

## Effects of Caffeine on Human Health

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### Abstract

Caffeine is one of the most broadly consumed psychoactive material all over the world[1]. Historically, tea and soda are the most oldest beverages including caffeine. Recently, variation of food production, which comprise caffeine, has increased such as energy drinks, specialist coffee, potato chips, gum and candy bar[8]. Therefore, the consumption of caffeine-containing drinks has raised remarkably throughout the world. Indeed, in recent years, the consumption of caffeine is higher than any other drug. Nearly 80% of the world's population consumes caffeine-containing products ever day, with tea (12%), soft drink (16%) and coffee (%71) being the most widely consumed[8,9]. There is an significant increase in caffeine consumption through last century with developing technology and innovative evolution in food industry. Actually, the rising demanding of the caffeine containing productions has brought along with its likley effects on human health. The present study reviewed the effects of caffeine consumption on human healthy in terms of cardiovascular system, anxiety, memory, sleep, depression and agression.

**Keywords:** Caffeine, Human Health, Nutrition

## Kafeinin İnsan Sağlığı Üzerindeki Etkileri

### Öz

Kafein, tüm dünyada en çok tüketilen psikoaktif maddelerden biridir. Tarihsel olarak çay ve soda kafein içeren en eski içeceklerdir. Son zamanlarda, enerji içecekleri, özel kahve, patates cipsi, sakız ve şekerler gibi kafein içeren gıda üretiminin çeşitliliğinde önemli artışlar olmuştur. Bu nedenle, kafein içeren içeceklerin tüketimi dünyada çapında önemli düzeylere ulaşmıştır. Son yıllarda kafeinin tüketimi, ilaçlarla karşılaştırıldığında daha yüksek oranlara sahiptir. Dünya nüfusunun yaklaşık % 80'i hergün kafein içeren içecekler tüketmektedir. Dünya çapında, kahve (%71) en çok tüketilen kafein içerikli içecek olmasıyla birlikte, alkolsüz içecekler (%16) ve çay (%12) bunu takip etmektedir. Gelişen teknoloji ve yeniliklerle birlikte gıda endüstrisinde kafein tüketimi arasında önemli bir artış vardır. Bu çalışmada kafein tüketiminin, kardiyovasküler sistem, anksiyete, hafıza, uyku, depresyon ve agresyon açısından insan sağlığı üzerindeki etkileri incelenmiştir. Kafeinin içeren içeceklere artan talebin, genel olarak insan sağlığı üzerine olumlu etkileri olduğu düşünülmektedir.

**Anahtar Kelimeler:** Kafein, İnsan Sağlığı, Beslenme

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## 1. Introduction

Caffeine from natural sources has been widely consumed and enjoyed by people all over the world for decades. Caffeine is usually produced by a different kinds of leaves, beans, and also fruit where its bitterness acts like a deterrent to pests[9]. It was discovered in 1820 for the first time from green coffee beans by Runge and Van Giese, after that it was described by Robiquet in 1823 and later by Pelletier as a crystalline and volatile substance. In 1827, caffeine was isolated from tea leaves which he called theine[2]. Coffee and tea are the most popular caffeine-containing drinks. Caffeine can be found black tea, coffee and chocolate because it is produced naturally in the leaves and beans of the plants consumed to manufacture these productions[8,15]. Furthermore, caffeine is used as an additive in many other productions, such as dietary supplements, energy drinks, soda and certain medication (headache treatments and painkillers) [8]. The rate of caffeine in these products can be change generally because of the strength of the preparation, as in the case of coffee and tea or the quantity that is added exogenously, like energy drinks and soda. The study examined that nearly 90% of adults consume caffeine regularly in addition to this, average daily intaking caffeine approximately 227 mg[12]. Another study showed that Americans drinks daily more than 400 million cups of coffee which is the main sources of caffeine for adults diet, compare to tea and caffeine involving soft drinks in adolescents and children[27]. There is an increasing trends, 'energy' drinks and cola account very little for consuming of caffeine worldwide for instance, less than 5% of the caffeine consumed by adults in the UK[21], while consumption of cola is comparatively higher among children in the USA[12]. Moreover, Europe where coffee and tea are the predominant sources of caffeine just as for the another countries, has the highest consumption of caffeine per capita[13].

According to research which has been carried out in Bristol in the UK, caffeine intakes were higher in men than woman and goes up to age 65 years, decreasing somewhat thereafter[21]. It was examined that the relationship between caffeine intaking and body weight related with ages, adults consume nearly 1,3 mg/kg, 12-17 ages consume 0.55mg/kg and children ages 2-11 consume 0,4 mg/kg[12]. Therefore, children consume caffeine approximately one half the concentration of caffeine compared with adults. These are a crucial statistics. Small effects of caffeine consumption on the healthy and wellbeing of individual caffeine consumers could result large effects at a population level. It is difficult that doing accurate research amount of individuals' daily caffeine intake because caffeine-containing drinks involve different kinds of material. On the other hand, there are a small number method related with brewing time and amount of tea or coffee used but data are readily available on average caffeine context that can be applied to consumption by regional or national populations.

## 2. Caffeine Concentration in Food

The concentration of caffeine can be changed among different kinds of food productions, with coffee having in the highest concentration compare to tea, energy drinks, soft drinks, solid foods and shot drinks. An important difference in caffeine concentration appears within a beverage impact on the central nervous system and taurine due to its physiological function of promoted endurance performance in addition to this, to purpose in the reduction of lactic acid build up after exercises[19]. Chocolate and other

cocoa containing foods, snacks and sweets promote small quantity of caffeine to the diet. Table 1 summarise selected productions that are existing in the market, their caffeine concentrations as well.

**Table1.** Caffeine content of selected beverages and foods

Product	Serving size (fl.oz)	Caffeine in one serving(mg)
<b>Coffee</b>		
Regular drip or percolated	8	95-330
Brewed or percolated, decaffeinated	8	3-12
Instant, prepared from powder	8	30-70
Espresso	1	50-150
<b>Tea</b>		
Black, regular, brewed or tea bag	8	40-74
Black, decaffeinated	8	2-5
Green, brewed or tea bag	8	25-50
Oolong, brewed or tea bag	8	21-64
White, brewed or tea bag	8	15
Instant, prepared from powder	8	33-64
Yerba mate, brewed or tea bag	8	65-130
Iced tea	12	27-42
<b>Beverages</b>		
Carbonated beverages with caffeine added	12	22-69
Alcoholic beverages with caffeine added	1	3-9
Energy drinks with caffeine added	8,2-23,5	33-400
Caffeinated waters	16,9-20,0	42-125
<b>Foods</b>		
Chocolates	8 oz	0-6
Sweets	Various	1-122
Snacks, from Us Department of Agriculture database	1 oz or 1 bar	3-41
Snacks, gums and mints	Various	20-400
Fast foods	Various	1-49

\* Adapted from de Mejia, Elvira Gonzalez, and Marco Vinicio Ramirez-Mares. "Impact of caffeine and coffee on our health." Trends in Endocrinology & Metabolism 25.10 (2014): 489-492.

### 3. Caffeine and Cardiovascular System

Lipids involve a kinds of organic compounds such as fatty acids, waxes, steroids, and phospholipids that are stored in the body and used as energy reserves. In addition, lipids comprise cholesterol, and elevated serum cholesterol levels are strongly correlated with heart strokes, attack and early death. The impact of caffeine containing drinks especially coffee on cardiovascular health is a continuously controversy issue. Caffeine affects adversely the cardiovascular system in terms of blood pressure-serum cholesterol, plasma homocysteine and heartbeat for everybody but some people are affected more seriously than others because of developing tolerance to caffeine. As the tolerance to the cardiovascular effects of caffeine develops, the impact initially observed quickly declines or even disappears. There are several studies with coffee and cholesterol from. One of them is related with filtered coffee and unfiltered coffee and their impact on cholesterol. According to study, when people consume

filtered coffee, their cholesterol levels increase much more compare with drinking unfiltered coffee but the most important point is that caffeine does not increase the cholesterol levels, lipids lead to rise the cholesterol levels. Moreover, the impacts of coffee on hyperglycemia, blood pressure and epinephrine concentrations all appear to be weaker than impacts of the same quantity of caffeine used in isolation[30]. The detrimental cardiovascular impacts of caffeine may be offset by the positive impacts of other compounds in coffee on the biological pathways included in the development of coronary heart disease[4]. In addition, the one type of risk that has not been extensively considered is the long-term cardiovascular effects of occasional coffee drinking in people without a tolerance. Most researchers think that some strong, naturally occurring ingredient of coffee is responsible for cholesterol levels and caffeine is no way implicated. The existing evidence on type 2 diabetes and cardiovascular impacts related with habitual coffee consumption is mainly reassuring. It can be said that people could be safer drinking coffee everyday compare with drinking once or twice a week. There is no certain evidence which the level of the caffeine consumption affects heart attacks or coronary heart disease.

#### **4. Caffeine and Anxiety**

Anxiety involving such symptoms as apprehension, unwarranted trepidation, turmoil, agitation, and uneasiness, is the one of the most common psychological disorder in all over the world. In some cases, it erupt into recurring panic attacks, the symptoms of which increased jitters, perspiration, heart rate, palpitations and rapid breathing. Researchers generally recognize that caffeine is an anxiogenic substance that is productive of anxiety. The pharmacological foundation of this effect remains indeterminate. One contributive mechanism is the process by which caffeine binds to adenosine receptors (primarily A1 and A2a), so prevent the impacts of adenosine and enhances neuronal activity[5,9], because adenosine is a restrictor neuromodulator that causes depression and drowsiness of neurons when it binds to its receptors[10]. Another approach is that caffeine interrupts with the noradrenergic system as a result, it cause to increase the release of adrenaline[18]. Adrenaline, the hormone the adrenal glands excrete in response to excitement, fear, or stress, produces a more rapid and stronger heartbeat and more rapid and deeper breathing and it can also produce anxiety. Some claim that caffeine in combination with emotional distress causes the release of more adrenaline than emotional distress alone, suggesting that even if it can not cause anxiety, caffeine may exacerbate it[15-19,23,29,34,36,37]. In 1971 R. Lynn, a leading British researcher, managed a massive study of personal traits and practices and psychological and physical disorders, involving cigarette smoking, coronary heart disease, psychiatric disorders, suicide, and anxiety. The study shows that people suffer from different levels of anxiety in term of nations. Lynn claim that in those countries in which anxiety levels were high, people would tend to consume less caffeine in order to avoid exacerbating their problems with it[35]. His theory was confirmed by the data. In those where caffeine consumption is high, anxiety is lower, and in those in which it is low, anxiety is relatively higher[35]. As a result, patients who have panic disorder, consume lower consumption and that panic attacks can be caused even in normal person challenged with high dose of caffeine[35].

## 5. Caffeine and Memory

In recent years, the studying of caffeine's effects on complex mental activities such as learning and reasoning has been continued by researchers who pay increasing attention to its effects on short-term memory. According to research, it is example of a more demanding sort of memory task is a test which is involve long word list of reading or listening. First of all, the long word list was given to participants and then they were listened after that researcher asked them to remember word as many as possible. As a result, researcher realize that no effect caffeine or perhaps even a small impairment. Regrettably, there is much indefiniteness in the data regarding with these effects. These results tend to supprt those of Amendola who found that caffeine in doses of 256, 128, 64 mg resulted in a dose dependent development in vigilance and mood, however, there was not a significant impacts on subject's memory of words presented in a set word list[1]. In addition, another study conducted by Terry and Phifer on non sleep deprived college students found that 100 mg of caffeine indeed led to poorer recall of words, especially Word appearing in the middle or end of the memorized list but this study was not strictly controlled[36]. On the other hand, another research which was conducted by V. E. Mitchell and his colleagues in 1974 shows that caffeine can improve performans of paticipants but there is a crucial point that when they were said that they had intaked the drug[31]. Moreover, long-term memory researching is so limited but there is a some researching about it. For instance, Menachem Segal, professor of neurosciences at the Weizmann Institue in Rebovot, Israel, and an expert on neuromodulatırs in the brain, suggest that caffeine led to changes to brain cells that are likely to have profoundly beneficial effects on long-term memory[33]. In earlier research, Segal found that increasing the amount of calcium absorbed by brain cells is on way of improving lon-term memory. The outcome of his studying confirmed this conjecture, proving that caffeine intake causes the calcium levels in brain cells. But Segal also observed a more astonishing phenomenon "Caffeine caused existing dendritic spines, the branching extensions at the ends of nerve cells that allow them to make synaptic connections with each other, to grow longer and even caused new spines and branches to develop as well"[33]. Although no direct experimental data are available on the actual effects, if any, of caffeine on long-term memory, neuroscienicists have long believed that an improvement in "writing" does in fact improve both long-term memory and learning[42]. Future study of impacts of caffeine on memory processing is necessary to revolve these issues.

## 6. Caffeine and Sleep

It is generally accpeted that coffee interfere a good night's sleep. As it is known that caffeine-containing drinks have been widely consumed, people realized that caffeine contaning drinks can aid to stay awake and they can also impact on the quality of night's sleep. The most common distruption related with caffeine is insomia, on the other hand there is, strongly enough, make a fuss sleep called 'hypersomnia,' or too much sleep, also sometimes consequent to its use. It is widely accepted that sleep is distrupted by caffeine among researchers. It is fact that according to P. B. Dews who is a leading caffeine researcher, the distruption of night's sleep is much more obvious than caffeine's daytime effects[12]. Although, there are a variation of sleep that people need, ranging from as few as three to as many as twelve hours, with an avearge of seven to nine, certain general observation are possible. Sleep is divided

into dreamless sleep and the sleep during which we dream. REM is acronym for "rapid eye movement" and mean that dreaming sleep because of following an action by people during the sleep, so to speak, by shifting our "gaze" back and forth. Non-REM sleep generally lasts approximately an hour or more and then shifts to REM sleep for approximately thirty minutes, in a model called the "ultradian rhythm" that is repeated four to six times during the night. Some research shows that taking intense doses of caffeine in the evening retard falling so it causes poorer sleep quality. For instance, according to a Japanese study, after drinking a strong cup of coffee, the falling sleep takes four times longer compared with normal. In addition, caffeine can do more than interrupt falling sleep such as cause change in the onset of REM sleep, impact on non-REM sleep, and total time of sleep. People who are heavy caffeine drinkers toss and turn in bed as caffeine causes not only restlessness but also muscle tension. Furthermore, movements can lead to staying awake [22]. Moreover, people who intake caffeine before they go to bed are more easily awakened by noises. According to brain-wave study, sleep is disturbed by caffeine throughout the first three or four hours [11]. Despite the fact that caffeine causes interference with nighttime sleep, some people claim that they are able to sleep very well after taking a high dose of caffeine instantly. However, some people are not capable of sleeping well after drinking caffeine-containing drinks but in fact they sleep too much, experiencing a condition of pathologic sleepiness called "hypersomnia" because of taking caffeine. As "pathologic Sleepiness Induced by Caffeine," a paper broadcasted by Quentin R. Regestein in 1989 in the American Journal of Medicine, states: "The aforementioned patients had severe sleepiness that decreased or remitted after they discontinued caffeine. In some individuals, therefore, heavy use of caffeine apparently provokes sleepiness. This is difficult to explain since caffeine is a stimulant... The unusual magnitude of the sleepiness and the rarity of this apparent association between caffeine and excessive sleepiness, even in sleep clinic patients, suggest an idiosyncratic phenomenon [31]. Thus, the studies based on objective criteria show that caffeine intake near bedtime reduces deep sleep, increases tossing and turning and light sleep. On the other hand it has no impact on REM sleep. It increases the time it takes to fall asleep up to threefold, decreases total sleep time by approximately two hours, and increases spontaneous awakenings.

## 7. Caffeine, Depression and Aggression

Just as it is hypothesized that when people adapt to intake caffeine, it reduces to avoid anxiolytic effects it is also claimed that people who are depressive increase their consumption in order to multiply the benefit from caffeine's euphoric and stimulating powers [6]. In other words, they effectively self-medicate with caffeine to deal with the dark clouds of lassitude, lethargy, and despair that hover around them. However, the studies are indecisive. The Thrombo Heart study which is another example of undetermination, carried on in 1983, the study shows that there is a remarkable correlation between high coffee consumption and depression among 150,000 women [36]. On the other hand, this correlation vanishes because the results are adjusted for cigarette smoking so it is difficult to draw any results.

A number of studies have found that when people drink at least two portions of caffeinated beverages per a day, they can improve moods, more self-confidence, energy, and a better social position. Another two large-scale studies show that people who drink coffee are less likely to commit suicide than coffee abstainers, extremely suggesting that caffeine can remarkably mitigate long-term depression. However, according to Roache and Griffiths, in which subjects consumed between 200 and 600 mg of

caffeine, produced small increases in sources on the Profile of Mood States Questionnaire(POMS) for hostility and anger, while also demonstrating an increase in friendliness[32].

## 8. Conclusion and Future Trends

It can be said that moderate consumption of caffeine pose no adverse effects on human health. The authors of a detailed review of the published literature concluded that the routine daily consumption of up to 1000 mg of caffeine posed no health risk[3]. The exact quantity of caffeine essential to produce a detrimental impact varies from person to person, depending on their weight and sensitivity to caffeine[12]. To sum up, consumption of the caffeine has increased significantly during last century due to the use of the technology and innovative evolution in manufacturing of food sector. Indeed, the increasing demand of the caffeine-related products has brought along with its possible impacts on human body. As discussed above, caffeine might have both beneficial and harmful impacts on people's health. Recent studies show that it has not scientifically proven yet that whether caffeine harmfully effects human health. Scientific evidence demonstrates that caffeine intake may cause various effects in terms of level of caffeine-tolerant of people. It may be asserted that consumption of caffeine-related food products should be well-balanced in order to keep healthy.

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