

Effect of green tea on antioxidant status in adults: A Systematic Review and Meta-analysis of Randomized Clinical Trials

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Abstract

Abstract Aim: Oxidative stress represents a cornerstone of a wide range of chronic diseases. Studies have identified an inconsistent effect of green tea on regulating oxidative stress. We aimed to examine the evidence from randomized clinical trials (RCTs) to assess the effects of green tea on oxidative stress markers including malondialdehyde (MDA), and total antioxidant capacity (TAC) in adults. **Methods:** A systematic search of English language publications in PubMed, Scopus and Embase was performed up to September 1, 2020. Data were pooled using the random-effects method and were expressed as weighted mean difference (WMD) and 95% confidence intervals (CI). **Results:** Fourteen RCTs met inclusion criteria. There was a significant relationship between green tea and TAC. Our results indicated that green tea had significant effects on TAC (weighted mean difference [WMD]: 0.18; 95 % CI, 0.07, 0.29, $P = 0.001$) and significant heterogeneity between studies ($I^2 = 98.6\%$, $p < 0.001$) which was largely related to sex and BMI. Subgroup analysis in TAC identified a significant relationship except in low dose and obese individuals. No relationship between MDA and green tea was observed overall and in all subgroups. **Conclusions:** We found that the intervention with green tea significantly increased the TAC, while, it had no significant effect on MDA. **Key Words:** green tea, oxidative stress, total antioxidant capacity, malondialdehyde.

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Table 2. Risk of bias assessment of the studies

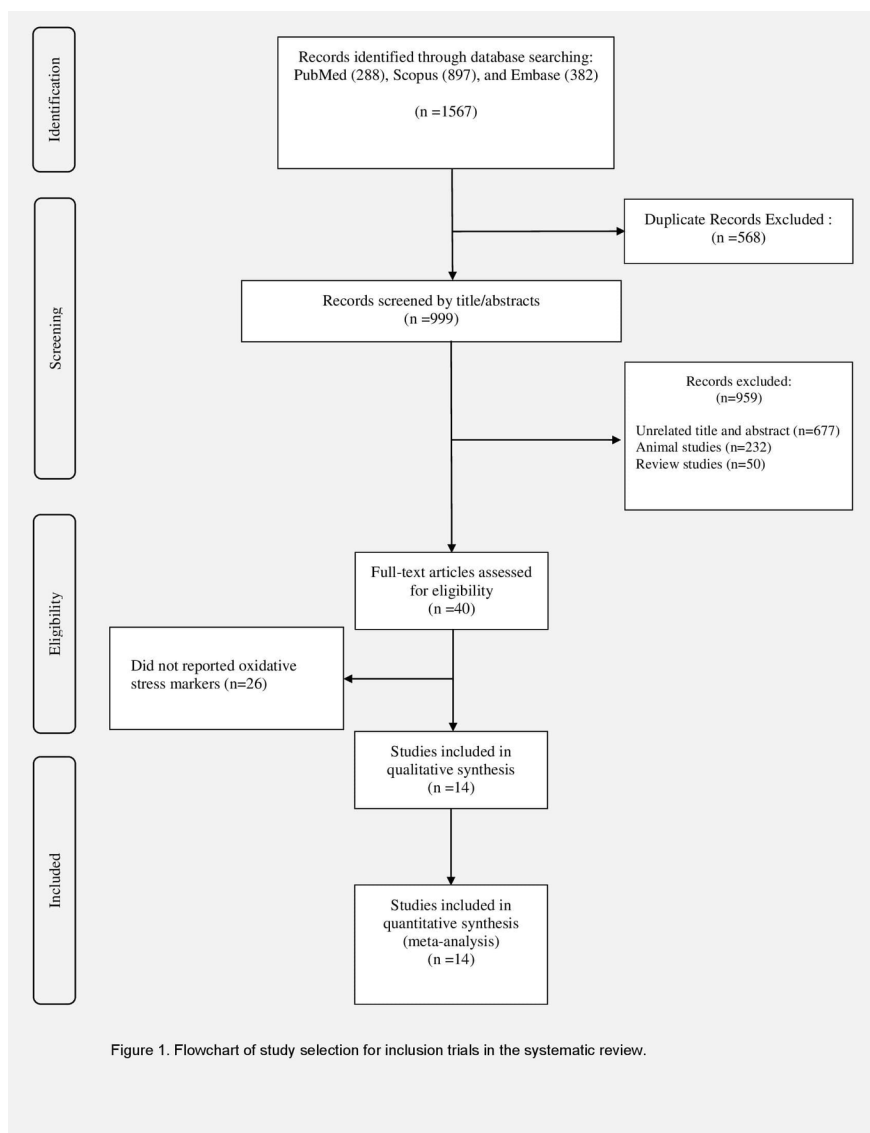
Study	Random Sequence Generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective outcome reporting	Other sources of bias
Ateke Mousavi (2013)	U	U	H	U	L	L	U
Lina Lasaitė (2014)	U	L	L	U	L	L	L
Atsa Spadiene (2014)	U	L	L	U	L	L	L
Ewa Jówko (2011)	U	L	L	U	U	L	U
Ewa Sadowska-Krepa (2019)	U	L	H	U	L	L	U
Paweł Bogdński (2012)	U	L	L	U	L	L	L
Amir Hadi (2016)	L	L	L	U	L	L	L
Hassan Mozaffari-Khosravi (2014)	U	H	U	U	U	L	U
Kamal Azizbeigi (2019)	U	U	H	U	U	L	U
Sáskia Ribeiro Vaza (2018)	U	L	L	U	H	H	U
Joanna Suliburska (2012)	L	L	L	U	U	U	L
Yu-Chi Kuo (2014)	U	L	L	L	U	U	L
Ehsan Socizi (2017)	L	L	H	L	L	L	L
Kamesh Venkatakrishnan (2018)	U	L	L	U	L	L	L

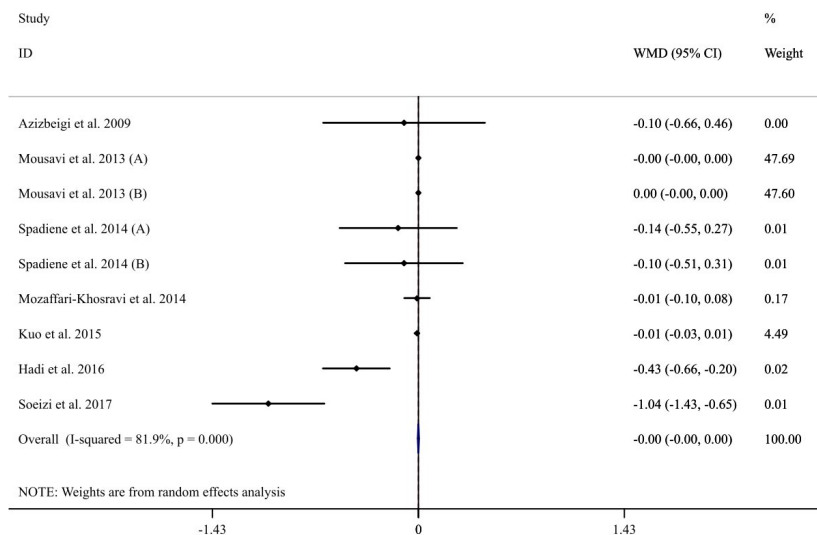
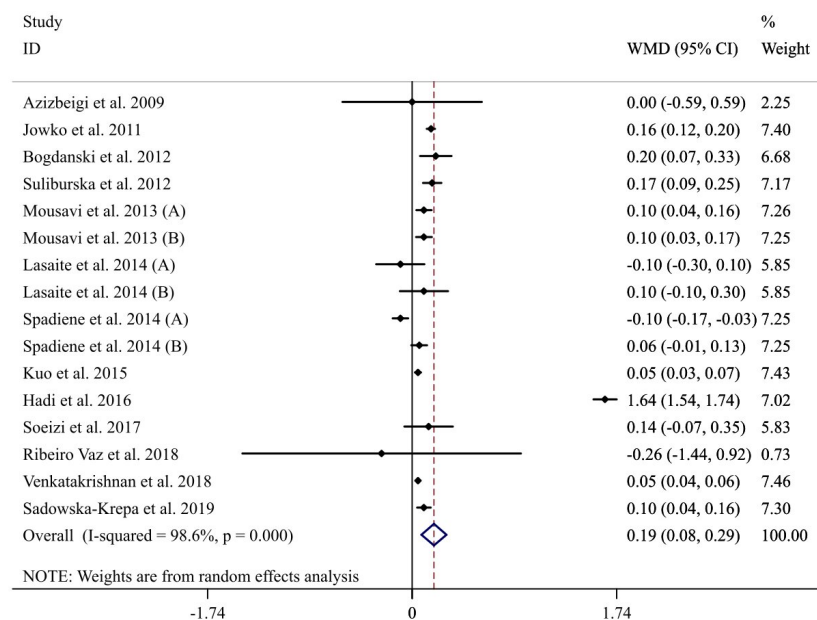
U; unclear risk of bias, L; low risk of bias, H; high risk of bias.

Table 3 Subgroup analyses of green tea on oxidative stress.

	NO	WMD (95%CI)	P within group	P heterogeneity	I ²	Between-subgroup heterogeneity
Subgroup analyses of green tea on TAC level.						
Overall effect	16	0.18 (0.07, 0.29)	0.001	<0.001	98.6%	
Trial duration (week)						
≥8	12	0.06 (0.02, 0.11)	0.005	<0.001	73.6%	<0.001
<8	4	0.48 (0.10, 0.86)	0.013	<0.001	99.7%	
Type of green tea						
Green tea	4	0.07 (0.03, 0.10)	<0.001	0.169	40.5%	<0.001
Green tea extract	12	0.20 (0.01, 0.40)	0.035	<0.001	98.9%	
Sex						
Male	5	0.41 (0.06, 0.77)	0.021	<0.001	99.6%	<0.001
Female	1	0.05 (0.04, 0.05)	<0.001	-	-	
Both	8	0.11 (0.07, 0.16)	<0.001	0.285	18.3%	
Intervention dose (mg/d)						
>400	10	0.26 (0.06, 0.46)	0.009	<0.001	99.1%	0.148
≤400	6	0.06 (-0.01, 0.13)	0.132	<0.001	87.1%	
Baseline BMI (kg/m ²)						
18.5-24.9	5	0.41 (0.07, 0.75)	0.016	<0.001	99.6%	<0.001
25-29.9	3	0.09 (0.05, 0.14)	<0.001	0.837	0.0%	
≥30	6	0.06 (-0.01, 0.13)	0.088	<0.001	85.3%	
Subgroup analyses of green tea on MDA level						
Overall effect	9	-0.00 (-0.00, 0.00)	0.634	<0.001	81.9%	
Trial duration (week)						
≥8	6	-0.00 (-0.00, 0.00)	0.857	<0.001	83.0%	0.146
<8	3	-0.08 (-0.21, 0.04)	0.185	0.002	84.2%	
Type of green tea						
Green tea	4	-0.00 (-0.00, 0.00)	0.860	<0.001	89.5%	0.136
Green tea extract	5	-0.15 (-0.37, 0.06)	0.156	0.010	69.9%	
Sex						
Male	3	-0.18 (-0.51, 0.15)	0.413	0.892	0.0%	0.252
Both	4	-0.00 (-0.00, 0.00)	0.860	<0.001	89.5%	
Intervention dose						
>400	7	-0.00 (-0.00, 0.00)	0.818	<0.001	85.8%	0.226
≤400	2	-0.01 (-0.02, 0.00)	0.215	0.530	0.0%	
BMI						
18.5-24.9	3	-0.46 (-0.98, 0.05)	0.081	<0.001	95.0%	0.172
25-29.9	3	-0.00 (-0.00, 0.00)	0.493	0.609	0.0%	
≥30	3	-0.11 (-0.37, 0.14)	0.374	0.989	0.0%	

Abbreviations: CI, confidence interval; WMD, weighted mean differences.





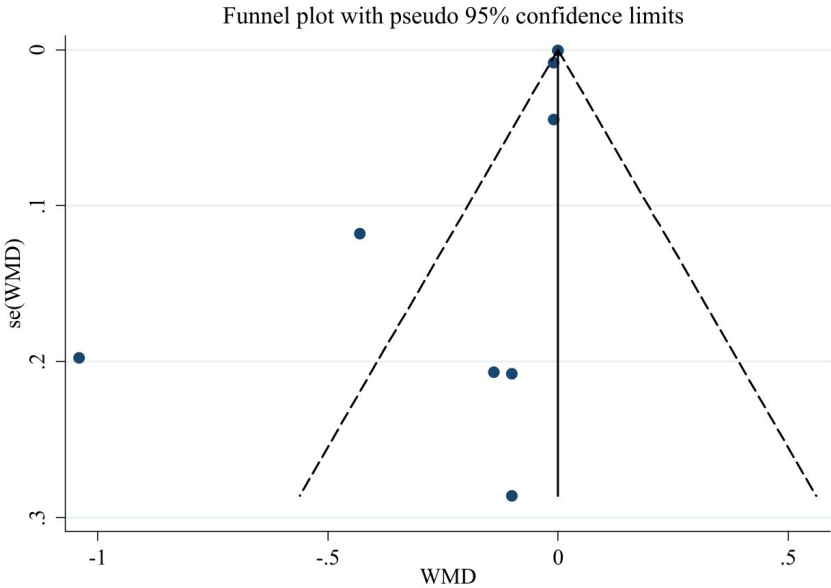
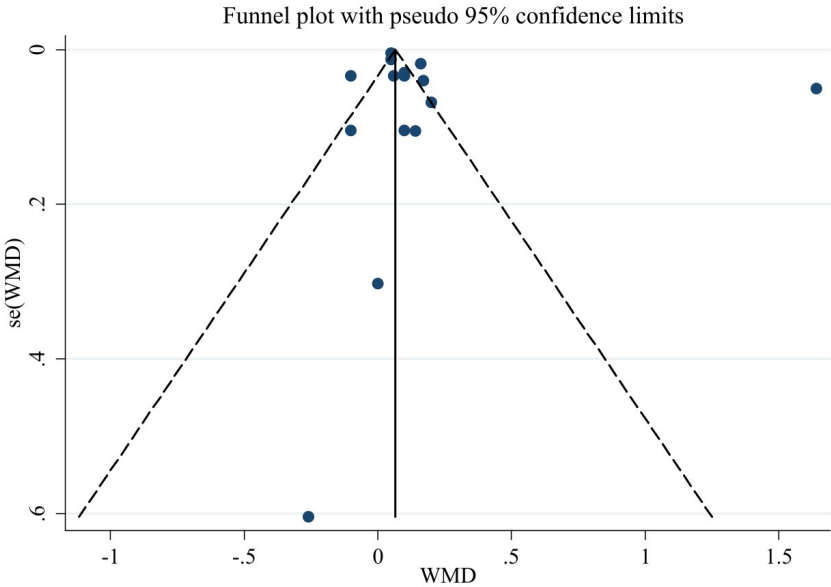


Table 1. Characteristic of included studies in meta-analysis

Author	Public ation Year	Country	Study Design	Participant	Sex	Trial Duration (Week)	Means Age		Means BMI		Intervention			Sample Size	
							IG	CG	IG	CG	Treatment group	Green tea dose (mg)	Control group	IG	CG
Azizbeigi et al. 2009	2009	Iran	RCT	Obese Men	M	8	23.9	22.8	31.8	30.8	Green tea extract	500 mg	500 mg sucrose	10	10
Jowko et al. 2011	2011	Poland	DB/R/PC	healthy individuals	M	4	21.5	21.2	23.85	23.31	Green tea extract	640 mg of polyphenols	maltodextrin	17	18
Bogdanski et al. 2012	2012	Poland	DB/R/PC	obese, hypertensive patients	F/M	12	49.2	51.5	32.5	33.9	Green tea extract	379 mg	pure microcrystal line cellulose	28	28
Suliburska et al. 2012	2012	Poland	DB/R/PC	Obese Patients	F/M	12	48.56	52.26	32.07	33.45	Green tea extract	379 mg	pure microcrystal line cellulose	23	23
Mousavi et al. 2013 (A)	2013	Iran	RCT	T2DM patients	F/M	8	54.6	52	27.4	28.1	Green tea	4 cup= 10000 mg	-	26	14
Mousavi et al. 2013 (B)	2013	Iran	RCT	T2DM patients	F/M	8	56.2	52	28.1	28.1	Green tea	2 cup= 5000 mg	-	25	14
Lasaitė et al. 2014 (A)	2014	Lithuania	DB/R/PC	T2DM patients	F/M	36	57.2	56.8	NR	NR	Green tea extract	400	microcrystal line cellulose	17	14
Lasaitė et al. 2014 (B)	2014	Lithuania	DB/R/PC	T2DM patients	F/M	36	57.2	56.8	NR	NR	Green tea extract	600	microcrystal line cellulose	17	14
Spadiene et al. 2014 (A)	2014	Lithuania	DB/R/PC	T2DM patients	nr	36	62.18	62.18	35.23	34.98	Green tea extract	400	microcrystal line cellulose	20	25
Spadiene et al. 2014 (B)	2014	Lithuania	DB/R/PC	T2DM patients	nr	36	62.18	62.18	35.23	34.98	Green tea extract	600	microcrystal line cellulose	20	25
Mozaffari- Khosravi et al. 2014	2014	Iran	RCT	Type 2 Diabetes Mellitus	F/M	4	52.2	52.1	28	28.3	Green tea	450 mLl	sour tea	48	46

Kuo et al. 2015	2015	Taiwan	DB/PC	healthy individuals	M	4	20	20	21.95	23.55	Green tea extract	250 mg	starch capsule	10	10
Hadi et al. 2016	2016	Iran	DB/R/PC	soccer players	M	3			22.6	22.82	Green tea extract	450 mg	450 mg of maltodextrin	18	18
Soeizi et al. 2017	2017	Iran	SB/R/PC	β -Thalassemia Major	F/M	8	23.1	24.2	20.9	19.42	Green tea	2500 mg	warm water	26	26
Ribeiro Vaz et al. 2018	2018	Brazil	DB/R/PC	type 1 DM or type 2 DM	F/M	20	46.48	52.29	27.58	25.6	Green tea extract	1120 mg	cellulose capsules	27	28
Venkatakrishnan et al. 2018	2018	Taiwan	DB/R/PC	hypercholesterolemic subjects	F	12	45	45	31.39	28.81	Green tea	600 ml (780.6 mg of catechin)	tea flavor with very less concentration of catechin and caffeine	20	20
Sadowska-Krepa et al. 2019	2019	Poland	RCT	male students of the Physical Education	M	6	22	23.1	23.73	24.72	Green tea extract	250 mg	microcrystalline cellulose, magnesium stearate and maltodextrin	8	8

Abbreviations: IG, intervention group; CG, control group; DB, double-blinded; SB, single-blinded; PC, placebo-controlled; CO, controlled; R, randomized; NR, not reported; F, Female; M, Male; RCT, randomized clinical trial.