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Analysis of academic stress factors in basic medical science courses among medical students: suggestions for curriculum improvement

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Purpose: This study aimed to identify the academic stress experienced by medical students in basic medical science courses and analyze its underlying factors.
Methods: A survey was conducted among 228 students from a medical school in Seoul, South Korea, of whom 204 who had completed at least one basic science course were included in the final analysis. A modified stress scale for medical students and a newly developed subject-specific academic stress scale, validated through literature review, student feedback, and expert review, were employed. Data were analyzed using IBM SPSS ver. 25.0 with descriptive statistics, t-tests, chi-square tests, and one-way analysis of variance.
Results: The overall academic stress among students was relatively high. The highest stress levels were observed in cell biology (mean=7.15), followed by bioinformatics (mean=5.97), molecular biology (mean=5.47), and organic chemistry (mean=5.20). Key stress factors included a lack of connectivity with clinical subjects, excessive learning volume, and inappropriate difficulty levels.
Conclusion: Academic stress varied significantly across courses, underscoring the need for curriculum improvements in basic medical science education. Faculty should consider adjusting course difficulty, enhancing clinical integration, motivating students, and managing workloads to reduce stress and support learning outcomes.

Key Words: Academic performance; Medical education; Medical students; Pre-medical students; Stress

Introduction

Medical students who successfully navigate intense entrance competitions often face significantly higher stress than students in other academic fields. This heightened stress comes from excessive workload, fear of failure, extended academic periods, high tuition fees, and lack of leisure time. Consequently, medical students experience higher depression and anxiety than the general population [1,2] and greater exam-related stress than non-medical students [3]. Research aimed at developing stress scales for medical students has identified that academic stress accounts for 11.24% of the total stress experienced by medical students [4].

Many medical students struggle when their academic achievements fall below expectations. This discrepancy frequently leads to elevated depression and anxiety [5].Sixty percent of university students are considered high-risk for depression and anxiety, with academic concerns being the most significant source of stress [6].

Chronic stress can deplete individuals' resources, leading to academic burnout [7]. In South Korea, a 2007 national survey on the mental health of medical students reported that 22.8% of students had experienced suicidal ideation, with 8.7% having experienced such thoughts within the past year. Alarmingly, academic underperformance was identified as the primary motivation for suicide attempts in 26.3% of the cases.

Despite these alarming figures, medical students in South Korea are often perceived as high-achieving individuals compared to their peers in other fields, leading to an underestimation of their psychological struggles [8]. The intense stress experienced during medical school does not end upon graduation; rather, it continues to affect physicians, potentially impairing doctor–patient relationships and the overall quality of care [9]. Therefore, it is crucial to appropriately manage academic stress to ensure physicians' well-being.

The primary causes of academic stress can be broadly categorized as academic performance, academic achievement, parental expectations, faculty expectations, and self-imposed expectations [10-14]. Although research on academic stress is extensive, studies on medical students often focus on the correlations between stress and demographic factors, such as sex, academic year, socioeconomic status, and differences between medical schools and graduate medical programs [5,15]. Academic problems are more frequently attributed to affective factors such as motivation and attitude than to cognitive factors such as memory or intelligence [2,16]. However, these studies fail to account for the demanding academic realities faced by medical students.

Understanding the levels and causes of academic stress in each basic science course within the pre-medical curriculum could inform strategies to reduce student stress and provide valuable insights into curriculum reforms. Such research is essential for academic support programs, improvement of teaching methods, and overall enhancement of the quality of medical education. This study analyzed academic stress in basic science courses to identify contributing factors to and support curriculum improvements.

Methods

1. Participants

This study was conducted from May 1–July 31, 2019 and targeted medical students enrolled in Seoul. The survey initially included 414 students in the first and second years of the pre-medical program and the first and second years of the medical program. Of these, 228 students participated in the survey, and 204 students who completed at least one basic science course were selected for the final analysis.

Third-year medical students were excluded because of their involvement in clinical rotations, which made their participation in the survey difficult. Similarly, fourth-year medical students were excluded because they had been admitted through the graduate-entry medical school system before Korea reverted to the six-year medical college system and therefore had not completed the pre-medical basic science curriculum. Participants had completed at least one basic science course within the pre-medical curriculum. Specific courses varied according to the academic year: (1) First-year pre-medical students completed medical chemistry and life sciences. (2) Second-year pre-medical students completed a questionnaire on medical physics, medical chemistry, organic chemistry, life sciences, cell biology, and bioinformatics. (3) First- and second-year medical students completed medical physics, medical chemistry, organic chemistry, life sciences, cell biology, molecular biology, genetics, and bioinformatics.

The survey on overall stress was analyzed based on responses from 228 students (55.1% of the eligible students). Data from 204 students (49.3%) were used to analyze academic stress specific to basic science courses, excluding 24 students who had not completed any basic science courses.

2. Research instruments

This study used data from an academic stress survey conducted by a medical school in South Korea that targeted students who had completed basic science courses. Survey data were used as secondary data and subjected to both statistical and qualitative analyses to ensure their suitability as research instruments.

1) General academic stress scale for medical students

To measure medical students' overall stress levels, this study employed a modified version of a standardized stress scale originally developed for South Korean medical students by Kim et al. [4] in 2014 and adapted for our current objectives. The scale comprises six domains: academics (nine items), clinical practice (11 items), interpersonal relationships (seven items), career planning (eight items), health (three items), and finance (two items). The content validity of the scale was reviewed by three medical education experts, and the reliability of each domain was confirmed: Cronbach's $\alpha = 0.85$, 0.85, 0.83, 0.83, 0.64, and 0.63, respectively.

For this study, the original scale was partially revised with additional validation conducted through consultations with one medical education expert and one education specialist. To focus specifically on stress related to basic medical science courses, items related to clinical practice were excluded, resulting in a refined scale that included five domains: academics (nine items), interpersonal relationships (seven items), career planning (eight items), health (three items), and finances (two items). Cronbach's $\alpha = 0.87$, 0.69, 0.85, 0.82, and 0.85, respectively, indicating that the overall reliability was acceptable.

The final version employed a 4-point Likert scale: "1 (strongly disagree)" to "4 (strongly agree)." Total scores ranged from 29–116, with higher scores indicating higher stress.

2) Academic stress factors and course satisfaction scale

An academic stress factor scale was developed to measure students' academic stress in basic science courses. The initial survey items were selected through an extensive literature review and were subsequently refined in consultation with the medical school student council. To ensure content validity, the final scale was reviewed by a medical education expert and a general education expert.

The scale includes 12 factors that contribute to academic stress: lack of learning motivation, attendance evaluations, feedback, lack of connection to clinical subjects, excessive workload, insufficient content relevance, inappropriate difficulty level, pressure related to grades and risk of failure, grading methods, challenging textbooks or learning materials, excessive class hours, and teaching methods misaligned with student preferences. Additional items were also included to identify other potential sources of stress.

The scale was designed using a combination of questions to capture a comprehensive range of responses: (1) 84 binary items (1 = yes; 2 = no), (2) 21 items using a 4-point Likert scale (1 = strongly agree to 4 = strongly disagree), (3) 14 items using a 10-point Likert scale (1 = very low to 10 = very high), (4) seven ranking questions, and (5) seven open-ended questions.

Additionally, three demographic questions were included to collect information on sex, academic year, and completion status of basic science courses, resulting in a final questionnaire with 136 items.

To assess academic satisfaction levels, this study focused on eight core basic science courses: medical physics, medical chemistry, organic chemistry, life sciences, cell biology, molecular biology, genetics, and bioinformatics. The course satisfaction was measured using a 10-point Likert scale (1 = very low to 10 = very high). This scale enabled a quantitative assessment of students' overall satisfaction with each course, helping to identify areas for potential improvement in the curriculum. Satisfaction data informed curriculum enhancements to improve education and reduce stress.

3. Data analysis

Data analysis was conducted via IBM SPSS ver. 25.0 (IBM Corp., Armonk, USA). Academic stress scores were calculated by applying reverse coding where necessary, followed by descriptive statistics to identify general trends and distributions of the data.

Frequency analysis was performed to compare academic stress across different basic science courses within the same group. Additionally, to examine differences in academic stress across academic years for the same courses, a one-way analysis of variance (ANOVA) was conducted.

For the qualitative analysis of the open-ended responses, two researchers specializing in education and medical education independently reviewed the data. Through subsequent discussions, the researchers ensured the validity of the analysis by reaching a consensus on the interpretation of the responses. This process allowed the identification of deeper factors contributing to academic stress and provided a qualitative complement to the quantitative results.

4. Ethical considerations

The survey was conducted anonymously to protect participants' privacy, ensuring that no personally identifiable information was collected. This study was exempt from ethical review by the Institutional Review Board (IRB) of Kyung Hee University (No. KH-SIRB-20-494), confirming that the research posed minimal risk to participants.

Results

1. General characteristics

This study included 228 medical students in the first and second years of both pre-medical and medical programs. The distribution by academic year was as follows: 42 first-year pre-medical students, 63 second-year pre-medical students, 89 first-year medical students, and 34 second-year medical students. The overall stress scale (maximum score of 116) showed an average score of 74.53 ± 13.9. By academic year, the mean scores were 65.50 ± 15.2 for first-year pre-medical students, 70.95 ± 11.1 for second-year pre-medical students, 79.60 ± 13.4 for first-year medical students, and 79.03 ± 11.1 for second-year medical students. The ANOVA revealed significant differences between academic years ($F = 14.382$, $p < 0.001$), with first-year medical students reporting the highest stress levels (Table 1).

The subscale analysis indicated significant differences in academic stress (mean = 2.67), interpersonal stress (mean = 2.64), and

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career-planning stress (mean = 2.82) across academic years, whereas health stress (mean = 1.66) and financial stress (mean = 2.25) showed no significant differences.

2. Enrollment of basic medical science courses by academic year

All participants had completed at least one basic medical science course during their pre-medical curriculum. The specific courses varied by academic year. Pre-medical year 1 students completed medical chemistry and life sciences. Pre-medical year 2 students completed medical physics, medical chemistry, organic chemistry, life sciences, cell biology, and bioinformatics. Medical year 1 and year 2 students completed medical physics, medical chemistry, organic chemistry, life sciences, cell biology, molecular biology, genetics, and bioinformatics. Table 2 summarizes the enrollment of basic medical science courses according to academic year.

Table 1. Paper presented at: National Assembly Seminar; May 3, 2018; Seoul, Korea

	Respondents	Mean ± SD	F (p-value)
Academic year			14.382 (0.000)
Pre-medical year 1	42	65.50 ± 15.2	
Pre-medical year 2	63	70.95 ± 11.1	
Medical year 1	89	79.60 ± 13.4	
Medical year 2	34	79.03 ± 11.1	
Total	228	74.53 ± 13.9	

SD: Standard deviation.

3. Academic satisfaction by basic science course

Academic satisfaction was measured across the eight basic science courses using a 10-point Likert scale. Cell biology had the highest satisfaction score (mean = 5.24), followed by life sciences (mean = 5.22), medical chemistry (mean = 5.10), and organic chemistry (mean = 4.99). The lowest satisfaction scores were obtained for bioinformatics (mean = 3.56), medical physics (mean = 4.21), genetics (mean = 4.72), and molecular biology (mean = 4.93).

4. Academic stress factors by basic science course

Academic stress levels were the highest in cell biology (mean = 7.15), followed by bioinformatics (mean = 5.97), molecular biology (mean = 5.47), and organic chemistry (mean = 5.20). These results are summarized in Table 3, which presents the mean stress levels, standard deviations, and number of respondents for each basic medical science course. Table 4 presents these results, showing significant differences by academic year in medical chemistry ($p = 0.002$), life sciences ($p < 0.001$), and bioinformatics ($p = 0.010$), while no significant differences were observed by sex.

The key stress factors varied across courses. In medical physics, students cited a lack of perceived necessity (72.9%) and a poor connection to clinical subjects (67.8%). In medical chemistry, inconsistent difficulty (37.6%) and a lack of perceived necessity (28.2%) were the main stressors. Organic chemistry and molecular biology were associated with high levels of difficulty and excessive

Table 2. Distribution of Basic Medical Science Course Completion by Academic Year

Academic year	Subjects							
	Medical physics	Medical chemistry	Organic chemistry	Life sciences	Cell biology	Molecular biology	Genetics	Bioinformatics
Pre-medical year 1		○		○				
Pre-medical year 2	○	○	○	○	○			○
Medical year 1	○	○	○	○	○	○	○	○
Medical year 2	○	○	○	○	○	○	○	○
Respondents (total students)	118 (160)	85 (199)	84 (162)	75 (199)	122 (162)	49 (98)	36 (98)	114 (158)

Circles (o) indicate the courses completed by students in each academic year. Numbers represent respondents (total students) for each course.

Table 3. Academic Stress Levels by Basic Medical Science Course

Academic year	Subjects							
	Medical physics	Medical chemistry	Organic chemistry	Life sciences	Cell biology	Molecular biology	Genetics	Bioinformatics
Academic stress ± SD	4.66 ± 2.859	4.04 ± 2.401	5.20 ± 2.541	4.10 ± 2.437	7.15 ± 2.408	5.47 ± 2.747	4.73 ± 2.483	5.97 ± 2.908
No. of respondents	160	199	162	199	162	98	98	158

SD: Standard deviation.

Table 4. Differences in Academic Stress Factors by Sex and Academic Year in Each Basic Medical Science Course

Academic year	Subjects							
	Medical physics	Medical chemistry	Organic chemistry	Life sciences	Cell biology	Molecular biology	Genetics	Bioinformatics
Sex	0.064	0.385	0.619	0.390	0.698	0.700	0.072	0.216
Academic year	0.095	0.002	0.443	0.000	0.250	0.839	0.324	0.010
No. of respondents	160	199	162	199	162	98	98	158

"Respondents" indicates the number of students who completed each course. The specific academic years in which each course was offered are as follows: Pre-medical year 1 (medical chemistry, life sciences); Pre-medical year 2 (medical physics, medical chemistry, organic chemistry, life sciences, cell biology, bioinformatics); Medical year 1–2 (all subjects including molecular biology and genetics).

workloads. In cell biology, pressures related to grades and failure (73.0%) and excessive workload (50.8%) were prominent. Genetics showed similar rates of a lack of perceived necessity (27.8%) and excessive workload (27.8%), whereas bioinformatics was marked by a lack of perceived necessity (63.2%) and limited clinical relevance (49.1%). In addition, subgroup analyses by sex and academic year were conducted to examine variations in academic stress factors across courses. Although most of the open-ended responses overlapped with the predefined stress factors presented in the tables, several additional themes emerged. These included errors caused by instructors' mistakes, dissatisfaction with education that was overly theory-based, and concerns about fairness in evaluation such as attendance policies. These points, while less frequently mentioned, indicate that students also perceived stress from issues related to instructional quality and evaluation practices.

5. Ranking of academic stress factors by basic science course

The ranking of academic stress factors for each basic science course was determined based on responses to 13 standardized items, with participants selecting the top four stressors. The results are shown in Table 5.

In medical physics, the most frequently selected primary stressor was "lack of understanding about the necessity of the course," followed by "lack of connection to clinical subjects" as the second-most common stressor. In both medical chemistry and organic chemistry, "high difficulty" and "excessive workload" were consistently ranked as the top two stressors.

In life sciences, "high difficulty" was most commonly ranked first, while "excessive workload" was the second-most cited factor. Cell biology stood out for its increased pressure related to "grades and risk of failure" as the primary stressor, followed by "excessive workload" in second place. In molecular biology, the leading stressor was "excessive workload," with "high difficulty" ranked second.

For genetics, "high difficulty" was the most significant stressor, while "challenging textbooks or learning materials" was the second-most cited. In bioinformatics, students most frequently selected "lack of perceived necessity" as the primary source of stress, followed by "high difficulty"

Discussion

This study analyzed the academic stress experienced by medical students in basic science courses, breaking it down by subject and identifying its underlying causes to explore potential improvements in medical education curricula. Medical students faced higher academic stress than students in other fields, largely because of the unique demands of medical education such as excessive workloads, rigorous evaluation standards, and the pressure of retention policies. These stressors increased the risk of mental health issues and academic burnout [1,17,18].

Despite the foundational role of basic science courses in fostering medical reasoning, these courses often contribute to academic stress because of their heavy reliance on rote memorization and lack of integration with clinical practice. This disconnection negatively affected student motivation and increased academic pressure [19,20].

The key stress-inducing factors identified included excessive workloads, weak connections to clinical applications, passive learning methods, gaps in prior knowledge, psychological pressure from retention policies, and limited opportunities for career exploration. Courses such as medical physics and chemistry significantly lowered student motivation, primarily because of their perceived lack of relevance to clinical practice. Medical students tend to value learning experiences directly linked to future clinical work, suggesting that basic science curricula should be restructured to create more meaningful connections with clinical medicine. It is essential to introduce an integrated curriculum that blends theoretical knowledge with clinical applications. Approaches such as case-based learning (CBL) and problem-based learning (PBL) can help

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Table 5. Primary Academic Stress Factors and Response Rates by Basic Science Course

Course	Respondents (total students)	Response rate (%)	Primary academic stress factor	Rate (%)
Medical physics	118 (160)	73.8	Lack of understanding about the necessity of the course	72.9
			Lack of connection to clinical subjects	67.8
			Inappropriate level of difficulty (too easy or too hard)	34.7
			Challenging textbooks or learning materials	33.9
			Lack of content relevance or appropriateness	16.1
			Teaching methods that do not suit my learning style	14.4
			Excessive workload	11.1
Medical chemistry	85 (199)	42.7	Inappropriate level of difficulty (too easy or too hard)	37.6
			Lack of understanding about the necessity of the course	28.2
			Lack of connection to clinical subjects	25.9
			Challenging textbooks or learning materials	20.0
			Teaching methods that do not suit my learning style	16.5
			Excessive workload	15.3
			Pressure related to grades and risk of failure	12.9
			Excessive class hours	12.9
			Stress related to attendance-based grading	10.6
			Lack of content relevance or appropriateness	10.6
Organic chemistry	84 (162)	51.9	Inappropriate level of difficulty (too easy or too hard)	45.2
			Excessive workload	31.0
			Lack of connection to clinical subjects	28.6
			Challenging textbooks or learning materials	27.4
			Lack of understanding about the necessity of the course	22.6
			Teaching methods that do not suit my learning style	13.1
			Lack of content relevance or appropriateness	11.9
			Pressure related to grades and risk of failure	11.9
Life sciences	75 (199)	37.7	Excessive workload	32.0
			Inappropriate level of difficulty (too easy or too hard)	30.7
			Excessive class hours	30.7
			Stress related to attendance-based grading	21.3
			Pressure related to grades and risk of failure	18.7
			Lack of connection to clinical subjects	17.3
			Lack of understanding about the necessity of the course	16.0
			Teaching methods that do not suit my learning style	16.0
			Challenging textbooks or learning materials	14.7
			Feedback style of the professor	13.3
			Evaluation or grading methods	12.0
			Lack of content relevance or appropriateness	10.7
Cell biology	122 (162)	75.3	Pressure related to grades and risk of failure	73.0
			Excessive workload	50.8
			Inappropriate level of difficulty (too easy or too hard)	27.9
			Challenging textbooks or learning materials	27.9
			Excessive class hours	27.0
			Class schedule that does not suit my routine or preferences	18.9
			Feedback style of the professor	12.3
Molecular biology	49 (98)	50	Excessive workload	42.9
			Inappropriate level of difficulty (too easy or too hard)	32.7
			Pressure related to grades and risk of failure	22.4
			Challenging textbooks or learning materials	20.4

(Continued to the next page)

Table 5. Continued

Course	Respondents (total students)	Response rate (%)	Primary academic stress factor	Rate (%)
			Teaching methods that do not suit my learning style	20.4
			Lack of understanding about the necessity of the course	14.3
			Excessive class hours	12.2
			Feedback style of the professor	10.2
			Lack of connection to clinical subjects	10.2
Genetics	36 (98)	36.7	Lack of understanding about the necessity of the course	27.8
			Excessive workload	27.8
			Lack of connection to clinical subjects	22.2
			Inappropriate level of difficulty (too easy or too hard)	19.4
			Challenging textbooks or learning materials	16.7
			Stress related to attendance-based grading	11.1
			Pressure related to grades and risk of failure	11.1
Bioinformatics	114 (158)	72.2	Lack of understanding about the necessity of the course	63.2
			Lack of connection to clinical subjects	49.1
			Inappropriate level of difficulty (too easy or too hard)	42.1
			Challenging textbooks or learning materials	41.2
			Lack of content relevance or appropriateness	31.6
			Evaluation or grading methods	30.7
			Teaching methods that do not suit my learning style	29.8
			Excessive workload	28.9
			Feedback style of the professor	13.2
			Excessive class hours	10.5

This table presents the response rates for all 13 academic stress factors. Multiple responses were allowed per participant.

students understand how basic scientific knowledge translates into real-world clinical scenarios, ultimately enhancing their learning motivation, critical thinking, and problem-solving skills.

Interestingly, cell biology showed both the highest satisfaction and the highest academic stress, suggesting that even when students perceived a course as meaningful and engaging, heavy workloads and grading pressure could still generate high stress levels. In contrast, bioinformatics demonstrated the lowest satisfaction but the second-highest stress level, indicating that when students fail to recognize the relevance or necessity of a course, stress may arise from a perceived lack of value combined with the difficulty of the subject matter. These findings highlight that academic satisfaction and stress do not always move in parallel and may reflect different underlying mechanisms. Excessive workloads were identified as a major contributor to academic stress, especially in the fields of organic chemistry, cell biology, and molecular biology. Students reported feeling overwhelmed by the volume of the material, leading to surface-level memorization aimed at short-term exam preparation. Heavy workloads reduce learning efficiency and encourage inefficient study habits focused on exam banks or past test questions [21]. To mitigate these issues, educators should differentiate between essential and supplementary content, allowing students to focus on core concepts, while using additional resources for deeper learning. Moreover, the adoption of diverse assessment methods that evaluate critical thinking and problem-solving skills rather than simple memorization could further alleviate academic pressure.

Moreover, discrepancies in students' backgrounds significantly affected their academic stress. Differences in high school science coursework result in varying levels of preparedness among medical students, contributing to stress, particularly in basic science subjects. This issue has been exacerbated since the implementation of the 2015 National Curriculum Reform in South Korea, which integrated humanities and science streams, leading to an increase in students entering medical schools without advanced science coursework. To address these disparities, medical schools should assess students' foundational knowledge upon admission and offer supplemental courses or online resources. Simultaneously, students with stronger backgrounds could be provided with opportunities for advanced studies. Implementing personalized learning pathways can help reduce stress and promote academic success in diverse student populations.

The medical school retention system is a key source of psychological pressure that intensifies academic stress. The fear of failing

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and repeating courses was a particularly strong stressor in subjects such as cell biology and molecular biology. Such pressure can negatively affect self-esteem and mental health, leading to anxiety, depression, and feelings of helplessness [1]. These findings call for a critical review of retention policies and evaluation systems that assess academic achievement and recognize students' efforts and improvements. Further, regular counseling services and mentoring programs should be implemented to help students manage their stress effectively. Open communication channels between faculty and students are essential to identify and address stressors early.

Another key factor contributing to academic stress is the lack of opportunities for career exploration. Medical students often face significant uncertainty regarding their future careers, which leads to heightened stress levels, especially during the early years of pre-medical and medical programs. In this study, 78.5% of respondents reported experiencing stress due to concerns about their future careers. This underscores the need for enhanced career support in medical curricula. Schools should offer structured career exploration programs, including seminars and workshops, that introduce various medical specialties and career paths. Additionally, mentorship programs that allow students to connect with professionals from different fields can help reduce career-related anxiety and provide clearer guidance for future planning.

1. Institutional recommendations

The implications of this study should be understood within the context of the pre-medical basic science curriculum. The findings do not extend to the entire medical curriculum, including clinical medicine and medical humanities. Instead, they highlight the need for medical schools to enhance support systems and refine teaching and evaluation methods specifically in the basic science courses of the pre-medical program. In conclusion, this study underscores the need for institutional efforts to improve basic medical science education within the pre-medical curriculum. Medical schools should establish support systems tailored for pre-medical students, including counseling services, stress management workshops, and academic mentoring programs. Regular monitoring of academic stress and early intervention systems could also help identify students at risk and provide timely support.

Curriculum reforms should focus on enhancing the perceived relevance of basic science subjects by connecting them more explicitly with clinical applications. Approaches such as CBL and PBL can bridge the gap between theory and practice and foster greater student engagement. Evaluation practices should emphasize formative feedback, fairness, and transparency, rather than punitive measures, to create a more constructive learning environment.

These institution-level strategies, while limited in scope, can meaningfully reduce academic stress and enhance learning outcomes in basic science courses. Future research should expand to multi-institutional and longitudinal studies, combining quantitative and qualitative approaches to better capture the complexity of medical students' academic stress and its impact on their overall well-being and professional development.

Although demographic and curricular variables were not directly analyzed in this study, these factors may have influenced students' reported stress levels. For instance, variations in prior science coursework or admission type could have affected preparedness for basic medical science courses, while changes in curriculum structure and learning support introduced after 2019 may have altered the overall stress experience of more recent cohorts. Therefore, the findings of this study should be interpreted in the context of these evolving educational and demographic conditions.

2. Limitations

This study has several limitations. First, it was conducted at a single medical school, which restricts the generalizability of the findings to other institutions. Second, the cross-sectional design prevents any causal inferences regarding the relationship between academic stress and its associated factors. Third, the data were collected in 2019, and subsequent curricular reforms or policy changes may have influenced current patterns of academic stress, limiting the temporal relevance of the findings. Fourth, only sex and academic year were included as demographic variables. However, academic stress is also likely to be affected by broader factors such as age, residential status, time since high school graduation, prior science coursework, admission type, and previous academic achievement levels. The exclusion of these variables reduces the comprehensiveness of the present analysis. Fifth, while both overall academic stress and course-specific stress were examined, their interrelationships were not analyzed in depth. It is plausible that students with higher levels of general stress also experienced greater stress in specific courses. Finally, although open-ended questions were included in the survey, their analysis was limited. Only a brief summary of recurring themes could be presented, and more systematic qualitative analysis will be necessary in future studies to fully capture the range of students' perspectives.

3. Directions for future research

Future research should expand beyond basic medical science education to examine academic stress across the full spectrum of medical education, including clinical training and medical humanities. Multi-institutional and longitudinal studies are particularly needed to strengthen the generalizability of findings and to track changes in stress patterns over time. Moreover, integrating quantitative approaches with qualitative analyses will help provide a more comprehensive understanding of the complex factors influencing medical students' stress. Such research will be crucial for developing effective strategies to improve medical education and for promoting students' academic satisfaction, mental well-being, and professional development.

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Conflicts of interest

No potential conflict of interest relevant to this article was reported.

Author contributions

Gwanwook Bang contributed to study conception, design, data collection, analysis, and manuscript drafting. So-Youn Park supervised the research process, provided critical revisions and served as the corresponding author. All authors reviewed and approved the final manuscript.

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