



Review Article

Green Tea Extract and Weight Management: Evidence-Based Meta-Analysis and Review

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ABSTRACT

Obesity is a major global health challenge, as it is a complex problem with many potential targets for intervention. Green tea extract (GTE) has emerged as one such strategy for weight management. This Systematic Review (SA) and meta-analysis (MA) synthesizes data from relevant clinical trials to assess the impact of GTE on weight loss. Nine clinical trials involving 532 participants were analyzed. The results of this MA indicate a moderate effect size (Cohen's d : -0.74, 95% CL [-1.40, -0.08]; $P = 0.03$, $I^2 = 0.92$), suggesting the potential for weight reduction through GTE use. However, some clinical trials have conflicting opinions regarding the effectiveness of GTE. In contrast, this MA demonstrates that GTE consumption may assist in weight control with significant statistical findings, but may not be clinically significant. The substantial heterogeneity among the included studies, as reflected by the high I^2 value of 92%, underscores the need for further research to standardize interventions and yield more conclusive evidence on the efficacy of green tea extract in promoting weight loss.

Keywords: Green Tea Extract, epigallocatechin gallate (EGCG), Obesity, Weight Loss, Meta-analysis.

Introduction

Obesity is a significant public health concern that continues to challenge healthcare systems worldwide, with the United States facing high rates of obesity among adults [1]. In 2017-2018, the Centers for Disease Control and Prevention reported that approximately 42.4% of American adults were classified as obese, highlighting the urgent need for effective weight management strategies [2]. Addressing obesity is crucial for reducing the risk of serious health conditions such as metabolic syndrome, cardiovascular diseases, type 2 diabetes, certain cancers, and respiratory issues [3]. These risks arise from the adverse effects of hormones such

as proinflammatory adipokines released from excessive, dysfunctional adipose tissue [4].

Metabolic syndrome, closely associated with obesity, is a consolidation of central abdominal obesity, hyperlipidemia, insulin resistance, and hypertension. This combination further elevates the risk of diabetes and severe atherosclerotic diseases such as strokes, heart attacks, and peripheral limb loss.[5] Effective weight management through a balanced diet, regular physical activity, behavioral modifications, and sustainable lifestyle changes is still of utmost importance and can help reduce morbidity and mortality. Several supplements and

foods are also often claimed to aid in weight loss, one being green tea extract.

Green tea extract, derived from the plant *Camellia sinensis*, has garnered attention for its potential role in weight management [6]. The bioactive compounds found in green tea extract, particularly tea polyphenols, such as epigallocatechin gallate (EGCG), are believed to be responsible for its potential weight-reducing effects. Other tea polyphenols present in smaller quantities include catechin, epicatechin (EC), epigallocatechin (EGC), and epicatechin gallate (ECG) [7][8][9][10]. Caffeine is another notable bioactive compound that contributes to weight loss, possibly by increasing energy metabolism [11]. Understanding the mechanisms by which green tea extract acts on the body to promote weight loss is critical in evaluating its efficacy as a supplement for managing obesity. These compounds and other unknown mechanisms contribute to weight reduction by resulting in the following effects: boosting thermogenesis, enhancing fat oxidation, suppressing appetite, improving metabolism, reducing inflammation, and regulating blood sugar levels [12]. These effects synergize, potentially supporting weight management when paired with a healthy diet and regular exercise [13].

Green tea extract has been associated with boosting thermogenesis—the body's process of generating heat and burning calories. This increase in thermogenesis can potentially elevate energy expenditure, aiding in weight loss [14]. Epigallocatechin gallate (EGCG), a potent catechin found in green tea, is characterized by its multiple hydroxyl groups and strong reducibility. Known for its remarkable anti-atherosclerotic, antioxidant, and anti-obesity properties, EGCG has been shown to influence lipid metabolism and help prevent obesity by regulating various biological processes in multiple studies [15][16]. EGCG enhances fat oxidation, promoting the breakdown of stored fats for energy utilization. This process can contribute to a decrease in fat accumulation and support weight loss efforts [17]. A study by Hursel et al. highlights that caffeine present in green tea enhances thermogenesis and fat oxidation, leading to increased energy expenditure. Specifically, caffeine can elevate metabolic rate and promote fat burning,

which aids in weight management. The study also emphasizes that when combined with catechins found in tea, caffeine's effects on weight control are amplified, showcasing a synergistic effect that further supports its role in managing body weight. These findings underline the potential of caffeine as a beneficial component in weight loss strategies, particularly when included in catechin-rich beverages [18]. Caffeine has also been associated with appetite suppression. By reducing feelings of hunger and increasing feelings of fullness, green tea extract may help in controlling caloric intake, which is crucial for weight management [19]. Additionally, components in green tea extract, such as EGCG, have been linked to better blood sugar regulation. Green tea extract may reduce fat storage and improve weight control by helping maintain stable blood sugar levels [20].

Green tea extract is available in various forms, including capsules and liquid preparations, making it convenient for consumption as a dietary supplement [21]. Through this systematic review and meta-analysis, we aim to investigate the impact of green tea extract on body weight and explore its potential as a complementary approach to weight management. This meta-analysis focuses on clinical trials exploring the use of green tea extract supplements for weight loss in overweight or obese adults. This focus will help evaluate the effectiveness of green tea extract in reducing body weight and provide valuable insights into its role as a weight management supplement.

Method

A Systematic review (SR) and Meta-analysis (MA) were conducted by using Google Scholar and PubMed electronic databases. Keywords such as 'green tea extract', 'weight loss', and 'weight loss management' were used as search criteria published between 2005 and 2024. These articles were screened and filtered to include only clinical trials or randomized clinical trials, which resulted in 300 articles that were then evaluated and assessed for suitability. The articles also had to include reports of the difference in weight at baseline and post-intervention as an outcome measure. Sixteen articles were included in the SR, out of which nine articles

were included in the meta-analysis with a total of 532 participants.

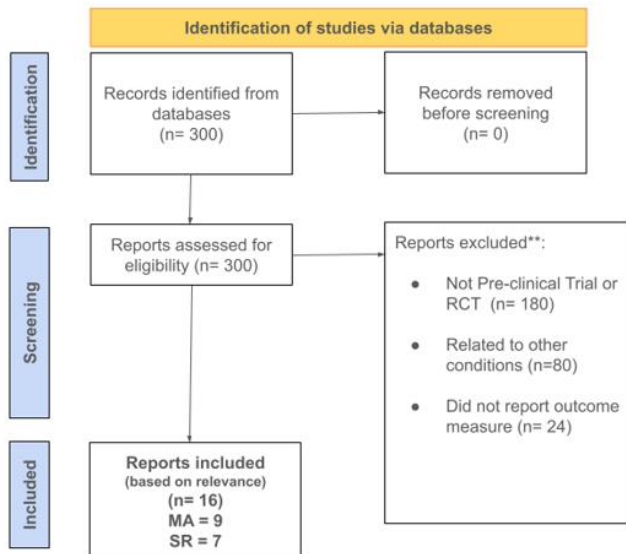


Figure 1: Flow chart of the study selection process and article screening

Results and Discussion

For this meta-analysis, nine clinical trials were included, with a study duration of 6 -12 weeks. The daily dose of green tea extract ranged from 400 mg

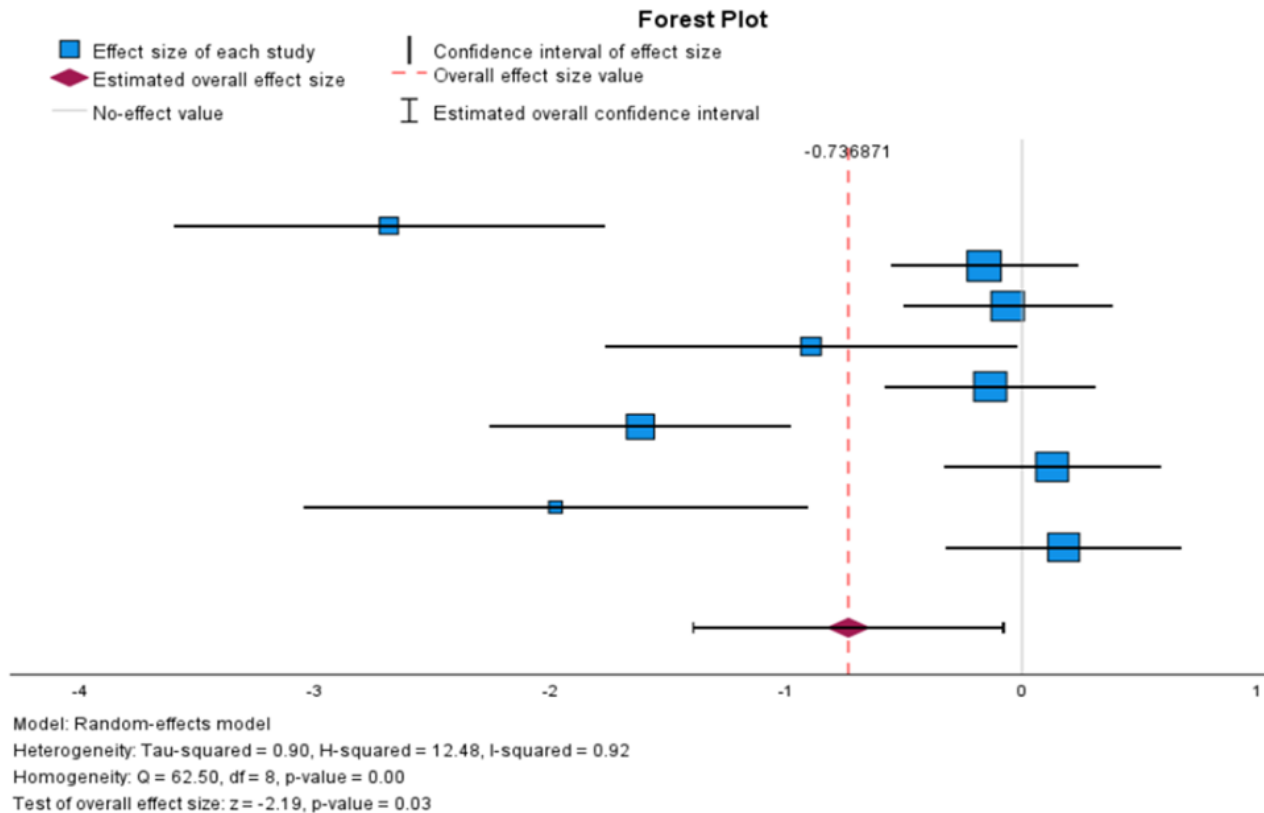
to 1500 mg across the studies. While six studies focused solely on green tea extract, others included additional ingredients such as black tea, ginger, asparagus, kidney beans, and vitamin D alongside green tea extract. The analysis was conducted using the SPSS software with a random-effects model.

In calculating Cohen's d for the meta-analysis on green tea extract and weight loss, the main body weight difference between baseline and post-treatment was analyzed. The standard deviations of both the treatment and control groups were also included. A Cohen's d of -0.74 [95% CL -1.40, -0.08; $P = 0.03$, $I^2 = 0.92$] indicates a moderate effect size in weight loss with green tea extract. The negative effect size value suggests that the green tea extract is associated with weight loss compared to the control. The heterogeneity was assessed using the I^2 statistic, with a value of 0.92, indicating substantial variability among studies. The forest plot analysis indicated a trend toward weight reduction. Although some of the clinical trials did not show a significant effect on weight loss, the results suggest some support for the potential benefits of green tea extract.

In the study conducted by Yao et al. (2024), a total of 62 participants were enrolled to investigate the effects of decaffeinated green tea polyphenols on health outcomes. Over 12 weeks, each participant received a daily dose of 400 mg of decaffeinated

Table 1: GTE for Weight Management: A Comprehensive Review of Clinical Studies

Author (Year)	Participants (#)	Duration (weeks)	GTE Dose/Day (mg)	Outcomes (✓/⊖)
Nagao et al (2005) [23]	35	12	690 mg GTE (Catechin)	✓
Opala et al. (2006) [24]	105	12	Tablets 1 (one hour before meals, comprises extracts of Asparagus, Green tea, Black tea, Guarana, Mate, and Kidney beans) and 2 (taken half an hour after meals, comprises extracts of Kidney bean pods, Garcinia cambogia and Chromium yeast) are taken twice daily with two main meals.	✓
CH Hsu et al (2008) [25]	78	12	1200 mg GTE (491 mg catechins containing 302 mg EGCG per capsule) (*126 mg EGCG plus other polyphenols & components)	⊖
B Narotzki et al. (2013) [26]	22	12	4.5 g GT & 400. IU of d-α-tocopherol.	✓
Chen et al. (2016) [27]	77	12	1500 mg GTE (*856.8 mg EGCG plus other polyphenols & components)	✓
Matsui Y. et al. (2016) [28]	144	12	560 mg green tea catechins	✓
M Taghizadeh et al (2017) [29]	50	8	500 mg green tea, 100 mg capsaicin, and 200 mg ginger extracts	✓
Huang et al. (2018) [30]	73	6	1500 mg GTE (*856.8 mg EGCG plus other polyphenols & components)	⊖
Bagheri et al. (2019) [31]	30	8	500 mg GTE capsules	✓
Yoshitomi et al. (2021) [32]	60	12	Green tea combined with α-glucosyl hesperidin (GT-gH), which contained 178 mg α-glucosyl hesperidin and 146 mg EGCG	✓
Yao et al. (2024) [22]	62	12	400 mg decaffeinated green tea polyphenols (EGCG 50%)	✓



ID	Cohen's d	Std. Error	Lower	Upper	p-value	Weight	Weight (%)
Nagao et al. (2005)	-2.69	0.47	-3.60	-1.77	0.00	0.89	10.08
T Opala et al. (2006)	-0.16	0.20	-0.56	0.24	0.43	1.06	11.96
CH Hsu et al. (2008)	-0.06	0.23	-0.51	0.38	0.79	1.05	11.83
B Narotzki et al. (2013)	-0.90	0.45	-1.77	-0.02	0.05	0.91	10.24
Chen et al. (2016)	-0.14	0.23	-0.58	0.31	0.55	1.05	11.83
M Taghizadeh et al. (2017)	-1.62	0.33	-2.26	-0.98	0.00	0.99	11.19
Huang et al. (2018)	0.13	0.23	-0.33	0.59	0.59	1.04	11.79
Bagheri et al. (2019)	-1.98	0.55	-3.05	-0.91	0.00	0.83	9.40
Yao et al. (2024)	0.18	0.25	-0.32	0.68	0.49	1.03	11.67
Overall	-0.74	0.34	-1.40	-0.08	0.03		

Figure 2: Forest plot (Green Tea Extract vs. Control): Evaluating the Effect of Green Tea Extract on Weight Loss

green tea polyphenols, with a composition of 50% epigallocatechin gallate (EGCG). The study aimed to assess these polyphenols' potential health benefits and immunomodulatory effects, providing valuable

insights into their role in promoting overall well-being. It is important to note that this study was conducted on children with obesity ages 6 - 10 years, and the outcomes showed that there were no

statistical differences between the DGTP group and the Control group in terms of height, weight, BMI, blood pressure, and the changes observed in these indicators before and after the intervention [22].

Some other research studies conducted on the effect of other tea extracts with similar compounds to GTE have been shown to aid in weight loss maintenance. A systematic review conducted in 2014 explores the impact of tea polyphenols on obesity-related parameters. The review synthesizes findings from various studies that investigated the effects of green, black, and oolong tea polyphenols on visceral fat accumulation and inflammation in mice subjected to high-fat, high-sucrose diets. The results consistently demonstrate that these tea polyphenols contribute to significant reductions in visceral fat and inflammatory markers, suggesting their potential role in mitigating obesity and its associated metabolic disorders. The review highlights the mechanisms through which tea polyphenols exert their effects, including enhanced fat oxidation, improved insulin sensitivity, and anti-inflammatory properties. This comprehensive evaluation underscores the therapeutic potential of tea polyphenols in obesity management and calls for further research to translate these findings into human studies [33]. Similarly, a review conducted by Li et al. 2022 included a total of 18 primary studies and one randomized controlled trial, with a total of 169,599 participants. The study examined the relationship between green tea consumption and various health markers, including lipoprotein levels, liver enzymes, body mass index (BMI), and liver cancer. The findings indicated improvements across all measures, with the most notable being a statistically significant reduction in BMI (MD: -0.69 ; 95% CI: -0.95 to -0.42 ; $p < 0.001$) compared to those who did not consume green tea [34]. Finally, a review study carried out in 2023 examines the impact of green tea supplementation on various cardiovascular risk factors. The authors conducted a comprehensive systematic review and meta-analysis of 55 randomized clinical trials (RCTs) involving 63 effect sizes. The findings indicate that green tea supplementation significantly reduces total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), fasting blood sugar (FBS), hemoglobin A1c (HbA1c), and diastolic blood pressure (DBP) while increasing high-density

lipoprotein cholesterol (HDL-C). These results suggest that green tea has a beneficial effect on lipid profiles, glycemic control, and blood pressure, highlighting its potential role in cardiovascular disease prevention [35].

Conclusion

This systematic review and meta-analysis suggest that GTE may offer a moderate effect on weight loss, potentially assisting in weight control. It may serve as a complementary approach to healthy lifestyle practices, but should not be solely relied upon for substantial weight loss. The high degree of heterogeneity observed among the included studies highlights the variability in results, emphasizing the need for more standardized and rigorous research to provide clear and definitive evidence regarding the efficacy of GTE as a weight management intervention.

Limitations of this Study

One significant limitation of this meta-analysis is the lack of uniformity in study size, inclusion, and exclusion criteria. The validity of the findings can be compromised if lower-quality studies are given equal weight to higher-quality studies. Additionally, the heterogeneity observed in this study was a major limitation, impacting the overall reliability of the results.

Conflict of interest

The authors declare no conflict of interest.

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