

The Impact of Frequent Caffeine Intake on Sleep Quality Duration in a Population of Graduate
Students

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Abstract

Caffeine is widely consumed and is known to influence sleep quality and duration, but its impact on graduate students, who may rely on caffeine because of academic stress, remains understudied. This work aimed to assess whether frequent caffeine intake (≥ 4 times per week), combined with typical eating habits, predicted shorter quality sleep duration compared to lower intake (< 4 times per week). In May 2025, a cross-sectional survey of 29 graduate students (mean age 32.3 ± 7.22 years) in an online nutrition research course was conducted. Self-reported sleep quality duration (short: < 7 h, normal: 7-9h, long: > 9 h) and caffeine intake frequency were evaluated using an FFQ and targeted questionnaire questions. Descriptive statistics, t-tests, Pearson correlation analysis, and linear regression were implemented to describe the population and quantify these relationships, controlling for age, gender, education level, and ethnicity. The study illustrated no significant differences between groups with frequent and infrequent caffeine intake ($t=0.754$, $p=0.457$, $d=0.313$), nor any associations with sleep quality duration ($R^2=0.068$, $p>0.05$). Limitations included the small sample size, self-reported data, and unmeasured factors like caffeine dose/timing of intake or dietary confounders. More studies incorporating objective sleep measures, larger samples of graduate students, and detailed caffeine metrics are needed to further define these relationships.

Introduction

Background, Literature Review, and Conceptual Framework

It is becoming increasingly well known that sleep and health are inextricably connected. With the rising prevalence of chronic illness, it is crucial that potential contributing factors, including diminished sleep quantity and quality, are examined. Continually, caffeine is a widely consumed compound that affects various aspects of health. Its intake may modulate the functioning of the cardiovascular and nervous systems, exerting effects that range from elevated heart rate to anxiousness and increased attention.^{1,2}

Recent research has investigated the relationship between caffeine intake and sleep in diverse populations, using rigorous study design and methodology, and evaluating multiple indicators of sleep quantity and quality. Gardiner et al. observed that perceptions of time spent asleep, quality and efficiency of sleep, and the time it took to fall asleep were all negatively impacted by caffeine consumption.³ Importantly, perceived sleep quality was also impacted by caffeine intake.³ Likewise, Jahrami et al. found that the students reporting high caffeine intake (>400 milligrams per day) in a sample from six universities in Bahrain frequently experienced trouble falling and staying asleep, with just over 30% exhibiting severe, symptomatic insomnia.¹ Some studies have only noted significant effects on sleep with similarly high caffeine doses, describing worsening outcomes the closer the caffeine is consumed to bedtime.⁴ Interestingly, subjective reports of sleep quality are not always impacted, even when objective measures indicate caffeine-induced disruptions.^{3,4}

Pauchon et al. noted that chronic (daily) caffeine consumption amplified the effects of acute caffeine intake, leading to reduced objective sleep quality throughout a recovery period

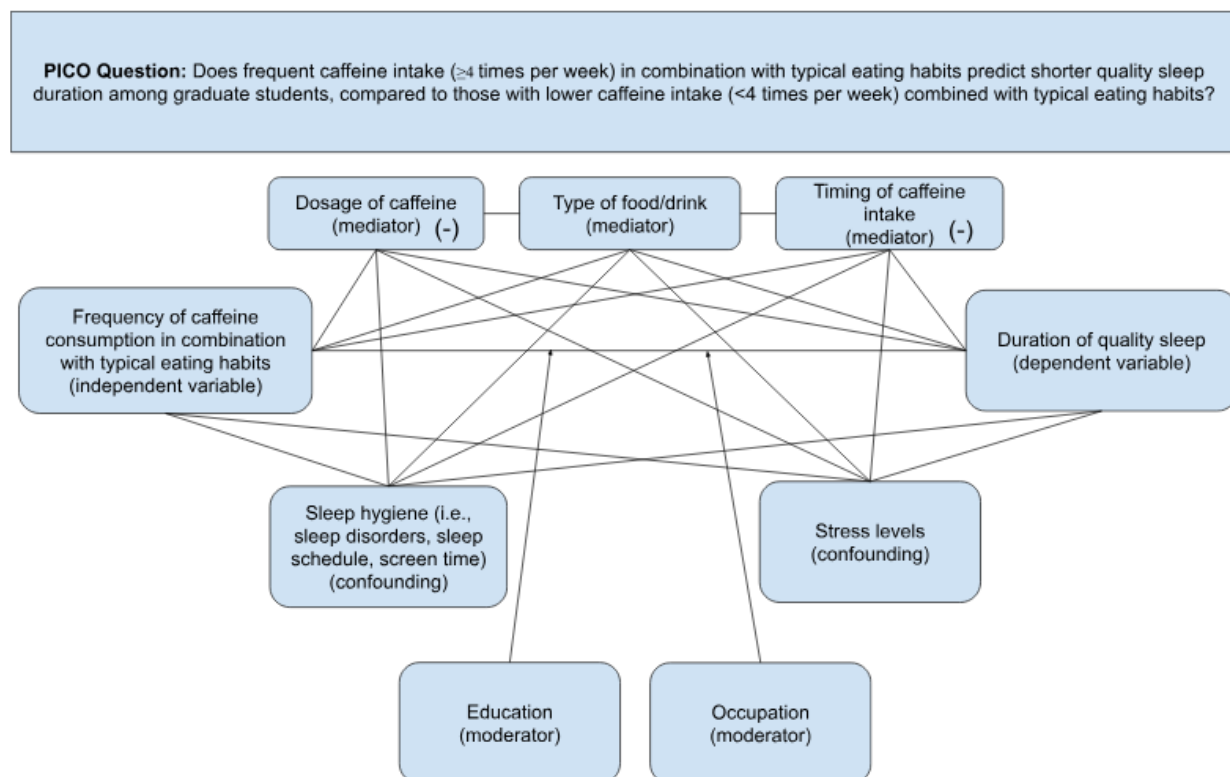
following sleep deprivation.² In contrast, Weibel et al. found that sleep quantity and quality were insignificantly different between those who did and did not consume caffeine, and those who were in a state of caffeine withdrawal.⁵ Furthermore, in a study by Schlichtiger et al., the total time spent asleep and the time at the onset of sleep/awakening were not substantially affected by the consumption of 240 milligrams of caffeine three hours before bedtime.⁶ However, unlike Wiebel et al., they reported significantly diminished sleep quality following caffeine consumption.⁶ Moreover, a study involving 886 undergraduate students in Spain identified a strong association between caffeine intake and self-reported reduced quality of sleep.⁷

The literature supports an important connection between caffeine intake and varying sleep outcomes. Yet, the strength of these relationships depends upon factors related to the population studied and the indications/patterns of caffeine use. Graduate students are one such population worth evaluating further due to their potential susceptibility to frequent caffeine intake, academic pressure, reduced sleep duration/quality, and the lack of representation of this group in the literature. Doing so may also aid in expanding the currently standing recommendations for caffeine intake relative to sleep and allow tailoring to specific groups. Furthermore, there is a paucity of evidence exploring the number of times per week caffeine is consumed, as compared to caffeine doses, timing of intake, and even the frequency of caffeine consumption within a single day. This is likely due to these factors mediating the interaction between the frequency of caffeine intake and quality sleep duration. Nonetheless, conducting research evaluating this facet of the relationship is critical, as it remains rather unexplored.

The conceptual framework presented below considers the common aspects affecting the relationship between the frequency of caffeine intake and the length of quality sleep (**Figure 1**). Dosage of caffeine and timing of its intake have been shown to have complex associations with

sleep, and further research has investigated the impact of different types of beverages on sleep quality and duration.^{3,8} Differences in the effects of these may be attributed to their respective caffeine content, but could also be impacted by the unique biochemical components of the food matrix (added sugars, saturated fat, etc.). Assessing the relationship between the frequency of caffeine intake and reported duration of quality sleep could provide further insights into why these outcomes are observed.

Figure 1. Conceptual Framework Portraying the Relationship Between the Frequency of Caffeine Intake and Duration of Quality Sleep



This conceptual framework postulates the relationship between the frequency of caffeine intake (in the context of typical dietary habits) and sleep quality duration, as influenced by other variables. Negative signs indicate the predicted influence of certain mediators on this

relationship, with increased caffeine dosage taken closer to bedtime expected to negatively impact (reduce) duration of quality sleep.⁴

Objective

The research question that this study aimed to answer was: Does frequent caffeine intake (≥ 4 times per week) in combination with typical eating habits predict shorter quality sleep duration among graduate students, compared to those with lower caffeine intake (< 4 times per week) combined with typical eating habits? The objective of this research was to quantitatively assess whether there was an association between caffeine intake and subjective sleep quality, among typical diet and lifestyle habits, in a population of graduate students. The hypothesis tested proposed that increased frequency of caffeine intake would be associated with reduced quality sleep reported in this group.

Literature Search Strategy

Two initial search strategies were implemented. One author utilized the Consensus search engine to identify potentially relevant papers, then applied their findings when acquiring works from the PubMed database. The other author used the PubMed database straightaway. The keywords from the latter PubMed search were the MeSH terms “caffeine” and “sleep quality.” The Boolean operator “AND” was used to connect these terms, which were then searched together using the PubMed Search Builder option. Inclusion criteria for the review were a publication date within the last five years, research solely involving humans, works available in English, documentation of subjective sleep quality outcomes, and an intervention including caffeine. Exclusion criteria were works older than five years, studies with animals as subjects, articles not published in English, a lack of sleep quality measurements and caffeine in the

intervention, and inaccessible copies of full texts. Filters were applied in PubMed to reflect these criteria. This search populated 16 results. Three of the most recent and relevant articles were selected for inclusion in this review. The other five articles were identified through the search using Consensus.

Methods

Study Design and Variables

A cross-sectional survey was conducted using a questionnaire that contained an FFQ and questions regarding demographics, health status, food security, sleep quantity and perceived quality, and stress levels. Stroop and CAIT Digit Span tests were implemented to assess cognitive function.

The independent variable of interest was the frequency of caffeine intake, which was categorized as high frequency (≥ 4 times per week) and low frequency (< 4 times per week). This was considered in the context of usual eating habits, such as alcohol or fried food consumption. The dependent variable was the reported duration of quality sleep, which was classed as being of shorter length (< 7 hours), normal length (7-9 hours), and longer length (> 9 hours). To ensure accurate analysis, age, gender, level of education, and ethnicity were controlled.

Inclusion and Exclusion Criteria

Inclusion criteria were being between 18 and 65 years old, being enrolled in an online graduate nutrition research course, and having no history of neurological disorders or cognitive impairment. Participants were excluded if they were < 18 and > 65 years of age, not currently enrolled in an online graduate nutrition research course, and/or if they had a history of neurological disorders or cognitive impairment.

Participants, Consent, and Study Procedures

Participants included five graduate students enrolled in an online nutrition course at King's College, located in Wilkes-Barre, Pennsylvania. Informed consent was acquired from each participant in a virtual format. King's College gave ethical approval of the study. Data from 24 other individuals were added to the dataset by Dr. Fakir Md Yunus. These individuals and their data were created and included in the course dataset to facilitate a more realistic experience while conducting statistical analyses.

Procedures for recruiting participants included in-class announcements. SharePoint questionnaires and the Stroop and CAIT Digit Span tests were made available to those who agreed to be in the study. These were accessible via links present on course assignment pages. The data were anonymized through the assignment of unique participant IDs and was collected over one week from May to June 2025. The dataset was merged and cleaned by Dr. Yunus and provided to the class for evaluation using the appropriate statistical tests.

Statistical Analysis

Statistical tests were run using Jamovi under the direction of Dr. Yunus. Descriptive statistics (mean, median, standard deviation, minimum, and maximum) were included to describe the central tendency of the data and the population's demographic characteristics. Frequency data were also measured, including total sample counts, proportions, and cumulative percentages. Multiple independent samples t-tests were conducted using sleep quality duration paired with one of four other variables: Education level, ethnicity, gender, and frequency of caffeine intake (defined as no caffeine or caffeine with other foods/dietary habits). A partial Pearson correlation was run using age and sleep quality duration. Finally, an adjusted multiple linear regression

model was used to assess the relationship between sleep quality duration, age, education level, gender, and ethnicity. The significance factor was set at $p < 0.05$.

Results

Descriptive Statistics

The sample students ($N=29$) exhibited a mean age of 32.4 years ($SD=7.22$, range=23-44). The gender distribution of the group was 51.7% male ($n=15$) and 48.3% female ($n=14$), with 65.5% being non-Hispanic ($n=19$) and 34.5% being Hispanic ($n=10$). Education level was split nearly 2:1, with 65.5% of participants holding a bachelor's or lower ($n=19$) and 34.5% a master's or higher ($n=10$). Caffeine intake patterns showed 72.4% regularly consumed caffeine with other foods ($n=21$), while 27.6% did not frequently consume caffeine ($n=8$). The self-reported sleep quality duration averaged 6.81 hours ($SD=1.65$, median=7.00).

Group Differences

Independent samples t-tests assessed the sleep quality duration differences (**Table 1**). There were no significant differences observed between gender ($t=-1.10$, $p=0.283$, $d=-0.407$), education ($t=0.0241$, $p=0.981$, $d=0.00940$), ethnicity ($t=-0.920$, $p=0.366$, $d=-0.407$), and caffeine intake ($t=0.754$, $p=0.457$, $d=0.313$) groups. The effect size was small ($d < 0.4$), and gender and ethnicity showed the greatest trends. However, those who consumed caffeine more frequently still tended to get fewer hours of quality sleep (6.67 ± 1.56) than those who did not (7.19 ± 1.93). The same was true for females (6.46 ± 1.55) compared to males (7.13 ± 1.73), and those who were not of Hispanic ethnicity (6.61 ± 1.60) compared to those who were Hispanic (7.20 ± 1.75). Those with a master's or higher level of education (6.80 ± 1.75) compared to those with a bachelor's or lower (6.82 ± 1.64) reported similar average quality sleep duration.

Table 1. Mean Difference of Quality Sleep Duration Across Frequencies of Caffeine Intake and Population Descriptives

Variable	N (%)	Quality sleep duration* Mean+/-SD	Mean diff	t ^{\$}	P [#]
Mean difference					
Gender identity					
Female	14 (48.3%)	6.46+/-1.55	-0.669	-1.10	0.283
Male	15 (51.7%)	7.13+/-1.73			
Education					
Bachelor's (BA, BSc) or lower	19 (65.5%)	6.82+/-1.64	0.0158	0.0241	0.981
Master's (MA, MS, MBA) and higher	10 (34.5%)	6.80+/-1.75			
Ethnicity					
Non-Hispanic	19 (65.5%)	6.61+/-1.60	-0.595	-0.920	0.366
Hispanic	10 (34.5%)	7.20+/-1.75			
Caffeine intake					

No caffeine	8 (27.6%)	7.19+/-1.93	0.521	0.754	0.457
Caffeine with other foods	21 (72.4%)	6.67+/-1.56			
Correlation**	Pearson correlation (r)				P#
Age (yrs)	0.059				0.762

*Quality sleep duration - Higher value indicates greater duration

\$Independent samples t-test

#P significant at <0.05

**Pearson (r) correlation

Correlation and Multivariate Analyses

A Pearson correlation analysis showed a weak, nonsignificant positive association between age and sleep quality duration ($r=0.059$, $p=0.762$, $N=29$), which suggests a minimal age-related influence within the sample.

A multiple linear regression model evaluated the combined effect of age, ethnicity, education, and gender on sleep quality duration (**Table 2**). This model explained that there was only a 6.8% of the variance ($R=0.261$ and $R^2=0.0680$), which indicated poor fit. All these predictors were nonsignificant (age, $p=0.085$; gender, $p=0.349$; education, $p=0.832$; and ethnicity, $p=0.427$), with standardized coefficients (i.e., β) reflecting small contributors. To specify, the β values for age (-0.00928) and education (-0.1502) indicate a very weak to weak

negative correlation, while the β values for ethnicity (0.591) and gender (0.62192) indicate a moderate positive correlation.

Table 2. Linear Regression (Controlled/Adjusted Model)

Variable	β	SE	Confidence interval		P#	t
			Low	High		
Age (yrs)	-0.00928	0.0487	-0.110	0.091	0.085	-0.191
Gender identity						
Male	Ref					
Female	0.62192	0.659	-0.731	1.989	0.349	0.954
Education						
Bachelor's (BA, BSc) or lower	Ref					
Master's (MA, MS, MBA) and higher	-0.1502	0.7009	-1.597	1.296	0.832	-0.214
Ethnicity						

Non-Hispanic	Ref					
Hispanic	0.591	0.7308	-0.917	2.0991	0.427	0.808

[#]*P significant at <0.05*

Discussion

Answering the PICO Question

This study found no statistically significant association between frequent caffeine intake (>4 times per week) and sleep quality duration in graduate students, contradicting the hypothesis. This aligns with the literature reporting no significant differences in subjective sleep quality between caffeine users and non-users.^{3,4} However, works have noted sleep impairment with the intake of high caffeine doses near bedtime.⁴ In the current study, those who consumed caffeine often tended to report lower length of quality sleep than those who did not, but a lack of significance indicates this did not substantially contribute to reduced sleep quality in this sample of graduate students. Notably, the small sample size, along with a lack of data on the dosage and timing of caffeine/caffeine intake, may explain these results. Similarly, dietary and lifestyle habits, such as fruit and vegetable consumption and exercise levels, could interfere with the negative effects of caffeine on sleep quality, leading to more frequent reports of positive sleep experiences. These factors were not controlled, and, therefore, might have influenced the outcomes observed.

Strengths and Limitations

The strengths of this work were the use of robust statistical analysis and targeting graduate students, an underrepresented group. Limitations included the small sample size, the

reliance on self-reported data, which is subject to bias, and uncontrolled factors like caffeine dose, timing of its intake, and dietary habits and patterns. These may have confounded results, as the regression model showed low explanatory power ($R^2=0.068$, $p>0.05$), noted previously. Still, the work completed here represents a meaningful starting point that authors interested in this population can base their future research on.

Implications

These findings suggest that the frequency of caffeine consumption may not significantly affect sleep quality in graduate students, possibly due to dietary or lifestyle factors, though a population-specific reaction to caffeine cannot be ruled out. Future research must evaluate objective sleep measures and detailed dietary, lifestyle, and caffeine-related data in adequately sized samples to further interpret these relationships, potentially informing the institution of sleep health recommendations specific to this group.

Conclusions

The research conducted here found no significant association between frequent caffeine intake (>4 times per week) and reduced sleep quality duration in graduate students, suggesting that how often caffeine is consumed may not be a primary predictor of negative sleep outcomes in this population. Limitations, such as a small sample size, self-reported data, and unmeasured factors like caffeine dose, time of consumption, and dietary habits or components (including the food matrix), could reduce generalizability. Nonetheless, graduate students, who are susceptible to academic stress and caffeine reliance, remain an important population to study. Future research should incorporate larger, more diverse samples, objective sleep measures, detailed

caffeine metrics, and longitudinal designs to clarify these relationships and develop strategies for optimizing sleep hygiene in this group.

REFERENCES

1. Jahrami H, Al-Mutarid M, Penson PE, Al-Islam Faris M, Saif Z, Hammad L. Intake of caffeine and its association with physical and mental health status among university students in Bahrain. *Foods*. 2020;9(4):473. doi:10.3390/foods9040473
2. Pauchon B, Beauchamps V, Gomez-Mérino D, et al. Caffeine intake alters recovery sleep after sleep deprivation. *Nutrients*. 2024;16(20):3442. doi:10.3390/nu16203442
3. Gardiner C, Weakley J, Burke LM, et al. The effect of caffeine on subsequent sleep: a systematic review and meta-analysis. *Sleep Med Rev*. 2023;69:101764. doi:10.1016/j.smrv.2023.101764
4. Gardiner CL, Weakley J, Burke LM, et al. Dose and timing effects of caffeine on subsequent sleep: a randomized clinical crossover trial. *Sleep*. 2025;48(4):zsae230. doi:10.1093/sleep/zsae230
5. Weibel J, Lin YS, Landolt HP, et al. The impact of daily caffeine intake on nighttime sleep in young adult men. *Sci Rep*. 2021;11(1):4668. doi:10.1038/s41598-021-84088-x
6. Schlichtiger J, Brunner S, Strüven A, Hoppe JM, Stremmel C. Effects of caffeine intake on self-administered sleeping quality and wearable monitoring of sleep in a cohort of young healthy adults. *Nutrients*. 2025;17(9):1503. doi:10.3390/nu17091503
7. Riera-Sampol A, Rodas L, Martínez S, Moir HJ, Tauler P. Caffeine intake among undergraduate students: sex differences, sources, motivations, and associations with smoking status and self-reported sleep quality. *Nutrients*. 2022;14(8):1661. doi:10.3390/nu14081661
8. Halldorsson TI, Kristjansson AL, Thorisdottir I, et al. Caffeine exposure from beverages and its association with self-reported sleep duration and quality in a large sample of Icelandic adolescents. *Food Chem Toxicol*. 2021;157:112549. doi:10.1016/j.fct.2021.112549