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**Original Article**

# Perceptions and Readiness of Oral and Maxillofacial Surgeons and Trainees Toward Artificial Intelligence Integration: A Singapore-Based Study

**M. Ruiz[1]*, Javier L. Moreno[2], Alejandro F. Ortega[3]**

[1]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Complutense University of Madrid, Madrid, Spain.
[2]Oral Surgery Unit, Hospital Clínico San Carlos, Madrid, Spain.
[3]Department of Oral Surgery, Faculty of Medicine, Autonomous University of Madrid, Madrid, Spain.

***E-mail** ✉ carlos.ruiz@outlook.com

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## ABSTRACT

This investigation sought to assess how oral and maxillofacial surgery (OMS) specialists and trainees understand, perceive, and apply artificial intelligence (AI) in their clinical work and training. A cross-sectional questionnaire was distributed to OMS clinicians and residents in Singapore to gather their perspectives on AI in the field. The instrument contained 25 items across five sections and was administered through an online survey system. A total of 48 individuals responded, comprising 37 specialists and 11 trainees. Among them, 60.4% indicated they lacked strong knowledge of AI, 52.1% were unfamiliar with AI applications in OMS, and 81.3% had never received formal instruction related to AI. Many believed that AI could support diagnostic and treatment-planning tasks (72.9%) and help improve patient outcomes (75.0%), and also agreed that AI should be integrated into OMS training (68.8%). No gender-associated differences were observed, although younger clinicians showed more positive views ($p < 0.05$). Key concerns included potential diagnostic or planning errors (77.1%), excessive reliance (70.8%), data security or privacy issues (41.7%), and rising healthcare expenses (41.7%). Despite 68.8% using AI in everyday activities and 62.5% noting that AI made tasks easier, most had not adopted AI in clinical work (62.5%) and felt insufficiently trained or resourced to do so (79.2% and 58.3%, respectively). OMS clinicians and trainees in Singapore generally express positive expectations regarding AI, with younger participants showing greater enthusiasm. Nonetheless, both familiarity and actual utilization of AI remain limited.

**Keywords:** Oral and maxillofacial surgeons, Singapore, Artificial intelligence, Clinical work and training

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## Introduction

Artificial intelligence (AI) has rapidly expanded within healthcare over recent years. Academic output in medical AI has risen steadily, with an annual increase of 28.4% [1]. Parallel developments are evident in oral and maxillofacial surgery, where AI-based systems have been designed to support diagnosis and surgical planning [2]. Major technology companies, including Google, are also contributing to this surge, producing systems such as MedLM for medical inquiry responses and AI tools for disease detection [3]. Within health-professional education, numerous AI-enabled applications have been proposed, such as instructional aids, independent learning resources, and automated evaluation systems [4].

Although the healthcare and education sectors are moving toward incorporating AI, the extent to which clinicians, faculty, and trainees are ready to adopt these tools in routine activities remains less explored. Knowledge, attitudes, and practices (KAP) studies are widely used in health sciences to evaluate baseline viewpoints and to guide program enhancement [5].

In relation to AI, various KAP assessments targeting researchers, instructors, students, and healthcare workers have been published over the past three years [6-8]. In dentistry, prior KAP investigations involving students and practitioners demonstrate mixed knowledge levels but generally supportive attitudes toward integrating AI into dental curricula and practice [9]. However, research focusing specifically on OMS clinicians is lacking, and very few studies have been conducted in East or Southeast Asia. OMS differs from general dentistry in its blend of medical and surgical responsibilities across facial hard and soft tissues, making it unclear whether OMS clinicians' perspectives mirror those of other dental professionals. Therefore, this study aims to assess OMS specialists' and trainees' knowledge, attitudes, and current use of AI within clinical practice and training environments.

## Materials and Methods

A cross-sectional survey of OMS clinicians from both public and private institutions in Singapore was carried out between 7 October 2024 and 15 November 2024. The survey adhered to the CHERRIES reporting guidelines for online questionnaires [10]. Eligible participants included OMS specialists—identified through specialist registration with the Singapore Dental Council—and OMS trainees enrolled in the National University of Singapore (NUS) Master of Dental Surgery (OMS) residency program, as well as graduates of OMS residency programs practicing without specialist accreditation. Ethical exemption from the NUS Institutional Review Board was secured before data collection (NUS-IRB-2024-892).

### *Survey development, testing and validation*

The questionnaire was hosted and managed using Qualtrics XM (USA). Items were developed collaboratively by the study team **(Table 1)**. Five sections were included:

- Section 1: demographic details (age, gender, years of practice)
- Sections 2–4: assessment of knowledge, attitudes, and practices
- Section 5: optional free-text comments

The survey incorporated multiple-choice formats, multiple-response selections, Likert-scale items, and open-ended prompts.



**Table 1.** Survey sections and questions.

| Section 1: Demographic Information — Response Options | | |
|---|---|---|
| **Item** | **Question** | **Options** |
| **Q1** | What is your current age? | ______________ |
| **Q2** | Please indicate your gender. | Male / Female |
| **Q3** | Are you a board-certified OMS specialist? | Yes / No |
| **Q4** | How long have you been practicing OMS? | 0–5 / 6–15 / >15 |
| Section 2: Knowledge | | |
| **Item** | **Statement / Prompt** | **Response Options** |
| **Q1** | I possess a solid understanding of artificial intelligence (AI), such as machine learning or large language models. | Strongly Agree / Somewhat Agree / Somewhat Disagree / Strongly Disagree |
| **Q2** | I am familiar with how AI can be used within OMS practice and educational settings. | Strongly Agree / Somewhat Agree / Somewhat Disagree / Strongly Disagree |
| **Q3** | I have previously attended AI-related courses, talks, or training sessions. | Strongly Agree / Somewhat Agree / Somewhat Disagree / Strongly Disagree |
| **Q4** | Please list any AI tools or systems you know of (inside or outside OMS). | ______________ |
| Section 3: Attitudes | | |
| **Item** | **Statement / Prompt** | **Response Options** |
| **Q1** | AI currently helps or could help improve patient outcomes in OMS. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q2** | AI ought to be adopted in clinical workflows for diagnosis and treatment planning. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q3** | AI should be incorporated into OMS training programmes. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q4** | AI might eventually replace OMS surgeons. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |

| | | |
|---|---|---|
| **Q5** | Excessive dependence on AI could lead to loss of important clinical skills. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q6** | What advantages do you believe AI offers in OMS practice or education? (select all that apply) | • Improved efficiency in clinical work• Lower workload for clinicians, teachers or trainees• Enhanced access and tailored experiences for patients/students• I believe there are no benefits• Other: ______________ |
| **Q7** | What concerns do you have about using AI in clinical care? (select all that apply) | • Issues related to data privacy or security• Risk of incorrect diagnosis or treatment• Overdependence leading to clinician redundancy• Higher healthcare costs• Other: ______________ |
| | Section 4: Practices | |
| **Item** | **Statement / Prompt** | **Response Options** |
| **Q1** | I have used AI systems in any context outside my professional work. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q2** | I have used AI tools within my OMS clinical practice. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q3** | I have used or considered using AI for the following purposes (choose all that apply): | • Diagnostic support (radiographic, histopathologic, clinical)• Educating patients or students• Independent learning• Planning treatment• Intraoperative assistance• I have not used nor considered the use of AI in my practice• Other: ______________ |
| **Q4** | I have used or thought about using AI for diagnosing or planning treatment in these OMS subspecialties (select all that apply): | • Dentofacial deformities• Dentoalveolar procedures• Surgical pathology (including oncology)• Maxillofacial trauma• Implant and preprosthetic surgery• TMJ procedures• I have not used or considered using AI in my practice |
| **Q5** | AI helps make my work easier to complete. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q6** | I feel I have sufficient training to handle AI tools. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q7** | My institution or clinic has the resources required to implement AI in routine care. | Strongly Agree / Somewhat Agree / Unsure / Somewhat Disagree / Strongly Disagree |
| **Q8** | What resources do you believe are needed to support better AI adoption in your practice? | ________________________________________ |
| | Section 5: Additional Feedback | |
| **Item** | **Prompt** | **Response Area** |
| **Q1** | Any further comments? | ________________________________________ |



A sample size estimate was completed before launching the survey, yielding a target of 52 participants based on a 95% confidence level and an 8% margin of error. Convenience sampling was intended for participant recruitment. Prior to distribution, the survey underwent qualitative review to ensure its validity. Content validity was confirmed through evaluation by three OMS/AI experts, who examined the relevance and completeness of the items. Face validity was established through pilot testing involving 6 individuals (representing 10% of the planned sample). This step supported refinement of question clarity, readability, and relevance. Internal consistency across Sections 2, 3, and 4 (Knowledge, Attitudes, and Practices) was examined using Cronbach's alpha, with values above 0.7 deemed acceptable.

*Survey administration*

The questionnaire was circulated to potential respondents through emails sent by professional bodies (e.g., the Association of Oral and Maxillofacial Surgeons Singapore, AOMSS) and academic institutions (NUS). The survey link was open-access without any login requirement. Participants were informed about the study purpose, investigators, and estimated completion time, and consent was obtained at the beginning of the survey. Involvement was optional, with the freedom to discontinue at any stage. No identifying information was requested, responses remained confidential, and no compensation was provided.

Data exported from the platform were compiled in an Excel spreadsheet. To prevent duplicate entries, records of unique users were checked using IP addresses and cookies. Response timestamps were reviewed to detect entries completed in under 20 seconds as well as incomplete submissions, which were removed due to likely inaccuracy.

*Data analysis*

For every survey item, descriptive statistics (counts and percentages) were generated. Additional statistical tests explored relationships between demographic variables (gender, age, practice duration) and survey outcomes. For Likert-type items, the positive categories ("Strongly Agree" and "Somewhat Agree") were merged into "Agree," and the negative categories ("Strongly Disagree" and "Somewhat Disagree") were combined into "Disagree." In five-point Likert items, "Unsure" was kept as a separate category. Associations between demographic factors and these variables were evaluated using Fisher's exact test. For multi-select questions, each choice was examined as an independent binary variable, again using Fisher's exact test to determine differences across demographic groups. All analyses were performed in R, with significance fixed at $p < 0.05$.

A thematic analysis of the free-text responses from Sections 4 and 5 was also carried out. The process involved familiarisation with the data, coding, and sorting coded segments into themes to better understand suggestions for integrating AI into routine practice.

**Results and Discussion**

A total of 55 submissions were received by 15 November 2024. Of these, **7** were incomplete and excluded, leaving 48 usable responses**.** The average completion time was 2.43 minutes. Participants had a mean age of 40.8 years, with 35 males (72.9%) and 13 females (27.1%)**.** Years of practice were evenly distributed: 15 (31.3%) had ≤5 years (trainees)**,** 17 (35.4%) had 6–15 years (junior specialists), and 16 (33.3%) had >15 years (senior specialists).

*Knowledge*

A considerable proportion of respondents indicated limited understanding of AI in the OMS context **(Table 2).** 60.4% reported "Strongly Disagree" or "Somewhat Disagree" when asked about having a good general grasp of AI, and 52.1% responded similarly regarding awareness of AI applications in OMS. Only 18.8% had ever received AI-related training. No statistically significant effects were found for gender **(**$p = 0.741$–1.000**),** age **(**$p = 0.153$–1.000**)**, or practice duration **(**$p = 0.222$–1.000**) (Table 3).** The knowledge section achieved a Cronbach's alpha of 0.76, indicating acceptable reliability **(Table 4).**



**Table 2.** Summary of responses to questions using the Likert scale.

| Question | Strongly Agree | Somewhat Agree | Strongly Disagree | Somewhat Disagree | Unsure |
|---|---|---|---|---|---|
| **Section 2: Knowledge and Familiarity with AI** | | | | | |
| Q1: I possess a solid understanding of artificial intelligence (AI) | 2 (4.2%) | 17 (35.4%) | 10 (20.8%) | 19 (39.6%) | NA |
| Q2: I am familiar with how AI is applied in oral and maxillofacial surgery (OMS) | 4 (8.3%) | 19 (39.6%) | 6 (12.5%) | 19 (39.6%) | NA |
| Q3: I have participated in courses, lectures, or other forms of AI training | 1 (2.1%) | 8 (16.7%) | 17 (35.4%) | 17 (35.4%) | NA |
| **Section 3: Attitudes Toward AI in OMS** | | | | | |
| Q1: AI is, or has the potential to be, helpful in improving patient outcomes in OMS | 17 (35.4%) | 19 (39.6%) | 1 (2.1%) | 1 (2.1%) | 10 (20.8%) |
| Q2: Artificial intelligence should be incorporated into clinical practice for diagnosis and treatment planning | 15 (31.3%) | 20 (41.6%) | 2 (4.2%) | 2 (4.2%) | 9 (18.8%) |
| Q3: AI should be included as part of OMS residency and continuing education | 14 (29.2%) | 19 (39.6%) | 2 (4.2%) | 4 (8.3%) | 9 (18.8%) |
| Q4: In the future, AI could completely replace oral and maxillofacial surgeons | 0 (0%) | 3 (6.3%) | 24 (50.0%) | 14 (29.2%) | 7 (14.6%) |
| Q5: Excessive dependence on AI might cause surgeons to lose important clinical skills | 6 (12.5%) | 22 (45.8%) | 4 (8.3%) | 11 (22.9%) | 5 (10.4%) |
| **Section 4: Current Use and Experience with AI** | | | | | |
| Q1: I have utilized AI technologies in areas of my life outside professional practice | 10 (20.8%) | 23 (47.9%) | 5 (10.4%) | 8 (16.7%) | 2 (4.2%) |

| | | | | | |
|---|---|---|---|---|---|
| Q2: I have incorporated AI technologies into my OMS clinical practice | 0 (0%) | 12 (25.0%) | 15 (31.3%) | 15 (31.3%) | 6 (12.5%) |
| Q5: Using AI simplifies and facilitates the completion of my professional tasks | 8 (16.7%) | 22 (45.8%) | 2 (4.2%) | 3 (6.3%) | 13 (27.1%) |
| Q6: I feel sufficiently prepared and trained to effectively use AI tools | 0 (0%) | 6 (12.5%) | 19 (39.6%) | 19 (39.6%) | 4 (8.3%) |
| Q7: My clinic/institution currently has the necessary infrastructure to integrate AI into practice | 0 (0%) | 10 (20.8%) | 16 (33.3%) | 12 (25.0%) | 9 (18.8%) |

**Table 3.** Relationship between demographic variables (gender, age, and years of practice) and Likert-scale item responses.

| Question | p-value (Gender) | Male | Female | p-value (Age) | Age ≤40 | Age >40 | p-value (Experience) | 1–5 years practice | 6–15 years practice | >15 years practice |
|---|---|---|---|---|---|---|---|---|---|---|
| **Section 2: Knowledge** | | | | | | | | | | |
| Q1 | 0.741 | | | 0.770 | | | 1.000 | | | |
| Disagree | | 22 (62.9%) | 7 (53.8%) | | 17 (63.0%) | 12 (57.1%) | | 9 (60.0%) | 10 (58.8%) | 10 (62.5%) |
| Agree | | 13 (37.1%) | 6 (46.2%) | | 10 (37.0%) | 9 (42.9%) | | 6 (40.0%) | 7 (41.2%) | 6 (37.5%) |
| Q2 | 0.335 | | | 1.000 | | | 0.393 | | | |
| Disagree | | 20 (57.1%) | 5 (38.5%) | | 14 (51.9%) | 11 (52.4%) | | 6 (40.0%) | 11 (64.7%) | 8 (50.0%) |
| Agree | | 15 (42.9%) | 8 (61.5%) | | 13 (48.1%) | 10 (47.6%) | | 9 (60.0%) | 6 (35.3%) | 8 (50.0%) |
| Q3 | 1.000 | | | 0.153 | | | 0.222 | | | |
| Disagree | | 28 (80.0%) | 11 (84.6%) | | 24 (88.9%) | 15 (71.4%) | | 14 (93.3%) | 14 (82.4%) | 11 (68.8%) |
| Agree | | 7 (20.0%) | 2 (15.4%) | | 3 (11.1%) | 6 (28.6%) | | 1 (6.7%) | 3 (17.6%) | 5 (31.2%) |
| **Section 3: Attitudes** | | | | | | | | | | |
| Q1 | 1.000 | | | 0.004* | | | <0.001* | | | |
| Disagree | | 2 (5.7%) | 0 (0.0%) | | 0 (0.0%) | 2 (9.5%) | | 0 (0.0%) | 0 (0.0%) | 2 (12.5%) |
| Unsure | | 7 (20.0%) | 3 (23.1%) | | 2 (7.4%) | 8 (38.1%) | | 1 (6.7%) | 1 (5.9%) | 8 (50.0%) |
| Agree | | 26 (74.3%) | 10 (76.9%) | | 25 (92.6%) | 11 (52.4%) | | 14 (93.3%) | 16 (94.1%) | 6 (37.5%) |
| Q2 | 0.251 | | | 0.009* | | | 0.024* | | | |
| Disagree | | 4 (11.4%) | 0 (0.0%) | | 0 (0.0%) | 4 (19.0%) | | 0 (0.0%) | 0 (0.0%) | 4 (25.0%) |
| Unsure | | 5 (14.3%) | 4 (30.8%) | | 3 (11.1%) | 6 (28.6%) | | 1 (6.7%) | 4 (23.5%) | 4 (25.0%) |
| Agree | | 26 (74.3%) | 9 (69.2%) | | 24 (88.9%) | 11 (52.4%) | | 14 (93.3%) | 13 (76.5%) | 8 (50.0%) |
| Q3 | 0.478 | | | 0.122 | | | 0.146 | | | |
| Disagree | | 5 (14.3%) | 1 (7.7%) | | 2 (7.4%) | 4 (19.0%) | | 1 (6.7%) | 1 (5.9%) | 4 (25.0%) |
| Unsure | | 8 (22.9%) | 1 (7.7%) | | 3 (11.1%) | 6 (28.6%) | | 2 (13.3%) | 2 (11.8%) | 5 (31.2%) |
| Agree | | 22 (62.9%) | 11 (84.6%) | | 22 (81.5%) | 11 (52.4%) | | 12 (80.0%) | 14 (82.4%) | 7 (43.8%) |
| Q4 | 0.846 | | | 0.865 | | | 0.415 | | | |
| Disagree | | 27 (77.1%) | 11 (84.6%) | | 22 (81.5%) | 16 (76.2%) | | 11 (73.3%) | 14 (82.4%) | 13 (81.2%) |
| Unsure | | 6 (17.1%) | 1 (7.7%) | | 4 (14.8%) | 3 (14.3%) | | 4 (26.7%) | 1 (5.9%) | 2 (12.5%) |
| Agree | | 2 (5.7%) | 1 (7.7%) | | 1 (3.7%) | 2 (9.5%) | | 0 (0.0%) | 2 (11.8%) | 1 (6.2%) |
| Q5 | 0.078 | | | 0.828 | | | 0.545 | | | |
| Disagree | | 13 (37.1%) | 2 (15.4%) | | 9 (33.3%) | 6 (28.6%) | | 7 (46.7%) | 3 (17.6%) | 5 (31.2%) |
| Unsure | | 5 (14.3%) | 0 (0.0%) | | 2 (7.4%) | 3 (14.3%) | | 1 (6.7%) | 2 (11.8%) | 2 (12.5%) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Agree | | 17 (48.6%) | 11 (84.6%) | | 16 (59.3%) | 12 (57.1%) | | 7 (46.7%) | 12 (70.6%) | 9 (56.2%) |
| **Section 4: Practices** | | | | | | | | | | |
| Q1 | 0.606 | | | 0.290 | | | 0.075 | | | |
| Disagree | | 9 (25.7%) | 4 (30.8%) | | 5 (18.5%) | 8 (38.1%) | | 1 (6.7%) | 5 (29.4%) | 7 (43.8%) |
| Unsure | | 1 (2.9%) | 1 (7.7%) | | 1 (3.7%) | 1 (4.8%) | | 1 (6.7%) | 0 (0.0%) | 1 (6.2%) |
| Agree | | 25 (71.4%) | 8 (61.5%) | | 21 (77.8%) | 12 (57.1%) | | 13 (86.7%) | 12 (70.6%) | 8 (50.0%) |
| Q2 | 0.448 | | | 0.335 | | | 0.880 | | | |
| Disagree | | 23 (65.7%) | 7 (53.8%) | | 15 (55.6%) | 15 (71.4%) | | 9 (60.0%) | 10 (58.8%) | 11 (68.8%) |
| Unsure | | 3 (8.6%) | 3 (23.1%) | | 5 (18.5%) | 1 (4.8%) | | 3 (20.0%) | 2 (11.8%) | 1 (6.2%) |
| Agree | | 9 (25.7%) | 3 (23.1%) | | 7 (25.9%) | 5 (23.8%) | | 3 (20.0%) | 5 (29.4%) | 4 (25.0%) |
| Q5 | 0.785 | | | 0.379 | | | 0.656 | | | |
| Disagree | | 3 (8.6%) | 2 (15.4%) | | 2 (7.4%) | 3 (14.3%) | | 1 (6.7%) | 1 (5.9%) | 3 (18.8%) |
| Unsure | | 10 (28.6%) | 3 (23.1%) | | 6 (22.2%) | 7 (33.3%) | | 3 (20.0%) | 5 (29.4%) | 5 (31.2%) |
| Agree | | 22 (62.9%) | 8 (61.5%) | | 19 (70.4%) | 11 (52.4%) | | 11 (73.3%) | 11 (64.7%) | 8 (50.0%) |
| Q6 | 0.437 | | | 0.880 | | | 0.810 | | | |
| Disagree | | 29 (82.9%) | 9 (69.2%) | | 21 (77.8%) | 17 (81.0%) | | 11 (73.3%) | 14 (82.4%) | 13 (81.2%) |
| Unsure | | 2 (5.7%) | 2 (15.4%) | | 2 (7.4%) | 2 (9.5%) | | 1 (6.7%) | 1 (5.9%) | 2 (12.5%) |
| Agree | | 4 (11.4%) | 2 (15.4%) | | 4 (14.8%) | 2 (9.5%) | | 3 (20.0%) | 2 (11.8%) | 1 (6.2%) |
| Q7 | 1.000 | | | 0.720 | | | 0.905 | | | |
| Disagree | | 21 (60.0%) | 8 (61.5%) | | 15 (55.6%) | 14 (66.7%) | | 8 (53.3%) | 10 (58.8%) | 11 (68.8%) |
| Unsure | | 7 (20.0%) | 2 (15.4%) | | 6 (22.2%) | 3 (14.3%) | | 3 (20.0%) | 4 (23.5%) | 2 (12.5%) |
| Agree | | 7 (20.0%) | 3 (23.1%) | | 6 (22.2%) | 4 (19.0%) | | 4 (26.7%) | 3 (17.6%) | 3 (18.8%) |

*Denotes statistically significant findings.



**Table 4.** Cronbach's alpha values for Sections 2–3 of the questionnaire.

| Section | Cronbach's alpha |
|---|---|
| 2 (Knowledge) | 0.76 |
| 3 (Attitudes) | 0.71 |
| 4 (Practices) | 0.78 |

When participants were asked to name existing AI tools**,** 25 (52.1%) were able to identify at least one OMS-related system; of these, 15 referred to tools for examination/diagnostic purposes, **7** mentioned options for treatment planning, and 3 cited other functions. For AI outside OMS, 24 (50.0%) listed a large language model, 5 (10.4%) identified robotics, and another 5 (10.4%) named speech-to-text or text-to-speech tools. 12 (25.0%) could not list any AI technology at all.

*Attitudes*

Overall, participants demonstrated favourable views toward AI use in OMS **(Table 2)**. A substantial proportion agreed that AI could improve patient outcomes (75.0%), should be incorporated into routine practice (72.9%), and ought to be included in OMS training (68.8%). Meanwhile, only 4.2–12.5% selected "Strongly Disagree" or "Somewhat Disagree" for these items. In contrast, 79.2% disagreed that AI may eventually replace surgeons, and 58.3% agreed that excessive dependence on AI could erode clinical competence. While gender showed no significant influence (p = 0.078–1.000), respondents aged 40 or younger were significantly more likely to believe AI can improve patient outcomes (p = 0.004) and should be introduced into clinical workflows (p = 0.009) **(Table 3)**. Significant differences were also seen among clinicians grouped by practice duration (p < 0.001 and p = 0.024). The attitudes section demonstrated adequate internal reliability, with a Cronbach's alpha of 0.71 **(Table 4)**.

Regarding perceived benefits and concerns, 83.3% highlighted greater efficiency, 72.9% cited reduced workload, 45.8% noted better personalisation, while 6.3% felt AI provided no benefit. A larger share of respondents aged ≤40 regarded personalisation as an advantage (p = 0.013), and experience level showed a significant association with reports of increased efficiency (p = 0.010) **(Table 5)**. Concerning drawbacks, 77.1% were worried about incorrect diagnostic or planning outputs, 70.8% about dependency, and 41.7% each about privacy/security issues and cost escalation. These patterns were consistent across demographic groups **(Table 5).**

**Table 5.** Associations between demographic characteristics and responses to multi-response questions.

| Question / Response Option | p-value (Gender) | Male | Female | p-value (Age) | Age ≤40 | Age >40 | p-value (Experience) | 1–5 years | 6–15 years | >15 years |
|---|---|---|---|---|---|---|---|---|---|---|
| **Section 3: Attitudes** | | | | | | | | | | |
| **Q6: Perceived Benefits of AI in OMS** | | | | | | | | | | |
| Greater clinical efficiency | 1.000 | 29 (82.9%) | 11 (84.6%) | 1.000 | 9 (81.8%) | 31 (83.8%) | 0.010* | 13 (86.7%) | 17 (100%) | 10 (62.5%) |
| Decreased workload for clinicians/educators/trainees | 0.466 | 24 (68.6%) | 11 (84.6%) | 0.246 | 10 (90.9%) | 25 (67.6%) | 0.355 | 13 (86.7%) | 11 (64.7%) | 11 (68.8%) |
| Improved accessibility and personalization | 0.210 | 14 (40.0%) | 8 (61.5%) | 0.013* | 9 (81.8%) | 13 (35.1%) | 0.050 | 11 (73.3%) | 6 (35.3%) | 5 (31.2%) |
| I do not see any advantages | 0.553 | 3 (8.6%) | 0 (0.0%) | 1.000 | 0 (0.0%) | 3 (8.1%) | 0.059 | 0 (0.0%) | 0 (0.0%) | 3 (18.8%) |
| **Q7: Concerns Regarding AI in Clinical Practice** | | | | | | | | | | |
| Privacy and data security concerns | 1.000 | 15 (42.9%) | 5 (38.5%) | 0.741 | 4 (36.4%) | 16 (43.2%) | 0.555 | 5 (33.3%) | 9 (52.9%) | 6 (37.5%) |
| Risk of inaccurate diagnosis/treatment | 0.458 | 28 (80.0%) | 9 (69.2%) | 0.246 | 7 (63.6%) | 30 (81.1%) | 0.755 | 12 (80.0%) | 12 (70.6%) | 13 (81.2%) |
| Over-dependence leading to obsolescence | 0.512 | 16 (45.7%) | 4 (30.8%) | 0.720 | 7 (63.6%) | 26 (70.3%) | 0.445 | 9 (60.0%) | 11 (64.7%) | 13 (81.2%) |
| Potential increase in healthcare costs | 0.182 | 22 (62.9%) | 11 (84.6%) | 0.741 | 4 (36.4%) | 16 (43.2%) | 0.175 | 8 (53.3%) | 4 (23.5%) | 8 (50.0%) |
| **Section 4: Practices** | | | | | | | | | | |
| **Q3: Reported or Considered Uses of AI in OMS** | | | | | | | | | | |
| Diagnosis (radiographic, histopathologic, clinical) | 0.746 | 17 (48.6%) | 5 (38.5%) | 0.732 | 6 (54.5%) | 16 (43.2%) | 0.020* | 10 (66.7%) | 9 (52.9%) | 3 (18.8%) |
| Patient or student education | 0.750 | 14 (40.0%) | 6 (46.2%) | 0.488 | 6 (54.5%) | 14 (37.8%) | 0.091 | 8 (53.3%) | 9 (52.9%) | 3 (18.8%) |
| Self-directed professional learning | 0.740 | 14 (40.0%) | 4 (30.8%) | 0.288 | 6 (54.5%) | 12 (32.4%) | 0.341 | 8 (53.3%) | 5 (29.4%) | 5 (31.2%) |
| Treatment planning | 0.317 | 15 (42.9%) | 3 (23.1%) | 1.000 | 4 (36.4%) | 14 (37.8%) | 0.934 | 5 (33.3%) | 7 (41.2%) | 6 (37.5%) |
| Intraoperative assistance | 0.656 | 6 (17.1%) | 1 (7.7%) | 0.653 | 2 (18.2%) | 5 (13.5%) | 0.227 | 4 (26.7%) | 1 (5.9%) | 2 (12.5%) |
| Have not used and do not plan to use AI | 1.000 | 7 (20.0%) | 3 (23.1%) | 0.089 | 0 (0.0%) | 10 (27.0%) | 0.009* | 0 (0.0%) | 3 (17.6%) | 7 (43.8%) |
| **Q4: AI Use or Consideration by OMS Subspecialty** | | | | | | | | | | |
| Dentofacial deformities | 0.740 | 18 (51.4%) | 5 (41.7%) | 1.000 | 5 (50.0%) | 18 (48.6%) | 0.594 | 8 (57.1%) | 9 (52.9%) | 6 (37.5%) |
| Dentoalveolar surgery | 0.065 | 7 (20.0%) | 6 (50.0%) | 1.000 | 2 (20.0%) | 9 (24.3%) | 0.358 | 5 (35.7%) | 4 (23.5%) | 2 (12.5%) |
| Surgical pathology (including oncology) | 0.703 | 9 (25.7%) | 2 (16.7%) | 1.000 | 3 (30.0%) | 13 (35.1%) | 0.800 | 4 (28.6%) | 7 (41.2%) | 5 (31.2%) |
| Maxillofacial trauma | 0.505 | 13 (37.1%) | 3 (25.0%) | 1.000 | 2 (20.0%) | 10 (27.0%) | 1.000 | 4 (28.6%) | 4 (23.5%) | 4 (25.0%) |
| Implant and pre-prosthetic surgery | 0.703 | 10 (28.6%) | 2 (16.7%) | 0.065 | 1 (10.0%) | 17 (45.9%) | 0.357 | 3 (21.4%) | 8 (47.1%) | 7 (43.8%) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TMJ surgery | 0.324 | 15 (42.9%) | 3 (25.0%) | 0.569 | 0 (0.0%) | 5 (13.5%) | 0.519 | 1 (7.1%) | 1 (5.9%) | 3 (18.8%) |
| Have not used and do not plan to use AI | 1.000 | 4 (11.4%) | 1 (8.3%) | 1.000 | 3 (30.0%) | 10 (27.0%) | 0.225 | 3 (21.4%) | 3 (17.6%) | 7 (43.8%) |

*Indicates significance

*Practices*

Although 68.8% reported using AI tools in non-clinical settings, only 25.0% had applied AI within OMS. While 62.5% felt AI could simplify work tasks, most believed they lacked adequate training (79.2%) and that their workplace lacked suitable infrastructure (58.3%) **(Table 2).** No significant differences emerged by gender (p = 0.437–1.000), age (p = 0.290–0.880), or years of practice (p = 0.075–0.905) **(Table 3)**. The practices section showed strong reliability with a Cronbach's alpha of 0.78 **(Table 4)**.

Concerning specific applications, respondents most frequently used or considered AI for diagnosis (45.8%), followed by patient/student education (41.7%), independent learning (37.5%), treatment planning (37.5%), and intraoperative uses (16.7%). Differences based on years of experience were significant only for diagnostic uses (p = 0.020) **(Table 5)**. 11 (22.9%) indicated that they had never used nor considered AI, a pattern significantly more common among clinicians with >15 years in practice (p = 0.009). The subspecialty most often identified for potential AI integration was dentofacial deformities (50.0%), followed by implant procedures (39.6%) and surgical pathology (35.4%). No demographic group differences were found (p > 0.05).

*Thematic analysis*

For the open-response prompt on what is needed to support AI integration in OMS, four themes emerged:

1. Training access,
2. Workflow/structural modifications,
3. Funding, and
4. Technological optimisation.

Ten (20.8%) responses emphasised training opportunities, such as structured programs, courses, and software access. Five (10.4%) highlighted the need for improved organisation and workflow design—including institutional processes and clarification of regulatory considerations like consent and privacy. Another 5 (10.4%) pointed to the need for increased financial support, such as government or institutional funding, to lower barriers to adoption. Finally, 2 (4.2%) responses mentioned the importance of enhancing AI technologies themselves; one recommended establishing a national database tailored to local populations, and another expressed reluctance to use AI until performance improves.

There is broad recognition that artificial intelligence (AI) has the capacity to influence numerous aspects of surgical care, including diagnosis, prognostic assessment, treatment planning, and even intraoperative decision-making [11]. As technological capabilities evolve, understanding the present landscape and the difficulties oral and maxillofacial surgery (OMS) practitioners encounter is essential for lowering barriers to AI adoption.

From the knowledge portion of the survey, only about half of respondents were aware of current AI applications in OMS. Likewise, roughly 50% could identify at least one AI tool relevant to clinical work, whereas approximately 25% were unable to recall any AI technology. These knowledge levels mirror findings reported in other healthcare groups and student populations [7, 12, 13]. Since no demographic subgroup showed superior knowledge, the generally modest performance likely stems from limited structured opportunities for AI education; over 80% of participants indicated they had never attended any form of AI-related training. This lack of exposure is not restricted to OMS—one survey of radiologists, for instance, found that nearly 70% had received no AI education [14]. Although the number of publications describing new surgical AI models has increased substantially [15], these developments do not appear to be reaching a significant portion of our clinical community.

In contrast, participants' attitudes toward AI were generally encouraging. Most respondents either "strongly agreed" or "agreed" that AI has the potential to improve patient care and deserves a role in OMS practice and training. Previous studies of nurses and other healthcare workers revealed similar optimism, with many believing AI could support diagnostic and treatment decisions and was important for modern healthcare delivery [12, 16]. However, unlike those studies—where approximately half of respondents worried about AI displacing their jobs—only 6.3% of participants in the present study expressed this fear. Even so, more than half cautioned that excessive reliance on AI might weaken clinical skills.

Participants younger than the mean age of 40.8 and those with fewer years in practice demonstrated more favourable attitudes toward AI. Although only the statements "AI can enhance patient outcomes" and "AI should be integrated into practice" reached statistical significance, many other non-significant comparisons showed a similar trend. For instance, 81.5% of respondents aged ≤40 and 80% with 1–5 years of experience agreed that "AI should be included in OMS training," compared with only 52.4% of those older than 40 and 43.8% with more than 15 years of experience. Additionally, those with over 15 years of practice were more likely to state that they do not use—and do not intend to use—AI. These tendencies align with common observations that younger clinicians are generally more open to adopting advanced technologies [17].

In the practice-related section, limited training and hands-on exposure emerged as major issues. Even though nearly two-thirds believed AI could simplify their workload, most had never attempted to utilise AI tools and felt unprepared to integrate such technologies into everyday practice. Importantly, this sentiment was consistent across all demographic categories. Around 30% of respondents also recommended expanding access to training and establishing more formalised workflows to facilitate AI adoption. Comparable barriers have been documented elsewhere; for example, medical schools often lack faculty expertise to teach AI, and healthcare professionals have suggested partnering with developers and advocating broader education initiatives [14, 18]. Incorporating AI earlier—perhaps at the postgraduate or even undergraduate level—may help familiarise future OMS practitioners and minimise the hesitation caused by unfamiliarity.

*Outstanding concerns*

Participants' remaining concerns could be categorised into three main themes: risks of inaccurate diagnoses or treatment recommendations, issues involving data security and patient confidentiality, and the potential for increased healthcare costs. Their four proposed strategies—expanding training opportunities, developing clearer clinical workflows, boosting funding, and refining existing AI systems—directly address these perceived challenges.

The most prominent worry was the possibility of misdiagnosis or flawed treatment planning. A small subset of respondents even emphasised the need for substantial improvement and further optimisation of AI tools before integrating them into real-world settings. Current large language models also show limitations; for example, one study reported an average accuracy of only 62.5% (equivalent to a B grade) on OMS-related examination questions [19]. Still, emerging research demonstrates strong diagnostic performance of AI systems in identifying pathology using clinical data, images, radiographs, and histological slides, as well as in forecasting oral disease outcomes [20–23]. Despite this progress, the potential consequences of incorrect outputs have led some to advocate for rigorous validation before deployment [24]. Ultimately, addressing this concern will require both enhancements to AI accuracy and broader understanding that these tools are intended to support—not replace—clinicians' decision-making.

Concerns about data protection and potential violations of patient privacy were raised by nearly half of the respondents. This issue is substantial, as AI systems require the ingestion and processing of large datasets throughout training and validation. Privacy breaches may occur during both development and clinical use, especially since regulatory frameworks such as the Health Insurance Portability and Accountability Act (HIPAA) currently lack detailed rules that specifically address AI technologies [25]. Anxieties that major technology corporations, including Google, may re-identify anonymised datasets by linking them to other sources are also justified; successful re-identification has been demonstrated in previous studies [26, 27], and related lawsuits have been filed [28]. Addressing this problem involves two main strategies. First, future AI systems could be trained using high-fidelity synthetic datasets generated by advanced models [29], reducing dependence on real patient data whenever feasible. Second, existing privacy regulations must be revised and strengthened to better safeguard patient information in settings where AI is used.

Ethical aspects of AI adoption in OMS, though not raised by respondents in this study, remain a pertinent topic. Even as AI shows promise for enhancing clinical outcomes, training, and research, its application must continue to uphold transparency, informed consent, and patient autonomy regarding the sharing of their health information and their participation in care decisions [30]. Professional responsibility also requires openly declaring the use of AI in both clinical and research environments. It is equally important to recognise that, at this stage, AI should augment rather than replace the human elements essential to patient care, academic instruction, and scientific inquiry. Rokshad *et al*. proposed a framework to guide the ethical refinement of AI tools in dental practice and research; it addresses challenges across eleven ethical pillars—transparency, diversity, well-being, respect for autonomy, privacy, accountability, equity, prudence, sustainability, solidarity, and governance—

offering a useful structure for protecting patients' interests as AI becomes more integrated [31].

Nearly half of respondents also anticipated that AI might raise healthcare costs. Interestingly, this contrasts with findings from a comparable study among nurses, in which most participants believed AI would actually lower expenses [16]. Although some fear that development costs for AI systems might eventually be passed on to patients, a 2022 review of 200 studies indicated that AI adoption in healthcare has generally resulted in considerable cost reductions [32]. These savings are linked to shorter diagnostic and treatment times, along with efficiency gains that accrue over sustained use. While cost-effectiveness analyses specific to OMS have not yet been conducted, similar financial benefits have been documented in dental applications such as caries detection and the early recognition of oral mucosal lesions [33, 34]. To avoid imposing added costs on patients, governments and institutions may need to invest directly in AI development. Additional cost-reduction strategies include model pruning to remove redundant components and designing explainable AI systems with feedback mechanisms that support usability and long-term sustainability [32].

This cross-sectional investigation is the first to examine the knowledge, attitudes, and practices of OMS specialists and trainees, and although many of their views align with those of other healthcare providers, understanding the specific concerns within our field enables more targeted solutions. Nonetheless, several limitations must be acknowledged. The relatively small OMS community in Singapore may result in an underpowered study. Although 55 responses were initially collected, 7 were incomplete and excluded, leaving a final sample size just below the target of 52. Moreover, the presence of only a single postgraduate training program may concentrate the perspectives of trainees, reducing the applicability of these findings to broader populations. These constraints reduce generalisability and robustness; future studies should therefore involve multiple centres across different countries to increase participant numbers.

Convenience sampling was selected due to limited project manpower and the impracticality of employing more complex sampling techniques such as systematic or stratified sampling. Although convenient, this approach may bias the sample toward individuals who frequently use digital communication channels, potentially producing results that appear more favourable toward AI. Fortunately, given the small OMS community and the high rate of digital literacy in Singapore, distributing the survey through email and social media platforms of professional organisations likely reached most OMS clinicians within the country. Additionally, the perspectives presented here largely reflect a population composed predominantly of ethnically Southern Chinese clinicians, which may differ from attitudes in Caucasian, African, or other ethnic groups [35]. Finally, these results represent the current cohort of OMS practitioners; their opinions may evolve significantly over the next decade as AI systems improve, laws are updated, and institutions increasingly shift toward AI-supported healthcare delivery.

## Conclusion

Although OMS clinicians and trainees in Singapore generally view AI positively, notable gaps in knowledge and practical familiarity remain. The suggestions provided highlight the need for both technological enhancement and policy development before AI can be fully and effectively incorporated into everyday practice and professional training.

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