

## Caffeine: beneficial or adverse for health?

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**Abstract:** Caffeine is probably the most widely used drug, a xanthine alkaloid compound. The use of caffeine is too excessive these days, making it the world's most popular substance. The utilization of caffeine is mostly in various beverages such as tea, coffee, cola-flavored carbonated beverages and in chocolate products. Caffeine is also added to a variety of other carbonated beverages and is an ingredient in a number of non-prescription drugs such as headache, cold, allergy, pain relief, and stay-awake pills. Although Caffeine is a useful compound but its erroneous use makes it harmful. Here in this research article, a brief discussion is given regarding its adverse and beneficial effects on human health.

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### INTRODUCTION

Caffeine is probably the most frequently ingested, pharmacologically active, mood altering and psychoactive substance in the world. Chemically, it is an alkaloid belonging to family, methylxanthine. Its chemical and systematic name is 1, 3, 7 trimethyl xanthine. In pure state it is an intensely bitter, white, fleecy, glistening needles or powder. It is the most important Purine base having stimulating and vitalizing effect which varies from person to person depending upon the factors such as age, time of day and weight<sup>1,2</sup>.

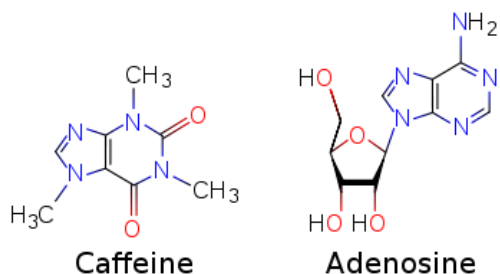
#### Sources

Caffeine is present in tea leaves (camellia sinensis) in amount of 3 - 5 % (3, 4) in guarana seeds (Paulinia cupana-Kunt) in amount of 3-5% that sometimes can exceed 6 %. Similarly the seeds of cola plants, mainly nitida and acuminate species have caffeine content of 1.5-2.5 and 0.8-1.3 %, respectively. Many other artificial sources of caffeine are black tea, green tea, white tea, tisanes (i.e. herbal teas). In herbal teas caffeine content depends on the herb, e.g. chamo have no caffeine while yerba mate and guarana contain varying quantities. Energy drinks, soft drinks, pill (caffeine) buck fast tonic wine, jolt gum, bawls etc. are also main sources of caffeine. It plays an integral role in the flavor profile of cola soft drinks and consequently it is added as an ingredient to approximately 70% of soft drinks in the USA. Caffeine constitutes a substantial portion of many over-the-counter medications, such as cold tablets, allergy or analgesic preparation, appetite suppressants, diuretics, and stimulants<sup>5-8</sup>.

#### Mechanism of action

Several mechanisms have been proposed to explain the physiological effects of caffeine. Physiological effects of caffeine can be seen in adults at doses of only 100-200 mg. Caffeine is

primarily an antagonist of the central nervous system's receptors for the neurotransmitter adenosine, the bodies of individuals that regularly consume caffeine adapt to the continuous presence of the drug by substantially increasing the number of adenosine receptors in the central nervous system<sup>9-11</sup>. First, the stimulatory effects of caffeine are substantially reduced, a phenomenon known as a tolerance adaptation. Second, because these adaptive responses to caffeine make individuals much more sensitive to adenosine, a reduction in caffeine intake will effectively increase the normal physiological effects of adenosine, resulting in unwelcome withdrawal symptoms in tolerant users<sup>12,13</sup>. Caffeine's principal mode of action is as an antagonist of adenosine receptors in the brain<sup>14</sup>.



#### Beneficial effects of caffeine

Beneficial aspects of caffeine were observed in both withdrawn consumers and in non-consumers. A number of recent studies have suggested that caffeine only improves mood and cognitive performance, endurance during prolonged, exhaustive exercise in regular caffeine consumers<sup>15,16</sup>. It is the most intensively studied food constituent, has unequivocal beneficial effects on<sup>17,18</sup> sustained vigilance and in sleep deprived individuals. It is also useful for competitive and recreational athletes who perform resistance training<sup>19</sup>. Athletic

performance has also been shown to improve significantly with consumption of moderate and high concentrations of caffeine. The studies showed that consumption of six and eight cups of caffeinated coffee resulted in increased muscle endurance during brief, intense exercise, and improved performance in timed trials, respectively. It has been found that addition of caffeine to aspirin has significant beneficial consequences with respect to mood and performance<sup>18</sup>. It also associated with increased subjective alertness, improved reaction time for both visual and auditory stimuli and improved performance of manual task such as driving and encoding of new information<sup>20</sup>. It has been concluded by many experiments that behavioral changes due to caffeine are merely the reversal of negative effects of long period of caffeine abstinence. Similarly caffeine containing beverages are also popular due to their effects of decreasing fatigue, increasing mental activity and improving cognitive functioning, an improvement in exercise performance in sub maximal endurance activities, following the intake of moderate doses. Because of its potential use as an ergogenic aid its use in sports is regulated by most sanctioning bodies<sup>21,22</sup>. It has been found that men who regularly consume caffeinated drinks have a lower risk of PD (Perkin's Disease) than non-drinkers. It may protect against PD by blocking adenosine receptors increasing the amount of dopamine in the brain. Further more high amount of caffeine are also used by athletes to increase temporary strength and stamina, therefore many students find caffeine useful for keeping them alert and paying attention in class, while the business world finds caffeine more suitable for a morning and afternoon jolt<sup>23</sup>. It also increases the level of circulating fatty acids, enhances fat oxidation and has been used for many years by runners and endurance people to enhance fatty acid metabolism<sup>24</sup>. In the same way according to a team of researchers for the University Of Minnesota School of Public Health has been reported that postmenopausal women who consumed six cups of coffee or more each day lowered their chance of 2 diabetes by 22 % and also observed that the risk of diabetes continued to drop as regular consumption increased<sup>25</sup>.

#### **Adverse effects of caffeine**

On the other hand it has been found from many literatures that caffeine withdrawal cannot kill people but it can be very painful. Cessation of regular consumption may cause dependence and abrupt discontinuation produces irritability, drowsiness, fatigue and Lethargy<sup>26</sup>.

Moderate daily caffeine intake at doses up to 400mg/day was associated with adverse effects, such as general toxicity, cardiovascular effects, effects on bone and calcium balance, change in adult behavior, increases the incidence of cancer and effects on male fertility. Actually when caffeine intake is reduced, body becomes oversensitive to adenosine (A naturally occurring xanthine in the brain used as a neurotransmitter at some synapses), in response to this, blood pressure drops dramatically causing an excess of blood in the head, leading to a head ache, body also shows restless, nervousness and feeling sleepy, in extreme cases, nausea and vomiting has been also reported<sup>27</sup>. Studies showed that unfiltered caffeinated and decaffeinated coffee contains lipids which raised serum cholesterol also.

#### **Toxic dose**

Caffeine can be lethal at very high doses i.e. 5-10 grams but in some literature 13-19 grams for oral administration, that varies from individual to individual according to weight. Ingestion of 150 mg/kg of caffeine seems to be the LD-50 for all people (LD-50 refers to amount of caffeine in take for a 50% chance of death). The minimum lethal dose ever reported is 3.2 gm<sup>24</sup>.

#### **Caffeine limit**

The popularity of energy drinks has risen considerably over the past few years, especially for younger adults, and thus there is interest in monitoring levels in beverages such as coffee, tea, soft drinks, energy drinks and insuring intakes do not exceed recommended levels. It is thus imperative for consumers to be knowledgeable about the caffeine content of these beverages. According to the recommendation at the Ministry of public health (MOPH) the upper limit of caffeine in energy drinks must not exceed 50 milligram per bottle.

The limit of caffeine content depends on the country. In United State there is a limit of 6 mg of caffeine per liquid ounce in beverages. Diet pills and stimulants often contain 100 to 200 milligrams caffeine. Diet pills and stimulants often contain 100 to 200 milligrams caffeine, such as Vivrin pill contains 200 mg of caffeine. Pre-teens should not consume high caffeine drinks and it is highly desirable to discourage their use by people in their early teens<sup>27</sup>.

#### **Caffeine intoxication**

Caffeine intoxication usually occurs with consumption above 250 milligrams (equivalent to about 2, ½ cups of coffee). Some signs of caffeine intoxications are the heart racing / palpitation, fatigue that worsens during the day, hyperactivity, an over stimulated mind, facial flushing etc. Some conditions that suggest caffeine intoxication are

diuretic, (causes increased urination as a result of which dehydration occurs). Chronic dehydration may result from long term of caffeine intoxication. Minerals and vitamins are distributed throughout our body and if we consume lot of caffeine, they can not be absorbed properly. Some of the common deficiencies from chronic dehydration include lack of vitamin B12, Iron deficiency, Folic Acid deficiency etc. According to another research the recommended maximum daily intake reported is 450mg caffeine per day only. In UK an average cola drink contains about 7mg of caffeine/100 ml serving, 27mg for 100ml of tea and 40mg for 100ml of instant coffee. Caffeine drinks especially energy drinks are widely consumed among construction workers who believe that it would give them more energy and make them alert. Caffeine in coffee also decreases the quality of sleep and in this way it is one of the leading causes of sleep disturbance. Its excess levels also cause<sup>27</sup> Restless Leg Syndrome (RLS), Allergic rhinitis/Hay fever, Post nasal drip, PVC's (Pre-ventricular contractions), Angina, Anemia (Iron deficiency). Many research showed that drinking coffee causes a significant loss of several vitamins and minerals, including Vitamins B and C, Calcium, Iron, and Zinc. Another kind of coffee known as decaf, which contains significant amounts of vitamin K, which is an important factor for blood coagulation. So people at high risk of blood clots strokes and heart attacks should avoid coffee and decaffe. It also stimulates gastric or peptic ulcers, raises adrenal levels, (as a result of which adrenal glands are no longer able to adequately respond to stress by releasing enough adrenaline), chronic fatigue, fibromyalgia syndrome, cystitis, bacterial bladder infection, panic attacks, Hypoglycemia, increased risk of bladder cancer, increased risk of coronary disease, increased risk of pancreatic cancer, increased risk of ovarian cancer, increased risk of kidney cancer<sup>28</sup>.

Coffee should absolutely be avoided during breast feeding, because fetuses and new born can not metabolize caffeine in their livers, so, it remains in their bodies for up to four days, stimulating their nervous system the entire time, causing irritability and premenstrual syndrome, male infertility (having five cups a day) appears to make sperms sluggish) and Female infertility. Research has indicated that women who drank more than one cup of coffee a day reduced their likelihood of conceiving by 50%. It was also reported that people suffering from insomnia often have an elevated caffeine level compared to normal sleepers. It is commonly believed that caffeine can cause or make tremors worse in those who are sensitive<sup>29</sup>.

According to many experimental evidences it was found that use of caffeine is not a factor to be concerned about in glaucoma management, however, taking a single dose of caffeinated coffee, (but not decaffeinated coffee) can increase intraocular pressure in persons with glaucoma<sup>30,31</sup>.

In an experiment of 882 randomly selected men (65-80 years old), coffee consumption was found to be associated with an increased risk of enlarged prostate<sup>32</sup>.

An increased risk of developing hypertension was also found associated with drinking five or more cups of coffee per day in a large study of former white male medical students followed an average age of 33 years, actually caffeine raises the production of adrenal hormone cortisol, which causes the blood vessels to constrict and the heart to pump harder, which leads to high blood pressure<sup>33</sup>.

#### ***Effect of caffeine on pregnant woman***

Some substances like caffeine and some pesticides easily cross the placenta from women body to her fetus. Human studies have found an increase rate of miscarriage, stillbirths, breech births, delivery of low birth babies, causing a mal-formation in fetus, when given in doses greater than 300mg (an amount equal to three cups of coffee or consuming as little as 100mg of caffeine per day. Pregnant women are also three times slower to metabolize caffeine than non-pregnant women. Therefore, they should consume less than this amount and advised to avoid energy drinks especially during the first trimester (three months) pregnancy and coffee should be completely avoided during pregnancy and breast feeding. Another important fact that the use of large amounts of caffeine by a mother during pregnancy may cause problems with the heart beat of fetus. Caffeine crosses the placenta and enters the fetal circulation and its use at a pharmacological level has been associated with low birth weight. Excessive consumption during lactation may cause irritability and wakefulness in a breast-fed baby<sup>34</sup>. In addition to this it has been recently reported that higher intake may be related to higher levels of homo cysteine. This may in turn contribute to the increased risk of spontaneous abortion in moderate coffee drinkers<sup>35</sup>.

#### ***Effect of caffeine on children***

It has been observed that children are no more sensitive to the effects of caffeine than adults and consume much less caffeine as compare to adults, even in proportion to their minor sizes<sup>36-38</sup>. They metabolize caffeine more quickly than adults. There are little evidences signifying that children, whose nervous systems are still developing, are at risk of negative effects of caffeine. The daily caffeine intake

by children should be limited to 2.5 mg/kg body weight as recommended by Health Canada<sup>39</sup>.

### Levels of caffeine

Different levels of caffeine (40-42) in different things are as given below:

Cup of coffee	90-150 mg
Instant coffee	60-80 mg
White Tea	30-70 mg
Black Tea	50 mg
Green Tea	30 mg
Mate	25-150 mg
Cola	30-45 mg
Chocolate bar	30 mg
Stay-awake pill	100 mg
Vivarin	200 mg
Cold relief tablet	30 mg
Energy drinks	50-160 mg
Soft drinks	30-60 mg
Cocoa beverage	3-32 mg

### Caffeine withdrawal

Regular use of caffeine decreases sensitivity to caffeine. Normally the people who reduce caffeine intake are reported of being irritated, unable to work, fatigue, nervous, restless, and feeling sleepy, flu, as well as having a headache. In extreme cases, nausea and vomiting has also been reported<sup>43-47</sup>. When caffeine intake is reduced, the body becomes oversensitive to adenosine. In response to this oversensitiveness, blood pressure drops dramatically, causing an excess of blood in the head (though not necessarily on the brain), leading to a headache<sup>24,47,48</sup>. This headache, well known among coffee drinkers, usually lasts from one to five days, and can be alleviated with analgesics such as aspirin. It is also alleviated with caffeine intake (in fact several analgesics contain caffeine dosages).

### Is caffeine safe?

From the above study it is debatable that Caffeine is safe when used conscientiously in moderation. If it is used properly it can make people alert, precise and stay up longer periods of time. At the same time Caffeine is an addictive drug and its regular use can lead to dependency with unknown long-term effects.

However, sensitive sub-populations, including pregnant women, children and older individuals, and those with a history of heart disease, may experience effects at lower levels of caffeine and should limit their consumption to three cups of coffee per day, or no more than 300mg/day, to avoid adverse effects<sup>41</sup>. These individuals should consult a physician about caffeine consumption. For the healthy adult population, moderate caffeine consumption of 300mg/day is safe and can even have beneficial

health implications as part of a healthful diet and physically active lifestyle.

## CONCLUSION

From the above discussion it can be anticipated that future research with caffeine will provide further valuable insights into the worlds most widely consumed mood altering drug, as well as insights into drug leaving effects more generally. However successive researches have shown that moderate caffeine consumption poses no risk to health. There are certain emerging areas of science that need to work regarding caffeine and health including improved immune function, control of different diseases and acquiring other benefits from caffeine.

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