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Cognitive Ergonomics Approach In Food Packaging Design Influence On Purchase Decisions Among Klang Valley Consumers, Malaysia  
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*Rozita Naina Mohamed, Mohd Saifullah Rusli and Mior Harris Mior Harun*

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# MOTIVATIONS INFLUENCING CAFFEINE CONSUMPTION BEHAVIOURS AND HABITUAL CAFFEINE INTAKE IN RELATION TO SLEEP QUALITY OF PUBLIC UNIVERSITY STUDENTS IN PENINSULAR MALAYSIA

## *(MOTIVASI YANG MEMPENGARUHI TINGKAH LAKU PENGAMBILAN KAFEIN DAN PENGAMBILAN KAFEIN SECARA BERKALA BERKAITAN DENGAN KUALITI TIDUR DALAM KALANGAN PELAJAR UNIVERSITI AWAM DI SEMENANJUNG MALAYSIA)*

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### Abstract

Excessive caffeine consumption can impair sleep quality, a concern particularly relevant to university students. Despite this, research on caffeine consumption and its impact on sleep among students in peninsular Malaysia is limited. Thus, the present study aimed to investigate the relationship between motivation, habitual caffeine consumption, and sleep quality among university students in this region. A total of 225 students participated in this cross-sectional study, with data collected through an online self-administered questionnaire. The questionnaire consisted of sections on socio-demographics, motives for caffeine consumption, caffeine intake, and sleep quality. The Motives for Caffeine Consumption Questionnaire (MCCQ) evaluated reasons for caffeine use, while the Caffeine Intake Questionnaire measured daily intake. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). Spearman's correlation analysis was conducted with SPSS to determine the relationship between caffeine intake and sleep quality. Results revealed that most students consumed caffeine mainly for its taste, with a median score of 4.5 (IQR = 1.5). The average daily caffeine intake was 225 mg, which is considered a safe level. However, the median PSQI score was 6 (IQR = 4), indicating poor sleep quality. A weak but significant positive correlation was found between caffeine intake and sleep quality ( $r_s = 0.188$ ,  $n = 225$ ,  $p = 0.005$ ). This suggests a weak association where higher caffeine intake is linked to poorer sleep quality among these students. The study highlights the need for strategies to encourage healthier caffeine consumption

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and improve sleep habits. Further research is required to understand the mechanisms connecting caffeine intake and sleep quality.

**Keywords:** Behaviour, Caffeine Consumption Motives, Caffeine, Sleep, Pittsburgh Sleep Quality Index (PSQI)

## **Abstrak**

*Pengambilan kafein yang berlebihan boleh menjejaskan kualiti tidur, yang merupakan isu penting khususnya bagi pelajar universiti. Walau bagaimanapun, kajian mengenai pengambilan kafein dan kesannya terhadap tidur dalam kalangan pelajar di Semenanjung Malaysia adalah terhad. Oleh itu, kajian ini bertujuan untuk menyiasat hubungan antara motivasi, pengambilan kafein secara kebiasaan, dan kualiti tidur dalam kalangan pelajar universiti di kawasan ini. Sebanyak 225 pelajar telah menyertai kajian rentas ini, dengan data dikumpulkan melalui soal selidik dalam talian yang diuruskan sendiri. Soal selidik ini terdiri daripada bahagian mengenai sosio-demografi, motif pengambilan kafein, pengambilan kafein, dan kualiti tidur. Kuestioner Motif Penggunaan Kafein (MCCQ) menilai sebab penggunaan kafein, manakala Kuestioner Pengambilan Kafein mengukur pengambilan harian. Kualiti tidur dinilai menggunakan Indeks Kualiti Tidur Pittsburgh (PSQI). Analisis korelasi Spearman dilakukan menggunakan SPSS untuk menentukan hubungan antara pengambilan kafein dan kualiti tidur. Keputusan kajian menunjukkan bahawa kebanyakan pelajar mengambil kafein terutamanya kerana rasa, dengan skor median 4.5 (IQR = 1.5). Pengambilan kafein harian purata adalah 225 mg, dianggap dalam tahap selamat. Walau bagaimanapun, skor median PSQI adalah 6 (IQR = 4), menunjukkan kualiti tidur yang buruk. Ditemui korelasi positif yang lemah tetapi signifikan antara pengambilan kafein dan kualiti tidur ( $r_s = 0.188$ ,  $n = 225$ ,  $p = 0.005$ ). Ini menunjukkan adanya hubungan yang lemah di mana pengambilan kafein yang lebih tinggi dikaitkan dengan kualiti tidur yang lebih buruk dalam kalangan pelajar ini. Kajian ini menekankan perlunya strategi untuk menggalakkan pengambilan kafein yang lebih sihat dan memperbaiki tabiat tidur. Kajian lanjut diperlukan untuk memahami mekanisme yang menghubungkan pengambilan kafein dan kualiti tidur.*

**Kata kunci:** Tingkah Laku, Motif Pengambilan Kafein, Kafein, Tidur, Indeks Kualiti Tidur Pittsburgh (PSQI)

## **Introduction**

Caffeine, or trimethyl xanthine, is a central nervous system (CNS) stimulant widely consumed worldwide (Evans et al., 2021). It can be obtained from various sources, including coffee, tea, chocolate, and energy drinks (Uddin et al., 2017). Caffeine consumption has recently increased in some countries, such as Brazil, Italy, and Ethiopia, due to population growth (Gabrielle et al., 2020). However, excessive

caffeine intake can have adverse effects on an individual's health, such as caffeine intoxication, which can cause symptoms like fidgeting, excitement, insomnia, increased urination, gastrointestinal disturbance, muscle twitching, rapid heartbeat, and psychomotor agitation (American Psychiatric Association, 2012). Besides that, overconsumption of caffeine is also believed to lead to increased body weight due to additional sugar or milk that directly increases the total calories due to caffeine intake.

Adults' recommended daily caffeine intake is 400 mg (European Food Safety Authority, 2015). Pregnant women should limit their caffeine intake to 200 mg per day, while for children and adolescents, the recommended intake is 3 mg per kilogram of body weight (European Food Safety Authority, 2015). The actual consumption of caffeine may vary depending on the sources consumed. Coffee is considered a significant source of caffeine, with one serving of espresso containing 320 mg of caffeine (Caffeine Chart, 2022). However, the concentration of caffeine may vary depending on the type of coffee consumed, as the consumption of two shots of coffee instead of one shot can result in double the caffeine concentration in the drink (Rachel et al., 2003).

Sleep quality is commonly defined as the level of satisfaction with the quantity, continuity, and revitalization of sleep (Feifei et al., 2021). University students are highly associated with increased caffeine consumption, which can affect the quantity and quality of their nighttime rest (Frances, 2018). A total of 85% sleep efficiency is considered necessary for good sleep quality and adequate rest (Hirshkowitz, 2015). Efficient sleep helps the body rest and be fully energized for the next day. However, while caffeine is widely consumed and has the potential to enhance performance, excessive intake can have adverse effects on health, including its impact on sleep quality. Monitoring and regulating caffeine intake is essential to maintain good health and wellness. High caffeine consumption among students has been well-documented in previous studies (McIlvain et al., 2011). Despite this, students tend to need more knowledge and understanding of the negative impacts that caffeine can have on their health (Nor et al., 2019; Hardy et al., 2021). This is supported by the results of a study conducted at Management and Science University (MSU), which showed that 58.7% of students had moderate knowledge about the effects of caffeine consumption.

In comparison, 21.7% had low knowledge (Nor et al., 2019). By increasing their awareness and understanding of these effects, students can better manage their caffeine intake and avoid potential health consequences. Unfortunately, there is a lack of research on caffeine consumption among students in Malaysia, which makes it difficult to obtain valid data and findings on this issue (Laia et al., 2019; Teng et al., 2019). Thus, further research is needed to provide more information and data on this critical topic. More studies need to be conducted regarding caffeine consumption behavior in Malaysia, which results in difficulty in finding valid data and finding the

issue (Laia et al., 2019; Teng et al., 2019). Thus, proper and new research needs to be conducted to help provide new data that may assist in future research. In investigating the issue and developing a better solution, adequate research must be undertaken. As a result, this research is critical to give a relevant baseline dataset regarding caffeine consumption among university students.

## Materials and Methods

The cross-sectional study was conducted among public university students in Malaysia. From the record, there are 1.2 million university students in Malaysia, but only 52.1% are public university students (Malaysian Investment Development Authority, 2021). The study involved the descriptive analysis of the cross-sectional study in determining the motivation influencing caffeine consumption behavior and the association between habitual caffeine intake and sleep quality among local university students in Peninsular Malaysia. A cross-sectional study is one observational study that measures the outcome in a short period and represents the current outcome of interest by university students. The quantitative research was also involved in this study. Quantitative research is the study that focuses on quantifying the collection and analysis of the data. This quantitative study method was used to obtain the numerical data for each questionnaire based on each category to measure the frequency and percentage of each questionnaire. This study involved the participation of 11 universities scattered around Peninsular Malaysia.

The three universities that are located in Terengganu which are Universiti Malaysia Terengganu (UMT), Universiti Sultan Zainal Abidin (UNISA), and Universiti Teknologi Mara (UiTM) Kuala Terengganu are selected through the convenience sampling. This is because the respondents from these three universities are approachable and more convenient due to their proximity, which may help in the personal distribution of the questionnaire instead of entirely depending on online promotion. However, the remaining eight universities are selected through purposive sampling. The remaining eight universities include Universiti Teknikal Malaysia (UTeM), Universiti Teknologi Malaysia (UTM), and Universiti Tun Hussein Onn Malaysia (UTHM) from southern Malaysia. Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Teknologi Mara (UiTM) Shah Alam from the western of Malaysia, and Universiti Utara Malaysia (UUM) with Universiti Pendidikan Sultan Idris (UPSI) from the northern part of Malaysia. These universities were selected due to the accessibility of promoting and distributing the questionnaire, which can be approached online. However, the shortcoming is that the online questionnaire can only be promoted and distributed to the representative, and the number of respondents cannot be controlled for each university because it depends on how many students the representative was able to share the questionnaire.

A total of 224 respondents were included in this research, and among the 224 respondents, only the respondents aged 18 to 25 years old were included in the data. Besides, the data was included if the university students who answered the questionnaire currently studied in Malaysia and the students were from the public university student and undergraduate. However, if among the 224 respondents, there was an international student, the data would be excluded. In addition to that, the questionnaire with incomplete answers and part-time students were also excluded from this research. This research involves the Motives for Caffeine Consumption Questionnaire (MCCQ), the Caffeine Intake Questionnaire, and the Pittsburgh Sleep Quality Index (PSQI). The Motives for Caffeine Consumption Questionnaire (MCCQ) involved 22 questions with six distinct factors contributing to caffeine consumption: habit, mood, alertness, symptom management, social, and taste. For the Caffeine Intake Questionnaire, the output was based on the total caffeine intake, and the respondents were divided into two groups based on whether there was an overconsumption of caffeine (>400mg) or average consumption. Last but not least, the Pittsburgh Sleep Quality (PSQI) was used to measure the respondent level of sleep quality based on seven different criteria, which include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction.

The data obtained from the questionnaire in the Google form was coded in Excel, and later, the analysis was run using Statistical Package for Social Science (SPSS) version 25. The data for the socio-demographic profile was presented using the descriptive test in terms of frequency and percentage. Since the total data is more than 50, the Kolmogorov-Smirnov Normality test was conducted to test the normality of the data. The normality distributed data was described as mean and standard deviation, while the not normally distributed data was stated in the median and interquartile range. To determine the motivation of caffeine consumption behavior and the interrelation between habitual caffeine intake and sleep quality, the Pearson correlation or Spearman Correlation was applied for the analysis depending on the normality of the data.

## **Results and Discussion**

### **Sociodemographic Profile**

Table 1 shows the sociodemographic profile of 225 respondents involved in this study. The research involved a sample of 232 respondents. However, only 225 respondents had complete data analyzed for the study. Table 4.1 presents the socio-demographic background of the 225 respondents. Most respondents were 17-19 (44.4%), followed by those in the 20-22 age group (34.2%). The age groups were divided into three categories, 17-19 years, 20-22 years, and 23-27 years, based on previous studies that measured caffeine consumption among students. The study

found that female respondents were more dominant, accounting for 173 (76.9%) of the total, while only 52 (23.1%) were male. This gender distribution aligns with the reported statistics of undergraduate students in Peninsular Malaysia, where 62% are female and 38% are male (Statista, 2022). Most respondents were from two universities in the eastern region of Malaysia: Universiti Malaysia Terengganu (UMT) with 52% of the respondents and Universiti Sultan Zainal Abidin (UNISZA) with 32% of the respondents. The data from these universities was collected through convenience sampling as they were accessible and nearby. During data collection, the respondents from these two universities were reached through online promotion and direct outreach. In contrast, the respondents from the other eight universities were only promoted online, and the number of participants from each university depended on the efforts of the student representative council to promote the study.

The study found that 203 (90.2%) of the 225 respondents were Malay, 14 (6.2%) were Chinese, and 8 (3.6%) were Indian. The majority of the respondents, 103 (45.8%), were from the eastern region of Malaysia, while the western region had 52 (23.1%) respondents, the northern region had 36 (16%) respondents, and the southern region had only 34 (15.1%) respondents. In terms of academic year, the majority of the respondents were first-year students (108 or 48%), followed by third-year students (46 or 20.4%), second-year students (41 or 18.2%), and senior students (30 or 13.3%). The majority of the respondents, 223 (99.1%), were single and had never been married, while only 2 (0.9%) were married. Lastly, regarding the socio-demographic background, 198 (88%) of the respondents did not have a part-time job, while 27 (12%) had a part-time job during their study year. This indicates that most respondents were full-time students who were not occupied with a side job.

**Table 1: Socio-Demographic Data of The Local University Students (N= 225)**

Variables	Distribution	
	Frequency	Percentage (%)
<b>Age</b>		
17 - 19	100	44.4
20 - 22	77	34.2
23 - 27	48	21.3
<b>Gender</b>		
Female	173	76.9
Male	52	23.1

**Table 1 (continues)**

Variables	Distribution	
	Frequency	Percentage (%)
<b>University</b>		
UMT	117	52.0
Unisza	72	32.0
UiTM Terengganu	13	5.7
UiTM Shah Alam	7	3.1
UTM	6	2.7
UKM	5	2.2
UUM	1	0.4
UPM	1	0.4
UPSI	1	0.4
UTeM	1	0.4
UTHM	1	0.4
<b>Race</b>		
Malay	203	90.2
Chinese	14	6.2
Indian	8	3.6
<b>Region</b>		
East Malaysia	103	45.8
West Malaysia	52	23.1
North Malaysia	36	16.0
South Malaysia	34	15.1
<b>Academic Year</b>		
First Year	108	48.0
Second Year	41	18.2
Third Year	46	20.4
Fourth Year and greater	30	13.3
<b>Marital Status</b>		
Single	223	99.1
Married	2	0.9
<b>Doing Part Time Job</b>		
No	198	88.0
Yes	27	12.0

**Motivation Influencing Caffeine Consumption Behavior**

Table 2 highlights the motivation for caffeine consumption among public university students. The results of this study indicate that taste is the primary motivator for caffeine consumption among university students, as demonstrated by its highest median score of 4.5 (1.5) in Table 2. This score is significantly higher than the second-highest median score of 3.5 (2.0), shared by the motives of habit and mood. The remaining three motives, alertness, social, and symptom management, showed lower median scores of 3.44 (1.5), 3.25 (1.5), and 2.5 (1.5), respectively. One

noteworthy observation from these data comparisons is the substantial difference between the highest median taste and the lowest median score of symptom management. This highlights the importance of taste as a motivator for caffeine consumption and the limited role of symptom management as a motivator. It should be noted that the symptom management motive refers to the respondent's effort to alleviate symptoms that may result from caffeine consumption.

**Table 2. Results for Caffeine Consumption Motives (N=225)**

Motives	Score for caffeine consumption motives
	Median (IQR)
Taste	4.5 (1.5)
Habit	3.5 (2.0)
Mood	3.5 (2.0)
Alertness	3.4 (1.5)
Social	3.3 (1.5)
Symptom Management	2.5 (1.5)

Median (IQR) was used because the data is not normally distributed. The median score ranges from 1.0 to 5.0.

The results of this study are in contrast to previous research conducted in Mexico City, Puebla, and Toluca in 2020, which found a strong desire for health as a motivator for caffeine consumption (Ariadne et al., 2020). Despite this opposition, the results of this study are supported by other research that also found taste to be a dominant motivator for caffeine consumption (Agoston et al., 2018; Caroline et al., 2019; Saskia et al., 2021). These studies suggest that university students may consume caffeine primarily to satisfy their craving for its taste but may be unaware of the negative consequences of overconsumption (Saskia et al., 2021). As the total caffeine intake among university students continues to increase (McIlvain et al., 2011), these findings can aid in understanding the motivations behind this trend and inform future intervention efforts to reduce excessive caffeine consumption. To further investigate the impact of taste as a motivator, measuring caffeine intake levels among university students motivated primarily by taste may be helpful. Overall, the results of this study provide important insights into the role of taste as a strong motivator for caffeine consumption among university students. The second-highest median score shared by the motives of habit and mood suggests that overall, students may consume caffeine for its taste and to improve their mood. However, these results should be viewed in the context of the limited role of symptom management as a motivator, as well as the potential negative consequences of excessive caffeine consumption.

### Habitual Caffeine Intake

This section focused on the total daily caffeine consumption among public university students. The maximum daily caffeine intake that students can consume is equivalent to 400 mg (European Food Safety Authority, 2015). However, total caffeine concentration and content may be distinct in different sources of caffeine consumed by the students. The data analyzed in this study were obtained from a caffeine intake questionnaire developed by Hafeez et al. (2016). Table 3 demonstrates that most respondents (80.9%) consume caffeine within safe limits daily. However, 43 respondents (19.1%) exceeded the recommended amount of 400 mg per day, which could result in caffeine intoxication (American Psychiatric Association, 2012) and other adverse effects such as elevated blood pressure and potentially cardiovascular disease (Aleksandra, 2012).

**Table 3. Total Daily Caffeine Intake Distribution among Public University Students (N=225)**

Types of caffeine	Total daily caffeine intake Frequency (%)		Median (IQR)
	< 400 mg	> 400 mg	
Total Caffeine consumption	182 (80.9)	43 (19.1)	225 (204.0)
<b>Types of caffeine</b>			
Coffee	219 (97.3)	6 (2.7)	125 (125.0)
Tea	225 (100.0)	0 (0.0)	50 (50.0)
Caffeinated Carbonated Drink	225 (100.0)	0 (0.0)	0 (32.0)
Energy Drink	225 (100.0)	0 (0.0)	0 (74.0)

Median (IQR) was used due to the data not normally distributed

The total caffeine consumption was calculated based on four sources: coffee, tea, caffeinated, carbonated drinks, and energy drinks. The results showed that most respondents (97.3%) consumed less than 400 mg of caffeine from coffee, while only six (2.7%) exceeded the recommended daily limit. No respondents exceeded the recommended limit from tea, caffeinated, carbonated, or energy drinks. The median daily caffeine intake among all 225 respondents was 225 mg (204). Interestingly, more than half of the respondents did not consume caffeinated, carbonated drinks or energy drinks, with medians of 0 (32) and 0 (74), respectively. These results suggest a minimal contribution of caffeinated, carbonated, and energy drinks to total caffeine consumption. This contradicts Elena et al. (2017) 's suggestion that measuring the intake of caffeinated, carbonated drinks and energy drinks is essential in adequately representing caffeine consumption.

Apart from Elena et al. (2017), Choi et al. (2020) also stated the high prevalence and favorable of energy and caffeinated, carbonated drinks among South Korean

students at Woosong University. Previous studies have shown similar results, with most university students staying within the recommended daily limit of caffeine consumption (Derbyshire et al., 2008; Neil, 2020). The current study was conducted during the semester break for undergraduate students, which may have influenced the results. However, Thomas et al. (2014) found that caffeine consumption increases among university students during exam preparation, suggesting that the results may differ if data were collected during busier times. This also justifies the lower energy intake and caffeinated, carbonated drinks among the local public university students due to the students primarily on the semester break. Since the students are on break, there is only a little desire for energy except for doing sports. Thus, it connects to how the students did not consume energy drinks then. The limitations of the current study include the potential inaccuracies in caffeine recall. Total caffeine consumption was calculated based on one serving of a caffeinated product, and the portion sizes may have been different for all respondents, potentially leading to an overestimation of total caffeine consumption. Future research should consider addressing this issue by standardizing serving sizes, such as by weight or standard portion cups, to improve the accuracy of caffeine consumption data. These results provide a preliminary understanding of the relationship between caffeine intake and sleep efficiency in university students.

### Pittsburgh Sleep Quality Index

The results of our study indicate that a significant proportion of the participants, 134 (59.6%) out of 225, reported poor sleep quality. In comparison, only 91 (40.4%) reported good sleep quality—the Pittsburgh Sleep Quality Index questionnaire measured sleep quality, with scores ranging from 0 to 21. A score of 0 to 5 indicated good sleep quality, while scores from 6 to 21 indicated poor sleep quality. The median score for the good sleepers was 4 (2), while for the poor sleepers, it was 8 (4). The overall median score for the sample was 6 (4), which indicates poor sleep quality.

**Table 4. Distribution of Sleep Quality Index among The Local University Students (N=225)columns**

Variables	Global PSQI Score <sup>a</sup>	
	Frequency (%)	Median (IQR)
Overall Sleep Quality	225 (100.0%)	6 (4)
Poor Sleeper	134 (59.6%)	8 (4)
Good Sleeper	91 (40.4%)	4 (2)

The global score for PSQI ranges from 0 to 21.

A median (IQR) was used because the data was not normally distributed.

Our findings align with previous research that suggests a high prevalence of poor sleep quality among university students, with 76% of 756 medical students reporting

poor sleep quality in a study conducted in Riyadh, Saudi Arabia (Abdullah et al., 2017). However, our sample had a higher proportion of good sleepers compared to previous studies, which is almost similar to few other Asian universities that record the proportion of higher distribution of good sleepers, which is almost similar to the poor sleepers (54.7%) (Ching et al., 2021). Overall, poor sleeping habits were somehow prevalent in this group of local university students, according to PSQI global scores, and a similar percentage of public university students had PSQI values that indicated poor sleep quality. One possible explanation for the poor sleep quality is the association with self-reported negative emotions such as anger, depression, tension, and stress, especially during the week and weekend (Hannah et al., 2010). Emotion and mental disorders in which is related to neuroticism are commonly associated with insomnia or sleeping disturbance that results in poor sleep quality measured in the study among students (Ching et al., 2021).

It is important to note that the sample size in our study was relatively small, and larger sample sizes may result in more accurate findings (Liu et al., 2018). Additionally, the unequal distribution of respondents in different regions of peninsular Malaysia, with a higher representation from the eastern region, may limit the generalizability of the findings. The data was also self-reported, which may introduce information bias. In conclusion, the results of our study suggest a high prevalence of poor sleep quality among the participants, but further research with larger sample sizes and a more balanced representation of different regions is needed to confirm these findings.

## **Relationship Between Total Caffeine Consumption and Sleep Quality Among Public University Students**

Given the non-normal distribution of the data for total caffeine intake and sleep quality among public university students, a non-parametric analysis was conducted using the Spearman correlation to examine the relationship between these two factors. Spearman's rank order correlations examined the relationship between caffeine intake and sleep quality. The results revealed a positive but weak significant correlation between caffeine intake and sleep quality,  $r_s = 0.188$ ,  $n = 225$ ,  $p = 0.005$ . This study is particularly noteworthy due to its findings, which suggest that even though most students consume caffeine within safe limits, it still negatively impacts their sleep quality and leads to a high number of poor sleepers among students, which is somehow biologically plausible. Generally, caffeine is a strong methylxanthine and adenosine receptor antagonist with psychoactive effects (Nehlig & Boyet, 2000). Considering adenosine concentration in the brain is a physiological sleep component, it dictates the depth and quality of sleep (Calamaro et al., 2009). Adenosine boosts slow brain wave activity while enhancing electroencephalogram arousal, sleepiness, and drowsiness (Nehlig & Boyet, 2000). Thus, sleeping slowly reduces the level of adenosine in the body. However, when caffeine is consumed, the caffeine will be attached to G protein-coupled receptors in the brain, which mediate

the biological actions of adenosine and act as an adenosine receptor antagonist (Nehlig & Boyet, 2000). Taken together, the research reveals several ways caffeine affects the central nervous system. It supports epidemiological data connecting poor sleep quality to increased caffeine intake rates and doses.

**Table 5. Spearman correlation result between total caffeine consumption and sleep quality (N=225)**

Total Caffeine Intake		
Sleep Quality	$r_s$ value	$p$ value
	0.188	0.005*

\*Spearman correlation is significant at  $p < 0.05$

Previous studies have also confirmed the high correlation between caffeine intake and sleep quality. Some studies have even recorded poor sleep efficiency (below 85%) among those who consume caffeine (Halldorsson et al., 2021; Caroline et al., 2020). Another study (Choi et al., 2020) found a strong correlation between sleep quality and caffeine intake but noted that other external factors could contribute to poor sleep quality. However, in contrast to this research, the current study only shows a significantly weak correlation between the total caffeine intake and the sleep quality among university students. These relationships may partly be explained by the fact that the data collection was conducted during the semester break, and the students did not experience a hectic day compared to the research by Choi et al. (2020). The study conducted at Woosong University in South Korea was conducted on a typical day within the semester, during which the students consumed caffeine for the desire of alertness and the energy it can provide them.

There are similarities between the findings of Choi et al. (2020) and the other experimental laboratory observations described by Carrier et al. (2007), which mention a strong correlation between a high caffeine intake and a negative impact on sleep quality. The study involved a laboratory study that mostly tends to give the participant higher amounts and doses of caffeine than the self-reported habitual amount applied in this study. During the study, the researcher gave the respondents 100 mg of caffeine three hours before bedtime and 100 mg again an hour before bed. The caffeine consumption within that period is prominent towards sleep consolidation and REM sleep, considering the participant consumes the same amount before bedtime. In contrast with the present study, some studies have found a more robust correlation between habitual caffeine intake and sleep quality. Still, several studies also showed no significant correlation between these two factors. The study proves this. DelBrutto et al. (2016), with a regression coefficient of 0.866, indicated that fragile evidence and no correlation indicate that caffeine intake does not affect sleep quality. Unlike the current study, despite being weak, there is still a significant correlation. The possible explanation for the respondent's poor sleep quality may be

affected by various external factors such as insomnia, light, and noise pollution without the caffeine consumed.

In conclusion, based on the findings of this research and previous studies, it can be inferred that caffeine consumption may contribute to poor sleep quality, which is not recommended for overall health. The results highlight the need for students to be mindful of their caffeine intake and consider alternative ways of promoting alertness and energy, such as through physical activity or good sleep habits, to maintain optimal sleep quality.

## **Conclusion**

Four main objectives were included in this study: to determine the motivation influencing caffeine consumption behavior, habitual caffeine, sleep quality, and the relationship between caffeine intake and sleep quality among public university students in Peninsular Malaysia. The results obtained from this study show that taste is associated with caffeine consumption, with the highest median score of 4.5 (1.5) among the six motives. Regarding caffeine intake, 80.9% of 225 respondents consumed caffeine in a safe range every day, but it turns out that more than half (59.6%) of students are poor sleepers. Thus, it strongly correlates with habitual caffeine intake and sleep quality, with an R-value of 0.893. Even though most students still consume a safe amount of caffeine daily, it is believed that caffeine indirectly affects their alertness. However, there are other motives for caffeine consumption among students.

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## **Ethical statement**

This study was approved by the Board of Human Ethics Committee of Universiti Malaysia Terengganu with an approval number UMT/JKEPM/2021/71.

## **Conflict of interest**

The authors declare no conflict of interest. (Do not change this sentence unless the authors have any conflict of interest to declare)

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