

## **The Impact of Caffeine Consumption on Non-neurotypical Student Stress Levels**

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### **ABSTRACT**

*The research into the question of caffeine intake in relation to university students' stress, both neurotypical and neurodivergent students, through an inclusive survey which consisted of 123 respondents, recorded sharp differences concerning caffeine's action and its relation to neurodiverse status: 65.4% of neurodivergent students experienced an increase in the level of stress from caffeine consumption, while 29.3% of neurotypical ones did. Despite higher adverse effects, characteristics were higher: 50% consume three or more per day compared to 19.6% of neurotypical peers. The mean stress level of the neurodivergent students was notably higher, at 8.2/10, compared to that of the neurotypical students, at 7.1/10. Sleep quality became a point of concern, as 88.5% of the neurodivergent students reported caffeine use to disrupt sleep moderately or significantly. Indeed, the paradoxical pattern underlined that, despite the more severe negative effects of caffeine, neurodivergent students retain higher caffeine consumption, probably due to self-medication patterns or poor alternative strategies to cope with stress. These findings emphasize the need for differentiated approaches in student support services and stress management programs, taking into consideration neurodiversity status while formulating wellness strategy formulations.*

**Keywords:** Academic Performance, Attention and Memory, Caffeine Consumption, Cognitive Function, Psychological Well-being, Stress Management, Student Mental Health.

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## INTRODUCTION

Educational institutions are increasingly recognizing the unique needs of non-neurotypical students, including those with autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and other neurodevelopmental conditions. These students often face heightened stress levels, which can negatively impact their academic performance. One factor that has garnered attention in recent years is the consumption of caffeine (1,3,7-trimethylxanthine), a common stimulant used to enhance alertness and cognitive function.

Caffeine is frequently consumed through beverages such as coffee, tea, and energy drinks, and is widely used by students to improve concentration and reduce fatigue. However, the effects of caffeine on non-neurotypical students remain under-researched. This study aims to address this gap by investigating the influence of caffeine consumption on stress levels in non-neurotypical students.

The primary research question is: Does caffeine consumption alleviate or exacerbate stress in non-neurotypical students? This study seeks to understand whether caffeine can be an effective tool for managing stress or if it presents additional challenges for these students. By analyzing self-reported stress levels and cognitive performance metrics, this research aims to provide insights that can enhance the educational experience of non-neurotypical students.

## LITERATURE REVIEW

Caffeine enhances mental function by interacting with the central nervous system, primarily acting as an antagonist of adenosine receptors. By blocking adenosine, a neuromodulator that promotes sleep and relaxation, caffeine prevents the downregulation of neurotransmitter release, thereby boosting dopamine and norepinephrine activity. This results in heightened alertness, improved attention, and enhanced working memory. Additionally, caffeine modulates the hypothalamic-pituitary-adrenal axis, reducing fatigue perception and counteracting cognitive decline under stress. However, while moderate doses can boost cognitive resilience, excessive intake can dysregulate the autonomic nervous system, leading to anxiety issues [1].

A study published in *Neuropsychologia* investigated caffeine's effects on cognitive functions such as attention, memory, and reaction time, particularly under stressful conditions. The researchers found that caffeine improved cognitive performance in tasks requiring sustained attention and working memory, and moderate consumption offset stress-induced impairments. These findings highlight caffeine's potential as an intervention to maintain cognitive efficiency in high-pressure contexts [2].

However, the study did not account for neurodivergent populations, raising questions about the applicability of its findings to these individuals.

Conditions like ADHD, autism, and dyslexia can significantly influence stress responses and reactions to stimulants like caffeine. The exclusion of neurodivergent participants limits the generalizability of the results, as their cognitive profiles and stress responses may differ from neurotypical individuals.

Furthermore, research with U.S. Navy SEALs demonstrated that moderate doses of caffeine improved cognitive performance after sleep deprivation and continuous stress exposure. Caffeine positively influenced tasks related to vigilance, reaction time, and alertness [3]. However, the effects of caffeine on neurodivergent groups remain uncertain. Some individuals with ADHD report increased attention, while others experience heightened anxiety or restlessness [4]. Understanding dosage requirements and tailoring interventions for neurodivergent individuals is crucial for developing inclusive cognitive support strategies.

Existing research highlights caffeine's potential benefits in stress management and cognitive enhancement among students. However, neurodivergent students have unique cognitive profiles and stress responses that warrant further investigation. Chronic caffeine consumption's long-term implications for cognitive function and stress levels are under-researched, and cultural factors influencing caffeine's impact are often overlooked. By addressing these gaps, this study aims to provide a more nuanced understanding of caffeine's effects on stress and cognitive function among neurodivergent students.

## **RESEARCH METHOD**

This study has used the mixed-methods approach, combining both quantitative data gathering through an online survey and qualitative analyses of participants' self-described experiences. Currently, this study will seek a correlation between consumption of caffeine with the level of stress in the students, considering how caffeine links with the influences of academic stresses on cognitive functioning.

### **Participants**

This study sample consisted of 123 undergraduate students in medicine attending the University of Debrecen. Participants were recruited through the university email database and on campus request. Full-time students (both local and international) within the age limit of 18 to 30 years were qualified for the present study. Special efforts were being made to collect data from people of different cultures and neurodiverse individuals.

The following hypotheses were proposed:

H<sub>1</sub>: Caffeine Consumption Enhances Cognitive Performance in neurodivergent students.

H<sub>2</sub>: Caffeine Intake Exacerbates Stress and Anxiety in non-neurotypical students.

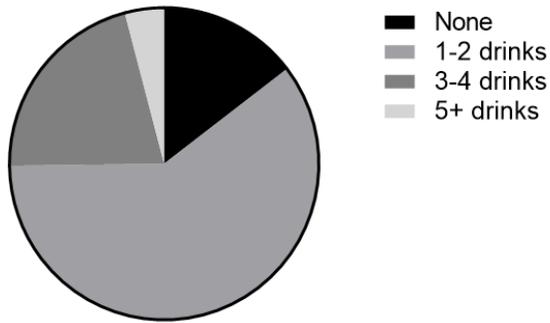
The data were collected using the Google Form structured with questions on demographic variables, perceived level of stress, and cognitive performance measures. It took 10 minutes to answer all the questions. It was open for five weeks.

- **Contact Information:** demographic information on the participants' data included age, gender, majoring, and year of study.
- **Caffeine Use:** Items queried the daily frequency and quantity of caffeine consumed, from sources like coffee, tea, energy drinks, and caffeine pills.
- **Stress Levels:** The perceived stress scale, PSS, determined the respondent's stress level during the last month. This psychological tool is widely used to determine the extent to which life situations are evaluated as stressful.
- **Mental health:** All the information regarding the mental health status of the test subjects was gathered and further validated, excluding answers from people who do not have a diagnosis made by a healthcare professional.

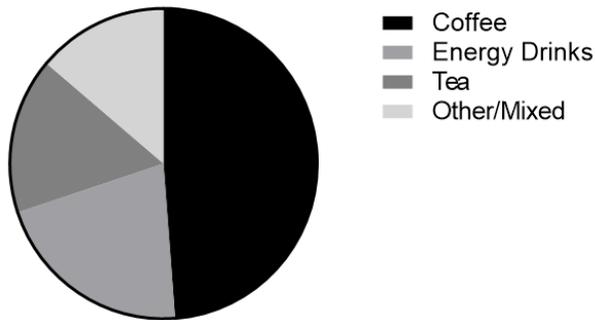
## RESULTS

Analysis of survey responses (N=123) identified a number of significant trends relating to caffeine use habits and their relation to student stress levels. The pie chart below depicts the number of caffeinated beverages consumed by the group of students in average during the semester. Most of the students consume at least 1 to 2 caffeinated drinks per day, and some admitted to even consuming more than 5 caffeine-containing drinks per day. In fact, 60.2% consumed between 1-2 caffeinated drinks per day. This was followed by 21.1% who reported between 3-4 caffeine drinks daily. A smaller proportion, 4.1%, reported 5 or more caffeine drinks daily, and 14.6% did not consume any regularly. (Figure 1)

Analyzing the pattern of students caffeine consumption, coffee was the preferred consumed beverage (48.8%), followed by energy drinks (21.1%) and tea (16.3%). The remaining students either consumed multiple types of beverages, including pre-workout, or other sources of caffeine (13.8%). (Figure 2)



**Figure 1: Daily caffeine consumption patterns among students (N=123).** *The figure illustrates the distribution of daily caffeine consumption among a sample of 123 students. The categories include no consumption, 1-2 drinks, 3-4 drinks, and 5 or more drinks per day.*

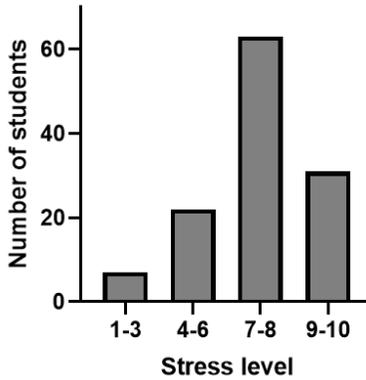


**Figure 2: Preferred beverage types among students (N=123).** *This figure depicts the distribution of preferred beverage types among students. The categories include coffee, energy drinks, tea, and other/mixed beverages.*

Among students, the majority (39.0%) consumed caffeine throughout the day. Others reported specific times of caffeine consumption: in the morning, afternoon, and evening/night, at 26.0%, 22.8%, and 12.2%, respectively.

### ***Stress Levels and Perceived Effects***

The average reported level of stress of the respondents was 7.4 out of 10 with  $SD \approx 1.9$ , indicating a generally high level of stress among the student population. Interestingly, while 13.0% of the respondents reported maximum stress levels (10/10), only 5.7% reported low levels of stress (1-3 out of 10). (Figure 3)



**Figure 3: Reported stress levels among students (N=123).** This figure presents the distribution of reported stress levels among students, categorized into four ranges: 1-3, 4-6, 7-8, and 9-10. The y-axis represents the number of students reporting each stress level.

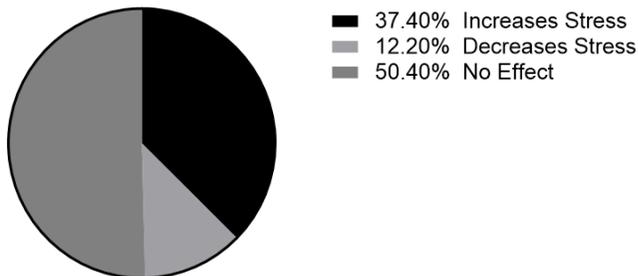
Perceived relationship between caffeine consumption and stress:

- 37.4% reported an increase in stress
- 12.2% reported a decrease in stress
- 50.4% did not notice any effects

**Physical and Psychological Effects**

The immediate actions of caffeine in the body differ among respondents as follows:

- 29.3% felt more energized
- 19.5% felt more alert
- 15.4% feel jittery or anxious
- 35.8% did not differ or other responses

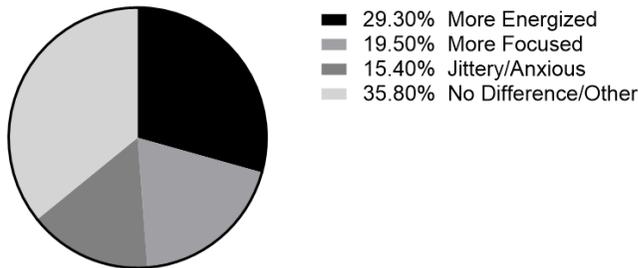


**Figure 4: Effect on stress levels among students (N=123).** This figure illustrates the perceived effects on stress levels among students. The categories

include increases in stress (37.40%), decreases in stress (12.20%), and no effect (50.40%)

On stressful symptoms following Caffeine Intake:

- 13.8% reported experiencing stress symptoms "Always" or "Often"
- 33.3% reported experiencing such symptoms "Sometimes"
- 30.1% said they experienced those symptoms "Rarely"
- 22.8% reported "Never" experiencing any such symptoms



**Figure 5: Immediate effects after consumption among students.** *This figure shows the immediate effects reported by students after consumption. The categories include feeling more energized (29.30%), more focused (19.50%), jittery/anxious (15.40%), and no difference/other effects (35.80%).*

### ***Sleep Impact***

Most respondents, 71.5%, perceived that caffeine impacted their sleep to one degree or another. Of those who reported the following levels of sleep impact:

- 22.8% significant sleep impact
- 48.7% moderate sleep impact

Another 52.0% had reduced or considered reducing their caffeine intake because of its effects on their level of stress while 31.7% had never considered reduction and 16.3% were undecided.

### ***Stress Management***

While 19.5% of the respondents reported taking caffeine for managing stress, the majority (80.5%) consumed caffeine for other reasons. Of those who reported diagnosed mental health conditions-21.1% of the respondents, while some preferred not to say-a higher proportion, 65.4%, reported experiencing stress-related symptoms after caffeine consumption compared to those without diagnosed conditions.

### ***Comparison of Caffeine Effects in Neurotypical and Neurodivergent Students***

Out of the 123 respondents, 26 students reported diagnosed mental health conditions (21.1%), 92 students reported no diagnosed conditions (74.8%), and 5 students preferred not to disclose this information (4.1%). This division allows for a meaningful comparative analysis to be made between neurotypical and neurodivergent student populations of caffeine's effects.

### **Consumption Patterns and Preferences**

As described below, the consumption patterns of neurodivergent students were radically different from those of their neurotypical peers in several ways.

#### **Frequency of Consumption:**

Consumed more caffeine in larger amounts-34.6% reported intake of 3-4 types of beverages each day compared with 17.4% in neurotypical students. Whereas 15.4% neurodivergent students reported caffeine intake of more than 5 types of caffeinated beverages compared with 2.2% in neurotypical students.

#### **Beverages Preferences:**

Use of energy drink use was significantly different amongst neurodivergent students, 30.8%, as compared to the neurotypical students that accounted for only 18.5%.

Coffee remained the primary choice for both groups, though slightly lower among neurodivergent students (42.3% vs. 50.0%)

#### **Stress Manifestation and Management:**

The relationship between caffeine consumption and stress showed marked differences between the two groups:

- Baseline Stress Levels: Neurodivergent students reported higher average stress levels (8.2/10) compared to neurotypical students (7.1/10)
- 26.9% of neurodivergent students reported maximum stress levels (10/10) versus 9.8% of neurotypical students

#### **Stress Response to Caffeine:**

65.4% of neurodivergent students reported an increase in stress from caffeine, as opposed to 29.3% of neurotypical students. Only 7.7% of neurodivergent students reported a reduction in stress from caffeine, as opposed to 13.0% of neurotypical students. The remaining 26.9% of neurodivergent and 57.7% of neurotypical students reported no noticeable effect.

## **Physical and Psychological Responses**

Neurodivergent students reported higher rates of jitteriness and anxiety (26.9% vs. 12.0%). The "focused" effect was reported less for neurodivergent students than neurotypical students: 15.4% vs. 20.7%, respectively. Sleep disruption for neurodivergent students was higher, with 88.5% reporting that their sleep was moderately to significantly affected, as opposed to 67.4% of the neurotypical students.

## **Coping Strategies and Adaptation**

The data showed a marked difference in managing caffeine intake for each group:

- **Intentional Use:** 34.6% of the neurodivergent students reported using caffeine specifically to manage stress, while for neurotypical students, this number was 15.2%. However, neurodivergent students were more likely to report adverse side effects from this coping strategy
- **Modification Attempts:** 73.1% of neurodivergent students had either tried or considered reducing their intake of caffeine due to stress-related effects, compared with 46.7% of neurotypical students. The success of reduction attempts was lower for neurodivergent students, 42.3% of whom reported failed attempts to reduce consumption.

## **Timing Patterns**

Neurodivergent students showed more variable consumption patterns throughout the day. Evening/night consumption was higher for neurodivergent students than for non-neurodivergent students: 19.2% vs. 10.9%, respectively. This difference in timing correlated with higher reports of sleep disruption.

## **DISCUSSION AND CONCLUSIONS**

This study will provide valuable insight into the correlation between caffeine use and perceived levels of stress among neurotypical and neurodivergent students, demonstrating complex patterns of interaction between caffeine use, stress management, and neurodiversity.

### **Differential Impact on Student Populations**

One of the most striking findings in this study is the striking difference in the effects of caffeine between neurotypical and neurodivergent students. The much larger proportion of neurodivergent students reporting stress-increasing effects of caffeine (65.4% vs 29.3% in neurotypical students) would suggest a fundamental difference in physiological and psychological responses to caffeine based on neurodiversity status. This may be attributed to heightened sensory sensitivity and

altered neurotransmitter functioning commonly associated with various neurodivergent conditions.

### **Paradoxical Consumption Patterns**

Neurodivergent students, including those with ADHD, autism, and other neurodevelopmental conditions, often face unique challenges that can influence their caffeine consumption patterns. Despite experiencing negative effects such as increased anxiety or restlessness, many neurodivergent students continue to consume caffeine. A paradoxical consumption pattern was noticed in the fact that though neurodivergent students reported more negative effects, they still consumed more caffeine. While 50% of the students in this group consumed 3 or more caffeinated beverages per day, the proportion among neurotypical students stood at 19.6%. This may be indicative of the following:

- Developing dependence despite negative effects
- Lack of awareness about managing stress
- Caffeine is used to deal with challenges other than managing stress.

Understanding the psychological and behavioral factors underlying this paradox is crucial for developing effective interventions and support strategies. Neurodivergent students may use caffeine as a form of self-medication to manage symptoms associated with their conditions. For instance, individuals with ADHD might consume caffeine to improve focus and concentration, as stimulants are known to enhance cognitive function. Similarly, students with autism may use caffeine to alleviate fatigue or enhance social interactions, despite the potential for adverse effects. This self-medication can become a coping mechanism, even if it is not the most effective or healthy long-term solution.

### **Sleep Impact and Academic Performance**

The high prevalence of sleep disruption, particularly among neurodivergent students, where 88.5% reported a moderate to significant sleep impact, feeds into concerns regarding the self-perpetuating cycle of caffeine use, sleep quality, and stress levels. This may be particularly pernicious for academic performance and general well-being, suggesting targeted interventions are needed that address both caffeine consumption and sleep hygiene. The academic environment can be particularly stressful for neurodivergent students, who may experience heightened levels of anxiety and pressure to perform well. Caffeine, with its stimulating effects, can provide a temporary boost in alertness and cognitive function, making it an appealing option for managing stress and meeting academic demands. However, this reliance on caffeine can lead to a cycle of dependence, where students consume more caffeine to maintain their performance, exacerbating underlying stress and anxiety.

Social influences and peer pressure can also significantly influence caffeine consumption among neurodivergent students. In many educational settings, caffeine use is normalized and even encouraged to enhance productivity and social engagement. Neurodivergent students may feel compelled to conform to these social norms, leading to increased caffeine consumption despite personal negative experiences. They may lack awareness or access to alternative strategies for managing stress and enhancing cognitive function. Without adequate coping mechanisms or support systems, caffeine can become a default solution. Educational institutions and healthcare providers can be crucial in providing neurodivergent students with evidence-based alternatives, such as mindfulness practices, cognitive-behavioural therapies, and tailored academic accommodations.

It is essential to recognize that neurodivergent students may have varying sensitivities to caffeine, influencing their consumption patterns and experiences. Some individuals may derive cognitive benefits from caffeine with minimal adverse effects, while others may be more susceptible to negative outcomes. Understanding these individual differences can inform personalized interventions and recommendations for caffeine use. Caffeine consumption can lead to psychological dependence, where individuals feel they need caffeine to function optimally. This dependence can be particularly challenging for neurodivergent students, who may rely on caffeine to manage symptoms and cope with daily demands. Breaking this habit requires a comprehensive approach that addresses both the psychological and behavioural aspects of caffeine use.

### **Implications for Support and Intervention:**

Addressing complex issues surrounding caffeine consumption among neurodivergent students requires nuanced strategies that account for unique circumstances beneath various factors. Support networks often play crucial part in promoting healthier lifestyles through various methods beneath murky circumstances. Firstly, raising awareness through workshops and seminars can empower students to make informed decisions about their caffeine use. These sessions should highlight both the benefits and risks, while peer support groups can provide a safe space for sharing experiences and exploring alternative coping mechanisms. Students benefit from customized support like tailored evaluations and behavioral therapy which fosters better coping mechanisms somehow. Promoting mindfulness practices and physical activity programs offers alternative strategies for managing stress and enhancing cognitive function. Additionally, creating flexible learning environments and providing access to assistive technologies can accommodate the unique needs of neurodivergent students, supporting their academic success. Collaboration with healthcare providers is essential for integrated support services and proper medication management,

ensuring that students receive the care they need. Institutions must develop policies promoting fairly responsible caffeine habits alongside partnerships with various outside organizations. Ongoing research and regular program evaluations are crucial for understanding the long-term effects of caffeine and refining interventions to meet students' needs better. By adopting these multifaceted strategies, educational institutions can foster a more inclusive and supportive environment that addresses the complex challenges faced by neurodivergent students, ultimately promoting their overall well-being and academic achievement.

## CONCLUSION

This study offers the basis for extensive insight into how complicated the relationship between caffeine consumption and levels of stress is within neurotypical and neurodivergent student populations in higher education. Responses from 123 students led to several key analyses that had ramifications for student wellbeing and institutional support services.

The findings from this study also show that even though caffeine consumption is quite prevalent among the population of students, its impact greatly differs between neurotypical and neurodivergent students. The finding that 65.4% of neurodivergent students report increased stress levels from caffeine consumption, compared to 29.3% of neurotypical students, draws attention to individualized approaches to stress management and wellness support within educational settings.

Of particular concern is the paradoxical pattern of higher caffeine consumption despite greater adverse effects in neurodivergent students, with 50% consuming three or more caffeinated beverages daily compared to 19.6% of their neurotypical peers. This pattern, coupled with higher baseline stress levels, 8.2/10 versus 7.1/10, indicates a critical need for targeted interventions and alternative stress management strategies for this population.

The results showed that sleep quality was a big concern: 88.5% of the neurodivergent students reported a moderate to significant sleep disturbance from caffeine consumption. This indicates how a vicious circle of caffeine consumption, disrupted sleep, and increase in the levels of stress-especially concerning academic performance-may be affecting overall well-being.

These findings have immediate practical implications for educational institutions, healthcare providers, and student support services. The development of neurodiversity-aware wellness programs, personalized stress management strategies, and improved screening for problematic caffeine use should be prioritized. Moreover, the results show that there is a need for greater awareness among students of the differential effects of caffeine both at an individual level and by neurodiverse status.

## IMPLICATIONS

Therefore, further studies should seek to investigate the physiological mechanisms underlying these differential responses to caffeine, monitor consumption longitudinally over academic terms, and evaluate the effectiveness of targeted interventions. In doing so, the current work further informs us as to how best to support our diverse student population in dealing with stress without sacrificing academic performance.

This study contributes to the growing body of research on student well-being and neurodiversity in higher education, while also providing practical insights to enhance the scope of student support services. The findings emphasize the importance of considering neurodiversity in the development of wellness strategies and advocate for more nuanced, personalized approaches to managing student health and stress within university settings.

Addressing caffeine consumption among neurodivergent students requires a multifaceted approach that includes raising awareness, providing personalized interventions, promoting alternative stress management strategies, and creating supportive academic environments. Collaboration with healthcare providers and ongoing research are essential for developing effective support systems. By implementing these strategies, educational institutions can foster a more inclusive environment that promotes the well-being and academic success of neurodivergent students.

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