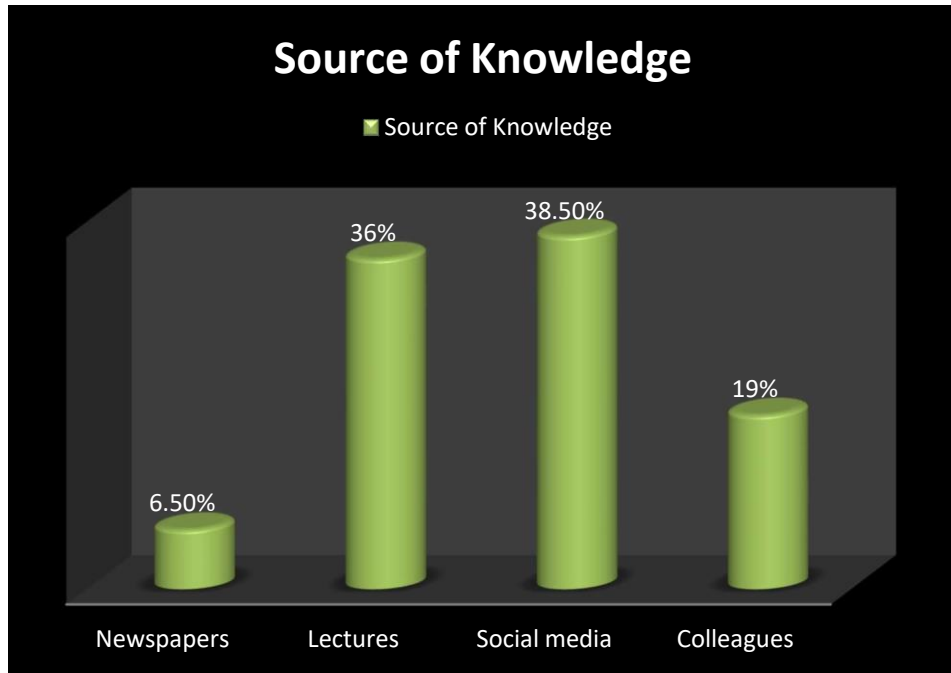


Figure 3: Source of AI knowledge as reported by the study participants

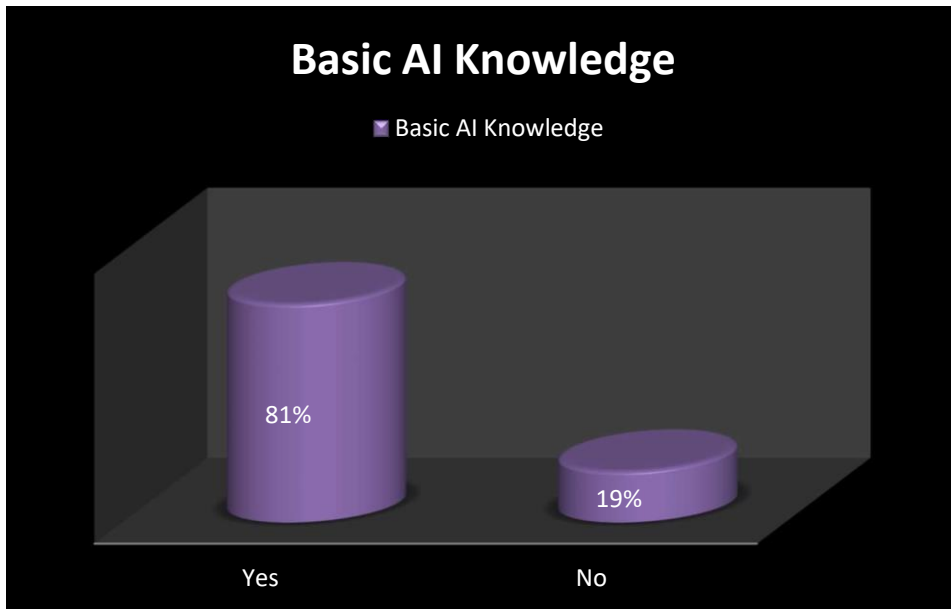


Figure 4: Presence of basic AI knowledge as reported by the study participants

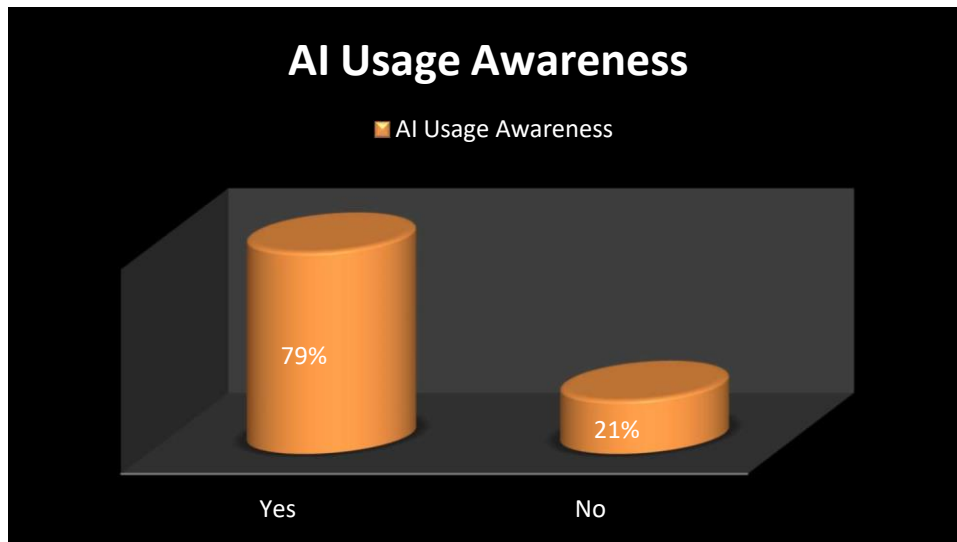


Figure 5: AI usage awareness among the study participants

Table 2: Comparison between male and female participants with their mean values (Independent samples t-test)

Questions	Gender	P-value
Do you think that significant advancements in dentistry and medicine will result from artificial intelligence?	Male: 4.255319 (SD 0.775099) Female: 4.179245 (SD 0.740620)	.479
Do you find it exciting that artificial intelligence is being used in dentistry and medicine?	Male: 4.351064 (SD 0.785725) Female: 4.367925 (SD 0.808590)	.882
AI may be used to identify and categorize dental implant systems based on periapical and panoramic radiography images.	Male: 4.297872 (SD 0.759595) Female: 3.971698 (SD 0.909815)	.007*

<p>AI can forecast the likelihood that CAD/CAM composite resin restorations will debond based on 2D pictures taken from 3D STL models of a die scanned by a 3D oral scanner.</p>	<p>Male: 4.202128 (SD 1.000858) Female: 4.028302 (SD 0.920223)</p>	<p>.202</p>
<p>AI can assist in the fabrication of monolithic zirconia crowns that are supported by implants and bonded on specialized hybrid abutments using a fully digital approach.</p>	<p>Male: 4.159574 (SD 0.871326) Female: 4.037736 (SD 0.849925)</p>	<p>.319</p>
<p>AI is able to assess the system's potential value and precision in identifying and forecasting periodontally damaged teeth.</p>	<p>Male: 4.085106 (SD 0.798649) Female: 4.084906 (SD 0.829434)</p>	<p>.999</p>
<p>Artificial Intelligence has the ability to categorize teeth accurately, which might be used in clinical settings to enhance digital workflow in dental prostheses.</p>	<p>Male: 4.063830 (SD 0.865199) Female: 4.037736 (SD 0.904218)</p>	<p>.836</p>

The table compares the viewpoints of male and female participants on artificial intelligence (AI) in dentistry and medicine. The first two questions concern the potential advancements and enthusiasm associated with AI in these domains. Males were somewhat more optimistic than

females in these areas, although not much ($p = .479$ and $p = .882$, respectively). Both genders scored these elements equally.

The questions that follow focus on particular uses of AI in dentistry. The utility of AI in recognizing and categorizing dental implant systems was scored higher by men than by women, with a statistically significant difference ($p = .007$). They did not, however, significantly vary in their assessments of AI's capacity to create implant-supported crowns ($p = .319$), estimate the likelihood that restorations would debond ($p = .202$), or assess the value of systems for identifying periodontally impaired teeth ($p = .999$).

Lastly, there was no discernible difference in how each gender evaluated AI's accuracy in classifying teeth for use in clinical practice ($p = .836$). Males and females alike had a generally good view of artificial intelligence (AI) in dentistry and medicine, with slight disparities in their excitement for certain applications.

Table 3: Comparison between general dentists and specialists with their mean values
(Independent samples t-test)

Questions	Gender	P-value
Do you think that significant advancements in dentistry and medicine will result from artificial intelligence?	GD: 4.220339 (SD 0.693506) Specialist: 4.207317 (SD 0.842363)	.905
Do you find it exciting that artificial intelligence is being used in dentistry and medicine?	GD: 4.457627 (SD 0.674873) Specialist: 4.219512 (SD 0.929946)	.037*
AI may be used to identify and categorize dental implant systems based on periapical and panoramic radiography images.	GD: 4.169492 (SD 0.765775) Specialist: 4.060976 (SD 0.973064)	.379

<p>AI can forecast the likelihood that CAD/CAM composite resin restorations will debond based on 2D pictures taken from 3D STL models of a die scanned by a 3D oral scanner.</p>	<p>GD: 4.254237 (SD 0.859203) Specialist: 3.902439 (SD 1.061210)</p>	<p>.010*</p>
<p>AI can assist in the fabrication of monolithic zirconia crowns that are supported by implants and bonded on specialized hybrid abutments using a fully digital approach.</p>	<p>GD: 4.144068 (SD 0.742776) Specialist: 4.024390 (SD 1.005855)</p>	<p>.334</p>
<p>AI is able to assess the system's potential value and precision in identifying and forecasting periodontally damaged teeth.</p>	<p>GD: 4.110169 (SD 0.782106) Specialist: 4.048780 (SD 0.859262)</p>	<p>.601</p>
<p>Artificial Intelligence has the ability to categorize teeth accurately, which might be used in clinical settings to enhance digital workflow in dental prostheses.</p>	<p>GD: 4.067797 (SD 0.874411) Specialist: 4.024390 (SD 0.902337)</p>	<p>.734</p>

The research's purpose was to examine general dentists' (GD) and experts' perspectives on the possible applications and effects of artificial intelligence (AI) in dentistry and medicine. The

answers to multiple questions from each group are included in the table, together with their mean scores and standard deviations (SD). The p-values from independent samples t-tests indicate the statistical significance of any differences between the two groups.

In general, ordinary dentists and experts had good opinions about artificial intelligence's potential in dentistry and medicine. Both groups had high mean scores when asked whether they thought AI would result in substantial advancements in the industry; there was no significant difference between them ($p = .905$). Both groups expressed excitement about the use of AI in dentistry and medicine, with specialists rating it somewhat lower than general dentists; this difference was statistically significant ($p = .037$).

Both general dentists and experts expressed equal degrees of excitement about certain uses of AI. They thought AI could be helpful for a number of tasks, including identifying and categorizing dental implant systems, forecasting the likelihood that CAD/CAM composite resin restorations will debond, and assessing the accuracy and usefulness of AI systems for periodontally compromised tooth diagnosis. However, when it came to the capacity of AI to forecast the likelihood of debonding, experts had more doubts than ordinary dentists ($p = .010$).

Discussion :

Artificial intelligence (AI) in dentistry is developing at a very quick speed. As a result, people find it quite difficult to conclude that they comprehend it completely. AI has the potential to transform the healthcare industry completely. This research set out to evaluate the knowledge, attitudes, and views of Riyadh-based dentists about artificial intelligence. The participants' experiences, learning, and exposure to AI are varied and have been acquired via a variety of work-related encounters, professional training, and social media. Over half of the participants understood AI.

One potential technology advancement in healthcare is artificial intelligence, which has a lot of applications, especially in dentistry. Males were somewhat more optimistic but not significantly so ($p = .479$ and $p = .882$, respectively) when it came to the potential advances and excitement related to AI in these fields. The current investigation found that 47.11% of participants were male and 53.11% were female. According to a previous survey, 86.11% of participants thought artificial intelligence (AI) would bring about significant advancements in dentistry and medicine in the future. This finding is consistent with a survey conducted in India in 2021 by Tampha, in which most participants felt that artificial intelligence (AI) would play a significant role in dentistry very soon. (2018) Lee J.H. et al. This could be the case because artificial intelligence covers a wide range of cutting-edge technologies that still impact day-to-day living. The development of AI paves the way for big data analysis, which enhances decision-making by yielding trustworthy information. (Et al., Seram T., 2022).

In the current study, males acknowledged artificial intelligence (AI) more highly than women did. Men felt that AI could be useful in identifying and classifying dental implant systems using panoramic and periapical radiographic images; that AI could predict the debonding probability of CAD/CAM composite resin restorations from 2D images taken from 3D models of a die scanned by a 3D oral scanner; that AI could assist in fabricating implant-supported

monolithic zirconia crowns cemented on customized hybrid abutments through a fully digital workflow; and that AI could assess the system's potential usefulness and accuracy in diagnosing and predicting periodontally compromised teeth. They did not, however, significantly vary in their assessments of AI's capacity to create implant-supported crowns ($p = .319$), estimate the likelihood that restorations would debond ($p = .202$), or assess the value of systems for identifying periodontally impaired teeth ($p = .999$).

Lastly, there was no discernible difference in how each gender evaluated AI's accuracy in classifying teeth for use in clinical practice ($p = .836$). Males and females alike had a generally good view of artificial intelligence (AI) in dentistry and medicine, with slight disparities in their acceptance of certain applications.

In previous research, a t-test indicated no statistically significant differences between the genders on any of the items, with the exception of "AI can replace dentists/physicians in the future," where men agreed with the statement at significantly higher rates than women. 62.31% of participants in a different survey said that using AI is interesting and that it is a "definitive diagnostic, prognostic as well as treatment planning tool." The majority of participants agreed that artificial intelligence (AI) had applications in forensic dentistry, soft tissue diseases of the mouth, radiographic detection of tooth caries, and 3D implant placement. Different models for identifying dental caries, identifying pathological lesions in the mouth, precisely placing dental implants, and using data in forensic dentistry have been suggested in a number of research. (Seram et al., 2021). A few obstacles or restrictions exist as well, such as the need to get precise data and the need to use many AI models.

Both general dentists and specialists in this research had positive opinions about artificial intelligence's potential in dentistry and medicine. Both groups had high mean scores when asked whether they thought AI would result in substantial advancements in the industry; there was no significant difference between them ($p = .905$). Both groups expressed excitement about the use of AI in dentistry and medicine, with specialists rating it somewhat lower than general dentists; this difference was statistically significant ($p = .037$).

Both general dentists and specialists expressed equal degrees of excitement about certain uses of AI. They thought AI could be helpful for a number of tasks, including identifying and categorizing dental implant systems, forecasting the likelihood that CAD/CAM composite resin restorations will debond, and assessing the accuracy and usefulness of AI systems for periodontally compromised tooth diagnosis. However, when it came to the capacity of AI to forecast the likelihood of debonding, specialists had more doubts than general dentists ($p = .010$).

Previous research has shown that having sufficient expertise in this field is mostly dependent on how often AI is used in everyday practice. 62% of respondents were reported to use AI either daily or weekly ($p < 0.001$). The growing popularity of aligner therapy, which incorporates AI-guided treatment planning or intraoral scanning, might be one of the factors contributing to the high frequency of AI usage in dentistry workflow Eschert et al., (2022).

According to the current research, general dentists tend to be more enthusiastic about artificial intelligence in dentistry and medicine, even though specialists and general dentists share

this view. These findings suggest that even while there is consensus on the potential benefits of artificial intelligence (AI) in dentistry and medicine, further research and development are necessary to alleviate concerns and ensure the effective integration of AI into clinical practice. Moreover, there are no notable results from previous studies in these domains.

Limitations

1. Cross-sectional Design: The study's cross-sectional design makes it more difficult to determine the variables' sources and impacts.

2. Sampling Bias: The sample included dentists in Riyadh, which could not be entirely representative of all dental professionals in Saudi Arabia or the world.

3. Self-Reported Data: This investigation used self-reported data, which can include bias or errors.

4. Limited Scope: The research did not examine other facets of AI in dentistry; instead, it concentrated on prosthodontics' impressions of the technology.

Prospective Suggestions:

1. Longitudinal investigations: To determine the causal linkages between prosthodontics' real usage of AI and perceptions of it, conduct longitudinal investigations.

2. Varied Sample: To improve the generalizability of the results, a more varied sample of dental professionals from various geographical areas should be included.

3. Qualitative Research: Conduct qualitative research to learn more about the factors influencing dental professionals' opinions on artificial intelligence in prosthodontics.

4. Follow-up Surveys: Use follow-up surveys to monitor how opinions and understanding of artificial intelligence in prosthodontics evolve.

5. Comparison research: Investigate cultural and contextual variations in prosthodontics AI perceptions by conducting comparison research across various locations or nations.

6. Intervention Studies: Conduct intervention studies to determine how AI education and training programs affect dental practitioners' views and understanding of prosthodontics.

Conclusions:

All participants had good average knowledge scores overall. There were no gender-specific statistically significant differences, with the exception of AI being helpful in identifying dental implant systems. Aside from AI being an interesting aspect of medicine and AI forecasting the debonding likelihood of CAD/CAM, no statistically significant differences were found across employment positions. According to the study's findings, dentists in Riyadh have a favorable opinion on prosthodontics' usage of AI. AI has the potential to improve dentistry and medicine, as acknowledged by both general dentists and specialists. Overall, the research points to a bright future for artificial intelligence in prosthodontics, notwithstanding some slight variations in opinion among genders and job categories. To overcome obstacles and guarantee the effective use of AI in clinical practice, further study is necessary.

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