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Effect of green tea, caffeine and capsaicin supplements on the anthropometric indices: A meta-analysis of randomized clinical trials

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ABSTRACT

We conducted a meta-analysis to assess the effect of green tea, caffeine and capsaicin supplements on the anthropometric indices in adults. PubMed/Medline, Scopus, Cochran and Web of Science databases were searched up to March 2017. Green tea significantly reduced weight by −0.65 kg (−1.10 to −0.20, P = 0.005), body mass index (BMI) by −0.26 kg/m^2 (−0.43 to −0.10, P = 0.002) and waist circumference by −1.11 cm (−1.99 to −0.23, P = 0.01) but not percent of body fat (PBF) (−1.42%, 95% CI: −3.02 to 0.18, P = 0.08). Caffeine supplement had no effect on weight (−2.99 kg, 95% CI: −7.83 to 1.41, P = 0.18). We observed a significant weight loss after capsaicin supplement (−0.50 kg; 95% CI: −0.90 to −0.11, P = 0.01) but PBF did not change significantly from baseline (0.11%, 95% CI: −0.22 to 0.43, P = 0.51). Green tea and capsaicin supplements have a significant mild weight-lowering effect. On the contrary, it seems caffeine had no effect on weight.

1. Introduction

Obesity is a pandemic disease that may affect the onset of diseases such as cancers, disability, short-life expectancy, chronic diseases and mortality (Low, Chin, & Deurenberg-Yap, 2009). In recent decades, the frequency of becoming overweight and obesity has increased in most countries, in different ages and both genders (Swinburn et al., 2011). The number of overweight and obese adults rose by 27.5% from 1980 (921 million) to 2013 (2.1 billion) worldwide (Ng et al., 2014). At present, current information demonstrates that 36.9% of men and 38.0% of women suffer from being overweight and obesity (Ng et al., 2014). Diet therapy, lifestyle changes and behavior therapy are suggested as the main approaches to treat being overweight and obesity. Anti-obesit agents also, suggested intherapy of body mass index (BMI) ≥27 kg/m^2, however, these can have psychological and neurological side effects (Al-Naggar, Osman, & Abdulghani, 2013). However, concomitantly, use of natural products as an adjunctive therapy is rising to reduce body weight (Basu et al., 2010; Chen, Liu, Chiu, & Hsu, 2016; Tsai, Chiu, Yang, Ouyang, & Yen, 2009).

Natural products are safe and healthy and were promoted to lose weight worldwide (Conforti & Pan, 2016; Sun, Wu, & Chau, 2016). The principal examples of natural plan products are green tea (Camellia sinensis), caffeine and capsaicin supplements (Hursel & Westerterp-Plantenga, 2009; Sun et al., 2016). Capsaicin is a main component of Chili pepper (a food additive) and is taken between 1.5 mg/d (in Europe and America) to 200 mg/d (in Asia) (Tundis et al., 2011). It has anti-inflammatory, antioxidant, anti-cancer and pain reliever properties (Luo, Peng, & Li, 2011). Nevertheless, the effectiveness of capsaicin on weight loss is only a hypothesis.

Although green tea is one of the main beverages in Asia especially Japan and China, it recently has became popular in western countries. It is rich in polyphenols compounds such as epigallocatechin gallate, epigallocatechin, epicatechin gallate, epigallocatechin and caffeine. It also has an antioxidant capacity and it can protect the body against cardiovascular disease (CVD) and diabetes mellitus. Green tea can increase fat oxidation and energy expenditure that results in weight lose (Hursel, Viechtbauer, & Westerterp-Plantenga, 2009). In addition, coffee and tea leaves contain caffeine, which is known as a sports supplement. Caffeine can stimulate fat oxidation, thermogenesis and energy expenditure subsequently, which reduces body weight (Joy et al., 2016). The result of observational studies have indicated that there are associations between coffee drinking and total body weight; the subjects who drink coffee routinely have lower BMI than subjects who never drink coffee (Icken et al., 2016).

Several clinical randomized trials (RCTs) have assessed the effect of green tea (Al-Naggar et al., 2013; Auvichayapat et al., 2008; Janssens et al., 2016; Vieira Senger, Schwanke, Gomes, & Valle Gottlieb, 2012; Zolfaghary, Taghian, & Hedayati, 2013), caffeine (Davoodi et al., 2014; Malek et al., 2006; Ohnaka et al., 2012; Toubro, Astrup, Breum, & Quaade, 1993) and capsaicin (Lee, Li, Zerlin, & Heber, 2010; Lejeune,

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Kovacs, & Westerterp-Plantenga, 2003; Nieman, Kam, Knab, & Shanely, 2012; Nirengi et al., 2016; Snitker et al., 2009) on weight and body composition. Moreover, their results are conflicting.

Previously, three meta-analyses have investigated the effect of green tea on weight and body composition (Baladia, Basulto, Manera, Martinez, & Calbet, 2014; Hursel et al., 2009; Jurgens et al., 2012). Two of them indicated that green tea decreased body weight (Hursel et al., 2009; Jurgens et al., 2012) in contrary, the last study showed insignificant effect of green tea on weight (Baladia et al., 2014). There are several reasons to conduct a meta-analysis study regarding the effect of green tea, caffeine and capsaicin supplements on the anthropometric indices: (a) the lack of accurate effects of green tea on body composition in two mentioned meta-analyses (Hursel et al., 2009; Jurgens et al., 2012). These studies compared high dosage green tea/catechins supplements as an intervention vs. low-dosage green tea/catechins supplements as a placebo, (b) the limitation of studied specimens in the previous meta-analyses, however this study provided 12 RCTs (including 598 persons) that have been published since 2012, (c) studies with short-time supplementation (< 12 weeks) in the past three meta-analyses were missed. On the other hand, there is no systematic review and meta-analysis that investigated the effect of caffeine or capsaicin supplements on weight and body composition. Therefore, this meta-analysis study attempts to provide more information to show the effect of green tea, caffeine and capsaicin supplements on the anthropometric indices in adults.

2. Methods

2.1. Data source

The present meta-analysis benefited from PubMed/Medline, Scopus, Cochran and Web of Science databases to screen relevant RCTs that investigated the effect of green tea, caffeine and capsaicin supplements on body weight. The main key words were “obesity”, “weight”, “weight loss”, “weight gain”, “body composition”, “fat mass”, “fat free mass”, “body mass index”, “BMI”, “adiposity”, “overweight”, “weight change”, “capsicum”, “capsicum annuum”, “pepper”, “chili”, “capsaicin”, “caffeine”, “caffeinated coffee”, “green tea” and “camellia sinensis”. English language articles published up to March 2017 were searched.

2.2. Study selection

Two researchers (M.G and M.A) studied the articles independently. The articles were divided into two group: The first group as inclusion criteria included (a) RCT framework, (b) adult participants (aged ≥ 19 yr), (c) interventions such as applied green tea/green tea extract, caffeine, capsaicin/pepper, (d) compared oral intervention supplement vs. placebo or intervention-fortified products vs. free-fortified products, (e) reported body weight, BMI, waist circumference (WC) or percent of body fat (PBF) as outcomes, and also studies of caffeinated coffee vs. decaffeinated coffee were included.

The second group as exclusion criteria included: (a) animal studies, observational studies or letters, (b) studies without placebo groups, (c) compared low-dose vs. high dose of supplement, (e) conducted in children, adolescents (aged < 18 yr), pregnant or lactating women, (f) studies that applied decaffeinated green tea vs. caffeinated green or placebo, (g) studies that used catechins or polyphenols supplement of green tea vs. placebo, (h) studies that used other forms of tea such as oolong tea or black tea and (i) studies that used coffee drinking vs. placebo. To prevent overlapping, recent studies and studies with larger sample size were included.

2.3. Definitions

The outcomes were changes in weight, BMI, WC and PBF from baseline. The intervention was green tea/green tea extract, caffeine and capsaicin supplementation.

2.4. Data extraction

The data of intended studies were categorized into: sample size, age, gender, publication date, mean and standard deviation (SD) of weight, BMI, WC and PBF at baseline, end of intervention and their changes from baseline, type of intervention (infusion or capsule), dosage and length of intervention. Jadad scale was used to assess risk of bias between studies (Jadad et al., 1996).

2.5. Statistical analysis

Meta-analysis index were mean outcome changes from baseline. If heterogeneity was among included studies, the random-effect model was performed to calculate the pooled effect size; otherwise the fixed-effect model was used. Heterogeneity was investigated using *I*-squared (I^2) and Tau-squared (τ^2). Egger’s regression symmetry test was used to determine publication bias. To investigate the effect of studies on the pooled effect size, sensitivity analysis was run. Meta-regression analyses were conducted to assess the source of heterogeneity. Age, dose and length of intervention were determined as a source of heterogeneity. All statistical analysis was performed using STATA software version 12 (STATA Corp, College station, Texas). A P value < 0.05 was defined as significant.

3. Results

The flow chart of studies shows in Fig. 1: The articles published and presented by PubMed/Medline, Scopus, Cochrane and Web of science revealed. 11,651 articles were assessed based on title and abstract (caffeine; 3208, capsaicin; 4524 and green tea; 3919), not counting duplicated articles made 8884 studies. Of those, only 169 relevant articles were retrieved because of relevant details. Finally 29 studies with 34 arms (including 1731 persons) were included for the meta-analysis.

Characteristics of included studies are presented in Table 1. Mean age of participants was 43.3 ± 12.1 yr in intervention and 42.4 ± 11.9 yr in placebo. Mean weight was 78.9 ± 8.8 and 80.4 ± 9.1 kg, BMI was 28.8 ± 2.9 and 29.5 ± 2.9 kg/m^2, WC was 94.8 ± 5.7 and 94.9 ± 5.7 cm and PBF was 35.8 ± 7.5 and 35.9 ± 6.8% in intervention and placebo, respectively. Mean length of intervention was 10.8 ± 4.2 (3–24 wk), 14.5 ± 7.1 (8–24 wk) and 6.8 ± 3.3 (4–12 wk) weeks in green tea, caffeine and capsaicin supplementation studies. The dosage of green tea was 379–20,000 mg, caffeine was 210–600 mg and capsaicin was 3–135 mg per day. Based on Jadad scale 11 studies had poor quality (Jadad score < 3) (Al-Naggar et al., 2013; Cardoso, Salgado, Cesar Mde, & Donado-Pestana, 2013; Davoodi et al., 2014; Fukino et al., 2008; Gahreman, Heydari, Boutcher, Freund, & Boutcher, 2016; Lejeune et al., 2003; Malek et al., 2006; Mousavi, Vafa, Neyestani, Khamseh, & Hoseini, 2013; Nirengi et al., 2016; Ohnaka et al., 2012; Vieira Senger et al., 2012).

Twenty studies with 24 arms (including 1134 persons) investigated the effect of green tea/green tea extract on the anthropometric indices (Al-Naggar et al., 2013; Auvichayapat et al., 2008; Bajerska, Mildner-Szkudlarz, & Walkowiak, 2015; Bogdanski et al., 2012; Cardoso et al., 2013; Chan et al., 2006; Diepvens, Kovacs, Vogels, & Westerterp-Plantenga, 2006; Fukino et al., 2008; Gahreman et al., 2016; Hovanloo, Fallah Huseini, Hedayati, & Teimourian, 2016; Hsu et al., 2008; Janssens et al., 2016; Kovacs, Lejeune, Nijs, & Westerterp-Plantenga, 2004; Mirzaei et al., 2010; Mohammadi et al., 2010; Mousavi et al., 2013; Pezeshki, Safi, Feizi, Askari, & Karami, 2015; Sulibursk et al., 2012; Vieira Senger et al., 2012; Zolfaghary et al., 2013). Ten studies applied green tea (infusion or capsule) and rest of them applied green tea extract supplements. Body weight was reported in 17 studies, BMI in 19 studies, WC in 13 studies and PBF in 10 studies (Table 1). Forest plot of studies that assessed the effect of green tea/green tea extract on weight, BMI, WC and PBF are presented in Figs. 2–5, respectively. Green tea/ green tea extract significantly reduced body weight by