The Effect of Academic Stress on the Cognitive Function of Medical Students

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Abstract: Stress, as a body's response to maintaining the balance of bodily functions, can affect academic performance and is categorized as academic stress. Medical education has special characteristics that distinguish it from other study programs due to the higher challenges in the educational process. This study aimed to determine the effect of academic stress on cognitive function in medical students, which was analyzed through the students' grade point average (GPA). The research was carried out using a quantitative method with a cross-sectional design. The subject was a medical student at Universitas Gunadarma. The number of samples was 130 respondents. A Medical Student Stressor Questionnaire (MSSQ) was administered. The student's GPA was collected. The data was analyzed using the Gamma test. The results were obtained that the majority of respondents experienced high-category stress. The majority of medical students had a GPA between 3 to 4. The analysis results showed that there was a significant correlation between the academic stress of the medical student and the GPA ($p=0.030$). Academic stress has a positive correlation with the cognitive function of medical students. The research results are expected to be input for educational institutions to make efforts to accompany and support students in overcoming academic stress.

Abstrak: Stres, sebagai respon tubuh untuk mempertahankan keseimbangan fungsi tubuh, dapat mempengaruhi performa secara akademik yang dikategorikan sebagai stres akademik. Pendidikan kedokteran memiliki karakteristik khusus yang membedakan dengan pendidikan program studi lainnya akibat tuntutan yang lebih tinggi pada proses pendidikan kedokteran. Penelitian ini bertujuan untuk mengetahui pengaruh stres akademik pada mahasiswa kedokteran terhadap kemampuan kognitif yang dianalisis melalui indeks prestasi kumulatif (IPK) mahasiswa. Penelitian dilaksanakan menggunakan metode kuantitatif dengan desain potong lintang. Subjek penelitian adalah mahasiswa kedokteran Universitas Gunadarma yang memenuhi kriteria inklusi dan eksklusi. Sampel penelitian adalah sebanyak 130 responden. Subyek diminta mengisi *Medical Student Stressor Questionnaire* (MSSQ) dan dilakukan pengambilan data IPK mahasiswa. Uji analisis yang digunakan adalah uji Gamma. Hasil penelitian diperoleh bahwa mayoritas responden mengalami stres kategori tinggi. Mayoritas mahasiswa memiliki IPK antara 3 hingga 4. Hasil analisis menunjukkan bahwa adanya pengaruh secara bermakna antara tingkat stress akademik terhadap Indeks Prestasi Kumulatif Mahasiswa (p=0,030). Stres akademik memiliki pengaruh positif terhadap kemampuan kognitif mahasiswa kedokteran. Hasil penelitian diharapkan menjadi masukan terhadap institusi pendidikan untuk melakukan upaya dalam mendampingi dan mendukung mahasiswa dalam mengatasi stres akademik.

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A. Introduction

Mental health issues, currently increasing in prevalence, were initially triggered by stressful conditions. Stress is part of the body's response to situations that disrupt the balance of bodily functions, known as homeostasis (Cavagna, 2019). The prevalence of stress globally, based on the results of the study, was 35.1%, with a higher prevalence in females than males (Smith & Wesselbaum, 2025). Stress can be classified based on several aspects, including 1) the source of stress, both physical and psychological, 2) its impact on each individual, 3) duration, and 4) stress-inducing factors (Kogler et al., 2015; Shahsavarani et al., 2015). Stress levels can be mild, moderate, or high (Emran et al., 2024). Stress affects the body, including cognitive function (Marin et al., 2011) and physical and mental health; therefore, it can affect academic performance (Pascoe et al., 2020).

The impact of stress on academic performance can be categorized as academic stress. Research on college students in Southeast Asia reported that the prevalence of academic stress ranged from 16.4% to 84.4 (Dessauvagie et al., 2022). The prevalence of stress in college students was dominated by the mild stress category at 33.8% and moderate stress at 35.4% (Asif et al., 2020). Academic stress is a psychological and physiological condition, especially when students face pressure or challenges while learning (Almarzouki, 2024). Triggers for academic stress include: 1) learning loads such as heavy assignments with thick time or multiple exams; 2) competition while undergoing the learning process; 3) the emergence of expectations for learning outcomes such as having too high expectations or fear of failure; 4) social factors such as lack of support; and 5) environmental factors such as the need to adapt on a new environment (Ng et al., 2016). Pressure and challenges related to academic factors can trigger the body's response, one of which can affect cognitive function (Blum, 2024). If students cannot make optimum efforts to overcome the body's response, it can negatively impact their academic performance (Iqra, 2024). The impact of academic stress on students is not only in the form of non-optimum academic performance. Apart from that, long-term effects such as anxiety, depression, sleep disturbances, and other impacts related to mental health could arise (Teh et al., 2015).

The stress mechanism involves the body's physiological functions. The stress mechanisms have several pathways related to the function of the nervous and endocrine systems (Almarzouki, 2024). The main pathways in responding to conditions that trigger stress (stressors) are the Hypothalamic Pituitary Adrenal (HPA) axis and the autonomic nervous system. The emergence of stressors stimulates the pituitary gland to release Adrenocorticotropic Hormone (ACTH). The release of ACTH signals the adrenal glands to release cortisol, which modulates the body in overcoming stress (Cavagna, 2019). In addition to cortisol release, the body activates the sympathetic nervous system by releasing adrenaline and noradrenaline. The body prepares for a fight or flight response facing the stressor stimuli (Kogler et al., 2015). The fight or flight response initiates the body's reaction to overcoming stressors. The body continues to adapt when stress continues. However, it generates responses toward the body, such as easily getting tired, and causing a broader impact on other body systems, such as the emergence of digestive disorders and decreased

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immunity. Also, it affects brain function (Shahsavarani et al., 2015).

The stress mechanism involves physiological functions and the vidual's response to stress that can affect psychological functioning. Psychological processes related to stress involve cognitive aspects, emotional responses, and changes in physiological conditions (Cavagna, 2019). Psychological processes are related to the amygdala, the part of the brain responsible for emotional aspects and triggers the emergence of fear responses (Kogler et al., 2015). The hippocampus and prefrontal cortex manage cognitive aspects such as decision-making and memory (Zhu et al., 2022; Sarmiento et al., 2024). Both are stimulated during stressful conditions through dysregulation of brain function, which can lead to mood changes and anxiety that can affect mental health (Girotti et al., 2024; Blum, 2024).

The stress response is an adaptive process to maintain homeostasis. Therefore, stress can also affect cognitive abilities. Increased cortisol release can cause dysregulation in brain function, particularly in the hippocampus and prefrontal cortex (Ng et al., 2016). The hippocampus and prefrontal cortex have important functions in learning and memory. Chronic stress can interfere with the hippocampus's function, decreasing the process of remembering, understanding, and analyzing a material (Girotti et al., 2024). Prolonged stress can cause dysregulation of neurotransmitter regulatory functions, affecting brain function (Marin et al., 2011). Dysregulation of serotonin and dopamine can lead to mood disorders that can contribute to a decrease in students' motivation to learn (Blum, 2024). Imoptimal management of emotions due to the amygdala's response to stress can lead to changes in psychological conditions such as bad mood or decreased concentration (Kogler et al., 2015). This, if not followed up with management efforts to overcome stress, can cause complaints from the physical and mental side that can affect performance in learning (Iqra, 2024).

Some research results showed that medical students experience academic stress levels varying from mild to severe. The results of a study on medical students in Saudi Arabia stated that 85.5% of students experienced moderate to severe stress (Al-Shahrani et al., 2023). Research in Indonesia revealed that the prevalence of academic stress in medical students was 61% (Zamroni et al., 2018). Research on the prevalence of stress in medical students in Syria showed that the majority of college students experience mild stress (50.6%) and moderate stress (37.0%) (Al Houri et al., 2023). The prevalence of moderate stress of 46.8% was experienced by medical students in Indonesia (Ndoen et al., 2021).

Medical education has special characteristics that distinguish it from other study programs; therefore, the challenges for medical students are higher. Learning in medicine uses a block system, an integrated learning process. Therefore, students face exams more often than students in other study programs. Research on stress in medical students in Saudi Arabia and Malaysia showed that the stress faced by medical students is often triggered by the pressure of the learning process and exams (Ebrahim et al., 2024; Abdulghani et al., 2011). The complexity of the material in medicine that requires analytical skills, a tight schedule, and challenges for becoming lifelong learners requires medical students to have the ability and space to apply self-directed learning (Charokar & Dulloo, 2022). As adult

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learners, medical students must learn independently because, in medical education, the principle of student-centered learning is applied (Mukhalalati & Taylor, 2019).

Various challenges and needs in the learning process of medical students can cause stress that will trigger several impacts on medical students. Research showed that academic stress in medical students is a serious problem and hurts academic performance (Melaku et al., 2015). Academic stress in medical students causes problems with physical health (Abdulghani et al., 2011). Research that analyzed anxiety in medical students due to stress showed that students experienced stress to varying degrees and experienced anxiety as a result (Ebrahim et al., 2024).

Previous studies on academic stress have been extensively conducted, including examining the prevalence of academic stress and its impact on medical students. Research on the impact of stress on academic performance has been conducted. However, more research on the effect of academic stress on cognitive function in medical students has not been widely done. The results of a study on the effect of stress on brain structure and function have been conducted. The results showed that dysregulation of brain function can occur when a person is stressed; hence, it can cause dysregulation of cognitive function, including in medical students. Therefore, research on the correlation between academic stress and cognitive function in medical students needs to be conducted to analyze the stress level and its effect on cognitive function as seen from learning outcomes in the form of a cumulative grade point average.

This research is important considering that medical education has a series of dense learning processes over a long period; accordingly, a cognitive function that declines due to academic stress can affect the timeliness of students in completing education. The results of this study are expected to provide an overview of the correlation of academic stress on medical students and students' cognitive functions. Therefore, it can provide input to educational institutions to make efforts to accompany and support students in overcoming academic stress.

B. Method

The research was conducted using a quantitative method with a cross-sectional design. The research subjects are medical students of the Faculty of Medicine, Universitas Gunadarma, who met the inclusion and exclusion criteria. The inclusion criteria were medical students who were status active and underwent undergraduate medical education for at least one semester. In contrast, the exclusion criteria were students who were status active but did not participate in the learning process and students who were diagnosed with mental disorders. The minimum sample calculation was carried out, and a minimum sample size of 124 respondents was obtained; however, 130 respondents were obtained in the study. The research flow is briefly shown in Figure 1.

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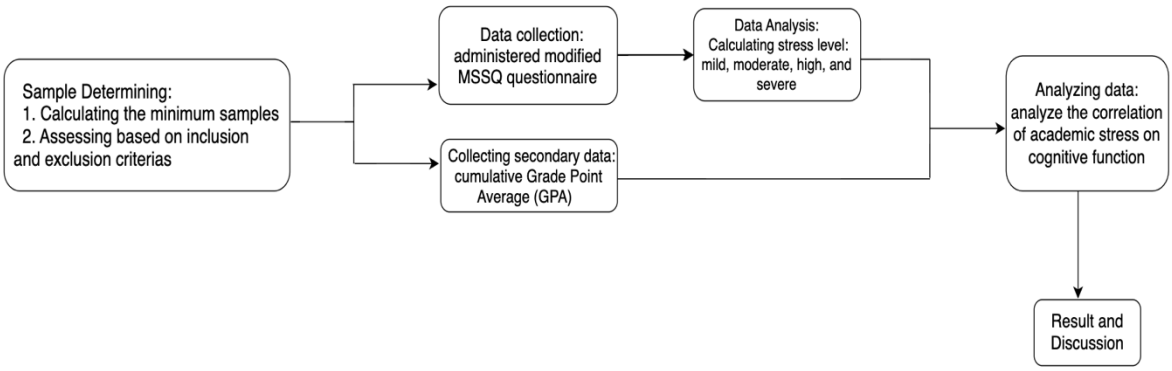

Figure 1. Research Flow Diagram

Figure 1 explains that the data collection instruments used in this study were the modified Medical Student Stressor Questionnaire (MSSQ) and secondary data on the student's Cumulative Grade Point Average (GPA). The validity test was carried out on the modified MSSQ questionnaire, and it was found that all items on the questionnaire were valid. The reliability test on the modified MSSQ questionnaire showed that the instrument was reliable, with a *Cronbach's Alpha* value of 0.962. The modified MSSQ questionnaire identifies the causes of academic stress in medical students, which then assesses the stress level in medical students. The modified MSSQ questionnaire consists of six domains, namely: 1) academic-related stressors, 2) interpersonal and intrapersonal-related stressors, 3) teaching and learning-related stressors, 4) social-related stressors, 5) drive and desire-related stressors, and 6) group activities-related stressors. The scoring scales on the modified MSSQ questionnaire include: 1) score 0 means no stress at all, 2) score 1 means mild stress, 3) score 2 means moderate stress, 4) score 3 means high stress, and 5) score 4 means severe stress. Secondary data in the form of GPA is obtained based on student grade data owned by the study program. GPA data was used to see students' cognitive functions.

The primary data from filling out the modified MSSQ questionnaire was processed using the MSSQ questionnaire scoring table. Then, the results were categorized based on stress levels, including mild, moderate, high, and severe stress. Academic stress level data and GPA data were analyzed using SPPS software to examine the effect of academic stress on cognitive function in medical students. The test used to analyze the effect of academic stress on cognitive function in medical students was the Gamma Test because the research data had an ordinal scale.

C. Result and Discussion

Result

This study surveyed 130 medical students from second to fourth year. The research was conducted when first-year medical students were still undergoing the educational process for two months; therefore, they were excluded from the respondent criteria. The data on respondent characteristics is presented in Table 1.

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Table 1. Distribution of Respondent Characteritics

Variabels	Frequency	Percentage
Year of study		
- Fourth	29	22.3
- Third	52	40
- Second	49	37.7
Gender		
- Male	34	26.2
- Female	96	73.8
Age		
- <20 years	38	29.2
- 20 – 25 years	92	70.8
GPA		
- GPA 3-4	88	67.7
- GPA <3	36	27.7
- GPA < 2	6	4.6
Academic Stress		
- Mild	13	10
- Moderate	40	30.8
- High	67	51.5
- Severe	10	7.7

Table 1 showed that most respondents were female and in the 20-25 age range. Most are third-year medical students; however, this number is not much different from second-year respondents. The Cumulative Grade Point Average (GPA) data in Table 1 showed that most students' GPA was 3 to 4. Based on the analysis of the overall level of academic stress, it was found that most respondents experienced stress in the high category.

Table 2. Distribution of Academic Stress Based On Each Domain

Variabels	Frequency	Percentage
Domain 1		
- Mild	7	5.4
- Moderate	35	26.9
- High	72	44.4
- Severe	16	12.3
Domain 2		
- Mild	22	16.9
- Moderate	33	25.4
- High	55	42.3
- Severe	20	15.4
Domain 3		
- Mild	22	16.9
- Moderate	46	35.4
- High	54	41.5
- Severe	8	6.2
Domain 4		
- Mild	18	13.8
- Moderate		

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Variabels	Frequency	Percentage
- High	59	45.4
- Severe	46	35.4
	7	5.4
Domain 5		
- Mild	33	25.4
- Moderate	45	34.6
- High	39	30
- Severe	13	10
Domain 6		
- Mild	29	22.3
- Moderate	59	45.4
- High	33	25.4
- Severe	9	6.9

Table 2 describes data on variations of academic stress levels based on each domain representing the factors that cause academic stress. Domain 1 represents academic-related stressors, while domain 2 represents interpersonal and intrapersonal-related stressors. Domain 3 is the domain of teaching and learning-related stressors, while domain 4 is the domain of social-related stressors. Domain 5 is the drive and desire-related stressors domain, while domain 6 is group activity-related stressors. The results of the stress levels analysis showed that the stress level was in the high category in almost every domain except domains 5 and 6, which were at moderate levels.

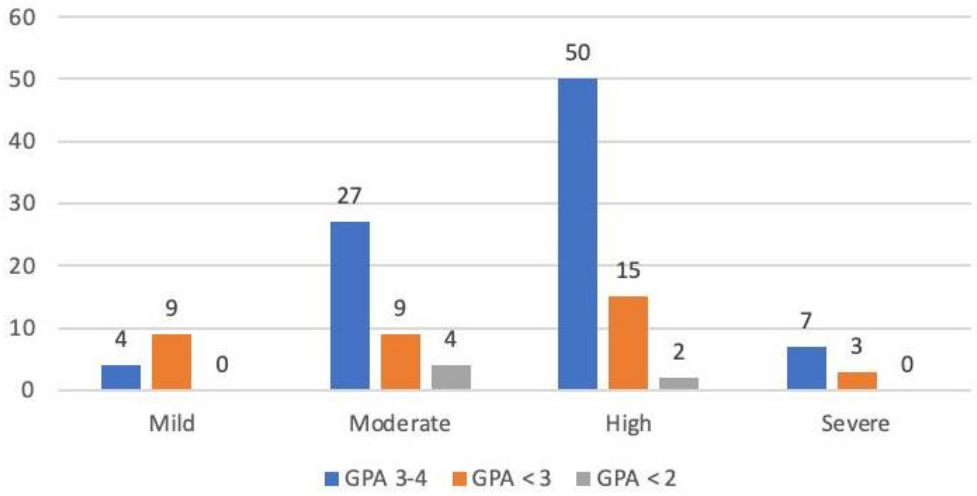

Figure. 2. Description of Academic Stress Levels and GPA

Figure 2 illustrates that the value of 3-4 on GPA dominates in almost every stress level, except for mild stress levels. A GPA under two was not found in mild and severe stress levels. The majority of students had high-stress levels; however, their GPA was in the range of 3-4. Data on stress levels and GPA were then analyzed using the Gamma Test to find out whether or not there was an effect of academic stress on cognitive functions, as seen from GPA.

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Table 3. Cross Tabulation Data of Academic Stress Related to GPA

Variabel	IPK 3-4		IPK < 3		IPK < 2		Total	P Value and Gamma Value
	n	%	n	%	n	%		
Mild	4	30.8	9	69.2	0	0	13	0.030
Moderate	27	67.5	9	22.5	4	10	40	and
High	50	74.6	15	22.4	2	3	67	0.309
Severe	7	70	3	30	0	0	130	
Total	88	67.7	36	27.7	6	4.6	130	

Table 3 shows the results of the analysis of the correlation between academic stress and GPA. The results of the analysis using the Gamma test showed that there was a significant correlation between the level of academic stress and the student's GPA. The correlation was positive, so it can be interpreted that the higher the stress level, the higher the student's GPA.

Discussion

This study generally aimed to determine the correlation between academic stress and student cognitive function. The stress category in this study was stress that arises as an effect of the learning process in the faculty of medicine. The learning process in the faculty of medicine is included in the dense and long category; therefore, it can affect students' cognitive function, which will later impact timely graduation.

This study did not specifically analyze the relationship between age and gender on stress prevalence and student GPA. However, age and gender characteristics in previous studies were stated to affect GPA. Ahmadi et al. conducted a study on medical students, and the results showed that age has a significant relationship with GPA. The younger the age, it is concluded that the GPA is getting better, while gender has no relationship with the student's GPA (NH et al., 2019). The results of other studies suggested that there was an influence between gender and stress prevalence. Research conducted by Baisth et al. stated that there was a significant difference between male and female students related to academic stress and strategies for coping with stress. The average academic stress was higher in females than males (Basith et al., 2021).

This study proved that medical students' stress levels varied from mild to severe. However, high stress levels became dominant, followed by moderate levels. These results aligned with research conducted by Al-Shahrani et al. on medical students, who stated that students experience various levels of academic stress, and most medical students experience moderate to severe stress (Al-Shahrani et al., 2023). Another study supported the result. Ragab et al. stated that medical students in Sudan also have a high prevalence of stress (Ragab et al., 2021). Academic factors, learning environment, and social and personal factors could affect medical students' moderate to high-stress levels. High academic stress can be triggered by study load, competition, high expectations or fear of failure, and social factors (Ng et al., 2016).

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Stressors in academics stimulate specific responses of physiological mechanisms to maintain homeostasis. However, they can provoke heavy responses in the body while stress is prolonged. Chronic stress physiologically triggers the increase of cortisol. This can interfere with regulating brain function, especially the hippocampus and prefrontal cortex, which play an important role in the learning and memory process. Prolonged stress can cause the ability to understand the material and the function to analyze to decrease (Girotti et al., 2024; Marin et al., 2011; Ng et al., 2016). Increased cortisol due to chronic stress can also interfere with the regulation of neurotransmitters such as serotonin and dopamine, which decrease students' motivation to learn (Blum, 2024). Based on the theory above, it is known that chronic stress can affect cognitive function through GPA indicators that can describe students' memory, concentration, and analytical thinking skills. This aligns with research conducted by Puspitasari and Affandi that academic stress contributes to decreased learning motivation, which can affect learning achievement (Puspitasari & Affandi, 2024). Calaguas also stated that there is a link between academic stress and increased student expectations (Calaguas, 2011). It is in line with this study that academic stress caused by student expectations and motivation is mainly in the medium and high categories. It can be seen in domain 5, namely drive and desire-related stressors.

The result of GPA in this study, as a parameter for cognitive function, contrasts with the result of academic stress level. This study showed that moderate to high stress levels are assumed to interfere with cognitive function due to the body's response to prolonged stress. Puspitasari and Affandi stated that stress and cognitive load affect students' cognitive function and learning, which can interfere with learning motivation (Puspitasari & Affandi, 2024). However, this study's results align with other studies that revealed that academic stress levels and responses to cognitive function also vary. This study's results align with the research of Ahmadi et al., who assessed cognitive function using the MMSE (Mini-Mental State Examination) instrument. The results found that mental conditions were not significantly different from students' GPAs (NH et al., 2019). It is in line with this study that a high GPA dominates in the moderate to severe stress category. This study means that stressors affect cognitive function, and several other factors can also affect cognitive function.

Results of this study revealed that the higher the level of academic stress, the higher the student's GPA. Our study differed from the research conducted by Puspitasari and Affandi which stated that academic stress and cognitive load influence learning motivation. Increased academic stress will reduce learning motivation (Puspitasari & Affandi, 2024). Basith et al. stated that moderate academic stress does not have a meaningful relationship with academic achievement. This study concluded that other factors dominate academic achievement more (Basith et al., 2021). The above studies differ from the research results conducted by researchers using a sample of medical students. The high level of academic stress in medical students has a positive effect that can trigger an increase in motivation and cognitive function; therefore, academic performance improves.

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The hormone dopamine is physiologically a hormone that plays a role in motivation. Students can use the release of dopamine during stress, which is only called a 'good' stress response. A 'good' stress response harnessed to some extent can mobilize the neural function necessary to achieve learning goals. This shows that a more positive perspective on stress can support students in participating in academic learning (Rudland et al., 2020). This is in line with research, which also found that respondents with high and severe stress levels had higher GPAs. This shows that students can cope with stress effectively. Each individual has a different way of dealing with stress. The coping mechanism is an individual's attempt to neutralize or overcome the stress in his body (Al-Shahrani et al., 2023). A good coping mechanism is needed to control stress, which can involve positive actions. Students will be better able to modify situations, respond more adaptively, and experience fewer symptoms of depression if they can use coping strategies well (Basith et al., 2021).

The result of this study may be different from other research. The relationship between academic stress and academic performance is a complex matter to research. The sample's variation and the population's characteristics, the context and methods of learning at the institutional level, and the methods used to measure academic stress may differ between one study and another. As a consequence, the results may differ. However, an aspect that must be considered in academic stress is that medical education requires students to adapt to the learning process; therefore, stress does not affect students' academic performance. Accordingly, medical education institutions are expected to make efforts to increase student motivation by providing full support and creating a positive environment in the learning process.

D. Conclusion

Most medical students in this study showed a high level of academic stress; however, it did not affect students' cognitive function. Higher levels of academic stress correlate with student academic achievement as measured by GPA. The results of this study showed that the emergence of stress can positively impact student achievement.

The effect of academic stress on student achievement is a challenge for medical education institutions. Stress can play a dual role, namely as a trigger for learning motivation, and can also be an obstacle if not followed by the right *coping* mechanism. Accordingly, based on the results of this study, it can be suggested that creating a supportive learning environment and designing the right curriculum are necessary so that students' learning load can be distributed appropriately.

Further research on academic stress and its influencing factors needs to be done so that it can be more detailed in knowing other factors that play a role and affect cognitive function, such as learning load and motivation. This study has not yet examined how students manage academic stress. Therefore, further research is needed to find out the coping stress management carried out by students to explore factors that can affect students' academic performance.

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