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How sleep deprivation and academic stress shape statistical achievement: Evidence of academic resilience in undergraduate learners

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Abstract

This study addresses a gap in the literature concerning the combined influence of stress and sleep duration on academic performance, particularly in demanding mathematics courses like Basic Statistics. Among mathematics education students—who rely heavily on concentration and logical reasoning—stress and poor sleep may significantly affect learning outcomes. Conducted at a state university in Surakarta, Indonesia, the research aimed to examine the associations between perceived stress, sleep duration, and course performance in 45 first-semester students who had completed Basic Statistics. A non-parametric quantitative design was used, with data gathered via the Perceived Stress Scale (PSS-10), a sleep duration questionnaire, and final course grades. Analyses employed chi-square tests and correspondence analysis. While no statistically significant relationships emerged, the correspondence analysis revealed intriguing proximity patterns: moderate-to-high stress and short-to-adequate sleep categories clustered near higher performance, hinting at possible nonlinear or adaptive effects. These findings, though preliminary, suggest that optimal—not minimal—stress and sufficient sleep may support academic achievement. The study underscores the need for expanded research with larger, more diverse samples to better understand these complex dynamics and inform holistic student support strategies in mathematics education.

Keywords: stress; sleep duration; statistics course performance

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Introduction

Academic achievement serves as a fundamental indicator of educational success in higher education. However, beyond cognitive capabilities, a range of non-academic factors—including psychological stress and sleep duration—significantly influence students' learning outcomes. A psychological response to internal or external demands that exceed an individual's coping ability is how stress is broadly defined (Hakim et al., 2024; Yunarti et al., 2024). This issue is particularly acute among first-year university students, who often struggle to adapt to academic transitions, heightened expectations, and a new social environment. In courses requiring advanced analytical thinking, such as statistics, academic stress can disrupt students' cognitive and emotional equilibrium, thus impairing performance.

Extensive research confirms that academic stress is a prevalent and persistent concern across university settings. According to Pascoe et al. (2020), 66% of students in 72 countries report experiencing academic stress, which has been shown to negatively affect mental health, sleep quality, and academic achievement. Stress manifests through symptoms such as anxiety, lack of focus, and emotional exhaustion, which may lead to reduced academic motivation or even decisions to discontinue studies (Fuente et al., 2020; Sinval et al., 2024). The global pandemic further intensified these challenges; remote learning and heightened uncertainty contributed to a noticeable rise in students' stress levels (Simon de Blas et al., 2024).

In some cultural contexts—such as in China—extreme academic pressure is often accompanied by unhealthy coping mechanisms, including excessive screen time and overreliance on learning aids, which may further diminish academic performance (Acosta-Enriquez et al., 2025; Yan, 2025). Stress, therefore, becomes not only a personal burden but a systemic barrier to learning, with consequences extending to physical health, emotional well-being, and cognitive function (Hsu & Goldsmith, 2021). In mathematics-intensive disciplines, such as statistics, academic underperformance is linked to both psychological strain and inadequate coping strategies. Qian (2025) emphasizes that low achievement in mathematics is often accompanied by reduced self-esteem, social withdrawal, and poor long-term academic motivation, perpetuating a cycle of failure.

At the same time, sleep quality and duration are essential but often overlooked factors in student success. Sleep plays an important role in cognitive processes such as memory storage, focus, and problem solving—functions that are essential for mastering abstract subjects such as statistics. The National Sleep Foundation (NSF, 2015) recommends 7–9 hours of nightly sleep for optimal brain function; however, many students sacrifice rest to meet academic demands. This pattern of sleep deprivation has been consistently linked to lower academic performance (Chaput et al., 2020; Okano et al., 2019; Vedaa et al., 2019). For instance, Lin et al. (2020) found that sleep duration had a more substantial influence on mathematics scores than socioeconomic status or parental education. Similarly, Machado et al. (2022) reported that students sleeping less than 7–8 hours faced a significantly higher risk of academic failure.

Nonetheless, the empirical relationship between sleep duration and academic achievement remains inconclusive. While some studies confirm strong associations, others report only weak or statistically insignificant correlations (Hasanah et al., 2023; Ouyang et al., 2024), suggesting the need for further exploration, particularly in cognitively demanding subjects.

Basic Statistics was chosen as the focus of this study because it is a fundamental and compulsory course for mathematics education students in their first semester. Focusing on mastery of basic concepts such as descriptive statistics and simple hypothesis testing, mastery of Basic Statistics material is very important as a foundation for understanding subsequent statistics courses and the application of quantitative methods in research.

During the transition from high school to college, students need to adapt to a more independent learning style that requires critical thinking skills. Differences in basic mathematical abilities among students can also lead to gaps in understanding abstract concepts, such as probability distributions and mathematical notation. In addition, the perception that statistics is a difficult course can trigger learning anxiety, because it emphasizes not only memorization of formulas, but also logical reasoning and data interpretation. Reading tables, graphs, or data sets is an important part of statistical analysis, but some students still have limited data literacy skills. Apart from academic factors, students also face social pressures and adaptation to the campus environment, which can potentially increase stress and affect sleep duration, thereby impacting the effectiveness of the Basic Statistics learning process.

Adding to this complexity is the subject of Basic Statistics, a foundational yet often daunting course required across disciplines. Proficiency in statistics is crucial both for educational achievement and for developing research competence as well as making evidence-based professional judgments (Ozen, 2017). However, statistics is widely perceived as abstract and challenging, often evoking anxiety and avoidance among students (Maat et al., 2022). In Indonesia, for example, fewer than half of the students in one study achieved satisfactory grades in statistics (Cahyawati et al., 2018), and many continued to struggle with core concepts and applications (Rozana, 2025).

While prior research has examined predictors of performance in statistics such as prior math ability, engagement with class resources, and demographic factors (Akimov et al., 2024) there remains a notable gap in studies that explore how stress and sleep interact to affect academic achievement in this particular subject. Despite abundant literature on each factor independently, few studies have jointly investigated their combined impact on learning outcomes in highly analytical courses.

In response to these concerns, the present study seeks to explore the interrelationship between stress levels, sleep duration, and academic achievement in the Basic Statistics course among undergraduate mathematics education students. Using the Perceived Stress Scale (PSS-10) and a self-reported sleep duration questionnaire, the study adopts a non-parametric quantitative approach, analyzed using the Chi-Square test and correspondence analysis to detect patterns and associations.

The novelty of this research lies in its integrative perspective: rather than isolating stress or sleep as independent variables, it examines their combined influence on academic performance in a course that is both cognitively intensive and central to many disciplines. By examining Basic Statistics, a course that often causes academic stress, this study provides further insight into how psychological and behavioral factors together influence academic achievement. The findings are expected to inform more holistic interventions that support student well-being alongside academic development.

Methods

This study utilized a quantitative, non-parametric research design to examine the associations between perceived stress levels, nightly sleep duration, and academic achievement among students enrolled in a cognitively demanding undergraduate course, Basic Statistics. The selection of a non-parametric approach was based on preliminary tests for normality, which showed that the data did not meet parametric assumptions, consistent with the rationale provided by Khangar and Kamalja (2017) regarding the suitability of non-parametric methods for non-normally distributed data. The research was conducted from April to June 2025 at a public university in Surakarta, Indonesia, targeting students enrolled in the Mathematics Education program who had completed the Basic Statistics course. This course was selected due to its complexity and central role in equipping students with data analysis skills crucial for academic success and professional development (Ozen, 2017).

The study utilized a cluster random sampling technique to select participants from three academic cohorts: 2022, 2023, and 2024, which had population sizes of 93, 88, and 94 students respectively. This method ensured proportional representation from each cohort while allowing for random selection across these distinct class clusters. The inclusion criteria required that participants be active students who had taken and completed the mandatory Basic Statistics course in their first semester, a requirement for all students in the program, and were willing to participate voluntarily. From the total population of 275 students, a final sample of 45 respondents was obtained for the study.

An online survey was conducted to collect data using a standardized, self-administered questionnaire deployed via Google Forms, which included three key components: (1) the Perceived Stress Scale (PSS-10) to assess psychological stress levels, (2) self-reported average daily sleep duration during the semester in which the course was taken, and (3) official academic grades in the Basic Statistics course.

The Perceived Stress Scale-10 (PSS-10), originally created by Cohen et al. (1983), serves as a well-established psychological tool designed to measure an individual’s perceived stress levels over the past month. This instrument incorporates 10 questions scored on a 5-point Likert-type scale, with response options extending from 0 (never) to 4 (very often). Notably, four positively framed items (specifically items 4, 5, 7, and 8) undergo reverse scoring during data processing. Composite scores, which span from 0 to 40 points, are conventionally classified into three distinct tiers: 0–13 (low stress), 14–26 (moderate stress), and 27–40 (high stress), consistent with established scoring protocols (Pascoe et al., 2020).

Sleep duration was classified into three categories: less than 6 hours (insufficient), 6–8 hours (adequate), and more than 8 hours (excessive), based on the classification framework proposed by Wang et al. (2019), which reflects established sleep health guidelines. Academic performance in the Basic Statistics course was assessed using students’ final grades. The conversion of these final grades to a standardized 4.0 GPA scale (e.g., C = 2.0, B = 3.0, and A

= 4.0) was applied for two main reasons: first, to enable quantitative statistical analysis of academic achievement, and second, because this scale directly reflects the official grading policy of the state university in Surakarta, Indonesia, where this research was conducted. Therefore, this standardization is not an arbitrary metric, but rather an accurate representation of the institution's own evaluation system, which ensures that our analysis is methodologically robust, consistent with previous research (e.g., Akimov et al. (2024), and grounded in the specific academic context of the students involved.

IBM SPSS Statistics version 25 was employed to conduct the data analyses. Initial analytical steps comprised descriptive statistics followed by application of the Shapiro–Wilk test to verify distributional normality. The violation of normality assumptions led to the application of non-parametric analysis techniques. The statistical relationship among stress levels, sleep duration, and academic performance was examined using Pearson's Chi-Square Test of Independence.

To further explore and visualize multivariate associations among categorical variables, a Correspondence Analysis (CA) was conducted. This technique, endorsed by Khangar and Kamalja (2017) and M. Methlagl (2022), was selected for its effectiveness in handling non-parametric data and revealing hidden patterns in contingency tables. CA enables the transformation of categorical data into a low-dimensional graphical space, typically a biplot, allowing researchers to observe the proximity between categories and detect clustering or divergence. The method also calculates inertia, a metric akin to total variance, to assess the strength of associations between categorical variables. Greater inertia values indicate stronger deviations from independence, and contributions to inertia across dimensions help identify which variable combinations are most significant (A. Methlagl, 2022).

By integrating validated instruments such as the PSS-10 and adopting a rigorous non-parametric analytical framework, this study sought to generate robust, context-specific insights into how stress and sleep patterns influence academic achievement in a high-demand analytical course. The novelty of this research lies in its simultaneous examination of both psychological (stress) and behavioral (sleep) factors in relation to academic performance, particularly within the under-researched context of Basic Statistics education. This methodological approach addresses a significant gap in the literature, where most prior studies have considered these variables in isolation or within less analytically intensive subjects.

Results

Based on questionnaires distributed to Mathematics Education students from the 2022, 2023, and 2024 cohorts at a state university in Surakarta, the collected data are presented in Figure 1 and Figure 2. Descriptive analysis revealed significant disparities in statistics course performance associated with students' stress levels and sleep duration. The distribution of statistics course performance by stress level was as follows: high stress (n = 8), moderate stress (n = 36), and low stress (n = 1). Similarly, the distribution by sleep duration was: short (n = 25), adequate (n = 19), and long (n = 1). As illustrated in Figure 1, students with moderate stress level demonstrated optimal statistics course performance, with grade distribution spanning A to B. The B+ grade emerged as the modal category (n = 16), followed by A (n = 8), A- (n = 7), and B (n = 5). In contrast, stress level showed a more varied grade distribution, with fewer top performers B+ (n = 3) and A (n = 2), along with A- and B (n = 1 each) and the sole occurrence of a C grade (n =1) in our dataset. This C grade manifestation suggests a potential negative correlation between elevated stress and mathematical achievement, though the small effect size warrants cautious interpretation. The low stress level was notably underrepresented, with only one B+ achiever identified.

In Figure 2, it can be seen that students with short sleep duration were the largest group and showed good statistics course performance, particularly in B+ grades (n = 12) and other high grades of A (n = 5), A- (n = 3), and B (n = 5), with no students receiving a C grade. Students with adequate sleep duration also had fairly good statistics course performance, but not as strong as students with short sleep duration. The grade distribution of students with adequate sleep duration was more varied, with B+ (n = 7), A- (n = 5), as well as A (n = 4) and B (n = 2), and there was one C grade (n = 1). Meanwhile, students with long sleep duration were only represented by one student in the A grade category, and none were found in other grade categories. It was found that most students who had good statistics course performance actually had short sleep duration.

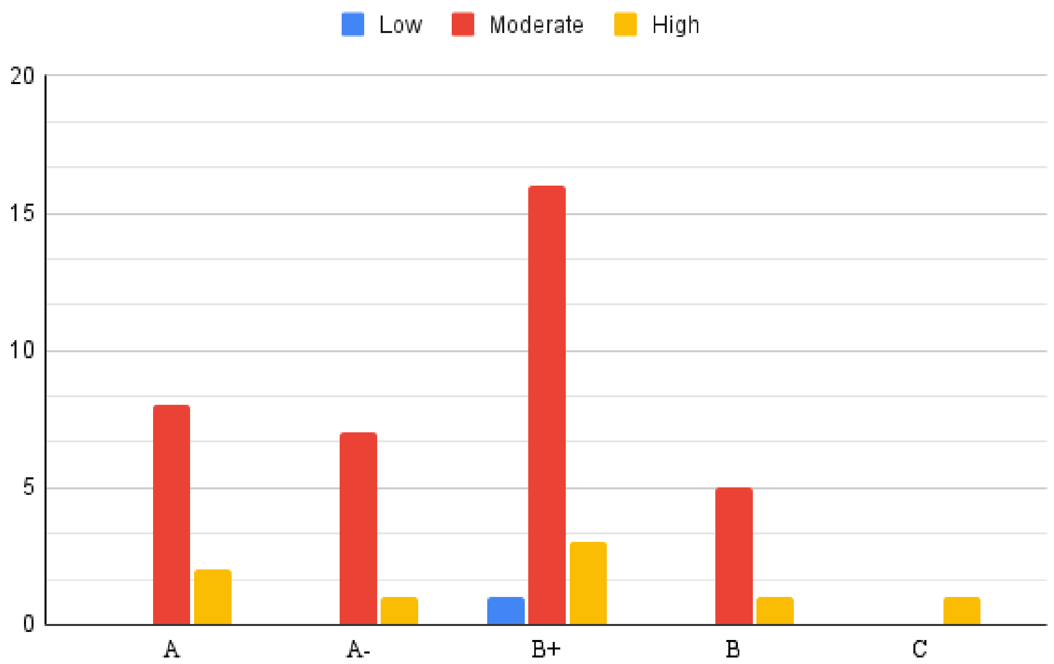

Figure 1. Distribution of statistics course performance Across Perceived Stress Levels

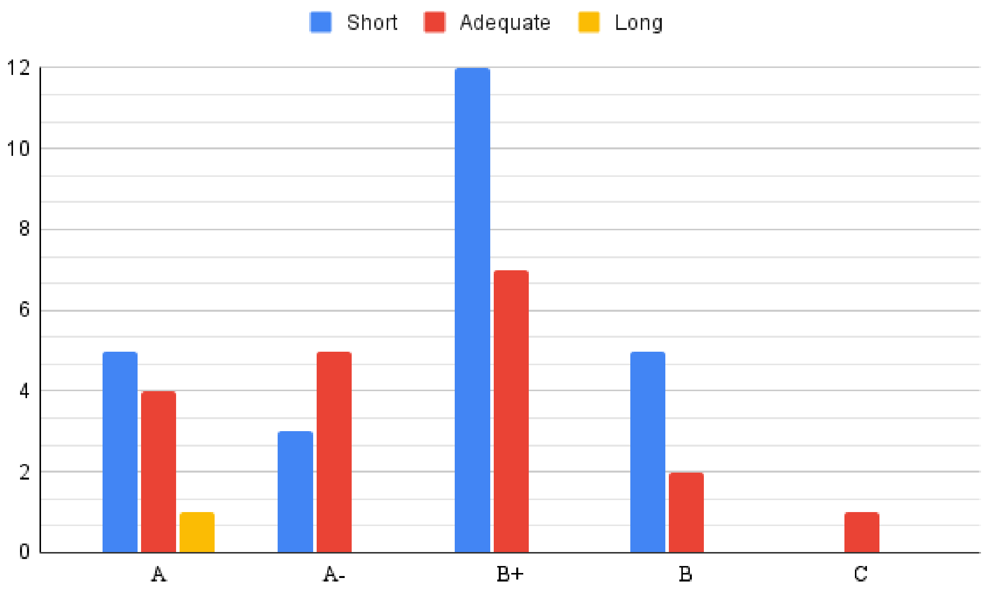

Figure 2. Distribution of statistics course performance across sleep duration categories

Parametric assumption testing was conducted through normality tests. As presented in Tables 1, the data distributions for moderate stress levels were found to be non-normal (Asymp Sig < 0.05). In contrast, the statistics course performance data distribution for high stress levels showed normal distribution (Asymp Sig > 0.05). However, it is important to note that normality tests could not be performed for the low stress category (n = 1) as indicated by the NaN result, due to an insufficient number of data points, as a sample size of one provides no measure of distributional variance. Therefore, it can be concluded that overall, the statistics course performance data grouped by stress level is not normally distributed.

Table 1. Normality Test Results for Stress Level Data

	Stress Level	**Asymptotic Significance**
statistics course performance	Low	NaN
	Moderate	0.000
	High	0.266

The normality test results for sleep duration data are shown in Table 2. The data distributions for both short sleep duration and adequate sleep duration were found to be non-normal (Asymp Sig < 0.05). In contrast, the statistics course performance data distribution for high stress levels showed normal distribution (Asymp Sig > 0.05). A normality test could not be conducted for the long sleep duration category, as shown by the NaN value, because there was only a single data point (n = 1) in this group, providing no measure of distributional variance.

Table 2. Normality Test Results for Sleep Duration Data

	Sleep Duration	Asymptotic Significance
statistics course performance	Short	0.000
	Adequate	0.001
	Long	NaN

The discussion proceeds with the interpretation of the Chi-Square test of independence, a non-parametric approach selected due to the non-normal distribution of the data. However, the validity of this test can be affected when expected cell frequencies fall below five, as occurred in this study where certain categories—such as low stress and long sleep duration—contained sparse data (n = 1). Consequently, the findings should be interpreted with caution.

As shown in Table 3, there was no statistically significant association between stress level and statistics course performance ($\chi^2(8)$ = 8.884, Asymp Sig = 0.352) or between sleep duration and course performance ($\chi^2(8)$ = 8.004, Asymp Sig = 0.433). To contextualize the magnitude of these non-significant results, Cramér's V was computed. The effect sizes were V = 0.31 for stress level and V = 0.30 for sleep duration—values that fall between small (0.10) and medium (0.30) according to conventional benchmarks. These findings suggest modest practical associations that, while not statistically significant, may warrant further investigation using larger and more balanced samples.

Table 3. Chi-square test of association between stress level, sleep duration, and statistics course performance

Pearson Chi-Square	χ^2Value	df	Asymptotic Significance	Cramér's V
Stress Level	8.884	8	0.352	0.31
Sleep Duration	8.004	8	0.433	0.30

Furthermore, correspondence analysis was employed to visualize the relationships between statistics course performance, stress levels, and sleep duration (see Pramesti, 2011 for methodology). This technique reveals structural patterns in the data, complementing the prior statistical tests. The two-dimensional solution accounts for 100% of the total inertia, with Dimension 1 explaining 68.2% and Dimension 2 explaining 31.8% of the variance. Figure 3 displays the correspondence plot for stress and achievement. The plot shows moderate stress levels positioned in spatial proximity to grade categories B and A. High stress levels also appear near these grades, but are the closest category to the solitary C grade. This spatial arrangement suggests that while high grades are common across stress levels, the occurrence of a C grade is visually associated with high stress in this dataset. In contrast, the low stress category is distantly positioned from all grade clusters, a pattern that is likely influenced by its underrepresentation in the sample.

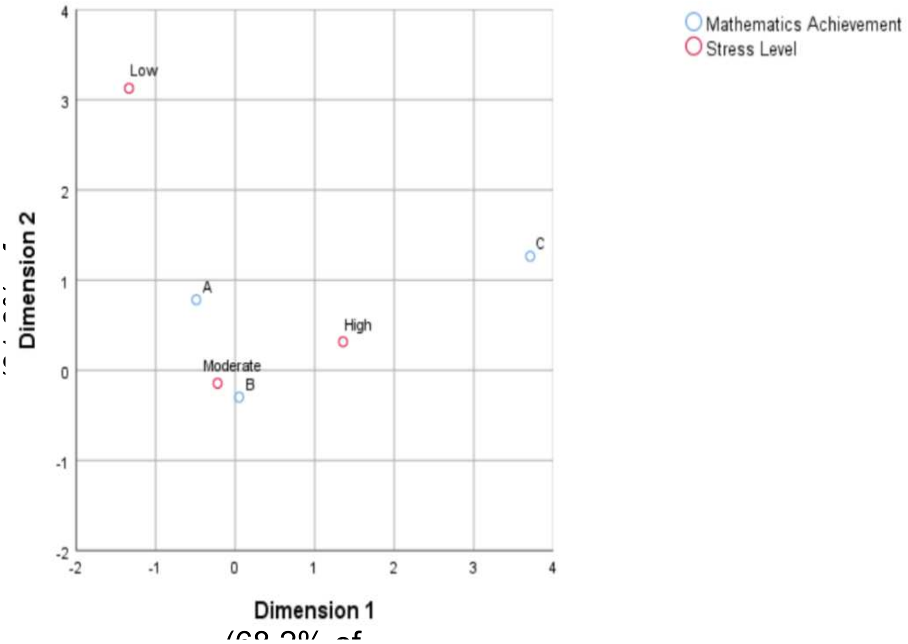

Figure 3. Correspondence plot stress level

Figure 4 presents the correspondence plot for sleep duration and achievement. The model explains 100% of the inertia, with Dimension 1 accounting for 73.0% and Dimension 2 for 27.0% of the variance. A visual cluster can be observed, comprising short sleep duration, adequate sleep duration, and the A and B grade categories. This pattern indicates an associative link between these sleep durations and higher grades in the perceptual map. Conversely, the long sleep duration category is positioned away from the main cluster of grades, suggesting a weaker association with high academic achievement in this visualization. The C grade is also distantly located from all sleep duration categories.

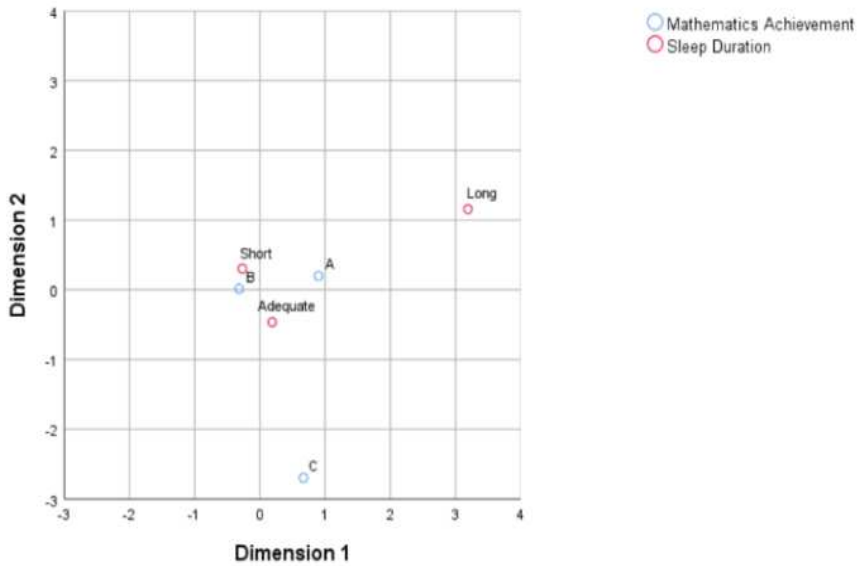

Figure 4. Correspondence plot sleep duration

Discussion

This study investigated the relationship linking perceived stress levels, sleep duration, and academic achievement in Basic Statistics among undergraduate Mathematics Education students across three academic cohorts at a public university in Surakarta, Indonesia. Chi-Square testing did not detect significant relationships linking stress levels or sleep patterns to statistics course performance. However, the descriptive trends and correspondence analysis uncovered important insights into behavioral and performance patterns worth discussing through the lens of educational psychology and cognitive science.

Descriptive data and correspondence analysis suggest that students experiencing moderate stress levels achieved the highest academic performance, particularly concentrated in the B+ to A range. The observed pattern aligns with the Yerkes-Dodson Law (Yerkes & Dodson, 1908), a seminal psychological framework positing that performance and arousal exhibit a curvilinear, inverted U-shaped association, where moderate levels of arousal or stress are associated with improved alertness and task focus. This classic model is deepened by modern theoretical frameworks. Attentional Control Theory (Eysenck et al., 2007), for instance, expands upon the Yerkes-Dodson framework by emphasizing how anxiety impairs the efficiency of attentional control mechanisms. It provides valuable insights into how stress influences cognitive performance, particularly under high stress, leading to increased distractibility and reduced working memory capacity. Similarly, Processing Efficiency Theory (Eysenck et al., 2007) highlights that anxiety can increase cognitive effort and reduce processing efficiency. This may explain why some students under moderate stress perform better by allocating more cognitive resources, whereas excessive stress overwhelms these compensatory mechanisms. According to these models, moderate stress is linked to better academic outcomes, while both low and high stress levels may hinder performance due to under-engagement or overwhelming anxiety, respectively. Together, these theories provide a nuanced understanding of the non-linear relationship between stress and academic achievement.

Students classified under high stress levels showed a wider distribution of grades, including the only recorded C grade in the dataset. While many still attained B+ and A grades, the presence of a lower-bound outcome in this group suggests variability in how students cope with heightened stress. This observation is consistent with findings from Fuente et al. (2020) and Pascoe et al. (2020), who noted that elevated academic stress may impair cognitive control, increase emotional reactivity, and reduce self-regulatory learning behaviors, ultimately disrupting academic performance in demanding courses such as statistics.

Interestingly, students reporting low stress levels were underrepresented and exhibited no strong correspondence with any grade category. This could suggest a lack of academic pressure leading to diminished performance drive, as theorized by the Yerkes-Dodson model. It may also reflect disengagement or low internal motivation, a pattern found in earlier work on academic underachievement under low-pressure conditions (Sinval et al., 2024).

Sleep duration presented a more nuanced relationship with academic achievement. Contrary to most sleep research, which emphasizes the importance of 7–9 hours of sleep for optimal cognitive functioning (Chaput et al., 2020; NSF, 2015), students with short sleep durations (<6 hours) represented the largest group of high achievers, particularly those earning B+ grades. This result also mirrors findings from Okano et al. (2019) and Hasanah et al. (2023), which showed that sleep patterns among high-performing students are often irregular, reflecting strategic time allocation for academic tasks rather than adherence to ideal sleep hygiene.

An intriguing finding in our study is the presence of high-achieving students who reported sleeping less than six hours per night. This paradox may be explained by frameworks of academic resilience and strategic sacrifice, where students consciously reduce sleep to allocate more time and effort to studying as a short-term coping mechanism. Such behavior reflects a form of adaptive resilience, enabling students to endure temporary sleep deprivation in pursuit of academic success, although this strategy may carry risks for long-term cognitive and health outcomes (Martin & Marsh, 2006). To further contextualize this phenomenon, we draw on cognitive load theory (Sweller, 1988), self-regulated learning (Zimmerman, 2002), and student resilience literature (Martin & Marsh, 2006). Cognitive load theory suggests that learners have limited cognitive resources, which must be efficiently managed to optimize learning; self-regulated learning emphasizes the importance of students' proactive control over their study strategies and time management, often balancing competing demands. Together, these frameworks provide a multidimensional understanding of how students may strategically allocate limited resources—such as sleep and study time—to maintain performance under academic pressure. Integrating these perspectives enriches our interpretation of the complex interactions between sleep patterns, stress levels, and academic achievement observed in this study.

This paradox may be explained by adaptive behaviors where students under academic pressure deliberately sacrifice sleep for study or exam preparation, especially in mathematically intensive subjects requiring problem-solving and analytical reasoning (Yan, 2025). However, while this strategy might yield short-term gains, sustained sleep deprivation has been widely associated with long-term cognitive decline, emotional instability, and health risks (Machado et al., 2022; Vedaa et al., 2019), suggesting a potential trade-off between immediate academic outcomes and overall well-being.

Students with adequate sleep (6–8 hours) also demonstrated solid academic performance, although slightly less concentrated in the top grade categories compared to short sleepers. This group exhibited a broader distribution of grades and included one instance of a C grade, possibly indicating that while adequate rest supports general cognitive performance, it alone does not guarantee academic success. Motivation, study habits, and time management likely play mediating roles (Acosta-Enriquez et al., 2025).

On the other hand, students with long sleep durations (>8 hours) were notably underrepresented and associated with the lowest academic output, with only one of them earning an A. This outcome supports findings by Ouyang et al. (2024) that suggest both insufficient and excessive sleep can impair cognitive function. Long sleep may also indicate underlying health issues, fatigue, or low engagement, factors that negatively impact learning outcomes.

Although Chi-Square analysis found no statistically meaningful relationships between stress levels or sleep duration and academic achievement, these non-significant results may be attributed to sample size limitations and the categorical nature of the variables, which can reduce test sensitivity. In contrast, correspondence analysis, a technique well-suited for uncovering latent patterns in categorical data (Pramesti, 2011), provided more nuanced visualizations of how stress and sleep dimensions align with academic performance.

For stress, moderate stress levels were positioned closest to grades B and A in the correspondence map, reinforcing the descriptive findings and theoretical alignment with the Yerkes-Dodson Law. High stress levels showed proximity to both high and low academic performance (including the C grade), highlighting its dual nature as both a potential motivator and a cognitive disruptor, depending on students' coping capacity and resilience.

Similarly, correspondence analysis of sleep data revealed that short sleep durations clustered near B and A grades, with adequate sleep also nearby. Meanwhile, long sleep duration was positioned distantly from all grade categories, particularly from B+ and A, suggesting minimal contribution to academic excellence. This spatial isolation further supports the view that longer-than-recommended sleep may not be conducive to high academic functioning and might instead signal disengagement or other non-academic influences.

These findings offer several critical implications for educators, academic counselors, and university policymakers. First, stress should not be viewed solely as a detriment to academic performance. Moderate levels of stress can enhance student engagement and achievement when accompanied by adequate support systems and coping strategies, such as time management training, academic counseling, and resilience workshops (Pascoe et al., 2020; Yunarti et al., 2024).

Second, the data challenge prevailing narratives around sleep hygiene in academic populations. While adequate sleep remains ideal from a health perspective, real-world student behavior suggests that strategic (albeit suboptimal) sleep reduction is often used as a coping mechanism to meet academic demands. Universities might address this paradox by promoting smarter scheduling, improving workload distribution, and teaching students about the long-term costs of chronic sleep deprivation, rather than prescribing rigid sleep targets.

From a research perspective, this study underscores the need for longitudinal research designs that can track stress, sleep, and academic outcomes over time. Future studies could incorporate objective sleep tracking technologies (e.g., wearables), control for mediating variables such as learning style and motivation, and compare results across diverse academic disciplines. Additionally, mixed-methods research—including qualitative interviews—may uncover the internal decision-making processes students use when balancing rest, stress, and academic performance.

While this research provides valuable preliminary insights, several limitations should be considered. First, the study's sample size (N = 45) was drawn from a single program at one university, which restricts the generalizability of the findings to broader student populations. Furthermore, the statistical power was limited for specific categories. This was particularly evident in the stress level distribution, where only one student was categorized as "low stress," making comparisons for this group unstable. Similarly, the "long sleep" group contained only one student, preventing meaningful analysis for these segments.

Methodologically, the reliance on self-reported measures for both stress levels (via the PSS-10) and sleep duration introduces the potential for recall and reporting bias. The study's focus was also limited to sleep duration, leaving critical aspects such as sleep quality, consistency, and chronotype unassessed. Additionally, the chosen sleep duration categories (< 6h as insufficient, 6–8h as adequate, > 8h as excessive), while providing a systematic framework based on Wang et al. (2019), present a limitation. This classification, originally designed for adult health outcomes, includes 6 hours in the "adequate" range, which is below the 7–9 hours recommended for young adults by the National Sleep Foundation (NSF, 2015). Consequently, this may not fully capture the sleep needs optimal for cognitive performance in a student population. Finally, the analysis did not account for several confounding variables known to predict academic performance, including prior mathematical ability, study habits, academic motivation, mental health history, and course engagement. Consequently, this research is best framed as an exploratory investigation, and the findings should be interpreted within this context.

Conclusion

This research sought to examine the association between students' perceived stress levels, sleep duration, and academic achievement in the Basic Statistics course. Based on the data analysis, the results indicate that there is no statistically significant association between stress levels or sleep duration and statistics course performance. These findings suggest that variations in psychological stress and sleep habits alone do not directly predict student performance in quantitative academic settings such as statistics.

However, the analysis offers a more nuanced view, uncovering patterns that point to a form of academic resilience, wherein students are capable of sustaining strong academic outcomes despite facing moderate stress or suboptimal sleep. The primary implication of this finding is that student success is influenced by a complex interplay of factors, challenging simplistic assumptions about the detrimental impact of stress and limited sleep. For academic practice, this underscores the need to integrate psychosocial and lifestyle support into student development programs. Universities should provide resources for stress management and sleep hygiene not solely to boost academic performance, but to foster holistic student well-being and teach adaptive coping mechanisms tailored to individual needs.

Building upon the limitations and findings of this exploratory study, future research should pursue more comprehensive and methodologically diverse approaches. First, it is crucial to investigate this topic with larger, more diverse, and more evenly distributed samples across stress and sleep categories from multiple institutions and academic disciplines to enhance generalizability and statistical power. To overcome the key methodological constraints identified, subsequent studies should prioritize longitudinal designs that track students over time, incorporating objective measures such as actigraphy for sleep monitoring and biomarkers for physiological stress. This would provide a more robust dataset that complements and validates self-reported measures, while also allowing refinement of sleep duration categories better suited to young adult populations, moving beyond the sole reliance on sleep duration to include critical assessments of sleep quality, consistency, and chronotype, which are vital for cognitive function.

Furthermore, research must expand its scope to include the numerous confounding variables that influence academic achievement. Future studies should develop and employ multivariate models that integrate factors such as prior mathematical ability, specific study habits, academic motivation, mental health history, and course engagement. Adopting mixed-methods approaches is highly recommended to unravel the "why" behind the observed patterns; qualitative interviews and focus groups can illuminate the coping strategies, time-management techniques, and resilience factors that enable some students to perform well under stress or limited sleep. Ultimately, such integrated research will yield a holistic understanding of the complex interplay between psychological, behavioral, and cognitive dimensions, offering deeper insights into causal pathways and informing more effective student support interventions.

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Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript.

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Author Contributions

Getut Pramesti: Conceptualization, validation, supervision, writing -review & editing, methodology; **Rifki Arifur Rohman**: Conceptualization, formal analysis, writing -original draft, visualization; **Sanggita Nariswari Cahyarani**: Conceptualization, formal analysis, writing -original draft

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