

The Relationship between Caffeine Consumption and Sleep Quality of Students of the Faculty of Sports Science Universitas Negeri Malang

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ARTICLE INFO	ABSTRACT
ORCID ID Author 1: https://orcid.org/0009-0008-6569-1064 Author 2: https://orcid.org/0000-0002-0341-1302 Author 3: https://orcid.org/0000-0001-7075-1641 Author 4: - Author 5: - Author 6: - Author 7: - Author 8: - Author 9: -	Coffee is a popular drink consumed in Indonesia, especially among people aged 17 until 25 years. Coffee contains thousands of natural chemicals, one of which is caffeine, which has negative impacts on health if consumed in excessive amounts. The purpose of this study is to describe the caffeine-based beverages consumed and sleep quality and to assess the association between caffeine use and sleep quality. This study used a cross-sectional design with 120 respondents who completed a questionnaire about the history of caffeine-based beverage consumption and PSQI sleep quality, PSQI is used to measure the state of sleep which consists of seven parts: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleep medication, and waking dysfunction. There is a significant correlation (p -value less than 0.05) between the level of caffeine beverage consumption and students' sleep quality. The higher the caffeine consumption category, the greater the risk of having poor sleep quality. It is suggested to implement health promotion strategies, such as educating about consumption limits and the side effects of coffee through various social media platforms to reduce the negative impacts of coffee consumption. Thus, the health of individuals in the productive age group can be maximized.
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1. Introduction

One of the essential human needs is rest, which is intended to help the body recover from daily activities and restore physical and mental fitness. Proper rest is equally as important as adequate nutrition and regular physical activity (Oktaria, 2020). Rest can take various forms depending on individual needs, such as meditation, engaging in hobbies, or sleep. Sleep affects an individual's ability to concentrate, make decisions, and maintain productivity in daily activities (Potter & Perry, 2009). The body undergoes a restorative process during sleep to recover stamina and maintain optimal function (Sarfriyanda et al., 2015). The need for sufficient sleep can be evaluated through two key aspects: sleep quality and sleep quantity. Sleep quality includes both quantitative and qualitative elements, such as sleep duration, sleep latency, frequency of nocturnal awakenings, and subjective experiences like sleep depth (Nilifda et al., 2016). However, sleep deprivation is increasingly common among young adults,

especially university students. This condition can lead to side effects, such as decreased focus, poor academic performance, and health complications.

This issue is especially prevalent among students at the Faculty of Sports Science, who experience high physical and cognitive demands. One contributing factor to sleep disturbances in this population is caffeine consumption. Research has consistently examined the complex relationship between caffeine intake and sleep patterns. Drapeau (2006), demonstrated that even moderate caffeine doses (200 mg) taken before bedtime significantly reduced sleep quality by disrupting sleep architecture and natural cycles. University students are particularly vulnerable to this effect due to academic pressure, extracurricular demands, part-time jobs, and irregular routines, which increase caffeine consumption. Quadra (2020), reported that the average daily consumption of 3 to 5 cups of coffee among students was linked to habitual short sleep duration (≤ 6 hours per night). Chronic sleep deprivation can impair cognitive function, reduce academic achievement, increase stress levels, and elevate the risk of mental health issues.

In Indonesia, studies at Udayana University (2015) and Atma Jaya Catholic University (2021) revealed that over 90% of student respondents reported having consumed coffee. Coffee is an accessible and widely consumed caffeine source among adolescents and young adults in Indonesia. Between 1990 and 2021, Indonesia experienced a dramatic 302.57% increase in coffee consumption, indicating a growing trend among all segments of society, including students (Br Ginting et al., 2022). Students perceive coffee as an energy booster, a way to combat drowsiness, and a means of increasing mental alertness (Liveina, 2018). Caffeine is believed to elevate mood, enhance concentration, reduce fatigue, and support cognitive function (Triantara & Widyastuti, 2017). According to the European Food Safety Authority (EFSA), packaged coffee often contains both caffeine and sugar, which, when combined, may enhance cognitive function and working memory (European Food Safety Authority, 2015). While caffeine can provide certain cognitive benefits, its impact depends heavily on dosage. Smit and Rogers (2000) found that consumption between 12.5 mg and 100 mg often had positive effects with minimal adverse outcomes (Ingrouille, 2013). However, when consumed in excess (>400 mg/day), caffeine can negatively affect sleep, leading to insomnia, increased anxiety, fatigue, and impaired cognitive performance (Masi et al., 2016). These effects can significantly impact the academic success and well-being of university students.

Given the increasing prevalence of caffeine use and sleep disturbances among university students, particularly those in health-related fields such as Sports Science, it is crucial to further investigate this relationship. Previous studies that discuss the relationship between caffeine consumption and sleep quality, especially in sports study program students in Indonesia, are still limited. Sports study program students have different characteristics from students in general, where most of them are athletes who need to maintain the quality of their performance. This study focuses on students in the Faculty of Sports Science at Universitas Negeri Malang, a population generally informed about health, lifestyle, and physical fitness. Therefore, this study is conducted to describe caffeine use and students' sleep quality, and also assess the association between caffeine use and sleep quality among them.

2. Method

Data were collected in July 2024 at the Faculty of Sport Science UM. A cross-sectional design analysis was employed in the study. Students in all undergraduate majors in the Faculty of Sport Science at UM in the classes of 2022 and 2023 made up the study's population. The voluntary sampling approach was used to collect the research sample. The sample size calculation, performed using the Lemeshow (1990), formula with a 95% Confidence Interval (CI) ($\alpha=0.05$), resulted in 120 respondents. Data was collected via an online questionnaire from July 3 to 10, 2023. Sleep quality is the dependent variable, measured using the Pittsburgh Sleep Quality Index (PSQI) questionnaire, while the independent variable, caffeine consumption, was assessed through a categorical caffeine intake instrument.

The PSQI instrument evaluates sleep quality over a one-month interval and consists of 19 questions grouped into seven assessment components: subjective sleep quality (question no. 9), sleep latency (questions no. 2 and 5a), sleep duration (question no. 4), habitual sleep efficiency (calculated by dividing sleep duration by time spent in bed and multiplying by 100), sleep disturbances (questions no. 5a to 5j), use of sleeping medication (question no. 6), and daytime dysfunction (questions no. 7 and 8) (Robins, 1988). Respondents are categorized based on the total score of the seven components, with good sleep quality indicated by a score of ≤ 5 and poor sleep quality defined as a score between 6–21 (Buysse et al., 1989). Additionally, data on respondent characteristics such as age, gender, department, and academic year were collected. Caffeine consumption was measured and classified into three categories based on daily intake: low (<100 mg/day) if consuming one cup (± 237 ml) of caffeine-containing beverages (coffee, tea, chocolate), moderate (100–400 mg/day) if consuming 2–3 cups per day, and high (>400 mg/day) if consuming more than 3 cups per day (questions no. 4 and 5) (Eskelinen & Kivipelto, 2010).

To show the respondents' distribution by category of caffeine use and sleep quality, a descriptive analysis was conducted. The relationship between the independent and dependent variables was analyzed using Spearman's Rank Non-Parametric Correlation Test to determine the association between caffeine consumption and sleep quality. This study passed the ethical review with the number 0015/HRECC.FODM/1/2024 from the Faculty of Dentistry, Universitas Airlangga.

3. Result and Discussion

A total of 120 students from the Faculty of Sports Science were among the responders who satisfied the inclusion criteria, according to the research data collecting findings.

3.1 Characteristics of Respondents

The frequency distribution of respondent characteristics, types of caffeine-containing drinks consumed, the following tables will show how many glasses of caffeinated beverages were drunk in a single day as well as the negative impacts of coffee use. Table 1 show about characteristics of respondents.

Table 1. Characteristics of Respondents by Age, Gender, Department, and Batch

Characteristics	Frequency (n)	Percentage (%)
Age (Year)		
18-20	96	80
21-23	24	20
Gender		
Male	52	43,3
Female	68	56,7
Department		
Physical education, health and recreation	30	25
Sports science	29	24
Sports coaching education	27	22,5
Public health science	34	28,5
Batch		
2022	67	55,8
2023	53	44,2
Total	120	100

Source: Primary Data, 2024

Based on Table 1, the results show that the respondents are mostly 20 years old with a total of 46 people or 38.3% of the total respondents. Then when viewed from gender, most respondents are male students with a total of 68 people or covering 39.5% of the total respondents. Many respondents are students from the Department of Public Health Sciences with a total of 34 people or (28.3%). Then when viewed from the class, most respondents are from the 2022 class with a total of 67 people or covering (55.8%) of the total respondents.

The American Academy of Pediatrics recommends that children ages 12 to 18 limit their caffeine intake to 100 milligrams per day, or about 1 cup of coffee, 1 cup of tea, or 2 glasses of soda. For those ages 12 and under, no set amount of caffeine is considered safe. Closely monitoring your child's caffeine intake will prevent them from negative side effects, such as dehydration, diarrhea, and anxiety. The National Institutes of Health found comparable results. People who consumed at least three cups of coffee every day had a 10% decreased risk of dying. Over 400,000 men and women aged 50 to 71 participated in the study. The Annals of Internal Medicine support the idea that drinking coffee is linked to longevity. One study of more than 185,000 Americans reported that coffee drinkers were 18 percent less likely to die than non-drinkers. Another research of over 520,000 adults in Europe discovered that people who drank multiple cups of coffee each day had a decreased chance of dying.

Although both sexes consume a lot of coffee, males drink somewhat more than women. When compared to the overall US population, women drink about 1.5 cups and males drink roughly 1.7 cups. In comparison, number of men is greater than women, so the percentage reaches 76.8%, compared to male respondents. Research in Japan is also in line, with the that men drink more coffee (50.8%) than women (32.8%) in young adulthood (Demura et al., 2013). This phenomenon is because men tend to consume coffee more often than women. Men have a higher prevalence of coffee-drinking choices through to improve their social status. Few women can afford expensive branded coffee that is starting to mushroom now, because women have lower incomes and more young men work than young women. Another reason may arise. Because men are less morning-oriented than women, especially in student samples. Perhaps sensory gender differences motivate men to prefer drinking higher-quality coffee than women (Tifferet et al., 2013).

3.2 Caffeine consumed

The category of types of caffeine-sourced drinks was also collected to describe the types most consumed by respondents through the following Table 2.

Table 2. Distribution of types of caffeine-containing drinks consumed

Types of caffeine		Frequency (n)	Percentage (%)
Coffee	Espresso	10	8,3
	Cappuccino	23	19,2
	Café Latte	29	24,2
	Americano	13	10,8
Tea	Green Tea	15	12,5
	Black Tea	9	7,5
	White Tea	2	1,6
Soft drink		6	5
Energy drink		2	1,6
Chocolate drink		11	9,3
Total		120	100

Source: Primary Data, 2024

According to Table 2, it can be inferred that the predominant form of caffeine consumption among respondents is coffee, with 75 individuals representing 62.5%. Among them, 29 individuals mostly consume Cafe latte, accounting for 24.2%. There are 26 people consuming tea caffeine (21.6%) with 15 people consuming green tea (12.5%). Followed by the consumption of chocolate drinks by as many as 11 people (9.3%), the consumption of soda drinks by as many as 6 people (5%), and as many as 2 people consuming energy drinks (1.6%). Espresso has 64mg caffeine/30mL, Green Tea has 28mg caffeine/237mL, Soft drink has 22mg caffeine/237mL. Energy drink has 71,9mg caffeine/237mL and Chocolate drink has 5mg caffeine/237mL. The type of coffee drink can relate to sleep quality where students who consume espresso coffee are 2.22 times more likely to experience poor sleep quality compared to students who consume other types of coffee. Based on research by Triantara (2017) shows the measurement of caffeine levels in various coffee beverages indicates that espresso contains the maximum caffeine concentration at 182.4 mg per cup, in contrast to cappuccino and latte, which have 54 mg and 41.25 mg per cup, respectively. Table 3 show about the distribution of the consumed caffeine in one day.

Table 3. Distribution of the number of glasses of caffeinated drinks consumed in one day

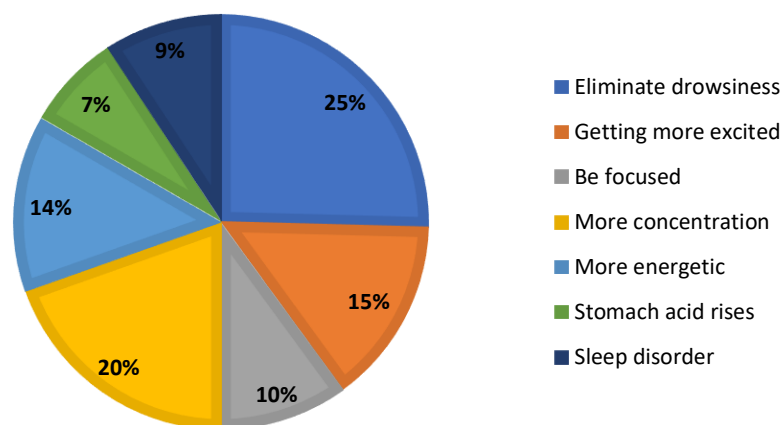
Characteristics	Frequency (n)	Percentage (%)
Consumed in one day		
One time	92	76,6
Twice	25	20,8
Three times	3	2,6
Total	120	100

Source: Primary Data, 2024

According to Table 3, the predominant frequency of caffeinated drink use among respondents is once daily, with a total of 92 respondents (76.7%). In March 2019, the American Journal of Clinical Nutrition came to the conclusion that consuming eight ounces, or six cups, of coffee daily can raise the risk of cardiovascular disease by 22%. The investigation examined nearly 350,000 individuals. The consumption of four glasses of coffee per day has been

determined to be safe by numerous studies. Even dietary guidelines recommend that a balanced diet can include three to five glasses of coffee per day.

This by research conducted by Clark & Landolt (2017) which states that coffee consumption can inhibit the adenosine neuromodulator system, and the receptor system related to the sleep cycle which indirectly affects a person's sleep quality. Based on Health Canada recommendations, normal caffeine consumption ranges from ≤ 400 mg per day (Mitchell et al., 2014). Coffee consumption in students of 3 to 5 cups per day is related to students' sleep habits of ≤ 6 hours per night (Chaudhary et al., 2016). A acute toxic effect may result from the consumption of excessive caffeine. Convulsions and regurgitation have been reported to occur following the consumption of caffeine in quantities of up to 10 g (Chowdhury et al., 2009). Recovery is completed within six hours. The estimated fatal acute oral dose of caffeine in humans is 10–14 g (150–200 mg/kg) (Hodgman, 1998). However, the toxic dose can be altered by a variety of factors, such as age, smoking, prior caffeine status, pregnancy status, and concomitant substance use, which can also affect an individual's sensitivity to caffeine. According to the information we have right now, a low caffeine dose of four cups of coffee or less per day, or 4400 mg of caffeine per day (Abraham & Singh, 1999). Distribution side effects felt by respondents after consuming coffee show in Figure 1.



Source: Primary Data, 2024

Figure 1. Distribution side effects felt by respondents after consuming coffee

Figure 1 shows that out of the 120 people who answered, 30 (25% of the total) said that it could stop them from feeling sleepy after drinking coffee. Although there isn't a set daily limit that will work for everyone, the body produces more caffeine when you consume more than 4 to 5 cups. Knowing when to drink coffee will help you avoid disrupting your sleep schedule. Caffeine has a biological half-life of seven to nine hours. The benefits will be worn off before bed if you consume a lot of coffee in the morning. However, if you consume it throughout the day, it can cause insomnia at night. Caffeine has different effects on different people. By consuming less coffee each day, you may avoid experiencing any bad effects from the drug, such as anxiety or sleeplessness.

Energy drinks and coffee claim to improve performance, concentration, and reaction speed, increase alertness, stimulate metabolism, and make people feel more energetic (Valeria et al., 2012). Meanwhile, caffeine concentrations vary between different drinks, with coffee generally having the highest value compared to tea and some energy drinks (Heckman et al., 2010). A cup of coffee, green tea, and commonly consumed energy drinks all contain varying amounts of caffeine. Numerous studies have discovered that excessive caffeine use might negatively impact cognitive function. According to Kaplan and colleagues (1997), a comparatively modest dose of caffeine (250 mg) resulted in improved cognitive performance and positive subjective effects (such as elation and pleasantness) in healthy volunteers. Nevertheless, the cognitive performance of the subjects was not significantly improved, and the positive subjective effects (such as anxiety, restlessness, uneasiness, and tension) were less pronounced at higher dosages (500 mg) than in the placebo group. Caffeine may have more adverse effects on nonusers than on frequent users (Tajfel & Turner, 1986). Benowitz (1990) has suggested that anxiety disorder may be misdiagnosed as excessive caffeine consumption (caffeinism for short). Individuals with agoraphobia or panic disorders have been demonstrated to experience anxiety or panic attacks in response to caffeine, while healthy controls do not (Boulenger et al., 1984; Charney et al., 1985).

Caffeine is a legal stimulant. Coffee is one of the most delicious forms of caffeine and is widely available in every home. Coffee can be categorized as a factor that can affect sleep patterns and quality. Several studies have reported that caffeine is useful for restoring a person's level of alertness/wakefulness and compensating for reduced cognitive abilities as a result of lack of sleep (Snel & Lorist, 2011) but caffeine consumption has also been shown to harm sleep patterns and cause daytime drowsiness (Glade, 2010). A study by Smit and Rogers (2000) stated that 12.5 - 100 mg of caffeine can have a positive effect and rarely cause side effects. The caffeine concentration of some caffeinated items, including coffee and energy drinks, isn't always readily apparent. The caffeine content in coffee is known to vary depending on the type of coffee. Each serving of instant coffee has between 66 and 100 milligrams of caffeine. Energy drinks have a high caffeine level (between 80 and 141 mg per cup) (Ingrouille, 2013).

3.3 Correlation of Caffeinated Beverage Consumption Categories and Quality of Sleep Categories

The association between the respondents' sleep quality and the categories of caffeine usage is examined using bivariate analysis. Table 4 show about correlation of caffeinated beverage consumption categories and quality of sleep categories.

Table 4. Correlation of Caffeinated Beverage Consumption Categories and Quality of Sleep Categories

Independent Variable Caffeine consumption categories	Dependent Variables Quality of sleep category				TOTAL	P-value Sig.(2- tailed)	Correlation Coefficient Figure (r)
	Good (<5)		Bad (≥5)				
	n	%	n	%			
Low (<200mg)	44	36.6	7	5.8	51	0.001	0.488
Moderate (200-400mg)	23	19.2	9	7.5	32		

High (<400mg)	11	9.2	26	21.7	37
Total	78	65	42	35	120

Source: Primary Data, 2024

According to Table 4, the category by caffeinated beverage consumption illustrates that out of 120 respondents, the majority of respondents, 44 (36.6%) have low levels of caffeine consumption in has Good Quality of Sleep category. A p-value of 0.001 was found in the Spearman rank correlation analysis results, indicating a relationship between the categories of caffeine use and sleep quality. One may argue that there is a correlation between the category of students who use caffeine and the category of sleep quality. The correlation coefficient of 0.488 means that if students consume caffeine in the high category, it can cause sleep quality to be in the bad category, while if students consume lower caffeine, it can improve sleep quality.

Table 4 also explains that respondents who consume caffeine in the high category or more than 400mg in 1 day have a bad sleep quality of 21.7%. Conversely, respondents who consume caffeine in the low category or less than 200mg in 1 day have a good sleep quality of 42.2%. The National Sleep Foundation shows that around 36% of young adults aged 18-29 years have difficulty waking up in the morning. Meanwhile, 22% of young adults are often late for work or class because they have difficulty waking up in the morning. Around 40% complain of feeling sleepy at work at least twice a week or more (Rizal & Afriandi, 2022). Poor sleep quality in medical school students is caused by working every day and various tasks that require students to stay awake all night. This plays a major role in affecting students' sleep hours. Going to bed at 23:00 and waking up at 05:00 is a good sleep time. This is because from 23:00 to 05:00 there is a regeneration of people in the body. If the body is still awake at that time, then regeneration is not going well (Dharmadi et al., 2021). Sleep quality is said to be good if there are no signs of sleep deprivation and no problems when sleeping. Poor sleep quality can cause physical disorders and even damage a person's memory and cognitive abilities. If it happens continuously, it can cause more dangerous complications in the future. According to research conducted by Almojali (2017), poor sleep quality is often found in medical students because students have new academic needs and demands that can disrupt sleep patterns. Medical students have less sleep time because of their busy lecture schedules, and many assignments that must be done, especially when approaching exams and working on their theses.

The insignificant proportion of poor sleep quality is thought to occur due to differences in individual sensitivity or tolerance to caffeine. Some things that can affect a person's sleep patterns include stress and anxiety about personal problems or situations that can disrupt a person's sleep. The physical surroundings in which an individual sleeps have a significant impact on their capacity to fall asleep and remain asleep; severe exhaustion from a demanding job makes it hard to fall asleep, and any illness that causes pain or physical discomfort can also lead to sleep issues (Surbakti et al., 2015). A good, regular, and appropriate sleep pattern will have a positive effect on a person's health, but on the other hand, if there is a problem with the sleep pattern it will cause fatigue and decreased performance. Humans who suffer from sleep difficulties may also work more slowly, and make more blunders because they are less focused, and have difficulty remembering things, this can cause decreased work productivity and can cause accidents (Thayeb et al., 2015).

Many factors affect the quality and quantity of sleep, including illness, environment, fatigue, lifestyle, emotional stress, stimulants, alcohol, diet, smoking, and motivation. Cheng SH, Shih defines sleep as one of the body's biological rhythms that is very complex. The Reticular Activating System (RAS) and the Bulbar Synchronising Region (BSR) are two parts of the brainstem that govern and regulate sleep activity. People think that the RAS in the upper portion of the brainstem has specific cells that can keep you awake and conscious, as well as provide you visual, auditory, pain, and tactile sensory impulses, as well as emotions and thoughts. Adults need 7-8 hours of sleep at night. Sleep quality encompasses both quantitative and qualitative dimensions, including sleep length, time required to achieve sleep onset, frequency of arousals, and subjective measures such as sleep depth.

The results of this study are in line with research conducted by Ravaandran & Wahyuni (2018), where the results of the study were that there was no significant relationship between coffee consumption and sleep quality with a p-value = 0.619. Although there is no significant relationship between coffee consumption and sleep quality, a study shows that it is better to consume no more than 200 mg of coffee per day to avoid sleep disorders and not to consume coffee or caffeine at least 4 hours before bedtime. The difference in the results of the above studies is likely because in this study not all factors that can affect sleep quality were assessed so it is not clear what can allow poor sleep quality to occur.

This study only involved students from a single faculty, namely the Faculty of Sports Science, which limits the generalizability of the findings to the broader student population. Additionally, other factors that may influence sleep quality—such as stress levels, gadget use habits, or daily physical activity—were not examined in depth in this study. These findings can serve as the basis for developing tailored interventions, such as sleep quality education programs and healthy caffeine consumption guidelines. Furthermore, they can inform social media education campaigns by the Faculty of Sports Science on the benefits of appropriate caffeine intake, specifically for Sports Science students. The results of this study can also be incorporated as material into relevant courses, such as Introduction to Sports Nutrition, Sports Health Promotion, and Sports Performance Supplementation.

4. Conclusion

This study found a significant relationship between caffeine consumption and sleep quality of students. Almost half of the respondents in the low caffeine consumption category had good sleep quality. This finding underlined that the amount of caffeine consumed in one day can determine the quality of sleep of students besides being caused by many other factors. This finding also explains that students are closely related to the habit of consuming coffee to increase concentration and eliminate drowsiness in supporting the learning process on campus which is a positive effect of caffeine. It is also important to provide preventive and promotive interventions related to the negative effects of excessive caffeine consumption and caffeine consumption limits among students. It is necessary to develop promotive efforts using an approach that is on the characteristics of students so that it can reduce the negative effects of coffee consumption and maximize the benefits of coffee consumption for the health of students who are in the productive age category.

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