Advances in Medical Education and Practice

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Integrating O-AMAS and Problem-Based Learning in Otolaryngology Education: A Self-Controlled Trial of a Novel Active Learning Framework

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Objective: To evaluate the effectiveness of integrating the O-AMAS teaching model with problem-based learning (PBL) in instructing medical undergraduates in otolaryngology-head and neck surgery, a specialty that demands rapid clinical decision-making and lifelong self-directed learning (SDL) ability.

Methods: This study utilized a self-controlled before-and-after trial design to evaluate the effectiveness of traditional teaching techniques in comparison to an innovative strategy that integrates the O-AMAS teaching model with PBL in otolaryngology-head and neck surgery education. Data was collected through in-class and phased tests, a student satisfaction survey evaluating various aspects of the new approach, and the advanced SDL rating scale measuring changes in students' self-directed learning abilities across four dimensions. Statistical analysis used paired sample *t*-tests.

Results: The new teaching model was associated with significantly higher scores in both in-class tests (mean difference = 4.7; Cohen's d = 1.01, 95% CI: 0.77–1.25) and stage tests (mean difference = 4.8; Cohen's d = 0.93, 95% CI: 0.69–1.17), as well as improved total SDL scores (Cohen's d = 0.68, 95% CI: 0.45–0.91), all $p < 0.001$.

Implications for School Health Policy, Practice, and Equity: None.

Conclusion: This preliminary evidence suggests that integrating O-AMAS with PBL is a promising approach for otolaryngology education. The observed short-term gains in performance and SDL warrant further evaluation in more rigorous, controlled designs.

Keywords: O-AMAS teaching model, problem-based learning, otolaryngology-head and neck surgery

Introduction

Otolaryngology-head and neck surgery is a science that studies the anatomy, physiology and disease phenomena of the ear, nose, pharynx, larynx, trachea and esophagus, as well as the skull base, neck and upper mediastinum. It is not only informative but also serves as a crucial secondary discipline in clinical medicine. Given its extensive coverage of physiological systems, abnormal manifestations of the ear, nose, throat, head and neck are often part of the clinical manifestations of systemic diseases. Clinicians must make rapid, high-stakes decisions in airway emergencies, integrate complex anatomical knowledge with procedural reasoning, and master multimodal diagnostic skills (eg, endoscopic, radiologic, and audiometric interpretation).[1] Therefore, it is imperative that every otolaryngology head and neck surgeon possesses extensive knowledge and advanced self-directed learning (SDL) ability.[1,2] However, achieving such SDL ability is particularly challenging in otolaryngology-head and neck surgery, a specialty with distinct educational demands. But traditional curricula often emphasize passive knowledge transmission, leaving students underprepared for the self-directed, lifelong learning required in a rapidly evolving specialty. In the traditional medical education, teachers often play a central role, primarily delivering knowledge through a rigid syllabus and addressing any confusion or inquiries raised by students during class.[3,4] However, the effectiveness of this approach can differ depending on the instructor. In this model, most students are often aware of only textbooks and syllabuses before class, and then passively acquire

https://doi.org/10.2147/AMEP.S556999
Received: 29 July 2025
Accepted: 22 April 2026
Published: 13 May 2026

knowledge in class, which often makes it difficult for them to develop the ability of active learning. Therefore, in order to cultivate high-quality otolaryngology head and neck surgeons, we have tried a new teaching model.

O-AMAS teaching model, independently developed and launched by the effective teaching team of Nankai University in 2017, is a new teaching mode.[5] This model is student-centered, learning results oriented, and driven by the positive interaction between teachers and students. Unlike generic active-learning strategies (eg., traditional team-based learning), the O-AMAS framework provides a structured five-step cycle, including objective design (O), activation (A), multi-learning (M), effective assessment (A), and summary (S), that explicitly operationalizes the development of SDL ability. Each step is designed to foster learner autonomy, from goal-setting to self-evaluation, which is often implicit in other models. So far, the model has been applied to the teaching of nursing,[6] pharmacology,[7] and microbial physiology.[8] Problem-based learning (PBL) is a student-centered educational strategy that encourages students to take the initiative to learn based on problems.[9,10] In the teaching of medical students, the utilization of clinical cases as the foundation for their basic learning and clinical science can enhance the retention and application of knowledge when compared to traditional methods.[10] And there is evidence that it can promote the improvement of students' SDL ability.[9–11] Despite the growing interest in active learning, there remains a lack of structured pedagogical models that are grounded in educational theory and have been evaluated specifically within otolaryngology-head and neck surgery undergraduate education. To address this gap, this study implemented the O-AMAS teaching model combined with PBL in the teaching of otolaryngology-head and neck surgery for medical undergraduates, and conducted a preliminary assessment of its feasibility and short-term outcomes.

Methods

Study Design

This study is a self-controlled before-and-after trial that compared the differences in SDL ability and phased level test scores of medical undergraduates before and after the course. A concurrent control group was not feasible due to the fixed curriculum sequence (all students received the same topics in the same order) and ethical considerations (withholding an active learning intervention was deemed inappropriate). The study is presented as a preliminary feasibility and proof-of-concept trial.

Participants

Using the cluster sampling method, 142 fourth-year clinical medicine students from Anhui Medical University who met the inclusion criteria were included in the study from September 2023 to January 2024. The specific steps of cluster sampling were as follows: (1) define the target population as all fourth-year clinical medicine students during the study period; (2) identify natural clusters—students were divided into 5 parallel classes based on official academic registration; (3) select clusters—all 5 classes were included (whole-population cluster sampling) to ensure representativeness and statistical power; (4) enroll all eligible individuals within selected clusters. A total of 150 students were initially enrolled; 8 were excluded (4 declined consent, 3 had incomplete data, 1 withdrew due to illness), resulting in a final sample of 142 participants. A priori power analysis indicated that for a paired t-test with $\alpha = 0.05$, power $(1\text{-}\beta) = 0.90$, and an expected moderate effect size (Cohen's $d = 0.5$), a minimum of 44 participants was required. Our sample of 142 is thus adequately powered.

Inclusion criteria: (1) Full-time undergraduates in their fourth year of clinical medicine; (2) Proficient reading comprehension skills; (3) Informed consent and agreement to participate in this study. Exclusion criteria: (1) Students with physical or mental disabilities; (2) Students who have been suspended, withdrawn, or enrolled mid-term.

The Instructional Team

The instructional team for this study consists of five experienced educators in otolaryngology and head and neck surgery, two pedagogical specialists, and one teaching assistant. The pedagogical specialists were tasked with overseeing and evaluating students' learning conditions, as well as facilitating the effective implementation of the new O-AMAS teaching model and the PBL methodology. The educators were accountable for delivering course content, engaging

with students, and assessing the course. The teaching assistant was responsible for the distribution and collection of survey questionnaires and examination papers.

Curriculum Design

The textbook used is the ninth edition of "Otolaryngology and Head and Neck Surgery", published by the People's Health Press. In the early stage of the teaching experiment, we first conducted a one-month foundational course on otolaryngology and head and neck surgery for the students included in the study. Subsequently, in the formal course, based on the textbook "Otolaryngology and Head and Neck Surgery", teaching would be conducted around prevalent diseases in otolaryngology and head and neck surgery. From October to November 2023, we used traditional teaching methods, where teachers were the main body to convey theoretical knowledge through answering students' questions, explaining slides or lecture notes, while students often passively received the knowledge. And from December 2023 to January 2024, student-centered O-AMAS teaching model combined with PBL was employed as a new method for teaching. After each stage of the course, we conducted periodic tests on students to evaluate their learning effectiveness; after all courses were completed, we evaluated the application of the new teaching meth od from three aspects: student satisfaction, student performance, and SDL ability. To ensure equivalence between pre- and post-intervention assessments, all test items were drawn from a validated item bank used in our institution for the past three years. Two independent otolaryngology educators (not involved in teaching) reviewed the pre- and post-test sets for content coverage and difficulty level using a standard rating form. No significant differences in mean difficulty index were found ($p > 0.05$).

Combining O-AMAS Model with PBL Effectively

Design Effective Teaching Objectives

In contrast to traditional teaching methods, the new teaching approach focused on enhancing students' SDL abilities, encouraging and guiding them to think independently, progressing from a superficial to a deeper understanding of clinical problems, and fostering their divergent thinking, rather than simply assisting them in answering questions and attaining higher grades. Using acute epiglottis as an example, students with SDL ability should engage in learning thinking at various stages of the course throughout the entire teaching process, including: (1) Self-study stage before class: comprehending the fundamental anatomical components and pathogenesis of epiglottis, mastering the characteristics of acute epiglottis, and gathering and summarizing relevant information. (2) Classroom PBL stage: analyzing and evaluating clinical cases through pre-class data collection, and discussing them in groups to further deepen knowledge understanding and proposing reasonable solutions to clinical problems; (3) Consolidation and promotion stage after class: analyze and summarize the knowledge obtained in class, find out one's own shortcomings, and make improvements and summaries. Figure 1 shows the teaching flow chart of O-AMAS effective teaching model combined with PBL designed according to the curriculum objectives.

Inspire Students' Learning Interests and Provide Multi-Teaching Methods

Unlike the traditional method of stimulating students' interest in learning through pre-class preparation, this study used clinical typical cases to arouse students' interest and raised pertinent questions to arouse their curiosity and thirst for knowledge, thereby encouraging them to actively seek solutions to the corresponding problems. In addition to PBL as the primary teaching method, we also employed various instructional strategies tailored to the specific content, including team-based learning, case-based learning, and the "donut" teaching method, to maintain student engagement and focus throughout the learning process.

Effective Assessment and Summary Improve Teaching Effectiveness

The three key elements of effective evaluation are the design, implementation and feedback of evaluation. Effective evaluation goes beyond merely scoring test papers; it involves using student score feedback to timely adjust the new teaching model, ultimately achieving teaching objectives and fostering the development of students' SDL abilities. This study assessed the effectiveness of teaching by conducting classroom tests, periodic assessments, and gathering feedback

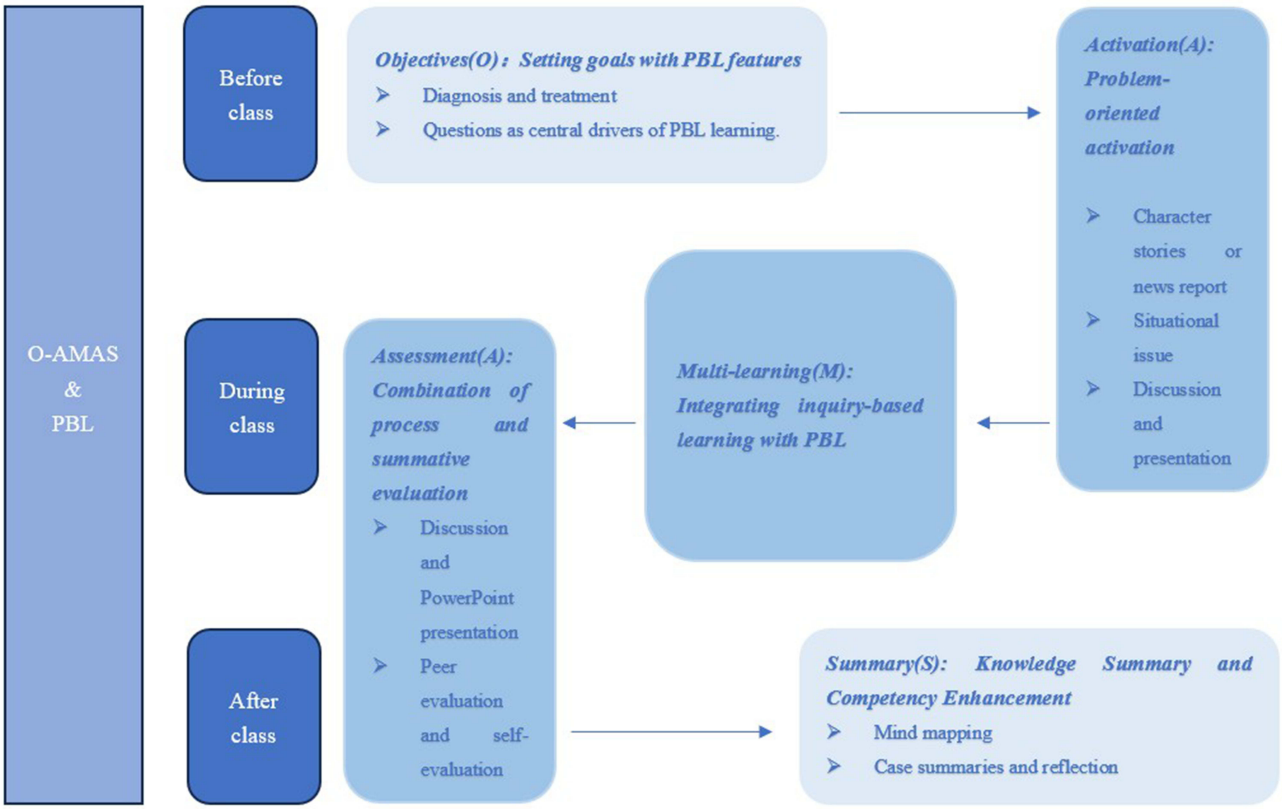

Figure 1 Teaching flow chart of O-AMAS effective teaching model combined with PBL designed according to the curriculum objectives.

through anonymous questionnaires regarding students' classroom satisfaction. Additionally, we evaluated students' SDL ability scores before and after implementing the new teaching model. The scores obtained from the questionnaires indicated the level of students' satisfaction. SDL ability was evaluated by the score of the SDL rating scale, which included four dimensions, learning motivation, planning and implementation, self-management, and interpersonal communication.[12] Furthermore, a concise and impactful summary frequently aids students in summarizing and reinforcing the key points imparted in class. Hence, towards the conclusion of every course, we encourage students to recapitulate the main takeaways of the class, construct a mind map based on their individual comprehension, and establish their own knowledge framework.

Statistical Data Analysis

SPSS 23.0 statistical software was used to input and analyze the data. The measurement data were expressed as mean ± standard deviation ($\overline{x} \pm s$). Paired sample *t*-test was used to compare the students' autonomous learning ability before and after the new teaching. Effect sizes (Cohen's *d*) with 95% confidence (95% CI) intervals were calculated for all primary outcomes. Internal consistency of the SDL rating scale in this cohort was assessed using Cronbach's α. The test level is $\alpha = 0.05$, $1\text{-}\beta = 0.9$, and $p < 0.05$, meaning the difference was statistically significant.

Ethical Consideration

Informed consent was obtained from the participants in this study before they were enrolled in the study. Ethical approval was obtained from the Institutional Review Committee of First Affiliated Hospital of Anhui Medical University before commencing the study.

Results

Comparison of Students' Grades Between Traditional and New Teaching Models

In our research, student testing was divided into in class testing and phased testing after different teaching models were completed. From Table 1, both in-class (Cohen's d = 1.01, 95% CI: 0.77–1.25, p<0.001) and stage tests (Cohen's d = 0.93, 95% CI: 0.69–1.17, p<0.001) showed statistically significant higher scores under the new method (in-class: mean=87.2, SD=4.5; stage: mean=90.1, SD=5.0) compared to the traditional method (in-class: mean=82.5, SD=4.8; stage: mean=85.3, SD=5.5), demonstrating its effectiveness in enhancing learning outcomes.

Results of Evaluation of Teaching Satisfaction

After teaching, a self-made questionnaire was used to evaluate the teaching effect. The questionnaire asked students about their overall satisfaction with the new teaching model, the effectiveness of PBL in promoting active learning, the quality of PBL cases, the responsiveness to teachers, and the opportunities for participation and teamwork. It also inquired about the level of satisfaction among students regarding the integration of O-AMAS principles. Overall, the results demonstrated a high level of satisfaction among students with the new teaching method. Over 90% of them expressed satisfaction with the integration of O-AMAS principles, quality of PBL cases, and teacher's responsiveness. The opportunities for active participation and teamwork garnered strong positive feedback, with satisfaction rates of 95% and 94%, respectively. Notably, the effectiveness of comprehensive methods in achieving teaching objectives and overall satisfaction with the new teaching model received the highest satisfaction rates at 97% and 96%, respectively (Table 2).

Results of Comparison of SDL Ability

SDL ability was assessed using the SDL rating scale, which comprises four subscales: learning motivation, planning and implementation, self-management, and interpersonal communication. Table 3 presents the comparison of SDL ability scores between traditional and new teaching methods.

Table 1 Comparison of Students' Performance in Tests Between Traditional and New Teaching Models ($\bar{x} \pm s$, Points)

Test	Traditional Teaching	New Teaching	Cohen's *d* (95% CI)	*p*-value
In-Class Tests	82.5±4.8	87.2±4.5	1.01 (0.77–1.25)	<0.001
Stage Tests	85.3±5.5	90.1±5.0	0.93 (0.69–1.17)	<0.001

Table 2 Results of Students' Evaluation of Teaching Satisfaction (%)

Category	Question	Satisfied (%)	Neutral (%)	Dissatisfied (%)
PBL Process within O-AMAS	Overall integration of O-AMAS principles	128 (90%)	10 (7%)	4 (3%)
	Quality and relevance of PBL cases	129 (91%)	10 (7%)	3 (2%)
	Teachers can answer questions in a timely manner and provide effective guidance	128 (90%)	12 (8%)	3 (2%)
	Effectiveness of PBL in promoting active learning	132 (93%)	7 (5%)	3 (2%)
	Opportunities for active participation	135 (95%)	5 (4%)	2 (1%)
	Opportunities for collaboration and teamwork	133 (94%)	6 (4%)	3 (2%)
Learning Outcomes & Overall Satisfaction	Effectiveness of comprehensive methods in achieving teaching objectives	138 (97%)	3 (2%)	1 (1%)
	Overall satisfaction with the new teaching method	136 (96%)	4 (3%)	2 (1%)

Table 3 Results of Comparison of SDL Ability Scores Between Traditional Teaching and New Teaching ($\bar{x} \pm s$, Points)

Teaching Method	Learning Motivation	Planning and Implementation	Self-Management	Interpersonal Communication	Total Points
Traditional Teaching	20.65 ± 3.05	18.72 ± 3.20	12.85 ± 1.92	13.48 ± 2.15	65.70 ± 6.55
New Teaching	22.38 ± 3.35	20.91 ± 3.75	13.95 ± 2.45	14.35 ± 2.60	71.59 ± 10.15
Cronbach's α	0.82	0.85	0.78	0.76	0.89
Mean Difference	1.73	2.19	1.10	0.87	5.89
Cohen's *d* (95% CI)	0.54 (0.31–0.77)	0.63 (0.40–0.86)	0.50 (0.27–0.73)	0.37 (0.14–0.60)	0.68 (0.45–0.91)
t	3.45	4.12	2.98	2.55	4.87
p-value	0.001	<0.001	0.003	0.012	<0.001

Students demonstrated significantly higher SDL ability scores under the new teaching method compared to the traditional method. The total SDL score increased from 65.70 to 71.59, with a mean difference of 5.89 (Cohen's $d = 0.68$, 95% CI: 0.45–0.91, $p < 0.001$), indicating a moderate-to-large educational effect. Significant improvements were also observed across all four subscales: learning motivation increased from 20.65 to 22.38 (mean difference = 1.73, Cohen's $d = 0.54$, 95% CI: 0.31–0.77, $p = 0.001$); planning and implementation increased from 18.7to 20.91 (mean difference = 2.19, Cohen's $d = 0.63$, 95% CI: 0.40–0.86, $p < 0.001$); self-management increased from 12.85 to 13.95 (mean difference = 1.10, Cohen's $d = 0.50$, 95% CI: 0.27–0.73, $p = 0.003$); and interpersonal communication increased from 13.48 to 14.35 (mean difference = 0.87, Cohen's $d = 0.37$, 95% CI: 0.14–0.60, $p = 0.012$).

The internal consistency of the SDL scale in this cohort was high, with a Cronbach's α of 0.89 for the total scale and subscale α values ranging from 0.76 to 0.85, all exceeding the acceptable threshold of 0.70. These results confirm that the scale performed reliably in our study sample.

Discussion

This study provides preliminary evidence that integrating the O-AMAS teaching model with PBL in otolaryngology-head and neck surgery education for medical undergraduates is a feasible and promising approach. The results suggest improvements in student performance, satisfaction, and SDL abilities when compared to traditional teaching methods, supporting the potential value of learner-centered approaches in medical education.

The model holds particular relevance for otolaryngology-head and neck surgery education. The specialty demands the rapid integration of anatomy, radiology, and endoscopic findings, a multimodal cognitive task that aligns well with the "multi-learning" component of O-AMAS. Furthermore, the structured development of SDL embedded in the model directly responds to a known gap in the education, namely the need to cultivate SDL ability essential for managing airway emergencies and navigating evolving clinical evidence.

In contrast to prior pedagogical studies in otolaryngology-head and neck surgery, which have largely focused on isolated active learning strategies, such as standalone PBL, team-based learning, or case-based learning, without embedding them within a structured framework for fostering SDL, the present study introduces a theoretically grounded and replicable model that integrates the O-AMAS framework with PBL.[4,13] This approach directly responds to long-standing concerns in the undergraduate education, including the considerable variability in curricular content and teaching methods, as well as the lack of standardized, competency-based learning objectives.[4] Furthermore, by reporting effect sizes alongside conventional significance testing, this study provides essential parameters to support future meta-analyses and evidence synthesis in otolaryngology-head and neck surgery education research, addressing a methodological gap that has been highlighted as an area requiring greater empirical rigor.

The observed improvements in student performance can be attributed to the active learning environment fostered by the O-AMAS and PBL approach. By actively engaging students in problem-solving activities, encouraging collaborative learning, and promoting self-reflection, this model facilitates deeper understanding, knowledge retention, and application of learned concepts.[14] The traditional didactic approach, with its emphasis on passive knowledge transmission, often fails to achieve such levels of engagement and cognitive processing.

The high levels of student satisfaction underscore the positive impact of the O-AMAS and PBL model on the learning experience. Students appreciate the opportunity to actively participate in the learning process, collaborate with peers, receive personalized feedback from instructors, and apply their knowledge to real-world clinical scenarios through PBL. This learner-centered approach caters to diverse learning styles and preferences, fostering a more engaging and fulfilling educational journey.[15]

Furthermore, the significant improvement in SDL abilities highlights the transformative potential of this model in equipping students with essential skills for lifelong learning and professional development. By encouraging students to take ownership of their learning, set goals, develop effective learning strategies, and evaluate their progresses, the O-AMAS and PBL approach equips them with the necessary skills to meet the demands of continuous learning and adaptation in the rapidly evolving medical field. These skills are crucial for maintaining competence and staying abreast of advancements throughout their careers. These findings align with a growing body of research demonstrating the benefits of PBL and active learning strategies in medical education.[16–18] The integration of the O-AMAS model provides a structured framework for implementing PBL,[5] ensuring alignment with learning objectives, and fostering a supportive learning environment. By explicitly incorporating elements of objective design, activation, multi-learning methods, effective assessment, and summary, the O-AMAS model maximizes the potential of PBL to enhance learning outcomes and cultivate SDL abilities.[12]

However, it is important to recognize the limitations of this study. First, the single-group pre-post design with no concurrent control group limits causal inference; improvements may reflect maturation, test familiarity, or other temporal confounders. Second, although we provided evidence of test equivalence, residual differences in assessment difficulty cannot be entirely excluded. Third, the reliance on self-reported SDL measures may introduce social desirability bias, and future studies should incorporate objective behavioral assessments. Fourth, the intervention period was relatively short, and long-term retention of knowledge and SDL skills remains unexamined. Fifth, the study was conducted at a single institution, which may limit generalizability to other settings or student populations. Future research should address these limitations by conducting multi-institutional studies, employing longitudinal designs, and incorporating qualitative data collection methods.

Conclusion

This study provides preliminary evidence that integrating the O-AMAS teaching model with PBL is a promising approach for teaching otolaryngology-head and neck surgery to medical undergraduates. The observed short-term improvements in performance, satisfaction, and SDL abilities suggest that this model warrants further evaluation in more rigorous, controlled designs. Because the study measured outcomes immediately after the intervention, it is unclear whether these gains persist over time. Future research should include follow-up assessments and objective clinical skill measures. For otolaryngology education specifically, where trainees must integrate complex anatomical knowledge with rapid diagnostic and procedural decisions, the structured, student-centered teaching model offers a feasible framework to foster self-directed, lifelong learning skills essential for safe and effective practice.

Abbreviations

PBL, Problem-Based Learning; SDL, Self-directed learning.

Data Sharing Statement

All raw data for this study can be obtained from the corresponding author.

Ethics Approval and Consent to Participate

The authors declare that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Ethical approval was obtained from the Institutional Review Committee of First Affiliated Hospital of Anhui Medical University before commencing the study. (Ref no 5101293, dated 1st March 2021). All participants provided written informed consent prior to data collection. The consent form outlined the study purpose, voluntary participation, confidentiality, and the right to withdraw at any time.

Consent for Publication

All authors consent to publication.

Acknowledgments

We acknowledge all the students who participated in the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

The study was supported by the Anhui Provincial Department of Education General Project (No. 2508085MH207), Applied Medicine Project of Hefei Municipal Health Commission (Hwk2023zc002), the Key Fund of the Anhui Provincial Education Sector (No. 2022AH051156), Provincial Special Project for Clinical Medicine Research and Translation (Grant No. 202527c10020032), and Member units and non-directly affiliated hospitals of the Health Alliance, Science and Technology Project of Bengbu Medical University (Grant No. 2024byzd376).

Disclosure

The authors declare no competing interests in this work.

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