

Effects Of Caffeine Intake And Withdrawal On Headache Patterns, Sleep Quality, And Mood Stability Amongst Medical Students Of India: A Cross-Sectional Study

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Abstract

Background: Caffeine is widely consumed by medical students to enhance alertness, especially during academic stress. However, excessive intake and abrupt withdrawal can lead to adverse effects, including headaches, sleep disturbances, and mood instability. Studies suggest that caffeine affects adenosine receptors, influencing sleep cycles and headache susceptibility. While global research highlights these concerns, data specific to Indian medical students remain limited. Medical students in India often rely on caffeine to cope with academic demands, yet its effects on their headache patterns, sleep quality, and mood stability are not well-documented. Understanding these impacts is crucial for promoting healthier consumption habits and mitigating withdrawal-related discomfort.

Aims & Objectives: The study targets to evaluate the effects of caffeine intake and withdrawal on headache patterns, sleep quality, and mood stability among medical students in India. The Study Objectives examine different patterns of Caffeine consumption prevalent in Indian MBBS students & getting insights into Gender wise & Professional year wise variation in the Study Outcome

Materials & Methods: Upon Institutional Ethics Committee approval, a cross-sectional study was conducted among 200 medical students across all the years, enrolled in Smt. Bhikhiben Kanjibhai Shah Medical Institute & Research centre, Piparia, Vadodara, Gujarat in India. Data were collected using validated questionnaires & Assessment of Headache Intensity, Sleep Quality & Mood Stability was done using Standardized Open access Scales like Numeric Rating Scale – NRS, Pittsburgh Sleep Quality Index - PSQI, and Depression, Anxiety, and Stress Scale - DASS-21 respectively. The effects of regular caffeine intake and withdrawal symptoms were analyzed using ANOVA and descriptive statistics.

Results: Regular caffeine consumers reported a reduction in headache intensity, while withdrawal led to increased headache severity. Majority (46.78%) of students who consumed caffeine regularly had reduced sleep duration (4-6 hours/night) and experienced difficulty in falling and staying asleep. Caffeine consumption was associated with increased focus, alertness, and concentration, but withdrawal led to increased daytime sleepiness, lack of motivation, and mood disturbances. ANOVA results showed significant differences ($p < 0.05$) in headache intensity, sleep quality, and mood stability between caffeine users and those experiencing withdrawal. **Conclusion:** This study highlights “the dual effects of caffeine”—while it enhances wakefulness and cognitive function, its withdrawal can severely impact headache patterns, sleep quality, and mood stability. Medical students should be encouraged to adopt moderate and regulated caffeine consumption while exploring “alternative strategies” for managing alertness and stress.

Key Words: Caffeine intake, caffeine withdrawal, headache intensity, sleep quality, mood stability, medical students, alertness, daytime sleepiness, cross-sectional study, Pittsburgh Sleep Quality Index (PSQI), Depression Anxiety and Stress Scale (DASS-21), Numeric Rating Scale (NRS).

INTRODUCTION

In India, the majority of caffeine consumption comes from liquids like tea and coffee., with tea being the traditional choice. However, current trends show a significant increase in coffee consumption, particularly

in urban areas. Between 2023 and 2024, India's coffee consumption surpassed one million 60-kilogram bags, reflecting a rise compared to the previous year 2022¹. Urban areas account for over 73% of total coffee consumption in India². Tamil Nadu leads the southern states in consumption, accounting for 60%, followed by Karnataka (25%), Andhra Pradesh (10%), and Kerala (5%)³. On average, an Indian drinks roughly 30 cups of coffee per year, which is much less than the global average of 200 cups per year⁴. Tea remains India's most popular beverage, with an annual consumption of around 1.2 billion kg as of the fiscal year 2022⁵. A study found that caffeine consumption among medical students increases during exam periods, with 60% reporting low consumption on regular days, which rises to 33% moderate and 7% high consumption during exams⁶. While tea remains the most popular source of caffeine in India, coffee consumption is increasing due to urbanization, changing lifestyles, and the spread of coffee culture.

Medical students frequently face high levels of stress, extended study hours, and unpredictable sleep patterns. As a result, caffeine consumption (via coffee, tea, energy drinks) is a typical coping method for increasing alertness, focus, and energy. Understanding caffeine's effects on their health, notably headaches, sleep, and mood, is critical for directing appropriate consumption habits. Caffeine withdrawal is a well-documented phenomena,⁷ however it is understudied in certain populations, such as medical students. Symptoms may include headaches, fatigue, irritability, or mood swings. Understanding the effects of caffeine withdrawal on headache frequency, sleep quality, and mood changes in a high-stress population such as medical students is critical for effective health management. With this information, students can make more informed decisions about when and how to minimize caffeine consumption, particularly during high-stress periods such as exam time. While caffeine consumption and withdrawal symptoms have been extensively examined in general populations, there is a scarcity of specific research on medical students. Conducting a study aimed exclusively at medical students will fill a vacuum in the existing literature and provide insights that are immediately pertinent to their life.

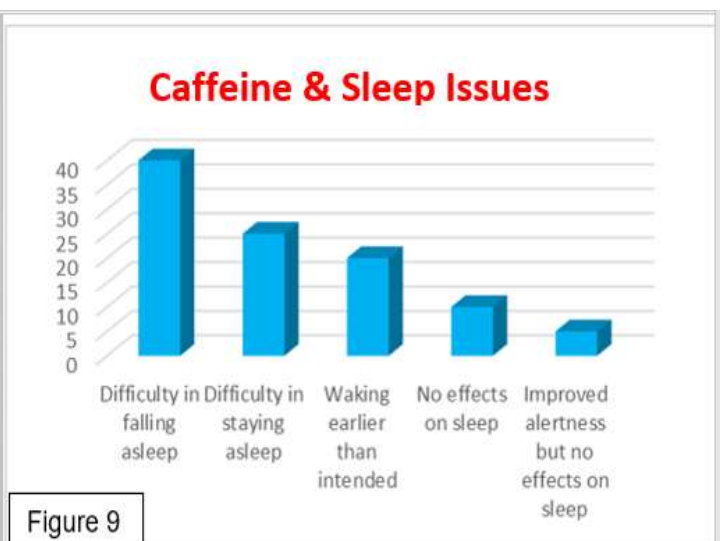
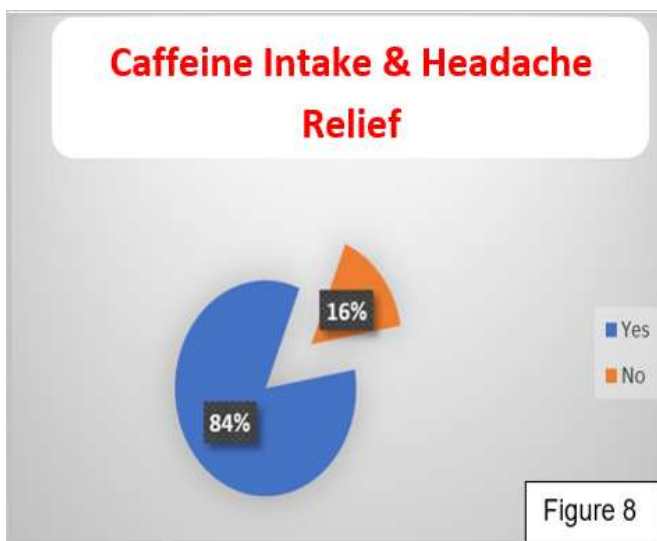
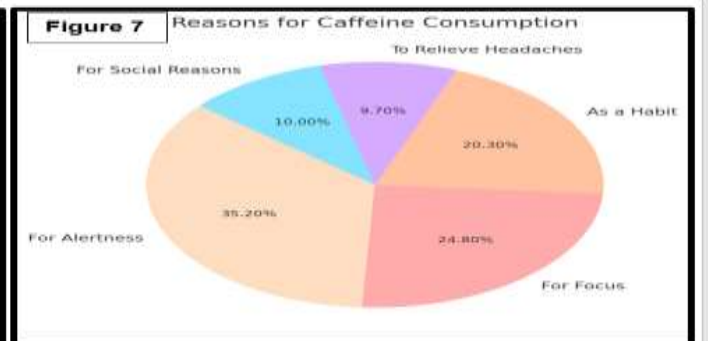
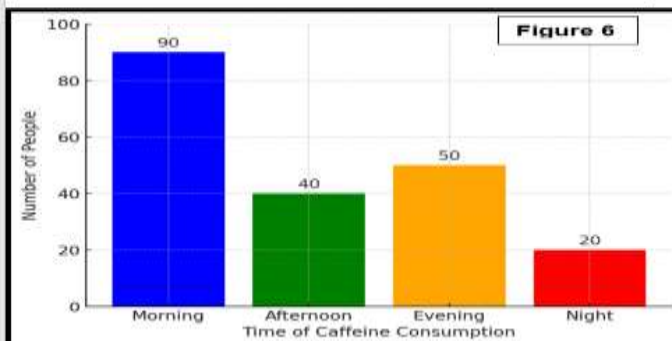
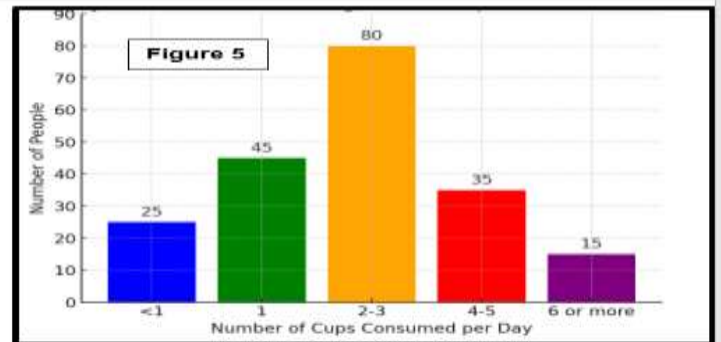
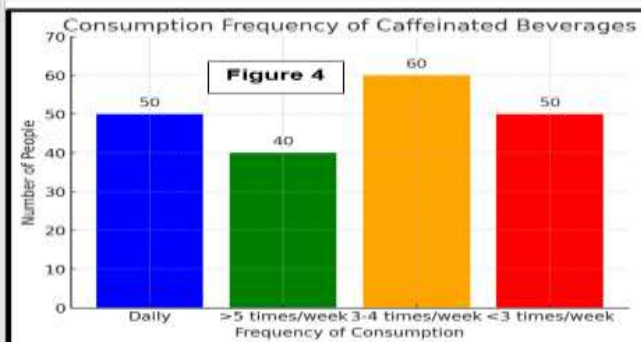
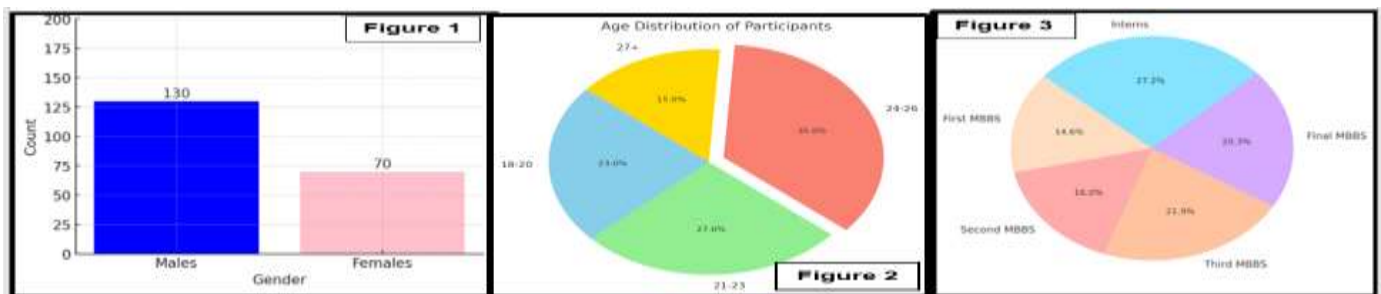
MATERIAL & METHODS:

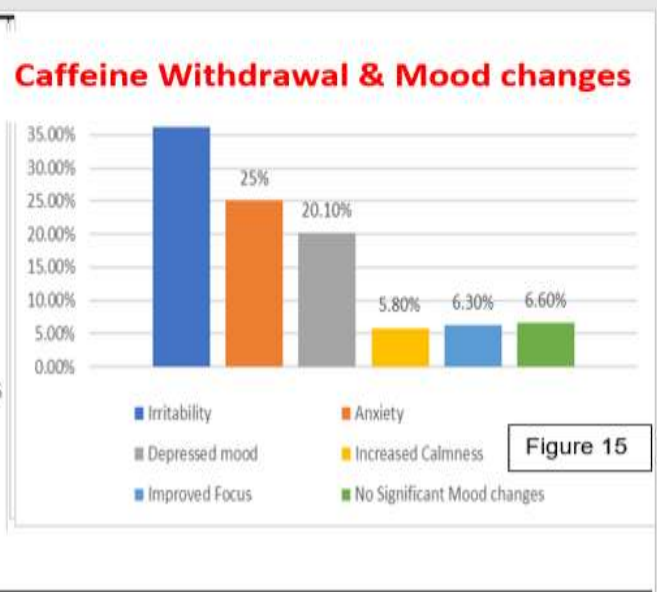
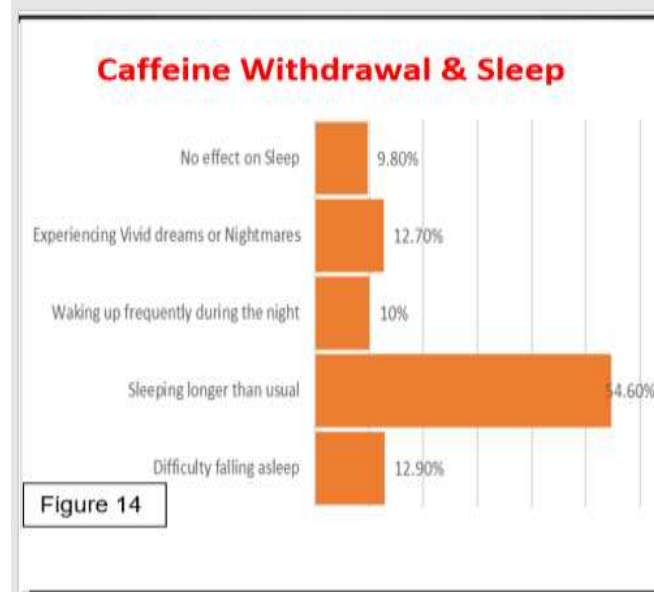
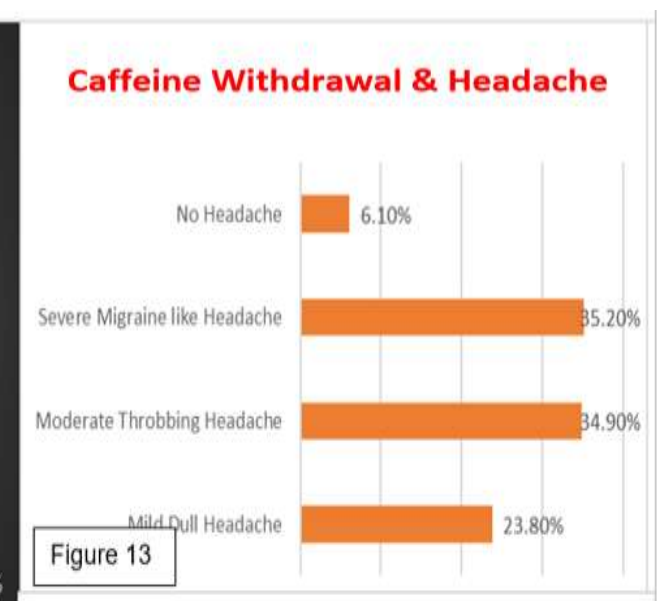
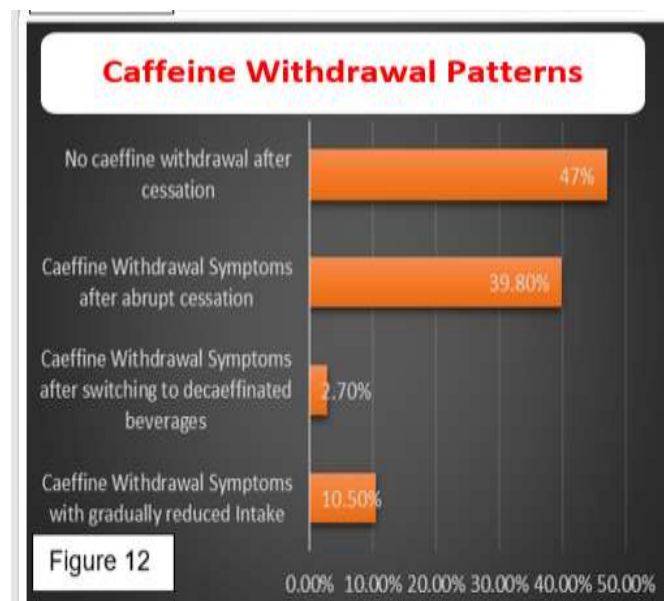
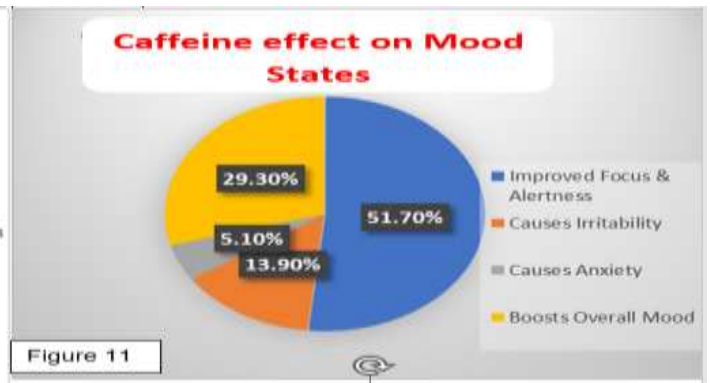
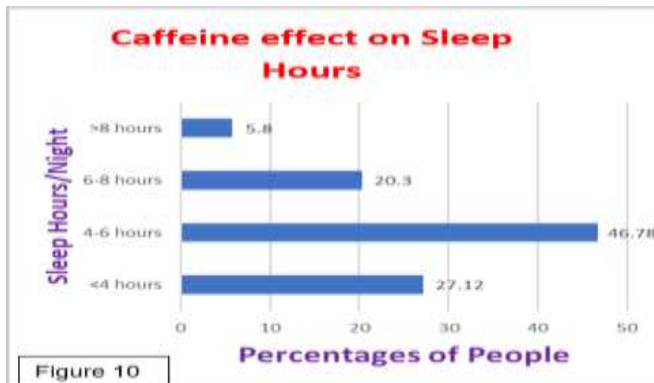
It is an Observational, Cross-Sectional type of study. The study commenced after grant of approval from Sumandeep Vidyapeeth Institutional Ethics Committee. Voluntarily willing, 18-30 years aged & regular caffeine consumers (at least 3 times a week), medical undergraduate students from all years of study at Smt Bhikhiben Kanjibhai Shah Medical Institute & Research centre, Piparia, Vadodara, Gujarat were included in the study. Students with pre-existing conditions that could significantly affect headache, sleep, or mood or Students currently on medication or undergoing treatment for mood disorders, chronic headaches & sleep disorders were excluded from the participation in the study. Sample size was calculated to be 200 based on an estimated medium effect size of 0.5, a confidence level of 95%, and a power of 0.8 using the formula $N = (z\alpha + z\beta)^2 * (k-1)/\text{effect size}^2$. A structured Questionnaire for capturing patterns of Caffeine Consumption or withdrawal & their effects on 3 health variables-headache intensity, sleep quality & mood stability of medical students was designed by the PI & Co-PI. It was pilot tested on 15% of Sample (30 Students) & was validated for clarity & reliability. For assessment of Headache Intensity, Sleep Quality & Mood stability, validated & open access Scales like Numeric Pain Rating Scale (NRS), Pittsburgh Sleep Quality Index (PSQI) & DASS-21 (Depression, Anxiety & Stress) scale respectively was also included with the questionnaire in separate sections in Google form. Google form link was shared with MBBS students across all the years & data was collected

Statistical Methods Data was analysed using SPSS (Statistical Package for Social Sciences). Descriptive statistics (mean, standard deviation) was used to summarize demographic characteristics and caffeine consumption patterns.

Inferential Statistics (Paired t-tests, Independent t-tests, Pearson correlation & Multivariate analysis) were used for detailed analysis of the data

RESULTS





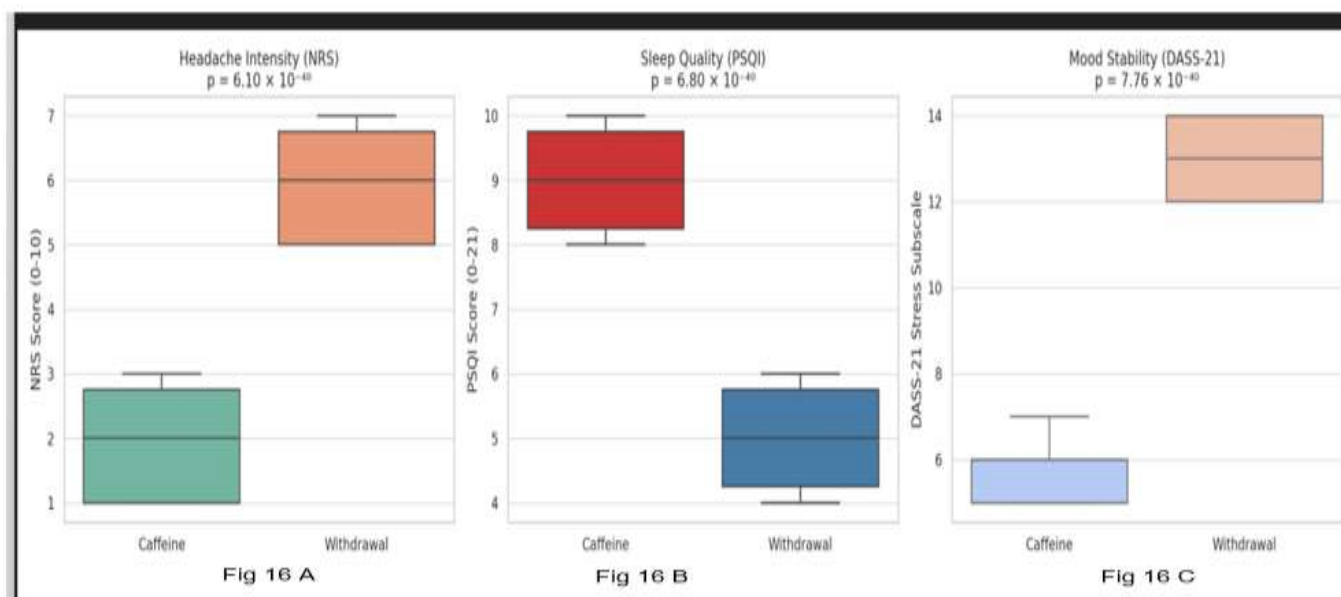


Figure 1 shows Gender-wise distribution of study participants. Male Participants were 130 and 70 female participants took part in study. The number of Males was significantly higher than females. Figure 2 represents the Age Distribution of the study population, divided into four age groups: 18-20 years age group accounted for 23.0% of the total population. 21-23 years represents 27.0% of the population. 24-26 years group was the largest segment, making up 35.0%. 27+ years was the smallest group, comprising 15.0%. The chart visually illustrates that the majority of individuals fall within the 24-26 age range, while the 27+ group has the least representation. Figure 3 illustrates the distribution of medical students across different academic levels in an MBBS program. The segments represent the following groups: Interns form the largest group, accounting for 27.2%. Final MBBS students constitute 20.3%. Third MBBS students make up 21.9%. Second MBBS students represent 16.0%. First MBBS students comprise the smallest group at 14.6%. The chart indicates that interns make up the highest proportion, while First MBBS students have the lowest representation. This suggests that the sample includes a relatively higher number of senior students and interns compared to early-stage MBBS students.

Figure 4-7 shows that a large majority find caffeine effective for headache relief. 25% Study population consumed Caffeine daily & an equal percentage were consuming caffeine less than 3 times per week. 20% subjects consumed more than 5 times a week. The Highest proportion of students were taking caffeine at least 3-4 times/week. The majority (80 students) consume 2-3 cups per day, indicating a moderate intake pattern. Most people prefer caffeine in the morning, likely to help them wake up and stay alert. Night time consumption is the least common. The Data analysis shows the main reason for caffeine consumption to be for alertness, followed by focus, suggesting that caffeine is primarily used to enhance cognitive function. This dataset provides insights into caffeine consumption patterns and motivations among the surveyed group.

Figure 8-11 represents the impact of caffeine consumption on sleep quality, categorizing different sleep disturbances experienced by individuals. Nearly 40% reported trouble initiating sleep after caffeine intake. This aligns with research showing that caffeine blocks adenosine receptors, delaying sleep onset. A significant portion of individuals faced sleep maintenance issues, such as waking up frequently during the night. This suggests that caffeine consumption disrupts the normal sleep cycle and reduces deep sleep duration. 25% participants reported waking up earlier than planned, likely due to caffeine's prolonged half-life, which can interfere with the body's ability to stay asleep. A small group of individuals did not experience any sleep disturbances, indicating variability in caffeine sensitivity among individuals. A minority (5%) of participants felt more alert without experiencing major changes in sleep patterns. This

suggests that some individuals can metabolize caffeine efficiently, reducing its impact on sleep. It was found that 4-6 Hours of Sleep were experienced by the largest group of participants (~46.78%), suggesting that caffeine consumption significantly reduces total sleep time. Many caffeine consumers likely experienced delayed sleep onset and fragmented sleep, leading to shorter rest periods. A substantial proportion of individuals (~27.12%) reported sleeping for less than 4 hours per night. This highlights severe sleep deprivation, which can impair cognitive function, mood, and overall well-being. A smaller group nearly 20.3% managed to get an adequate amount of sleep despite caffeine consumption. This suggests that individual differences in caffeine metabolism may influence its effects on sleep. A very small percentage (~5.8%) of participants reported sleeping over 8 hours, indicating that caffeine rarely promotes longer sleep durations. The graph strongly suggests that caffeine consumption is linked to reduced sleep hours, with most individuals sleeping less than the recommended 7-9 hours per night. Fig 15 provides a clear view of how caffeine affects people's mood states. The majority (81%) of participants associate caffeine with positive mood states (focus and mood boosting). Only 19% report negative effects (irritability or anxiety). This chart supports the idea that caffeine, when consumed in moderate amounts, tends to enhance productivity and mood for most individuals.

Figure 12 to 15, present data related to caffeine withdrawal symptoms across different aspects—headache patterns, sleep, and mood changes. 47% reported no symptoms after stopping caffeine. 39.8% experienced withdrawal symptoms after abrupt cessation. 10.5% had symptoms even after gradually reducing intake. 2.7% had symptoms after switching to decaffeinated beverages. Abruptly stopping caffeine is most likely to cause symptoms. Gradual reduction or switching to decaf seems to help but may still trigger symptoms in some. A large majority (over 90%) experienced some kind of headache, often severe or moderate in nature. Regarding the impact of withdrawal on sleep: 54.6% reported sleeping longer than usual. 12.9% had difficulty falling asleep. 12.7% experienced vivid dreams. 10% woke up frequently during the night. 9.8% said caffeine withdrawal had no effect on sleep. Most people sleep longer during withdrawal, possibly due to reduced stimulation. Vivid dreams and trouble sleeping are also common. The emotional and psychological effects of withdrawal were also highlighted. Mood disturbances like irritability and anxiety are most prevalent. Positive effects (like calmness or focus) are rare.

Fig 16 A compares the headache intensity between caffeine users and those experiencing caffeine withdrawal, measured using the Numeric Rating Scale (NRS) – a common 0-10 pain scale. Caffeine users have lower NRS scores – meaning they report milder headaches. Withdrawal group has higher scores – indicating more intense headaches. The ANOVA p-value is $p = 6.10 \times 10^{-40}$, so this difference is statistically significant. Caffeine appears to reduce headache intensity, while withdrawal increases it. Fig 16 B compares sleep quality using the Pittsburgh Sleep Quality Index (PSQI) – higher scores mean worse sleep. Caffeine users have higher PSQI scores, indicating poorer sleep quality. Those in the withdrawal group have lower scores, implying better sleep. The ANOVA p-value is $p = 6.80 \times 10^{-40}$, confirming a significant difference. Even though caffeine may help with alertness, it negatively affects sleep quality. Fig 16 C uses the DASS-21 (Depression, Anxiety, and Stress Scale) – specifically the stress subscale – to compare mood stability and cognitive clarity. Caffeine users score lower, suggesting they feel less stressed, with better mood and concentration. The withdrawal group reports higher stress, reflecting worse mood and reduced focus. The ANOVA p-value is $p = 7.76 \times 10^{-40}$, which is statistically significant. Caffeine consumption is associated with better mood and cognitive focus, while withdrawal worsens these factors.

DISCUSSION:

Our analysis demonstrated that caffeine significantly reduces headache intensity amongst medical students. This aligns with findings from a study published in *Psychopharmacology*, which reported that caffeine intake can alleviate headache symptoms in habitual consumers⁸. Caffeine consumption was found to decrease overall sleep quality and reduce total sleep hours. A systematic review in the *Journal of Clinical Sleep Medicine* supports this, indicating that caffeine intake, especially close to bedtime, adversely affects sleep parameters⁹. Our findings suggest that caffeine enhances focus and alertness while reducing stress and anxiety levels. This is corroborated by research published in *Advances in Psychiatric Treatment*, which

notes that caffeine can improve mood and cognitive performance in the short term¹⁰. Another study in the *Journal of Alzheimer's Disease* suggests caffeine may act as a cognitive enhancer¹¹. Upon cessation of caffeine, a significant number of individuals experienced increased headaches. This is consistent with studies indicating that headache is a hallmark symptom of caffeine withdrawal¹². Increased daytime sleepiness was reported during caffeine withdrawal. Research in *Neuropsychobiology* has documented that caffeine withdrawal can lead to heightened fatigue and drowsiness¹³. Many individuals reported a lack of motivation and reduced initiative during caffeine withdrawal. A study in *Drug and Alcohol Dependence* highlights mood disturbances, including irritability and depressed mood, as common withdrawal symptoms¹⁴. Thus, gradual caffeine reduction strategies may be beneficial in preventing severe withdrawal symptoms, promoting better energy management without dependence.

CONCLUSION:

Through this research study, we gained significant insights into the aftereffects of Regular Caffeine Intake & caffeine withdrawal over the health profile of Medical Students. Caffeine has both positive and negative effects on Health parameters. Our research has examined effects of caffeine consumption & withdrawal over 3 variables-Headache Intensity, Sleep Quality & Duration & Mood Stability. While Caffeine can reduce headache intensity and boost overall mood, increasing alertness & focus, it may also impair sleep quality & decrease sleep hours. We also observed few proportion of students in whom there was no headache relief & no cut down in sleep hours & sleep quality even after regular caffeine consumption. Caffeine withdrawal was significantly associated with increased headaches, daytime sleepiness, and mood disturbances. The study concludes that there is variation in the effects of Caffeine Intake or Withdrawal. Each Individual is not affected in exactly the same way towards caffeine & there exists a significant difference in the way body handles caffeine in each individual. These results highlight the complex relationship between caffeine use and neurophysiological health in an academically stressed population. Awareness about moderated caffeine consumption and its potential impact on health is crucial for promoting better lifestyle choices among medical students. Further longitudinal studies are recommended to deepen understanding and guide interventions aimed at improving student well-being.

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