ASSESSMENT OF KNOWLEDGE AND PERCEPTIONS OF ARTIFICIAL INTELLIGENCE AMONG DENTAL STUDENTS OF KARACHI, PAKISTAN. A MULTI-CENTER SURVEY

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ABSTRACT

For the past few years, Artificial Intelligence (AI) has been a topic of great interest in dentistry. There has been an exponential increase in the usage of AI-based technology in daily dental practice. AI applications are being routinely used to assist dental practitioners in the diagnosis and treatment planning of patients. The purpose of this study was to assess knowledge and perception of AI amongst dental students of Karachi, Pakistan. A multi-center, cross-sectional study was conducted using an online (Google forms) survey. A pre-validated questionnaire comprising of 22 questions was circulated among 5 dental schools of Karachi, Pakistan from December 2021 till January 2022. The questionnaire is comprised of various sections aiming to evaluate the dental students' knowledge and attitudes toward AI and its possible applications in dentistry. Descriptive analysis and Pearson chi-square test were used for data analysis. A total of 355 students (73.2% female, 26.8% male) responded to the questionnaire. Out of these 58.3% of students had basic knowledge about AI working principles. 74.7% showed agreement that dentistry would be revolutionized by AI. 31.5% of participants showed a neutral opinion that AI could replace them in the future. Furthermore, 85.6% of students responded that AI was not a part of their current undergraduate teaching curriculum moreover 66.0% and 69.1% of the participants agreed that AI should be included in the undergraduate and post-graduate curriculum respectively. Overall, the participants responded towards having low awareness regarding AI but showed a willingness to improve their knowledge in this field. Furthermore, participants showed willingness to include AI in undergraduate and post-graduate teaching curricula.

Keywords: *Artificial intelligence, knowledge, perception, dental students, Pakistan, self-reported survey.*

INTRODUCTION

The human brain has been a source of research and intrigue for centuries. Scientists have based inventions on the functioning of the human brain and yet the aspiration that machines can properly think like a human being seems far-fetched.[1] Disruptive innovations are an integral part of modern medicine and artificial intelligence (AI) is one of them. This concept was introduced by John McCarthy in 1956 which gave roots to further exploration.[2] AI is best defined 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".[3] Many are unaware that AI plays an essential role in our daily lives; ranging from voice and fingerprint recognition systems in phones to Google Maps, humans have now become dependent on this technology.[4] These days, AI is being widely used in the health sector as deep learning and machine learning. Deep learning systems are being effectively used in a variety of clinical fields of medicine and dentistry including diagnosis of different cancer, oral radiology, denture design, temporomandibular joint disorders, caries diagnosis, periodontal diseases, cephalometric analysis, and others.[5, 6]

Digital dentistry like CAD/CAM, intraoral scanners, CBCT, and 3D printing are some examples of AI

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technologies that are currently being taught to dental students and are also part of routine clinical practice usage.[7, 8] Moreover, virtual assistants are now being utilized to book patient appointments, digitize records, devise treatment planning methods, and also inspect patient compliance to therapy.[9, 10]

AI not only has the potential to provide treatment planning for existing modalities but also impart domain-based detection. Advanced AI technology now has the ability to yield ideal decisions in complex and unpredictable situations. It is suggested that automatic systems can reduce workload, complement, assist, and perform at the level of a junior dentist although, in no way it is considered as a replacement for a dental professional.[11, 12]

The usefulness of this technology cannot be undermined. It is imperative that knowledge regarding it should be taught in medical and dental schools and universities. As the new generation of healthcare professionals are entering the workforce, equipping these future practitioners with awareness and understanding will help them to stay up to date with the latest development in the digital future. The inclusion of AI dentistry in the dental curriculum has been advocated previously.[13, 14] Furthermore, there is no doubt that the COVID pandemic proved that telemedicine and AI are a necessity for patient welfare and disease prediction.[15] Addition of simulation and robotic technology alongside intelligent tutoring systems may provide wider avenues to gain knowledge and experience. Switching from the traditional training sessions to AI methods of learning may very well improve clinical learning especially with respect to self-evaluation and objective feedback.[16, 17]

Consequently, dental professionals, students, and educators should be well informed about data science, robo-ethics, data analysis, and AI algorithms as the future healthcare landscape is expected to bring more AI-based technological advancement.[16] Therefore, this study aimed to assess the knowledge and perceptions of Pakistani dental students towards AI and its utilization in dentistry. With the help of this study, inclusion of this aspect in the dental curriculum may be considered.

MATERIALS AND METHODS

A descriptive observational study was conducted amongst the dental students from 5 different dental schools of Karachi, Pakistan. The research project was approved by the university ethics and dental review committee (Document reference number: sscms/college/principal(dental)/2021/082). A pre-validated questionnaire developed by Yüzbaşıoğlu [18] was designed using web-based electronic software (Google Forms) and distributed using social media platform (WhatsApp). The data was collected for a period of one month from

December 2021 till January 2022.

The sample size was calculated using OpenEpi, Version 3 with a confidence level of 95% and a 5% error margin considering a 50% outcome variable. Keeping in view the number of dental students from all five years studying in different dental colleges of Karachi city, the total population at an average calculated would be 1450. The sample size for the study was calculated as 304 students.

The survey questionnaire comprised of data collected on demographics and educational information about dental students, knowledge of and attitudes towards AI, future application areas of AI in dentistry, and topics of AI in dental education. The first part of the survey required data on sociodemographic characteristics such as gender, name of attending dental school, and grade of dental education. In the second part, the participants were asked questions about (1) "information source of recent AI applications," (2) "having basic knowledge about the working principles of AI," (3) "being aware of the usage of AI in dentistry." and (4) "If AI is a part of the current teaching curriculum of the institute". In the third section, the participants were presented with 15 statements and asked to indicate their level of agreement on a 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree). For purposes of ensuring anonymity, no tracking system was used.

The data were analysed with IBM SPSS software, Version 23. Descriptive analysis such as frequencies and percentages were calculated. Pearson chi-square test was used for the analysis of all categorical data. The significance level was taken as $P < 0.05$.

RESULTS

During study period 355 dental students completed the survey, among which 73.2% (n = 260) were female and 26.8% (n = 95) were male. All the students were from the public and private sector dental colleges of Karachi. Dental students who completed the survey were from 1st year 17.5% (n = 62), 2nd year 25.1% (n = 89), 3rd year 17.5% (n = 62), 4th year 18.6% (n = 66) and 5th year 21.4% (n = 76). A total of 208 respondents were not aware of AI in dentistry and health sciences. However, 207 participants responded that they had basic knowledge regarding the working principles of AI technologies. Moreover, 304 participants reported that AI was not a part of the current teaching curriculum of their institute (Figure 1).

The answers of the participants reflecting their attitude about all 15 statements regarding the potential of AI usage in dentistry are shown in Figure 2. Regarding the source of artificial intelligence in dentistry 30.7% (n = 109) of students learned about AI through social media (Facebook/Twitter), 7.9% (n

TABLE 1: COMPARISON OF "HAVING A BASIC KNOWLEDGE ABOUT THE WORKING PRINCIPLE OF AI" AND "BEING AWARE OF THE USAGE OF AI IN DENTISTRY" BETWEEN INFORMATION AND YEARS OF EDUCATION.

Information sources	Having a basic knowledge about AI			Being aware of the usage of AI in dentistry		
	Yes	No	p-value	Yes	No	p-value
Friends and family etc.	14	2	<0.001	11	5	<0.001
Through scientific journal	22	2		21	3	
Lectures in the university	23	5		20	8	
Social media Facebook/ Twitter etc.	94	15		85	24	
Others	9	9		8	10	
Not sure	45	115		2	158	
Year of education	Yes	No	p-value	Yes	No	p-value
1st	34	28	0.004	19	43	0.172
2nd	65	24		42	47	
3rd	35	27		28	34	
4th	28	38		23	43	
5th	45	31		35	41	

Pearson chi-square test

TABLE 2: RESPONSES TO STATEMENTS ABOUT PERCEPTIONS AND ATTITUDES TOWARDS AI IN DENTISTRY

Statements	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)	Statistical significance according to			
						Gender	Dental school year	Having a basic knowledge of AI	Being aware of the use of AI
Can AI lead to advancement in dentistry/medicine	89 (25.1)	176 (49.6)	68 (19.2)	8 (2.3)	14 (3.9)	0.288	0.581	0.001	0.003
Can AI replace dentists/physicians in the future?	27 (7.6)	93 (26.2)	112 (31.5)	84 (23.7	39 (11.0)	0.009	0.372	0.08	0.226
Are you excited for its use?	53 (14.9)	173 (48.7)	106 (29.9)	13 (3.7)	10 (2.8)	0.795	0.332	0.66	0.475
Can it be a diagnostic tool?	47 (13.2)	167 (47.0)	108 (30.4)	22 (6.2)	11 (3.1)	0.484	0.084	0.05	0.017
Can AI be a prognostic tool?	44 (12.4)	171 (48.2)	118 (33.2)	16 (4.5)	6 (1.7)	0.286	0.458	0.05	0.003

Can AI be used for radiographic diagnosis of tooth caries	37 (10.4)	199 (56.1)	97 (27.3)	19 (5.4)	3 (8)	0.053	0.278	0.007	<0.001
Can AI be used in the radiographic diagnosis of periodontal diseases	39 (11.0)	184 (51.8)	111 (31.3)	16 (4.5)	5 (1.4)	0.014	0.241	0.02	0.004
Can AI diagnose soft tissue lesions of the mouth?	35 (9.9)	176 (49.6)	119 (33.5)	16 (4.5)	9 (2.5)	0.182	0.681	0.01	<0.001
Can AI be used in 3-dimensional implant positioning and planning.	51 (14.4)	169 (47.6)	112 (31.5)	18 (5.1)	5 (1.4)	0.087	0.460	0.001	<0.001
Can AI be used as a treatment planning tool in diagnosis and treatment planning in dentistry	36 (10.1)	196 (55.2)	102 (28.7)	14 (3.9)	7 (2.0)	0.503	0.380	0.003	<0.001
Artificial intelligence can be used as a quality control tool to assess the success of treatments	37 (10.4)	177 (49.9)	124 (34.9)	12 (3.4)	5 (1.4)	0.109	0.123	0.066	0.001
Can AI be used in the radiographic diagnosis of pathologies in the jaws.	38 (10.7)	180 (50.7)	114 (32.1)	20 (5.6)	3 (0.8)	0.328	0.650	0.262	0.006
Can AI be used in forensic dentistry	49 (13.8)	182 (51.3)	106 (29.9)	14 (3.9)	4 (1.1)	0.230	0.576	0.061	0.041
Should AI be part of undergraduate dental training and curriculum	68 (19.2)	166 (46.8)	94 (26.5)	19 (5.4)	8 (2.3)	0.374	0.009	0.072	0.022
Should AI be part of postgraduate dental training and curriculum	73 (20.6)	172 (48.5)	86 (24.2)	18 (5.1)	6 (1.7)	0.303	0.132	0.001	0.002

Pearson chi-square test

= 28) of students via lectures given in the university, 6.8% (n = 24) of students from scientific research papers whereas 5.1% (n = 18) of students had knowledge from other sources and 4.5% (n = 16) through friends/family. However, 45.1% (n = 160) of the participants reported that they were unsure about their AI source of information. Statistically significant results were observed between the information sources of participants who had basic knowledge about the working principles of AI ($P < 0.001$), and also between the information sources of participants who were aware of the usage of AI in dentistry ($P < 0.001$). Comparison in terms of education grade showed a statistical difference between education year and having basic knowledge about AI (P 0.004) (Table 1)

A vast majority of the participants agreed that dentistry would be revolutionized by AI (74.7% agreement), but 31.5% of the participants responded that
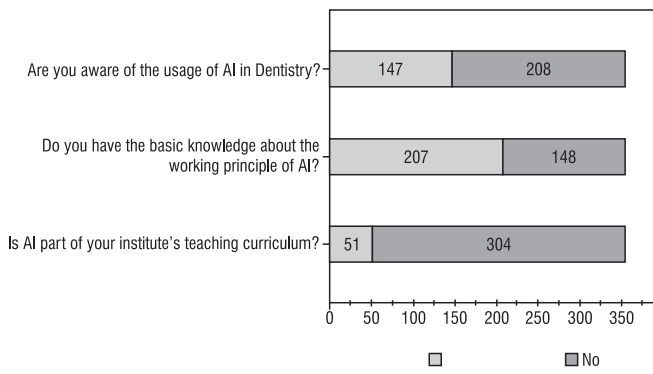
Fig 1: Distribution of responses regarding AI awareness, knowledge, and part of current teaching curriculum
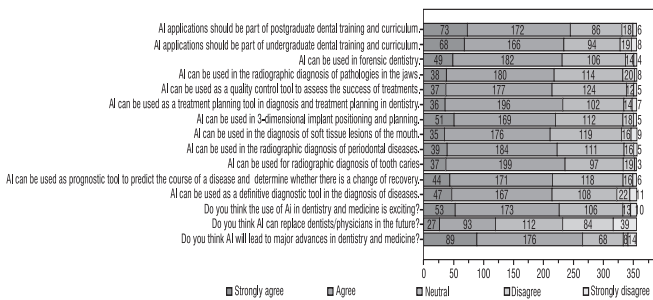

Fig 2: Distribution of answers regarding all statements about AI usage in dentistry.

AI could replace themselves in the future. Many of the participants showed excitement towards the use of AI in dentistry (63.6% agreement). It was predominantly agreed among the students that AI could be successfully used in a variety of applications and tasks such as disease diagnosis tool (60.2% agreement vs. 9.3% disagreement), as a prognostic tool to predict the course of a disease and recovery chances (60.6% agreement vs. 6.2% disagreement), aid in the radiographic diagnosis of tooth caries (66.5% agreement vs. 6.2% disagreement) and periodontal diseases (62.8% agreement vs. 5.9% disagreement), diagnosis tool for oral soft tissue lesions (59.5% agreement vs. 7.0% disagreement), 3D implant planning and positioning (65.3% agreement vs. 5.9% disagreement), a "quality control tool" to evaluate the success of treatments (60.3% agreement vs. 4.8% disagreement), as a tool for radiographic diagnosis of jaw pathologies (61.4% agreement vs. 6.4% disagreement) and in forensic dentistry (65.1% agreement vs. 5.0% disagreement). Furthermore, 66.0% and 69.1%% of participants respectively agreed that AI should be included in undergraduate and postgraduate dental education. Statistically significant difference was observed between "having basic knowledge about AI" and "being aware of the usage of AI in dentistry" with several statements which indicate the level of agreement about the perceptions towards AI in dentistry. Responses to questions about perceptions and attitudes towards AI in dentistry are shown in Table 2

DISCUSSION

It is a ubiquitously acknowledged view that AI will majorly impact the field of medicine and dentistry. A vast majority of study participants agreed that AI is a valuable asset in the detection of various soft and hard tissue dental pathologies, as a diagnostic and treatment planning tool for radiographic image interpretation, implant placement, and forensic dentistry. Many AI-based applications have already been developed with deep learning algorithms to detect and identify dental lesions; this has revolutionized the way physicians diagnose and treat patients. Therefore, the next generation of dental practitioners must have a sound and fundamental understanding of the core workings and practical applications of AI. Keeping this significance in mind, we conducted a multi- centre survey amongst the dental students of Karachi to assess their attitudes and perceptions towards AI in dentistry.

This is the first survey that explored the attitudes and perceptions of dental students of Karachi, Pakistan towards AI. The results revealed that the majority of the dental students were not aware of the use of AI in dentistry, but they knew its basic working principles. These results are in contrast to a similar study carried out among Turkish dental students [18] and Korean dental professionals.[19]

The students agreed that AI will innovate and revolutionize future dentistry and expressed excitement about the upcoming prospects of AI in dentistry, but they hold a neutral opinion (31.5%) with regards to AI replacing dental professionals in the future. Similar inferences were drawn by another study, where medical healthcare professionals perceived that AI-based programs can perform certain functions such as aiding in radiographic image interpretation, disease diagnosis, and predicting clinical outcome but it cannot build the essential doctor-patient relationship.[19] They believe that AI cannot perform certain person-centered responsibilities such as providing personal and psychiatric counselling, and empathetic patient care, and due to these limitations practitioners believe that AI will not replace them in the future but can only assist the physicians alongside patient diagnosis and management.[20, 21] On the contrary, another study conducted among medical students of United Kingdom revealed that 48.3% of the participants believed that certain medical specialties will be completely replaced by AI in the future. Furthermore, 49.2% of the participants were less likely to consider a career in radiology due to the perceived success of AI in this field and the potential of AI replacing radiologists in the near future.[22]

Our survey revealed that 85.6% of study partici-

pants responded that AI was not a part of the teaching curriculum of their institution. They further expressed enthusiasm and a high interest in the addition of AI as a part of the undergraduate and post-graduate teaching syllabus. In addition, the participants disclosed that they received their information regarding AI working principles via social media and not through academics. This supplements the findings of recording low awareness of AI applications in our study as it is not taught as a part of the routine dental curriculum. Dental students are not introduced to AI and its fundamental principles at the undergraduate level. These findings are consistent with other survey-based studies carried out on Turkish [18], Saudi Arabian [4], Canadian [23], German [24], and Indian [25] dental and medical students all revealing similar results, with regards to students gaining knowledge regarding AI via social media rather than academics. Considering the potentially huge impact this technology will have on the future landscape of dentistry, there is a strong and urgent need for dental universities to recognize this lacking and take steps to implement changes in their respective teaching curricula to incorporate at least basic AI topics at undergraduate level to compensate for this deficiency and help prepare students towards adaptation and better understanding of future healthcare developments.

The limitation of this research is that the survey participants included were from Karachi, Pakistan only, and therefore, these results may not be generalized to a larger population. Although this is a multi-centre survey with a consistent representative pool from all years of dental schools (Year 1st: 17.5%, 2nd: 25.1%, 3rd: 17.5%, 4th: 18.6%, 5th:21.4%), the overall goal of this survey was not to draw a representative conclusion regarding all Pakistani dental school but rather to understand how dental students' knowledge and perception could inform curriculum development, which we believe have achieved with our sample. We recommend that the medical and dental education experts should use this data and construct a curricular framework for implementation and a more detailed assessment. Furthermore, this survey only included dental students whereas the viewpoints of post-graduate residents were not included. Therefore, it could be stated that their perceptions may differ from the students` points of view.

CONCLUSION

This survey explored the knowledge and perception of dental students with regard to the use of AI in dentistry. The students showed an overall optimistic attitude towards AI`s role in dental healthcare. The survey also highlighted a lacking AI-related topic in the teaching curricula of different dental schools of Karachi Pakistan. Keeping in mind, as AI-powered technologies and applications are increasingly being integrated into the healthcare systems worldwide; medical and dental education institutes must consider its inclusion at the undergraduate teaching level to produce competent graduates who can cope with delivering high-quality patient health care.

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Hira Akhtar and Rimsha Qasim are responsible for conceptualization, planning and writing of the manuscript. Sanam Faheem and Fariha Irfan analysed and interpreted the survey data and reviewed the final manuscript. Anum Tanwir, Hina Hammad and Suriaya Hirani performed the data collection and critically reviewed the manuscript. All authors have read and approved the final manuscript.