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ORIGINAL ARTICLE

OMS residents' obstructive sleep apnea-related education, knowledge, and professional behavior: A national survey

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Abstract

Objectives: Oral and maxillofacial surgeons (OMS) treat adult and pediatric patients with obstructive sleep apnea (OSA). Objective 1 assessed sleep apnea–related education, knowledge, and professional behavior of OMS residents in the United States. Objective 2 was to compare the responses of junior versus senior residents and residents in single- versus dual-degree programs.

Methods: OMS residents in the United States received a recruitment email with a link to an anonymous online survey; 81 residents responded. The survey included 20 questions to assess respondents' OSA-related education, knowledge, attitudes, and professional behavior.

Results: Respondents generally agreed that they had received OSA-related didactic-based education (5-point scale with "5" = agree strongly: mean = 3.62) and clinical training (mean = 3.75). Clinical and classroom educational gaps were identified in relation to treatment with oral appliances and hypoglossal nerve stimulation. The residents scored on average 10.38 out of 18 (58%) possible correct answer points for the knowledge questions. Findings about pediatric OSA suggest that only 43.8% of residents understand diagnostic criteria for pediatric OSA, with only 26.6% screening pediatric patients for OSA. A case analysis showed that only 1.5% of residents correctly identified an apnea–hypopnea index of 17 as moderate sleep apnea.

Conclusion(s): This survey found knowledge gaps in several areas that can be improved upon. It identifies deficiency in objective knowledge about OSA among OMS residents and a specific lack of clinical training and confidence with hypoglossal nerve stimulation and management of pediatric patients with OSA. Junior and senior residents and single- and dual-degree residents showed no statistically significant differences in any category except senior residents in regard to surgical management of OSA, particularly with maxillomandibular advancement.

KEYWORDS
dental, education, obstructive surgery, OMFS residents, oral residency, professional attitudes, professional behavior, sleep apnea

1 | INTRODUCTION

Obstructive sleep apnea (OSA) is a chronic medical condition characterized by repeated episodes of complete or partial upper airway obstruction that can be associated with oxygen desaturations, cortical arousals, daytime sleepiness, and cardiometabolic disease. OSA remains undiagnosed in 80%–90% of cases[1–4] with a prevalence of 9%–38% in the adult population.[5–7] This multifactorial condition is associated with several hereditary, physiological, and anatomic risk factors.[8–14] OSA is associated with cardiovascular morbidity, increased inflammatory burden, and increased incidence of motor vehicle accidents.[8,10,15,16] Positive airway pressure is considered the gold-standard treatment for OSA in adults, with other nonsurgical and surgical options available for appropriately selected individuals.[2,4,17] Excellent information about risk factors for, and diagnosis and treatment of OSA is widely available.[18–21]

As the prevalence of OSA increases, adequately training future clinicians in OSA diagnosis and treatment can result in a significant decrease in medical and societal costs and an improvement in patients' quality of life.[1,2] In addition to diagnoses with polysomnography or a home sleep apnea tests, screening for symptoms of OSA is essential. For example, screening patients for OSA prior to ambulatory anesthesia can minimize perioperative and postoperative complications.[22] Singh et al. found that 58% of surgeons failed to identify symptomatic OSA patients preoperatively when preoperative polysomnograms (PSG) were collected, and clinicians were blinded to the PSG results.[23] Several programmatic factors may yield heterogeneity in the extent of OSA-related surgical training and education that exists in oral and maxillofacial surgery (OMS) residency programs. Based on current accreditation standards set by the Commission on Dental Accreditation (CODA) for OMS, specific procedures for OSA are within the realm of orthognathic surgery, but no specific requirements exist to demonstrate competency in specifically managing patients with OSA.[24]

Studies about OSA-related education and knowledge suggested that inadequate time was dedicated to teaching about sleep disorders in medicine and dentistry.[25–29] Education about sleep disorders in US dental schools was limited to didactic-based teaching and only engaged students at an introductory level.[30] Being part of a dental surgical subspecialty, OMS should be educated about a variety of procedures and treatments. Having education about oral appliances, hypoglossal nerve stimulation or adenotonsillectomy would allow clinicians to weigh the pros and cons of different treatment modalities and refer to the appropriate provider for treatment that they do not perform. Moreover, if surgical interventions are indicated, OMS providers should be familiar with the different types of surgical procedures available.[31] OSA may result from upper airway collapsibility at multiple levels. However, data from otolaryngology residency programs showed a predominance of oropharyngeal procedures that were being taught and performed.[32] A lack of hypopharyngeal procedures may lead to inadequate OSA treatment. Surgical interventions for OSA should be performed by experienced surgeons who also understand the indications for and limitations of upper airway surgery.[33] It should be considered that the number and type of surgical procedures performed during residency, including nonsurgical modalities, is likely to shape the graduates' professional behavior after graduation.

Based on these considerations, the first objective was to assess the sleep apnea–related education, knowledge, and professional behavior of OMS residents in the United States (US). The second objective was to compare the differences between the responses of junior versus senior residents and of residents in single- versus dual-degree programs.

2 | METHODS

This research was determined to be exempt from Institutional Review Board (IRB) oversight by the Health Sciences and Behavioral Sciences IRB at the University of Michigan on October 19, 2019 (HUM 00170454). The design was a cross-sectional survey design with group comparisons.

Respondents: An a priori power analysis with the program package G*Power 3.1.2 (http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3) was conducted to determine the sample size needed to have the power to test hypotheses about relationships between the constructs of interest. It was assumed that alpha = 0.05, power = 0.80, medium effect size of |rho| = 0.30, when using one-sided tests to test for the significance of correlations. The results showed that 62 respondents were required

to have the power to test for the significance of such correlations.

At total of 81 residents responded to this survey. Two surveys were excluded from data analysis because they lacked responses to the majority of the questions. For the 2020–2021 residency year, 1207 OMS residents attended residency programs (personal communication from AAMOS administrative office). However, a response rate cannot be determined because it is unknown how many program directors and American Association of Craniomaxillofacial Surgery (AACMFS) members forwarded the recruitment email for this survey to their residents.

Procedure: During the year 2020, 99 OMS program directors and 215 members of the AACMFS received an email that informed them about the purpose of this project and asked them to forward an attached recruitment email to their residents. The program directors were identified through the American Association of Oral and Maxillofacial Surgeons (AAOMS) webpage, which included program directors of all CODA-accredited OMS residency programs at the time of inception of this study. The program directors received one follow-up reminder email.

Materials: The email sent to the OMS program directors explained the purpose of the study and asked them to forward an attached recruitment email to their residents. The residents were also informed about the purpose of the study and were asked to respond to an anonymous Qualtrics survey that they could access with a web-link provided in the email. One follow-up email to the program directors and the members of the AACMFS explained that more responses were needed. It asked them to forward an attached recruitment email to their residents.

A pilot study was conducted with a first draft of the survey. A recruitment email was sent to 18 OMS residents at the University of Michigan. It informed them about the purpose of the research and asked them to provide pilot feedback about the survey. Five residents returned the survey with feedback. The responses showed that the average time of completion was acceptable (6 min and 33 s). In addition, the feedback was used to make minor revisions and to finalize the survey.

The final survey was developed by the research team. It consisted of five sets of questions. Part 1 evaluated the OSA-related classroom-based and clinical education provided in the residency program. Part 2 consisted of nine knowledge-related closed-ended questions. Six questions were adapted from the Obstructive Sleep Apnea Knowledge and Attitude (OSAKA) questionnaire,[34] one question from the Assessment of Sleep Knowledge in Medical Education (ASKME) questionnaire,[35] and two new questions were added. Both the OSAKA[34] questionnaire and the ASKME[35] questionnaire are well validated, reliable instruments that have been widely used. In addition to the coauthors on this study who are faculty (one OMS, one ENT, and one sleep medicine faculty member) involved in teaching and treating OSA, the pilot feedback from the five residents was used to assure the face validity of these two newly developed knowledge questions. One open-ended question asked the respondents how they managed a patient with OSA. Part 3 focused on assessing OSA-related attitudes and assessed the likelihood and confidence of residents in performing surgical treatment for their patients after completing their residency training. Additional questions asked how they would screen adult and pediatric patients for OSA. The screening method alternatives provided included STOP-Bang,[36] Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD),[37] Pediatric Sleep Questionnaire (PSQ),[38] Pittsburgh Sleep Quality Index (PSQI),[39] and some additional questions. Part 4 assessed the residents' professional behavior. Specifically, the questions asked about how many maxillomandibular advancements (MMAs), genioglossus advancements, hyoid suspensions, and palatal or pharyngeal surgeries they had performed. The inclusion of surgical procedures in this manner encompasses the multilevel involvement of OSA.

Part 5 inquired about their educational background such as whether they were in a single- or dual-degree program, and in which postgraduate year (PGY) of training they were. Junior residents in single-degree programs were considered PGY1/2, whereas in dual-degree programs junior residents were considered trainees in PGY 1/2/3. Senior residents were in PGY 3/4 for single-degree programs and in PGY 4/5/6 for dual-degree programs.

Statistical analysis: Data were downloaded from the Qualtrics web site as an SPSS (Version 26) data file. Descriptive statistics such as means and standard deviations were computed to provide an overview of the results. The first set of indices was based on factor analyses (Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization) of subsets of Likert-type items. Cronbach alpha inter-item consistency coefficients were computed for the items loading on a given factor with factor loadings >0.40 to determine if there was sufficient inter-item consistency to justify creating indices. Based on the recommendations of DeVellis,[40] Cronbach alphas between 0.7 and 0.8 were considered "acceptable," alphas between 0.8 and 0.9 "good" and alphas over 0.9 "excellent." If the Cronbach alphas were >0.70, indices were computed by averaging the responses to the items loading on a given factor. The knowledge index was computed as a sum score of correct response to the knowledge-based questions. Inferential statistics such as independent sample *t*-tests were used to compare the mean responses of residents in single- versus dual-degree programs and of junior versus senior residents. In

TABLE 1 Percentages of students in a single- versus a dual-degree program by postgraduate year and percentages and average responses related to education about obstructive sleep apnea (OSA)

	Postgraduate year (PGY)					
OMFS training is	**PGY-1** ***N* = 23**	**PGY-2** ***N* = 15**	**PGY-3** ***N* = 16**	**PGY-4** ***N* = 16**	**PGY-5** ***N* = 4**	**PGY-6** ***N* = 6**
A single-degree program ($N = 33$)	33.3%	9.1%	24.2%	30.3%	3.0%	0.0%
A dual-degree program ($N = 46$)	26.1%	23.9%	17.4%	13.0%	6.5%	13.0%
Both programs ($N = 79$)	29.1%	17.7%	20.3%	20.3%	5.1%	7.6%
In my residency program, I received CLASSROOM-BASED EDUCATION about	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
The diagnosis of OSA	5.0%	16.3%	8.8%	33.8%	36.3%	3.80 (1.237)
The treatment of OSA	3.8%	16.5%	5.1%	34.2%	40.5%	3.91 (1.211)
The nonsurgical management of OSA	6.3%	18.8%	10%	32.5%	32.5%	3.66 (1.282)
Continuous positive airway pressure [CPAP]	6.3%	18.8%	7.5%	41.3%	26.3%	3.63 (1.236)
Hypoglossal nerve stimulation as an option for management of OSA	6.3%	28.7%	8.8%	35.0%	21.3%	3.36 (1.275)
Oral appliance therapy for OSA	15.0%	33.8%	7.5%	27.5%	16.3%	2.96 (1.373)
The surgical management of OSA	2.5%	15.0%	6.3%	35.0%	41.3%	3.98 (1.147)
OSA-related classroom-based education index (alpha = 0.948)	***Mean = 3.62***		***SD = 1.098***		***Range: 1–5***	
In my residency program, I received CLINICAL TRAINING about	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
The diagnosis of OSA	1.3%	16.5%	17.7%	40.5%	24.1%	3.70 (1.054)
The treatment options for OSA	3.8%	17.5%	13.8%	40.0%	25.0%	3.65 (1.148)
The surgical management of OSA	2.7%	12.2%	10.8%	47.3%	27.0%	3.84 (1.047)
OSA-related clinical education index (alpha = 0.935)	***Mean = 3.75***		***SD = 1.002***		***Range: 1.33–5***	
Single item: I received CLINICAL TRAINING about	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
Hypoglossal nerve stimulation as an option for management of OSA	20.3%	43.2%	16.2%	17.6%	2.7%	2.39 (1.083)

[a]Answers range from 1 = "disagree strongly," 2 = "disagree," 3 = "neither disagree nor agree," 4 = "agree" to 5 = "strongly agree."

addition, inferential statistics were used to test for the significance of correlations. A value of $p < 0.05$ was accepted as significant.

3 | RESULTS

A total of 81 responses were received from OMS residents in the United States and 80 responses were analyzed due to the high percentage of missing responses in one survey. Table 1 shows that 33 respondents attended a single-degree program and 46 a dual-degree program. It also provides information about the distribution of the respondents in the different PGYs.

Education: The first objective was to assess residents' classroom-based and clinical education pertaining to OSA. In terms of classroom-based education, most respondents agreed/strongly agreed that they had received classroom-based education about the diagnosis (70.1%) and treatment (74.7%) of OSA, about the non-surgical management of OSA (65%), continuous positive airway pressure [CPAP] (67.6%), and surgical management of OSA (76.3%). Fewer respondents agreed/strongly agreed about receiving classroom-based education on oral appliance therapy (OAT) for OSA (43.8%) and hypoglossal nerve stimulation (56.3%) (see Table 1).

When asked about clinical training concerning the diagnosis, treatment and surgical management of OSA, about two thirds of the residents agreed/strongly agreed that they had received clinical training related to diagnosis (64.6%), treatment options (65%), and surgical management of OSA (74.3%). However, when asked if they had received clinical training about hypoglossal nerve stimulation as an option for management of OSA, only 23% agreed/strongly agreed that they had received such clinical training (see Table 1).

Knowledge/attitudes: The second objective was to assess OMS trainees' knowledge and attitudes about OSA and their practice intentions after completing their residency

program. Concerning assessing OSA-related knowledge, questions concerning objective knowledge as well as self-perceived subjective knowledge and future behavioral intentions were included in this study (see Table 2).

Nine questions assessed the residents' objective knowledge. These questions were formulated as statements and the respondents indicated how much they disagreed/agreed with each statement. For correct statements, a response of "agree" received one knowledge point and a response of "strongly agree" received two knowledge points. For an incorrect statement, a response of "disagree" received one point and a response of "disagree strongly" received two knowledge points. The sum of the knowledge points could therefore range from 0 to 18. Overall, more than 90% of the respondents received one or two knowledge points for four objective knowledge statements. Between 70% and 89% received one or two knowledge points for each of three questions, and only slightly more than 50% received any knowledge points for two questions. Overall, the average sum of points for these objective knowledge responses was only 10.38, with a range from 0 to 18 points.

Concerning the subjective self-reported knowledge, Table 2 shows that the majority of respondents (79.9%) agreed/strongly agreed that they understood the diagnostic criteria for OSA in adults. However, only 43.8% of respondents agreed/strongly agreed that they understood the diagnostic criteria for pediatric OSA. In addition, although over half agreed that they were comfortable providing surgical treatment for OSA in adults (53.8%), a lower percentage of respondents (35%) agreed/strongly agreed that they were comfortable providing surgical treatment for OSA in the pediatric population (see Table 2).

When asked how likely they were to provide surgical treatment for OSA in adults and in children after completion of residency training, 75% agreed/strongly agreed that they were likely to provide surgical treatment for adults, whereas only 35% agreed/strongly agreed that they were likely to do so in children. Most of the respondents (67.5%) agreed/strongly agreed that they would feel confident performing surgical procedures for OSA after training, and 82.6% agreed/strongly agreed that they would feel confident performing MMA (see Table 2).

Group differences in education and knowledge: In addition to analyzing the education- and knowledge-related responses for all residents, it is also of interest to consider if the responses of junior versus senior residents and residents in dual- versus single-degree programs differ. Table 3 shows that there were no differences in the average responses related to classroom-based education as a function of time in program or type of program. However, there is one difference in the average responses of junior versus senior residents in response to the statement if they received clinical training related to the surgical management of OSA. Senior residents agreed more strongly that they had received clinical training about the surgical management of OSA (4.13 vs. 3.62, $p = 0.034$) than junior residents. In addition, the senior residents agreed more strongly with the statement "I am comfortable providing surgical treatment for OSA in adults" than the junior residents (3.76 vs. 3.02; $p = 0.006$). No significant differences were found between single- versus dual-degree programs for classroom or clinical education related responses (see Table 3). No significant differences existed between junior and senior residents' responses concerning their behavioral intentions of how likely they were to provide surgical treatments and how confident they felt after completing their residency program (see Table 3). The data also showed that there were no differences in junior versus senior residents and in single versus dual residents' responses concerning their knowledge.

Professional behavior: Table 4 provides an overview of the responses concerning OSA-related professional behavior, specifically when screening, diagnosing, and treating patients with OSA. Regarding patient screening, 73.4% agreed that they screened for OSA in adult patients, whereas only 26.6% agreed that they screened for OSA in pediatric patients. The most commonly used screening modality was the STOP-Bang questionnaire[36] (59.3%). This survey consists of four questions concerning snoring, tiredness, observed apneas, and high blood pressure. In addition, it has four questions about demographic information, namely, body mass index, age, neck circumference, and gender. This scale has a moderate sensitivity and high negative predictive value to detect moderate and severe OSA.[36,41] Fewer respondents selected other screening scales such as the ESS[37] (40.7%) or informal questions during a patient interview (34.6%). Nearly all residents (96.2%) reported never having performed hyoid suspension surgeries or palatal or pharyngeal surgeries (87.3%). About two thirds (67.1%) had never performed genioglossus advancement surgery and nearly half (46.8%) had never performed MMA.

Although 85.3% of senior residents versus 64.4% of junior residents screened adult patients for OSA ($p = 0.033$), no other responses of senior versus junior residents differed significantly. In addition, significantly more junior residents had never performed MMA than senior residents (67.2% vs. 18.2%; $p < 0.001$). No other differences between these two groups and between residents in single- versus dual-degree programs were significant (see Table 4).

In addition to the closed-ended questions, one open-ended question provided the respondents with a case description and asked them to provide their assessment of the severity of OSA and their first step in treating this

TABLE 2 Percentages and average objective knowledge-related responses, self-reported knowledge, and behavioral intentions

Objective knowledge–related statements	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
Untreated OSA is associated with hypertension and cardiac arrhythmias. (true)—OSAKA[b]	0%	1.3%	1.3%	**42.5%**	**55.0%**	4.51 (0.595)
The gold standard for diagnosing OSA is an overnight-attended polysomnogram. (true)—OSAKA	0%	0%	2.5%	**42.5%**	**55.0%**	4.53 (0.551)
The loss of upper airway muscle tone during the sleep cycle contributes to the pathogenesis of OSA. (true)—OSAKA	0%	1.3%	3.8%	**65.0%**	**30.0%**	4.24 (0.579)
Large tonsils and adenoids are the most common cause for OSA in adults. (false)—adapted from OSAKA	**22.5%**	**52.5%**	7.5%	12.5%	5.0%	2.25 (1.097)
The first line therapy for severe OSA in adults is uvulopalatopharyngoplasty. (false)—OSAKA	**31.3%**	**42.5%**	16.3%	10.0%	0%	2.05 (0.940)
In men, a collar size greater than 17 inches is associated with OSA. (true)—OSAKA	0%	1.3%	12.5%	**55.0%**	**31.3%**	4.16 (0.683)
Menopausal women are at higher risk for developing obstructive sleep apnea compared to premenopausal women. (true)—ASKME[c]	0%	5.0%	37.5%	**43.8%**	**13.8%**	3.66 (0.779)
Oral and maxillofacial surgeons should be involved in the care of patients with obstructive sleep apnea. (true)	0%	2.5%	3.8%	**38.8%**	**55.0%**	4.46 (0.693)
A postoperative overnight attended polysomnogram is not necessary following surgical treatment of OSA. (false)	**15.0%**	**37.5%**	30.0%	17.5%	0%	2.50 (0.955)
Sum of knowledge scores[d]	***Mean = 10.38***		***SD = 3.577***		***Range: 0–18***	
OSA-related self-reported knowledge and skills	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
I understand the diagnostic criteria for OSA in adults	3.8%	11.3%	5.0%	51.2%	28.7%	3.90 (1.063)
I understand the diagnostic criteria for OSA in children	7.5%	31.3%	17.5%	32.5%	11.3%	3.84 (1.182)
I understand nonsurgical treatments of OSA	3.8%	8.8%	17.5%	47.5%	22.5%	3.90 (1.022)
I am comfortable providing surgical treatment for OSA in adults	7.5%	23.8%	15.0%	33.8%	20.0%	1.254
I am comfortable providing surgical treatment for OSA in children	12.5%	42.5%	10.0%	27.5%	7.5%	3.35 (1.207)
OSA-related subjective knowledge index (alpha = 0.869)	***Mean = 3.37***		***SD = 0.931***		***Range: 1–5***	
Behavioral intentions: After completion of my residency training:	**1**[a]	**2**	**3**	**4**	**5**	**Mean (SD)**
I am likely to provide surgical treatment for OSA in adults	1.3%	13.8%	10.0%	50.0%	25.0%	3.84 (0.999)
I am likely to provide surgical treatment for OSA in children	8.8%	32.5%	23.8%	25.0%	10.0%	2.95 (1.157)
I will feel confident performing a surgical procedure for OSA	6.3%	12.5%	13.8%	42.5%	25.0%	3.68 (1.167)
I will feel confident performing maxillomandibular advancement surgery for treatment of OSA	2.5%	7.5%	7.5%	41.3%	41.3%	4.11 (1.006)
OSA-related surgical considerations after completion Index (alpha = 0.785)	***Mean = 3.64***		***SD = 0.846***		***Range: 1.75–5***	

Abbreviations: ASKME, Assessment of Sleep Knowledge in Medical Education; OSA, obstructive sleep apnea; OSAKA, Obstructive Sleep Apnea Knowledge and Attitude.

[a]Answers range from 1 = "disagree strongly," 2 = "disagree," 3 = "neither disagree nor agree," 4 = "agree" to 5 = "strongly agree."

[b]These items were adapted from the OSAKA Scale.[34]

[c]These items were adapted from the ASKME Scale.[35]

[d]The "Sum of knowledge scores" was computed by adding the knowledge scores received for all items.

TABLE 3 Comparison of average educational experiences and knowledge of junior versus senior and of dual- versus single-degree students

Educational experiences	Students		Programs	
CLASSROOM-BASED EDUCATION	**Junior**	**Senior**	**Single**	**Dual**
The diagnosis of OSA	3.58[a]	4.09	3.82	3.78
The treatment of OSA	3.78	4.09	3.88	3.93
The nonsurgical management of OSA	3.51	3.85	3.76	3.58
Continuous positive airway pressure (CPAP)	3.62	3.62	3.52	3.69
Hypoglossal nerve stimulation as an option for management of OSA	3.29	3.44	3.48	3.24
Oral appliance therapy for OSA	2.84	3.09	2.91	2.96
The surgical management of OSA	3.84	4.15	4.00	3.98
CLINICAL EDUCATION	**Junior**	**Senior**	**Single**	**Dual**
The diagnosis of OSA	3.66	3.74	3.64	3.73
The treatment options for OSA	3.58	3.74	3.70	3.60
The surgical management of OSA	**3.62**	**4.13***	3.91	3.77
Hypoglossal nerve stimulation as an option for management of OSA	2.55	2.13	2.39	2.31
Objective knowledge-related statements	**Junior**	**Senior**	**Single**	**Dual**
Untreated OSA is associated with hypertension and cardiac arrhythmias.[b] (true)	1.56[a]	1.50	1.30	1.71
The gold standard for diagnosing OSA is an overnight-attended polysomnogram.[b] (true)	1.53	1.53	1.39	1.64
The loss of upper airway muscle tone during the sleep cycle contributes to the pathogenesis of OSA.[b] (true)	1.27	1.24	1.12	1.36
Large tonsils and adenoids are the most common cause for OSA in adults.[b] (false)	1.04	0.91	0.85	1.11
The first line therapy for severe OSA in adults is uvulopalatopharyngoplasty.[b] (false)	1.09	1.03	0.97	1.16
In men, a collar size greater than 17 in. is associated with OSA.[b] (true)	1.16	1.21	1.00	1.31
Menopausal women are at higher risk for developing obstructive sleep apnea compared to premenopausal women.[c] (true)	0.78	0.62	0.67	0.73
Oral and maxillofacial surgeons should be involved in the care of patients with obstructive sleep apnea. (true)	1.47	1.50	1.33	1.60
A postoperative overnight attended polysomnogram is not necessary following surgical treatment of OSA. (false)	0.69	0.68	0.55	0.80
Sum of knowledge scores[d]	***10.58***	***10.21***	***9.18***	***11.42***
OSA-related self-reported knowledge and skills	**Junior**	**Senior**	**Single**	**Dual**
I understand the diagnostic criteria for OSA in adults	3.84	3.97	4.06	3.76
I understand the diagnostic criteria for OSA in children	2.93	3.26	3.21	3.00
I understand nonsurgical treatments of OSA	3.64	3.91	3.88	3.67
I am comfortable providing surgical treatment for OSA in adults	**3.02**	**3.76****	3.55	3.18
I am comfortable providing surgical treatment for OSA in children.	2.73	2.74	2.61	2.80
OSA-related subjective knowledge index (alpha = 0.869)	***3.24 1.017***	***3.53 0.795***	***3.46 0.729***	***3.28 1.069***
Behavioral intentions: after completion of my residency training:	**Junior**	**Senior**	**Single**	**Dual**
I am likely to provide surgical treatment for OSA in adults	3.93	3.71	3.79	3.87
I am likely to provide surgical treatment for OSA in children	3.29	2.47	2.70	3.09
I will feel confident performing a surgical procedure for OSA	3.73	3.59	3.76	3.60
I will feel confident performing maxillomandibular advancement surgery for treatment of OSA	3.98	4.29	4.27	4.04
OSA-related surgical considerations after completion Index (alpha = 0.785)	***3.73 0.900***	***3.51 0.776***	***3.63 0.818***	***3.65 0.893***

Note: * = $p < 0.05$; ** = $p < 0.01$.

Abbreviations: OSA, obstructive sleep apnea.

[a]One knowledge point was assigned to a response of "agree" to a "true" statement and a response of disagree to a "false" statement. Two knowledge points were given for a response of "strongly agree" to a "true" statement and a response of "strongly disagree" to a "false" statement.

[b]These items were adapted from the OSAKA Scale.[34]

[c]These items were adapted from the ASKME Scale.[35]

[d]The "Sum of knowledge scores" was computed by adding the knowledge scores received for all items.

TABLE 4 Respondents' professional behavior related to diagnosing and treating patients with obstructive sleep apnea (OSA) overall and by type of student and type of program

	All respondents		Students		Programs	
Screening questions	**Yes**	**No**	**Junior (% Yes)**	**Senior (% Yes)**	**Single (% Yes)**	**Dual (% Yes)**
Do you screen for OSA in your adult patients?	73.4%	26.6%	**64.4%**	**85.3%***	78.8%	68.9%
Do you screen for OSA in your pediatric patients?	26.6%	73.4%	26.7%	26.5%	30.3%	24.4%
Which of the following to you use for screening?	**Yes**	**No**	**Junior (% Yes)**	**Senior (% Yes)**	**Single (% Yes)**	**Dual (% Yes)**
Epworth Sleeping Scale for children and adolescents	40.7%	59.3%	35.6%	50.0%	42.4%	42.2%
Pediatric Sleep Questionnaire (PSQ)	6.2%	93.8%	4.4%	8.8%	6.1%	6.7%
STOP-Bang Questionnaire	59.3%	40.7%	57.8%	64.7%	69.7%	55.6%
Pittsburgh Sleep Quality index	7.4%	92.6%	6.7%	8.8%	9.1%	6.7%
Informal questions during patient interview	34.6%	65.4%	33.3%	38.2%	36.4%	33.3%
Other: 2× CBCT imaging for airway ESS for adults	2.5%	97.5%	2.2%	2.9%	0.0%	4.4%
No. of surgical procedures per-formed during residency	**N**	**Percentages**	**Junior (% Yes)**	**Senior (% Yes)**	**Single (% Yes)**	**Dual (% Yes)**
Maxillomandibular advancement (MMA)?						
None	37	46.8%	**67.4%**	**18.2%***	39.4%	53.3%
1-10	37	46.8%	28.3%	72.7%	54.5%	40.0%
11-20	4	5.1%	2.2%	9.1%	6.1%	4.4%
>20	1	1.3%	2.2%	0.0%	0.0%	2.2%
Genioglossus advancement surgeries?						
None	53	67.1%	80.4%	48.5%	57.6%	75.6%
1-10	24	30.4%	19.6%	45.5%	36.4%	24.4%
11-20	1	1.3%	0.0%	3.0%	3.0%	0.0%
>20	1	1.3%	0.0%	3.0%	3.0%	0.0%
Hyoid suspension surgeries?						
None	76	96.2%	97.8%	93.9%	97.0%	95.6%
1-10	3	3.8%	2.2%	6.1%	3.0%	4.4%
Palatal or pharyngeal surgeries?						
None	69	87.3%	93.5%	78.8%	84.8%	88.9%
1-10	8	10.1%	6.5%	15.2%	9.1%	11.1%
11-20	1	1.3%	0.0%	3.0%	3.0%	0.0%
>20	1	1.3%	0.0%	3.0%	3.0%	0.0%

Note: * = $p < 0.05$.

patient (see Table 5). The case description was about an adult patient with moderate OSA, who presented with an apnea–hypopnea index (AHI) of 17 events per hour. The correct response concerning the severity of the OSA would have been moderate. However, Table 5 shows that the vast majority incorrectly diagnosed it as moderate to severe (77%) or severe (14.8%). In response to the question about their first step in managing this patient, a lack of information provided does not allow a definitive correct answer. Instead, it is informative to realize that the answers ranged widely from diagnostic to lifestyle modifications and included medical, dental, and surgical treatments. For example, only 24.4% mentioned diagnostic steps such as determining the level of obstruction or using fiberoptic pharyngoscopy and 7.3% would refer for polysomnography. Concerning treatment, 23.1% would recommend lifestyle modifications and 32.9% would recommend medical treatment such as CPAP, reassessment/assessing surgical appropriateness. Only 13.4% recommend dental treatment like an oral appliance. Finally, only 3.7% would recommend surgery treatment with responses consisting of adenotonsillectomy, removal of local obstruction, and multilevel surgery.

Pearson correlation coefficients were computed to assess relationships between PGYs, OSA-related education, knowledge, and professional behavior (see Table 6). The year in the program was only correlated with the frequency of MMA surgery ($r = 0.39$; $p < 0.001$) and

TABLE 5 Case analysis

Adult patient presents with an apnea–hypopnea index (AHI) of 17 events per hour	**1 = Mild**	**2 = Moderate**	**3 = Moderate to severe**	**4 = Severe**
What severity of OSA diagnosis would you make?	4 (6.6%)	1 (1.6%)	47 (77.0%)	9 (14.8%)
What would be your first step in the management of this patient?	**Frequency (Yes)**	**Percentage (Yes)**		
Medical treatment:	27	32.9%		
CPAP, reassessment/assess surgical appropriateness	27	32.9%		
Diagnostics:	20	24.4%		
Asleep fiberoptic pharyngoscopy/determine level of obstruction/laryngoscopy	6	7.3%		
CPAP trial	3	3.7%		
History, physical, full workup, risk factor assessment	4	4.9%		
Referral/Polysomnography/sleep study	6	7.3%		
CBCT	1	1.2%		
Lifestyle modification:	19	23.1%		
Behavior modifications	2	2.4%		
Weight loss, diet, exercise	14	17.0%		
Conservative	3	3.7%		
Dental treatment:	11	13.4%		
Dental splint	1	1.2%		
MAD	2	2.4%		
Oral appliance	8	9.8%		
Surgical treatment:	3	3.7%		
Adenotonsillectomy	1	1.2%		
Remove local obstruction	1	1.2%		
Multilevel surgery	1	1.2%		

Abbreviations: CPAP, continuous positive airway pressure; OSA, obstructive sleep apnea.

genioglossus advancement surgery ($r = 0.28$; $p < 0.05$). However, independent of program year, classroom-based and clinical education correlated significantly with objective and with self-reported subjective knowledge as well as with the residents' professional behavioral intentions after their graduation. Only the clinical education and the self-reported knowledge and behavioral intentions correlated with the screening sum score.

4 | DISCUSSION

Several studies have evaluated OSA-related education, knowledge, attitudes, and professional behavior in other health-care fields.[25–28] This study is the first research exploring the quantity and quality of OSA-related training for residents in oral and maxillofacial surgery graduate programs. It analyzed the education, knowledge, and professional behavior of OMS residents concerning OSA diagnosis and management in adult and pediatric patients.

Concerning OSA-related classroom education, it was expected that the likelihood of having received this education would increase over the course of the residency education. However, the year in the program did not correlate with the extent of classroom based and clinical education. This raises the question whether all residents will be competent at the time of their graduation from their programs to provide optimal diagnoses, treatment, and surgical management of adult and pediatric patients with OSA.

Specifically, interesting is the fact that less than half of the residents had been educated about OAT for OSA.[42–45] This relative lack of education about oral appliances and the lack of clinical education about hypoglossal nerve stimulation[46] are concerning. Although OMS may not be involved directly in prescribing these therapies, having knowledge seems to be important to avoid overdiagnosing patients with surgery or underdiagnosing them when surgical management is necessary. It also raises the question whether OMS residency programs focus their attention primarily on training their residents to perform surgery in connection with OSA.

Results from research with dental and dental hygiene students also showed limited and mostly classroom-based education about sleep disorders[26,27] and a potential lack of knowledge among dental school graduates concerning

TABLE 6 Correlations

	OSA-related educational responses			OSA-related knowledge-related responses		
	Postgraduate year	Classroom-based education	Clinical education	Objective knowledge	Self-reported knowledge	Behavioral intentions
OSA-related educational experiences						
Average classroom-based education index	0.14	1	0.67***	0.29**	0.70***	0.42***
Average clinical education index	0.15	0.67***	1	0.25*	0.71***	0.54***
OSA-related knowledge						
Objective knowledge score	0.00	0.29**	0.25*	1	0.12	0.08
Self-reported knowledge score	0.22	0.70***	0.71***	0.12	1	0.59***
Behavioral intentions	−0.03	0.42***	0.54***	0.08	0.59***	1
OSA-related behavior—diagnosis						
Screening sum score	0.20	0.22	0.34**	−0.04	0.45***	0.30**
OSA-related behavior—treatment						
Maxillomandibular advancement?	0.39***	0.40***	0.40**	0.01	0.42***	0.21
Genioglossus advancement surgeries?	0.28*	0.08	0.05	−0.24*	0.16	0.06
Hyoid suspension surgeries?	0.12	0.06	0.04	0.05	0.8	−0.03
Palatal or pharyngeal surgeries?	0.21	−0.01	−0.03	−0.13	0.7	−0.01

Abbreviation: OSA, obstructive sleep apnea.
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

the use of oral appliances for patients with OSA. This situation is unfortunate because OAT has been used alone or in combination with other measures to improve AHI, oxygen saturation, sleep architecture and reduce blood pressure. Research showed that the effectiveness of OAT was comparable to CPAP. It also showed that the use of OAT resulted in a subjective improvement in STOP-Bang scores.[42–45]

Concerning the benefits of hypoglossal nerve stimulation, outcome data showed the effectiveness of this approach. A 68% reduction in AHI was found within 12 months of implantation.[46] Utilization of a hypoglossal nerve stimulator appears to represent an alternative treatment to MMA surgery for patients with severe OSA and should thus be included when providing patients with treatment options. Furthermore, combined treatment with hypoglossal nerve stimulation and oral appliance has shown nearly 96% reduction in AHI for patients with severe OSA.[47] These results indicate the importance of educating OMS residents about treatment modalities other than MMA surgery.

A second finding that needs attention is related to the suboptimal objective knowledge of these residents. For example, only slightly over 50% deemed a postsurgical PSG necessary. However, when surgery is chosen as a treatment modality, the American Academy of Sleep Medicine provided a clinical guidance statement that a postoperative PSG must be done to evaluate patients and follow them longitudinally.[48] Despite a high surgical success rate with MMA surgery, persistent OSA requiring treatment is common. For instance, in a large meta-analysis pooling 45 studies on MMA surgery for OSA, 455 patients with AHI data were found to have an overall surgical cure rate of 38.5%.[49] Subjects with a baseline AHI of <30/h, and 30 to <60/h had a surgical cure rate of 55.7% and 45.8%, respectively. Moreover, subjects with higher preoperative AHI also had the lowest likelihood of achieving a surgical cure. A recent prospective multicenter study confirmed these findings, noting a success rate of 74.1% (AHI < 15/h), with a surgical cure rate of 55.6%.[50] Despite this, for the management of moderate-to severe OSA (AHI > 15), MMA is more efficacious than uvulopalatopharyngoplasty.[51] All this to say, a postoperative PSG is a necessity to assess outcomes considering the variability in patient responsiveness to surgery and variability in the utilization of treatment modalities and future OMS need to know that.

A third consideration raised by these findings is related to the respondents' knowledge and professional behavior related to diagnosing and treating OSA in pediatric patients. The prevalence of OSA in children is only between 1% and 10%.[52] However, research showed that the incidence of pediatric OSA is associated with a variety of physical and developmental sequelae.[48,49,53] Comprehensive training is therefore needed.

On the positive side of findings, it is noteworthy that single- and dual-training programs did not differ in the OSA-related education. One possible explanation of the finding that the length of being in a program did not correlate with the residents' objective knowledge and most training experiences could be that much of the learning in residency is independent. The fact that residents in the dual-degree programs spend time in medical education and thus might be exposed to more information about OSA did not result in any differences between the residents in these two types of programs.

This study has several limitations. First, although the number of respondents was greater than the number required based on the a priori power analysis, we would have had more power to test differences between subgroups if we had more respondents. Second, the fact that we did not directly recruit respondents but instead asked program directors and experts to forward recruitment emails might also have limited the sample size. In addition, it prevented to determine an exact response rate. However, this problem is similar to the challenges encountered in other survey studies of this nature.[54,55] Third, this survey did not ask about the location of the residency program. It would have been interesting to explore regional differences. Fourth, no questions were asked about objective educational information such as how many hours of classroom-based training in which year of the program were provided. Future research might consider including such questions and also questions about the exact clinical experiences of the residents. Future research should also explore in a survey of OMS faculty members which surgical approaches they include in their educational efforts. Fifth, additional questions concerning education through independent reading or attending additional continuing education programs about OSA would also have been informative. Finally, the COVID-19 pandemic might also have affected the response rate as well as the type of education provided in hybrid settings and with asynchronous lectures.

5 | CONCLUSIONS

Based on the findings of this study, it can be concluded that the majority of OMS residents received classroom-based education in diagnosis, treatment, and surgical and nonsurgical management of OSA. However, less than half received education about OAT for OSA. The majority received clinical training about the diagnosis, treatment, and surgical management of OSA, with limited clinical training about hypoglossal nerve stimulation as an option for managing OSA. Objective OSA-related knowledge and self-reported subjective knowledge are not optimal and do not improve over the course of the education.

Professional behavior-related questions show that only three of four residents screen their adult patients and only one in four screen their pediatric patients. Overall, the screening modalities range widely. MMA surgery is the most widely taught of all OSA-related surgeries. The finding that only one resident was able to assess the severity of OSA when provided with an AHI is concerning.

Comparisons between junior and senior residents and residents in single versus dual programs showed no consistent differences.

Program directors should consider including a multidisciplinary approach to OSA education. Moreover, defining specific adult and pediatric OSA-related training requirements through CODA may generate boarder adoption of these educational goals.

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CONFLICT OF INTEREST

At the time of this publication, Dr. Shelgikar is a board member of the American Academy of Sleep Medicine. Dr. Shelgikar contributed to this article in her personal capacity. The views expressed are her own and do not necessarily represent the views of the American Academy of Sleep Medicine.

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