Generative Artificial Intelligence for Self-Regulated Learning in English for Specific Purposes

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Abstract: Generative artificial intelligence (GenAI) offers new opportunities to support autonomous language learning through the development of personalised, context-specific educational materials. However, existing research has predominantly examined students' direct use of AI tools, with comparatively limited attention to lecturer-designed and validated AI-generated activities intended to promote self-regulated learning (SRL), particularly in vocational English for Specific Purposes (ESP) contexts. Based in Zimmerman's SRL framework and the concept of instructional scaffolding, this exploratory study investigates vocational higher education students' perceptions of AI-generated autonomous learning materials, focusing on perceived usefulness, personalisation, motivation, engagement, and independent learning. A semester-long pedagogical intervention was implemented during the 2025-2026 academic year in two Portuguese vocational higher education programmes: Nature and Adventure Tourism and Gastronomy and Food Production. Lecturers developed, reviewed, and adapted GenAI-generated activities incorporating profession-specific vocabulary, authentic communicative scenarios, and independent practice tasks aligned with course objectives. Following the intervention, 20 students completed a questionnaire comprising 13 five-point Likert-scale items. Data were analysed using descriptive statistics, Cronbach's alpha, and Mann–Whitney U tests to explore differences between programmes. The questionnaire demonstrated high internal consistency (α = .911). Findings revealed generally favourable perceptions, particularly regarding the usefulness of the materials for autonomous English learning (M = 3.75), their capacity to facilitate independent study (M = 3.70), and their perceived contribution to learning (M = 3.70). Students also reported positive perceptions of motivation (M = 3.50) and overall satisfaction (M = 3.65). Nevertheless, respondents expressed a preference for traditional learning resources (M = 3.40) and generally disagreed that AI-generated materials could replace teachers' explanations (M = 2.40). No statistically significant differences were identified between the two programmes (all exact $p > .05$). These findings suggest that lecturer-designed GenAI materials may constitute a valuable instructional scaffold for autonomous ESP learning across different vocational domains. However, the small sample and reliance on self-reported perceptions limit generalisability and prevent conclusions about actual learning gains or improvements in self-regulatory skills. The study highlights the importance of pedagogical validation, teacher mediation, and blended learning approaches when integrating GenAI into vocational language education.

Keywords: Self-Regulated Learning, Generative Artificial Intelligence, English for Specific Purposes, Vocational Higher Education, Instructional Scaffolding, Autonomous Learning

1. Introduction

The ability to regulate one's own learning has become a fundamental skill in contemporary higher education. Beyond acquiring disciplinary knowledge, university students are increasingly expected to develop the capacity to plan, monitor and evaluate their learning independently, enabling them to adapt to rapidly changing academic, technological and professional environments. These self-regulatory skills are widely recognised as essential for lifelong learning and employability, particularly in vocational education including vocational higher education, where graduates are required to update their knowledge continuously in response to evolving workplace demands (Zimmerman, 2002; Zimmerman & Schunk, 2011; European Commission, 2020).

Within English for Specific Purposes (ESP), self-regulated learning assumes particular importance. ESP courses are designed to prepare learners for communication within specific academic or professional domains, requiring them to develop specialised linguistic skills that extend beyond general language proficiency (Dudley-Evans & St John, 1998; Hyland, 2006). Because classroom instructions alone is rarely sufficient to address the complexity and diversity of professional communication, students are expected to engage in autonomous learning outside formal teaching sessions, consolidating vocabulary, practising communicative situations and expanding their knowledge independently. However, maintaining students' engagement in autonomous study remains a persistent challenge, particularly in vocational higher education programmes where learning is strongly practice-oriented and students often demonstrate diverse linguistic backgrounds and learning preferences.

Recent developments in Generative Artificial Intelligence (GenAI) have introduced new possibilities for supporting autonomous and self-regulated learning. Unlike previous generations of educational technologies, large language models can generate contextualised learning materials, simulating authentic professional interactions, providing immediate feedback and adapting educational content to specific learning objectives

(Kasneci et al., 2023; Crompton & Burke, 2024). These affordances have stimulated growing interest in the educational community, leading researchers to investigate how AI may enhance language learning, personalise instruction and facilitate independent study. At the same time, scholars have emphasised that the educational value of generative AI depends less on the technology itself than on the pedagogical approaches guiding its implementation (UNESCO, 2023). In other words, AI should be understood not as a replacement for teachers but as a pedagogical resource whose effectiveness depends on intentional instructional design.

Within language education, the literature has primarily examined students' use of generative AI for writing assistance, language production, feedback and conversational practice (Lo, 2023; Yan, 2023; Zhai, 2023). While these studies have contributed significantly to understanding learners' acceptance and use of AI, considerably less attention has been devoted to the role of lecturer-designed AI-generated learning activities as structured resources for autonomous learning. This distinction is particularly relevant because allowing students to use AI freely differs fundamentally from integrating AI into carefully planned pedagogical interventions designed to support specific learning outcomes. From a self-regulated learning perspective, the educational value of AI lies not merely in its capacity to generate content but in its potential to support learners' planning, monitoring and reflection throughout the learning process.

This gap becomes even more evident within vocational English for Specific Purposes. Although research on AI in language education has expanded rapidly, empirical studies examining AI-supported autonomous learning in vocational ESP contexts remain scarce. Furthermore, little is known about how students perceive AI-generated learning activities developed by educators to reinforce classroom learning over an extended period, particularly across programmes representing different professional domains. Understanding these perceptions is important because students' acceptance, engagement and perceived usefulness of such activities may influence the successful integration of AI into future ESP curricula.

To address this gap, the present study examines an educator-designed pedagogical intervention implemented in two English for Specific Purposes courses within vocational higher education in Portugal. Students enrolled in (i) Gastronomy and Food Production and (ii) Nature and Adventure Tourism programmes were provided with AI-generated autonomous learning activities throughout one academic semester to reinforce classroom learning and support independent study. Based in Zimmerman's Self-Regulated Learning framework, these activities were conceptualised as pedagogical framework intended to support students' planning, monitoring and reflection, rather than as substitutes for teacher guidance. The purpose of this study is to examine the potential of AI-generated autonomous learning activities to support self-regulated learning in English for Specific Purposes and to explore students' perceptions of this pedagogical intervention across two vocational higher education programmes. By positioning generative AI within an SRL framework, the study contributes to the emerging literature on AI-enhanced language learning and offers practical implications for the design of autonomous learning activities in vocational ESP contexts. Therefore, this study addresses the following research questions:

> RQ1: How do students perceive the usefulness of AI-generated activities for supporting autonomous learning in vocational English for Specific Purposes courses?
>
> RQ2: To what extent do students perceive these activities as contributing to their autonomous learning, personalization and motivation?
>
> RQ3: Are there differences between students enrolled in the Gastronomy and Food Production and Nature and Adventure Tourism programmes regarding their perceptions of the AI-generated autonomous learning activities?

2. Theoretical and Empirical Background

2.1 Self-Regulated Learning and Instructional Scaffolding

The concept of Self-Regulated Learning (SRL) has become one of the most influential theoretical perspectives in educational research for explaining how learners actively manage their own learning processes (Zimmerman, 2000, 2002). Rooted in social cognitive theory, SRL conceptualises learners as proactive agents who set learning goals, monitor their progress, regulate their cognitive and motivational strategies, and reflect upon their learning outcomes rather than passively receiving information (Zimmerman, 2000; 2002). This perspective represents a shift from teacher-centred models of instruction towards learner-centred approaches in which students assume increasing responsibility for directing their own learning.

Among the various theoretical models proposed to explain self-regulated learning, Zimmerman's cyclical model remains one of the most widely adopted in higher education research. According to Zimmerman (2002), effective self-regulation occurs through three interconnected phases: forethought, performance, and self-reflection. During the forethought phase, learners establish objectives, analyse learning tasks, activate prior knowledge and select strategies before beginning an activity. The performance phase involves implementing these strategies while monitoring understanding, sustaining motivation and regulating behaviour throughout the learning process. Finally, during the self-reflection phase, learners evaluate their performance, interpret the effectiveness of the strategies employed and use this information to improve subsequent learning experiences. Rather than occurring sequentially, these phases form a continuous cycle through which learners progressively refine their learning behaviours.

The concept of instructional scaffolding originates from the sociocultural perspective of learning, particularly the work of Vygotsky (1978) and the subsequent interpretation developed by Wood, Bruner and Ross (1976). Scaffolding refers to the temporary support provided by a more knowledgeable individual or instructional resource that enables learners to perform tasks beyond their current level of competence. As learners progressively develop the required knowledge and skills, this support is gradually reduced, encouraging increasing independence and self-regulation. Rather than diminishing learner autonomy, effective scaffolding facilitates its development by providing appropriate guidance during the learning process.

The emergence of Generative Artificial Intelligence (GenAI) represents a significant development within this evolution of digital scaffolding. Unlike earlier educational technologies, large language models are capable of generating original educational content, adapting explanations, creating contextualised learning activities and responding dynamically to learners' requests. These characteristics allow educators to design highly personalised learning experiences while maintaining alignment with specific pedagogical objectives (Kasneci et al., 2023). Consequently, the educational potential of GenAI lies not simply in its capacity to generate information but in its ability to provide flexible instructional support that complements teachers' pedagogical intentions.

Viewed through the lens of Self-Regulated Learning, generative AI can therefore be understood as a form of instructional scaffolding. Carefully designed AI-generated learning activities may encourage learners to organise their study routines, engage in repeated practice, monitor their progress and reflect upon their learning outcomes while maintaining responsibility for the learning process itself. In this regard, AI does not replace self-regulation; rather, it provides structured opportunities through which self-regulatory behaviours may develop. This interpretation shifts the focus from AI as a technological innovation to AI as a pedagogically designed scaffold supporting autonomous learning.

2.2 Generative AI for Vocational English for Specific Purposes

English for Specific Purposes (ESP) has long been recognised as a learner-centred approach to language education in which instructional decisions are guided by learners' academic, occupational and professional communication needs rather than by general language proficiency alone (Dudley-Evans & St John, 1998; Hyland, 2006). Consequently, ESP extends beyond the teaching of specialised vocabulary or professional terminology, seeking instead to develop learners' ability to communicate effectively within authentic disciplinary and workplace contexts. This emphasis on authenticity requires learning experiences that closely reflect the communicative situations students are likely to encounter in their future professions.

Unlike General English courses, ESP is characterised by considerable diversity regarding learners' backgrounds, professional aspirations and communicative requirements. Students enrolled in vocational higher education programmes frequently require language skills directly applicable to highly specialised contexts, such as customer interaction, technical communication, problem-solving, teamwork and intercultural communication. As a result, ESP educators are expected to design learning experiences that integrate linguistic development with professional practice, encouraging students to transfer classroom learning to authentic workplace situations (Basturkmen, 2010).

The rapid emergence of generative artificial intelligence has stimulated a substantial increase in research examining its educational applications, particularly within language learning. Existing studies have explored a wide range of topics, including students' perceptions of generative AI, its influence on writing performance, feedback generation, vocabulary development, conversational practice and academic integrity (Lo, 2023; Yan, 2023; Zhai, 2023). Collectively, this body of research suggests that generative AI offers considerable potential

for supporting language learning by providing immediate feedback, personalised explanations and flexible opportunities for independent practice.

Within English for Specific Purposes, however, the available literature remains comparatively limited. Although several studies acknowledge the potential of generative AI to produce profession-specific learning materials and authentic communication scenarios, empirical research has predominantly focused on students' direct interaction with AI systems, particularly for writing support, translation or information retrieval. Consequently, the educational intervention itself has often consisted of learners independently using AI tools rather than educators deliberately integrating AI-generated resources into structured instructional designs.

In this context, the present study addresses an emerging gap in the literature by examining a semester-long pedagogical intervention in which lecturers designed AI-generated autonomous learning activities to support self-regulated learning in two vocational higher education English for Specific Purposes (ESP) courses. Rather than investigating students' spontaneous use of generative AI, this study explores learners' perceptions of a structured instructional approach in which AI was employed as a pedagogical resource to extend learning beyond the classroom while encouraging independent study. By interpreting students' perceptions through the theoretical lens of Self-Regulated Learning, the study contributes to the growing body of research on AI-enhanced language education and provides empirical evidence regarding the pedagogical integration of generative AI in vocational ESP contexts (Kasneci et al., 2023; UNESCO, 2023).

2.3 Conceptual Framework

The literature reviewed in the previous sections suggests that the educational value of Generative Artificial Intelligence lies not in the technology itself but in the way it is integrated into teaching and learning. Building upon Zimmerman's (2002) Self-Regulated Learning framework and the concept of instructional scaffolding (Wood et al., 1976), the present study conceptualises AI-generated autonomous learning activities as pedagogically designed learning resources intended to support students' self-regulatory processes within English for Specific Purposes.

More specifically, the proposed framework assumes that lecturers retain responsibility for the instructional design of the learning experience. Generative AI is employed as a pedagogical resource to produce contextualised autonomous learning activities aligned with specific learning objectives and professional communication needs. Students engage with these activities independently outside the classroom, regulating their own learning while receiving structured support through carefully designed tasks. Consequently, AI-generated activities are expected to scaffold learners' planning, monitoring and self-reflection, thereby facilitating the development of self-regulated learning.

Within this framework, students' perceptions represent an important source of evidence regarding the educational value of the intervention. Rather than measuring attitudes towards generative AI as a technology, the present study examines learners' perceptions of an AI-supported pedagogical approach designed to foster autonomous learning in vocational higher education ESP courses. Students' evaluations are therefore interpreted as indicators of how the instructional design may have supported their engagement with self-regulated learning processes. Figure 1 summarises the conceptual relationships underpinning the study.

3. Materials and Methods

3.1 Design and Participants

This exploratory, post-intervention questionnaire study examined students’ perceptions of lecturer-designed GenAI learning activities. The data presented are quantitative; the study does not report a separate qualitative dataset. The intervention took place in the first semester of 2025–2026 in two first-year Portuguese vocational higher education programmes: Nature and Adventure Tourism and Gastronomy and Food Production.

Participants consisted of students enrolled in the two vocational English for Specific Purposes courses during the academic semester in which the pedagogical intervention was implemented, first semester of the 2025-2026 academic year. Participation in the study was voluntary, and all students who completed the questionnaire provided informed consent for their responses to be used anonymously for research purposes.

The participants were 20 vocational higher education students enrolled in two different courses. Regarding the gender, 50% of the respondents identified as female, 40% as male and 10% preferred not to disclose it. The vast

majority of the respondents (95%) were aged between 18 and 24 whereas only 5% reported being over 30 years old. No participants were included in the 25-29 age category.

In terms of respondents' self-reported English proficiency level, most students (65%) classified themselves as intermediate English students, whereas four participants reported an advanced level of English (20.0%) and three classified themselves as beginners (15.0%).

Regarding course distribution, 14 students were enrolled in the Nature and Adventure Tourism programme, representing 70.0% of the sample, while six students attended the Gastronomy and Food Production programme, corresponding to 30.0%.

3.2 Pedagogical Intervention and Questionnaire

The pedagogical intervention consisted of a series of lecturer-designed autonomous learning activities created with the support of Generative Artificial Intelligence and implemented throughout one academic semester. Rather than encouraging unrestricted use of AI by students, the intervention adopted a teacher-centred instructional design approach in which the lecturers used generative AI to develop contextualised learning materials aligned with the considered learning outcomes of each ESP course.

The activities were specifically designed to reinforce classroom learning by providing opportunities for independent practice outside formal teaching sessions. Depending on the professional context of each programme, the materials included vocabulary exercises, reading comprehension tasks, professional dialogues, scenario-based activities and communicative exercises reflecting authentic workplace situations in Gastronomy and Food Production and Nature and Adventure Tourism. All activities were reviewed and adapted by the lecturers before being made available to students, ensuring their linguistic accuracy, pedagogical appropriateness and alignment with course objectives.

Grounded in Zimmerman's (2002) Self-Regulated Learning framework, the activities were intended to encourage students to organise their independent study, engage actively with profession-specific language tasks, monitor their own learning progress and reflect upon their performance before subsequent classroom sessions. In this sense, generative AI functioned as a pedagogical design resource rather than as an autonomous instructional system.

Data were collected at the end of the semester through a structured questionnaire developed by the researchers to evaluate students' perceptions of the AI-generated autonomous learning activities.

The questionnaire consisted of two sections. It started with an introduction regarding the description of the study and informed consent. Then, the first section comprised 13 closed-ended items measured on a five-point Likert scale, addressing dimensions such as perceived usefulness, engagement, motivation, confidence and contribution to autonomous learning. The second section included four questions used to collect demographic information concerning participants (gender, age and level of English) and their programme of study.

3.3 Analysis and Ethical Considerations

Quantitative data were analysed using descriptive statistical techniques, by resorting to SPSS software, to summarise students' responses regarding their perceptions of the AI-generated autonomous learning activities. Frequencies, percentages, means and standard deviations were calculated for each questionnaire item to provide an overall description of participants' evaluations.

The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient. The instrument revealed excellent reliability (Cronbach's $\alpha = .911$), which demonstrates a high degree of internal consistency among the 13 Likert-scale items.

The study considered the ethical principles governing educational research. Participation was voluntary, and students were informed about the objectives of the study before completing the questionnaire. Participants' anonymity and confidentiality were guaranteed throughout the research process, and no personally identifiable information was collected or reported. The data were analysed exclusively for research purposes and are presented in aggregate form to protect the participants' privacy.

Comparisons were performed using Mann–Whitney U tests. The small sample, particularly the Gastronomy and Food Production subgroup ($n = 6$), limits the power of these comparisons.

4. Results

Table 1: Participant characteristics (N = 20).

Characteristic	Category	N	%
Gender	Female / Male / Undisclosed	10 / 8 / 2	50 / 40 / 10
Age	18–24 / 25–29 / Over 30	19 / 0 / 1	95 / 0 / 5
English proficiency	Beginner / Intermediate / Advanced	3 / 13 / 4	15 / 65 / 20
Programme	Nature and Adventure Tourism / Gastronomy and Food Production	14 / 6	70 / 30

The descriptive statistics results reveal generally positive perceptions about the use of AI-generated materials for self-regulated learning, as mean scores ranged from 2.25 to 3.75 on the five-point Likert scale and with most mean scores above the midpoint of the scale (3.0).

The highest rated items were those pertaining to the usefulness these materials (M = 3.75, SD = 1.21), the easiness of autonomous learning provided by the materials (M = 3.70, SD = 1.22) and the contribution of the materials to learning (M = 3.70, SD = 1.26).

There are also moderately positive aspects that are important to highlight, namely the perception that the materials increased students' motivation to learn (M = 3.50, SD = 1.28), they would recommend the materials to other students (M = 3.45, SD = 1.05). An interesting result was the fact that students preferred traditional learning materials (M = 3.40, SD = 1.14), which reveals some resistance to change, despite the receptiveness that is also shown.

Regarding the items with the lowest mean scores, they correspond to items 5 (M = 2.25, SD = 1.12), pertaining to the materials being confusing and/or inaccurate, and 3 (M = 2.40, SD = 1.35), referring to the idea that the materials can replace a teacher's explanation. Since these items were formulated in a negative wording, the low scores actually reinforce the idea that the autonomous learning materials are not perceived as confusing or inaccurate, although students seem to perceive that AI should complement rather than replace the teacher.

Table 2: Students' perceptions of GenAI-generated materials (five-point Likert scale).

Item	M	SD
Useful for autonomous English learning	3.75	1.21
Make autonomous learning easier	3.70	1.22
Can replace a teacher's explanation	2.40	1.35
Engaging	3.30	1.13
Confusing and/or inaccurate	2.25	1.12
Tailored to my programme	3.30	1.13
Contribute to my learning	3.70	1.26
Help me practise English	3.25	1.37
Increase motivation	3.50	1.28
Prefer traditional learning materials	3.40	1.14
Enjoyed using materials	3.30	1.22
Satisfied with experience	3.65	1.09
Would recommend materials	3.45	1.05

In order to assess whether students enrolled in different courses perceived the autonomous learning materials differently, Mann–Whitney U tests were conducted for each questionnaire item. The results revealed that there are no statistically significant differences between students enrolled in the Nature and Adventure Tourism (N=14) and the Gastronomy and Food Production (N=6) courses for any of the 13 questionnaire items (all exact $p > .05$)

5. Discussion

Regarding the first research question, the findings suggest that students generally perceived AI-generated materials as useful resources for autonomous English learning, particularly in terms of facilitating independent study (M = 3.70) and contributing to their learning (M = 3.70). Considering the fact that the materials could replace the lecturer received one of the lowest mean scores, so this suggests that students distinguish between two specific dimensions, namely using AI-supported materials for self-regulated learning, from replacing human teaching practice. As the materials were validated by the faculty members and they were perceived as positive, this suggests that GenAI can work as a supplementary tool rather than an independent teaching model.

More specifically, as GenAI was used to create materials within two different vocational courses and no differences were found between them, we believe that GenAI can be used to create materials around specific vocabulary, communicative situations and professional tasks that are relevant to each programme. Furthermore, as students perceived these materials to contribute to their autonomous learning, they can be seen as a tool to provide additional opportunities for independent learning, which is particularly useful when contact hours are limited and there is a high number of hours defined just for independent learning, which is the case.

Regarding the second research question, students rated motivation positively (M = 3.50), alongside engagement (M = 3.30), perceived tailoring to the programme (M = 3.30), and English practice (M = 3.25). These are self-reported perceptions rather than direct measures of motivation, self-regulatory behaviour or proficiency. The standard deviations reported in Table 2 are used consistently here.

Personalization and differentiation become especially relevant in this context, where the lecture should remain the pedagogical mediator in the process, verifying the materials and validating others that could be important to guide students in different proficiency levels. As students showed positive perceptions about the materials but still revealed a preference for traditional autonomous learning materials, a blended approach may be preferable in this context, so that students also contact with authentic documents and conventional online resources.

Lastly, the third research question focused on the potential differences between students enrolled in the Gastronomy and Food Production and Nature and Adventure Tourism programmes regarding their perceptions of the AI-generated autonomous learning activities. As already mentioned in the results section, Mann-Whitney U tests were conducted but no statistical significant differences were observed for any of the questionnaire items. This suggests that students in both groups perceived the usefulness of the materials similarly, and that this pedagogical approach may be transferable across distinct contexts. This is in keeping with general literature about the use of AI in language learning, where it is stated that the most important thing is to provide a clear pedagogical approach, as already mentioned (Kasneci et al., 2023).

Therefore, the present findings extend previous research by investigating not only general English and higher education contexts in general, but two specific vocational programmes in English for Specific Purposes. However, there are also challenges in the use of Chat GPT that need to be taken into account, namely the need for teacher verification and reliability, as these tools can also generate inaccurate information (Lai et al., 2026) and foster a risk of both overreliance and of hindering the development of independent critical thinking skills (Liu et al., 2025).

As these materials rely on teacher mediation, the findings also point to the need for faculty training, to ensure that Gen-AI assisted materials promote meaningful autonomous learning without compromising their necessary linguistic and pedagogical quality.

6. Conclusions

This study explored students' perceptions about the use of Gen-AI language learning materials for self-regulated language learning in vocational courses and the general results were very positive, with particular emphasis on autonomous learning, personalization and motivation. Self-regulated learning implies that learners set their goals proactively, select strategies, monitor their performance and reflect on outcomes (Zimmerman, 2002). In this study, as students found the GenAI materials to make autonomous learning easier, contributing to their learning, supporting motivation and helping them practice English, the results can be interpreted through the aforementioned SRL framework, especially regarding task organisation, goal-directed practice, persistence and self-monitoring.

Despite these results, there are also specific limitations that need to be addressed, starting with the small sample size (n=20), which does not allow for the generalization of the results. Besides, the results reflect only self-reported perceptions, so they do not measure motivation changes throughout time or specific English proficiency gains, so further studies could investigate this, especially regarding the four communication skills. Moreover, new studies could replicate the study with larger samples or compare English performance with a control group along with pre/post tests.

Ultimately, this study tries to show that the potential of GenAI materials for ESP does not involve replacing regular teaching practices but rather enabling lecturers to develop more flexible learning opportunities that are tailored to students' own needs, beyond the classroom context, which allows them to have pedagogical guidance that promotes meaningful autonomous learning.

Ethics Declaration

No ethical clearance was required.

AI Declaration

In the preparation of this manuscript, artificial intelligence (AI)-assisted tools were used exclusively to support the research and writing process. ChatGPT and Skywork were used to improve some Figures. NotebookLM was employed to assist with the organization and synthesis of the literature reviewed, facilitating the identification and management of relevant bibliographic sources. Grammarly was used to improve the linguistic quality of the manuscript by providing suggestions for grammar, spelling, punctuation, and style.

All intellectual content, including the study design, data analysis, interpretation of results, and final conclusions, were developed solely by the authors. The authors carefully reviewed and validated all AI-assisted outputs and take full responsibility for the accuracy, integrity, and originality of the manuscript.

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