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Caffeine Revisited – Does it just wake you up?

What is caffeine?

Caffeine is a purine alkaloid and is known chemically as trimethylxanthine (also known as caffeine, theine, mateine, guaranine or methyltheobromine) [1]. Caffeine is a naturally occurring substance found in more than 60 plants [2]. These include coffee and cocoa beans, kola nuts and tea leaves, which are used to make many favourite beverages such as coffee, tea, cola drinks, and foods such as chocolate. Caffeine is extracted from plants and manufactured synthetically for use as a flavour in some food products [2,3]. Caffeine is one of the most studied ingredients in the food supply [4]. A lot is known about caffeine and it has been consumed safely for centuries. Caffeine exists in our diet from a variety of sources primarily coffee, tea, chocolate, cola drinks, and in both prescription and non-prescription drugs. Caffeine may be added to certain medications, such as acetaminophen and acetyl salic acid to increase their effectiveness [5]. If caffeine is listed as a medicinal ingredient in medications it must comply with the specifications of Schedule B pharmacopoeial or equivalent standard [6]. The amount of caffeine per dose must be listed. If caffeine is added to a food product or beverage as an ingredient, it must be included on the ingredient list but the quantity does not have to be disclosed. [6].

How much caffeine is considered 'safe?'

Moderation is the key. Most experts and Health Canada suggests a limit of up to 400-450 mg/day for the average adult without any adverse effects [7]. Age and body size can make a difference in caffeine's effect. While most adults can tolerate this dose, women of childbearing age and children age 4-12 years are advised to consume even less [7]. Health Canada recommends that pregnant and breast-feeding women not exceed caffeine intakes of 300 mg/day [7]. Caffeine will be transferred to breast milk and maternal intakes greater than 300 mg/day have been reported with moderate irritability and poor sleeping patterns in infants [8,9]. Recommended maximum intakes for children are 45 mg/day for ages 4-6 years, 52.5 mg/day for ages 7-9 years, and 85 mg/day for ages 10-12 [7]. Studies have shown that there is individual variation in a person's response to caffeine and some sensitive individuals experience side effects such as insomnia, headaches, irritability and nervousness[7].

How much caffeine are we consuming?

Estimating the caffeine consumption of individuals can be difficult considering that the caffeine content of various food items can vary greatly making true estimates of intake inconsistent and difficult. In Canada, the four most significant dietary sources of caffeine are regular coffee, instant coffee, regular tea, and cola soft drinks [2,10]. Caffeine is also found in Guarana, a plant native to South America, which can now be found in many foods such as energy drinks [11]. The Food and Agriculture Organization estimated caffeine intakes of Canadians to be 210-238 mg/day [10]. The caffeine content of various foods can be found at the Canadian Nutrient File 2005 http://www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/index_e.html [12].

What are caffeine's effects on the body?

Although caffeine has received most of the scientific scrutiny, coffee, tea and chocolate, are complex mixtures of many compounds, including carbohydrates, lipids, amino acids, vitamins, minerals, alkaloids, diterpenes and phenolic compounds [13]. Making the distinction between caffeine containing products and pure caffeine is paramount when reviewing the literature.

Caffeine as a diuretic

Although caffeine is commonly assumed to be a diuretic, the literature does not support this. Until there is evidence to support the impact of caffeine on cumulative water deficits in individuals with habitual intakes of significant amounts of caffeine, caffeinated beverages seem to contribute to the total daily water intake in a manner similar to noncaffeinated beverages [14].

Caffeine as a stimulant

Caffeine is a drug documented to enhance alertness [1,13]. Caffeine stimulates the central nervous system, increases heart rate and respiration, transiently increases blood pressure, and has psychotropic (mood altering) properties [1,2,3,4,7]. Caffeine blocks the action of adenosine in the brain and increases nerve cell activity which leads to the release of epinephrine (adrenaline). Adrenaline is known as the 'fight or flight' hormone, and its effects include dilated pupils, increased liver glucose output, increased

heart rate, increased blood pressure increased blood flow to the muscles, and decreased blood flow to the skin and organs [1,2]. Caffeine also increases secretion of dopamine which is the neurotransmitter associated with the sensation of pleasure [1]. It is the caffeine-dopamine connection that is thought to contribute to caffeine's addictive properties. Caffeine has a metabolic half life of 4-6 hours and therefore could remain biologically active until completely eliminated [2]. With regular consumption, tolerance to many of the effects of caffeine develops and sudden cessation of caffeine consumption may result in caffeine withdrawal symptoms such as headache, fatigue, irritability and depressed mood [15].

Caffeine and diabetes

Epidemiological evidence suggests that higher habitual coffee consumption may reduce the risk of type 2 diabetes [16-24]. The two largest prospective cohort studies to examine the relationship between coffee consumption and type 2 diabetes were the Health Professionals Follow-up Study (41,934 men) and the Nurses' Health Study (84,276 women) in the US [17,18]. Men and women who drank at least 6 cups of coffee daily had a risk of developing type 2 diabetes that was 54% and 26%, respectively, lower than those who did not drink coffee. [17]. Decaffeinated coffee consumption was associated with a more modest decrease in the risk of type 2 diabetes, suggesting that compounds other than caffeine may contribute to the reduction in risk. The mechanism explaining the reductions in the risk for type 2 diabetes is unclear. Short-term clinical trials have found that caffeine administration impairs glucose tolerance and decreases insulin sensitivity at doses similar to and even less than Health Canada's safe intake guideline of 400-450mg/day with most studies using 5mg/kg body weight [25-34].

Caffeine and cardiovascular health

Caffeinated coffee has been suggested as being responsible for cardiovascular related morbidity and mortality [35]. While most case control studies (although limited by the potential of recall bias) have suggested an increased associated risk of CHD (defined as atherosclerosis of the coronary arteries) in people who consume 5 or more cups per day, the majority of epidemiological and prospective studies however have not found significant associations between coffee intake and CHD risk [35-39]. Acute intake of coffee and other caffeine-containing beverages can rapidly increase blood pressure, heart minute volumes, and cardiac index, as well as activate the sympathetic nervous system in non-habitual coffee drinkers. However, the observed effects wane in habitual coffee drinkers [35,36,40]. A meta-analysis of 16 studies demonstrated a significant increase in both systolic and diastolic blood pressure with pure caffeine (supplemental) ingestion however these effects were not seen when the caffeine was ingested through coffee [41]. Research has shown a negative effect of coffee in normo-tensive subjects on aortic stiffness and wave reflections, which are associated with increased cardiovascular disease risk, however the effects were not seen with decaffeinated coffee [42,43]. A moderate intake of caffeine (supplemental) of 250 mg/day was demonstrated to have an unfavourable effect on aortic stiffness in subjects with mild-to-moderate hypertension in a placebo-controlled, double-blind, cross-over design [44]. Although habitual consumption has been found to result in a degree of tolerance to the blood pressure-raising effect of caffeine, the results of several clinical trials suggest that this tolerance is not always complete even in those who consume caffeine daily [45,46,47]. The implications of this effect and the impact of long term caffeine consumption by hypertensive or hypertensive-prone people remains unclear and warrants further study. A meta-analysis of 14 randomized controlled trials found that consumption of unfiltered coffee dose dependently raised serum total and LDL cholesterol while the consumption of filtered coffee resulted in no change [48]. The cholesterol-raising factors in unfiltered coffee have been identified as cafestol and kahweol, diterpenes that are largely removed from coffee by paper filters [49].

Caffeine and bone health

Caffeine-containing beverage consumption has been reported to be associated with reduced bone mass and increased fracture risk in some, but not the majority of observational studies [50]. Clinical studies have demonstrated a clear but minimal depressant effect of caffeine on intestinal calcium absorption, and no effect on total 24-h urinary calcium excretion [50,51,52]. Observations implicating caffeine-containing beverages as a risk factor for osteoporosis have been made in populations consuming significantly less than optimal calcium intakes. The decrease in absorption was small enough to be fully offset by as little as 1-2 tablespoons of milk [51]. There is no evidence that caffeine has any harmful effect on bone health or calcium balance in individuals who consume a calcium rich diet.

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Dietitian Practice Points

Limit caffeine intake to 400-450 mg/day for the average adult.

Limit caffeine if you are pregnant or nursing. Moderate caffeine (up to 300mg/day) during pregnancy is considered safe. Small amounts of caffeine consumption by a nursing mother does not appear to affect the baby.

Recommended maximum intakes for children are 45 mg/day for ages 4-6 years, 52.5 mg/day for ages 7-9 years, and 85 mg/day for ages 10-12 years.

If cutting back on caffeine, do so gradually to avoid headaches, drowsiness and concentration difficulties. Some tips include:

Choose a smaller sized coffee cup/serving size.

Mix half caffeinated with half decaffeinated coffee.

Brew tea for less time.

Try café-au-lait made of half coffee & half milk.

If soft drinks are a must, choose caffeine-free ones.

Substitute noncaffeine containing beverages for coffee, tea and cola soft drinks to reduce caffeine intake.

Read food, beverage, ingredient lists and medication labels carefully to identify those with caffeine.

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