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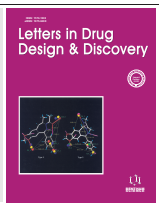
CURRENT FRONTIER

Coffee, Caffeine and Cognition: A Benefit or Disadvantage?



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Abstract: Coffee, one of the world's most consumed products, is extracted from the roasted seeds of *Coffea sp*., a plant native to Africa. The effects of coffee on the human body have been recognized for centuries and have now become the subject of systematic research. Caffeine's impact on a person's cognitive ability was reviewed through a large set of literature related to the subject. Learning and memory tasks are not typically influenced by caffeine when it comes to performance. However, in some cases, it has been used to produce inhibitory or facilitatory effects on learning and/or memory. Caffeine facilitates performance in tasks involving the working memory, but it has been seen that tasks that rely on working memory may be hindered because of it. Moreover, caffeine can augment the performance of memory during times where a person's alertness is suboptimal at best. However, a large body of research points to an improvement in reaction time. Consuming it has little to no impact on long-term memory. Caffeine can be taken as a mild stimulant, proven by its effect on performance in the context of subjects who are tired or fatigued. In some cases, it has been observed that caffeine prevents cognitive decline, specifically when it comes to healthy subjects; however, these results are heterogeneous at best. While drinking coffee positively influences both physical and mental capacity, caffeine cannot and should not be viewed as an "absolute" enhancer of cognitive function. Existing literature shows that the impact it causes on an individual is complex, and can alter, for example, anxiety, performance and arousal.

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1. INTRODUCTION

Roasted coffee beans are brewed to prepare coffee (Fig. **1**). These beans are extracted from the Coffea plant, which is found in tropical Africa. The production of coffee beans was at some point in history exported to the rest of the world, and now more than 70 countries are producing it themselves. The Arabica and Robusta are the two strains that are typically grown, with Arabica being the more popular of the two. The Robusta is less in demand, despite being stronger in taste and impact. Coffee, the most popular beverage in the world, is loaded with caffeine [1]. Another extremely popular beverage containing caffeine is a variety of tea, and we must not forget the fast-growing production of caffeine-containing energy drinks. Caffeine stimulates the central nervous system because it is a bioactive compound. For this very reason, it has positive impacts on an individual's long-term memory [2].

Fig. (1). Roasted coffee beans.

It is true that consuming coffee is typically associated with health problems. Despite this, more recent studies show that consuming it can have benefits [3-5]. Some studies have

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analysed brain functions to see the long-term impact. The higher consumption of these products, or elevated plasma caffeine levels, can actually keep one safe against cognitive decline and impairment, thereby also protecting against dementia [2]. Meanwhile, there are other bodies of research that promote a more positive role of coffee in the fight against Alzheimer's [6]. In this paper, we discuss the impact of caffeine on human health with a focus on the cognitive function of the brain. The present document looks at how cognitive ability is impacted by caffeine, under both chronic and acute consumption.

2. COFFEE AND CAFFEINE CONSUMPTION

The drinking of coffee has long been limited to the Arab world, but in the 15th-century, coffee consumption reached Europe and during the 16th century, it then rapidly spread throughout Europe [7]. The amount of caffeine (Fig. **2**) in a single cup can be different because of several factors, including the type of product being used, how large or small the serving is, and what ingredients have been permitted (Arabica or Robusta) [8]. Arabica is the foremost coffee to be consumed heavily throughout the world and world coffee consumption is increasing [7]. Table **1** looks at a summarized version of the different constructions of a single cup of coffee, based on the method of preparation.

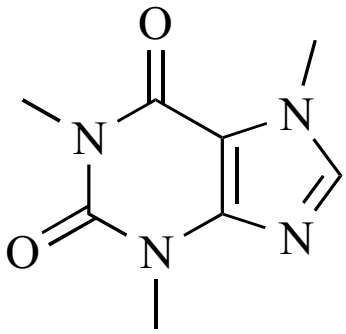

Fig. (2). Chemical structure of caffeine.

Table 1. Content of caffeine in a cup of coffee according to the mode of preparation (data from Colton *et al.*, 1968 [9]).

Mode of Preparation	Volume of Serving (ml)	Caffeine Content (mg/cup)
Filter	50–190	28–161
Boiled	150–190	11–177
Percolated	150–190	55–88
Espresso	50–150	74–99
Instant	50–190	19–34

The most important source of caffeine is coffee, but coffee isn't the only product to use caffeine, it is found in several other dietary sources, including cocoa beverages, soft drinks, tea, and candy bars. On average, a person consumes 76 grams of it during a single day. However, within Canada and the United States, this value jumps up to around 210 to 238 grams per day. In Finland and Sweden, it goes even higher to around 400 grams per day. Around 80 to 100 percent of this consumption can be traced back to coffee [10, 11]. In the UK, the rate of consumption is more or less the same as Finland and Sweden. However, 72 percent can be attributed to tea [8].

3. CAFFEINE

Caffeine (1,3,7-trimethylxanthine) is a plant secondary metabolite and purine alkaloid which was first isolated from the coffee bean in 1819 by German chemist Friedlieb Ferdinand Runge [12] (Fig. **2**). A bitter-tasting pure anhydrous option looks like a white odourless powder, and melts between 235-238 degrees Celsius. At room temperature, caffeine is somewhat water-soluble (2g per 100 ml). On the other hand, its solubility changes in boiling water, where it rapidly disintegrates (66g per ml). In ethanol, it is moderately soluble (1.5g per 100 ml). It is classified as an achiral molecule because it has no stereogenic centres.

Caffeine acts as a methylxanthine class stimulant when it comes to the Central Nervous system (CNS) [13]. Apart from being an ingredient in one of the most popular drinks of the world, it is also widely consumed by athletes as an ergogenic boost, and as a psychoactive drug. During prolonged and exhaustive exercise, it positively impacts both endurance and performance. It may also influence high-intensity performance for athletes in the short term, albeit to a lesser degree. It can augment alertness, enhance concentration and diminish fatigue. While most other psychoactive substances are illegal, caffeine is not. It is furthermore largely unregulated around the world. The impact of caffeine can be explained by a few mechanisms of action. To start with, it prevents drowsiness by blocking the impact of adenosine. It also engaged with acetylcholinesterase, phosphodiesterase, monoamine oxidase, ryanodine receptors, *etc.* Some parts of the autonomic nervous system may also be stimulated by caffeine. Contemporary research looks at its role in immunity alteration and neurodegenerative illnesses [14].

4. PHARMACOKINETICS OF CAFFEINE

This substance is rapidly absorbed from the gastrointestinal tract in over 45 minutes after it is consumed. This is true for around 99 percent of people [15, 16]. Pharmacokinetics are administrated *via* IV or orally, after which they become comparable in animals and humans [17-19]. Caffeine's hydrophobic nature allows it to go through most membranes, and this includes the Blood-Brain Barrier (BBB) [20]. In a rabbit model experiment, it was found that when caffeine is chronically ingested, the body is able to protect itself against BBB disruptions that are a result of a high cholesterol diet. Moreover, this substance, or others

similar to it, could prove helpful in treating Alzheimer [21]. BBB disruptions, alongside elevated levels of cholesterol, have been seen as an issue when it comes to Alzheimer and/or Parkinson's disease. While these underlying processes are yet to be entirely explored, the substance in question has protected against both PD and AD, in studies involving both animals and humans [22, 23].

For humans, it takes around 15 to 120 minutes from the point of oral intake for peak plasma concentrations of caffeine. The literature reports study where this took place between 45 to 120 minutes after consumption. The half-life of caffeine ranges between two-and-a-half to ten hours, in the context of humans [24]. In healthy subjects, caffeine elimination's intra-individual variability, was seen to be varied within a wide range. In a study by Balogh *et al.* [25], the variance registers at 21.4% and 78.6% for intra and inter-individual, respectively.

In the single dose open study on twenty obese subjects (BMI exceeding 30 kg/m^2) and 14 lean subjects (BMI 22.6 +/- 1.7 kg/m^2), it was shown that caffeine pharmacokinetics are only minimally altered by obesity [26]. Several quinolone antibacterial agents, including pefloxacin, ciprofloxacin, enoxacin and pipemidic acid, have been seen reducing methylxanthine clearance. The impact of ciprofloxacin and temafloxacin on caffeine's pharmacokinetics were looked into by Mahr and associated with a trifold, crossover research, which involved 12 young and healthy participants [27]. The participants were volunteers, each one of whom consumed around 183 mgs on a daily basis, alongside a placebo administered twice a day (this included ciprofloxacin 750mg and temafloxacin 600 mg). The sequence was random. The plasma concentration-time curve area was seen to double (77.8 *vs* 31.8 mg/L·h) and caffeine's terminal-phase half-life (9.7 *vs* 4.5h) were both studied under ciprofloxacin. On the other hand, temafloxacin did not produce any impact on caffeine's pharmacokinetics [27]. Similarly, grapefruit juice, known to alter the pharmacokinetics and metabolism of certain drugs [28], has no effect on the pharmacokinetics or hemodynamic effects of caffeine [29].

5. COGNITION

Cognitive abilities have to do with acquiring or processing information so that it can be further processed and understood through the senses, thoughts and experiences [30]. This includes attention, knowledge, working memory, judgement, decisions, reasoning, and more. The cognitive processes that humans experience can be natural or induced. They can also be unconscious and conscious, conceptual or intuitive, and abstract or concrete. Such processes will use the knowledge that already exists to create newer information. This process is complex and involves attention, perception, memory, psychomotor functions, language and executive functions. These aspects on their own are complex, within this complex system. Memory has to do with encoding, storing and retrieving data from the brain. It can be seen in three parts, namely, short-term memory, long-term memory and working memory. On the other hand, attention can be specific. It can be sustained, divided or selective. Perception has to do with many different levels through which recognition can be achieved for different modalities, *i.e.* tactile, auditory and visual.

Executive functions have to do with processes of cognition that are mandatory for control of behaviour, and the selection and monitoring of behaviour which leads to the completion of a given aim that was chosen. Therefore, executive functions involve reasoning, planning, evaluation, strategic thinking, *etc.*

6. IT IS POSSIBLE TO STUDY THE EFFECTS OF CAFFEINE ON HUMAN COGNITION?

It is possible, but it is exceedingly difficult. It is obvious that most people have different methods of consuming caffeine. Some take it in the form of a drink, including tea, hot chocolate, coffee, energy drinks and soft drinks. Some take it as food, which mainly consists of chocolate. It is also consumed as medication. Therefore, it is not possible to control the impact of caffeine, since the nature of its impacts given the variability of use has not been entirely understood. Groups of non-exposed true control subjects with zero exposure almost do not exist. Although the effect of caffeine on cognitive function has been the subject of many studies over the last few decades, certain prejudices can be found in each of these studies. Perhaps that is why the issue of the influence of caffeine on the human brain and its cognitive function is still unclear and is the subject of interest in numerous discussions in the media and the public.

7. CAFFEINE AND MEMORY

When it comes to humans, their memory can be split into - as previously mentioned - long and short term memory. A memory that functions in the shorter term are at times also referred to as working memory. It has to do with information that is stored for a limited time, whereby the mind processes it for a given task. The amount of information that can go into working memory is limited. Any information stored for more than two minutes at a time is considered to be a part of the long-term memory for humans [31]. Long-term memory will typically hold enormous amounts of data, which is kept for a much larger amount of time, and often extends through a person's life. The working memory is connected to long-term memory [32] and this connection is especially important for a person's normal life. Both types of memory can be engaged when a person is performing a given task at this point, they turn into explicit memories.

Many studies, of an experimental nature, have looked at the impact that caffeine has one memory. However, they have focused on only a few, exceedingly simple evaluations of episodic memory that has been newly acquired or established [33]. This part of the review will, therefore, focus on memory that is short term and long term.

7.1. Short-Term Memory

Many consume the substance in question to improve their cognitive ability. Nevertheless, a lot is not known about whether this is a useful thing to do or not when it comes to enhancing one's memory. Some studies on memory performance, conducted in the past, have shown inconsistent results.

7.1.1. Free Recall Task

The influence of caffeine in the free recall task was tested in several studies. Free recall is a basic paradigm in the psychological study of memory. A total of 30 such studies have been found in literary sources. Caffeine was found to either have no effect on free recall performance in twenty studies [34-52], improve recall in seven studies [53-59], and damper recall in three studies [36, 60, 61].

Studies suggest that there is a difference between introverts and extroverts, with extroverts performing working memory actions taking away more benefit than their counterparts. Caffeine, in this case, improved reaction time, and enhanced the speed with which new information was encoded. These effects were not altered due to extraversion. The results indicate that caffeine's impact on cognition is linked to some biological mechanisms [59].

7.1.2. Selective Attention Task

In selective attention tasks, one dose was analysed in divided and focused attention. A search task, that was visual in nature, was handed out. Participants had to then engage in controlled search processes and find a given target. Overnight abstinent coffee consumers were administered a 3 mg per kg of body weight of lactose or caffeine, mixed into a decaffeinated cup of coffee. The dose was given to the subjects deceptively and double-blindly. Subjects reacted faster in the caffeinated state. Search processes, as reflected in a negative event-related potentials ERP deflection, were not affected by caffeine [62]. The results of [63], show the substance has specific impacts on information processing. These effects were more visible in participants that were fatigued, as opposed to well-rested individuals. This shows that the impact that this substance has varied as per the state that a subject is in.

Young and elderly participants were also studied to observe the energetic and structural processes when it comes to information processing. A selective search task, visual in nature, was instituted. Participants had to select relevant information, subsequent to which they were asked to locate a target during a controlled memory search. The 30 participants were equally split into young and elderly individuals. Moreover, all participants were healthy, did not smoke, and already consumed some form of caffeine (around 250 to 600 mg a day). They were given 250 mgs of a placebo or caffeine, mixed into decaf coffee. The elderly participants' ERP results indicated a decrease in their level of energy resources. Caffeine improved performance in both young and old subjects. These results suggest that caffeine makes more energy resources available for task performance [64].

Kenemans and Verbaten looked at the impact of 1.5 mg and 3 mg per kg [65]. They also studied visual attention and worked with 24 healthy participants. In two of three tests, it was observed that caffeine helped speed up responses by a large margin. The results of this study show that caffeine has a positive impact in low-load conditions, and this cannot be linked to diminished distractibility or augmented suppression of response tendencies that are task-irrelevant.

Lorist *et al.* looked at the impact that caffeine has on selective visual search and attention [62]. This study found that the 3 mg per kg dose did not reduce reaction times for high display load but did the opposite for low display load. Previously, it was found that this differential effect indicates that caffeine could help with performance when it comes to somewhat complex tasks or fairly simple ones. When it comes to complex tasks, it has little to no impact, and may even do harm instead of good [66, 67]. It helps with tasks where working memory is involved, albeit only to an extent. But for a task that seriously relies on working memory, it may hinder performance instead.

In studying the literature on the effect of caffeine on cognition, we often find differences that seem unjustified. The variations and discrepancies in the literature have to do with the fact that the method of assessment (recognition or recall) is different. The sex and age of the subjects are also different. The period deployed may vary, some may look at immediate processes while others may employ a delayed approach. The inverted U-shaped function for arousal performance may be one explanation [68]. Caffeine may augment the performance of memory in conditions that witness low arousal [69, 70].

7.2. Long-Term Memory

The influence that this substance may have on long-term memory has not been observed in much detail. There are some studies, but the body of work is fairly small. One research consisting of 12 participants was administered 5 mg per kg before a session to learn and retrieve information. The group of six men and six women were given 16 words to study during the learning session. Two days later, their memory was evaluated in terms of the number of words they remembered without causing any effect on memory [71]. Even in the group of healthy men and women of middle (45–60 years) and older age (60–75 years), caffeine (100 mg dose) did not have an effect on long-term memory in the cross-over design study. A positive effect on memory was seen in higher doses of caffeine (200–250 mg) [37].

7.2.1. Consolidation of Memory

Borota *et al.* tested caffeine to see if it can have a long-term impact on a human's memory [72]. They found that caffeine, under the inverted U-shaped curve for dose response, augmented performance a full 24 hours after administration; this effect was particularly linked to consolidation not retrieval. This study proposed that the substance augmented consolidation of long-term memory when it comes to human participants.

8. MECHANISM OF ACTION OF CAFFEINE

Caffeine's impact can be elaborated on by looking at three mechanisms, inhibiting phosphodiesterase, blocking adenosine receptors, specifically in CNS and mobilizing intracellular calcium storage. A small dose is needed to block adenosine receptors, however, for the other two mechanisms, larger doses are needed; such doses are not possible through common dietary outlets, and ergo cannot be held responsible for the physiological impact of caffeine.

Most of the neuropharmacological effects of caffeine are probably mediated by adenosine receptors.

8.1. Antagonism of Adenosine

Caffeine blocks adenosine receptors, competitively antagonizing their action [73, 74] and causing an increased release of dopamine, noradrenalin, and glutamate [75, 76]. Caffeine is able to reduce myocardial [77] and cerebral blood flow [78] by hindering A1, A2A and A2B adenosine receptors and restricting adenosine-mediated vasodilation [79].

The A2A receptors are blocked in the basal ganglia, where the globus pallidus and corpus striatum are crucial for caffeine's stimulatory impact [80]. The results depend significantly on dopaminergic neurotransmission that is intact. A good amount of evidence of the link between dopamine D1 and adenosine A2A exists [81]. A selective A2A receptor can be employed to replicate the impact of low doses of caffeine [80]. The findings show that the link between dopaminergic transmission and interaction of caffeine in higher dosage, finds root in the augmented transmission of the post-synaptic D2 receptor. The blocking effect of caffeine on A2A is in line with a diminished risk of PD when the consumption of caffeine sees an increase [82].

The A2a and A1 are subtypes that are linked to the impact of the substance itself, whereas the A2b and A3 have a small part. A1s have a negative link to adenyl cyclase. A2a share a positive link. A1s are widely spread out through the brain, and are found in abundance in the thalamus, hippocampus, cerebellar and cerebral cortex [83-85].

8.2. Calcium Mobilization

Caffeine can induce intracellular calcium release from the sarcoplasmic reticulum [86] and can also inhibit its reuptake [87] and with these mechanisms, caffeine can raise contractility in submaximal contractions in nonhabitual and habitual caffeine consumers. An excess intracellular calcium concentration is commonly noticed in many injuries found in cardiac cells. Calcium overload elicits diastolic and systolic failure; it is linked to the genesis of arrhythmias [86]. There are some impacts that result from caffeine and may be somewhat mediated by neuromuscular function modulation by calcium concentration.

8.3. Inhibition of Phosphodiesterases

Phosphodiesterases hydrolyze the phosphodiester linkages in molecules, for instance, cAMP (cyclic adenosine monophosphate), blocking breakdown. Caffeine is a nonselective competitive blocker of phosphodiesterases [88]. A vital role is played by cAMP when it comes to adrenaline cascade [89]. It activates kinase A, which is a protein. This results in the several enzymes being phosphorylated, implicated in glucose and lipid metabolism [90]. This requires high dosage, which is not possible in the typical diet that people consume.

9. CAFFEINE AND MOOD

Products that contain this substance have a direct impact on the heart, *i.e.* the cardiovascular system. Chronotropic and inotropic effects create an impact. Use of the substance can lead to dose-dependency and result in augmented energy and arousal. Moreover, locomotor activity may also be stimulated [91]. It would be interesting to see whether the substance can also be harmful to a person's health [92]. When the dose is low, this substance can reduce anxiety and hedonic tone sees improvement. On the other hand, high doses can result in anxiety, jitteriness and nervousness because of a hike in tense arousal. It can help increase concentration and focus by removing distractions [93, 94].

Under conditions of abstinent vs long-term use, there is little evidence to suggest that caffeine can be beneficial for mood or performance [95]. Subjects with extreme fatigue are likely to undergo subjective mood alterations, as compared to subjects that are moderately fatigued or not fatigued at all. [34] The study consists of a double-blind study where 95 participants were included. These were young adults in good health. They were randomly placed into three categories, as per dosage, *i.e.* 0, 200 and 400 mg. The substance was administered orally and resulted in a negligible impact on learning, cognition and performance of memory. However, difficult mathematic tasks that were handed out to the subjects were better performed, and the subjects also reported being less bored and less relaxed.

10. CAFFEINE AND VIGILANCE

There are occupations that rely on maintaining optimal physical and cognitive ability over long stretches of time. This includes military personnel, amongst others. Coffee or caffeine maybe consumed on days where they have experienced inadequate sleep but need to maintain their performance [96-100].

10.1. Caffeine and Military Operation

Soldiers are employed to perform many tasks, some of which may be prolonged through periods where they have acquired little to no sleep. This can lead to diminished cognitive ability [98, 101]. Lieberman *et al.* caffeine can help maintain said ability [99]. During military training, where sleep was restricted for over three days, and the soldiers were handed mental and physical challenges, a dose of 200 to 300 milligrams proved helpful. It enhanced reaction time, vigilance, mood and attention. The speed of acquiring the target during a test of marksmanship was also augmented, as compared to other subjects that were on a placebo [99, 102].

Many other studies show that a dose of 600 mg consumed through the night, where sleep was not possible, helped maintain vigilance during observational and simulated tasks [103, 104] The substance helped restore or improve performance as opposed to the rested state [104]. It was furthermore helpful when it came to maintaining or improving marksmanship [103, 105, 106].

Many studies have shown that caffeine is effective in maintaining alertness, restoring or improving physical performance, military personnel's use of energy drinks and shot is debatable. Military duties may be impacted by the consumption of high amounts of caffeine. Overconsumption and its side effects are serious problems for service members

that are required to perform unique roles, and have critical responsibilities [107].

10.2. Caffeine and Children with ADHD

Coffee does not consistently improve performance in young children that suffer from Attention Deficit Hyperactivity Disorder (ADHD). Although it has been reported to mildly augment their performance and reaction time [108]. It is true, in an animal model of ADHD, the Spontaneously Hypertensive Rat (SHR), pre-training administration of caffeine attenuated the spatial learning deficit [109] and improved performance in an object-recognition task [110]. There are little transcendental studies available on the effects of caffeine on cognitive abilities in children with ADHD [111-113], nevertheless, the use of caffeine in ADHD clinical practice is discussed [114].

11. CAFFEINE AND ATTENTION

Contemporary studies have shown that even doses as small as 40mg or less can augment alertness in a person, and better performance efficacy when tasks require attention. Past research has administered the substance *via* beverages and capsules. It was interesting to note whether the same impact could be achieved when it was administered as a gum [115].

A number of older studies [63, 116-118] confirm that it improved complex and simple tasks where attention is required. It impacts executive and alerting networks of control. Studies suggest that it has helpful impacts for attention, and they are larger than previously thought [119].

12. CAFFEINE AND PARKINSON'S DISEASE

This illness is the world's second most prominent disorder when it comes to neurodegenerative illnesses. Most cases are not a result of genetic predispositions. This means that there is a significant role played by environmental elements. In terms of PD's etiology, a complex mix of environmental and genetic facets is at play. Although there is a serious need for more research, existing studies suggest that some dietary elements can impact PD risk. Such a factor often studied in relation to PD is caffeine. Caffeine consumption has been associated with a reduced risk of PD. Palacios *et al.* found that caffeine could reduce the risk of PD, after adjusting for smoking, alcohol and age [120]. Decaffeinated coffee was not linked to the risk factor in any way. The study results are consistent with the idea that the substance has a protective impact in terms of PD.

Intake reduces PD risk more so in persons with higher susceptibility because of their genetic predisposition, as opposed to individuals with a lower susceptibility [121]. A recent GWAIS isolated the GRIN2A gene. This encodes a receptor subunit of NMDA-glutamate, engaged in the brain's excitatory neurotransmission, as a PD genetic modifier in inverse association with caffeine intake. This study highlighted additional results that confirm that coffee or caffeine has protective capabilities against PD [122].

MAO-B inhibitors are developed during PD treatment and block MAO-B-catalysed metabolism of dopamine in the brain. However, recent pharmacological remedies for PD are not adequate. Recently enhanced therapeutic agents are needed. Adenosine A2A receptor blockers are fairly new when it comes to anti-Parkinson agents. They work by potentiating dopamine-mediated neurotransmission via dopamine D2 receptors. Caffeine could be significant as the main compound for the discovery and design A2A inhibitors and MAO-B blockers. Compounds that limit the functionality of both MAO-B and A2A have a synergistic impact when it comes to treating patients that suffer from PD [123].

The current view on the emergence and prevention is that augmented risk of the illness has been linked to being exposed to pesticides, ingesting dairy, brain injury trauma, and melanoma history. A reduced risk has been found when it comes to caffeine consumption, smoking, physical activity, and use of common medicines such as ibuprofen [124].

13. CAFFEINE AND ALZHEIMER'S DISEASE

Alzheimer is the most prominent and prevalent reason behind dementia, and devastating chronic disease without adequate treatment [125]. Globally, around 24 million people suffer from dementia, and this amount is slated to multiply four times by 2050. Within the United States, AD frequently causes dementia [126]. By the year 2050, around 13 million people in the country will be living with AD. The cost of care for said people will hit $1.2 trillion [127]. The AD brain's main neuropathological hallmarks are neuritic and diffuse extracellular amyloid plaques and intracellular neurofibrillary tangles [128]. It remains unclear what etiological mechanisms are behind these changes. However, they are most likely caused by both genetic and environmental elements.

There have been no conclusive protections found against AD and similar illnesses. A multitude of research suggests that some methods, including coffee consumption, may help reduce cognitive aging. While the use of this substance in the short-term has been seen to enhance cognition and memory, some studies suggest that it may slow down cognitive decline and protect against dementia [129].

The probable neuroprotective mechanisms of caffeine's actions have been found in animal models, both *in vitro* and pre-clinical [130-132], though epidemiology has produced mixed results [133, 134]. Some studies suggest a certain protective effect [129] while others do not provide convincing results. The findings of the published studies are somewhat inconsistent, but most studies support coffee's favourable effects against cognitive decline, dementia or AD [135].

CONCLUSION

The effects of coffee on the human body have been recognized through centuries and have now become the subject of systematic research [136]. In current times, caffeine has become the most widely consumed psychostimulant in the world, with coffee being its main form. Most individuals are motivated to drink coffee to enhance memory and concentration and at times, the

physical performance. This substance has a direct impact on the cardiovascular system because of its chronotropic and inotropic impacts. It also influences the CNS because of its anxiogenic impacts, and as a stimulant of locomotor activity. These are the reasons that we need to examine whether its influence could prove harmful to a person's health. Moreover, the abuse of this substance is becoming increasingly common. This can lead to unnatural or premature death because higher consumption can lead to intoxication.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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