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# Impact of Caffeine on Mental Health and Cognitive Function

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**Abstract**

Cancer is a multifactorial process, most frequently induced by genetic mutations that affect key cellular processes such as DNA repair, apoptosis, immune signaling, and cell proliferation. Five representative human cancer-associated genes, TP53, TNF, IL-6, ATM, and APC, were studied with a set of bioinformatics tools to compare their sequence similarity, conserved domains, and protein structures. NCBI gene sequences were accessed and aligned using MEGA 12, and phylogenetic reconstruction was performed. Similarity-based clustering was observed, with TP53 and ATM grouped according to their roles in DNA damage response, and TNF and IL-6 grouped based on cytokine-mediated immune function. APC showed distinct sequence divergence, consistent with its unique role in Wnt signaling and in preventing colorectal cancer. Conserved domain prediction with the NCBI CDD tool confirmed the presence of functionally important regions in all five proteins, and protein translation by ExPASy and BLASTp showed similarity to human cancer proteins with known functions. 3D protein models provided structural details about possible mutation sites. These findings illustrate that, despite differences in their biological functions, these genes share functional similarities that can be leveraged to identify early cancer and target treatment. This synergy illustrates the utility of in silico resources in cancer genomics and underscores the need for further investigation of multi-gene therapeutic and diagnostic methods.

**Keywords:** Psychoactive, stress-related symptoms genetically, caffeinism, cognitive function, brain's adenosine neurotransmitter

## 1 Introduction

The most commonly ingested psychoactive chemical worldwide is caffeine (1, 3, 7-trimethylxanthine), a natural alkaloid and central nervous system (CNS) stimulant of the methylxanthine class. Coffee is the most popular beverage that includes caffeine. It is consumed more often and has a higher caffeine content than most other beverages. (Isa et al., 2021). While chocolate and other foods containing cocoa contribute less caffeine to the diet, tea, carbonated soft drinks, and energy drinks are the main sources of caffeine consumption

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(Cholewa et al., 2023). Research has shown that caffeine is a psychoactive substance that can either produce or exacerbateanxiety and other symptoms associated with stress in a number of ways (Marmorstein, 2016; Isa et al., 2021). Caffeine is used by different groups for different purposes. For instance, physicians and surgeons use it to increase alertness and decrease fatigue, athletes use it to improve their physical performance, and young adults use it to boost their energy levels, for taste, as part of social gatherings, or to improve their appearance (Jahrami et al., 2020). In adults with generalizedanxiety disorder, caffeine use has been linked to elevated anxiety levels. On the other hand, caffeine users also frequently report higher levels of behavioral benefits, such as increased arousaland alertness. Caffeine is extensively utilized as an energy source since it is readily available (Bertasi et al., 2021). Adults in the United States of America typically take in 179 mg of caffeine a day, which is equal to two cups (100 mg/240 mL) of ground coffee. One of the most popular beverages in the world, coffee has a significant long term health impact. The Washington Post (2015) reports that 2 billion cups of coffee are consumed daily worldwide. (Lieberman et al., 2018). It is believed that caffeine works through a number of mechanisms, including adenosine receptor antagonism, phosphodiesterase inhibition, intracellular calcium release, and benzodiazepine receptor antagonism. Additionally, it has been reported that caffeine alters women's estrogen levels (Jee et al., 2020). The stimulatory antagonism of methylxanthines at the level of adenosine receptors is one of three ways that caffeine acts on the central nervous system to produce a psychostimulant effect (Liu et al., 2024). The adenosine system is made up of four receptors: A1, A2A, A2B, and A3. At normal physiological levels, A1 and A2A bind to caffeine with high affinity and reversibly. The prefrontal cortex, amygdala, and hippocampal regions are home to the majority of adenosine receptors (Liu et al., 2024). Depression has drawn a lot of attention as a prevalent mental illness and a major contributor to disability (Alimyar et al., 2024). Depression has become a global public health concern due to its steadily rising incidence in recent years. Caffeine is frequently found in coffee and tea, two of the most consumed drinks worldwide (Torabynasab et al., 2023). Because it alters dopaminergic transmission and promotes serotonin release, caffeine may be linked to depression. Tea contains neuroprotective substances such polyphenols and L-theanine in addition to caffeine (Torabynasab et al., 2023). In most nations worldwide, coffee consumption is also a significant aspect of office culture. Caffeine use, however, can potentially have a number of negative effects. Anxiety, nausea, tremors, nervousness, muscular spasms, rambling, and disorientation are all side effects of caffeine (Erdős, 2023). Caffeine consumption is significantly influenced by genetic variables. Genetic factors contribute to individual variances in sensitivity to the effects of caffeine. There are possible negative psychological and physical repercussions linked to caffeine use (Czajkowski et al., 2021). Caffeine, for instance, is not recommended for people with anxiety, sleeplessness, urine incontinence, or gastrointestinal issues. It is also linked to weakness when used during pregnancy(Abdoli et al., 2024). Regularly consuming large amounts of coffee (more than 300 mg) has beendemonstrated to produce mood fluctuations, anxiety, and a delay in the recovery process for bipolar individuals. Even those who have never experienced manic episodes or psychotic symptoms before can develop caffeine consumption disorder (Ágoston et al., 2018). Additionally,some caffeine users develop a dependence on the drug and exhibit deprivation and withdrawal symptoms (Abdoli et al., 2023).

### 1.1 General Psychotropic Effects of Caffeine

Due to its "mental activating" qualities, caffeine boosts energy and alertness while decreasing drowsiness and exhaustion. In certain conditions, such as early in the morning, when sleep is lacking, or when continuous effort is required, these benefits are very noticeable and help to improve performance. Higher doses of caffeine, particularly in sensitive people, can cause symptoms of a condition known as "caffeinism," which mimics the clinical picture known as mixed mood state (Gilliland & Andress, 2022). These symptoms include anxiety, restlessness, nervousness, dysphoria, insomnia, excitement, psychomotor agitation, and

rambling flow of thought and speech (Greden, 2021). However, withdrawal effects from caffeine might include headache, drowsiness or exhaustion, anxiety, and depression (Grosso et al., 2016). These symptoms can peak 12 days after stopping caffeine use and last for a week (Agritelley & Goldberger, 2021). Withdrawal symptoms, a persistent need to reduce or regulate consumption, and tolerance are all signs of clear caffeine dependence in some people. Increased cerebral blood velocity, elevated EEG theta, and lower beta 2 power are all associated with abstinence (Sigmon et al., 2023). Caffeine therefore, has a "therapeutic window" of psychostimulant qualities that may be beneficial and mild to moderate reinforcing effects. Caffeine is obviously free of significant adverse effects on performance, social adjustment, and health when compared to other medications that have the potential to cause dependence (Clark et al., 2019). Regarding mental health specifically, caffeine consumption was not a causative factor but rather a moderate risk factor fora variety of psychiatric and drug use problems in the general population (Kendler et al., 2017). Both coffee consumption and the risk for mental illnesses appear to be predisposed by genetic factors, most likely inherited in nature. Notably, when the study design supports the reversal of short-term withdrawal, which has not been reliably controlled for in many trials, the benefits of caffeine are emphasized. Studies using low amounts of caffeine (50_100 mg) indicate thatwithdrawal reversion accounts for the majority of effects in frequent users. Other research, however, found that caffeine had a substantial impact on mood, performance, and alertness in participants who were not experiencing caffeine withdrawal from either long-term abstinence or continuous caffeine usage (Lara, 2010). Furthermore, a recent study discovered that at 150 mg, but not at 50 mg, caffeine caused greater energy, vigor, and arousal as well as decreased weariness in mild, nondependent users (mean 116 mg/week). With 450 mg, anxiety rose, but not with 150 or50 mg. In contrast to amphetamine, caffeine did not produce the reinforcing effects of "liking" and "wanting more" at any dose. In contrast to continued usage of lesser amounts over a longer periodof time, the effects of caffeine have primarily been researched utilizing a single big dose as shown in Table 1. Nevertheless, Brice and Smith (2002) discovered that the mood and performance improvements following a 200 mg dose were also present following four doses of 65 mgadministered at hourly intervals (Lara, 2010).

**Table 1:** General Psychotropic Effects of Caffeine

| Aspect | Key Points | Reference |
|---|---|---|
| **Stimulant effects** | Increases energy, alertness, and performance; reduces drowsiness and fatigue. | Greden (2021) |
| **High-dose effects (caffeinism)** | Anxiety, restlessness, nervousness, insomnia, dysphoria, agitation, and rapid speech/thoughts. | Greden (2021) |
| **Withdrawal symptoms** | Headache, fatigue, drowsiness, anxiety, and depression; symptoms typically peak within 1–2 days and may last up to one week. | Agritelley & Goldberger (2021) |
| **Dependence signs** | Tolerance, craving, difficulty reducing intake; EEG and cerebral blood flow changes during abstinence. | Sigmon et al. (2023) |
| **Therapeutic window** | Mild to moderate psychostimulant benefits with limited adverse effects compared with other addictive drugs. | Kendler et al. (2017) |
| **Mental health risk** | Moderate risk factor but not a direct cause of psychiatric disorders. | Kendler et al. (2017) |
| **Genetic influence** | Genetic factors may predispose individuals to both coffee use and mental illness risk. | Lara (2010) |
| **Low dose (50–100 mg)** | Effects are primarily due to the reversal of withdrawal symptoms | Lara (2010) |
| **Moderate dose** | Increased energy, vigor, and alertness; reduced fatigue. | Lara (2010) |

| Aspect | Key Points | Reference |
|---|---|---|
| **(150 mg)** | | |
| **High dose (450 mg)** | Increased anxiety. | Lara (2010) |
| **Dosing pattern** | Smaller repeated doses (e.g., 4 × 65 mg) also improve mood and performance, similar to one large dose | Lara (2010) |

## 2 Specific effects of caffeine

Mood and mood disorders both internalized symptoms like sorrow, anhedonia, apathy, and anxiety as well as externalized expressions like excessive activity, euphoria, impatience, and highly pleasure-oriented behavior are components of both healthy and abnormal mood. Overall, it has been demonstrated that modest dosages of caffeine can both prevent mood symptoms and cause mood alterations, especially at higher doses (Childs et al., 2008). Although greater quantities of caffeine typically more than 300 mg have historically been thought to cause anxiety, there is littleevidence linking caffeine use to anxiety or anxiety-related characteristics. In addition to dosage, individual factors like genetic background, caffeine preference, and the existence of certain anxiety disorders all affect the anxiogenic action of caffeine. Researchers have looked into the genetic underpinnings of caffeine's anxiogenic effects (Hohoff et al., 2009). Compared to the other genotypic groups, people with the 1976T/T genotype for A2A adenosine receptors reported higher increases in anxiety following caffeine administration. among the Western population, this genotype (also known as 1083 C>T) was linked to lower caffeine intake, panic disorder, and blood injury phobia but not among Asians (Hohoff et al., 2009). Caffeine's strong anxiogenic effects appear to be limited to those who are at least predisposed to certain anxiety disorders, and they are impacted by higher levels of psychopathology as well as genetic and ethnic characteristics. When it comes to preference, people who prefer caffeine pills over placebo typically report stimulant and "positive" mood effects, while people who select placebo typically attribute unpleasant symptoms (such as increased anxiety and dysphoria) after taking caffeine (Masdrakis et al., 2008). Similarly, whereas caffeine raised the self-rated alertness of both caffeine consumers and nondrinkers, it only significantly affected psychomotor performance, mood, and motivation in caffeine consumers. Caffeine dosages of 50_100 mg are typically enough to produce mood effects, while some peoplecan still detect the effects of 20_30 mg. The perceived effects of caffeine are influenced by the presence of particular anxiety disorders, as shown in Table 2. Prior research has indicated that individuals with panic disorder and generalized anxiety disorder are more susceptible to the anxiogenic effects of high doses of coffee (usually greater than 400 mg) (Nowaczewska et al., 2020). These findings were expanded in more recent research to include first degree relatives of patients with panic disorder as well as individuals with performance social anxiety disorder, but not generalized social anxiety disorder. Additionally, nonspecific general psychopathology is much higher in individuals with panic disorder who experience panic attacks brought on by caffeine (Silverman et al., 2019). On the other hand, small amounts of caffeine can also improve mood and reduce anxiety in people. About 10% of participants with a moderate daily intake (mean 235 mg per day) may see an increase in anxiety and depression ratings after quitting caffeine for a few days, and roughly 50% of volunteers may experience headaches as a result (Silverman et al., 2019). Compared to a working group, the nonworking population in this study may have higher base line levels of depression, which would likely make it easier to detect this effect. In terms of suicide, higher consumption of tea and coffee was linked to a decreased risk (relative risk per cupof coffee per day = 0.87, 95% CI = 0.77 to 0.98). Additionally, moderate coffee use (2_6 cups per day) was found to be significantly associated with an increased risk of suicide (KawachiI et al., 2019). But according to another study, caffeine and suicide have a J shaped a connection. Suiciderates were shown to be reduced at low and moderate dosages, but they were significantly higher among individuals

who drank eight or more cups of coffee per day. The response tendency to better performance in people who consistently consume 400 mg of caffeine per day resembles this pattern (Schwartzhaupt et al., 2019). The fast-acting antidepressant effects of sleep deprivation have been suggested to be mediated via adenosine. If this were the case, caffeine could be detrimental to depressed patients on such medications. However, taking 150 mg of caffeine three times overnight did not make people feel happier the next day. Caffeine deprivation and mental health (Schwartzhaupt et al., 2019). The sole effect that was noted was a lack of decreased energy during sleep deprivation, which suggests that caffeine's therapeutic antidepressant effects may not entail adenosine and that caffeine consumption may facilitate patients' ability to withstand sleep deprivation (O'Callaghan et al., 2018). Caffeine may cause mania, according to a few case studies, and excessive caffeine use may make it more difficult for people with bipolar disorder or manic type mood episodes to recover. (Lara, 20101). These findings are consistent with its antidepressantand psychostimulant properties. Caffeine can raise elation in healthy volunteers at 250 mg and irritation at higher dosages (500 mg), which is relevant to mania. Furthermore, a transversal design of this study and the absence of genetic control make it impossible to establish causality, but high coffee consumption was linked to suicidal behavior in bipolar illness patients (Lara, 2010). Low to moderate consumption of caffeine is considered safe for the majority of individuals and may help reduce depressed symptoms. But further research is required on this subject. In conclusion, coffee may help people with mood and anxiety problems who are depressed or low on energy, but it may hurt some hypersensitive patients who have panic and/or performance anxiety disorder, as well as people with bipolar illness. However, complete abstinence may be harmful to those with main depressive symptomatology and is unlikely to produce a meaningful improvement in those with low to moderate caffeine intake (Lara, 2010). Impact on Sleep, Anxiety, and Hydration and Withdrawal Symptoms. Caffeine use later in the day can increase sleep latency and lower the quality of sleep, as is predicted from its effects on fatigue. Furthermore, caffeine can cause anxiety, especially in sensitive individuals, such as those with anxiety or bipolar illnesses, and at high dosages (>200 mg per occasion or >400 mg per day). Caffeine's effects on anxiety and sleep vary greatly from person to person. Variants in the adenosine receptor gene and variations in the rate ofcaffeine metabolism could be the cause.

**Table 2:** Specific Effects of Caffeine

| Aspect | Key Points | Reference |
|---|---|---|
| **Mood effects** | Low to moderate doses improve mood and relieve depressive symptoms; high doses may alter mood. | Hohoff et al. (2009) |
| **Anxiety** | High doses (>300–400 mg) may increase anxiety, especially in sensitive individuals. | Hohoff et al. (2009) |
| **Genetic influence** | The *ADORA2A* (1976T/T genotype) is associated with greater caffeine-induced anxiety and lower habitual caffeine intake. | Hohoff et al. (2009) |
| **Dose response** | Approximately 50–100 mg is sufficient for mood enhancement; some individuals respond to 20–30 mg. | Nowaczewska et al. (2020) |
| **Vulnerable groups** | Individuals with panic disorder, generalized anxiety disorder, or social performance anxiety may be more sensitive to caffeine's anxiogenic effects. | Silverman et al. (2019) |
| **Withdrawal mood effects** | Abrupt cessation of caffeine may increase anxiety, depression, and headache. | Silverman et al. (2019) |
| **Depression risk** | Regular low-to-moderate caffeine intake is associated with a lower risk of depression. | Kawachi et al. (2019) |
| **Suicide risk** | Low-to-moderate caffeine intake may be protective, whereas very high intake exhibits a J-shaped or increased risk relationship. | Kawachi et al. (2019); Schwartzwap et al. (2019) |

| Aspect | Key Points | Reference |
|---|---|---|
| **Mania/Bipolar disorder** | High doses may trigger irritability or manic symptoms in individuals with bipolar disorder. | Lara (2010) |
| **Sleep effects** | Delayed sleep onset and reduced sleep quality, particularly when caffeine is consumed later in the day. | Nehlig (2025) |
| **Hydration** | Moderate caffeine intake (≤400 mg/day) does not impair hydration. | Nehlig (2025) |
| **Withdrawal symptoms** | Headache, fatigue, reduced alertness, and depression; symptoms typically peak within 1–2 days and may last up to 9 days. | Nehlig (2025) |

### 2.1 Neurologic Diseases

Coffee, Caffeine, and Health: A correlation between Parkinson's disease risk and caffeine consumption. Parkinson's disease is not linked to decaffeinated coffee use, indicating that caffeine, not other coffee ingredients, is the cause of the unfavourable relationship. Caffeine also prevents Parkinson's disease in animal studies, presumably by antagonising the adenosine A2A receptor, thereby inhibiting nigrostriatal dopaminergic neurotoxicity and neurodegeneration. In numerous cohorts in the US and Europe, coffee and caffeine use have also been linked to lower rates of depression and suicide85. However, these results might not hold true for people who consume very large amounts of these substances (≥8 cups per day). Coffee drinking has not been reliably linked to an increased risk of Alzheimer's or dementia (Larsson & Markus, 2018).

### 2.2 Cancer and Liver Diseases

The beverage coffee, Caffeine, and Health: A relationship between caffeine intake and the risk ofParkinson's disease. The fact that decaffeinated coffee use is not associated with Parkinson's disease suggests that caffeine, not other coffee constituents, is the source of the negative association. In animal research, caffeine also prevents Parkinson's disease, most likely by preventing adenosine A2A receptor antagonism, which prevents neurodegeneration and nigrostriatal dopaminergic neurotoxic effects. Coffee and caffeine use have also been associated with lower incidence of depression and suicide in a number of cohorts in the US and Europe. However, those who take very high amounts of these substances (≥8 cups per day) may not experience these effects. Coffee consumption has not been consistently associated with a higher risk of dementia or Alzheimer's disease (Larsson & Markus, 2018). There is no evidence linking coffee and caffeine use to a higher risk of developing cancer or dying from it. A somewhat lower risk of melanoma, nonmelanoma skin cancer, breast cancer, and prostate cancer is linked to coffee drinking. Coffee drinking has been found to have stronger negative correlations with the incidence of hepatocellular carcinoma and endometrial cancer. While the correlations between caffeinated and decaffeinated coffee and endometrial cancer are comparable, the correlation between caffeinated coffee and hepatocellular carcinoma seems to be stronger. Other elements of liver health, such as decreased levels of enzymes indicative of liver damage and a decreased risk of liver fibrosis and cirrhosis, have also been consistently linked to coffee. (Van Dam et al., 2018). Because adenosine stimulates tissue remodeling, including collagen synthesis and fibrinogenesis, caffeine may inhibit adenosine receptors, so preventing hepatic fibrosis. According to a randomized study,drinking caffeinated coffee lowers liver collagen levels in hepatitis C patients, caffeine suppresses hepatocarcinogenesis in animal models, and caffeine metabolites decrease collagen deposition in liver cells. Additionally, by enhancing lipid homeostasis and lowering oxidative stress, coffee polyphenols may offer protection against liver steatosis and fibrogenesis (Van Dam et al., 2018).

### 2.3 Physiological Effects of Caffeine

Coffee and caffeine both have important physiological consequences. Coffee contains caffeine, a stimulant that increases alertness and improves focus by blocking the brain's adenosine neurotransmitter. Additionally, it increases the production of neurotransmitters that improve mood and cognitive performance, including as dopamine and norepinephrine. Blood pressure and heart rate can be momentarily elevated by caffeine. Caffeine consumption in moderation can improve performance and alertness. A significant source of caffeine, coffee also has other potentially health promoting substances such antioxidants and chlorogenic acids (Czchowski et al., 2024). Depending on the dosage, caffeine, a pharmacologically active drug, can have modest central nervous system stimulant effects. (Tearney, 2024). In this regard, caffeine is not unique; it is one of several food elements that have the ability to have pharmacological and physiological impacts. For instance, when caffeine is taken orally, it is quickly absorbed into bodily fluids and dispersed throughout the body in its "water phase" (blood, urine, etc.). Capsaicin, which is found in hot peppers, also produces the well-known burning sensation that frequently generates perspiration. On the other hand, consuming too much coffee or caffeine can lead to anxiety, jitters, stomach troubles, and insomnia. In order to profit from caffeine and coffee without experiencing negative side effects, it is crucial to consume them in moderation (Gaspar et al., 2024).

## 3 Influence of Caffeine on Physical Performance

Numerous studies have demonstrated the potential advantages of caffeine for athletes and active people, and its impact on physical performance is well-established (Szerej et al., 2024). Both the central nervous system and the muscular system are stimulated by caffeine. Caffeine can decrease perceived effort and exhaustion by inhibiting adenosine receptors in the brain, enabling people to exercise more intensely and for longer periods of time. It has been demonstrated that caffeine increases muscle contraction and strength, which improves performance in exercises like weightlifting and running. In order to save glycogen and postpone the onset of tiredness during endurance exercise, caffeine can enhance the mobilization and utilization of fat stores (Graham, 2020). Caffeine has dose dependent ergogenic effects; ideal dosages usually fall between 3 and 6 mg per kilogram of body weight (Searle, 2024). Caffeine is widely acknowledged as a safe and effective ergogenic aid for enhancing physical performance in a variety of athletic endeavors, although individual responses to the stimulant can vary and some people may experience side effects like jitteriness, an elevated heart rate, or gastrointestinal discomfort (Brice & Smith, 2002).

### 3.1 Individual Differences in Caffeine Sensitivity

The term "individual differences in caffeine sensitivity" refers to how people respond to caffeine, which varies with age, weight, metabolism, genetics, and overall health (Penolazzi, 2021). Some people could need higher doses of caffeine to feel its effects, while others might need more to feel anything at all. Some people may be more sensitive to caffeine and experience stronger effects even with tiny amounts. Caffeine use should be avoided by persons who are pregnant, have health conditions, or are taking medication. (Yokomukai, 2022). To stay safe and reap the benefits without the risks, it's critical to understand your unique boundaries and how caffeine affects you. Caffeine sensitivity is largely determined by genetic factors, with specific genetic differences affecting the body's metabolism of caffeine (Yokomukai, 2022). Caffeine sensitivity can also be influenced by age, with younger people generally more sensitive than older people due to differences in liver function and metabolism. Because caffeine is distributed differently in the body depending on body weight and metabolism, sensitivity to caffeine can also be influenced by overall health and medical conditions. For example, people with anxiety disorders or gastroesophageal reflux disease (GERD) are more susceptible to the negative effects of caffeine, and people with liver disease, pregnant women, and infants have slower metabolism of caffeine (de Paula & Farah,2021).

**Disadvantages of Caffeine to the Human Body**

Although coffee and caffeine have advantages, they can also have drawbacks. Excessive

caffeine intake, whether from coffee or other sources, can lead to issues including jitters, anxiety, headaches, and difficulty falling asleep. Additionally, it can worsen cardiac problems, increase blood pressure, and result in irregular heartbeats, particularly in those who already have heart disease. Additionally, pregnant women should exercise caution because excessive caffeine use might impact the development of the unborn child and increase the risk of miscarriage (Caton et al., 2012). Regularly using large amounts of caffeine might cause your body to become accustomed to requiring more to achieve the same effects, and if you abruptly reduce your intake, you may experience fatigue and irritability (Thayer, 2018). Some individuals may be especially susceptible to the negative effects of caffeine, such as those who suffer from anxiety, insomnia, or gastrointestinal problems. Since caffeine is essentially a stimulant and, like all stimulants and substances, abuse or overuse of caffeine can have negative effects, it may be harmful to a hypertensive who is under stress and takes it. Over 500_600 mg of caffeine per day might have negative consequences like irritation, agitation, restlessness, insomnia, upset stomach, fast heartbeat, and muscular tremors (Caton et al., 2012). While moderate coffee and caffeine intake can be healthy for most people, it's important to watch how much you have and be aware of potential problems. Adults and adolescents engaging in endurance exercise, pregnant women, lactating women, children possibly divided by age group, and breastfed infants consuming caffeine via mother's milk are among the relevant population groups that experience adverse health effects from caffeine intake (Caton et al., 2012). Effects of Caffeine on Gastrointestinal and Urinary Caffeine and coffee have an impact on the bladder and stomach, as shown in Figure 1. Caffeine, which is found in coffee, can raise stomach acid and cause heartburn in certain people. Additionally, some people may experience more frequent bowel motions as a result of it. While coffee and caffeine can have both positive and negative effects on the stomach and bladder, it's important to use them in moderation to avoid problems. Coffee has been linked to a lower risk of certain stomach and liver issues. However, caffeine's diuretic effect can cause more frequent urination, but regular coffee drinker softens become tolerant to this (Bird et al., 2024). Coffee and caffeine impact the stomach and bladder. Coffee contains caffeine, which in some people can increase stomach acid and result in heartburn. Furthermore, it may cause some people to have more frequent bowel movements. Although caffeine and coffee can affect the stomach and bladder in both positive and bad ways, it's crucial to consume them sparingly to prevent issues. Coffee consumption has been associated with a decreased risk of certain liver and gastrointestinal problems. Regular coffee drinkers typically develop tolerance to the diuretic action of caffeine, which can lead to increased frequency of urine (Bird et al., 2024).

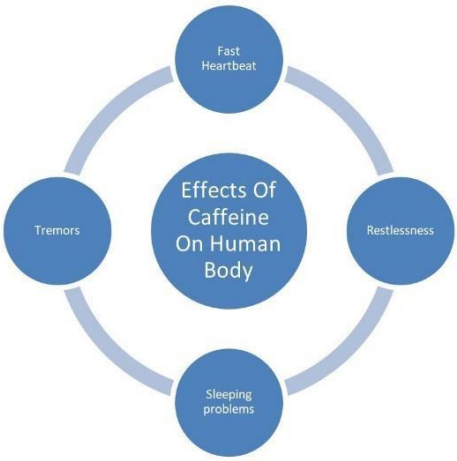


**Figure 1:** Representation of effects of caffeine on health

## 4 Conclusion

Caffeine, a psychoactive chemical found in coffee, tea, and energy drinks, is the most commonly consumed substance globally. It can cause anxiety, stress-related symptoms, sleep issues, and alter estrogen levels. Caffeine consumption is influenced by genetics and is not recommended for individuals with anxiety, sleeplessness, or gastrointestinal issues. High doses can cause symptoms of "caffeinism" and withdrawal effects. Caffeine consumption is a moderate risk factor for psychiatric and drug use problems in the general population. Both caffeine and coffee have physiological effects, with caffeine increasing alertness and focus by blocking the brain's adenosine neurotransmitter and increasing neurotransmitter production, improving mood and cognitive performance. Caffeine boosts energy and alertness, improving performance in certain conditions. However, high doses can cause "caffeine's, a mixed mood state. Withdrawal effects include headaches, drowsiness, anxiety, and depression. Clear caffeine dependence can be identified by withdrawal symptoms, a persistent need to reduce consumption, and tolerance. Abstinence is associated with increased cerebral blood velocity, elevated EEG theta, and lowerbeta 2 power.

### Author Contributions

Aqib Ishaq, Mehak Fatima, Momina Batool, and Muhammad Soban Mumtaz contributed to the conceptualization, literature search, review and synthesis of relevant evidence, organization of the scientific content, interpretation of the literature, and preparation of the manuscript. All authors contributed to writing—original draft and writing—review and editing. All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

### Conflict of Interest

The authors declare that they have no financial, professional, institutional, commercial, or personal conflicts of interest that could have influenced the content or conclusions of this article.

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### Data Availability

No new data were generated or analysed in this study. All information supporting the discussion and conclusions was obtained from the published literature cited in the article.

### Informed Consent

Not applicable. No human participants were recruited and no identifiable personal or clinical data were collected.

### Use of Generative AI

The authors declare that no generative artificial intelligence tools were used to conduct the literature analysis, generate the scholarly content, interpret the evidence, or formulate the conclusions presented in this article.

## 5 References

Abdoli, F., Davoudi, M., Momeni, F., Djafari, F., Dolatshahi, B., Hosseinzadeh, S., & Khalili, Z. (2023). Estimate the prevalence of daily caffeine consumption, caffeine use disorder, caffeine withdrawal and harm in Iran: A cross-sectional study. *Research Square*. https://doi.org/10.21203/rs.3.rs-3699710/v1

Abdoli, F., Davoudi, M., Momeni, F., Djafari, F., Dolatshahi, B., Hosseinzadeh, S., & Khalili, Z. (2024). Estimate the prevalence of daily caffeine consumption, caffeine use disorder, caffeine withdrawal and perceived harm in Iran: A cross-sectional study. *Scientific Reports*, 14(1), Article 7644. https://doi.org/10.1038/s41598-024-58496-8

Ágoston, C., Urbán, R., Richman, M. J., & Demetrovics, Z. (2018). Caffeine use disorder: An item-response theory analysis of proposed DSM-5 criteria. *Addictive Behaviors*, 81,

109–116. https://doi.org/10.1016/j.addbeh.2018.02.012

Agritelley, M. S., & Goldberger, J. J. (2021). Caffeine supplementation in the hospital: Potential role for the treatment of caffeine withdrawal. *Food and chemical toxicology*, *153*, 112228. https://doi.org/10.1016/j.fct.2021.112228

Alimyar, O., Nahiz, A., Monib, A. W., Baseer, A. Q., Hassand, M. H., Kakar, U. M., & Niazi, P. (2024). Coffee plant (caffeine): Examining its impact on physical and mental health. *European Journal of Medical and Health Research*, 2(2), 143–154. https://doi.org/10.59324/ejmhr.2024.2(2).16

Bertasi, R. A., Humeda, Y., Bertasi, T. G., Zins, Z., Kimsey, J., Pujalte, G., & Pujalte, G. G. (2021). Caffeine intake and mental health in college students. *Cureus*, 13(4), Article e14313. https://doi.org/10.7759/cureus.14313

Bird, E. T., Parker, B. D., Kim, H. S., & Coffield, K. S. (2024). Caffeine ingestion and lower urinary tract symptoms in healthy volunteers. *Neurourology and Urodynamics*, 24(7), 611–615. https://doi.org/10.1002/nau.20179

Brice, C. F., & Smith, A. P. (2002). Factors associated with caffeine consumption. *International Journal of Food Sciences And Nutrition*, *53*(1), 55–64.

Caton, S., Chadwick, D., Chapman, M., Turnbull, S., Mitchell, D., & Stansfield, J. (2012). Healthylifestyles for adults with intellectual disability: knowledge, barriers, and facilitators. *Journal of Intellectual and Developmental Disability*, *37*(3), 248–259. https://doi.org/10.3109/13668250.2012.703645

Childs, E., Hohoff, C., Deckert, J., Xu, K., Badner, J., & De Wit, H. (2008). Association betweenADORA2A and DRD2 polymorphisms and caffeine-induced anxiety. *Neuropsychopharmacology*, *33*(12), 2791-2800.

Cholewa, K., Czarnek, K., Grzywacz, A., & Masiak, J. (2023). Energy drink use disorder—A review of the literature. *Teka Komisji Prawniczej*, 16(1), 21–31. https://doi.org/10.32084/tkp.5425

Clark, K. S., Coleman, C., Shelton, R., Heemstra, L. A., & Novak, C. M. (2019). Caffeine enhances activity thermogenesis and energy expenditure in rats. *Clinical and Experimental Pharmacology and Physiology*, 46(5), 475–482. https://doi.org/10.1111/1440-1681.13065

Czajkowski, N., Kendler, K. S., Torvik, F. A., Ystrom, E., Rosenström, T., Gillespie, N. A., & Reichborn-Kjennerud, T. (2021). Caffeine consumption, toxicity, tolerance and withdrawal: Shared genetic influences with normative personality and personality disorder traits. *Experimental and Clinical Psychopharmacology*, 29(6), 650–660. https://doi.org/10.1037/pha0000429

Czchowski, K., Kościołek, A., Misiak, J., Kościołek, D., Kępczyk, M., Ojdana, M., ... & Tokarski, M. (2024). The frequency of coffee consumption in the Slavic population and its impact on health. *Journal of Education, Health and Sport*, *62*, 46–60. https://doi.org/10.12775/JEHS.2024.62.003

de Paula, J., & Farah, A. (2021). Caffeine consumption through coffee: Content in the beverage, metabolism, health benefits and risks. *Beverages*, *5*(2), 37https://doi.org/10.3390/beverages5020037

Erdős, Á. (2023). Coffee, energy drinks consumption and caffeine use disorder among law enforcement college students in Hungary. *European Journal of Mental Health*, 18, 1–12.https://doi.org/10.5708/EJMH.18.2023.0008

Gaspar, C., Rocha, C., Balteiro, J., & Santos, H. (2024). Effects of caffeine on cerebral blood flow. *Nutrition*, Article e112217. https://doi.org/10.1016/j.nut.2023.112217

Gilliland, K., & Andress, D. (2022). Ad lib caffeine consumption, symptoms of caffeinism, and academic performance. *American Journal of Psychiatry*, 138(4), 512–514. https://doi.org/10.1176/ajp.138.4.512

Graham, T. E. (2020). Caffeine and exercise: Metabolism, endurance and performance. *Sports Medicine*.

Greden, J. F. (2021). Anxiety or caffeinism: A diagnostic dilemma. *American Journal of Psychiatry*, 131, 1089–1092. https://doi.org/10.1176/ajp.131.10.1089

Grosso, G., Micek, A., Castellano, S., Pajak, A., & Galvano, F. (2016). Coffee, tea, caffeine and risk of depression: A systematic review and dose-response meta-analysis of observational studies. *Molecular Nutrition & Food Research*, 60(1), 223–234. https://doi.org/10.1002/mnfr.201500620

Hohoff, C., Domschke, K., Schwarte, K., et al. (2009). Sympathetic activity relates to adenosine A(2A) receptor gene variation in blood-injury phobia. *Journal of Neural Transmission*, 116, 659–666. https://doi.org/10.1007/s00702-008-0089-5

Isa, Z. M., Anuar, A. A., Azmi, A. D., Selvan, S. T., Hisham, N. S., & Qing, Y. Z. (2021). Does caffeine intake influence mental health of medical students? *Malaysian Journal of Public Health Medicine*, 21(2), 22–28. https://doi.org/10.37268/mjphm/vol.21/no.2/art.626

Jahrami, H., Al-Mutarid, M., Penson, P. E., Al-Islam Faris, M. E., Saif, Z., & Hammad, L. (2020). Intake of caffeine and its association with physical and mental health status among university students in Bahrain. *Foods*, 9, Article 473. https://doi.org/10.3390/foods9040473

Jee, H. J., Lee, S. G., Bormate, K. J., & Jung, Y. S. (2020). Effect of caffeine consumption on the risk for neurological and psychiatric disorders: Sex differences in human. *Nutrients*, 12(10), Article 3080. https://doi.org/10.3390/nu12103080

Kawachi, I., Willett, W. C., Colditz, G. A., Stampfer, M. J., & Speizer, F. E. (2019). A prospective study of coffee drinking and suicide in women. *Archives of Internal Medicine*, 156, 521–525. https://doi.org/10.1001/archinte.1996.00440050067008

Kendler, K. S., Myers, J., & Gardner, C. O. (2017). Caffeine intake, toxicity and dependence andlifetime risk for psychiatric and substance use disorders: An epidemiologic and co-twin control analysis. *Psychological Medicine*, 36, 1717–1725.https://doi.org/10.1017/S0033291706008622

Lara, D. R. (2010). Caffeine, mental health, and psychiatric disorders. *Journal of Alzheimer's Disease*, 20(S1), S239–S248. https://doi.org/10.3233/JAD-2010-1378

Larsson, S. C., & Markus, H. S. (2018). Does treating vascular risk factors prevent dementia and Alzheimer's disease? A systematic review and meta-analysis. *Journal of Alzheimer's Disease*, *64*(2), 657–668. https://doi.org/10.3233/JAD-180288

Liu, C., Wang, L., Zhang, C., Hu, Z., Tang, J., Xue, J., & Lu, W. (2024). Caffeine intake and anxiety: A meta-analysis. *Frontiers in Psychology*, 15, Article 1270246. https://doi.org/10.3389/fpsyg.2024.1270246

Marmorstein, N. R. (2016). Energy drink and coffee consumption and psychopathology symptoms among early adolescents: Cross-sectional and longitudinal associations. *Journal of Caffeine Research*, 6(2), 64–72. https://doi.org/10.1089/jcr.2015.0018

Masdrakis, V. G., Papakostas, Y. G., Vaidakis, N., Papageorgiou, C., & Pehlivanidis, A. (2008). Caffeine challenge in patients with panic disorder: Baseline differences between those who panic and those who do not. *Depression and Anxiety*, 25, E72–E79. https://doi.org/10.1002/da.20333

Nehlig, A. (2025). What Are the Effects of Coffee at the Different Levels of the Digestive Tract? I M. Banach & S. Surma (Eds.), *The Link Between Coffee and Health*, 193–234. Springer Publications.

Nowaczewska, M., Wiciński, M., & Kaźmierczak, W. (2020). The ambiguous role of caffeine in migraine headache: from trigger to treatment. *Nutrients*, *12*(8), 2259

O'Callaghan, F., Muurlink, O., & Reid, N. (2018). Effects of caffeine on sleep quality and daytime functioning. *Risk Management and Healthcare Policy*, 11, 263–271. https://doi.org/10.2147/RMHP.S156404

Penolazzi, B., Natale, V., Leone, L., & Russo, P. M. (n.d.). Individual differences affecting caffeine intake: Analysis of consumption behaviours for different times of day and caffeine sources.

Schwartzhaupt, A. W., Lara, D. R., Hirakata, V. N., Schuch, A., Almeida, E., Silveira, L., Caldieraro, M. A., & Fleck, M. P. (2019). Does caffeine change the effect of sleep deprivation on moderate to severe depressed patients? *Journal of Affective Disorders*, 112, 279–283. https://doi.org/10.1016/j.jad.2008.04.015

Searle, W. (2024). Effects of caffeine on muscle strength: Influence of genetics (Doctoral dissertation, University of Kent).

Sigmon, S. C., Peck, K. R., Batchelder, S. R., Badger, G. J., Heil, S. H., & Higgins, S. T. (2023). Technology-assisted buprenorphine treatment in rural and nonrural settings: Two randomized clinical trials. *JAMA Network Open*, *6*(9), e2331910.

Silverman, W. K., Marin, C. E., Rey, Y., Kurtines, W. M., Jaccard, J., & Pettit, J. W. (2019). Group-versus parent-involvement CBT for childhood anxiety disorders: Treatment specificity and long-term recovery mediation. *Clinical Psychological Science*, *7*(4), 840–855. https://doi.org/10.1177/2167702619830404

Szerej, K., Dorobek, W., Stankiewicz, K., & Świeczkowski-Feiz, J. (2024). The role of caffeine in enhancing physical performance: from metabolism to muscle function. *Journal of Education, Health and Sport*, *59*, 158–165. https://doi.org/10.12775/JEHS.2024.59.010

Tearney, C. (2024). CNS stimulants. In T. Aarnes, & P. Lerche (Eds.), *Pharmacology in veterinary anesthesia and analgesia* (pp. 177–182). Wiley Online Library. https://doi.org/10.1002/9781118975169.ch14

Thayer, R. E. (2018). *The origin of everyday moods: Managing energy, tension, and stress*. OxfordUniversity Press.

Torabynasab, K., Shahinfar, H., Payandeh, N., & Jazayeri, S. (2023). Association between dietary caffeine, coffee, and tea consumption and depressive symptoms in adults: A systematic review and dose-response meta-analysis of observational studies. *Frontiers in Nutrition*,10, Article 1051444. https://doi.org/10.3389/fnut.2023.1051444

van Dam, R. M., Hu, F. B., & Willett, W. C. (2020). Coffee, caffeine, and health. *New England Journal of Medicine*, 383(4), 369–378. https://doi.org/10.1056/NEJMra1816604

Yokomukai, Y., Cowart, B. J., & Beauchamp, G. K. (2022). Individual differences in sensitivity to bitter-tasting substances. *Chemical Senses*, *18*(6), 669–681. https://doi.org/10.1093/chemse/18.6.669