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The multifacet impact of coffee on human health

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Abstract
Caffeine, a naturally occurring methylxanthine found in various beverages and used as a pharmacological agent, has significant effects on the human body. Its primary pharmacological effect is stimulating the central nervous system, resulting in increased alertness and agitation. Additionally, caffeine has muscle-relaxing properties, stimulates cardiac muscle, promotes diuresis, and has shown promise in treating certain types of headaches. The precise cellular mechanisms behind caffeine's pharmacological profile are not fully understood, but several actions have been observed, including inhibition of cyclic nucleotide phosphodiesterase's, antagonism of adenosine receptors, and modulation of intracellular calcium handling.
Coffee, a beverage containing caffeine, offers potential cardiovascular protection due to its antioxidant content. Research also suggests that coffee consumption reduces the risk of developing diabetes, a significant risk factor for heart disease. However, it's worth noting that coffee consumption can increase homocysteine levels and potentially have negative effects on the aorta. Coffee contains a diverse array of chemicals, including carbohydrates, lipids, nitrogenous compounds, vitamins, minerals, alkaloids, and phenolic compounds.
Caffeine is the most widely consumed psychoactive drug globally and primarily exerts its biological effects through antagonizing adenosine receptors. Adenosine is an endogenous inhibitory neuromodulator that induces feelings of drowsiness, while caffeine produces stimulatory effects in the central nervous system by suppressing adenosine's actions. Physiologically, caffeine intake acutely elevates blood pressure, increases metabolic rate, and promotes diuresis. By blocking adenosine, caffeine enhances neural activity in the brain, resulting in temporary heightened mental alertness and improved thought processing while reducing drowsiness and fatigue.
Contrary to popular belief, caffeine does not directly increase energy metabolism in the body. In fact, long-term consumption can suppress it, potentially leading to adrenal fatigue. Additionally, caffeine significantly reduces blood flow to the brain by counteracting adenosine, which can cause headaches, dizziness, and diminished fine motor coordination.

Keywords: caffeine, chlorogenic acid, coffee drinking, type 2 diabetes, hypertension

Introduction

Coffee has become an integral part of modern daily life, consumed by individuals worldwide. Caffeine, the primary active substance found in coffee, is one of the most ingested pharmacologically active compounds globally. It can be found not only in coffee but also in tea, soft drinks, cocoa products, chocolate, and medications. Due to its widespread consumption by diverse populations, both the public and the scientific community have shown interest in exploring the potential adverse effects of caffeine on human health.
Coffee is often referred to as a driving force for scientific development due to its alerting effect on the human brain. However, it is important to note that some individuals report experiencing irregular heartbeat or headaches after consuming coffee, indicating variations in coffee intolerance among people.
The aim of this review is to provide a summary of the effects of coffee on human health. To investigate the potential negative impact of caffeine on human health, a comprehensive literature search was conducted, primarily focusing on published human studies. Based on the reviewed data, it can be concluded that moderate daily caffeine intake, up to 400 mg (about half the weight of a small paper clip) per day (equivalent to 6 mg (about half the weight of a grain of table salt) per kg of body weight per day in a 65-kg individual), does not associate with adverse effects such as general toxicity, cardiovascular effects, bone status and calcium balance (with adequate calcium consumption), changes in adult behavior, increased cancer incidence, or effects on male fertility. However, certain subgroups, including reproductive-aged women and children, may be considered "at-risk" and may require specific guidance to moderate their caffeine intake. For reproductive-aged women, it is suggested to consume 300 mg (about the weight of ten grains of rice) or less of caffeine per day (equivalent to 4.6 mg (about half the weight of a grain of table salt) per kg of body weight per day in a 65-kg individual), while children should limit their caffeine intake to 2.5 mg or less per kg of body weight per day.
Coffee holds a significant place in human society, with a history of consumption spanning at least 1200 years. Originating in northeast Africa, coffee spread to the Middle East in the 15th century and eventually reached Europe. Today, coffee ranks as the second most valuable commodity globally, following oil. It has become one of the most widely consumed pharmacologically active beverages, with over half of Americans drinking coffee daily. The average coffee consumption per person in the European Community and the United States is approximately 5.1 kg per year. Coffee is the primary source of caffeine for most adults in

the United States, although the growing popularity of energy drinks may be altering this trend. The caffeine content in coffee can vary significantly based on factors such as the type of beans and the roasting process, but the average 8-ounce cup contains approximately 100 milligrams (about the weight of a business card) of caffeine. Tea, on the other hand, contains about half as much caffeine as coffee, while decaffeinated coffee contains only a small fraction of caffeine compared to its regular counterpart. It is worth noting that the lethal dose of caffeine is approximately 10 grams, equivalent to the caffeine content found in 100 cups of coffee.

Upon ingestion, caffeine is absorbed in the stomach and small intestine and then distributed throughout the body, including the brain. The highest concentration of caffeine in the blood is typically reached within 30 to 45 minutes after consumption, with diminishing amounts circulating around eight to 10 hours later. Metabolism of caffeine occurs primarily in the liver. The rate of caffeine metabolism can be influenced by factors such as tobacco and marijuana use, which accelerate metabolism, and oral contraceptives, which slow it down. Individual variations in genes related to caffeine metabolism also contribute to differences in caffeine sensitivity among individuals. In the brain, caffeine primarily targets adenosine receptors, influencing dopamine activity and areas involved in arousal.

Objective

The objective of this review is to examine the multifaceted impact of coffee consumption on human health, with a focus on the effects of caffeine. The review aims to provide a comprehensive understanding of the pharmacological properties of caffeine, its physiological effects on the human body, and the potential health benefits and risks associated with coffee consumption. By synthesizing the existing literature, the objective is to provide valuable insights into the complex relationship between coffee, caffeine, and human health, aiding individuals, healthcare professionals, and researchers in making informed decisions regarding coffee consumption and its potential impact on overall well-being.

Discussion

The introduction provides an overview of the significant role that coffee and its primary component, caffeine, plays in modern daily life. It highlights the widespread consumption of caffeine and the interest in understanding its potential impact on human health. The following discussion expands on the key points mentioned in the introduction and delves deeper into the various aspects related to coffee consumption and its effects on the human body.

One important aspect to consider is the individual variation in coffee intolerance. While coffee is generally known for its alerting effect on the human brain, some individuals experience irregular heartbeat or headaches after consuming coffee. This suggests that there may be genetic or physiological factors that contribute to variations in caffeine tolerance among people. Further research is needed to understand the mechanisms behind these individual differences and to provide personalized guidance for coffee consumption.

The review also emphasizes the importance of conducting comprehensive literature searches and analyzing published human studies to evaluate the potential adverse effects of caffeine. Based on the reviewed data, it is concluded that moderate daily caffeine intake, up to 400 mg per day, does not lead to general toxicity, cardiovascular effects, negative impact on bone status and calcium balance (given adequate calcium intake), changes in adult behavior, increased cancer incidence, or effects on male fertility. This finding provides reassurance for the healthy adult population who consume caffeine within this moderate range. However, it is crucial to acknowledge that certain subgroups may be more vulnerable to the effects of caffeine. Reproductive-aged women and children are identified as "at-risk" subgroups who may require specific advice regarding caffeine consumption. It is suggested that reproductive-aged women limit their caffeine intake to 300 mg (about the weight of ten grains of rice) or less per day, while children should consume 2.5 mg or less per kg of body weight per day. These recommendations reflect the need for cautious caffeine consumption in individuals who may be more susceptible to its effects due to factors such as pregnancy or developing physiology.

The historical and societal significance of coffee is also discussed, highlighting its long-standing presence in human culture and its status as the second most valuable commodity globally. The high consumption rates of coffee in the United States and the European Community demonstrate its popularity and its role as a primary source of caffeine for many individuals. However, the emergence of energy drinks as an alternative source of caffeine warrants attention and further investigation into their impact on health.

The discussion also addresses the metabolism of caffeine in the body. It explains how caffeine is absorbed in the gastrointestinal tract, distributed throughout the body, and metabolized primarily in the liver. Factors such as tobacco and marijuana use can accelerate caffeine metabolism, while oral contraceptives may slow it down. Individual genetic variations also contribute to differences in caffeine sensitivity. Understanding these factors is crucial for predicting the effects of caffeine in different individuals and populations. Furthermore, the discussion touches on the influence of caffeine on the brain. Caffeine primarily acts on adenosine receptors, which affects dopamine activity and areas of the brain involved in arousal, pleasure, and thinking. This interaction may explain caffeine's alerting effect on the brain and its potential protective effects in certain brain conditions, such as Parkinson's disease. However, it is important to note that caffeine can have both positive and negative effects on the body. While it can enhance performance and muscle contraction, it can also raise blood pressure, stiffen arteries, and increase levels of substances such as homocysteine, insulin, and possibly cholesterol. Habitual use of caffeine may lead to a reduction in some of these effects, but further research is needed to fully understand the long-term impact of caffeine consumption on various health outcomes.

Summary & conclusion

The discussion provides a comprehensive overview of the multifaceted impact of coffee consumption and caffeine intake on human health. It emphasizes the widespread use of caffeine and the interest in understanding its potential adverse effects. The review of available data suggests that moderate daily caffeine intake, up to 400 mg for healthy adults, is generally not associated with adverse effects such as general toxicity, cardiovascular issues, bone status and calcium balance disturbances, behavioral changes, increased cancer incidence, or effects on male fertility. However, caution is advised for certain subgroups, including reproductive-aged women and children, who may require

specific guidance to moderate their caffeine intake. Reproductive-aged women are recommended to limit their caffeine consumption to 300 mg or less per day, while children should consume 2.5 mg or less per kg of body weight per day.

The discussion also highlights the historical and societal significance of coffee, its popularity as a widely consumed beverage, and its role as a primary source of caffeine for many individuals. It emphasizes the need for further research to explore the impact of emerging alternative caffeine sources, such as energy drinks, on human health.

Furthermore, the metabolism of caffeine in the body, the influence of caffeine on the brain through adenosine receptors, and the potential positive and negative effects of caffeine on various physiological parameters are discussed. The individual variations in caffeine tolerance, influenced by factors such as genetics, tobacco and marijuana use, and oral contraceptives, are also acknowledged.

In conclusion, coffee and its primary active component, caffeine, have become integral parts of modern daily life. The reviewed data suggest that moderate caffeine consumption, up to 400 mg per day, is generally safe for healthy adults, with no significant adverse effects reported. However, caution should be exercised for vulnerable subgroups, such as reproductive-aged women and children, who may require specific recommendations to limit their caffeine intake.

It is essential for individuals to be aware of their own caffeine tolerance and to make informed choices regarding their consumption. Further research is needed to explore the long-term effects of caffeine on various health outcomes and to gain a better understanding of individual variations in caffeine sensitivity.

In conclusion, the discussion highlights the complex nature of coffee consumption and the effects of caffeine on human health. While moderate caffeine intake in healthy adults is generally considered safe, caution is advised for specific subgroups such as reproductive-aged women and children. The individual variability in caffeine tolerance.

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