RESEARCH
Original Research

Caffeine Transiently Affects Food Intake at Breakfast

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ABSTRACT

Background Caffeine is frequently added to dietary supplements with claims it facilitates weight loss.

Objective The purpose of this study was to test the hypothesis that caffeine administration reduces laboratory and free-living food intake by reducing appetite and that these effects vary by body mass index (BMI).

Participants/setting Fifty adults aged 18 to 50 years completed the study (42% male). Exclusion criteria included no previous experience with caffeine, previous adverse event following caffeine consumption, taking any medications or having a medical condition contraindicating caffeine or stimulant consumption or affecting appetite or eating, and reported tobacco use within the past 6 months.

Design and intervention Participants visited the laboratory on four separate occasions to complete a double-blind, placebo-controlled, randomized, crossover study. On the first three visits, participants consumed a beverage containing 0, 1, or 3 mg/kg caffeine (order randomized). Thirty minutes later, participants consumed a buffet breakfast, ad libitum. After leaving the laboratory, participants completed hourly appetite assessments and dietary habit books until midnight or bedtime. The fourth session consisted of questionnaires, debriefing, and compensation.

Main outcome measures Total and macronutrient intake and appetite sensations in and out of the laboratory were measured.

Statistical analyses performed Intake data were analyzed using mixed analysis of covariance (ANCOVA). Appetite sensations were analyzed using repeated measures mixed ANCOVA.

Results Total laboratory energy intake was lower (~10%) after 1 mg/kg caffeine (650.4±52.2 kcal at 1 mg/kg; 721.2±63.2 at 0 mg/kg; 714.7±79.0 at 3 mg/kg) (P=0.046). In the laboratory, appetite sensations were not significantly different by caffeine treatment. Out of the laboratory, neither total intake nor appetite was significantly different by caffeine treatment. There were no significant interactions between caffeine treatment and BMI on intake and appetite sensations in or out of the laboratory.

Conclusions These results suggest caffeine has weak, transient effects on energy intake and do not support caffeine as an effective appetite suppressant.

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AS OBESITY PREVALENCE CONTINUES TO CLIMB IN developed countries, it becomes imperative to determine ways to reduce energy intake and increase energy expenditure. One common way to induce hypophagia (reduced intake and eating behavior) and increase expenditure is through dietary supplements such as caffeine. Epidemiological evidence suggests regular caffeine consumers have lower body mass index (BMI; calculated as kg/m^2) than nonconsumers, and coffee consumption may attenuate long-term weight gain or improve weight loss.[1-5] Some research has speculated these effects are achieved through caffeine's thermogenic properties.[6] Caffeine has been shown to increase thermogenesis and fat oxidation in humans, with increases in energy expenditure ranging from 5% to 22% (kilojoules [kJ]) in lean participants and blunted responses (5% to 10% kJ) in overweight and obese participants.[7,8]

Another potential explanation for the relationship between caffeine and body weight is that caffeine suppresses appetite. For example, together caffeine's effects on leptin, glucose, epinephrine, and dopamine may lead to an overall suppression of appetite and intake.[9-19] However, empirical support for appetite suppression due to caffeine is equivocal. Acute caffeine administration has been shown to reduce hunger in some studies, but not others.[19-21] Similarly, in studies that have directly examined the impact of preloads (premeal foods and beverages) containing caffeine on energy intake, results have been mixed, with some studies showing caffeine decreases energy intake, some showing no effect of caffeine on energy intake, and others showing caffeine increases energy intake.[7,12,20,22] One possible explanation for these differences may be that peak caffeine concentrations occurred after leaving the laboratory. For example, the average half-life

of caffeine is 4.5 hours among normal and underweight individuals, but average half-life is longer among overweight and obese individuals.[23,24] Many other factors could account for these differences, including different doses of caffeine used, expectancy of caffeine created when using coffee and tea beverages, other ingredients in the caffeinated preloads such as fiber or green tea catechins, different amounts of time between caffeine administration and eating, and different levels of usual caffeine intake, withdrawal, and withdrawal reversal.[7,19-22,25] Further research is needed describing the effects of acute caffeine administration on energy intake considering the factors described previously.

The purpose of this study was to examine the impact of acute caffeine administration on energy intake at breakfast and throughout the remainder of the day in adults. This study tested the following hypotheses: (1) caffeine dose-dependently reduces ad libitum laboratory and free-living energy intake; (2) caffeine exerts its effects on energy intake by reducing hunger and desire to eat; and (3) the effects of caffeine on appetite and energy intake vary as a function of BMI.

RESEARCH SNAPSHOT

Research Question: Does acute caffeine administration decrease laboratory and free-living energy intake and reduce appetite, and do these effects vary by BMI?

Key Findings: This double-blind, placebo-controlled, randomized, crossover study showed total laboratory energy intake was 10% lower after 1 mg/kg caffeine and this small, transient effect did not persist throughout the day. There were no significant effects or interactions with caffeine or BMI on appetite in the laboratory or throughout the day. The findings of this study do not support the use of caffeine as an appetite suppressant.

MATERIALS AND METHODS

Participants

Potential participants were recruited from flyers posted around the University at Buffalo campus and surrounding community. In addition, potential participants were identified from the Nutrition and Health Research Laboratory database and recruitment e-mails. Fifty-three adults aged 18 to 50 years began this study. Two females did not complete the study due to scheduling conflicts, and one female was removed due to a change in health status that contraindicated caffeine consumption, leaving 50 adults (42% male) completing the study (Table 1). Potential participants were excluded from the study if they had no previous experience or a previous adverse event with caffeine, were taking any medication or had a medical condition contraindicating caffeine or stimulant consumption, were taking any medications or had a medical condition affecting appetite or eating, or reported using tobacco products within the past 6 months. The State University of New York University at Buffalo Institutional Review Board approved the study protocol, and all participants provided written informed consent. All sessions took place at University at Buffalo, Department of Exercise and Nutrition Sciences, Nutrition and Health Research Laboratory.

Study Design

This study was a randomized, double-blind, placebo-controlled, crossover design with order of caffeine treatment presentation counterbalanced (0, 1, 3; 1, 3, 0; or 3, 0, 1) by random number generator (https://www.randomizer.org). To minimize variability, each participant visited the laboratory for three breakfast sessions at the same time of day, the same day of the week, over 3 consecutive weeks. Participants returned to the laboratory 2 to 7 days after the final breakfast session to collect follow-up data, be debriefed about the purpose of the study, and receive compensation. To minimize expectancy effects, upon obtaining written informed consent, participants were told that the beverage may have different levels of one or more of the following substances normally found in foods and beverages: sugar, caffeine, artificial sweetener, or flavoring or coloring.

Baseline Characteristics. To describe and assess baseline characteristics of the sample, participants were asked to complete a demographic questionnaire. To describe eating habits and screen for potential eating disorders (n=0), participants completed three eating behavior questionnaires: (1) Three Factor Eating Questionnaire, (2) Questionnaire on Eating and Weight Patterns, and (3) Binge Eating Scale.[26-28] To assess anthropometrics, waist and hip circumferences were measured using a soft tape measure, and height and weight were taken using a digital wall-mounted stadiometer (SECA) and a digital scale (SECA). Body mass index (BMI) was calculated using the Centers for Disease Control website for adult BMI calculations (metric). Body weight was used to calculate relative dose (0, 1, and 3 mg caffeine per kilogram body weight) for the caffeine treatments.

Caffeine and Physical Activity Abstinence. The day prior to breakfast sessions, participants were instructed to abstain from beverages and foods containing caffeine, to consume only plain water as a beverage, and not to engage in any vigorous exercise, which was defined and explained according to the talk test.[7,19,20,29] In addition, participants were required to abstain from all foods and beverages except plain water overnight for a minimum 8 hours. Participants were told they would be asked to provide a 2.5 mL saliva sample; they provided a 2.5 mL saliva sample at the beginning of each breakfast session to encourage compliance with study protocols, but these samples were not analyzed. All participants completed a Caffeine Use Questionnaire to quantify their usual daily caffeine intake (milligrams per day) by source as well as occasions and reasons for caffeine consumption.[30,31]

Caffeine Preparation and Administration. At all breakfast sessions, the beverage vehicle was 350 mL of the same chilled juice beverage of their choice (orange [165 kcal], lemonade [165 kcal], or cranberry-grape [225 kcal]). Participants were given a body weight (relative) dose of caffeine treatment (0, 1, 3 mg caffeine per kilogram body weight) added to the beverage. Caffeine doses were selected based on the known range (~150 to 250 mg/d) of usual caffeine intake in a population 18 to 50 years old and previous caffeine