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Perceptions, attitudes, and barriers to research engagement among general medicine undergraduates in a tertiary hospital in Guangdong, China

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Abstract

Background Research is a critical component of medical education, fostering critical thinking and evidence-based practice. However, in China, particularly in the context of general practice, undergraduate medical students often face significant barriers to engaging in research. This study aims to assess the perception, attitude, and practice toward research among undergraduate medical students in a tertiary hospital in Guangdong, China, and to identify the barriers they face.

Methods A cross-sectional study was conducted among 90 undergraduate medical students from a tertiary hospital in Guangdong, China, from May to June 2024. A self-administered questionnaire was used to collect data on students' perception, attitudes, practices, and perceived barriers toward research.

Results The majority of students (46.6%) expressed a strong desire to pursue postgraduate studies, while only 25.5% showed a strong interest in participating in research. Key barriers included lack of time (65.5%), insufficient research guidance (56.6%), and limited access to resources (47.8%). Students' self-assessment of their research abilities was generally low, with only 9.5% feeling confident in their ability to handle data. Positive correlations were found between access to research guidance and interest in scientific literature ($r = 0.62$, $P < 0.001$).

Conclusion This study identifies key areas for improving research training among undergraduate medical students, particularly in general practice programs. It suggests that standardized curricula, enhanced mentorship, and hospital-university research platforms may help address existing gaps. Given the study's limited sample and setting, further research is needed to confirm these findings in broader contexts.

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Keywords Medical undergraduate medical students, Research perception, Research attitude, Research practice, Barrier factors

Background

Research involves systematic investigation or experimentation aimed at discovering new knowledge and revising existing knowledge [1]. It is vital to developmental activities and is carried out in academic and research institutions [2]. Moreover, research plays a crucial role in understanding the issues that impact the health of individuals, communities, and health systems [3–7]. In the field of medical education, research training has become an essential component, as it not only enhances students' critical thinking and problem-solving skills but also prepares them for future careers in evidence-based medicine and academic medicine [8–10].

In recent years, there has been a growing emphasis on involving undergraduate medical students in research activities. Studies have shown that early exposure to research can significantly improve students' confidence, knowledge, and skills related to conducting research [11–12]. For instance, participation in research projects during undergraduate years has been linked to increased likelihood of pursuing research careers and higher academic achievements in postgraduate programs [13–16]. However, despite its importance, the integration of research training into undergraduate medical curricula remains inconsistent across different regions and institutions [10, 17–18].

This inconsistency may result in varying levels of students' research perception (awareness of research importance and processes), attitude (motivation and perceived value of research), and practice (actual research participation) - three interdependent dimensions where proper understanding fosters positive engagement, which in turn enables effective implementation. To systematically examine these psychosocial dimensions, our study is grounded in the Theory of Planned Behavior (TPB) [19], which conceptualizes behavior as driven by attitudes (e.g., valuation of research), subjective norms (perceived social expectations), and perceived behavioral control (confidence in overcoming barriers). This framework aligns with the identified dimensions of perception, attitude, and practice, which provides a mechanistic understanding. Existing research on these dimensions among undergraduate medical students has identified several challenges and barriers [11, 17–18, 20–21]. Common issues include lack of time, inadequate research training, limited access to resources, and insufficient mentorship. In developing countries, these challenges are often exacerbated by resource constraints and a lack of emphasis on research within the medical education system. For example, studies conducted in several Middle Eastern countries found that although medical students had a positive attitude toward research, their actual participation and knowledge levels were often unsatisfactory [8, 22]. Similar findings have been reported in other regions, highlighting the need for targeted interventions to improve the research engagement of undergraduate medical students [18, 21, 23–24].

In the context of general medicine, research has its unique characteristics. General medicine (GM) focuses on comprehensive healthcare for individuals of all ages, genders, and disease types. Its research often involves community-based health issues, primary care effectiveness, and the coordination of multi-disciplinary medical service [25]. For undergraduate students majoring in general medicine, they need to master research methods applicable to these areas [26]. However, compared with other specialized medical fields, general medicine research may face more challenges in terms of resource allocation and research guidance. For example, due to its broad scope, it may be more difficult to obtain in-depth and targeted research resources [27]. And in some regions, the lack of professional general medicine researchers may lead to insufficient guidance for undergraduate students [28].

In the context of China, the situation is further complicated by the rapid expansion of medical education programs, which has led to an increased number of medical students (from 51,800 graduates in 2002 to 182,900 in 2018, an 8.2% annual growth) but has not been matched by a corresponding increase in research opportunities or resources [29–30]. This imbalance is particularly evident in the field of undergraduate medical research, especially when we consider that China's medical schools enrolled an average of 509 undergraduates per institution in 2018—far exceeding the global average of 160 [31]. The disproportionately high student-to-resource ratio at institutional level may create measurable shortages in research resource allocation. While some medical schools have incorporated research courses and projects into their curricula [20], the overall participation and perception of research among students remain underexplored. In particular, there is limited data on the specific challenges faced by undergraduate medical students in tertiary hospitals, where clinical practice and research opportunities are closely intertwined. This research gap is particularly urgent given China's ongoing healthcare reforms, such as the "Healthy China 2030" initiative [32–33], which emphasizes the importance

of enhancing primary care and workforce competency. These policy directives, including the complementary Doctor of Excellence Education Training Program 2.0 [34], identify research training as fundamental to developing clinician-scientists capable of translating evidence into practice, especially in community and primary care settings. Undergraduate engagement in research not only cultivates early competencies in evidence-based medicine but also aligns with national priorities to strengthen primary care delivery and promote grassroots healthcare innovation.

As China's most populous province and a major economic powerhouse, Guangdong hosts one of the country's most advanced healthcare systems and has played a leading role in GM training and primary care reform. Although tertiary hospitals are traditionally linked with specialty care, they also function as academic hubs capable of supporting GM research. In Guangdong, these institutions offer GM students: (1) access to multidisciplinary mentorship; (2) exposure to patient populations spanning community and hospital settings; and (3) research infrastructure that can be leveraged for primary care-focused studies. Furthermore, Guangdong's strong hospital-community partnerships and early adoption of national GM training policies make it a frontrunner in integrating research into primary care education. As such, identifying barriers in this progressive context can yield actionable insights for nationwide efforts to enhance undergraduate research training in GM.

Therefore, this study aims to investigate the perception, attitude, and practice toward research among undergraduate medical students in a tertiary hospital in Guangdong, China. By understanding the current situation and identifying key barriers, we hope to provide insights for improving research training and support systems within the medical education context in China.

Methods

Study design

This study adopted a cross-sectional survey design. The aim was to collect data on the perceptions, attitudes, and practices of undergraduate medical students towards research at a tertiary hospital in Guangdong, China, at a single point in time. This design enabled a comprehensive understanding of the research-related situations of this group at a specific moment. By using this approach, a large amount of information could be obtained in a relatively short time, and the relationships between different factors could be analyzed, providing a basis for subsequent research.

Participant recruitment

The research subjects were undergraduate medical students at a tertiary hospital in Guangdong, China. With the help of the hospital's teaching management system, the lists of all undergraduate medical students were obtained. Based on the sample size calculation formula for a finite population—$n = (N \times Z^2 \times p \times (1-p)) / [(d^2 \times (N-1)) + (Z^2 \times p \times (1-p))]$—with a 95% confidence level ($Z = 1.96$), 5% margin of error ($d = 0.05$), estimated proportion $p = 0.5$, and a total population size of 121 undergraduate students, a minimum sample size of approximately 92 was required. The formula is derived from Cochran's classic text on sampling methodology [35]. A total of 90 students were ultimately recruited through stratified random sampling. Despite being slightly below the calculated minimum, the sample still meets acceptable thresholds for statistical precision in finite populations. A stratified random sampling method was employed, stratifying by grade (such as the fourth year, fifth year etc.) and gender. Based on the sample size calculation formula, considering a 95% confidence interval, a 5% margin of error, and the total number of undergraduate medical students in the hospital, an appropriate sample size was determined. An appropriate number of students were randomly selected from each stratum. Each selected student received an individual invitation to participate in the study on a voluntary basis, along with the questionnaire link and an informed consent form. These were distributed via the hospital's internal notification system, class groups, and other common communication platforms, such as WeChat group messages and '@everyone' notifications. Participation was entirely optional and students were informed that their decision to participate or not would not affect their academic standing or evaluation in any way. Although recruitment relied on digital platforms, the students were first selected through stratified random sampling based on the complete student roster, which minimized the risk of selection bias due to differing engagement levels.

Data collection

In this study, a self-developed questionnaire was employed as the data collection instrument. Specifically designed for this research and not previously published, the questionnaire is detailed in Supplementary File 1. The content of the questionnaire was designed based on a review of relevant literature and interviews with medical education experts, teachers, and some students. To systematically assess the three target dimensions (perception, attitude, and practice), we employed the following operationalization. Perceptions were operationalized using matrix-style Likert-scale questions (five-point scale from "Very Inconsistent" to "Very Consistent") covering students' clarity about scientific research, perceived access to guidance, and awareness of peer engagement. Attitudes were measured via a similar set of Likert-scale items reflecting desire to pursue further education,

interest in literature, and motivation to participate in research. Practices were assessed through factual binary and multiple-choice questions about actual involvement in research activities, such as participation in projects, literature reading habits, use of data analysis tools, and publication experience. The first part of the questionnaire collected students' basic demographic information, such as gender, age, hometown, pre-internship grades, computer proficiency certificate status, desired education level, and employment orientation. The second part covered students' research participation experiences, literature reading channels and frequencies, data processing skills, and other research-practice-related content. The third part used a series of scale questions to understand students' attitudes towards research, such as their expectations for different research learning methods and satisfaction with research environmental factors. The fourth part included multiple-choice questions with with free-text entry options to collect students' suggestions for cultivating research abilities. Before the formal distribution of the questionnaire, a pilot test was conducted with 30 undergraduate medical students who shared similar backgrounds with the target population. Feedback from the pilot was used to revise the questionnaire, refining question wording and layout to ensure validity and reliability. Internal consistency reliability was assessed using Cronbach's alpha [36–37] for Likert-type items. The Cronbach's alpha values for the perception, attitude, and practice scales were 0.84, 0.81, and 0.79 respectively, indicating good internal consistency.

To achieve optimal compliance and the highest response rate, we implemented the following measures: (1) comprehensive pre-survey communication emphasizing how participation would contribute to improving research training for both current students and future cohorts; (2) a carefully designed anonymous questionnaire that could be completed in < 15 min; (3) multiple gentle reminder messages from research assistants over a 7-day period; and (4) the use of structured multiple-choice questions that were easier to complete than open-ended formats. Participation was completely voluntary and not tied to any academic evaluation.

Data analysis

SPSS 26.0 software was used to analyze the collected data. For categorical variables such as gender and hometown, descriptive statistics in the form of frequencies and percentages were applied. For continuous variables like age and pre-internship grades, the mean and standard deviation were used to present the central tendency and dispersion degree. For Likert-scale items, responses were treated as ordinal data, and descriptive statistics (e.g., frequency distributions, median, and mode) were used to summarize participants' responses. For all free-text entries across the questionnaire, we conducted a focused thematic analysis that manually aligned all entries with the predefined options through independent dual-reviewer coding with consensus resolution, confirming their fit within the existing framework and reinforcing the validity of the closed-ended categories. Through correlation analysis (such as Pearson correlation analysis), the relationships between different factors, such as students' interest in research, willingness to participate, and need for research skills, were explored. The descriptive statistical results were used to analyze the overall situation of students' research cognition, attitudes, and practices, and the correlation analysis was used to uncover the potential relationships among various factors, providing data support for the research conclusions and recommendations.

Results

Response rate

Out of 90 questionnaires distributed, 90 students respond and returned completed questionnaires giving the response rate of 100% (43 fourth-year students, 47 fifth-year students).

Demographics and characteristics of participants

A total of 90 undergraduate medical students from a tertiary hospital in Guangdong, China, participated in this study. The participants were predominantly male (53.3%) and aged between 20 and 23 years, with the majority being 21 years old (32.2%). The majority of students hailed from urban areas (55.6%) and had a pre-internship grade mostly ranging from 80 – 70 (54.4%). Regarding computer proficiency, 26.7% of students possessed a computer level certificate, and 58.9% desired postgraduate education. The employment direction was diverse, with 44.5% aiming for a pure clinical career, 41.1% for research and clinical combined, and 3.3% for pure research. Detailed demographic characteristics are presented in Table 1.

Expectations for learning scientific research-related content

Figure 1 shows that for medical undergraduates' expectations for learning scientific research-related content, 46.7% of students had a high expectation for scientific research participation, followed by research group learning with 42.2% of students having a high expectation, and the scientific research innovation training program with 33.3% of students having a high expectation. Students have the highest expectation for scientific research participation. The distribution shows that hands-on research experience is highly valued by students. Additionally, group-based learning and innovation-focused training programs are also quite popular among students, while

Table 1 Characteristics of survery students

Characteristics	Summary, *n* (%)
Gender	
Male	48 (53.3)
Female	42 (46.7)
Age	
20	18 (20.0)
21	29 (32.2)
22	26 (28.9)
23	17 (18.9)
Hometown	
Urban	50 (55.6)
Rural	40 (44.4)
Pre-Internship Grade	
100 – 90	7 (7.8)
90 – 80	18 (20.0)
80 – 70	49 (54.4)
70 – 60	16 (17.8)
Computer Level Certificate	
True	24 (26.7)
False	66 (73.3)
Class Leader	
Desired Education	
Undergraduate	29 (32.2)
Postgraduate	53 (58.9)
Doctorate	8 (8.9)
Employment Direction	
Pure Research	3 (3.3)
Pure Clinical	40 (44.5)
Research and Clinical	37 (41.1)
Non - Medical	10 (11.1)

entrepreneurship training program and some other aspects like paper writing skills and literature search skills have relatively lower expectations.

Awareness of scientific research

As depecited in Fig. 2, among the medical undergraduates, 51 students did not participate in research because they had no access to opportunities, 31 did not participate due to academic pressure, and 31 did not participate because they had no available time. Only 7 students actively participated in research by directly contacting a supervisor, and 6 were recommended by senior students. In total, 68 students did not participate in research, while 15 participated in university innovation and entrepreneurship programs, 9 in basic medical practice courses, 9 in research project design, and 7 in academic clubs.

Regarding literature reading channels, 44 students read literature via CNKI, 37 via public WeChat accounts, 30 had not read any literature, 17 via Wanfang Medical Network, and 14 via PubMed. In terms of monthly literature reading volume, 71 students read 0 articles per month, 18 read more than 5 articles per month, and only 1 read more than 10 articles per month. For data processing skills, 45 students were not proficient in any tool, 24 were proficient in Python for data processing, 12 were proficient in more than two tools, and 8 were proficient in R for data processing.

The main reasons for students not participating in research are lack of opportunities, academic pressure, and lack of time. The most commonly used literature reading channel is CNKI. The data also shows that students' literature reading volume is generally low, and most students lack proficiency in data processing tools.

Self-evaluation of scientific research abilities

As shown in Fig. 3, for the self-evaluation of scientific research abilities of undergraduate medical students, the evaluation levels range from A (Very Inconsistent) to E (Very Consistent), and there are ten different abilities (I - X). Among these, for the ability to identify research-worthy questions (Ability I), the proportion of students with evaluation levels of D and E is relatively high, indicating that a considerable number of students believe they are consistent or very consistent in this aspect. Similarly, for the ability to retrieve comprehensive and valuable literature (Ability II), many students also gave relatively high self-evaluations.

However, in terms of the ability to draw innovative conclusions in line with social reality (Ability VIII), the proportion of students with lower evaluation levels (A and B) is relatively large, suggesting that students have lower self-confidence in this regard. Also, for the ability to write relevant information into a thesis (Ability VII), the self-evaluation is not as high as some other Abilities, with a significant number of students rating themselves as average or lower.

Satisfaction with research-related environmental factors

Figure 4 shows the satisfaction levels of medical undergraduates with different environmental factors affecting their research engagement. For the willingness to share difficulties, 46 students (51%) were neutral, 18 (20%) satisfied, 7 (7%) very satisfied, 8 (8%) dissatisfied, and 11 (12%) very dissatisfied. Regarding interest in literature, 44 students (48%) were neutral, 9 (10%) satisfied, 5 (5%) very satisfied, 17 (18%) dissatisfied, and 15 (16%) very dissatisfied. As for peer enthusiasm, 37 students (41%) were neutral, 9 (10%) satisfied, 19 (21%) dissatisfied, and 23 (25%) very dissatisfied. In terms of research guidance, 32 students (35%) were neutral, 10 (11%) satisfied, 4 (4%) very satisfied, 29 (32%) dissatisfied, and 15 (16%) very dissatisfied.

The majority of students were neutral or dissatisfied with their willingness to share difficulties, interest in literature, and peer enthusiasm. Although the dissatisfaction rate with research guidance was high (32% dissatisfied, 16% very dissatisfied), it was relatively better

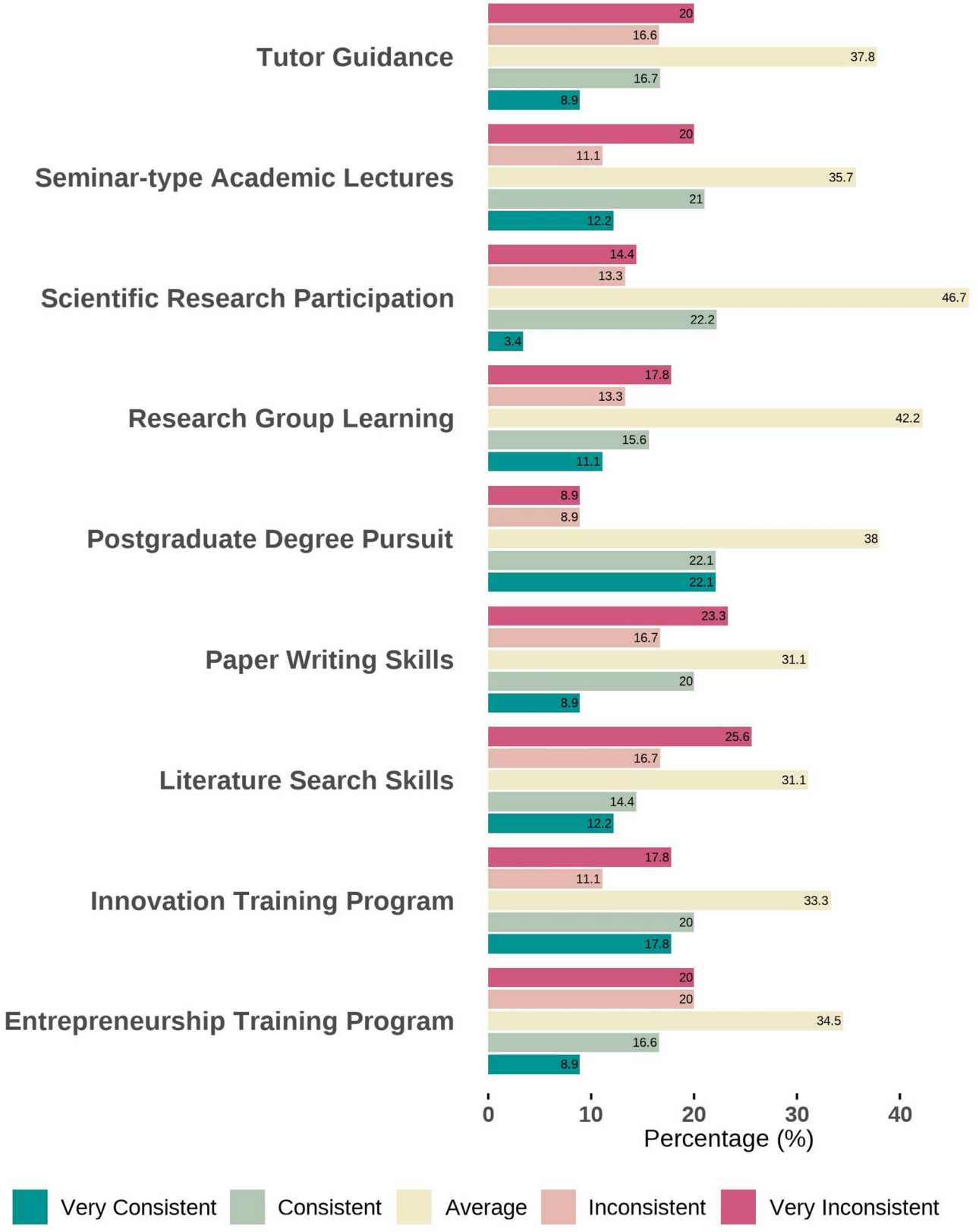

Fig. 1 Expectations for Learning Scientific Research-related Content. The figure illustrates students' expectations across various research-related learning areas, categorized into five levels: Very Consistent, Consistent, Average, Inconsistent, and Very Inconsistent. Percentages for each category are displayed for topics such as Tutor Guidance, Seminar-type Academic Lectures, and Scientific Research Participation

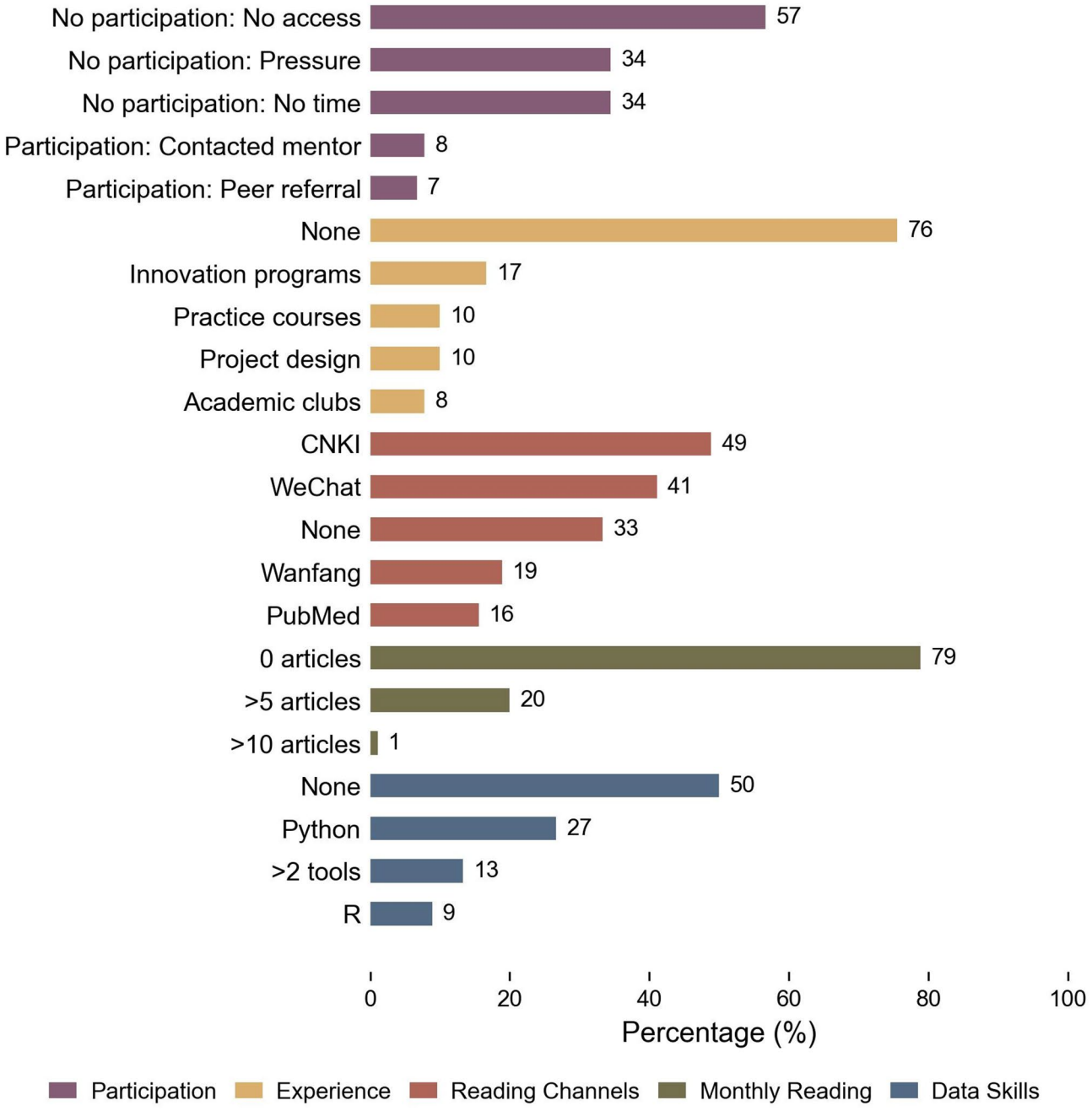

Fig. 2 Awareness of scientific research. This figure illustrates medical students' awareness of scientific research across four key areas: research participation status and limiting factors, research experience, literature reading habits, and data processing skills. Categories are color-coded for clarity, showing the number of students involved in research, their preferred literature sources, and their proficiency in data analysis tools. CNKI, China National Knowledge Infrastructure Database

than the other factors, with 10 students satisfied. The low satisfaction with sharing difficulties and interest in literature may be due to a poor academic communication atmosphere and limited literature reading guidance. The low satisfaction with peer enthusiasm and research guidance could result from insufficient peer interaction in research-related activities and a lack of high-quality research guidance resources.

Suggestions on cultivating basic scientific research abilities

The radar chart (Fig. 5) illustrates medical undergraduates' suggestions for cultivating basic scientific research abilities. The most-favored suggestion, at 76.67%, is providing opportunities to study in research groups, highlighting students' eagerness for immersive, collaborative research learning. Organizing innovation and entrepreneurship activities garners 54.44% support, indicating

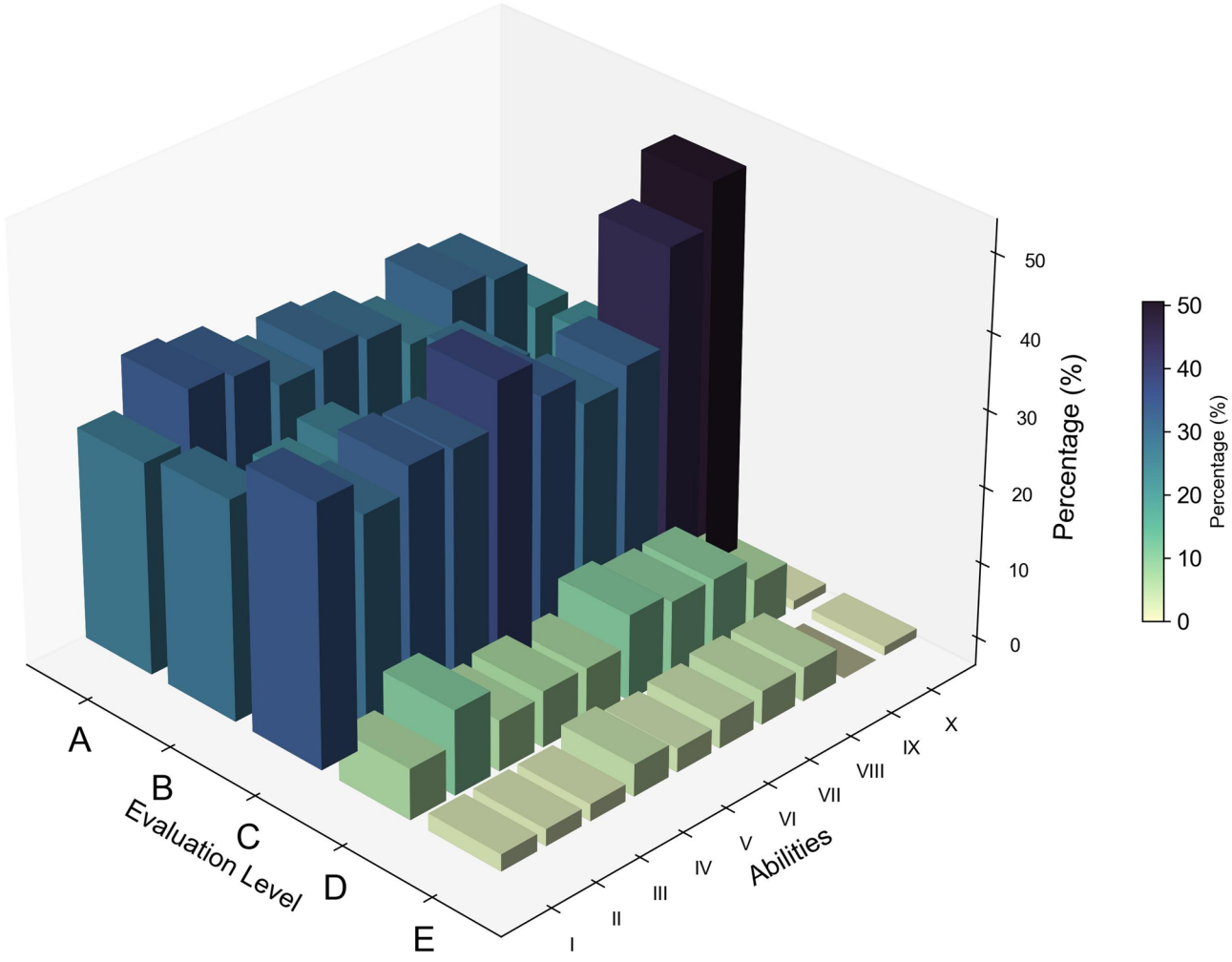

Fig. 3 Self-evaluation of scientific research abilities. This 3D bar chart displays the self-assessment of ten scientific research abilities (I-X) across five evaluation levels: **A** (Very Inconsistent), **B** (Inconsistent), **C** (Average), **D** (Consistent), and **E** (Very Consistent). Abilities include identifying research-worthy questions (I), retrieving literature (II), proposing hypotheses (III), selecting methods (IV), completing tasks (V), collecting data (VI), writing theses (VII), drawing conclusions (VIII), processing data (IX), and understanding content (X). The chart shows the number of students at each level for each ability

students' recognition of such activities in fostering innovative and practical skills relevant to research. With 73.33% of the vote, the call to lower the threshold for accessing supervisors suggests students face barriers in obtaining mentor guidance and view it as crucial for their research development.

Holding more academic lectures or activities, supported by 57.78% of students, shows their aspiration for increased exposure to academic frontier and exchange platforms to expand their knowledge and research acumen. Meanwhile, 56.67% of students advocate studying basic medical practice courses, emphasizing their belief in the importance of a solid practical foundation in medical research. Overall, the relatively even distribution of support percentages (ranging from 54.44 to 76.67%) across these suggestions reveals that students perceive the development of basic scientific research abilities as a multi-faceted process, with no single approach being overwhelmingly dominant.

Correlation analysis

The analysis of the heatmap presented in Fig. 6 reveals significant correlations among various factors associated with research engagement among undergraduate medical students. A robust positive correlation exists between the eagerness to participate in research and the propensity to share academic challenges, with a correlation coefficient of 0.63. This suggests that students who exhibit a stronger desire to engage in research activities are also more inclined to share the difficulties they encounter in their academic pursuits. Additionally, a strong positive correlation is observed between the recognition of the need for specific research skills and the capability to manage research data effectively, indicated by a correlation coefficient of 0.66. This implies that students who are aware of

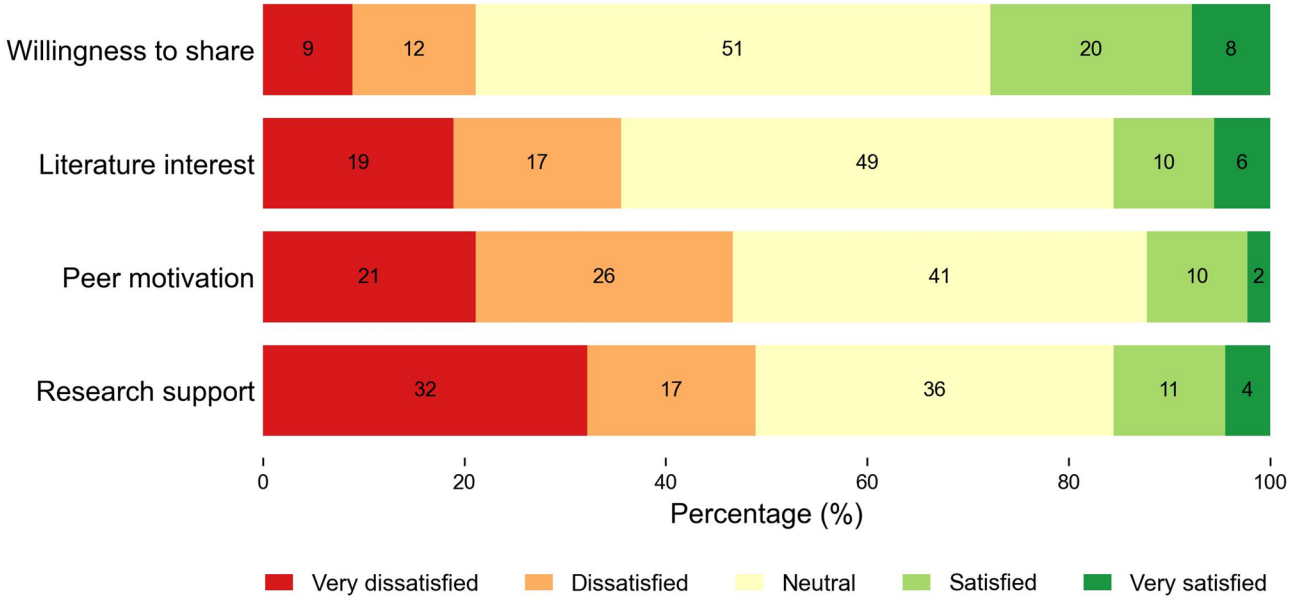

Fig. 4 Satisfaction levels with environmental factors. This bar chart illustrates the satisfaction levels of medical undergraduates with four key environmental factors influencing their research engagement: willingness to share difficulties, interest in literature, peer enthusiasm, and research guidance. Satisfaction is categorized into five levels: Very dissatisfied, Dissatisfied, Neutral, Satisfied, and Very satisfied. The chart shows the count of students for each satisfaction level across the four factors

the necessity for specialized research skills tend to possess superior abilities in handling research data.

Furthermore, the heatmap demonstrates a strong positive correlation between the desire to participate in research and the need for specific research skills ($r = 0.46$), as well as between awareness of research and interest in scientific literature ($r = 0.58$). These correlations underscore the relationship between a student's interest and awareness in research and their likelihood to engage in research activities and strive to enhance their skills. The moderate positive correlation between the willingness to share academic difficulties and the ability to handle research data ($r = 0.38$) further suggests that students who are more open to sharing their academic challenges may also be more motivated to improve their research data management skills.

Discussion

This study investigated the perception, attitude, and practice toward research among undergraduate medical students in a tertiary hospital in Guangdong, China. The results indicated that there are observed deficiencies in research training among undergraduate medical students, particularly those in general practice-oriented programs. These findings are relevant to the broader context of medical education in China, including rural healthcare training, as they highlight common challenges faced by students regardless of their specific training tracks. Students' self-assessed research competencies are critically low, with only 9.5% feeling confident in their data-handling ability. Their motivations for research are predominantly utilitarian, as shown by the fact that 46.6% expressed a strong desire to pursue postgraduate studies, yet only 25.5% showed a strong interest in research. Key barriers identified include lack of time (65.5%), insufficient research guidance (56.6%), and limited access to resources (47.8%). Positive correlations were found between access to research guidance and interest in scientific literature ($r = 0.62$, $p < 0.001$), suggesting that students with greater access to guidance tend to report higher interest in literature.

Similar to many previous studies, this research found that lack of time and insufficient research guidance are major barriers to undergraduate medical students' research participation. For example, studies in various regions such as Jordan [11], Saudi Arabia [8], and India [38] also reported these factors as significant obstacles. However, this study uniquely focused on undergraduate medical students in a tertiary hospital in China, providing insights into the specific situation in this context, which has not been well-explored in previous research.

Given these global findings, it is particularly important to examine the prevalence of these barriers within the local context of China's medical education system. While the barrier of "lack of time" is a common issue faced by undergraduate medical students globally, its prevalence in our study (65.5%) warrants a deeper examination in the context of the local medical education structure in China. Specifically, the undergraduate medical curriculum in China is characterized by a heavy emphasis

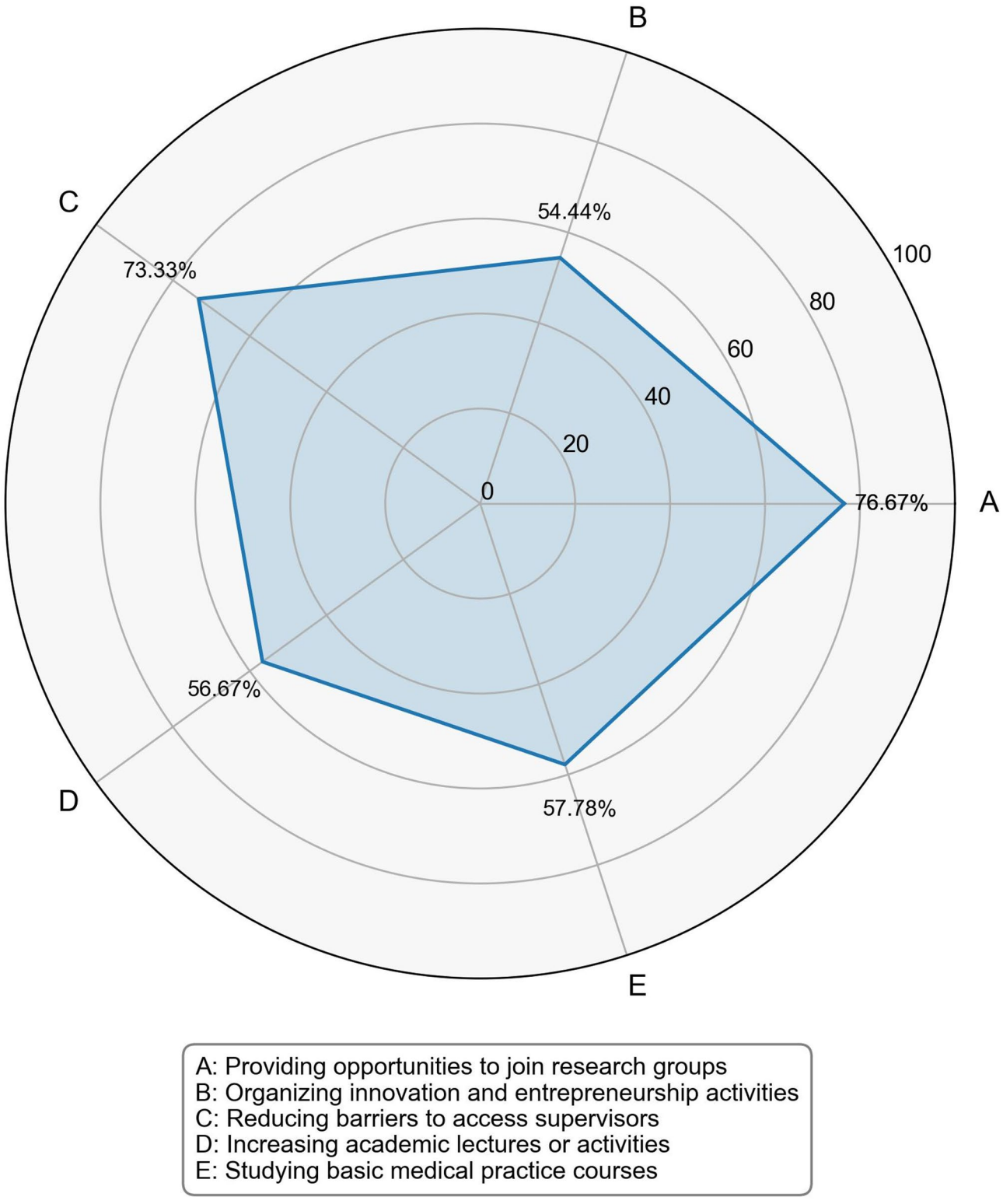

Fig. 5 Suggestions for Cultivating Scientific Research Abilities. This radar chart outlines the key suggestions from medical undergraduates aimed at enhancing their basic scientific research skills. The recommendations include: (**A**) providing opportunities to join research groups (76.67%), (**B**) organizing innovation and entrepreneurship activities (54.44%), (**C**) reducing barriers to access supervisors (73.33%), (**D**) increasing academic lectures or activities (56.67%), and (**E**) studying basic medical practice courses (57.78%). Each axis represents a suggestion, with the length indicating the percentage of students in support

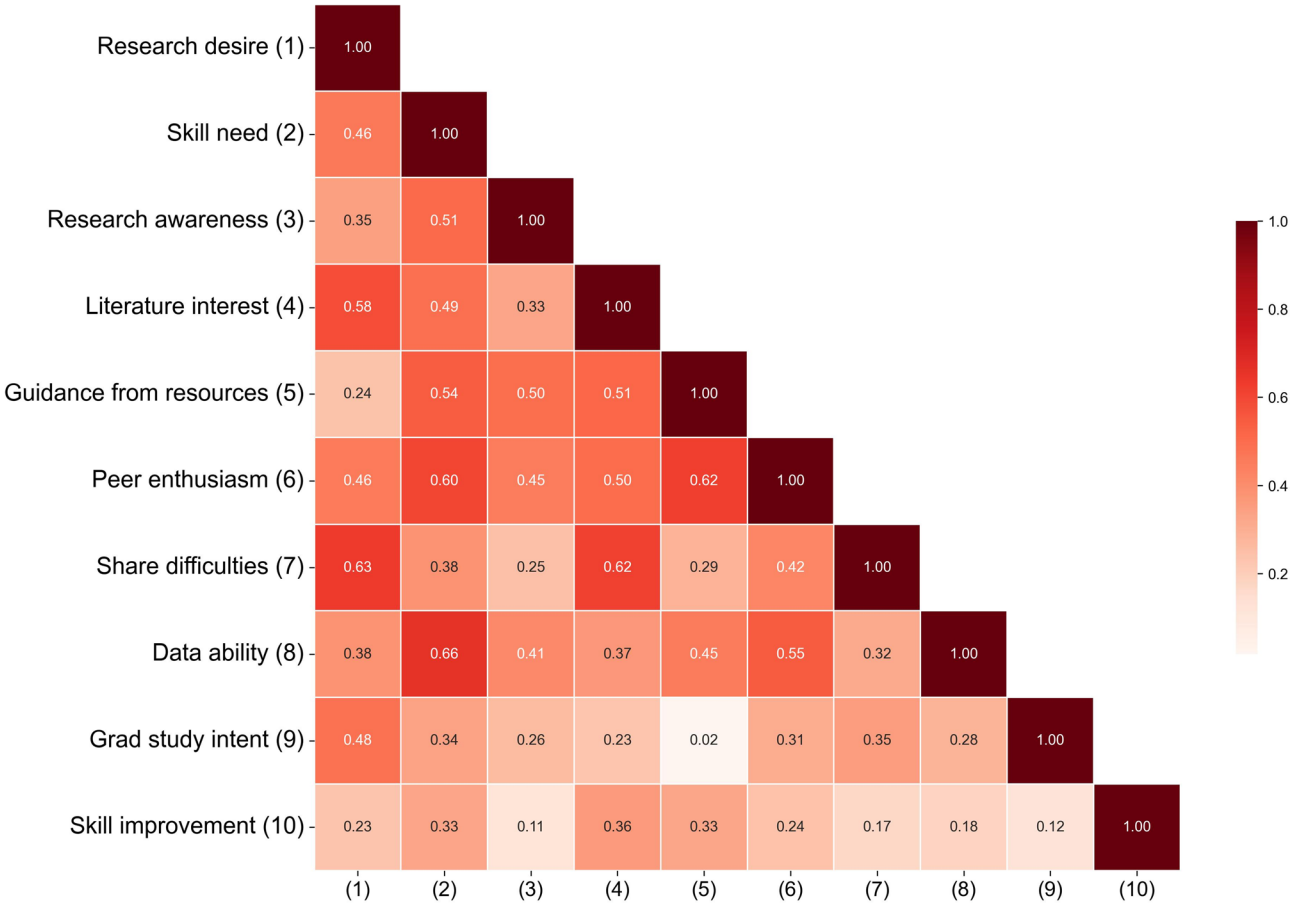

Fig. 6 Pearson Correlation Analysis of Factors Influencing Students' Research Attitudes and Abilities. This heatmap visualizes the correlation coefficients derived from Pearson correlation analysis among various factors influencing medical students' research-related attitudes and abilities. Factors assessed include desire to participate in research, need for specific research skills, awareness of research, interest in scientific literature, research guidance, enthusiasm for research among peers, willingness to share academic difficulties, ability to handle research data, desire to pursue graduate studies, and desire to improve research skills. Correlation coefficients are represented by color intensity, with darker red indicating stronger positive correlations

on clinical rotations and academic examinations, which may significantly limit the time available for research activities. For example, students often spend a substantial portion of their academic year engaged in clinical clerkships, where they are required to rotate through various departments to gain practical experience [39–40]. This demanding schedule leaves little room for additional activities, such as research participation. Moreover, the high-stakes nature of the postgraduate entrance examination in China further exacerbates the time constraints faced by students [41–42]. The preparation for this exam often requires intensive study of core medical subjects, leaving students with limited time to engage in research. This systemic focus on clinical rotations and exam preparation creates a challenging environment for students who wish to pursue research, as they must balance these competing demands.

To address this issue, we suggest incorporating more flexible and integrated research training programs into the undergraduate medical curriculum. For example, some medical schools have successfully implemented longitudinal research programs that allow students to engage in research activities throughout their undergraduate studies, rather than requiring them to complete research in a single, dedicated block of time [9]. Additionally, reducing the emphasis on high-stakes exams and incorporating research experience as a criterion for postgraduate admission could incentivize more students to engage in research activities, thereby fostering a more research-oriented mindset among future clinicians [43].

In terms of students' attitudes and perceptions, some studies have shown that students generally have a positive attitude toward research but a gap exists between attitude and actual participation [8, 38]. Our study further elaborated on the complex relationship between different factors related to research engagement among undergraduate medical students, such as the positive correlations between eagerness to participate in research and other factors. This in-depth exploration of relationships

comprehensively helps understand students' research-related behaviors.

Compared with previous studies, this research has made progress in identifying the specific challenges faced by undergraduate medical students in tertiary hospitals in China. It fills a gap in the existing literature by focusing on this particular group, which is important for tailoring effective interventions to improve their research training and engagement. In the context of China's medical reform, which aims to enhance the overall quality of medical services and promote the development of primary healthcare, understanding the research situation of undergraduate medical students is of great practical significance. These findings hold particular relevance for China's ongoing healthcare reforms, most notably the Healthy China 2030 initiative [32–33] and the complementary Doctor of Excellence Education Training Program 2.0 [34], both of which explicitly identify research training as fundamental to developing clinician-scientists capable of advancing evidence-based practice. By improving students' research abilities, we may cultivate more high-quality medical talents who are capable of using evidence-based medicine to provide better medical services, thus contributing to the success of the medical reform.

Given the importance of research training in advancing medical education and healthcare reform, it is concerning to observe that 46.6% of undergraduate medical students expressed a strong desire to pursue postgraduate studies, while only 25.5% showed a strong interest in research. This discrepancy highlights a critical tension within the current medical education system. This tension may be partly attributed to the systemic emphasis on postgraduate entrance exams over research training. In China's postgraduate admission system, the national unified written examination heavily emphasizes subject-specific knowledge assessment, while research experience and interdisciplinary skills are typically evaluated only during the secondary re-examination stage [41–42]. As a result, many students may feel compelled to focus on exam preparation rather than engaging in research activities, which are not directly assessed in the entrance exams.

This systemic issue is further compounded by the limited availability of research opportunities and guidance at the undergraduate level. Previous studies have shown that the lack of research infrastructure and mentorship in medical schools can significantly hinder students' interest and participation in research [11, 21, 24]. For example, a study conducted in Saudi Arabia found that the absence of research courses and dedicated mentors was a major barrier to medical students' engagement in research [8]. Similarly, in China, the rapid expansion of medical education programs has led to a disproportionate increase in the number of students compared to research resources, resulting in a high student-to-resource ratio that further exacerbates this problem [29]. Similar findings have also been reported in Thailand. A recent study in Thai medical schools revealed that both students and their research advisors identified the lack of knowledge about research topics and protocol writing as major barriers. The study emphasized the importance of research teaching in the curriculum, advisor engagement, and special research projects or conferences in facilitating student research success [44]. These insights further underscore the critical need for integrated research training and structured mentorship within undergraduate medical education in Asia.

To address this critical tension, we propose several targeted interventions. First, incorporating research training into the undergraduate curriculum, with a focus on developing research skills and fostering a research-oriented mindset, could help bridge the gap between students's desire for postgraduate studies and their interest in research. Second, reducing the emphasis on entrance exams and incorporating research experience as a criterion for postgraduate admission could incentivize more students to engage in research activities. Finally, enhancing mentorship programs and providing more research opportunities through collaborations between hospitals and universities could create a more supportive environment for students to develop their research interests [45–46]. Finally, given that CNKI is the predominant literature access platform among undergraduate medical students in our study (44 out of 90 students), this highlights a potential regional disparity in research resources. While CNKI is a valuable resource for Chinese-language literature, its coverage of international journals is limited. To address this gap, we propose incorporating training on how to effectively search and utilize international databases into the undergraduate curriculum. This would enable students to expand their literature search beyond CNKI and gain access to a broader range of international research findings. By equipping students with the skills to navigate global databases such as PubMed, Web of Science, we can better prepare them to engage with the broader scientific community and stay abreast of global research trends.

While this study provides valuable insights into research engagement challenges among undergraduate medical students, certain limitations should be acknowledged. The sample size of 90 participants, though adequate for preliminary analysis, may not fully capture the diversity of experiences across China's medical education landscape. Additionally, as the study was conducted at a single tertiary hospital in Guangdong province, the findings may reflect contextual factors specific to this institution's research infrastructure and training environment.

These characteristics - while representative of leading teaching hospitals in southern China - suggest that further validation would be beneficial when considering applications to other regions or institution types with differing resource allocations and curricular approaches.

While this study provides valuable insights into research engagement challenges among undergraduate medical students, certain limitations should be acknowledged. The sample size of 90 participants, though adequate for preliminary analysis, may not fully capture the diversity of experiences across China's medical education landscape. This relatively small sample size limits the representativeness of our findings and consequently affects their generalizability, a concern consistent with previous research demonstrating how limited samples can reduce external validity [8]. The sample constraints also prevented meaningful subgroup analyses between pre-clinical and clinical phase students, which could have yielded important insights into how educational stage influences research engagement. Additionally, as the study was conducted at a single tertiary hospital in Guangdong province, the findings may reflect contextual factors specific to this institution's research infrastructure and training environment. These characteristics - while representative of typical teaching hospitals in southern China - suggest that further validation would be beneficial when considering applications to other regions or institution types with differing resource allocations and curricular approaches. The study also relied on self-reported data, which may be subject to bias, as commonly observed in self-reported skill evaluations [47]. Students' self-evaluations of their research abilities and attitudes may be influenced by factors such as social desirability or inaccurate self-perception. Similar concerns about self-reported data have been raised in other studies [21, 48]. Future studies would benefit from triangulating self-evaluations with objective assessments of research skills and external evaluations. In addition, the study was conducted in a single tertiary hospital in Guangdong, China. The results may not be applicable to undergraduate medical students in other regions or hospitals with different characteristics, such as different levels of research resources and academic environments. Further multicenter studies involving diverse institutional settings across China would be valuable to validate and extend these findings.

To address the issue of a small sample size, future studies could expand the sample to include more undergraduate medical students from different regions and hospitals in China. This would enhance the representativeness of the sample, improve the generalizability of the findings, and enable the use of multivariate regression analyses to control for potential confounders (e.g., grade level, prior research experience). To reduce the potential bias in self-reported data, researchers could consider using multiple data collection methods, such as objective tests to assess students' research perception and skills in addition to self-reported questionnaires. This approach has been recommended in previous research to obtain more reliable data [48]. For the limitation of a single-hospital study, multi-center studies could be conducted in the future. By including students from different hospitals, the results would better reflect the overall situation of undergraduate medical students in China, and it would be possible to explore how different hospital environments affect students' research-related perceptions, attitudes, and practices.

Based on the current study, future research could explore how to effectively implement standardized research curricula in medical education. For example, it could investigate the optimal content and teaching methods of research courses to improve students' research competencies. As suggested by previous research, research methodology courses early in the curriculum can increase students' interest in research [43]. Another research direction could be to study the impact of hospital-university "medical-education-research" platforms on students' research development. Future studies could evaluate the effectiveness of these platforms in providing research opportunities, resources, and guidance to students, and how to optimize their operation. Furthermore, research could focus on developing more effective mentorship systems that are competency-aligned. It is necessary to explore how to match mentors with students more appropriately, and what kind of support and training mentors need to provide to enhance students' research abilities. This is in line with the view in previous research that competent research supervisors are critical in motivating students to become research-oriented [49].

Conclusion

This study highlights several areas for improvement in the research training of undergraduate medical students, particularly in general practice-oriented programs. While students demonstrate a strong desire for postgraduate education, their self-assessed research competencies are generally low. Additionally, institutional gaps such as inadequate mentorship and limited research opportunities remain significant challenges. Based on the findings, we suggest that prioritized structural interventions, including implementing standardized research curricula, developing hospital-university "medical-education-research" platforms, and establishing competency-aligned mentorship systems—may help mitigate these challenges. These measures could play a role in fostering general practitioners with competencies in both clinical care and research, which may align with and contribute to the goals of China's ongoing primary healthcare reform efforts. However, the relatively small

sample size and single-institution design limit the generalizability of these findings. Future multicenter studies are needed to validate and extend these results.

Abbreviations

CNKI	China national knowledge infrastructure
GM	General medicine
TPB	Theory of planned behavior

Supplementary Information

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Supplementary Material 1

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Author contributions
Y. Hou, L. Hu, S. Qiu, Z. Yan, X. Ke, and Y. Huang contributed to the conception or design of the research. Y. Hou, L. Hu, S. Qiu, Z. Yan, M. Zhou, F. Zheng, and Z. Li contributed to the acquisition, analysis, or interpretation of data. Y. Hou, L. Hu, S. Qiu, Z. Yan, X. Ke, and Y. Huang drafted the manuscript. X. Ke and Y. Huang critically revised the manuscript. All authors reviewed the manuscript.

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Data availability
All data sets are available and can be shared by requesting it from the corresponding author by email.

Declarations

Ethics approval and consent to participate
This study adhered to the principles of the Declaration of Helsinki and fully complied with national relevant ethical regulations and standards for medical research involving human subjects. All procedures involving human participants were reviewed and approved by the Ethics Committee of Maoming People's Hospital, which operates in accordance with the requirements of national laws and regulations. Informed consent was obtained verbally from the student participants after they were fully informed about the study's objectives, methods, potential risks, and benefits. Throughout the research process, strict confidentiality of participants' personal information was maintained, and all data were used solely for the purpose of this study to contribute to the development of medical education and healthcare improvement in line with the well-being of the public.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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