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Knowledge and Perceptions of Dental Students Towards the Use of Artificial Intelligence in Dentistry: A Study from Sudan, 2024

Diş Hekimliği Öğrencilerinin Diş Hekimliğinde Yapay Zeka Kullanımına Yönelik Bilgi ve Algıları: Sudan'dan Bir Araştırma, 2024

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ABSTRACT

Objectives: Artificial intelligence (AI) has entered most of specialties in Dentistry; it has been included in diagnosis, radiography & education Assess the knowledge and perceptions of dental students towards use of AI in the field of dentistry in Sudan 2024.

Materials and Methods: This cross-sectional study focuses on dental students at Karary University, Omdurman, Sudan. Data were collected via online questionnaires and analyzed using SPSS software.

Results: Of the 100 dental students who participated in the study, 84% were female and 16% male, with 48% being in their 5th year of study. A total of 59% had attended AI training, with 35% acquiring their knowledge through self-study and 23% through university education. The average AI knowledge score was 79.2±13.26, with 72% of students demonstrating good knowledge. The average perception score was 71±12.7, with 45% holding positive perceptions and 50% fair perceptions of AI. There were no significant gender differences in knowledge or perception scores. However, students who had received AI training had significantly better perceptions of AI. Overall, a positive correlation was found between higher AI knowledge and more favorable perceptions of its applications in dentistry.

Conclusion: Dental students demonstrate strong knowledge of AI, though perceptions are more varied. AI knowledge improves with study progression, and targeted educational initiatives could further enhance positive perceptions. Training significantly influences attitudes, emphasizing the need to integrate AI into dental curricula. The positive correlation between knowledge and perception suggests that as understanding deepens, acceptance of AI in dentistry is likely to grow.

Keywords: Artificial Intelligence (AI), dental student, dentistry, Sudan, knowledge, perceptions.

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INTRODUCTION

Artificial Intelligence (AI) has emerged as a leading and extensively researched topic worldwide (Agrawal & Nikhade, 2022). Historically, AI had limited practical applications, but it is now experiencing a transformative revolution due to the advent of big data and advancements in computational technology (Haenlein & Kaplan, 2019). This revolution is increasingly affecting our daily lives through various applications, such as voice and text recognition, email spam filters, and smartphone personal assistants (Bisdas et al., 2021). AI is characterized by its ability to process input data, learn from it, and apply that knowledge to achieve specific tasks and objectives (Haenlein & Kaplan, 2019). In the medical field, Artificial Intelligence has made significant strides, particularly in specialties like radiology and pathology, where it offers notable advantages over traditional methods. AI enhances data processing, decision-making, and task execution, providing improved accuracy, speed, and efficiency while reducing manpower requirements (Vodanović et al., 2023, Seram et al., 2021).

In dentistry, AI is integrated into multiple areas of practice. For instance, it is used in educational settings to create preclinical models that simulate the human mouth, aiding in student training. AI also, plays a role in patient management, diagnosis, treatment planning, and predicting outcomes. In endodontics, AI helps determine working lengths and detect root fractures through high-resolution CBCT scans. Additionally, it is utilized to diagnose conditions like TMJ disorders and maxillary sinus diseases. Further, AI applications extend to orthodontics, prosthodontics, maxillofacial surgery, and forensic odontology (Agrawal & Nikhade, 2022). Despite these advancements, AI has not been fully adopted in all areas of dentistry, particularly in developing countries. This highlights the need for updated and accurate education on AI for students and an assessment of their attitudes toward AI's role in the future of dentistry (Pauwels & Del Rey, 2021). There is still a lack of clarity regarding dental students' perceptions of AI in practical applications and their interest in AI-related topics (Bisdas et al., 2021).

In Sudan, as in many developing countries, the adoption of AI in healthcare, including dentistry, is still in its nascent stages. The integration of AI technologies could potentially enhance diagnostic accuracy, streamline clinical workflows, and improve patient outcomes (Guo & Li, 2018). However, understanding how dental students perceive and comprehend these technologies is crucial for fostering effective integration and ensuring that future practitioners are well-prepared to utilize AI in their professional practice (Balay-Odao et al., 2024). Previous studies highlight the disparities in AI knowledge and attitudes towards its application among dental professionals and students globally. Also, some studies has shown that AI knowledge among dental students can be relatively advanced, but the level of practical application and perception varies (Amiri et al., 2024). In contrast, studies from developing regions often report lower levels of AI familiarity and integration, reflecting broader challenges in technology adoption and education (Umer et al., 2024). Subsequently, this study aims to assess the knowledge and perceptions of dental students at Karary University regarding AI technology and explore their expectations and preferences for incorporating AI into dental education. This information will help establish a foundation for successful technological applications and identify the training needs of healthcare professionals, ultimately driving continuous progress in AI applications across the industry. Thus, this cross-sectional study was conducted to evaluate students' knowledge and perceptions.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted with dental students at Karary University/College of Oral and Dental Medicine in Sudan during the 2024 academic year. Data collection occurred in May 2024, involving active surveillance to assess students' knowledge and perceptions regarding AI applications in dentistry, using Likert scales and multiple-choice questions. Ethical considerations included obtaining approval from the faculty administration, securing informed consent from students, ensuring confidentiality, and providing information about the study's purpose and potential impact. For data analysis, questionnaire responses were entered into SPSS, and data cleaning was performed to address any missing or inconsistent entries. Descriptive statistics summarized the distribution and central tendencies of knowledge and perception levels. To determine the students' knowledge levels, scores were categorized as follows: below 50 poor, 50-75 fair, 75-100 good. Similarly, perception scores were classified into: below 50 poor, 50-75 fair, 75-100 good. Inferential statistics, including T-tests and ANOVA, were used to explore differences in mean knowledge and perception scores across various groups, such as year of study, gender, and training status. Correlation analysis assessed the relationship between knowledge and perception scores, while multiple regression examined the impact of knowledge and demographic variables on perceptions. Cross-tabulation and Chi-Square tests explored associations between perceptions and categorical variables.

RESULTS

Dental students from Karary University, Omdurman, Sudan, were recruited for this study. Of all 100 participants, the gender distribution shows a significant predominance of females, who comprise 84% of the sample, compared to 16% males. Additionally, the academic level distribution reveals that the majority of the population is in the fifth year, accounting for 48%, while the smallest group, at 7%, is in their fourth year. Both the first and third years were each represented by 13%, while the second year was slightly higher at 19%. With nearly half of the respondents in their final year, the insights gathered may reflect a higher level of experience and possibly

more developed opinions on the subject matter of AI in dentistry. Considering the gender imbalance, it may be beneficial to explore the reasons for this disparity and consider if additional sampling or weighting adjustments are necessary. Leveraging the high percentage of 5th-year students can provide deeper insights, as these students are likely to have the most comprehensive understanding of their field and its challenges, including the application of AI in dentistry. Regarding sources of training on AI. Out of the total, 59% have attended a course or training on AI, while 41% have not. Among those who have received training, 23% attribute their knowledge to university education, 35% to self-study efforts, and 1% to a combination of both university education and self-study efforts (Table 1). The reliability statistics suggest that the Cronbach's Alpha coefficient for the study is 0.879. This indicates a strong internal consistency among the items or measures used in the study, showing that the data are reliable and the results are consistent.

Table 1. Sources of training on Al.

Attended a course or training on AI	Yes	No
Source of training	Frequency (%)	Frequency (%)
University education	23 (23%)	-
Self-study efforts	35 (35%)	-
Both	1 (1%)	-
Total	59 (59%)	41 (41%)

The knowledge scores ranged from a minimum of 20 to a maximum of 100, with a mean of 79.2±13.26. This indicates that, on average, participants have a relatively high level of knowledge about AI, with some variability in their scores. Perception scores ranged from 32 to 100, with a mean of 71±12.7. This suggests that participants generally have a positive perception of AI, though there is some variation in their views.

The grading of knowledge and perception scores among the study population reveals significant insights into their understanding and attitudes towards AI. Regarding knowledge scores, 3% of participants is classified as having poor knowledge (score less than 50%), 25% as having fair knowledge (score between 50% to 75), and a substantial 72% as having good knowledge (score more than 75%), indicating that the majority of participants have a strong grasp of AI concepts. In terms of perception, 5% of participants have a poor perception (score less than 50%), 50% have a fair perception (score between 50% to 75), and 45% have a good perception (score more than 75%). This distribution shows that while knowledge about AI is predominantly high, perceptions are more varied, with half of the participants viewing AI fairly and the other half viewing it positively. These findings suggest that while the overall understanding of AI among participants is robust, there is an opportunity to further enhance positive perceptions through targeted educational initiatives.

Knowledge scores are very similar for both males (79± 10.783) and females (79.24± 13.737). The mean perception scores are slightly higher for males (72.75± 7.759) compared to females (70.67± 13.452). Levene's test for equality of variances suggests that the variances are equal for knowledge scores ($p = 0.783$) but marginally unequal for perception scores ($p = 0.070$). Despite this, the t-tests for both equal and unequal variances show that the differences in means are not statistically significant ($p > 0.05$). Therefore, we can conclude that there are no significant gender differences in knowledge and perception scores regarding AI in this study.

Regarding level of study, the ANOVA results indicate a significant variation in knowledge scores across different years of study, with a notable F-value of 3.196 and a p-value of 0.017. Post hoc tests reveal that third-year students have significantly higher knowledge scores compared to first and second-year students, as well as significantly lower scores compared to fifth-year students. On the other hand, the ANOVA results for perception scores show no significant differences between years of study, with an F-value of 1.713 and a p-value of 0.154. However, post hoc tests highlight a significant difference in perception scores between third-year and fifth-year students. These findings suggest that students' knowledge of AI improves significantly as they progress through their studies, particularly in the third year, while their perceptions of AI do not vary as markedly by year of study (Table 2).

Table 2. ANONA for Knowledge and Perception scores by year of study.

		Sum of Squares	df	Mean Square	F	Sig.
Knowledge scores	Between Groups	2064.525	4	516.131	3.196	.017
	Within Groups	15343.475	95	161.510		
	Total	17408.000	99			
Perception scores	Between Groups	1074.855	4	268.714	1.713	.154
	Within Groups	14905.145	95	156.896		
	Total	15980.000	99			

The T-Test analysis compared the knowledge and perception scores between students who have received courses or training on AI applications and those who have not. The results show no significant difference in knowledge scores between the two groups ($p= 0.911$). However, there is a significant difference in perception scores ($p= 0.010$), with those who have received training having higher perception scores (Mean= 2.53± 0.504) compared to those who have not (Mean= 2.22±0.652). This suggests that while the knowledge level about AI does not significantly differ based on whether students have received training, their perception of AI is positively influenced by such training.

The correlation analysis demonstrated a significant positive relationship between knowledge scores and perception scores among dental students concerning AI applications in dentistry. The Pearson correlation coefficient was 0.484, with a p-value less than 0.01, indicating a statistically significant and moderately

strong correlation. This finding implies that students with higher levels of knowledge about AI in dentistry tend to hold more favorable perceptions of its use. The positive correlation underscores the critical role of educational initiatives in enhancing both knowledge and perceptions of AI technologies in the dental field. As students' understanding of AI increases, their attitudes toward its applications become more positive, highlighting the importance of integrating comprehensive AI education into dental curricula to foster acceptance and effective utilization of AI in dental practice.

Multiple regression made to understand the factors influencing dental students' perceptions of AI applications in dentistry. The independent variables included knowledge scores, gender, AI training, level of study, and age. The model's R Square value of 0.287 suggests that these variables explain approximately 28.7% of the variability in perception scores, indicating a moderate fit. The ANOVA results show that the regression model is statistically significant ($F = 7.582$, $p < 0.001$), confirming that the independent variables collectively influence perception scores. Among the predictors, knowledge scores ($B = 0.446$, $p < 0.001$) emerged as a significant positive predictor, indicating that higher knowledge about AI correlates with more favorable perceptions. Interestingly, AI training ($B = -4.993$, $p = 0.032$) was also significant but negatively associated, suggesting that students who received AI training have slightly more critical views of AI applications. On the other hand, age ($B = -0.150$, $p = 0.902$), gender ($B = -1.995$, $p = 0.534$), and level of study ($B = 1.067$, $p = 0.519$) did not significantly influence perception scores, indicating that these factors do not play a substantial role in shaping student's perceptions of AI in dentistry. Overall, regression analysis highlights the importance of knowledge in shaping positive perceptions of AI among dental students, while also suggesting that AI training might lead to more critical evaluations.

The analysis of knowledge and perception scores across different levels of study reveals distinct patterns. For knowledge scores, there is no significant association with the level of study, Pearson Chi-Square (9.686, df=8, p=0.288). This suggests that student's knowledge levels remain relatively consistent regardless of their level of study. In contrast, perception scores show a significant association with the level of study. Pearson Chi-Square (16.688, df=8, p=0.034) indicates that student's perceptions of the subject matter change as they progress through their academic years. Specifically, while a high percentage of students in all years have good knowledge scores, perceptions vary more significantly, suggesting that as students advance, their views on the subject become more nuanced or change in response to their increasing experience and exposure (Table 3).

Table 3. Frequencies of knowledge and perception grades across levels of study.

Level of study (Year)	Knowledge scores			Perception scores			Total
	Poor	Fair	Good	Poor	Fair	Good	
1st year	0 (0%)	3 (23.1%)	10 (76.9%)	0 (0%)	8 (61.5%)	5 (38.5%)	13 (100%)
2nd year	0 (0%)	6 (31.6%)	13 (68.4%)	0 (0%)	11 (57.9%)	8 (42.1%)	19 (100%)
3rd year	2 (15.4%)	4 (30.8%)	7 (53.8%)	2 (15.4%)	7 (53.8%)	4 (30.8%)	13 (100%)
4th year	0 (0%)	2 (28.6%)	5 (71.4%)	2 (28.6%)	1 (14.3%)	4 (57.1%)	7 (100%)
5th year	1 (2.1%)	10 (20.8%)	37 (77.1%)	1 (2.1%)	23 (47.9%)	24 (50%)	48 (100%)
Total	3 (3%)	25 (25%)	72 (72%)	5 (5%)	50 (50%)	45 (45%)	100 (100%)

Table 4. Frequencies of knowledge and perception grades across Training on AI applications in dentistry status.

Training on AI applications in dentistry.	Knowledge scores			Perception scores			Total
	Poor	Fair	Good	Poor	Fair	Good	
Yes	1 (1.7%)	16 (27.1%)	42 (71.2%)	0 (0%)	28 (47.5%)	31 (52.5%)	59 (100%)
No	2 (4.9%)	9 (22%)	30 (73.3%)	5 (12.2%)	22 (53.7%)	14 (34.1)	41 (100%)
Total	3 (3%)	25 (25%)	72 (72%)	5 (5%)	50 (50%)	45 (45%)	100 (100%)

Age does not appear to significantly influence the knowledge and perception of dental students towards AI applications in dentistry ($P = 0.797$, 0.883) respectively. Gender does not appear to significantly influence the knowledge and perception of dental students towards AI applications in dentistry ($P = 0.639$, 0.575) respectively.

The effect of training on AI applications in dentistry does not significantly impact knowledge scores (Pearson Chi-Square = 1.089, $p = 0.580$), indicating that knowledge levels are similar regardless of training status, but it does have a substantial effect on perception scores (Pearson Chi-Square = 9.200, $p = 0.010$). Students who have received training tend to have a more favorable perception of AI applications compared to those who have not. This significant difference in perception scores suggests that training influences how students view the

role and importance of AI in dentistry, even if it does not directly affect their measured knowledge of the subject (Table 4).

DISCUSSION

The present study assesses the knowledge and perceptions of dental students at Karary University, Omdurman, Sudan. Of the 100 participants, females represented a significant majority at 84%, compared to 16% males. The academic distribution showed that nearly half of the students were in their 5th year (48%), while the smallest group (7%) was in their 4th year. The 1st and 3rd years each accounted for 13%, with the 2nd year slightly higher at 19%.

In terms of knowledge, 3% of participants demonstrated poor knowledge (scoring below 50%). While 25% had fair knowledge (scoring between 50% and 75%), and 72% showed good knowledge (scoring above 75%). The high percentage of participants with good knowledge may reflect the increasing emphasis on technology and AI in dental education, aligning with global trends. However, the 25% with fair knowledge indicate that there is still an area for improvement.

The perception scores show a range of attitudes towards AI in dentistry. The 5% with poor perceptions (below 50%) may reflect concerns about AI's role, possibly due to limited familiarity with its benefits. The 50% with fair perceptions (50% to 75%) indicate a moderate level of understanding and openness, suggesting some awareness but also uncertainty about practical AI applications. The 45% with positive perceptions (above 75%) demonstrate a strong favorability towards AI, likely due to positive experiences or effective integration of AI technologies in dental education. This distribution highlights the need for enhanced education and exposure to AI to cultivate more uniformly positive perceptions among dental students.

These findings are comparable to the results from Taibah University, where the average basic AI knowledge among dental students was 58.62% (Hamouda et al., 2019). This is also somewhat similar to a study on dental professionals in Saudi Arabia, which found that 49.4% of participants were aware of AI, 44.5% had a basic understanding of AI principles, and 42.2% were aware of AI's applications in dentistry (Aboalshamat, 2022). However, the results differ from a study in Riyadh, Saudi Arabia, where 50.1% of dental students had no basic knowledge of AI, and 55.8% were unaware of its use in dentistry (Khanagar et al., 2021). Indian medical students similarly reported limited awareness of AI, likely due to a lack of related workshops and conferences. The lack of AI integration in the curriculum, limited exposure to practical AI applications, and insufficient opportunities for learning about AI, such as a lack of workshops and conferences, might contribute to these low levels of knowledge and awareness.

In this study, gender-related knowledge scores were nearly identical, with males scoring 79 ± 10.783 and females scoring 79.24 ± 13.737, suggesting that both male and female students have a comparable foundational understanding of AI. Meanwhile, perception scores were slightly higher for males (72.75 ± 7.759) compared to females (70.67 ± 13.452). This aligns with a study in India, where male dental students were found to have significantly more knowledge about AI than female students ($p < 0.05$) (Shyaame,2024). This disparity in perception scores despite similar knowledge levels might be attributed to varying levels of interest or exposure to AI applications among genders, highlighting the need for targeted educational interventions to address these perceptual differences. The consistent knowledge levels across different academic years suggest that foundational AI education is uniformly integrated into the curriculum, providing all students with a similar base level of understanding irrespective of their year of study. This observation aligns with findings by Plch 2020, who reported that while medical students' foundational knowledge remains stable, their perceptions of new technologies evolve with practical experience (Plch, 2020). In contrast, our results reveal that perception scores are significantly associated with the level of study, indicating that students' attitudes towards AI improve as they gain more academic experience and exposure. Similarly, Baby et al. found that students' attitudes towards technologies, including AI, become more positive with progression through their education (Baby et al., 2023). As students advance, they encounter more practical applications and gain deeper insights into AI, which likely refines their perceptions (Baby et al., 2023). Additionally, the effect of training on AI applications in dentistry does not significantly affect knowledge scores, but it has a substantial effect on perception scores. This means that although all students acquire a similar level of foundational knowledge, the additional insights and practical experiences gained through specialized training can significantly influence their perceptions of the value and role of AI in dentistry.

CONCLUSIONS

Dental students demonstrate strong knowledge of AI, though perceptions are more varied. AI knowledge improves with study progression, and targeted educational initiatives could further enhance positive perceptions. Training significantly influences attitudes, emphasizing the need to integrate AI into dental curricula. The positive correlation between knowledge and perception suggests that as understanding deepens, acceptance of AI in dentistry is likely to grow.

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