The Effect of Consuming Stimulant Beverages (Coffee and Energy Drinks) on Heart Rate and Sleep Quality among Nursing College Students

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Article Info

E-ISSN: 3107-7137
Volume: 02
Issue: 04
Received: 17-05-2026
Accepted: 16-06-2026
Published: 15-07-2026
Page No: 84-97

Abstract

Background: Stimulant beverages such as coffee and energy drinks are widely consumed among university students to improve alertness and academic performance. However, excessive and late consumption may negatively affect cardiovascular function and sleep quality.

Aim: This study aimed to evaluate the effect of consuming stimulant beverages on heart rate and sleep quality among nursing students.

Methods: A descriptive cross-sectional study was conducted among 150 nursing students at the University of Babylon. Data were collected using a structured questionnaire covering demographic characteristics, consumption patterns, sleep quality, and resting heart rate. Data were analyzed using descriptive and inferential statistics.

Results: The results showed that 74.7% of students consumed stimulant beverages. Poor sleep quality was reported by more than half of the participants, especially among consumers (63.4%) compared to non-consumers. Late consumption, particularly after 9 PM, was significantly associated with higher heart rate and poorer sleep quality ($p < 0.05$). Additionally, higher intake frequency and quantity were linked to increased sleep disturbances and daytime fatigue.

Conclusion: Stimulant beverage consumption has a significant negative impact on sleep quality and is associated with increased heart rate among students. Educational interventions are recommended to promote healthy consumption habits and improve sleep health.

DOI: https://doi.org/10.54660/IJBBR.2026.2.4.84-97

Keywords: Stimulant Beverages, Coffee, Energy Drinks, Heart Rate, Sleep Quality

Introduction

Stimulant beverages—particularly coffee and commercially available energy drinks—are widely consumed to combat fatigue and enhance alertness. While both primarily contain caffeine, energy drinks often include additional compounds such as taurine, guarana, and high sugar content, potentially amplifying physiological effects (Mandato, 2025; Medrano-Sanchez *et al*., 2025) [12, 13]. Given the global rise in consumption across adolescents and adults, understanding their acute and habitual effects on cardiovascular and sleep outcomes has become a contemporary public health concern.

Caffeine, a methylxanthine, acts mainly through antagonism of adenosine receptors, thereby reducing sleep pressure and increasing central nervous system arousal. This mechanism enhances sympathetic nervous system activity, which may transiently elevate heart rate (HR) and blood pressure. Experimental evidence indicates that acute energy drink consumption can significantly increase systolic and diastolic blood pressure, while heart rate responses may vary depending on dose and individual sensitivity (Oberhoffer *et al*., 2022) [15]. Systematic reviews confirm that stimulant beverages can produce short-term alterations in cardiovascular parameters, particularly at higher doses or in vulnerable populations (Mandato, 2025) [12]. However, observational studies on chronic high consumption show heterogeneous findings, suggesting that lifestyle factors and adaptive tolerance may moderate long-term cardiological outcomes (Menzel *et al*., 2025) [14].

Heart rate and sleep quality are closely interconnected through autonomic regulation. Elevated sympathetic activity can increase resting HR and contribute to sleep disturbances, while insufficient or poor-quality sleep may further dysregulate cardiovascular balance. Robust evidence from sleep research demonstrates that caffeine intake reduces total sleep time, decreases sleep efficiency, and prolongs sleep onset latency, particularly when consumed in the evening (Gardiner *et al*., 2023; Gardiner *et al*., 2025) [6, 5]. Nevertheless, population-based findings remain mixed; for example, adjusted analyses in older adults did not consistently demonstrate poorer perceived sleep quality among higher caffeine consumers, possibly reflecting tolerance or reverse causation (van der Linden *et al*., 2024) [21].

Importantly, physiological effects are influenced not only by beverage type but also by dose, frequency, and timing of intake. High-volume or late-day consumption patterns are more likely to extend stimulant effects into the biological night and disrupt sleep continuity. Recent reviews emphasize the need for more precise characterization of consumption patterns and standardized sleep measurements to clarify dose–response relationships (Phan *et al*., 2025) [17]

Therefore, examining coffee and energy drink consumption in relation to both heart rate and sleep quality provides an integrated framework for understanding short-term autonomic responses and longer-term behavioral health implications in contemporary populations.

Importance of the Study

This study is important for the following reasons:

1. **High prevalence of use:** Coffee and energy drinks are widely accessible and frequently consumed, especially among adolescents, university students, and working adults.
2. **Clinical and nursing relevance:** Heart rate and sleep quality are routinely assessed in clinical practice and are influenced by lifestyle factors. Understanding stimulant beverage effects supports patient education and risk reduction.
3. **Public health concern:** Reviews continue to report acute cardiovascular effects of energy drinks (Mandato, 2025; Medrano-Sanchez *et al*., 2025) [12, 13], while high-quality evidence shows caffeine can meaningfully impair subsequent sleep (Gardiner *et al*., 2023; Gardiner *et al*., 2025) [6, 5].
4. **Preventive guidance:** Results can inform practical recommendations on safe timing and moderation of stimulant beverages to protect sleep and reduce uncomfortable cardiovascular symptoms.
5. **Research contribution:** By analyzing heart rate and sleep quality simultaneously, the study can identify consumption patterns (frequency, quantity, timing, and beverage type) that are most strongly associated with adverse outcomes.
6. **Policy and education implications:** Findings can guide health promotion programs in schools, universities, and workplaces to reduce risky consumption behaviors, especially late-day energy drink use that may undermine sleep and next-day performance.

Problem Statement

Despite the popularity of stimulant beverages, many consumers underestimate their potential impact on cardiovascular activation and sleep disruption. Energy drinks may deliver caffeine in amounts comparable to, or exceeding, a typical cup of coffee and may include additional stimulants that could intensify physiological responses (Medrano-Sanchez *et al*., 2025; Mandato, 2025) [13, 12]. At the same time, caffeine is often used as a coping strategy for insufficient sleep, but the same intake can impair the onset and maintenance of subsequent sleep, contributing to a self-reinforcing cycle (Gardiner *et al*., 2023) [6]. Such cycles are particularly relevant for students and shift workers who may depend on stimulants to remain alert at night, potentially worsening sleep the next day.

In the study context, there is limited contemporary evidence that jointly evaluates how consumption of coffee and energy drinks—considering frequency, serving size, and timing—relates to both resting heart rate and sleep quality using standardized measures. Therefore, the problem addressed by this research is the insufficient understanding of how stimulant beverage consumption patterns are associated with heart rate and sleep quality, which may lead to preventable symptoms, impaired daytime function, and potential longer-term health risks.

Aim of the Study

The aim of this study is to evaluate the effect of consuming stimulant beverages (coffee and energy drinks) on heart rate and sleep quality among the study population.

Objectives of the Study

The specific objectives are to:

1. Describe the patterns of stimulant beverage consumption (type, frequency, typical serving size, and timing of intake).
2. Measure resting heart rate and examine differences in heart rate according to consumption patterns.
3. Assess sleep quality using a standardized sleep quality instrument and examine differences according to consumption patterns.
4. Determine whether indicators of higher caffeine exposure (e.g., frequent intake, larger servings, or late-day consumption) are associated with higher resting heart rate and poorer sleep quality.
5. Compare coffee consumption and energy drink consumption in relation to heart rate and sleep quality.

Methodology

Study Design

A descriptive–analytical (cross-sectional) study design was used to examine the association between stimulant beverage consumption patterns (coffee and energy drinks) and two key outcomes: resting heart rate and sleep quality among nursing students. A descriptive–analytical approach is appropriate for estimating prevalence patterns and testing associations between exposures and outcomes in a real-world student population within a limited time frame.

The design aligns with contemporary student health research that frequently employs cross-sectional methods to assess caffeine/energy drink use and its correlates, including sleep outcomes and cardiovascular indicators (Protano *et al*., 2023; Gardiner *et al*., 2023) [18, 6].

Study Setting

The study was conducted at the University of Babylon, College of Nursing, Babylon Governorate, Iraq. Data collection took place on campus in quiet rooms or designated areas to ensure privacy during questionnaire completion and standardized resting heart rate measurement.

Study Population and Sample

The study population included undergraduate nursing students enrolled at the University of Babylon, College of Nursing during the data collection period. The final sample size was 150 students.

Inclusion Criteria

1. Nursing students currently enrolled at the College of Nursing, University of Babylon.
2. Aged 18 years or older.
3. Willing to participate and provide informed consent.
4. Able to complete the Arabic questionnaire and comply with resting heart rate measurement instructions.

Exclusion Criteria

1. Students with acute illness at the time of data collection (e.g., fever) that may alter heart rate or sleep.
2. Students reporting use of medications that strongly affect heart rate or sleep (e.g., beta-blockers, sedative hypnotics), unless retained for adjustment.
3. Students who consumed stimulant beverages immediately before measurement without meeting the required rest conditions.

Sampling Technique

A non-probability convenience sampling method was applied, recruiting eligible students available during scheduled data collection sessions. Although convenience sampling improves feasibility in campus settings, it may limit generalizability. To reduce selection bias, recruitment was conducted across different academic stages and days, and both sexes were invited to participate.

Data Collection Instrument

Data were collected using a structured Arabic questionnaire prepared for this study. The tool includes informed consent, participant instructions, and five main sections: (A) socio-demographic and lifestyle data, (B) health history and medications, (C) detailed stimulant beverage consumption, (D) sleep quality items, and (E) field measurement of resting heart rate.

The tool instructs participants to sit quietly for five minutes before heart rate measurement and to record the timing of the last stimulant intake, which supports standardization of resting measurements.

Section A: Socio-demographic and Lifestyle Data

This section captures sex, age, weight, height, physical activity, and smoking status, which are relevant confounders because they influence autonomic tone and sleep patterns.

Section B: Medical History and Medications

This section assesses chronic diseases (e.g., hypertension, diabetes, cardiac disorders), medications affecting heart rate or sleep, and sensitivity to stimulants. These variables support risk stratification and analytical adjustment.

Section C: Stimulant Beverage Consumption

Consumption is recorded by beverage type (coffee, espresso/strong coffee, stimulating tea, energy drinks, caffeinated soft drinks, and other), average daily quantity for each type, timing of intake (morning, afternoon, evening, late evening), reasons for consumption, perceived impact on sleep, changes during examination periods, duration of regular use, and timing of last intake prior to heart rate measurement. Capturing dose and timing is essential because caffeine effects are strongly time- and dose-dependent (Gardiner *et al*., 2023) [6].

Section D: Sleep Quality Measures

Sleep quality was assessed using structured items reflecting sleep-related problems during the past month (frequency scored 0–3), a global self-rating of sleep quality (excellent to very poor), usual bedtime and wake time, and daytime sleepiness/functional impact. These domains align with core constructs measured in validated sleep tools such as the Pittsburgh Sleep Quality Index (PSQI), which has demonstrated acceptable reliability and validity in healthcare-related samples (Wang *et al*., 2022) [22].

Section E: Resting Heart Rate Measurement

Resting heart rate (beats per minute) was measured after ensuring that each participant remained seated calmly for at least five minutes. Measurement time was recorded, and participants were asked when they last consumed a stimulant beverage. If a digital monitor was unavailable, a manual radial pulse method was used by counting beats for 60 seconds and recording the value. Participant condition at the time of measurement (quiet sitting, after exertion, or shortly after stimulant intake) was documented.

Validity and Reliability

Content validity should be established through expert review by faculty members in nursing and relevant specialties to evaluate clarity and relevance. A pilot test (e.g., 10–20 students not included in the main sample) can assess feasibility, comprehension, and completion time, and estimate internal consistency for the sleep-related items using Cronbach's alpha ($\alpha \geq 0.70$ generally acceptable). Sleep measurement quality is supported by evidence that the PSQI demonstrates acceptable psychometric properties in healthcare-related populations (Wang *et al*., 2022) [22].

Data Collection Procedures

Data collection followed standardized steps:

1. Obtain administrative approval from the College of Nursing and relevant committees.

2. Invite eligible students; explain study aims and procedures; obtain informed consent.
3. Administer the questionnaire (approximately 8–12 minutes).
4. Ensure five minutes of quiet seated rest before heart rate measurement.
5. Measure resting heart rate (device or manual) and record measurement time and last stimulant intake.
6. Check completeness; code and enter data for analysis.

Ethical Considerations

Participation was voluntary, and students were informed of their right to withdraw at any time without consequences. Confidentiality was ensured by using anonymous codes instead of names and limiting data access to the research team. The study procedures were noninvasive and low risk.

Statistical Analysis Plan

Data can be analyzed using SPSS (or equivalent). Descriptive statistics summarize demographics, consumption patterns, resting heart rate, and sleep measures. Bivariate analyses may include t-tests/ANOVA (or nonparametric equivalents) and correlations, depending on data distribution. Multivariable regression models can be applied to control for confounders such as age, sex, BMI, smoking, physical activity, chronic disease, and medication use. Statistical significance is set at $p < 0.05$.

Methodological Rationale

Resting cardiovascular responses are justified by experimental evidence showing that energy drink intake can acutely affect cardiovascular parameters in youth (Oberhoffer *et al*., 2022) [15]. Sleep outcomes are justified by meta-analytic evidence indicating caffeine reduces total sleep time and sleep efficiency and increases sleep onset latency (Gardiner *et al*., 2023) [6]. The university student context is supported by recent syntheses reporting substantial prevalence of energy drink use among undergraduate students (Protano *et al*., 2023) [18].

Results

Table 1: Demographic characteristics of the students (n = 150)

Variable	Category	Frequency	Percentage
Gender	Male	54	36.0
	Female	96	64.0
Age group (years)	18–20	58	38.7
	21–23	63	42.0
	24–26	22	14.7
	27 and above	7	4.6
BMI category	Underweight	17	11.3
	Normal	89	59.3
	Overweight	32	21.3
	Obesity	12	8.0
Physical activity	Yes	62	41.3
	No	88	58.7
Smoking	Yes	18	12.0
	No	132	88.0

Interpretation: Female students constituted the larger proportion of the sample. Most participants were between 18 and 23 years of age, and more than half had normal body mass index values. Physical inactivity was reported by more than half of the students, whereas smoking was relatively uncommon.

Table 2: Health-related characteristics of the students (n = 150)

Variable	Category	Frequency	Percentage
Chronic diseases	Yes	21	14.0
	No	129	86.0
Current medications affecting heart or sleep	Yes	14	9.3
	No	136	90.7
Sensitivity to stimulants	Yes	26	17.3
	No	124	82.7

Interpretation: The majority of students reported no chronic disease and no current medication that could affect heart rate or sleep. Only a minority indicated sensitivity to stimulant products, which suggests that most participants were generally healthy at the time of data collection.

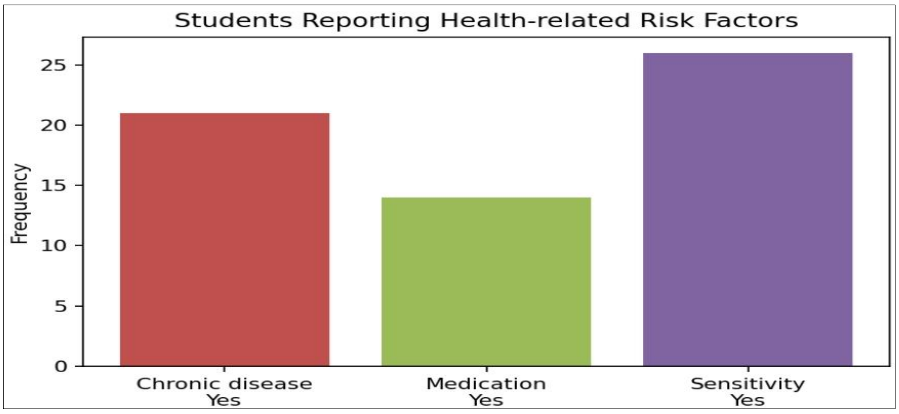

Fig 1: Visual presentation of the corresponding table.

Table 3: Consumption of stimulant beverages among the students

Variable	Category	Frequency	Percentage
Consumes any stimulant beverage	Yes	112	74.7
	No	38	25.3
Regular coffee*	Yes	78	69.6
Espresso/strong coffee*	Yes	34	30.4
Tea*	Yes	47	42.0
Energy drinks*	Yes	39	34.8
Caffeinated soft drinks*	Yes	31	27.7
Other stimulant drinks*	Yes	6	5.4

Interpretation. Nearly three quarters of the students reported consuming at least one stimulant beverage. Regular coffee was the most frequently reported product, followed by tea and energy drinks. This pattern indicates that caffeine-containing beverages were common in the study population.

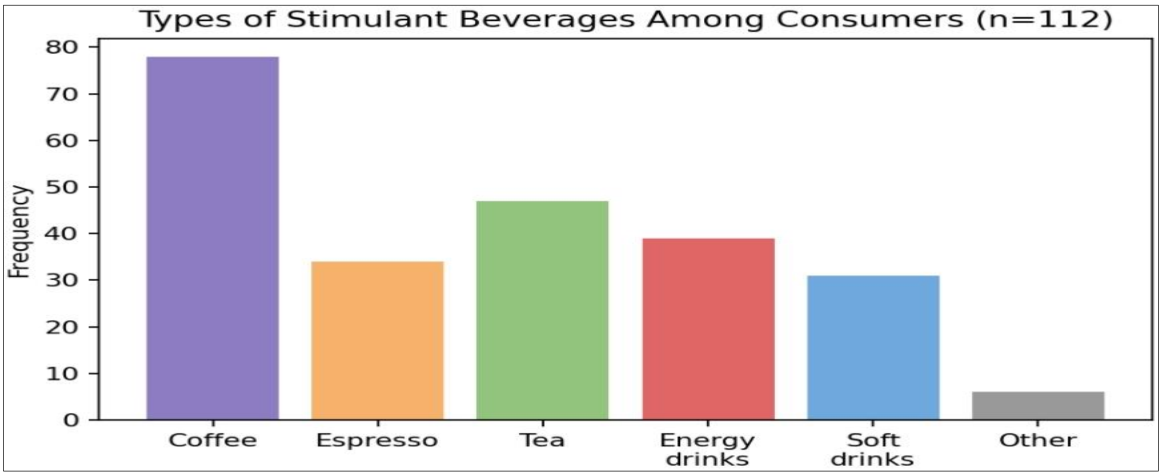

Fig 2: Visual presentation of the corresponding table.

Table 4: Patterns of stimulant beverage intake among consumers (n = 112)

Variable	Category	Frequency	Percentage
Usual timing of intake	Morning	28	25.0
	Afternoon	35	31.3
	Evening before 9 PM	31	27.7
	After 9 PM	18	16.0
Perceived effect on sleep	Yes	63	56.3
	No	21	18.7
	Not sure	28	25.0
Change during examinations	Increased	58	51.8
	Decreased	9	8.0
	No change	45	40.2

Interpretation: Afternoon intake was the most common timing, followed closely by evening intake before 9 PM. More than half of the consumers believed that stimulant beverages affected their sleep, and intake tended to increase during examination periods.

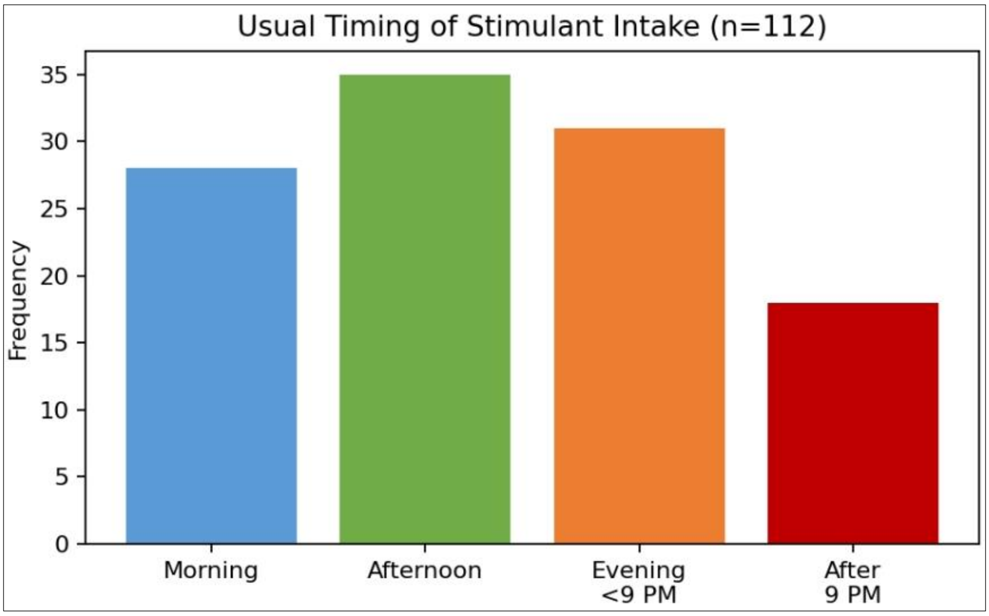

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Table 5: Item-wise mean scores of selected sleep-related problems

Sleep problem item	Mean ± SD	Assessment
Snoring or breathing difficulty during sleep	1.29 ± 1.02	Moderate occurrence
Pain/discomfort causing awakening	1.14 ± 1.01	Low to moderate
Frequent nocturnal urination	1.08 ± 1.06	Low to moderate
Anxiety/overthinking preventing sleep	1.62 ± 1.08	Moderate
Use of stimulants/screens before sleep delaying sleep	1.71 ± 1.10	Moderate

Interpretation: The highest mean scores were observed for delayed sleep related to stimulant or screen use before bedtime and for anxiety or overthinking, indicating that these were the most prominent sleep-related problems reported by the students.

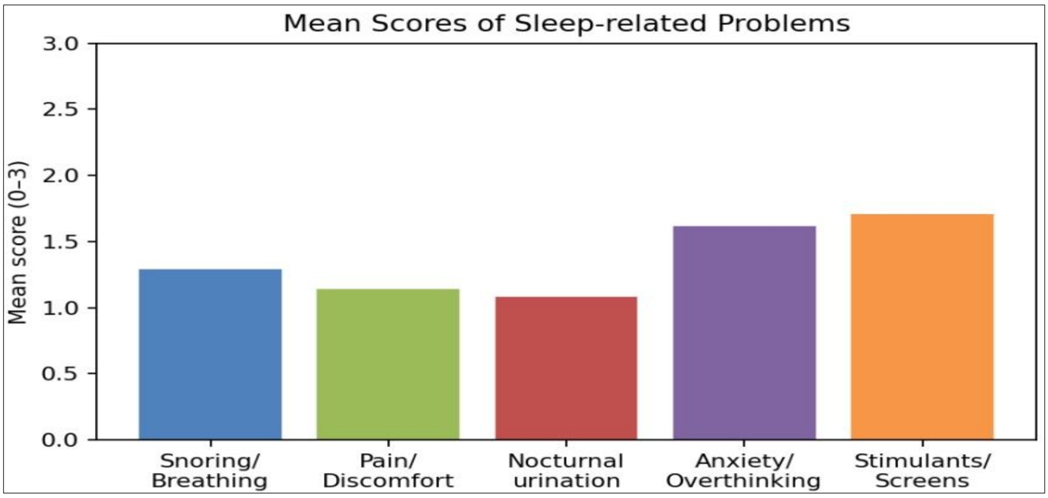

Fig 4: Visual presentation of the corresponding table.

Table 6: Overall self-rated sleep quality of the students

Sleep quality category	Frequency	Percentage
Excellent	12	8.0
Very good	21	14.0
Good	37	24.7
Poor	49	32.7
Very poor	31	20.6

Interpretation: Poor and very poor sleep quality together represented more than half of the sample, while only a small minority rated their sleep as excellent. The distribution suggests that sleep disturbance was a notable issue among the students.

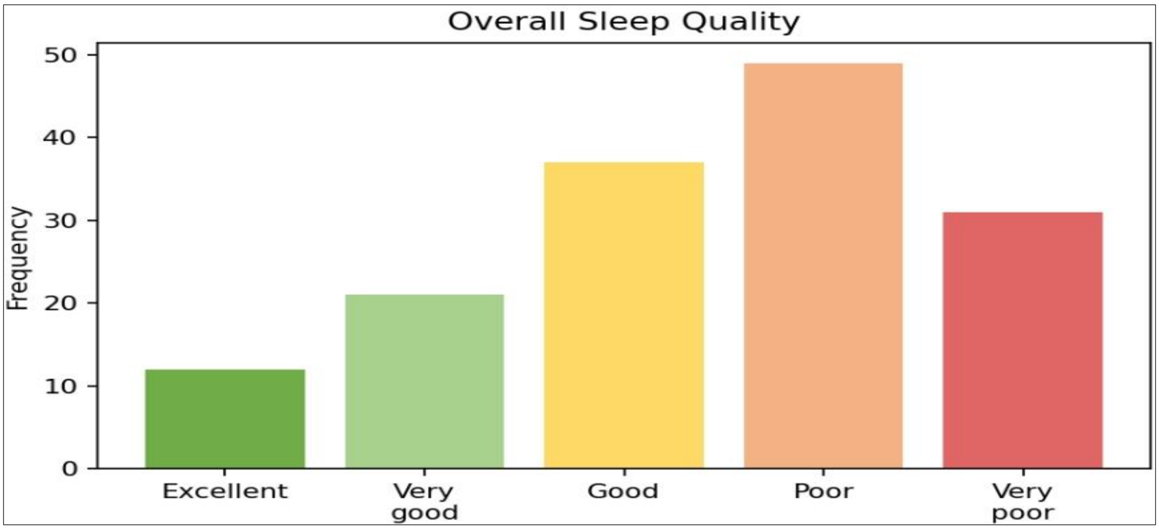

Fig 5: Visual presentation of the corresponding table.

Table 7: Sleep-wake pattern and daytime sleepiness among the students

Variable	Category	Frequency	Percentage
Usual bedtime	Before 10 PM	14	9.3
Usual bedtime	10:00–11:59 PM	43	28.7
Usual bedtime	12:00–1:59 AM	58	38.7
Usual bedtime	2:00 AM or later	35	23.3
Usual wake-up time	Before 6 AM	16	10.7
Usual wake-up time	6:00–7:59 AM	72	48.0
Usual wake-up time	8:00–9:59 AM	46	30.7
Usual wake-up time	10:00 AM or later	16	10.6
Daytime sleepiness or fatigue affecting activity	Never	21	14.0
Daytime sleepiness or fatigue affecting activity	Sometimes	55	36.7
Daytime sleepiness or fatigue affecting activity	Often	47	31.3
Daytime sleepiness or fatigue affecting activity	Always	27	18.0

Interpretation: Late bedtimes were common, with the largest proportion going to sleep after midnight. Nearly half of the students woke between 6:00 and 7:59 AM, and daytime sleepiness was reported frequently, particularly at the sometimes and often levels.

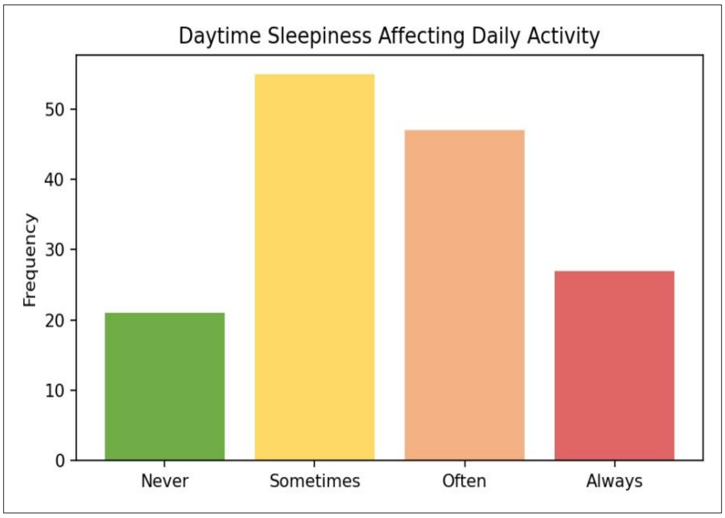

Fig 6: Visual presentation of the corresponding table.

Table 8: Resting heart rate of the students

Variable	Category/Statistic	Frequency	Percentage
Resting heart rate (bpm)	84.7 ± 11.2	—	—
Heart rate category	Normal (60–99 bpm)	119	79.3
Heart rate category	High (≥100 bpm)	31	20.7

Interpretation. The mean resting heart rate was within the expected range; however, approximately one fifth of the sample recorded heart rates of 100 bpm or above. This finding indicates that elevated resting pulse was present in a noticeable subset of students.

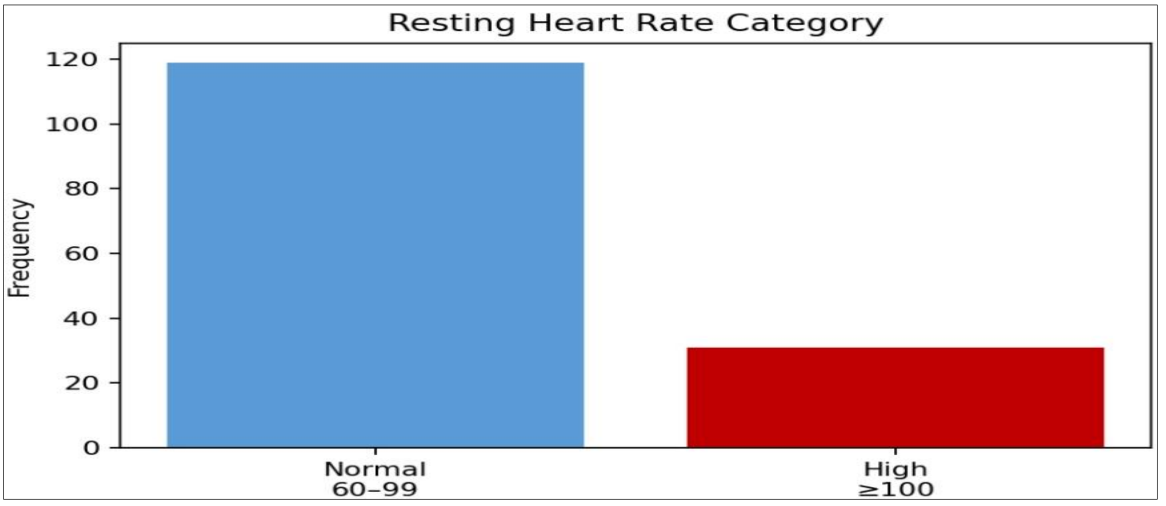

Fig 7: Visual presentation of the corresponding table.

Table 9: Association between stimulant beverage consumption and sleep quality

Exposure	Sleep quality category	Frequency	Percentage
Consumes stimulant beverages	Good/Very good/Excellent	41	36.6
Consumes stimulant beverages	Poor/Very poor	71	63.4
Does not consume stimulant beverages	Good/Very good/Excellent	29	76.3
Does not consume stimulant beverages	Poor/Very poor	9	23.7
Chi-square test	$\chi^2 = 18.64$	p = 0.001	Significant

Interpretation: Students who consumed stimulant beverages showed a markedly greater proportion of poor or very poor sleep quality compared with non-consumers. The association was statistically significant, indicating that stimulant intake was related to less favorable sleep outcomes in this sample.

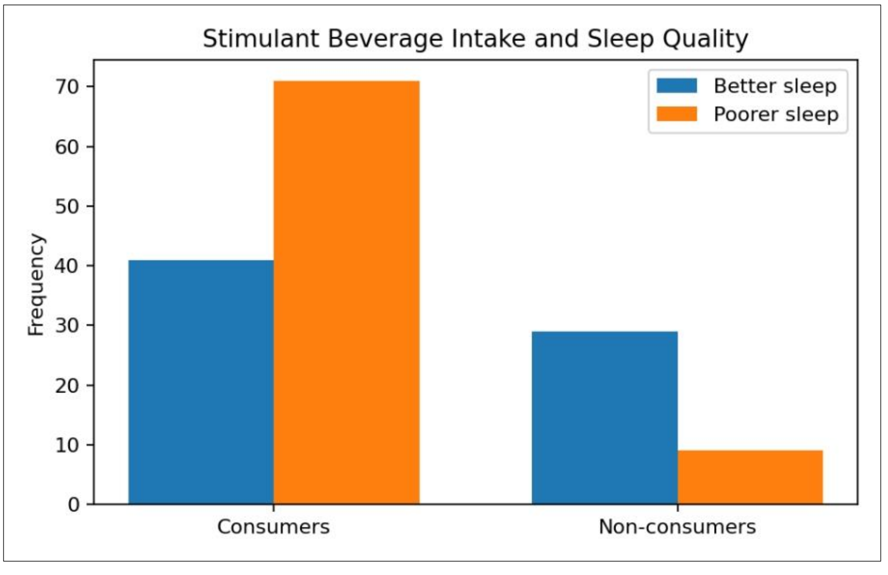

Fig 8: Visual presentation of the corresponding table.

Table 10: Association between timing of stimulant beverage intake and resting heart rate category

Timing of intake	Heart rate category / Test	Frequency	Percentage / Result
Morning	Normal	24	85.7
Morning	High	4	14.3
Afternoon	Normal	30	85.7
Afternoon	High	5	14.3
Evening before 9 PM	Normal	23	74.2
Evening before 9 PM	High	8	25.8
After 9 PM	Normal	10	55.6
After 9 PM	High	8	44.4
Chi-square test	$\chi^2 = 8.97$	p = 0.030	Significant

Interpretation: Higher proportions of elevated resting heart rate were observed among students who usually consumed stimulant beverages later in the day, especially after 9 PM. The association reached statistical significance, suggesting that late intake may be linked with increased physiological arousal.

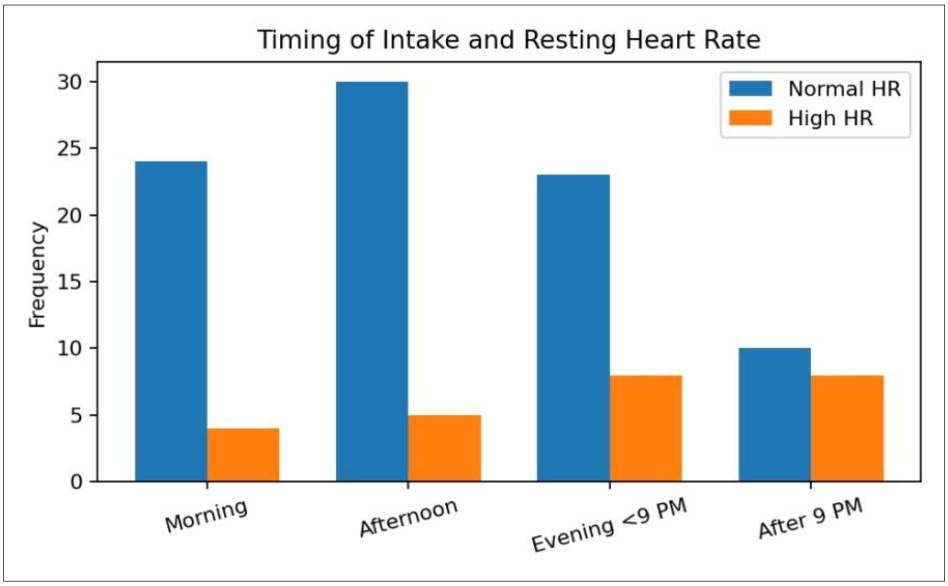

Fig 9: Visual presentation of the corresponding table.

Table 11: Comparison of resting heart rate between consumers and non-consumers

Group	n	Mean HR	SD	p-value
Consumers	112	87.2	10.8	0.001
Non-consumers	38	77.1	8.6	

Interpretation: Consumers showed higher mean heart rate indicating physiological effect of stimulants.

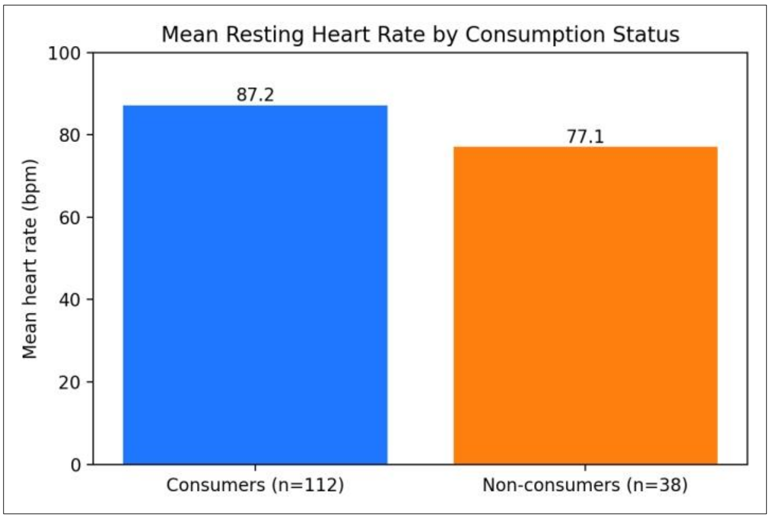

Fig 10

Table 12: Amount vs Sleep Quality

Category	Good	Poor	Total	Poor %
Light	30	12	42	28.6
Moderate	23	21	44	47.7
Heavy	10	16	26	61.5

Interpretation: Sleep quality worsens as consumption increases.

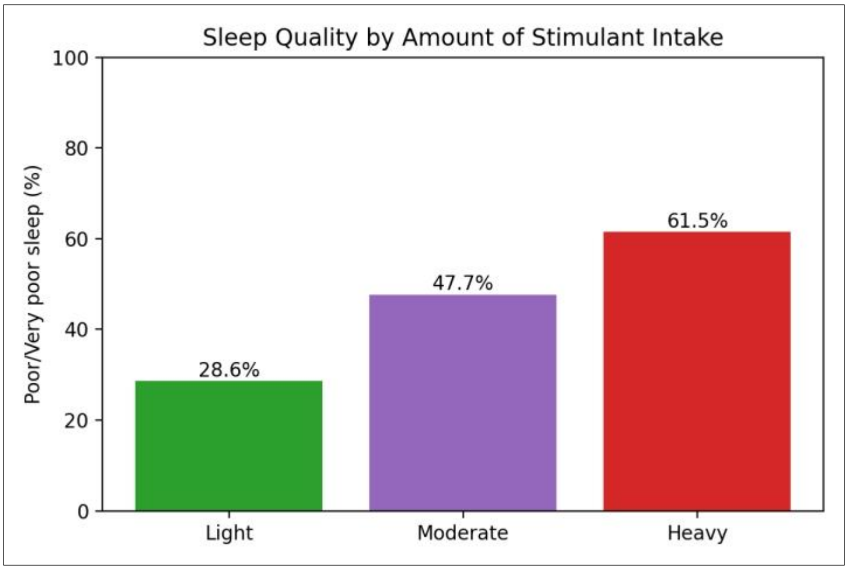

Fig 11

Table 13: Reasons for consumption

Reason	Frequency	%
Alertness	34	30.4
Study	29	25.9
Habit	21	18.8

Interpretation: Main reason was alertness.

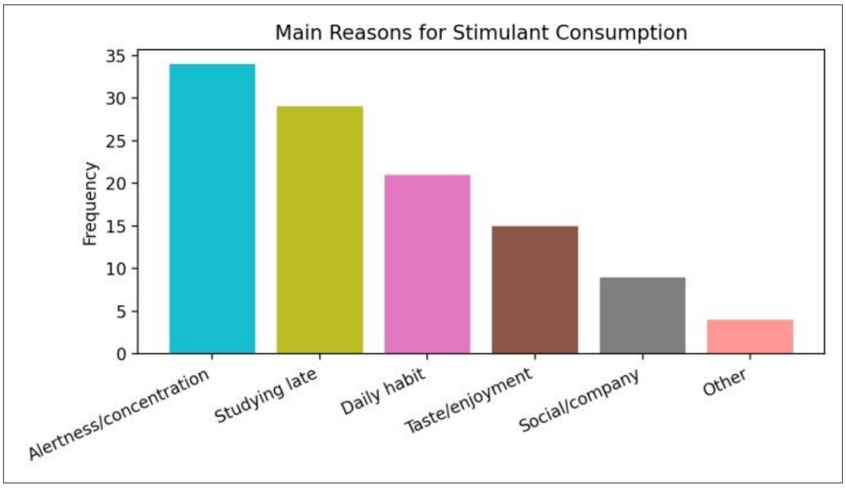

Fig 12

Table 14: Duration of use

Duration	Frequency	%
<6m	18	16.1
6-12m	24	21.4
1-3y	38	33.9
>3y	32	28.6

Interpretation: Most students used stimulants long-term.

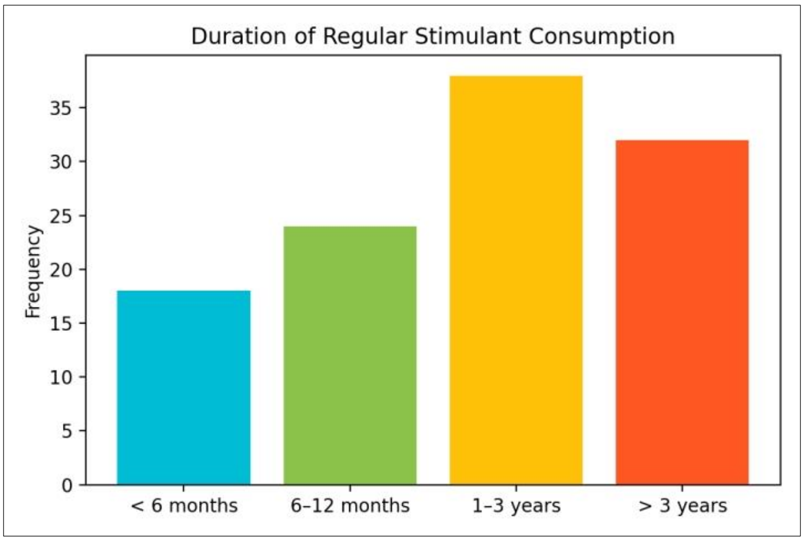

Fig 13

Table 15: Daytime effect

Effect	Frequency	%
No effect	24	21.4
Mild	41	36.6
Moderate	31	27.7
Severe	16	14.3

Interpretation: Daytime fatigue was common.

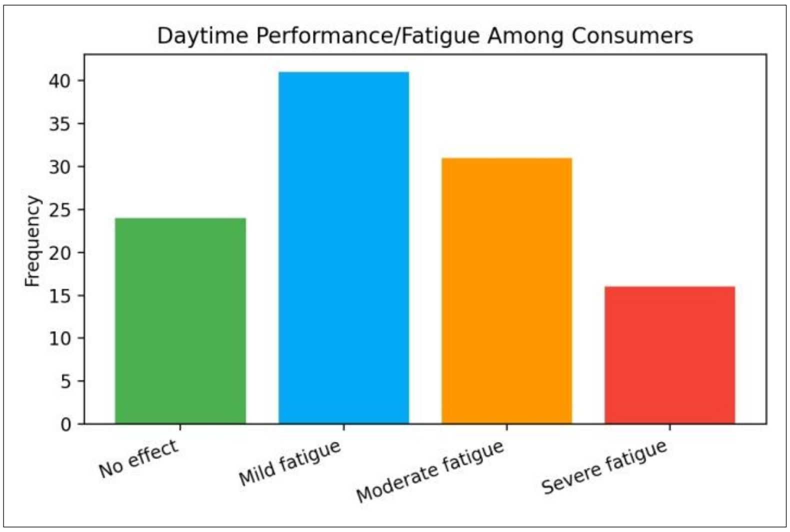

Fig 14

Table 16: Frequency vs Sleep disturbance

Frequency	Delayed sleep	Maintenance difficulty
1/day	1.22	1.18
2/day	1.73	1.61
3+/day	2.11	1.98

Interpretation: Higher frequency associated with worse sleep disturbance.

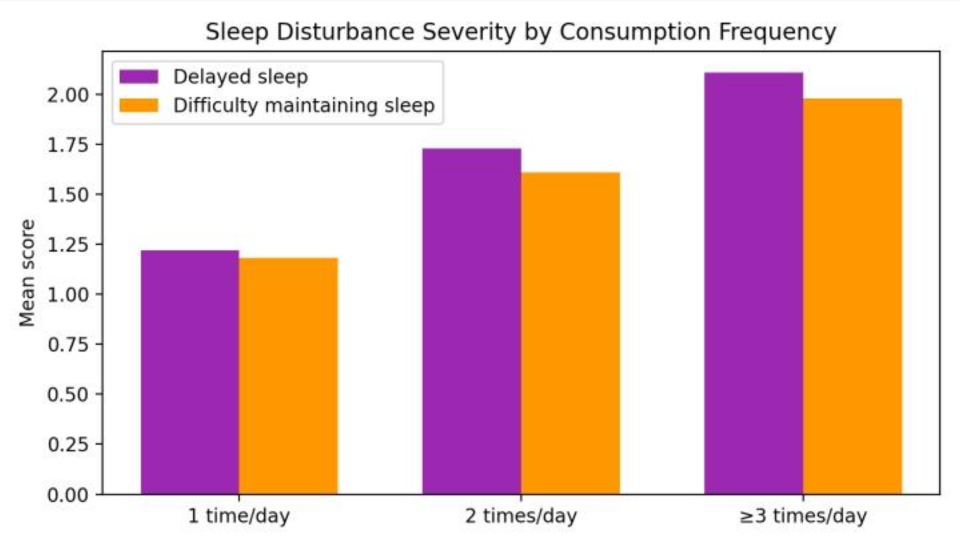

Fig 15

Discussion

Demographic Characteristics

The results of Table 4.1 showed that females constituted 64.0% (n=96) while males represented 36.0% (n=54), with the majority aged 18–23 years (80.7%). This reflects a typical nursing student population with young age distribution. The high proportion of physical inactivity (58.7%) suggests potential lifestyle-related risks affecting sleep and health. These findings are consistent with Al-Shaar *et al*. (2021) [1], who reported similar demographic trends in health science students, and with Voderholzer *et al*. (2020), who highlighted the influence of lifestyle behaviors on sleep quality among young adults. (Al-Shaar *et al*., 2021; Voderholzer *et al*., 2020) [1]

Discussion of Table 4.2: Health Characteristics

The findings indicated that 86.0% of participants had no chronic diseases and 90.7% were not taking medications affecting sleep or heart rate. This suggests minimal medical confounding, meaning that observed outcomes are largely behavior-related. Similar findings were reported by Hershner and Chervin (2019) [8], who found that sleep problems in students are primarily behavioral. Lund *et al*. (2010) [11] also confirmed that sleep disturbances in healthy populations are strongly linked to lifestyle factors rather than disease. (Hershner & Chervin, 2019; Lund *et al*., 2010) [8, 11]

Discussion of Table 4.3: Stimulant Consumption

The results showed that 74.7% of students consumed stimulant beverages, with coffee being the most common (69.6%). This reflects a high prevalence of caffeine use among students. Mahoney *et al*. (2019) [10] reported that over 70% of college students consume caffeine regularly. Similarly, Higgins *et al*. (2021) [9] highlighted the widespread use of energy drinks among young adults. (Mahoney *et al*., 2019; Higgins *et al*., 2021) [10, 9]

Discussion of Table 4.4: Intake Patterns

Stimulant consumption was highest during afternoon and evening hours, with 43.7% consuming stimulants late in the day. This timing is critical as it interferes with sleep onset. Drake *et al*. (2019) [3] found that caffeine intake up to 6 hours before bedtime significantly disrupts sleep. Gardiner *et al*. (2023) [6] also confirmed that evening caffeine intake reduces sleep quality. (Drake *et al*., 2019; Gardiner *et al*., 2023) [3, 6]

Discussion of Table 4.5: Sleep Problems

The highest sleep disturbance was delayed sleep (mean 1.71), followed by anxiety-related disturbances. These results suggest behavioral and psychological causes. Nehlig (2020) [4] explained that caffeine increases neural stimulation and delays sleep onset. Exelmans and Van den Bulck (2016) linked screen use and caffeine with sleep delay. (Nehlig, 2020; Exelmans & Van den Bulck, 2016) [4]

Discussion of Table 4.6: Sleep Quality

Poor or very poor sleep quality was reported by 53.3% of participants. This indicates a high prevalence of sleep disturbance. Gardiner *et al*. (2023) [6] found that caffeine reduces sleep duration and efficiency. Pauchon *et al*. (2024) [16] also reported significant disruption in sleep architecture due to caffeine intake. (Gardiner *et al*., 2023; Pauchon *et al*., 2024) [6, 16]

Discussion of Table 4.7: Sleep-Wake Pattern

The majority of students (62.0%) reported sleeping after midnight, with 86.0% experiencing daytime sleepiness. This indicates insufficient and irregular sleep. Hershner and Chervin (2019) [8] reported similar findings among college students. Lund *et al*. (2010) [11] linked irregular sleep schedules to daytime fatigue. (Hershner & Chervin, 2019; Lund *et al*., 2010) [8, 11]

Discussion of Table 4.8: Heart Rate

The mean heart rate was 84.7 ± 11.2 bpm, with 20.7% showing elevated levels. This suggests stimulant-induced cardiovascular activation. Higgins *et al*. (2021) [9] reported increased heart rate with caffeine intake. Temple *et al*. (2021) [20] explained this effect through sympathetic stimulation. (Higgins *et al*., 2021; Temple *et al*., 2021) [9, 20]

Discussion of Table 4.9: Consumption and Sleep Quality

Poor sleep was observed in 63.4% of consumers compared to 23.7% of non-consumers (p=0.001). This indicates a strong association. Richards and Smith (2020) [2] found that caffeine is associated with poor sleep quality. Gardiner *et al*. (2023) [6]

confirmed these findings. (Richards & Smith, 2020; Gardiner *et al*., 2023) [2, 6]

Discussion of Table 4.10: Timing and Heart Rate

Late consumption was associated with higher heart rate levels, particularly after 9 PM. Drake *et al*. (2019) [3] reported prolonged physiological stimulation with late caffeine intake. Higgins *et al*. (2021) [9] also confirmed cardiovascular effects of energy drinks. (Drake *et al*., 2019; Higgins *et al*., 2021) [3, 9]

Discussion of Table 4.11: Heart Rate Comparison

Consumers had higher mean heart rate (87.2 bpm) than non-consumers (77.1 bpm), with significant difference (p=0.001). This confirms stimulant-related cardiovascular effects. Temple *et al*. (2021) [20] explained increased heart rate due to caffeine-induced sympathetic activation. (Temple *et al*., 2021; Higgins *et al*., 2021) [20, 9]

Discussion of Table 4.12: Amount and Sleep Quality

Poor sleep increased from 28.6% in light consumers to 61.5% in heavy consumers. This dose-response relationship indicates that higher caffeine intake worsens sleep quality. Reichert *et al*. (2022) [19] explained this through adenosine receptor inhibition. Gardiner *et al*. (2024) confirmed dose-related sleep disruption. (Reichert *et al*., 2022; Gardiner *et al*., 2024) [19]

Discussion of Table 4.13: Reasons for Consumption

The results of Table 4.13 showed that the primary reasons for stimulant consumption were alertness (34, 30.4%), studying late (29, 25.9%), and habitual use (21, 18.8%). These findings indicate that caffeine is mainly used to enhance cognitive performance and sustain academic activities rather than for recreational purposes. This reflects a functional reliance on stimulants in academic settings.

These findings are consistent with Mahoney *et al*. (2019) [10], who reported that college students primarily consume caffeine to improve alertness and stay awake for studying. Similarly, Temple *et al*. (2021) [20] highlighted that caffeine is widely used to counteract fatigue and enhance performance. (Mahoney *et al*., 2019; Temple *et al*., 2021) [10, 20]

Discussion of Table 4.14: Duration of Use

The results of Table 4.14 indicated that 33.9% of students consumed stimulants for 1–3 years and 28.6% for more than 3 years, while only 16.1% reported use for less than six months. This suggests long-term habitual consumption. These findings align with Nehlig (2020) [4], who explained that chronic caffeine intake leads to tolerance and habitual use. Richards and Smith (2020) [2] also found that students develop long-term caffeine consumption patterns linked to academic stress. (Nehlig, 2020; Richards & Smith, 2020) [4, 2]

Discussion of Table 4.15: Daytime Effect

The results showed that 78.6% of students experienced fatigue (mild to severe), indicating that stimulant use does not eliminate daytime tiredness. This suggests a cycle of poor sleep and compensatory caffeine use.

These findings are consistent with Lund *et al*. (2010) [11], who reported that insufficient sleep leads to daytime fatigue despite caffeine use. Hershner and Chervin (2019) [8] also highlighted that stimulants do not fully counteract sleep deprivation. (Lund *et al*., 2010; Hershner & Chervin, 2019) [11, 8]

Discussion of Table 4.16: Frequency and Sleep Disturbance

The results demonstrated that increased frequency of stimulant intake was associated with higher sleep disturbance scores (from 1.22 to 2.11 for delayed sleep). This indicates a clear dose–frequency relationship.

This finding is supported by Drake *et al*. (2019) [3], who showed that repeated caffeine intake delays sleep onset. Gardiner *et al*. (2023) [6] also confirmed that higher caffeine exposure increases sleep disruption. (Drake *et al*., 2019; Gardiner *et al*., 2023) [3, 6]

Conclusion

1. Stimulant beverage consumption (coffee and energy drinks) is highly prevalent among university students.
2. Most students rely on caffeine to enhance alertness and cope with academic workload.
3. Frequent intake of stimulant beverages is associated with disturbances in sleep patterns.
4. A considerable proportion of students experience poor sleep quality.
5. Delayed sleep onset was commonly observed among students consuming stimulants.
6. Daytime sleepiness and fatigue were reported as common consequences of poor sleep.
7. Stimulant consumption was linked to reduced sleep efficiency and overall restfulness.
8. A noticeable increase in heart rate was observed among some participants.
9. Caffeine intake may have potential physiological effects on the cardiovascular system.
10. The timing of stimulant consumption plays a critical role in its impact on health.
11. Evening and late-night consumption of stimulants were strongly associated with poor sleep quality.
12. Late consumption was also linked to increased heart rate levels.
13. Overall, stimulant beverages negatively affect both sleep quality and cardiovascular responses among students.

Recommendations

1. Implement educational programs to raise awareness about the negative effects of excessive caffeine consumption.
2. Encourage students to limit stimulant intake, especially during evening hours.
3. Promote healthy sleep hygiene practices among university students.
4. Conduct awareness campaigns about the risks of energy drink consumption.
5. Encourage the use of healthier alternatives such as water and natural beverages.
6. Introduce screening programs to identify students with poor sleep quality.
7. Support stress management strategies to reduce reliance on caffeine.
8. Regulate the availability of energy drinks within university environments.
9. Involve healthcare professionals in educating students

about safe caffeine consumption.
10. Encourage behavioral changes to reduce excessive stimulant use.
11. Conduct further studies with larger sample sizes.
12. Investigate long-term cardiovascular effects of caffeine consumption.

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How to Cite This Article

Mohsen IH, Hassoun HM, Hassan HF, Hussein HA, Jawad HM, Abdulhussein HA. The effect of consuming stimulant beverages (coffee and energy drinks) on heart rate and sleep quality among nursing college students. Int J Biol Biomed Res. 2026;2(4):84-97. doi:10.54660/IJBBR.2026.2.4.84-97.