Journal of Nutrition and Food Security
Shahid Sadoughi University of Medical Sciences
School of Public Health
Department of Nutrition
Nutrition & Food Security Research Center

eISSN: 2476-7425 pISSN: 2476-7417 JNFS 2023; 8(4): 535-543 Website: jnfs.ssu.ac.ir

Impact of Caffeine Consumption on Sleeping Hours and Stress Scale among Anesthesiologists: A Cross-Sectional Study

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ARTICLE INFO

ORIGINAL ARTICLE

Article history:
Received: 21 Oct 2022
Revised: 30 Nov 2022
Accepted: 30 Nov 2022

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ABSTRACT

Background: Due to its stimulatory effects, caffeine is one of the most frequently consumed mood and behavior altering beverages. It is commonly used to improve alertness in cases of fatigue after prolonged work. Health authorities recommend not to exceed a daily intake of <200 mg/day. The purpose of this study is to measure the prevalence of unsafe caffeine daily consumption (>200 mg/day), detect caffeine withdrawal and intoxication symptoms, and investigate the relationship between caffeine intake and stress and sleeping hours. **Methods:** 168 anesthesiologists answered a questionnaire during the period of April to July 2022. After estimating daily consumption of caffeine, anesthesiologists were classified into either safe level group (daily consumption ≤ 200 mg/day), or unsafe level group (daily consumption >200 mg/day); then, further analysis was done. **Results:** Almost 80% of the total participants were unsafe consumers. Junior doctors and registrars (group J) had a statistically higher caffeine consumption than consultants (group S) (433.9±228.7 mg versus 363.6±244.5 mg, respectively; *P*=0.017). Additionally, 45% of group J experienced intoxication symptoms, and 54% experienced withdrawal symptoms. These symptoms had a significantly higher prevalence in group J compared to group S (*P*=0.001 and *P*=0.004, respectively). Finally, no significant correlation was found between average daily caffeine consumption and daily sleeping hours and stress scale score (*P*=0.831 and *P*=0.324, respectively). **Conclusion:** The consumption of caffeine-containing drinks among anesthesiologists was very high. Junior anesthesiologists specifically reported higher caffeine consumption, more intoxication and withdrawal symptoms, and a higher stress score than consultants.

Keywords: *Anesthesiologists; Caffeine; Behavior; Fatigue.*

Introduction

Anesthesia is a stressful occupation, requiring optimal physical and cognitive function due to its clinical challenges. (Freedman *et al.*, 2022). Furthermore, anesthesiologists' extended working hours results in altered sleep patterns and sometimes sleep deprivation (Huffmyer *et al.*, 2020). Consequently, many anesthesiologists consume caffeine to increase their alertness when fatigued (Richards and Smith, 2015). The effect of Caffeine on alertness is very consistent from study to study.

This paper should be cited as: Mohamed Khamis A, Hasan Mostafa R, Salah EldinW, Nabil Saleh A. ***Impact of Caffeine Consumption on Sleep and Stress among Anesthesiologists: A Cross-Sectional Study".*** *Journal of Nutrition and Food Security (JNFS),* 2023; 8(4): 535-543.

Even small doses (32 mg or ~0.5 mg/kg) can have beneficial effects (McLellan *et al.*, 2016). Unfortunately, the effective dose required to affect both physical and cognitive performance is larger when the subject is sleep deprived (McLellan *et al.*, 2016). Additionally, regular use of caffeine results in tolerance; so, many people increase their daily intake hoping to experience its positive effects. They may be unaware of the total amount of caffeine ingested. In spite of health concerns suffered by participants, the desire to use caffeine to stay awake was more important to people than any reported side effects. As a result, consumption might sometimes reach dangerous daily levels (Huffmyer *et al.*, 2020). According to the criteria of diagnostic and statistical manual of mental disorders - 5th edition (DSM-5) (AlAteeq *et al.*, 2021), people were considered to have caffeine intoxication if they suffered from developing ≥5 of specific symptoms during or after recent consumption of caffeine (typically >250 mg) (El-Nimr *et al.*, 2019). Moreover, Toxic effects are estimated to occur with intakes of 1.2 g or higher. This toxic effect can lead to agitation, severe anxiety, elevated blood pressure, and palpitations (Walter, 2022).

The objective of this study is measuring the prevalence of caffeine consumption among a sample of anesthesiologists and comparing their daily intake to the safe level suggested by the European Food Safety Authority (EFSA). Furthermore, the designed questionnaire was planned to detect caffeine withdrawal and intoxication symptoms and investigate the relationship between caffeine intake and stress and sleeping hours. Finally, the rate of caffeine consumption was determined among anesthesiologists in different ranks: group J (juniors): residents and registrars; and group S (seniors): consultants. The authors hypothesized that high consumption of caffeine would be associated with higher levels of stress (indicated by an elevated score of perceived stress scale-10 (PSS-10)) and less sleeping hours (Cohen *et al.*, 1983).

Materials and Methods

Study design and participants: A descriptive cross-sectional study was performed on 168 anesthesiologists in a tertiary hospital in Cairo, Egypt, from April to July 2022. Participants completed an online questionnaire designed using Google Forms web tool. The predesigned questionnaire was based on the previous literature (Bhojaraja *et al.*, 2016, El-Nimr *et al.*, 2019, Samaha *et al.*, 2020, Simpson, 2016), and consisted of structured, close-ended questions. Face validity was used to test the validity of the questionnaire (Bolarinwa, 2015).

Based on a pilot test, it was supposed to be filled in 7 to 10 minutes. The questionnaire was divided into 6 domains.

1. Personal data
2. Habits and health status
3. Caffeine consumption characteristics
4. Intoxication symptoms

People were considered to have caffeine intoxication if they suffered from developing ≥5 of the specific symptoms during or after the recent consumption of caffeine (typically >250 mg). These symptoms are: restlessness, nervousness, excitement, insomnia, flushed face, diuresis, gastrointestinal disturbance, muscle twitching, rambling flow of thought and speech, tachycardia or cardiac arrhythmia, periods of inexhaustibility and psychomotor agitation (El-Nimr *et al.*, 2019).

5. Withdrawal symptoms

The most common symptom of caffeine withdrawal is headache. This headache is usually throbbing and sensitive to movement. (American Psychiatric Association, 2005)

6. PSS-10

Inclusion criteria were any anesthesiologists who voluntarily agreed to participate in the study, while exclusion criteria were incomplete questionnaires and/or irrelevant responses.

Measurements: Any anesthesiologist who reported consuming a caffeinated product at least 1 day a week during the past month was considered a caffeine consumer (Dillon *et al.*, 2019). The estimate of caffeine's daily consumption was derived from the "Food Data Central" utilized in the previous literature (Mitchell *et al.*, 2014, van Dam *et al.*, 2020). Products included in the questionnaire were

[DOR: 20.1001.1.24767417.2023.8.4.4.6]
[DOI: 10.18502/jnfs.v8i4.14003]

regular/green coffee, instant coffee, espresso, decaffeinated coffee, black tea, green tea, cola drinks, energy beverages, dark chocolate, milk chocolate, and medication with caffeine.

Caffeine is known to be the highest content in coffee, energy drinks, and caffeine tablets per usual serving; moderate in tea; and lowest in soft drinks (van Dam *et al.*, 2020). The EFSA stated in 2015 that consuming caffeine up to 200 mg (about 3 mg/kg) from any source is safe **(El-Nimr *et al.*, 2019).** Caffeine consumers were grouped accordingly into:

a. Safe level group: daily consumption ≤ 200 mg/day

b. Unsafe level group: daily consumption >200 mg/day

PSS-10 (Cohen et al., 1983): The PSS-10 is a 10-item questionnaire originally developed by Cohen (Cohen *et al.*, 1983). It is widely used to assess stress levels in young people and adults more than 12 years old, over the preceding 30 days. Other versions include PSS 14-item and the PSS 20-item Questionnaires (Simpson, 2016).

A Likert-type scale was used to capture responses to the PSS-10 ("never," "almost never," "sometimes," "fairly often," and "very often"). Scores were reversed for questions 4, 5, 7, and 8. A score of 0-13 was considered as low stress, 14-26 moderate, and 27-40 as high perceived stress

Sample size: The sample size was calculated using Pass program, setting type-1 error (α) at 0.05 and the distance from the mean to the confidence limits to 5. The results of the previous study showed that the mean and standard deviation of caffeine consumption among anesthesiologists was 39±27 mg (Giesinger *et al.*, 2015). Calculation according to these values produced a sample size of 150 cases, taking into account 20% drop out rate.

Data analysis: The collected data was revised, coded, tabulated and entered into a PC using the Statistical Package for Social Science (IBM Corp. Released 2017. IBM SPSS Version 25.0. Armonk, NY: IBM Corp.). Shapiro Wilk's test was used to evaluate normal distribution of quantitative data. Quantitative variables were presented as mean and SD values or as median and interquartile range according to data distribution, while qualitative variables were expressed as frequencies and percent. Student t test and Mann Whitney Test were used to compare the quantitative variables between the two study groups according to data distribution. Chi square and Fisher's exact test were used to examine the relationship between categorical variables. Correlation analysis using Spearman's method was employed to assess the strength of association between the two quantitative variables, a P-value< 0.05 was considered statistically significant.

Ethical considerations: All procedures were in accordance with the ethical standards of the institutional research committee and 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethical approval for this study (FMASU R/66 2022) was provided by the Ethics committee of Ain Shams University hospital, Abbasia, Cairo, Egypt.

Results

The study included 168 anesthesiologists, 75.6% males and 24.4% females. Group J (residents and registrars) represented 51.8% of the participants, while Group S (consultants) represented 48.2%. The mean age, body mass index (BMI) and sleeping hours among participants were 37.77±7.49 years, 29.03±4.65 kg/m^2 and 6.29 ±1.18 hours, respectively. About 77%, 17.9%, 21.4%, and 60.7% of the sample were married, smokers, experienced comorbidity, and had an active lifestyle, respectively. Among female participants, 2.4% were using contraceptive pills and 4.9% were pregnant. 80% of participants were unsafe caffeine consumers (≥200 mg), while approximately 20.2% were safe consumers. The mean daily caffeine consumption was equal to 399.89±238.4 mg, while the median (interquartile range) was equal to 364 mg (252-517). The mean age at the onset of caffeine consumption was 21.5±6.81 years old, and the mean money spent weekly was 140.5±152.3 Egyptian pounds. About 33% and 44% of the participants had intoxication and withdrawal symptoms, respectively.

[DOR: 20.1001.1.24767417.2023.8.4.4.6]

[DOI: 10.18502/jnfs.v8i4.14003]

There was no significant difference between group J and group S in terms of gender, lifestyle, BMI and sleeping hours. However, a significant difference was found regarding age, comorbidities, smoking, and stress scale (*P*=0.001, 0.001, 0.028 and 0.001, respectively). 9.2% of group J were severely stressed compared to only 2.5% in group S (**Table I**).

A significant difference was found between groups J and S with regard to average daily consumption (*P*=0.017). Additionally, the mean age at the onset of consumption in group J was lower than group S (*P*=0.006). Intoxication and withdrawal symptoms were significantly more common in group J (*P*=0.001 and 0.004, respectively; **Table 2**).

There was no significant difference between groups J and S considering the attitude of participants towards caffeine consumption, except for the reason of drinking (*P*=0.039). This item received various responses in both groups. For example, 22.2% in group S drank for taste compared to 6.9% in group J for the same reason. On the other hand, in groups, 43% in group J and 47% in group S said that the main reason for drinking was to increase alertness.

There was no significant difference between safe and unsafe consumers in terms of sleeping hours and stress score (*P*=0.158 and 0.66, respectively). 61.8% of safe consumers had <7 hours of sleep compared to 64.2% of unsafe consumers, and 2.9% of safe consumers had severe stress compared to 6.6% of unsafe consumers (**Table 3**).

There were significant positive correlations between average daily consumption and each of intoxication and withdrawal scores (*P*=0.003 and 0.0001, respectively). However, no significant correlation was found between average daily consumption and each of sleeping hours and stress scale score (*P*=0.831 and 0.324, respectively) (**Table 4**).

Table 1. Comparison between group J and S regarding personal and medical data.

Variables	Group J (n=87)		Group S (n=81)		P-value[c]
Age (year)	32.19 ± 3.01[a]	32 (30 - 35)[d]	43.94 ± 5.96	44 (39 - 48)[d]	0.001
Body mass index (kg/m^2)	28.75 ± 5.26	84 (70 - 95)	29.33 ± 3.92	28.7 (26.5 - 31.1)	0.433
Sleeping hours	6.16 ± 1.27	6 (5-7)	6.42 ± 1.07	6 (6-7)	0.158
Gender					
Male	62 (71.3)[b]		65 (80.2)		0.176
Female	25 (28.7)		16 (19.8)		
Comorbidities					
No	77 (88.5)		55 (67.9)		0.001
Yes	10 (11.5)		26 (32.1)		
Smoking					
No	66 (75.9)		72 (88.9)		0.028
Yes	21 (24.1)		9 (11.1)		
Lifestyle					
Active	53 (60.9)		49 (60.5)		0.955
Sedentary	34 (39.1)		32 (39.5)		
Stress					
Low	6 (6.9)		24 (29.6)		0.001
Moderate	73 (83.9)		55 (67.9)		
Severe	8 (9.2)		2 (2.5)		
Sleeping hours					
< 7	56 (64.4)		51 (63.0)		0.850
7-9	31(35.6)		30 (37.0)		
>9	0 (0.0)		0 (0.0)		

Group J: Junior doctors and registrars; Group S: Seniors and consultants; [a]: Mean±SD; [b]: n (%); [c]: For categorical variable Chi-square and for quantitative variable student t-test; [d]: Interquartile range (IQR).

[DOR: 20.1001.1.24767417.2023.8.4.6.6]
[DOI: 10.18502/jnfs.v8i4.14003]

Table 2. Comparison between groups J and S with regard to caffeine consumption characteristics.

Variables	Group J (n=87)		Group S (n=81)		P-value
Average daily consumption (mg)	433.9 ± 228.7[a]	395(271-572)[c]	363.6 ± 244.5	315(203-465)[c]	0.017[d]
Age at onset of consumption (year)	17.95 ± 6.20	18(15-22)	21.58 ± 9.25	20(16-28)	0.006[e]
Money spent weekly on caffeine beverages (Egyptian pounds)	135.97 ± 161.67	100(50-150)	145.62 ± 142.33	100(50-200)	0.700[d]
Caffeine consumption					
Safe	14 (16.1)[b]		20 (24.7)		0.166[f]
Unsafe	73 (83.9)		61 (75.3)		
Intoxication					
No	48 (55.2)		65 (80.2)		0.001[f]
Yes	39 (44.8)		16 (19.8)		
Withdrawal					
No	40 (46.0)		55 (67.9)		0.004[f]
Yes	47 (54.0)		26 (32.1)		

Group J: Junior doctors and registrars; Group S: Seniors and consultants; [a]: Mean±SD;, [b]: n (%); [c]: Interquartile range (IQR); [d]: student t-test; [e]: Mann Whitney test; [f]: Chi-square test.

Table 3. Comparison between safe and unsafe consumers regarding sleeping hours and stress score

Variables	Safe consumer (n= 34)		Unsafe consumer (n= 134)		P-value[c]
Stress score	18.8±5.9[a]	19 (14-23)[d]	18.6±5.2	19 (15-22)[d]	0.68
Sleeping hours	6.32±1.20	6 (5 - 7)	6.28±1.19	6 (5 - 7)	0.15
Sleeping hours					
<7	21 (61.8)[b]		86 (64.2)		0.79
7-9	13 (38.2)		48 (35.8)		
>9	0 (0.0)		0 (0.0)		
Stress					
Low	7 (20.6)		23 (17.2)		0.66
Moderate	26 (76.6)		102 (76.1)		
Severe	1(2.9)		9 (6.6)		

Group J: Junior doctors and registrars; Group S: Seniors and consultants; [a]: Mean±SD; [b]: n (%); [c]: For categorical variable Chi-square and for quantitative variable student t-test; [d]: Interquartile range (IQR).

Table 4. Spearman correlations between average daily consumption and each of intoxication and withdrawal score, sleeping hours, and stress scale score.

	Intoxication score	Withdrawal Score	Sleeping hours	Stress scale score
R	0.232	0.352	-0.017	0.077
P-value	0.003	0.0001	0.831	0.324

[DOR: 20.1001.1.24767417.2023.8.4.4.6]
[DOI: 10.18502/jnfs.v8i4.14003]

[DOR: 20.1001.1.24767417.2023.8.4.4.6]

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Discussion

Caffeine consumption characteristics among the participants: Few studies have investigated the prevalence of caffeine consumption in physicians (Bodar *et al.*, 2019, Franke *et al.*, 2015, Giesinger *et al.*, 2015). In the present study, the authors found that 100% of the anesthesiologists in the sample consume caffeine. This high prevalence is not surprising especially because approximately 90% of the general population in the world consumes caffeine daily (El-Nimr *et al.*, 2019). Additionally, caffeinated beverages, particularly tea and coffee, are an essential part of Arab hospitality and the most widely available drink products. Finally, in a previous study on 400 Egyptian students, the same consumption prevalence was observed (El-Nimr *et al.*, 2019).

In contrast, Giesinger *et al.* observed low caffeine consumption in anesthesiologists when using the hospital's electronic payment system (Giesinger *et al.*, 2015). The relatively low coffee consumption of anesthesiologists could be attributed mostly to underestimated intake.

Unfortunately, present study shows that 80% (134 out of 168) of the participants were unsafe consumers, with an average daily consumption of 400±238 mg. Further analysis showed higher daily consumption of group J compared to group S (434±229 mg versus 364±245 mg). This higher caffeine consumption in group J may be due to 2 main reasons: 1-their longer working hours and night shifts requiring more vigilance, thus, more caffeine purchase, and 2-higher smoking prevalence compared with group S (24% versus 11%). Consistent with this study, Frank *et al.* investigated the use of caffeinated drinks for pharmacological cognitive enhancement (CE) among surgeons (Franke *et al.*, 2015). They noted that caffeine consumption was more prevalent in younger male surgeons. On the other hand, Giesinger *et al.* observed that senior consultants drank more coffee per year than juniors (Giesinger *et al.*, 2015). They attributed this to seniors' attempt to fight age and fatigue plus having the time to socialize.

As expected, an adverse consequence to higher daily consumption was noticed in group J. Intoxication and withdrawal symptoms were significantly more common among them than group S. Moreover, there was a significant positive correlation between average daily consumption and both symptoms. This was confirmed by other study (AlAteeq *et al.*, 2021).

Caffeine consumption in relation to stress: Chronic stress experienced by anesthesiologists can lead to mental disorders like depression, anxiety, or burnout in the long term (LaRocca, 2020). The relationship between stress and caffeine consumption, however, is still unclear (Ríos *et al.*, 2013).

In present study, 128 of the participants (76.2%) suffered from moderate stress. Additionally, 84% in group J were moderately stressed compared to 68% in group S. 9.2% of group J participants were severely stressed compared to only 2.5% of group S (P=0.001). Although initial positive relationship was found between average daily consumption and stress, there was no significant correlation between them. Similarly, two studies observed no association between the consumption of caffeinated beverages and academic stress among students (Ríos *et al.*, 2013, Simpson, 2016). On the other hand, some studies found that higher caffeine intake was associated with higher stress score (AlAteeq *et al.*, 2021, Khalil and Antoun, 2020). Furthermore, Magalhaes observed that higher stress scores were observed in coffee drinkers (CD) when compared to non-coffee drinkers (NCD) (Magalhaes *et al.*, 2021). These three contradictory studies mentioned above necessitate further research with a larger sample size to explore the actual relationship between caffeine consumption and stress level.

Caffeine consumption in relation to sleeping hours: Caffeine consumption is commonly avoided in the evening to prevent adverse consequences on nocturnal sleep. Its use as a stimulant during the day may disrupt sleep at night, and consequently, affect alertness in the following day. This may result in more caffeine

[DOR: 20.1001.1.24767417.2023.8.4.4.6]

[DOI: 10.18502/jnfs.v8i4.14003]

intake to achieve alertness, and a vicious cycle initiates (Chaudhary *et al.*, 2016). Proper sleep homeostasis has been related to effects of high adenosine concentrations during waking hours, and their dissipation during the sleep episode. Caffeine, due to its adenosine receptor antagonistic nature, could interfere with this mechanism and disrupt sleep. Furthermore, it has been reported that caffeine may decrease melatonin secretion through the adenosine blocking effect (Riera-Sampol *et al.*, 2022).

According to previous literature, the recommended sleep duration is 7 to 9 hours of sleep in a 24-hour period (Lubas *et al.*, 2021). Short sleep duration is defined as <7 hours, and long sleep duration is defined as >9 hours. In this study, average sleeping hours were 6.29 hours, with the majority of participants in groups J and S belonging to the "short sleep duration" group (64% and 63%, respectively). But, no significant correlation was found between average daily caffeine consumption and sleeping hours.

Conversely, Hicks observed that habitual short sleepers (6h) use 3.6 times more caffeine each day than long sleepers (>8h) (Hicks *et al.*, 1983). Also, Shilo *et al.* revealed that drinking regular caffeinated coffee, compared to decaffeinated coffee, caused a significant decrease in the total duration of sleep (Shilo *et al.*, 2002). Additionally, caffeinated coffee caused a decrease in 6-Sulphoxymelatonin (the main metabolite of the melatonin in urine) excretion during the following night. Again, further research with a larger sample size is suggested to explore the actual relationship between caffeine consumption and sleep duration.

There were multiple limitations to this study. The major limitation was that the obtained data were self-reported with the possibility of recall bias. Second**,** because this was an observational study, rather than a randomized trial, the authors could only study associations between variables, not causality. A longitudinal study design would better determine the prospective relationship between caffeine use and any of the explored parameters (Richards and Smith, 2015)**.** Third**,** measurement error can affect the assessment of caffeine intake, as some beverages listed in the questionnaire were not brand or type specific. Finally**,** a larger sample size is needed to explore the actual relationship between caffeine consumption and both the sleep duration and stress level. Despite these limitations, this study shed some light on a previously neglected topic and gave a representative overview on anesthesiologists' caffeine consumption.

Conclusions

The consumption of caffeinated drinks among anesthesiologists is very high and exceeds health authorities' approved daily amount. Junior anesthesiologists specifically reported higher caffeine intake, more intoxication and withdrawal symptoms, and a higher stress score than consultants. The average daily caffeine consumption was not correlated with daily sleeping hours and stress scale score. Self-control and monitoring of caffeine's daily intake are necessary through developing awareness programs on the negative health effects of high caffeine consumption.

Acknowledgments

Authors thank all participants in this work.

Authors' contributions

Hasan Mostafa R and Salah W involved in study concept and design. Nabil Saleh A involved in data collection. Salau W participated to data analysis and interpretation of them. Hasan Mostafa R and Mohamad Khamis A involved in writing the manuscript. All authors read and approved final version of manuscript.

Conflict of interest

The authors declared no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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[DOR: 20.1001.1.24767417.2023.8.4.4.6]

[DOI: 10.18502/jnfs.v8i4.14003]