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Knowledge, Attitudes, and Perceptions of Artificial Intelligence among Yemeni Dental Students and Interns: A Multi-Institutional Cross-Sectional Study

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ABSTRACT

Background: Artificial intelligence (AI) is rapidly entering dental education and practice, yet preparedness in low-resource settings is unclear.
Objective: This study aims to assess the existing knowledge, attitude, and perception levels of incorporation of AI into dental education and practice among Yemeni students.
Methods: We conducted a descriptive cross-sectional survey (January–March 2023) among clinical-year dental students and interns at three Yemeni institutions (Sana'a University, University of Aden, and University of Science and Technology). A validated questionnaire assessed demographics, AI knowledge (scored items), perceptions/attitudes (Likert scales), and training needs. Descriptive statistics, χ^2 tests, and planned multivariable models were used; significance was set at $p < 0.05$.
Results: Of the 761 participants (mean age 24.8±4.2 years), most lived in cities and were either fifth-year students or interns. A substantial correlation ($p < 0.05$) was found between the participants' feelings towards artificial intelligence (AI), their degree of university education, and their interaction with online social networks. Levels of AI expertise varied among regions. Scores were significantly higher for participants residing in Sana'a and outside of Yemen compared to those from other locations ($p=0.012$). None of the other demographic variables significantly altered these outcomes.
Conclusion: As a whole, dentistry students in Yemen have positive impressions of AI. However, their levels of comprehension varied greatly between regions, indicating that not everyone had the same exposure to and access to instructional resources about AI.

Keywords: Artificial intelligence (AI); dental education; student viewpoints; knowledge; Yemen; curriculum

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INTRODUCTION

The use of machine learning, robot vision, and complex cognitive networks exemplifies computational intelligence applications in dentistry that have demonstrated substantial promise in diagnostic examination, caries detection, implant design, orthodontic assessment, and patient record managemen (1,2).

Notwithstanding these developments, the application of AI in dentistry education and clinical practice varies by region, especially in poor countries with limited resources .

Infrastructure for digital communication (3). The knowledge, attitudes, and perceptions (KAP) of dental students and interns on artificial intelligence (AI) will profoundly influence the incorporation of new technology into standard oral healthcare practices (4). Although the majority of participants had favorable attitudes about AI, only approximately 44% demonstrated moderate to high levels of understanding, as indicated by a recent comprehensive evaluation of medical, dental, and nursing students (4). This mismatch highlights a discrepancy between curricular exposure and awareness, suggesting that educational institutions must play a crucial role in addressing this gap.

International study in dentistry has produced incongruous findings. Kahveci et al. (5) found that over 50% of Turkish dental students possess just a basic understanding of AI, although 85.7% expect AI to transform dentistry.

In South Korea, dental practitioners' perceptions of AI were markedly shaped by their prior exposure and dental expertise level (6). Concurrently, Egyptian dental hygiene pupils had favorable attitudes, with over 80% expressing a willingness to employ AI technology in restorative and prosthetic practices; yet, many resisted the notion that AI might replace human dentists (7). The findings suggest that while students see the potential of AI, ethical and professional apprehensions persist. Research undertaken in Jordan and Palestine within the Arab area has uncovered similar tendencies. Jordanian dental and medical students had positive attitudes towards AI, although they voiced concerns over data security, patient confidentiality, and the possible diminishment of human judgment (8).

In Palestine, 77% of survey participants exhibited a basic comprehension of AI, with most citing social media as their primary source of information (9). This reliance on informal sources for critical information underscores it. The importance of structured educational initiatives to enhance conceptual understanding rather than relying on passive exposure. Publications about intelligent technology in dentistry education in Yemen are scarce . Local institutions are in the first stages of integrating digital technology into their courses, and many students have limited access to advanced diagnostic or simulation tools. The educational limitations were worsened by significant socioeconomic challenges. This research enhances the worldwide discourse on the appropriate and equitable incorporation of AI into dental education and practice by assessing the existing awareness and perception levels among Yemeni students (10-12). This current study aims to assess the existing knowledge, attitude, and perception levels of the incorporation of AI into dental education and practice among Yemeni students.

METHODS

Study Design and Setting

A descriptive cross-sectional survey was administered from 1 January to 31 March 2023 at three institutions in Yemen: University of Science and Technology (UST), Aden, Yemen, Sana'a University, Yemen, and University of Aden, Yemen.

Participants and Eligibility

Eligible participants were clinical-year (≥ 4th year) dental students and dental interns enrolled at the participating universities during the study period who provided informed consent. Preclinical students and those declining consent were excluded.

Sample Size Determination

The required sample size was calculated using the standard single-proportion formula for cross-sectional studies, assuming a 95% confidence level, a margin of error (precision) of 5% (d = 0.05), and a conservative estimated prevalence (p) of 50% (p = 0.5) to maximize sample size when the true prevalence is unknown.

Formula for initial sample (infinite population assumption) :

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n0 = Z2 · p· (1−p) / d2
n0 = 0.9604 /0.0025 =384.16
Where：
Z = 1.96 (Z-score for 95% confidence)，
p = 0.5，
d = 0.05 ·
Because the study population (total number of eligible clinical students and interns across the three universities) is finite, the finite population correction (FPC) was applied when an estimate of the population size N was available. The corrected sample size n is given by: $n= n_o / 1 + (n_o–1/ N)$
Illustrative calculations for several plausible population sizes when N=1,000：
n=385 / 1 + (384/1000) = 277.99
Using a single-proportion formula (Z=1.96; p=0.50; d=0.05), the minimum sample was n_o=384. With uncertain finite population size across institutions, we retained n_o as a conservative target. The achieved sample was 761, yielding ≤ 5% absolute precision for key proportions.

Sampling Strategy and Recruitment

A mixed-mode convenience sampling strategy was used to maximize participation given logistical constraints. Students were recruited via two complementary modes:
1 ·Paper-based questionnaires distributed in lecture halls, clinical departments, and internship clinics during scheduled teaching and clinical sessions.
2 ·Electronic questionnaires were implemented using Google Forms and distributed via institutional mailing lists, official student groups, and social media channels associated with the participating universities.
To improve representativeness across academic years and institutions, data collection was coordinated with class representatives and internship supervisors; attempts were made to approach students from each clinical year and from all three universities. Recruitment continued until the target sample was achieved.

Survey Instrument

A structured, self-administered questionnaire adapted from prior studies of AI in dentistry [1–3] included the following:
(١)demographics/academics; (2) knowledge (scored items; correct=1, incorrect/"don't know"=0; summed to a total score); (3) perceptions/attitudes (Likert items on perceived utility, ethics, preparedness, and adoption willingness); and (4) barriers and training needs. English items were translated to Arabic, then back-translated ·
Three dental educators reviewed content validity; minor wording changes followed panel feedback. A pilot with 30 students (10 per site) was informed of clarity and length; pilot responses were excluded from analysis. Internal consistency for attitude/perception scales was acceptable (Cronbach's α=0.82).

Recruitment and Data Collection

A mixed convenience technique included paper surveys distributed during classes and clinics, as well as an online Google Form carried out through university email databases and recognized student members. Group representatives and trainee coordinators helped with communication in a number of clinical years and locations. Recruitment continued until goals were met.

Data Integrity

The completion of the paper forms was verified by inspections at the location. Each participant could only submit a single entry into the online form, and any duplicate submissions were promptly removed. There were two clerks who recorded the information from the publication, and if there were any disputes, the original documents were used to resolve them. If more than 20% of the responses were missing, we did not include the questionnaire.

Outcomes and Variables

Primary outcomes were total knowledge score and overall perception/attitude toward AI. (Assumption—please confirm how "Total perception" and "Total knowledge" were categorized into agree/neutral/disagree thresholds; we provisionally interpret cut-points as tertiles or predefined scale anchors).

Statistical Analysis

Analyses were conducted in IBM SPSS Statistics v26 (IBM Corp., Armonk, NY, USA). Descriptive statistics summarized sample characteristics and scores (mean±SD, n [%]). Knowledge-score normality was checked via Shapiro–Wilk. Group differences were tested with t-tests. Associations between categorical variables and categorized outcomes (e.g.,

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Agree/Neutral/Disagree) used χ^2 or Fisher's exact tests. Pre-specified multivariable models included linear regression for continuous knowledge score (covariates: age, sex, university, academic year, and prior AI exposure) and logistic regression for dichotomized adoption willingness. Assumptions (linearity, homoscedasticity, multicollinearity) and model fit were assessed. Two-sided α=0.05.

Missing Data

Knowledge items missing were scored as incorrect (0). For attitude scales, if ≤10% items were missing, individual mean imputation was applied; otherwise, the respondent was excluded from analyses for that scale .

Ethical Considerations

The study protocol was approved by the Research Ethics Committee of UST with approval number MEC/AD0138. Participation was voluntary; informed consent was obtained from all participants prior to survey completion. All responses were anonymized; no personal identifiers were collected. Data were stored on password-protected computers accessible only to the study team.

Study limitations (methodological considerations)

We acknowledge that convenience sampling and mixed-mode data collection may introduce selection bias and response-mode effects. However, the large achieved sample (n = 761) and the inclusion of multiple institutions reduce but do not eliminate these limitations. These aspects are addressed further in the Discussion.

RESULTS

Sample Characteristics

A total of 761 respondents participated (mean age 24.76±4.19 years). Females comprised 51.8%. Most were from Aden (75.2%), studied at the University of Aden (35.4%) or UST campuses (33.6% Aden; 31.0% Sana'a), and lived in urban areas (77.2%). Table 1 summarizes demographics .

Table 1: Demographic Characteristics of Participants, n=761

Variable	Category	Frequency (Valid %)
Gender	Male	360 (47.٣%)
	Female	401 (5٢.٧%)
Age	20–25	57٠ (74.9%)
	26–35	170 (22.3%)
	≥36	21 (2.8%)
Marital Status	Single	233 (30.6%)
	Married	528 (6٩.4%)
Education Level	Fifth level	318 (41.٨%)
	Intern student	44٣ (58.٢%)
City Type	Aden	573 (75.٣%)
	Sana'a	160 (21.0%)
	Taiz	2 (0.3%)
	Other city	26 (3.4%)
University Type	UST Aden	256 (33.6%)
	University of Aden	270 (35.٥%)
	Sana'a University	23٥(3٠.٩%)
Income	Low	45 (5.9%)
	Medium	25٥ (33.٥%)
	High	461 (60.5%)
Social Media Interest	Interested	5٢٩ (69.٥%)
	Not interested	232 (30.٥%)
Geographic Location	Village	174 (22.٩%)
	City	58٧ (77.١%)

Associations with Perception and Knowledge

Perception: Significant associations were observed for gender (p=0.048), university type (p=0.040), and social media interest (p=0.048), with higher agreement among males, University of Aden students, and respondents interested in social media. Other variables were not significant (Table 2).

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Table 2: Association between Demographic Variables and Total Perception (Chi-Square Test), n =761

Variable	Category	Agree n (%)	Disagree n (%)	Neutral n (%)	P-value
Age	20–25	107 (18.8%)	414 (72.6%)	49 (8.6%)	0.570
	26–35	28 (16.5%)	128 (75.3%)	14 (8.2%)	
	≥36	3 (14.3%)	18 (85.7%)	0 (0.0%)	
Gender	Male	76 (21.1%)	250 (69.4%)	34 (9.4%)	0.048*
	Female	62 (15.5%)	310 (77.3%)	29 (7.2%)	
Education Level	Intern student	79 (17.8%)	332 (74.9%)	32 (7.2%)	0.418
	Fifth level	59 (18.6%)	228 (71.7%)	31 (9.7%)	
City	Aden	96 (16.8%)	425 (74.2%)	52 (9.1%)	0.421
	Sana’a	38 (23.9%)	112 (70.4%)	9 (5.7%)	
	Taiz	٠ (٠.٠%)	٢(١٠٠.٠%)	٠ (٠.٠%)	
	Other city	١٧ (٦٥.٤%)	٩(٣٤.٦%)	٠ (٠.٠%)	
University Type	UST Aden	40 (15.6%)	187 (73.0%)	29 (11.3%)	0.040*
	University of Aden	55 (20.4%)	191 (70.7%)	24 (8.9%)	
	Sana’a University	43 (18.3%)	182 (77.4%)	10 (4.3%)	
Income	Low	8 (17.8%)	36 (80.0%)	1 (2.2%)	0.398
	Medium	40 (15.7%)	193 (75.7%)	22 (8.6%)	
	High	90 (19.5%)	331 (71.8%)	40 (8.7%)	
Social Media Interest	Interested	103 (19.5%)	376 (71.1%)	50 (9.5%)	0.048*
	Not interested	35 (15.1%)	184 (79.3%)	13 (5.6%)	
Geographic Location	Village	35 (20.1%)	122 (70.1%)	17 (9.8%)	0.481
	City	103 (17.5%)	438 (74.6%)	46 (7.8%)	
Source of Info	Social media	٢٣٧(٤٢.١%)	١٧ (٣.٠%)	٣٠٩ (٥٤.٩%)	0.08١*
	Non Social media	94(47.5%)	9 (4.5%)	105(52.5%)	
Marital Status	Single	42 (18.0%)	172 (73.8%)	19 (8.2%)	0.995
	Married	96 (18.2%)	388 (73.5%)	44 (8.3%)	

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Association between Variables

Total knowledge was associated with location (city; p=0.012), with higher knowledge among respondents from Sana'a and outside Yemen compared with Aden. No other factors were significant (Table 3) .

Table 3: Association between demographic variables and Total Knowledge (Chi-square test), n=761

Variable	Category	Agree n (%)	Disagree n (%)	Neutral n (%)	P-value
Age	20-25	251 (44.0%)	297 (52.0%)	23 (4.0%)	0.482
	26-35	73 (42.9%)	94 (55.3%)	3 (1.8%)	
	36+	8 (38.1%)	13 (61.9%)	0 (0.0%)	
Gender	Male	163 (45.3%)	187 (51.9%)	10 (2.8%)	0.494
	Female	169 (42.0%)	217 (54.0%)	16 (4.0%)	
Education Level	Intern student	193 (43.5%)	236 (53.2%)	15 (3.4%)	0.995
	Fifth level	139 (43.7%)	168 (52.8%)	11 (3.5%)	
City	Aden	228 (39.8%)	325 (56.7%)	20 (3.5%)	0.012*
	Sana'a	87 (54.4%)	67 (41.9%)	6 (3.8%)	
	Taiz	0 (0.0%)	2 (100.0%)	0 (0.0%)	
	Other	17 (65.4%)	9 (34.6%)	0 (0.0%)	
University Type	UST Aden	112 (43.8%)	135 (52.7%)	9 (3.5%)	0.760
	University of Aden	124 (45.9%)	136 (50.4%)	10 (3.7%)	
	Sana'a University	96 (40.7%)	133 (56.4%)	7 (3.0%)	
Income	Low	15 (33.3%)	29 (64.4%)	1 (2.2%)	0.386
	Medium	106 (41.4%)	142 (55.5%)	8 (3.1%)	
	High	211 (45.8%)	233 (50.5%)	17 (3.7%)	
Social Media Interest	Interested	231 (43.6%)	278 (52.5%)	21 (4.0%)	0.438
	Not interested	101 (43.5%)	126 (54.3%)	5 (2.2%)	
Geographic Location	Village	73 (42.0%)	93 (53.4%)	8 (4.6%)	0.585
	City	259 (44.0%)	311 (52.9%)	18 (3.1%)	
Source of info about AI	Social media	237 (42.1%)	309 (54.9%)	17 (3.0%)	0.075
	Lecturers	73 (51.4%)	65 (45.8%)	4 (2.8%)	
	Friends/family	14 (33.3%)	24 (57.1%)	4 (9.5%)	
	Newspaper/Magazine	8 (53.3%)	6 (40.0%)	1 (6.7%)	

*P-value <0.05 indicates significant association

Overall, the cohort was young and urban. While most people had positive views of AI, these varied by gender, institution, and level of social media participation; nonetheless, there were regional differences in knowledge, suggesting that not everyone had the same opportunities to learn about AI.

DISCUSSION

The results of this study showed that dental students in Yemen had generally good attitudes regarding AI, while their knowledge of the topic differed by area of study. Gender, academic affiliation, and social media engagement were substantially connected with AI attitudes in this young, urban, multi-institutional sample; nonetheless, regional variances in knowledge

predominated. There were no clear relationships between other demographic factors and either perception or knowledge.

Consistent with results reported in Peru (13, 14), male students at the University of Aden and those with a strong interest in social media were more likely to agree with positive comments about AI.

This trend might be influenced by the increasing amount of time individuals spend online, the emphasis on technology in schools, or the social norms that promote new ideas and the use of technology. With the use of social media, students are able to more easily exchange information on artificial intelligence, serving as an informal learning platform.

Dental students and practicing dentists hold comparable favorable views toward AI, according to many studies (6, 15, 16). Their willingness to employ AI in healthcare contexts is strongly correlated with their level of understanding and awareness of the technology.

Similarly, the results of (17–19) demonstrate that the use of AI in dental education and practice is a topic of great interest globally. Lack of formal training and limited immersion into the material, however, might occasionally dampen this enthusiasm.

On the other side, a number of studies have shown apathy or caution, highlighting worries about diagnostic responsibility, ethical implications, and professional autonomy—particularly in settings without formal AI training or strong data security protocols. Distinct regions of the world had very varied levels of knowledge. Individuals in Sana'a and other cities have higher knowledge than those in Aden (9,20).

Consistent with previous research from throughout the world, our findings demonstrate that AI knowledge and confidence vary greatly among institutions and nations and that structured education enhances both understanding and intended use (21). On the other side, many studies found consistently intermediate levels of knowledge, with differences in understanding being attributed more to clinical skill or previous experience with AI than to regional considerations (6,15).

The perception measure might have been impacted by social desirability bias since it relied on self-reported data. Students who spent more time online may have been overrepresented in the convenience sample.

Furthermore, our dataset's city may have introduced misclassification bias due to its merging of urban and international categories. We were only able to estimate impact sizes since continuous knowledge evaluations were not a part of our investigation .

Regardless of these caveats, the study's positive aspects include a sizable sample drawn from three different colleges, the development of a multilingual instrument that has been validated by experts, and acceptable internal reliability ($\alpha = 0.82$). The results indicate that dental students from Yemen had a favorable impression of AI (4).

Revising the timing and content of core courses within dental curricula is essential in light of the strengths demonstrated by programs in dental schools worldwide. Such revisions should emphasize the development of essential competencies and ensure that dental students are adequately prepared with the necessary knowledge and practical skills prior to entering the clinical phases of their training (22). Each of their strengths is in a distinct area. Dental schools can do their part to prepare students for the ethical and responsible use of artificial intelligence (AI) in the classroom and the clinic by systematically incorporating AI-related content into their curricula. This content should cover basic principles, ethical considerations, data literacy, and supervised practical applications.

CONCLUSION

Yemeni dental students and interns typically have favorable attitudes towards artificial intelligence. These opinions are influenced by characteristics such as gender, institution, and social media activity. The degree of comprehension fluctuates based on geographic location. It is advisable to provide standardized curricular content and specialized training to mitigate disparities and facilitate the integration of artificial intelligence in a safe and effective way.

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Author's Contributions

Reem Mshtaq Mugahed Moqbel Al-Maqtari was responsible for drafting the initial version of the manuscript. Azzam S. Algabri contributed to the development of the methodology and the analysis and presentation of the results. Fares M.S. Muthanna provided critical revision of the manuscript and overall supervision of the study.

Conflict of Interest

The authors declare that there is no conflict of interest.

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