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Study of the relationship between caffeine consumption and sleep patterns

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ABSTRACT

Objectives: One of the stimulants that individuals use the most often in our everyday lives is caffeine, especially for people who want to be more awake and productive, because of its capacity to lessen weariness and sleepiness. Caffeine is used by almost 80% of people worldwide because it is a socially acceptable substance. This study aimed to identify the relationship between the amount of caffeine consumed by people aged 20–40 years and its effect on sleep duration.

Materials and Methods: The randomized study was conducted on 150 males and females. The participants were divided into three groups. The first group included 50 individuals who consumed 1–3 cups of caffeinated beverages, the second group included 50 individuals who consumed more than 3 cups, and the third group included 50 individuals who did not consume any caffeinated beverages.

Results: The results showed that increased caffeine consumption by people affects the duration of sleep during the night, as there is a noticeable decrease in the number of hours of sleep at night.

Conclusion: Abstaining from caffeine is beneficial for improving sleep quality. Therefore, abstaining from caffeine is recommended in sleep hygiene recommendations for treating insomnia and improving sleep.

Keywords: Caffeine consumption, Caffeine, Sleep behaviors, Sleep disruption, Sleep quality, Sleep, Sleepiness

INTRODUCTION

This study aims to determine the relationship between caffeine consumption and sleep duration among adults aged 20–40 years.

MATERIALS AND METHODS

This descriptive analytical study utilized a structured self-reported questionnaire to collect data on caffeine consumption patterns and sleep duration among 150 males and females, which was determined to ensure adequate statistical power for Chi-square analysis and to allow meaningful comparisons across the three caffeine-intake groups. They were randomly selected from among those aged between 20 and 40 years. The questionnaire included items on beverage types, timing of intake, quantity consumed, and reasons for consumption, alongside sleep duration categories and basic demographics, in addition to age and gender. The other section included questions related to the individual's sleep patterns, such as the number of hours of sleep per night. Participants' occupational status (students and employees) and health status were included to examine their potential impact on the relationship between caffeine consumption and sleep. Participants with confounding factors, including smoking, alcohol intake, irregular physical activity, chronic medical conditions, medication affecting sleep, or psychological distress, were excluded. The use of a structured, self-reported tool is supported by established survey methodologies in substance-use research, such as Afzal *et al.* (2022), reinforcing the reliability of this approach.[1] The participants were divided into three groups. The first group included 50 individuals who consumed 1–3 cups of caffeinated beverages; the second group included 50 individuals who consumed more than 3 cups; and the third group included 50 individuals who did not consume any caffeinated beverages. Data were analyzed using Statistical Packages of Social Sciences (2019), employing descriptive statistics and Chi-square tests at significance levels of 0.05 and 0.01.[2] However, self-reported data are inherently

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vulnerable to recall and reporting bias, as highlighted by Afzal *et al.* (2021), and this limitation should be considered when interpreting results.[3] Ethical approval was obtained, and informed consent was secured from all participants.

RESULTS

The results showed that the percentage of individuals who sleep less than 4 h reached (4.00%) in the first group who consume 1–3 cups of caffeine, (6.00%) in the second group who consume more than three cups, and (0.00%) in the third group who do not consume caffeine. The Chi-square test showed no significant differences between the percentages of individuals who sleep <4 h in the three groups, as the probability value reached $P = 0.358$, which is higher than the significance level of 0.05 ($P > 0.05$), as shown in Table 1 and Figure 1.

The results also showed that the percentage of individuals who sleep from 4 to 6 h reached (14.00%) in the first group who consume from 1 to 3 cups of caffeine, and reached (34.00%) in the second group who consume more than three cups, and (26.00%) in the third group who do not consume caffeine. The Chi-square test showed significant differences between the percentages of individuals who sleep from 4 to 6 h in the three groups, where the probability value reached $P = 0.0395$, which is less than the significance level of 0.05 ($P \leq 0.05$), as shown in Table 1 and Figure 1.

The percentage of individuals who sleep from 6 to 8 h reached (70.00%) in the first group who consume from 1–3 cups of caffeine, and reached (56.00%) in the second group who consume more than three cups, and (44.00%) in the third group who do not consume caffeine. The Chi-square test showed the presence of significant differences between the percentages of individuals who sleep from 6 to 8 h in the three groups, where the probability value reached $P = 0.0081$, which is less than the significance level of 0.01 ($P \leq 0.01$), as shown in Table 1 and Figure 1.

Table 1: The number and the proportions of the sample studied according to the number of cups consumed and the number of hours of sleep.

Number of hours	1–3 cups (%)	More than 3 cups	They do not consume caffeine	*P*-value
<4	2 (4.00)	3 (6.00)	2 (4.00)	0.358NS
4–6	7 (14.00)	17 (34.00)	7 (14.00)	0.0395*
6–8	35 (70.00)	28 (56.00)	35 (70.00)	0.0081**
More than 8	6 (12.00)	2 (4.00)	6 (12.00)	0.0096**
The total	50	50	50	--
P-value	0.0001**	0.0001**	0.0001**	--

NS: Not Significant, indicating that the *P*-value is greater than 0.05. *: Statistical significance at $p < 0.05$, **: Statistical significance at $P < 0.01$

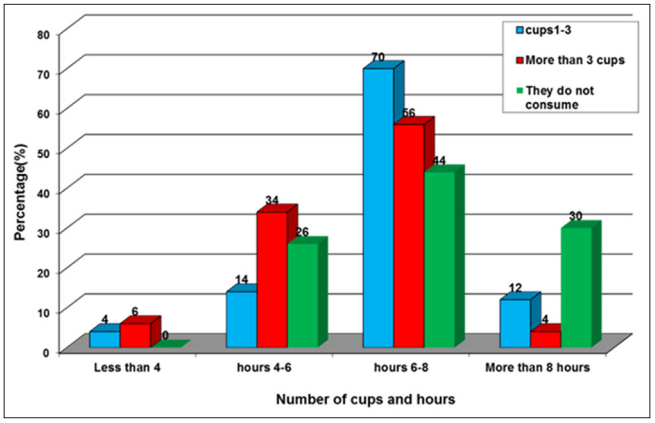

Figure 1: The figure shows the proportions of the studied sample based on the number of cups consumed and the number of hours of sleep.

The results showed that the percentage of individuals who sleep more than 8 h reached (12.00%) in the first group who consume 1–3 cups of caffeine, (4.00%) in the second group who consume more than three cups, and (30.00%) in the third group who do not consume caffeine. The Chi-square test showed the presence of significant differences between the percentages of individuals who sleep more than 8 h in the three groups, where the probability value reached $P = 0.0096$, which is less than the significance level of 0.01 ($P \leq 0.01$) as shown in Table 1 and Figure 1.

DISCUSSION

Through the research results, we find that the percentage of people who sleep less than 4 h in the three groups is low. Caffeine may reduce sleep hours, but not to the extent that it reaches less than four hours, meaning that its effect does not reach the number of hours of sleep that is very low. Numerous studies have looked at this, but the results are still inconsistent, making it difficult to determine how frequent caffeine use affects how well people experience their sleep. Caffeine may shorten overall sleep duration, according to some research,[4] despite this, Jareebi *et al.* have not reported any noticeable effect.[5] Caffeine-induced sleep problems have a variety of reasons. Numerous lifestyle, physiological, and psychological variables that may affect coffee usage and sleep disruptions have not been examined. Future research on these topics is thus necessary. Our findings are consistent with previous work demonstrating that sleep patterns are shaped by multiple lifestyle factors beyond caffeine alone. Afzal *et al.* (2021) emphasize the influence of behavioral and psychosocial variables on sleep quality, underscoring the importance of considering occupation, stress, and general health when interpreting our results.[6]

Furthermore, deeper statistical modeling may enhance future analyses. Regression-based approaches, such as those

demonstrated by Afzal and Das (2023), could help identify independent predictors of sleep disturbance and quantify the specific contribution of caffeine relative to other demographic and lifestyle factors.[7]

Furthermore, the results of the current study showed that people who sleep 4–6 h, we notice that the highest percentage is in those who consume more than 3 cups of caffeine, and the lowest percentage is in people who consume 1–3 cups, as well as those who do not consume it. Here, caffeine may have an effect on the number of hours of sleep. As for people who sleep 6–8 h, the highest percentage was in those who drink 1–3 cups and more than three cups, while the lowest percentage was in people who do not drink caffeine. As for people who slept more than 8 h, the highest percentage was found in people who did not consume caffeine, and the lowest percentage was found in people who consumed 1–3 cups or more than 3 cups of caffeine.

The results of the current investigation show that caffeine affects the quality of sleep. This study supports earlier research that found links between dietary caffeine use and poor sleep quality. Caffeine disrupts sleep at night, at least in susceptible people, according to the neuromodulator and receptor system, which plays a significant role in sleep–wake regulation. Even when the amount of caffeine in saliva had almost completely returned to zero at the start of the sleep cycle, the equivalent of one or two double espressos consumed up to 16 h before bedtime causes consistent alterations in the sleep electroencephalogram (EEG) that are suggestive of more shallow sleep.[8,9] It decreases slow-wave sleep (SWS) and neurophysiological indicators of sleep intensity and postpones the beginning of sleep. Thus, caffeine-induced sleep disturbances may have detrimental effects on many facets of general health and functioning that rely on undisturbed sleep in addition to causing the daytime drowsiness it is intended to treat.[10] Caffeine seems to change the architecture of sleep, particularly SWS, which is essential for cognitive and physical recovery, as well as delay the beginning of sleep and decrease its efficiency.[11] Caffeine's wake-promoting actions are influenced by a number of neurotransmitter systems, including the dopaminergic, serotonergic, and noradrenergic pathways, in addition to its basic impact on adenosine receptors. These interactions may change the quality of sleep in addition to affecting the capacity to fall asleep.[12] Coffee was the primary source of caffeine in the studies, which is consistent with its widespread use as the second most common beverage in the world, behind water.[13] The present research's findings are in line with a prior study conducted by Gardiner *et al.* (2023), in which 30 healthy volunteers, ages 19–36 years, were given equal-volume beverages that were comparable to one or two cups of water, tea, or coffee.[14] Actigraphs showed that shorter sleep durations were associated with higher caffeine intake.[14] Also, the results of this study are consistent with a previous study that examined the association between caffeine intake and sleep quality in 880 Dutch students, as well as potential modification by chronotype and time of consumption. However, caffeine can be utilized to deal with daytime drowsiness that results from poor sleep quality,[15] and caffeine consumption can also lower sleep quality.[16] For non-evening caffeine consumers, a higher weekly caffeine intake was exclusively linked to a worse subjective sleep quality. According to this, coffee may lower the subjective quality of sleep in those who do not drink it in the evening without causing them to have difficulty falling asleep or sleep for fewer hours, perhaps by decreasing the amount of time they spend in deep sleep.[17] Higher habitual caffeine use was associated with decreased sleep disruption, according to experimental studies.[18] Regular caffeine consumption can reduce sensitivity to certain of its effects due to tolerance.[19] Since the time course of caffeine concentrations was identical in those who were caffeine sensitive and those who were not, caffeine sensitivity is related to metabolic speed but does not directly represent it. Caffeine sensitivity is also influenced by genetics; self-reported caffeine sensitivity was linked to polymorphisms in the adenosine A2A receptor gene.[20] When considering the effect of caffeine, genetic susceptibility has been linked to both subjective and objective (EEG) sleep-related results.[21] Studies have indicated a negative correlation between caffeine intake and the amount of time spent sleeping.[22] Caffeine is also thought to increase sleep latency, decrease sleep efficiency, and degrade subjective sleep quality. There are also biological underpinnings in the brain for the connection between coffee and sleep. It is commonly acknowledged that adenosine receptor agonists encourage sleep, and that caffeine inhibits the sleep-inducing effects of adenosine by antagonistically binding to adenosine receptors. Nevertheless, caffeine is frequently regarded as a sleep-inhibiting substance.[16] Caffeine abstention is therefore frequently recommended in sleep hygiene recommendations for insomnia in an attempt to enhance sleep.[14] Chronic sleep deprivation raises the risk of health epidemics, including increased susceptibility to mental health disorders and cardiometabolic disease.[23,24] Such negative consequences have a substantial financial impact on both the individual and society, as they result in diminished productivity and compromised health.[25] Therefore, guidelines for healthy sleeping habits have been created to provide people with ways to maximize the amount and quality of their sleep. Avoiding caffeine close to bedtime is a typical behavioral prescription to maximize sleep.[26] A common psychostimulant, caffeine can be found in foods, supplements, and prescription drugs.[27] Approximately 80% of people worldwide use caffeine because it is a socially acceptable substance.[28] By acting on the homeostatic aspect of sleep–wake control, caffeine, an adenosine antagonist, may be able to temporarily lower sleep pressure.[29] The central nervous system is stimulated

by this activity, which reduces feelings of exhaustion and drowsiness.[30] Caffeine is therefore frequently used during the day to induce a state of wakefulness in response to inadequate sleep.[31] However, using caffeine to increase alertness may make it harder to go asleep and stay asleep later,[32] which might lead to a vicious cycle of less sleep and more caffeine usage.[33] For example, those who suffer from a sleep problem such as narcolepsy or shift work may use coffee to improve their quality of sleep.[34] Caffeine may affect older people's sleep differently than it does for younger people, according to EEG spectral analysis measurements.[35] In addition, responses to caffeine may be influenced by sensory signals from the autonomic nervous system[36] or the beverage's flavor and odor. Complex chemical compounds that may have subtle and distinct biological impacts make up coffee and tea.[37] For example, it has been demonstrated that the flavonoids in tea interact with γ aminobutyric acid type A and adenosine receptors, and tea may encourage peripheral vasodilation.[38] It's possible that individuals' habitual caffeine consumption enhanced their overall caffeine exposure and intensified the effects on sleep disturbance.[39] Insufficient sleep duration has been associated with caffeine consumption.[40] When used as a stimulant during the day, it can interfere with sleep at night and impact alertness the next day. To acquire the alertness, this vicious cycle may lead to increased caffeine use, especially in the latter hours of the circadian day.[41] The chronic nature of caffeine usage is one element that makes this interaction more difficult. Acute caffeine usage results in shorter sleep on the same or next nights.[10] At the community level, daily coffee use is linked to symptoms of sleeplessness; this association can be explained by underlying anxiety levels and participant racial/ethnic disparities. A greater risk for nighttime restlessness (NRS) was linked to a favorable relationship between increased coffee intake and inadequate sleep. At the population level, sleep and other factors influence the intricate link between caffeine use and symptoms of insomnia.[42]

CONCLUSION

Through the results of the study, it can be concluded that increased caffeine consumption negatively affects the number and quality of sleep at night. Caffeine reduces the hours of sleep for people who consume 1–3 cups or more of caffeinated beverages such as coffee, tea, and others. As for those who do not consume caffeine, their sleep hours were within the recommended normal range. Abstaining from caffeine is beneficial for improving sleep quality. Therefore, abstaining from caffeine is recommended in sleep hygiene recommendations for treating insomnia and improving sleep.

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Ethical approval: The research/study approved by the Ethics Committee of Al-Anbar University, Iraq, number 2978, dated 30th December 2022.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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