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Knowledge, attitudes, and practices of physicians regarding multidisciplinary treatment of obstructive sleep apnea: a cross-sectional study

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To investigate physicians' knowledge, attitudes, and practices (KAP) regarding the multidisciplinary treatment of Obstructive Sleep Apnea (OSA). A multicenter cross-sectional study was conducted in May 2024, enrolling physicians from southwestern China. The study collected demographic data and assessed KAP through self-administered questionnaires, with the respiratory and otolaryngology departments defined as relevant departments. A total of 329 valid questionnaires were collected. Of these respondents, 173 (52.6%) were female, and 114 (34.7%) had participated in multidisciplinary OSA-related training. The mean scores for knowledge and attitudes were 24.61 ± 8.27 (possible range: 0–34) and 39.99 ± 4.34 (possible range: 10–50), respectively. Practice scores of the physicians in departments directly and indirectly involved in OSA treatment averaged 24.28 ± 4.70 and 21.28 ± 4.24 (possible range: 6–30), respectively. Structural equation modeling results indicated that in departments directly related to OSA, knowledge had a significant positive effect on both attitudes (β = 5.53, $P < 0.001$) and practices (β = 5.8, $P < 0.001$). For departments indirectly related to OSA, knowledge had a significant positive effect on attitudes (β = 5.41, $P < 0.001$). Physicians showed adequate knowledge and attitudes toward OSA treatment; targeted education is recommended to enhance consistency in practices across departments.

Keywords Obstructive sleep apnea, Multidisciplinary treatment, Knowledge, attitudes, and practices, Cross-Sectional study

Obstructive Sleep Apnea (OSA) is characterized by repeated episodes of apnea and hypopnea during sleep, leading to intermittent hypoxia and sleep fragmentation[1]. This condition affects approximately one billion adults aged 30–69 worldwide, posing a significant global public health challenge; around 425 million of these individuals require medical intervention[2]. In China, the prevalence of OSA is about 24.2%[2]. OSA is associated with severe cardiovascular diseases and cognitive impairment, highlighting its potential to significantly impact overall health[3–5].

OSA is considered a chronic condition requiring long-term, multidisciplinary management for effective treatment. It affects multiple systems beyond airway obstruction, leading to cardiovascular, metabolic, and neurocognitive consequences. Treatment options vary by severity; mild cases may be managed conservatively, while moderate cases often require mandibular advancement splints or continuous positive airway pressure (CPAP) devices, and severe cases typically necessitate CPAP or surgical interventions[6,7]. The multidisciplinary treatment of OSA involves collaboration across several medical specialties to ensure comprehensive care[8]. Primary respiratory concerns are managed by departments such as Respiratory Medicine and Otorhinolaryngology. Additionally, Cardiology addresses cardiovascular complications, while Neurology, Psychiatry, and Endocrinology manage related conditions like stroke and metabolic disturbances. Dental departments contribute by fitting oral appliances, and Sleep Medicine specialists coordinate the overall treatment strategy, ensuring a holistic approach to managing OSA[9]. While CPAP remains the primary treatment, alternative approaches such as mandibular advancement devices and surgical interventions are essential for improving adherence and outcomes[10]. Especially in pediatric patients, interdisciplinary evaluation is particularly critical to mitigate long-

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term neurobehavioral and cardiovascular risks[11]. Despite these considerations, physicians' understanding and implementation of multidisciplinary OSA care vary, potentially limiting optimal patient outcomes. Despite clinical guidelines highlighting the importance of multidisciplinary approaches for managing OSA, the extent to which physicians across specialties integrate and apply these strategies remains unclear, with implementation often inconsistent. Furthermore, limited research has examined physicians' perspectives on and adherence to multidisciplinary OSA management.

The KAP survey functions as a research tool that elucidates a group's understanding, beliefs, and actions regarding a specific topic, particularly within the realm of health literacy. It is based on the premise that increased knowledge positively influences attitudes, which subsequently shape behaviors[12]. In the context of OSA management, the KAP framework is particularly relevant as it can reveal how physicians' knowledge of OSA's multisystemic nature influences their attitudes toward interdisciplinary collaboration and their actual practices in patient care. The knowledge component assesses physicians' understanding of OSA pathophysiology, its systemic complications, and various treatment modalities. The attitude component evaluates their perceptions and beliefs about the necessity and effectiveness of multidisciplinary management approaches. The practice component examines how this knowledge and attitudes translate into actual clinical behaviors, such as interdepartmental consultations and collaborative treatment planning. While some studies have shown how doctors in various departments perform KAP for OSA[13,14], there is a lack of investigations specifically examining KAP in relation to multidisciplinary treatment approaches. Given that OSA is a complex condition impacting multiple systems and necessitating comprehensive management, understanding how physicians from various specialties perceive and implement multidisciplinary approaches is crucial. This study aims to fill a significant void in the existing literature by systematically exploring physicians' KAP regarding the multidisciplinary treatment of OSA, with the goal of identifying potential barriers and facilitators to effective collaborative care.

Methods

Study design and participants

This multicenter cross-sectional study was conducted in May 2024 across 14 general hospitals in southwestern China, all of which have the multidisciplinary capabilities required for the diagnosis and treatment of OSA. The hospitals were selected through a systematic process focusing on tertiary hospitals with regional influence. Selection criteria included: (1) adequate OSA patient volume; (2) presence of comprehensive respiratory medicine departments capable of pressure titration and ventilator guidance; (3) ENT/Head & Neck Surgery departments equipped with laryngoscopy and polysomnography facilities, and staff capable of analyzing sleep studies and performing OSA-related surgeries; and (4) coverage of all departments required for multidisciplinary OSA treatment. From an initial pool of 16 hospitals, two were excluded due to insufficient OSA treatment capabilities. This selection process ensured that participating hospitals had the necessary infrastructure and expertise for comprehensive OSA management. In this study, the respiratory and otolaryngology departments were defined as directly related to OSA, while other departments were defined as indirectly related to OSA. Inclusion criteria were as follows: (1) Physicians from departments either directly or indirectly related to OSA treatment; (2) Physicians possessing a medical practice license; (3) Currently employed as a physician. Graduate students and visiting physicians were excluded to ensure that our findings reflected the perspectives and practices of permanently employed physicians with full clinical decision-making authority in their respective departments. The study received ethical approval from the Ethics Committee of Guiqian International Hospital (Approval number: Guiqian2024Ethics (18)). Informed consent was obtained from all participants prior to their involvement in the study.

Questionnaire

The initial draft of the questionnaire was based on the "multidisciplinary guidelines for the diagnosis and treatment of adult obstructive sleep apnea"[15] and was revised following feedback from an associate senior expert in otorhinolaryngology, head and neck surgery, and OSA. To mitigate potential biases, the questionnaire underwent a structured review process, including expert review and a pilot test. Experts also recommended distinguishing between those directly involved in OSA management and those who are not, as well as adding a question about participants' personal OSA status to improve content validity. A preliminary survey, yielding 32 valid responses, was conducted to test the questionnaire. The overall Cronbach's alpha coefficient for this pilot study was 0.932, with the knowledge section scoring 0.967, the attitude Sect. 0.830, and the practice Sect. 0.754. During the pilot study, participants were encouraged to provide feedback on any items they found confusing or unclear. Since no items were reported as problematic, this confirmed the face validity of the questionnaire.

The final questionnaire, presented in Chinese, comprised four sections: basic information and scales assessing KAP. Basic information included gender, age, education, the nature of the institution, professional title, department, years of clinical experience, the average monthly number of OSA patients diagnosed or consulted, personal OSA status, and participation in multidisciplinary OSA-related training. The knowledge section consisted of 17 items, with scoring options of 2 ("very knowledgeable"), 1 ("heard about it"), and 0 ("not clear"), culminating in a possible score range of 0–34. The trap question was set as "35*4 = 130," and those who selected "True" were considered invalid respondents. The attitude section featured 10 questions, with items 4, 5, and 9 requiring reverse scoring; the remaining items were scored positively from "strongly agree" (5 points) to "strongly disagree" (1 point), yielding a total score range of 10–50. The practice section included 12 items, all scored positively, with physicians in departments directly related to OSA addressing questions 1–6, and those in non-directly related departments responding to questions 7–12. Scoring ranged from "always" (5 points) to "never" (1 point), with each group having a score range of 6–30. Scores exceeding 70% of the maximum in each section indicated adequate knowledge, a positive attitude, and proactive practice[16].

Questionnaire distribution and quality control

Each hospital's designated contact was informed by phone about the research purpose, ethical considerations, and the limited scope of data collection. Subsequently, the contact person distributed the questionnaire link via the WeChat work group to physicians in the specified departments of the respective hospitals. The selected hospitals were tertiary hospitals in southwestern China with the capacity to manage OSA and provide multidisciplinary treatment. Hospitals were chosen based on their ability to handle OSA cases and their provision of multidisciplinary treatment. Specifically, respiratory medicine departments and ENT/Head & Neck Surgery departments were required to regularly manage OSA patients. While not all staff needed to be experts, there was a requirement for certain key personnel to be proficient in diagnosing and treating OSA. The selection process initially identified 16 hospitals, of which two were excluded due to insufficient OSA treatment capabilities.

The questionnaire distribution process involved multiple levels: the primary investigator initially contacted hospitals, followed by hospital leaders or specialist practitioners distributing surveys within their institutions, and in some cases, a third tier of distribution through department heads. The questionnaire link was configured to allow only one response per IP address, with mandatory completion of all questions. Criteria for identifying invalid questionnaires included the following: (1) completion time of less than 90 s; (2) inaccurately provided basic information; and (3) incorrect answers to trap questions designed to ensure respondent attentiveness.

Sample size

A single population proportion formula, $n=[(Z_{\alpha/2})^2*P(1-P)]/d^2$, was used to calculate the sample size. Since there were no prior KAP studies on OSA among physicians from various departments, the sample size for this study was calculated based on an expected proportion of 50%, with a confidence level of 95% and a margin of error of 5%, requiring a sample size of 384 individuals.

Statistical methods

Data analysis was conducted using both R 4.3.2 (R Foundation, Austria) and Stata 18.0 (Stata Corporation, College Station, TX, USA) to leverage the strengths of each software. R was used primarily for data preprocessing, visualization, and correlation analyses, while Stata was chosen for its robust structural equation modeling (SEM) modeling capabilities. Continuous data were presented as mean ± standard deviation (SD) and assessed for normality. T-tests were applied to normally distributed data, while the Wilcoxon Mann-Whitney test was used for skewed distributed data when comparing two groups. For comparisons among three or more groups, ANOVA was utilized for normally distributed data with uniform variance, while the Kruskal-Wallis test was employed for skewed distributed data. Categorical data were presented as n (%). Spearman correlation coefficients were used to assess correlations. Using the KAP theoretical framework, SEM was employed to examine whether attitudes mediate the relationship between knowledge and practices, including assessments of both direct and indirect effects. The SEM model assumed multivariate normality, and model fit indices were assessed using RMSEA (< 0.08), SRMR (< 0.08), TLI (> 0.8), and CFI (> 0.8). A bootstrapping approach was applied to estimate indirect effects to account for potential deviations from normality. The model fit indices for SEM were evaluated against the following thresholds: root mean square error of approximation (RMSEA) < 0.08, standardized root mean square residual (SRMR) < 0.08, Tucker–Lewis index (TLI) > 0.8, and comparative fit index (CFI) > 0.8. A two-sided P-value of less than 0.05 was considered statistically significant.

Results

A total of 404 questionnaires were collected. Exclusions included 5 non-consent forms, 13 with response times under 90 s, 9 with incorrect information, and 48 with trap questions answered incorrectly. This resulted in 329 valid responses.

In the formal study, overall and subscale internal consistency was robust. The total Cronbach's alpha coefficient for departments directly related to OSA was 0.8655, with subsection scores of 0.9432 for knowledge, 0.6516 for attitudes, and 0.8169 for practices. For departments indirectly related to OSA, the total Cronbach's alpha coefficient was 0.8512, with subsection scores of 0.9517 for knowledge, 0.7835 for attitudes, and 0.6832 for practices.

Basic information of the respondents and scores for KAP

Among the 329 participants, 165 (50.2%) were from departments directly related to OSA, 173 (52.6%) were female, 135 (41.0%) were aged 28–34 years old, 157 (47.7%) had an associate or bachelor's degree or below, 164 (49.8%) held an intermediate professional title, 112 (34.0%) had been in clinical practice for 10–20 years, and 114 (34.7%) had participated in multidisciplinary OSA-related training. In the past year, 119 (36.2%) had an average of 1–3 OSA patients diagnosed or consulted per month. The mean scores for knowledge and attitudes were 24.61 ± 8.27 (possible range: 0–34) and 39.99 ± 4.34 (possible range: 10–50), respectively (Table 1) Practice scores in departments directly and indirectly involved in OSA treatment averaged 24.28 ± 4.70 (possible range: 6–30) and 21.28 ± 4.24 (possible range: 6–30), respectively (Tables 2 and 3).

Participants' knowledge scores varied significantly depending on gender ($P = 0.022$), age ($P < 0.001$), education ($P = 0.019$), professional title ($P = 0.004$), department ($P < 0.001$), years of clinical experience ($P = 0.002$), cases of OSA patients ($P < 0.001$), and participation in any multidisciplinary OSA-related training ($P < 0.001$). Meanwhile, attitude scores varied significantly by gender ($P = 0.011$), department ($P < 0.001$), and cases of OSA patients ($P = 0.002$). Specifically, female physicians demonstrated higher knowledge (25.80 ± 7.45 vs. 23.30 ± 8.93, $P = 0.022$) and attitude scores (40.55 ± 4.07 vs. 39.37 ± 4.54, $P = 0.011$) compared to male physicians, suggesting a potential greater awareness or engagement in OSA-related education. Older physicians, particularly those aged 45 and above, exhibited the highest knowledge scores (28.36 ± 5.65, $P < 0.001$), likely reflecting cumulative clinical experience and exposure to OSA cases. However, attitudes did not show significant variation across

N = 329	*N* (%)	Knowledge		Attitudes	
		Mean ± SD	*P*	Mean ± SD	*P*
Total score	329 (100.0)	24.61 ± 8.27		39.99 ± 4.34	
Gender			0.022		0.011
Male	156 (47.4)	23.30 ± 8.93		39.37 ± 4.54	
Female	173 (52.6)	25.80 ± 7.45		40.55 ± 4.07	
Age, year			< 0.001		0.744
<28	52 (15.8)	25.00 ± 7.91		39.62 ± 5.10	
28–34	135 (41.0)	22.52 ± 8.17		39.83 ± 4.45	
35–44	106 (32.2)	25.82 ± 8.68		40.27 ± 3.99	
45 or above	36 (10.9)	28.36 ± 5.65		40.33 ± 3.75	
Education			0.019		0.337
Associate/Bachelor's degree or below	157 (47.7)	24.92 ± 8.62		40.01 ± 4.30	
Master's degree	150 (45.6)	23.78 ± 7.98		39.82 ± 4.41	
Doctorate/Medical Doctorate	22 (6.7)	28.14 ± 6.72		41.09 ± 4.08	
Nature of your institution			0.628		0.625
Tertiary	289 (87.8)	24.54 ± 8.27		39.95 ± 4.29	
Other	40 (12.2)	25.12 ± 8.38		40.33 ± 4.68	
Professional title			0.004		0.995
None/Junior	92 (28.0)	23.16 ± 8.06		40.05 ± 4.60	
Intermediate	164 (49.8)	24.26 ± 8.39		39.96 ± 4.36	
Associate Senior/Senior	73 (22.2)	27.23 ± 7.76		40.00 ± 3.98	
Department			< 0.001		< 0.001
Respiratory Medicine	33 (10.0)	27.27 ± 6.71		39.79 ± 3.81	
Otorhinolaryngology and Head and Neck Surgery	132 (40.1)	29.42 ± 5.80		41.42 ± 4.09	
Other	164 (49.8)	20.21 ± 7.88		38.88 ± 4.32	
Years of clinical experience			0.002		0.804
< 5 years	82 (24.9)	23.39 ± 7.56		39.72 ± 4.74	
5–10 years	91 (27.7)	23.56 ± 8.67		39.79 ± 4.59	
10–20 years	112 (34.0)	24.71 ± 8.79		40.25 ± 3.98	
> 20 years	44 (13.4)	28.84 ± 5.79		40.27 ± 3.94	
The number of OSA patients diagnosed or consulted per month on average in the past year			< 0.001		0.002
None	93 (28.3)	18.17 ± 7.82		38.63 ± 4.17	
1–3 cases	119 (36.2)	24.92 ± 7.38		40.16 ± 4.37	
4–9 cases	54 (16.4)	28.48 ± 6.11		40.52 ± 4.33	
≥ 10 cases	63 (19.1)	30.24 ± 5.28		41.24 ± 4.08	
Do you have OSA			0.082		0.645
Yes	33 (10.0)	26.64 ± 7.85		40.24 ± 4.16	
No	296 (90.0)	24.39 ± 8.30		39.97 ± 4.36	
Participation in any multidisciplinary OSA-related training			< 0.001		0.432
Yes	114 (34.7)	28.92 ± 6.52		40.28 ± 4.43	
No	215 (65.3)	22.33 ± 8.20		39.84 ± 4.29	

Table 1. Knowledge and Attitudes. Legend: OSA, Obstructive Sleep Apnea. Knowledge scores range from 0 to 34, with higher scores indicating greater knowledge. Attitude scores range from 10 to 50, with higher scores reflecting more positive attitudes towards multidisciplinary OSA treatment. P-values represent comparisons across groups.

age groups, indicating a broadly shared perspective on the importance of multidisciplinary treatment. Physicians with higher professional titles (Associate Senior/Senior) scored significantly higher in knowledge (27.23 ± 7.76, $P = 0.004$), reinforcing the impact of advanced training and experience (Table 1). For those who worked in departments directly related to OSA, practice scores varied significantly depending on the number of OSA cases ($P < 0.001$) and participation in multidisciplinary OSA-related training ($P < 0.001$) (Table 2). For those who worked in departments indirectly related to OSA, practice scores varied significantly more likely to vary depending on the department ($P = 0.036$), cases of OSA patients ($P = 0.028$), OSA status ($P = 0.040$), and participation in multidisciplinary OSA-related training ($P = 0.013$) (Table 3).

N = 165	*N* (%)	Practices	*P*
		Mean ± SD	
Total score	165 (100.0)	24.28 ± 4.70	
Gender			0.362
Male	70 (42.4)	24.86 ± 4.01	
Female	95 (57.6)	23.85 ± 5.12	
Age, year			0.274
<28	33 (20.0)	23.67 ± 5.46	
28–34	49 (29.7)	23.67 ± 4.40	
35–44	57 (34.5)	25.18 ± 4.41	
45 or above	26 (15.8)	24.23 ± 4.76	
Education			0.653
Associate/Bachelor's degree or below	92 (55.8)	23.99 ± 5.22	
Master's degree	59 (35.8)	24.83 ± 3.93	
Doctorate/Medical Doctorate	14 (8.4)	23.86 ± 4.07	
Nature of your institution			0.201
Tertiary	135 (81.8)	24.64 ± 4.22	
Other	30 (18.2)	22.67 ± 6.24	
Professional title			0.098
None/Junior	50 (30.3)	23.16 ± 5.31	
Intermediate	73 (44.2)	24.34 ± 4.61	
Associate Senior/Senior	42 (25.5)	25.50 ± 3.77	
Department			0.857
Respiratory Medicine	33 (20.0)	24.09 ± 5.50	
Otorhinolaryngology and Head and Neck Surgery	132 (80.0)	24.33 ± 4.50	
Years of clinical experience			0.317
< 5 years	42 (25.5)	23.88 ± 5.17	
5–10 years	38 (23.0)	23.34 ± 4.47	
10–20 years	53 (32.1)	24.98 ± 4.33	
> 20 years	32 (19.4)	24.75 ± 4.85	
The number of OSA patients diagnosed or consulted per month on average in the past year			< 0.001
None	22 (13.3)	19.23 ± 5.02	
1–3 cases	55 (33.3)	24.75 ± 4.57	
4–9 cases	36 (21.9)	24.72 ± 3.75	
≥ 10 cases	52 (31.5)	25.62 ± 3.95	
Do you have OSA			0.232
Yes	18 (10.9)	25.61 ± 4.60	
No	147 (89.1)	24.12 ± 4.70	
Participation in any multidisciplinary OSA-related training			< 0.001
Yes	86 (52.1)	25.71 ± 3.93	
No	79 (47.9)	22.72 ± 4.99	

Table 2. Practices in departments directly related to OSA. Legend: OSA, Obstructive Sleep Apnea. Practice scores range from 6 to 30, with higher scores indicating greater adherence to multidisciplinary OSA treatment practices. P-values represent comparisons across groups.

Distribution of KAP dimensions

The distribution of knowledge dimensions showed differences between departments directly and indirectly involved in OSA management. In departments directly related to OSA, regarding the statement, "Oral appliances can be the first-line treatment for mild to moderate OSA patients who do not require CPAP or surgery" (K9), only 3.6% chose "Not clear", compared to 20.1% in departments indirectly related to OSA. For K4, the most frequent "Not clear" responses were consistently higher in indirectly related departments, particularly for the urogenital system (K4.6, directly: 9.1%, indirectly: 22%), endocrine system (K5.5, directly: 7.9%, indirectly: 25%), and digestive system (K6.1, directly: 6.7%, indirectly: 20.7%) (Table 4 and Table S1-2).

In terms of attitudes, variations were observed between department types. In departments directly related to OSA, 28.5% strongly agreed that multidisciplinary treatment for OSA consumes the energy of medical staff and wastes medical resources (A4), while in indirectly related departments, theis percentage was lower at 14.6%. Similarly, regarding the statement "whether the multidisciplinary treatment process for OSA is cumbersome and

N = 164	*N* (%)	Practices mean ± SD	*P*
Total score	164 (100.0)	21.28 ± 4.24	
Gender			0.078
Male	86 (52.4)	20.84 ± 4.17	
Female	78 (47.6)	21.77 ± 4.30	
Age, year			0.473
<28	19 (11.6)	20.42 ± 4.73	
28–34	86 (52.4)	21.30 ± 4.10	
35–44	49 (29.9)	21.29 ± 4.55	
45 or above	10 (6.1)	22.70 ± 2.95	
Education			0.290
Associate/Bachelor's degree or below	65 (39.6)	20.97 ± 4.35	
Master's degree	91 (55.5)	21.34 ± 4.19	
Doctorate/Medical Doctorate	8 (4.9)	23.12 ± 3.94	
Nature of your institution			0.595
Tertiary	154 (93.9)	21.30 ± 4.32	
Other	10 (6.1)	21.00 ± 2.87	
Professional title			0.365
None/Junior	42 (25.6)	20.83 ± 4.07	
Intermediate	91 (55.5)	21.25 ± 4.47	
Associate Senior/Senior	31 (28.9)	21.97 ± 3.80	
Department			0.036
Respiratory Medicine	46 (28.0)	23.07 ± 3.52	
Neurology	13 (7.9)	20.85 ± 4.32	
Dentistry	17 (10.4)	21.00 ± 5.01	
Endocrinology	15 (9.1)	21.53 ± 3.81	
Gastroenterology	38 (23.2)	20.55 ± 4.07	
Urology	35 (21.3)	19.91 ± 4.53	
Years of clinical experience			0.280
< 5 years	40 (24.4)	20.82 ± 3.75	
5–10 years	53 (32.3)	21.25 ± 4.65	
10–20 years	59 (36.0)	21.22 ± 4.39	
> 20 years	12 (7.3)	23.25 ± 2.83	
The number of OSA patients diagnosed or consulted per month on average in the past year			0.028
None	71 (43.3)	20.18 ± 4.47	
1–3 cases	64 (39.0)	21.77 ± 3.86	
4–9 cases	18 (11.0)	22.39 ± 3.29	
≥ 10 cases	11 (6.7)	23.73 ± 4.71	
Do you have OSA			0.040
Yes	15 (9.1)	23.33 ± 3.20	
No	149 (90.9)	21.07 ± 4.29	
Participation in any multidisciplinary OSA-related training			0.013
Yes	28 (17.1)	22.86 ± 5.24	
No	136 (82.9)	20.96 ± 3.95	

Table 3. Practices in departments indirectly related to OSA. Legend: OSA, Obstructive Sleep Apnea. Indirectly related departments include Neurology, Endocrinology, Gastroenterology, and others. Practice scores range from 6 to 30, with higher scores indicating greater adherence to multidisciplinary OSA treatment practices. P-values represent comparisons across groups.

has little clinical significance" (A5), 22.4% strongly agreed and 11.5% agreed in directly related departments, compared to 11% in indirectly related departments (Table 5 and Table S3-4).

The practices of those who worked in departments directly related to OSA showed that 29.7% just sometimes studied the latest guidelines for multidisciplinary OSA treatment (P1), and 22.4% just sometimes assessed whether the patient had other systemic damage related to OSA (P2). For those from departments indirectly related to OSA, 9.1% often did not invite OSA-related doctors for consultation to avoid wasting medical resources (P7),

Knowledge	Very Knowledgeable	Heard about it	Not clear
1. Obstructive Sleep Apnea (OSA) is a sleep breathing disorder characterized by snoring with apnea and daytime sleepiness, and is also a systemic disease.	191(58.1%)	128(38.9%)	10(3%)
2. Typical manifestations of OSA include snoring, apnea, poor sleep quality, daytime drowsiness, and increased nighttime urination.	210(63.8%)	115(35%)	4(1.2%)
3. Simple factors like obesity, fatigue, alcohol consumption, and old age can cause improper sleeping posture and relaxed throat muscles, leading to physiological snoring without apnea, whereas OSA involves varying degrees of apnea and hypoxia, which is pathological snoring.	199(60.5%)	125(38%)	5(1.5%)
4.1 Cardiovascular system (e.g., hypertension, coronary heart disease, arrhythmias, sudden cardiac death)	190(57.8%)	122(37.1%)	17(5.2%)
4.2 Respiratory system (e.g., respiratory failure, worsened asthma, chronic refractory asthma, pulmonary hypertension, pulmonary embolism)	175(53.2%)	145(44.1%)	9(2.7%)
4.3 Nervous system (e.g., cerebrovascular disease, cognitive impairment, anxiety, depression, sleep disorders)	162(49.2%)	153(46.5%)	14(4.3%)
4.4 Endocrine system (e.g., type 2 diabetes)	144(43.8%)	135(41%)	50(15.2%)
4.5 Digestive system (e.g., gastroesophageal reflux, liver function impairment)	139(42.2%)	146(44.4%)	44(13.4%)
4.6 Urogenital system (e.g., increased nighttime urination, decreased libido, sexual dysfunction)	127(38.6%)	151(45.9%)	51(15.5%)
4.7 Ear, nose, and throat (e.g., throat foreign body sensation, blockage, chronic refractory pharyngitis)	172(52.3%)	137(41.6%)	20(6.1%)
4.8 Oral and craniofacial (e.g., protruding teeth, narrowed dental arch, dry mouth, worsened periodontitis)	150(45.6%)	140(42.6%)	39(11.9%)
5. When OSA patients develop complications beyond the upper respiratory tract, relevant specialists should be consulted.	206(62.6%)	108(32.8%)	15(4.6%)
6. OSA patients should use sedative-hypnotic drugs with caution to avoid worsening OSA.	185(56.2%)	125(38%)	19(5.8%)
7. When general treatment for OSA is ineffective, multidisciplinary treatment should be implemented.	184(55.9%)	128(38.9%)	17(5.2%)
8. Multidisciplinary treatment of OSA includes non-invasive positive airway pressure (NPPV) therapy, oral appliance therapy, and surgical treatment.	176(53.5%)	131(39.8%)	22(6.7%)
9. Oral appliances can be the first-line treatment for mild to moderate OSA patients who do not require CPAP or surgery.	131(39.8%)	159(48.3%)	39(11.9%)
10. Patients who respond effectively to multidisciplinary treatment should have regular follow-ups, and their treatment plans should be adjusted based on effectiveness.	164(49.8%)	140(42.6%)	25(7.6%)

Table 4. Knowledge distribution. Legend: OSA, Obstructive Sleep Apnea. Knowledge was assessed through 17 items, with responses categorized as "Very Knowledgeable," "Heard About It," or "Not Clear." The table presents the proportion of physicians who selected each response. Directly related departments include Respiratory Medicine and Otorhinolaryngology; indirectly related departments include Neurology, Endocrinology, Gastroenterology, and others.

Attitudes	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I believe that OSA can cause damage to multiple systems beyond the upper respiratory system and needs to be taken seriously.	229(69.6%)	91(27.7%)	8(2.4%)	1(0.3%)	0 (0%)
2. I believe that multidisciplinary treatment is beneficial for improving nighttime snoring, insomnia, and daytime sleepiness in OSA patients.	225(68.4%)	90(27.4%)	12(3.6%)	2(0.6%)	0 (0%)
3. I believe that multidisciplinary treatment helps control symptoms caused by other systemic damage in OSA patients (e.g., hypertension, diabetes, gastroesophageal reflux; dizziness, headaches, frequent nighttime urination, etc.).	229(69.6%)	90(27.4%)	10(3%)	0 (0%)	0 (0%)
4. I believe that multidisciplinary treatment for OSA consumes the energy of medical staff and wastes medical resources.	71(21.6%)	45(13.7%)	57(17.3%)	73(22.2%)	83(25.2%)
5. I believe that the multidisciplinary treatment process for OSA is cumbersome and has little clinical significance.	55(16.7%)	46(14%)	56(17%)	85(25.8%)	87(26.4%)
6. I believe that multidisciplinary treatment for OSA requires the cooperation of multiple departments and higher patient involvement.	194(59%)	111(33.7%)	22(6.7%)	1(0.3%)	1(0.3%)
7. I believe it is necessary to inform patients that OSA is a systemic disease that may cause complications in other systems.	219(66.6%)	96(29.2%)	12(3.6%)	1(0.3%)	1(0.3%)
8. I believe that before conducting multidisciplinary treatment, it is necessary to independently assess whether the patient has pathological snoring.	184(55.9%)	117(35.6%)	15(4.6%)	10(3%)	3(0.9%)
9. I believe that distinguishing between physiological and pathological snoring should be left to specialists.	180(54.7%)	126(38.3%)	17(5.2%)	4(1.2%)	2(0.6%)
10. I believe it is necessary to evaluate the effectiveness of general treatment for OSA patients before deciding on multidisciplinary treatment.	189(57.4%)	111(33.7%)	22(6.7%)	6(1.8%)	1(0.3%)

Table 5. Attitude distribution. Legend: OSA, Obstructive Sleep Apnea. Attitudes were assessed using a 10-item scale, with responses ranging from "Strongly Agree" (5 points) to "Strongly Disagree" (1 point). The table presents response distributions across physicians in directly and indirectly related departments. Higher scores indicate more positive attitudes toward multidisciplinary treatment.

and 12.2% occasionally collaborated with OSA-related doctors to determine the patient's subsequent treatment plan (P9) (Table 6).

Correlation analysis

Correlation analysis for those who worked in departments directly related to OSA showed significant positive correlations between knowledge and attitudes ($r = 0.282$, $P < 0.001$), as well as between knowledge and practices ($r = 0.543$, $P < 0.001$). Additionally, there was a correlation between attitudes and practices ($r = 0.231$, $P = 0.003$) (Table S5). Correlation analysis for those who worked in departments indirectly related to OSA showed similar correlations as mentioned above (Table S6).

SEM

For those who worked in departments directly related to OSA, the fitting index of the structural model (RMSEA = 0.080, SRMR = 0.067; TLI = 0.833; CFI = 0.847) indicated a satisfactory fit to the data (Table S7). The SEM results indicated that in departments directly related to OSA, knowledge had a significant positive effect on both attitudes (β = 5.53, $P < 0.001$) and practices (β = 5.8, $P < 0.001$), whereas attitudes did not significantly influence practices (β = -0.6, $P = 0.545$) (Fig. 1 and Table S9).

For those who worked in departments indirectly related to OSA, a good fit was also achieved (Table S8), and the SEM results showed that knowledge positively influenced attitudes (β = 5.41, $P < 0.001$) but had a negative and non-significant effect on practices (β = −1.77, $P = 0.077$). Additionally, attitudes negatively impacted practices, though this effect was also not significant (β = -1.63, $P = 0.104$) (Fig. 2 and Table S10).

Discussion

Physicians demonstrated sufficient knowledge and positive attitudes towards the multidisciplinary treatment of OSA, with proactive practices observed in both departments directly and indirectly involved in OSA treatment. Given these findings, it is recommended that targeted educational interventions be developed to enhance physician knowledge, which is likely to further improve attitudes and practices regarding the multidisciplinary management of OSA.

In departments directly involved with OSA treatment, correlation analysis revealed significant positive correlations between knowledge and attitudes, as well as between knowledge and practices. These correlations suggest that enhanced knowledge in these specialized settings not only fosters more positive attitudes but also effectively translates into improved practices[17,18]. The SEM results further demonstrated that knowledge had a significant positive effect on both attitudes and practices, reinforcing the critical role of targeted educational and training programs in such departments.

Conversely, in departments indirectly involved with OSA, while the correlation coefficients were similar, indicating consistent relationships across different clinical settings, the SEM revealed that knowledge had a positive effect on attitudes, but both knowledge and attitudes had non-significant or negative effects on practices. This suggests that structural challenges in these departments, such as limited access to OSA-specific training, lack of interdisciplinary collaboration, and the absence of standardized referral pathways, may hinder the translation of knowledge and attitudes into practice. Additionally, physicians in these departments may not routinely assess OSA symptoms or initiate referrals due to time constraints, competing clinical priorities,

Practices	Always	Often	Sometimes	Occasionally	Never
Departments Directly Related to OSA ($n = 165$)					
For OSA patients presenting with snoring as the main complaint: 1.I actively study the latest guidelines for multidisciplinary OSA treatment.	44(26.7%)	59(35.8%)	49(29.7%)	12(7.3%)	1(0.6%)
2.I assess whether the patient has other system damage related to OSA.	53(32.1%)	62(37.6%)	37(22.4%)	12(7.3%)	1(0.6%)
3.I first evaluate the effectiveness of general treatment before deciding on multidisciplinary treatment.	59(35.8%)	60(36.4%)	34(20.6%)	10(6.1%)	2(1.2%)
4.I educate patients that OSA is a systemic disease that may require multidisciplinary treatment.	73(44.2%)	57(34.5%)	28(17%)	6(3.6%)	1(0.6%)
5.When the patient has complications beyond my department, I invite relevant specialists for consultation.	79(47.9%)	58(35.2%)	19(11.5%)	7(4.2%)	2(1.2%)
6.I work with doctors from related departments to determine the patient's subsequent treatment plan.	75(45.5%)	49(29.7%)	31(18.8%)	6(3.6%)	4(2.4%)
Departments Indirectly Related to OSA (n = 164)					
For patients presenting with other systemic diseases highly related to OSA, but not snoring: 7.I do not invite OSA-related specialists for consultation to avoid wasting medical resources.	5(3%)	15(9.1%)	40(24.4%)	41(25%)	63(38.4%)
8.I consider whether the patient's symptoms are related to OSA and invite relevant specialists for consultation.	50(30.5%)	53(32.3%)	44(26.8%)	13(7.9%)	4(2.4%)
9.I work with OSA-related specialists to determine the patient's subsequent treatment plan.	51(31.1%)	53(32.3%)	36(22%)	20(12.2%)	4(2.4%)
10.I suggest the patient be referred to an OSA-related department.	51(31.1%)	56(34.1%)	33(20.1%)	20(12.2%)	4(2.4%)
11.I recommend positional therapy to patients, including side sleeping and elevating the head of the bed.	55(33.5%)	60(36.6%)	30(18.3%)	17(10.4%)	2(1.2%)
12.When prescribing sleep medications, I consider the potential of the medication to worsen the patient's snoring and hypoxia symptoms.	57(34.8%)	51(31.1%)	38(23.2%)	13(7.9%)	5(3%)

Table 6. Practice distribution. Legend: OSA, Obstructive Sleep Apnea. Practices were assessed based on a 12-item questionnaire, with responses ranging from "Always" (5 points) to "Never" (1 point). Directly related departments (e.g., Respiratory Medicine, Otorhinolaryngology) and indirectly related departments (e.g., Neurology, Endocrinology) are presented separately. Higher scores indicate greater engagement in multidisciplinary OSA treatment practices.

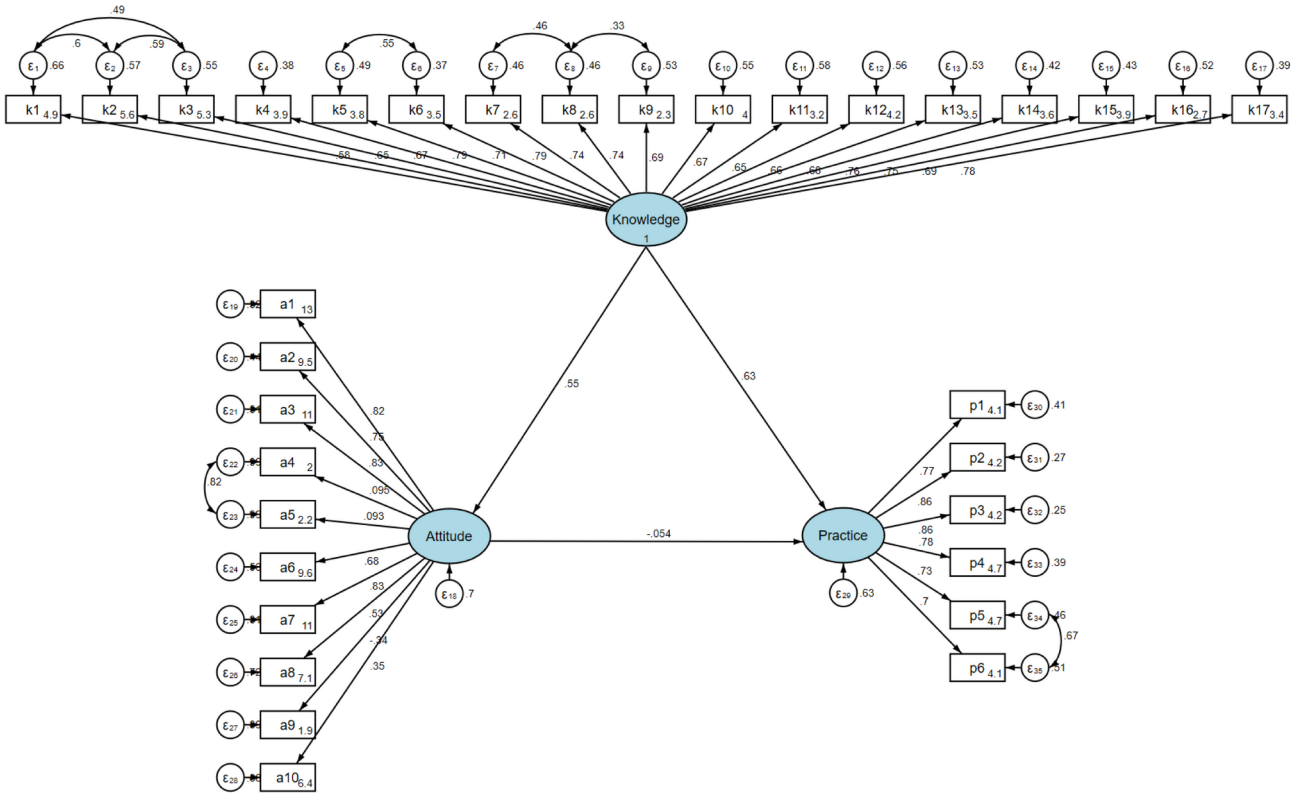

Fig. 1. Structural Equation Model (For Departments Directly Related to OSA).

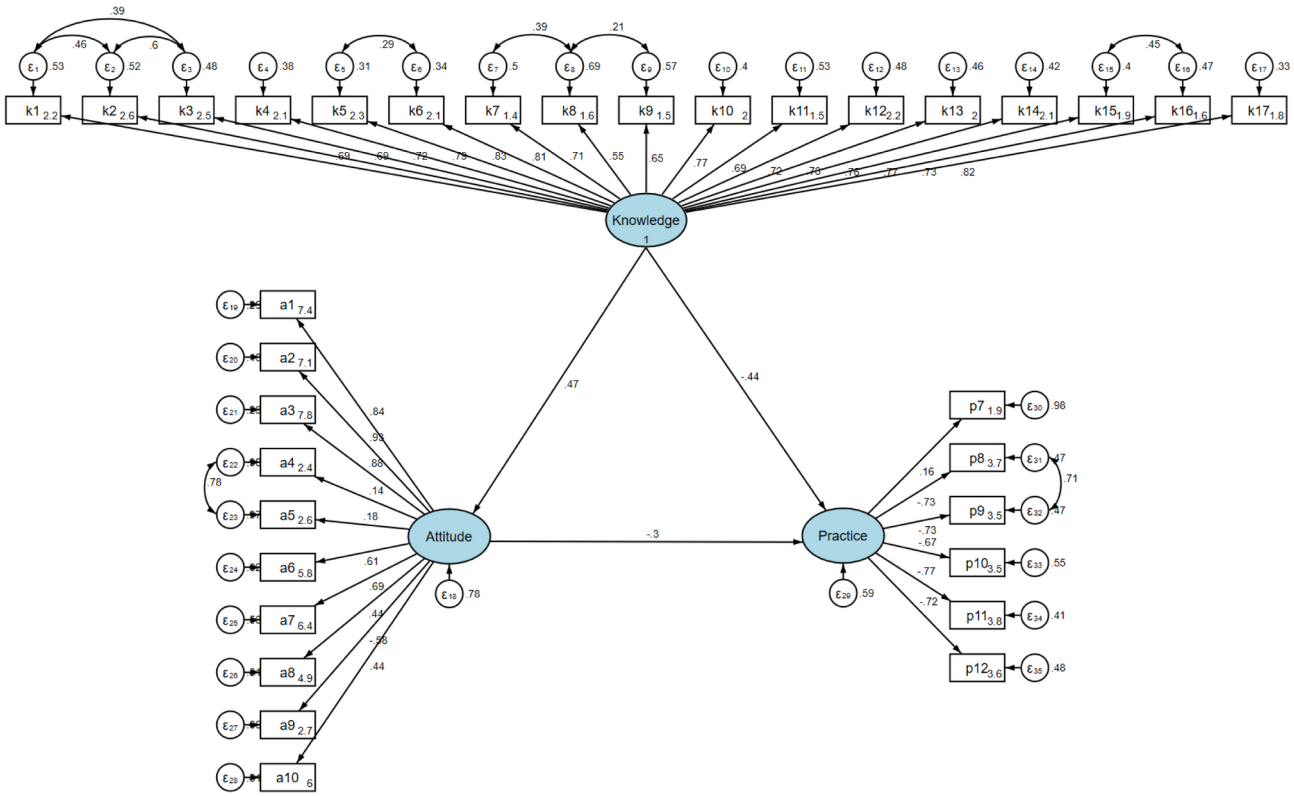

Fig. 2. Structural Equation Model (For Departments Indirectly Related to OSA).

or insufficient institutional support[19]. Similar patterns have been observed in international studies, where multidisciplinary collaboration and targeted education have been shown to improve physician adherence to OSA management protocols. For instance, a study in the United States found that structured interdisciplinary training enhanced physicians' recognition and treatment of OSA-related complications, leading to improved patient outcomes[20]. Additionally, European research highlights the role of national guidelines in promoting standardized multidisciplinary care, suggesting that regional variations in training and awareness may contribute to differences in practice implementation[21]. The comparison between these two groups highlights the complex dynamics that govern the application of knowledge and attitudes in varied clinical settings. In directly involved departments, the pathway from knowledge to practice appears more straightforward, likely due to regular exposure to OSA cases and specialized training. In contrast, the indirect involvement group faces challenges that may require additional structural or systemic interventions to bridge the gap between KAP. Furthermore, both regional differences and structural challenges contribute to inconsistencies in OSA management practices. Physicians in less urbanized or resource-limited regions often face reduced access to interdisciplinary teams, sleep laboratories, and referral networks, limiting standardized protocol implementation[22]. Structural barriers within healthcare systems further complicate multidisciplinary care, including departmental silos that impede communication, lack of integrated electronic health records for cross-specialty documentation, insufficient reimbursement models for collaborative care, and competing clinical priorities in non-sleep specialties[23,24]. Some departments may lack formalized pathways for OSA referrals or consultation, while others struggle with resource allocation and staffing constraints that make comprehensive screening unfeasible[25]. Research has shown that implementing standardized screening tools, developing clear referral algorithms, and creating formal interdepartmental care pathways can help overcome these structural challenges[26]. Region-specific training programs combined with institutional reforms addressing these structural barriers may enhance multidisciplinary collaboration and improve patient outcomes.

Significant differences were observed across variables such as gender, age, education, and professional title, influencing physicians' KAP towards the treatment of OSA. For instance, female physicians demonstrated higher knowledge and attitude scores, potentially due to greater engagement in continuous education and a focus on patient care[27,28]. Age also played a critical role, with older physicians exhibiting better knowledge, reflecting the cumulative benefits of extended clinical experience and education[29]. However, the consistency in attitude scores across age groups suggests a shared professional commitment to patient care, irrespective of age. Furthermore, educational achievements were linked with knowledge levels but did not similarly affect attitudes, indicating that while higher academic qualifications enhance specific knowledge, they do not necessarily alter the fundamental professional outlook towards OSA management. Professional titles showed a similar pattern, with higher titles correlating with increased knowledge but not with different attitudes, pointing to the influence of clinical experience and professional advancement on knowledge without necessarily impacting the general approach to OSA treatment.

The distribution of knowledge among physicians regarding OSA highlights areas of robust understanding as well as notable deficiencies. Most physicians are well-informed about the basic features and consequences of OSA, including its typical manifestations and implications for the cardiovascular and respiratory systems. However, gaps in knowledge become apparent when considering the broader systemic impacts of OSA, especially in the endocrine, digestive, and urogenital systems, where awareness is significantly lower. Literature suggests that multidisciplinary educational initiatives improve knowledge retention and application[30,31]. To address these gaps, targeted training modules could be developed, focusing on the less recognized impacts of OSA, supported by visual aids and interactive content to enhance understanding[32,33].

Attitudes towards multidisciplinary treatment for OSA are generally positive, reflecting a recognition of its necessity and benefits. However, there is notable skepticism about the resource intensity and clinical significance of such approaches, with a significant minority viewing them as cumbersome and resource-wasting. This skepticism can be addressed by showcasing successful case studies and outcomes from multidisciplinary approaches. Furthermore, integrating feedback from physicians into the planning and execution of treatment protocols could increase buy-in and reduce perceptions of inefficiency. Workshops that simulate multidisciplinary case management could also be helpful, providing hands-on experience and demonstrating the practical benefits of such treatments[34–36].

The practice of managing OSA in specialized departments like Respiratory Medicine and Otorhinolaryngology indicates a proactive stance, with considerable engagement in multidisciplinary treatment protocols. However, practices in departments indirectly related to OSA show significant room for improvement, particularly in recognizing and integrating considerations for OSA in the management of related systemic diseases. To enhance practice across all departments, cross-departmental training sessions could be implemented, ensuring that all healthcare providers have the skills to identify and address OSA symptoms and implications, regardless of their primary focus. Collaboration tools and regular interdisciplinary meetings could foster a more integrated approach, as suggested by the improved outcomes in institutions that adopt such strategies[37–39]. Additionally, creating standardized protocols for referring OSA suspects to specialized care can streamline processes and ensure consistency in patient management across different departments[40,41].

This study has several limitations. First, its cross-sectional design limits the ability to establish causality between physicians' KAP regarding OSA, although SEM in cross-sectional studies can provide a surrogate for causality. Second, this study has inherent sampling limitations. The sample was restricted to physicians from tertiary hospitals in southwestern China with the capacity to manage OSA and provide multidisciplinary treatment. While these hospitals were selected based on their ability to handle OSA cases, the findings may not be generalizable to physicians in primary or secondary healthcare settings, or to regions with different healthcare structures and resource availability. The non-randomized questionnaire distribution via hospital contacts and WeChat work groups may have introduced selection bias, and the indirect dissemination by hospital leaders

or department heads may have led to uneven participation across institutions. Future studies should adopt randomized or stratified sampling across multiple regions to improve representativeness. Third, self-reported data from questionnaires may be subject to response bias, as participants might provide answers they perceive as socially acceptable rather than those that reflect their true beliefs and behaviors. Moreover, the voluntary nature of participation may have introduced self-selection bias, as those with greater interest or experience in OSA may have been more likely to respond. Fourth, due to the multi-tiered questionnaire distribution process through WeChat work groups, the precise response rate could not be determined, further limiting the ability to assess potential nonresponse bias. Finally, the study did not assess institutional differences in resource availability or training programs, which could influence physicians' engagement in multidisciplinary OSA management.

Conclusions

In conclusion, physicians demonstrated sufficient knowledge and positive attitudes towards the multidisciplinary treatment of OSA, with proactive practices observed in departments both directly and indirectly involved in OSA treatment. However, variations in practice implementation suggest a need for targeted educational initiatives. Expanding structured training programs, incorporating multidisciplinary case discussions, and developing standardized referral protocols could enhance cross-departmental collaboration and improve the consistency of OSA management. Furthermore, this study highlights the importance of future research on regional differences in multidisciplinary OSA management and the impact of educational interventions on physician practices.

Data availability

All data generated or analysed during this study are included in this published article.

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Author contributions
As the sole author of the paper, Peili Shen was responsible for all aspects of the study and was responsible for the final publication of the paper.

Declarations

Competing interests
The authors declare no competing interests.

Ethics approval and consent to participate
The study received ethical approval from the Ethics Committee of Guiqian International Hospital (Approval number: Guiqian2024Ethics (18)). Wrintten informed consent was obtained from all participants prior to their involvement in the study. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Additional information
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