SUPPLEMENTARY MATERIAL TO THE MANUSCRIPT

Effects of Nutritional Supplements on Inflammatory Biomarkers in Overweight and Obese Adults: A Systematic Review and Network Meta-Analysis of Randomized Controlled Trials

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Supplementary File S1
PRISMA 2020 Checklist

	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	2-4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4-5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	4，Supplementary file 2.
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	4-5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5

	Item #	Checklist item	Location where item is reported
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	5-6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	6
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	4-5
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	5-6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6-7
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	-
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6，Figure 3.
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6-7
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	6-7 Figure 1.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	6-7
Study characteristics	17	Cite each included study and present its characteristics.	7-8, Supplementary Table 1.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	8, Supplementary Figure 2 and

	Item #	Checklist item	Location where item is reported
			Supplementary Table 4.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	11-15，Supplementary Table 2.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	7-8
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	8-16, Tables 1-4 and Figures2-3;Supplementary Tables 2-3.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	18, Supplementary Figure S4 and Table S5.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	-
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	9, Supplementary Figure 3.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Supplementary Table 6.
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	18-21
	23b	Discuss any limitations of the evidence included in the review.	21
	23c	Discuss any limitations of the review processes used.	21
	23d	Discuss implications of the results for practice, policy, and future research.	21-22
OTHER INFORMATION			

	Item #	Checklist item	Location where item is reported
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	4, PROSPERO CRD42026134882 3.
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	-
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	-
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	22
Competing interests	26	Declare any competing interests of review authors.	22
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	22

Supplementary File S2

Search strategy of PubMed, Embase, Cochrane, Web of Science, and EBSCO

Database	Search Terms	Number of records
PubMed	("Overweight"[Mesh] OR "Obesity"[Mesh] OR "Body Mass Index"[Mesh] OR "Adiposity"[Mesh] OR overweight*[tiab] OR obese[tiab] OR obesity[tiab] OR "body mass index"[tiab] OR BMI[tiab] OR "body weight"[tiab] OR "weight loss"[tiab] OR "weight gain"[tiab] OR adipos*[tiab] OR "fat mass"[tiab] OR "waist circumference"[tiab]) AND ("Magnesium"[Mesh] OR magnesium[tiab] OR Mg[tiab] OR Resveratrol[Mesh] OR "Vitamin D"[Mesh] OR "vitamin d"[tiab] OR cholecalciferol[tiab] OR ergocalciferol[tiab] OR calcitriol[tiab] OR "Zinc"[Mesh] OR zinc[tiab] OR "Probiotics"[Mesh] OR probiotic*[tiab] OR lactobacillus[tiab] OR bifidobacterium[tiab] OR "Thioctic Acid"[Mesh] OR "alpha-lipoic acid"[tiab] OR "lipoic acid"[tiab] OR "thioctic acid"[tiab] OR ALA[tiab] OR "Fatty Acids, Omega-3"[Mesh] OR "omega-3"[tiab] OR "n-3 fatty acids"[tiab] OR "eicosapentaenoic acid"[tiab] OR EPA[tiab] OR "docosahexaenoic acid"[tiab] OR DHA[tiab] OR "fish oil"[tiab] OR "Synbiotics"[Mesh] OR synbiotic*[tiab] OR "Vitamin E"[Mesh] OR "vitamin e"[tiab] OR tocopherol[tiab] OR tocotrienol[tiab] OR "Camellia sinensis"[Mesh] OR "green tea"[tiab] OR "tea extract"[tiab] OR epigallocatechin gallate[tiab] OR EGCG[tiab] OR "Curcumin"[Mesh] OR curcumin[tiab] OR turmeric[tiab]) AND ("Inflammation"[Mesh] OR inflamm*[tiab] OR "inflammatory markers"[tiab] OR "inflammatory mediators"[tiab]) AND (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized[tiab] OR placebo[tiab] OR randomly[tiab] OR trial[tiab] OR groups[tiab])	649
Embase	('obesity'/exp OR 'overweight'/exp OR obes*:ti,ab,kw OR overweight*:ti,ab,kw) AND ('interleukin 6'/exp OR 'tumor necrosis factor alpha'/exp OR 'c reactive protein'/exp OR 'leptin'/exp OR 'adiponectin'/exp OR 'il 6':ti,ab,kw OR 'tnf alpha':ti,ab,kw OR 'tnf α':ti,ab,kw OR crp:ti,ab,kw OR leptin:ti,ab,kw OR adiponectin:ti,ab,kw OR 'inflammation'/exp OR 'innate inflammatory response':ti,ab,kw OR 'inflammatory response, innate':ti,ab,kw OR inflammatory) AND marker*:ti,ab,kw AND ('magnesium'/exp OR magnesium:ti,ab,kw OR mg:ti,ab,kw OR 'vitamin d'/exp OR 'vitamin d':ti,ab,kw OR vd:ti,ab,kw OR 'zinc'/exp OR zinc:ti,ab,kw OR resveratrol:ti,ab,kw OR 'probiotic agent'/exp OR probiotic*:ti,ab,kw OR 'synbiotic agent'/exp OR synbiotic*:ti,ab,kw OR 'alpha lipoic acid'/exp OR 'alpha lipoic acid':ti,ab,kw OR ala:ti,ab,kw OR 'omega 3 fatty acid'/exp OR 'omega 3':ti,ab,kw OR pufa:ti,ab,kw OR 'vitamin e'/exp OR 'vitamin e':ti,ab,kw OR ve:ti,ab,kw OR 'green tea extract'/exp OR 'green tea extract':ti,ab,kw OR 'curcumin'/exp OR curcumin:ti,ab,kw) AND ('randomized controlled trial'/exp OR 'clinical trial'/exp OR random*:ti,ab,kw OR placebo:ti,ab,kw) AND (placebo:ti,ab,kw OR control*:ti,ab,kw OR compar*:ti,ab,kw) AND ('adult'/exp OR adult*:ti,ab,kw)	1582
Cochrane	((overweight):ti,ab,kw OR (obesity):ti,ab,kw OR (obese):ti,ab,kw) AND ((magnesium):ti,ab,kw OR (Mg):ti,ab,kw OR (vitamin D):ti,ab,kw OR (cholecalciferol):ti,ab,kw OR (ergocalciferol):ti,ab,kw OR (zinc):ti,ab,kw OR (Zn):ti,ab,kw OR (probiotic):ti,ab,kw OR (probiotics):ti,ab,kw OR (lactobacillus):ti,ab,kw OR (bifidobacterium):ti,ab,kw OR (alpha lipoic	1188

	acid):ti,ab,kw OR (Thioctic Acid):ti,ab,kw OR (ALA):ti,ab,kw OR (omega-3):ti,ab,kw OR (omega-3 fatty acid):ti,ab,kw OR (n-3 PUFA):ti,ab,kw OR (eicosapentaenoic acid):ti,ab,kw OR (EPA):ti,ab,kw OR (docosahexaenoic acid):ti,ab,kw OR (DHA):ti,ab,kw OR (fish oil):ti,ab,kw OR (synbiotic):ti,ab,kw OR (synbiotics):ti,ab,kw OR (vitamin E):ti,ab,kw OR (tocopherol):ti,ab,kw OR (tocotrienol):ti,ab,kw OR (green tea):ti,ab,kw OR (tea extract):ti,ab,kw OR (EGCG):ti,ab,kw OR (epigallocatechin gallate):ti,ab,kw OR (curcumin):ti,ab,kw OR (turmeric):ti,ab,kw) AND ((inflammation):ti,ab,kw OR (inflammatory marker):ti,ab,kw OR (inflammatory mediator):ti,ab,kw OR (cytokine):ti,ab,kw OR (adipokine):ti,ab,kw OR (interleukin-6):ti,ab,kw OR (IL-6):ti,ab,kw OR (tumor necrosis factor-alpha):ti,ab,kw OR (TNF-alpha):ti,ab,kw OR (TNF-α):ti,ab,kw OR (C-reactive protein):ti,ab,kw OR (CRP):ti,ab,kw OR (leptin):ti,ab,kw OR (adiponectin):ti,ab,kw) AND ((randomized controlled trial):ti,ab,kw OR (randomized):ti,ab,kw OR (placebo):ti,ab,kw OR (randomly):ti,ab,kw) AND ((supplementation):ti,ab,kw OR (intake):ti,ab,kw)	
Web of Science	TS=((overweight OR obesity OR adiposity OR obese OR "weight loss" OR "weight gain" OR adipos* OR "fat mass" OR "waist circumference")AND (magnesium OR Mg OR "vitamin D" OR cholecalciferol OR "25-hydroxyvitamin D" OR "25(OH)D" OR zinc OR Zn OR probiotic* OR lactobacillus OR bifidobacterium OR saccharomyces OR "streptococcus thermophilus" OR "alpha-lipoic acid" OR "lipoic acid" OR "thioctic acid" OR ALA OR "omega-3" OR "n-3 fatty acid*" OR "eicosapentaenoic acid" OR EPA OR "docosahexaenoic acid" OR "resveratrol" OR DHA OR "fish oil" OR synbiotic* OR symbiotic* OR "vitamin E" OR tocopherol* OR tocotrienol* OR "green tea" OR "tea extract" OR "camellia sinensis" OR "epigallocatechin gallate" OR EGCG OR curcumin OR turmeric OR curcuma)AND (inflamm* OR "inflammatory marker*" OR "inflammatory mediator*" OR "interleukin-6" OR "IL-6" OR "tumor necrosis factor-alpha" OR "TNF-alpha" OR "TNF-α" OR "C-reactive protein" OR CRP OR leptin OR adiponectin) AND (randomized OR "randomized controlled trial" OR "controlled clinical trial" OR placebo OR randomly OR trial OR groups OR "double-blind" OR "single-blind" OR "clinical trial"))AND WC=("Nutrition & Dietetics")	1858
EBSCO	(MH "Obesity" OR MH "Overweight" OR TI (overweight OR obesity OR obese) OR AB (overweight OR obesity OR obese)) AND (MH "Magnesium" OR MH "Vitamin D" OR MH "Zinc" OR MH "Probiotics" OR MH "Fatty Acids, Omega-3" OR TI (magnesium OR "vitamin D" OR zinc OR probiotic* OR omega-3 OR EPA OR DHA OR "fish oil" OR synbiotic* OR curcumin) OR AB (magnesium OR "vitamin D" OR zinc OR probiotic* OR omega-3)) AND (MH "Inflammation" OR MH "Interleukin-6" OR MH "Tumor Necrosis Factor-alpha" OR MH "C-Reactive Protein" OR MH "Leptin" OR MH "Adiponectin" OR TI (cytokine* OR "IL-6" OR "TNF-alpha" OR CRP OR leptin OR adiponectin) OR AB ("IL-6" OR "TNF-alpha" OR CRP OR leptin OR adiponectin)) AND (MH "Randomized Controlled Trial" OR TI (randomized OR placebo) OR AB (randomized OR placebo))	302

Supplementary Table S1

Characteristics of included studies.

Author	Year	Country	Sample		Age Mean(SD) /Range	Male %	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Walker et al. [1]	2018	America	14	14	47 ± 8 48 ± 9	100	35.0 ± 3.0 33.8 ± 3.3	Placebo vs. Resveratrol (2000 mg, b.i.d.)	yes	yes	4	CRP
Arzola et al. [2]	2016	Mexico	15	24	33.7 ± 11.9 38.8 ± 9.6	15.4	35.6 ± 2.7 34.7 ± 2.9	Placebo vs. Resveratrol (300 mg, q.d.)	no	yes	24	Leptin, Adiponectin
Kantartzis et al. [3]	2018	Germany	52	53	18-70	100	33-35	Placebo vs. Resveratrol (150 mg, q.d.)	no	no	12	IL-6,CRP, Adiponectin
Poulsen et al. [4]	2012	Denmark	12	12	44.7 ± 12.1 31.9 ± 10	100	32.5 ± 0.6 35.9 ± 1.2	Placebo vs. Resveratrol (500 mg, q.d.)	no	no	4	IL-6,TNF-α,CRP, Leptin
Seyyedebrahimi et al. [5]	2018	Iran	23	23	54.96 ± 6.37 58.72 ± 6.06	52	29.0 ± 3.4 28.9 ± 5.3	Placebo vs. Resveratrol (400 mg ,b.i.d.)	no	yes	8	CRP
Joris et al. [6]	2017	Netherlands	26	25	62 ± 6 62 ± 6	57.7	29.6 ± 2.8 29.6 ± 2.8	Placebo vs. Magnesium (350 mg,q.d.)	no	yes	24	IL-6,TNF-α,CRP
Moslehi et al. [7]	2012	Iran	35	34	40-55	0	28.0 ± 3.2 28.1 ± 2.9	Placebo vs. Magnesium (250 mg, q.d.)	no	no	8	IL-6，CRP
Chacko et al. [8]	2010	America	7	7	47.0 ± 13.8 41.9 ± 12.7	69.2	28.3 ± 1.6 28.1 ± 2.2	Placebo vs. Magnesium (500 mg,q.d.)	no	no	4	IL-6,TNFα, CRP,Leptin
Talari et al. [9]	2019	Iran	27	27	61.8 ± 10.2 58.8 ± 10.1	46	27.2 ±5.6 26.1 ±4.5	Placebo vs. Magnesium (250 mg, q.d.)	no	no	24	CRP

Author	Year	Country	Sample		Age Mean(SD) /Range	Male %	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Abiri et al. [10]	2021	Iran	25/26/26	25	34.40 ± 9.39 34.15 ± 9.28 34.30 ± 9.24 34.36 ± 9.36	0	33.47 ±1.82 33.18 ±1.92 33.00 ±1.93 33.40 ±1.93	Placebo vs. Vitamin D (50,000 IU, q.w.) vs. Magnesium (250 mg, q.d.) vs.Vitamin D (50,000 IU, q.w.) + Magnesium (250 mg, q.d.)	no	no	8	IL-6,TNF-α, CRP,
Kheyruri et al. [11]	2020	Iran	42	41	45 ± 5.9 46.7 ± 6.7	0	27.6-35.05	Placebo vs. Vitamin D (50,000 IU, q.w.) + Magnesium (250 mg, q.d.)	no	no	8	IL-6,TNF-α, CRP
Agbalalah et al. [12]	2022	UK	28	27	35.9±11.8 33.1±12.2	100	29.9 ± 3.3 28.4 ± 2.6	Placebo vs. Vitamin D(125 μg, q.d.)	no	no	8	CRP
Cheung.et al. [13]	2022	America	21/34	23	41.0-45.3	35.9	25-40	Placebo vs. Vitamin D (1000 IU, t.i.d.) vs.Mg (360 mg, t.i.d.) + Vitamin D (1000 IU, t.i.d.)	no	yes	12	IL-6,CRP,Adiponectin
Duggan et al. [14]	2015	America	109	109	60.3 ± 5.3 59.0 ± 4.7	0	28.51 ±1.04 28.39 ±0.87	Placebo vs. Vitamin D (2000 IU, q.d.)	yes	yes	52	IL-6,TNF-α, Leptin,Adiponectin
Khodadoust et al. [15]	2021	Iran	13	13	45-55	100	33.7 ± 4.1 33.0 ± 4.3	Placebo vs. Vitamin D (50,000 IU,q.w,)	yes	no	8	TNF-α
Zittermann et al. [16]	2009	Germany	82	83	47.4±10.3 43.7±10.1	32.7	33.17 ±6.34 32.64 ±2.37	Placebo vs. Vitamin D (3,332IU,q.d.)	no	yes	52	IL-6,TNF-α, CRP
Khorsandi et al. [17]	2019	Iran	18	22	35.63 ± 3.2 32.95 ± 1.7	28	30-58.5 28.51 ±1.04	Placebo vs. Zinc (30 mg, q.d.)	no	yes	15	CRP
Santellano et al. [18]	2024	Mexico	8/9	7	NA	25	28.39 ±0.87	Placebo vs. Zinc (50 mg, q.d.) vs. Resveratrol (500 mg, q.d.)	no	no	8.5	Leptin

Author	Year	Country	Sample		Age Mean(SD) /Range	Male %	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Foster et al. [19]	2013	Australia	12/10	10	65.0 ± 7.8	0	28.6 ± 5.1	Placebo vs. Zinc (40 mg, q.d.) vs. α-Lipoic acid (2 g , q.d.)	no	no	12	IL-6,TNF-α,CRP
Kobyliak et al. [20]	2020	Ukraine	28	26	56.29 ± 11.14 55.73 ± 8.76	50	35.66 ± 5.35 35.63 ± 7.76	Placebo vs. Probiotic+omega-3 PUFA (1 sachet, q.d.)	no	no	8	IL-6,TNF-α
Laue et al. [21]	2023	Germany	60/60	60	61.50 ± 11.30 56.90 ± 14.60 61.80 ± 10.30	36.7	32.37 ± 5.18 31.98 ± 5.73 32.64 ± 5.50	Placebo vs. Probiotic (5×10^9 CFU, b.i.d.) vs. Synbiotic (10 g, q.d.)	no	no	12	CRP
Noori et al. [22]	2025	Iran	32	35	65-66	100	26.97 ± 2.46 27.34 ± 3.02	Placebo vs. Probiotic（3×10^9 CFU, q.d.)	no	no	8	IL-6,CRP
Tenorio-Jiménez et al. [23]	2019	Spain	25	28	NA	NA	38.30 ± 7.3 38.76 ± 7.2	Placebo vs. Probiotic(5×10^9 CFU, q.d.)	yes	yes	12	IL-6, TNF-α, CRP, Leptin, Adiponectin,
Nasiri et al. [24]	2021	Iran	21/21/21	21	34.67 ± 5.02 37.33 ± 7.64 34.86 ± 5.73 34.29 ± 7.25	NA	27.57 ± 0.77 27.26 ± 0.57 27.78 ± 0.98 27.87 ± 0.51	Placebo vs. Probiotic (500 mg, q.d.) vs. Alpha-Lipoic Acid (600 mg, q.d.) vs. Probiotic (500 mg, q.d.) + Alpha-Lipoic Acid (600 mg, q.d.)	no	yes	24	CRP
Rajkumar et al. [25]	2014	India	15/15/15	15	40–60	50	28.79 ± NA	Placebo vs. Probiotic (1.125×1011CFU, q.d.) vs. Omega-3 (180 mg EPA + 120 mg DHA, q.d.) vs.Probiotic(1.125×1011CFU, q.d.) + Omega-3(180 mg EPA + 120 mg DHA, q.d.)	no	no	6	CRP

Author	Year	Country	Sample		Age Mean(SD) /Range	Male%	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Farrokhian et al. [26]	2017	Iran	30	30	50-85	36.7	32.3 ± 6.0	Placebo vs. Synbiotic (2× 109CFU/g + 800 mg inulin)	no	no	12	CRP
Kanazawa et al. [27]	2021	Japan	44	42	61.1 ± 11.0 61.1 ± 11.0	70.5	29.6 ± 4.6 29.5 ± 4.4	Placebo vs. Synbiotic(3×10^8 CFU b.i.d.)	no	yes	24	IL-6
Lyon et al. [28]	2023	India	46	49	41.13 ± 6.58 41.74 ± 7.21	20.4	29.1 ± 3.7 31.15 ± 2.83	Placebo vs. Synbiotic(2×1010 CFU,q.d.)	no	no	12	CRP
Rabiei et al. [29]	2018	Iran	20	20	57.1 ± 1.5 60.8 ± 1.6	28.3	29.89 ± 2.59 32.7 ± 1.0	Placebo vs. Synbiotic (2×10^8 CFU, b.i.d.)	no	yes	12	IL-6,CRP
Raji Lahiji et al. [30]	2021	Iran	36	36	56.56 ± 5.07 58.31 ± 6.44	0	32.7 ± 1.0 NA	Placebo vs. Synbiotic (1×10^9 CFU, q.d.)	no	yes	8	CRP,Adiponectin
Ekhlasi et al. [31]	2017	Iran	15/15	15	25-64	80	27.28 ± 2.21	Placebo vs. Synbiotic (4×10^8 CFU, q.d.) vs. Vitamin E(400 IU, q.d.)	no	yes	52	TNF-α
Pauls et al. [32]	2021	Canada	21	22	21-51	0	36.8 ± 6.10 36.8 ± 6.10	α-Lipoic acid (4 g,q.d) vs. Omega-3 (3.86 g DHA + 1.01 g EPA, q.d.)	no	yes	4	IL-6,TNF-α,CRP, Adiponectin
Huerta et al. [33]	2015	Spain	19	21	38 ± 7 39 ± 8	0	27.5-40	Placebo vs. α-Lipoic acid (300 mg, q.d.)	no	yes	10	Leptin
Mohammadi et.al. [34].	2015	Iran	28	30	39 ± 6.44 36.8 ± 7.48	100	27.77 ± 4.33 28.02 ± 5.09	Placebo vs. α-Lipoic acid (600 mg, q.d.)	no	no	12	IL-6,CRP
Sardu et al. [35]	2017	Italy	33	40	58.8 ± 6.7 61.5 ± 8.1	52	29.6±4.8 28.9±2.5	Placebo vs. α-Lipoic acid (600 mg, q.d.)	no	no	52	IL-6,TNF-α, CRP

Author	Year	Country	Sample		Age Mean(SD) /Range	Male%	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Marfella et al. [36]	2015	Italy	22	21	63.7 ± 6.5 63.9 ± 5.2	0	27.0 ± 1.6 27.6 ± 2.2	Placebo vs. α-Lipoic acid (600 mg, q.d.)	no	no	52	TNF-α,CRP
Manning et al. [37]	2012	New Zealand	34/36	40	55±10 57±10 54±13	37.1	31.7 ± 6.2 31.5 ± 5.6 31.3 ± 5.3	Placebo vs. α-Lipoic acid (600 mg, q.d.) vs. Vitamin E (100 IU, q.d.)	no	yes	52	IL-6,TNF-α,CRP, Adiponectin
Zhang et al. [38]	2011	China	13	9	52.5 ± 8.2 52.6 ± 6.2	50	30.2 ± 1.4 30.4 ± 2.1	Placebo vs. α-Lipoic acid (600 mg, q.d.)	no	yes	2	IL-6,TNF-α,Adiponectin
Bakker et al. [39]	2023	Netherlands	26	30	44-49	0	41-43	Placebo vs. Omega-3(920 mg EPA + 760 mg DHA, q.d.)	no	yes	4	IL-6,CRP
Itariu et al. [40]	2012	Austria	27	28	39 ± 10.6 39 ± 10.6	14.8	43.5 ± 5.5 44.4 ± 5.4	Placebo vs. Omega-3(1840 mg EPA + 1520 mg DHA q.d.)	no	no	8	IL-6,CRP,Leptin, Adiponectin
Krebs et al. [41]	2006	UK	35	32	21-69	0	35.3 ± 5.6	Placebo vs. Omega-3 (1300mg EPA + 2900mg DHA, q.d.)	yes	yes	24	IL-6,TNF-α,CRP, Leptin,Adiponectin
Munro et al. [42]	2013	Australia	15	18	18-60	33	30-40	Placebo vs. Omega-3 (1620 mg DHA + 420 mg EPA,q.d)	no	yes	12	IL-6,TNF-α,CRP, Leptin,Adiponectin
Huerta et al. [43]	2015	Spain	16/19	21	20–50	0	27.5-40	Placebo vs. Omega-3(1300 mg, q.d.) vs. α-Lipoic acid (300 mg, q.d.)	no	yes	10	IL-6,CRP,Adiponectin
Hejazi et al. [44]	2015	Iran	14	13	48.0 ± 6.28 46.61 ± 7.58	25.9	29.22 ± 6.62 28.81 ± 4.04	Placebo vs. Vitamin E (400 IU, q.d.)	no	no	6	IL-6,CRP
Khosla et al. [45]	2013	America	41	40	59 ± 12 59 ± 12	53	30.3 ± 8.1 28.7 ± 8.2	Placebo vs. Vitamin E (220 mg ,q.d.)	no	no	16	IL-6

Author	Year	Country	Sample		Age Mean(SD) /Range	Male%	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Devaraj et al. [46]	2008	America	20	20	57 ± 14 56±11	30	35 ± 7 39 ± 15	Placebo vs. Vitamin E(800 mg α-Tocopherol + 800 mg γ-Tocopherol, q.d.)	no	no	6	IL-6,TNF-α
Stonehouse et al. [47]	2016	Australia	28	29	18-70	57	30.7-34.8	Placebo vs. Vitamin E (132 mg α-Tocopherol + 420 mg γ-Tocophero, q.d.)	no	yes	8	TNF-α
Pervez et al. [48]	2018	Pakistan	31	33	44.7 ± 8.8 43.9 ± 9.2	50	30.68 ± 2.9 31.30 ± 3.1	Placebo vs. Vitamin E(600mg,q.d.)	yes	yes	12	CRP
Bagheri et al. [49]	2020	Iran	15	15	43.8±3.4 44.6±3.0	100	27.3 ± 0.4 27.8 ± 0.3	Placebo vs. Green tea extract (500 mg, q.d.)	yes	yes	8	TNF-α,CRP Adiponectin
de Oliveira Vogado et al. [50]	2024	Brazil	32	29	20-60	0	27.5-28.9	Placebo vs. Green tea extract (558 mg, q.d.)	no	yes	12	IL-6
Nogueira et al. [51]	2016	Brazil	20	20	41.1 ± 8.4 41.1 ± 8.4	0	33.56 ± 0.98 33.56 ± 0.98	Placebo vs. Green tea extract (1500 mg, q.d.)	no	no	4	IL-6,TNF-α,CRP, Adiponectin
Bogdanski et al [52]	2012	Poland	28	28	51.5 ± 7.4 49.2 ± 8.8	50	32.5 ± 3.3 33.9 ± 2.3	Placebo vs. Green tea extract (379 mg,q.d.)	no	yes	12	TNF-α,CRP
Basu et al. [53]	2010	America	7	11	39.5 ± 3.0 44.6 ± 3.2	41.7	36.1 ± 1.3 36.1 ± 1.3	Placebo vs. Green tea extract (460 mg,q.d.)	no	yes	8	CRP,Leptin,Adiponectin
Cunningham et al. [54]	2026	America	50	47	60.4± 5.3 60.4± 5.5	0	29.1 ± 3.1 28.7 ± 2.7	Placebo vs. Green tea extract (843 mg , q.d.)	no	no	52	IL-6,TNF-α,CRP
Campbell et al. [55]	2019	America	10	10	18-35	NA	NA	Placebo vs. Curcumin (500 mg, q.d.)	no	no	12	Adiponectin
Ganjali et al. [56]	2014	Iran	42	42	18-65	NA	NA	Placebo vs. Curcumin (1000 mg , q.d.)	no	no	4	IL-6,TNF-α

Author	Year	Country	Sample		Age Mean(SD) /Range	Male%	BMI	Interventions	Exercise	Diet control	Duration (week)	Outcome
			T	C								
Hellmann et al. [57]	2022	Denmark	18	19	46 ± 14	73	38.0 ± 5.5 39.5 ± 6.8	Placebo vs. Curcumin (400 mg, q.d.)	no	no	6	IL-6,TNF-α,CRP, Adiponectin
Jazayeri-Tehrani et al. [58]	2019	Iran	42	42	41.8 ± 5.6 42.5 ± 6.2	54.8	30.67 ± 2.14 30.75 ± 2.35	Placebo vs. Curcumin (80 mg, q.d.)	yes	yes	12	IL-6,TNF-α,CRP
Sohaei et al. [59]	2019	Iran	27	24	29.40 ± 5.33 29.58 ± 5	0	29.67 ± 3.72 31.32 ± 4.60	Placebo vs. Curcumin (1000 mg,q.d.)	no	no	6	CRP
Yaikwawong et al. [60]	2024	Thailand	113	114	60.27 ± 0.83 62.26 ± 0.81	51.1	27.21 ± 0.37 26.76 ± 0.38	Placebo vs.Curcumin (1500 mg, q.d.)	yes	yes	48	IL-6,TNF-α

Supplementary File S3

List of included studies.

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Supplementary Table S2

Pairwise meta-analysis

Comparisons	Studies	Participants	Heterogeneity%	Mean diff. (95% CI)
IL-6				
Resveratrol vs Placebo	**2**	**129**	(P=0.13), I^2=56.27	-0.142 (-0.966, 0.683)
Mg vs Placebo	**4**	**197**	(P=0.073), I^2=56.46	0.053 (-0.162, 0.267)
VD＋Mg vs Placebo	**3**	**179**	(P=0.607, I^2=0	-0.110 (-0.348, 0.127)
Zinc vs Placebo	**1**	**22**	NA	-0.140 (-0.454, 0.174)
omega-3+Probiotics vs Placebo	**1**	**54**	NA	0.980 (-4.209, 6.169)
Probiotics vs Placebo	**3**	**120**	(P=0.008), I^2=78.47	-0.854 (-1.792, 0.084)
VD vs Placebo	**4**	**476**	(P=0.863), I^2=0	-0.030 (-0.350, 0.291)
α-lipoic acid vs Placebo	**7**	**328**	(P<0.001), I^2=90.34%	-0.319 (-0.789, 0.151)
Synbiotic vs Placebo	**2**	**126**	(P=0.757), I^2=0	-0.026 (-0.286, 0.234)
omega-3 vs Placebo	**6**	**289**	(P=0.567), I^2=0	-0.259 (-0.506,-0.013)
VE vs Placebo	**4**	**222**	(P=0.869), I^2=0	-0.295 (-0.914, 0.324)
Green tea vs Placebo	**3**	**154**	(P=0.973), I^2=0	-0.946 (-2.299, 0.406)
Curcumin vs Placebo	**3**	**151**	(P=0.102), I^2=69.6%	-0.285 (-0.971, 0.402)

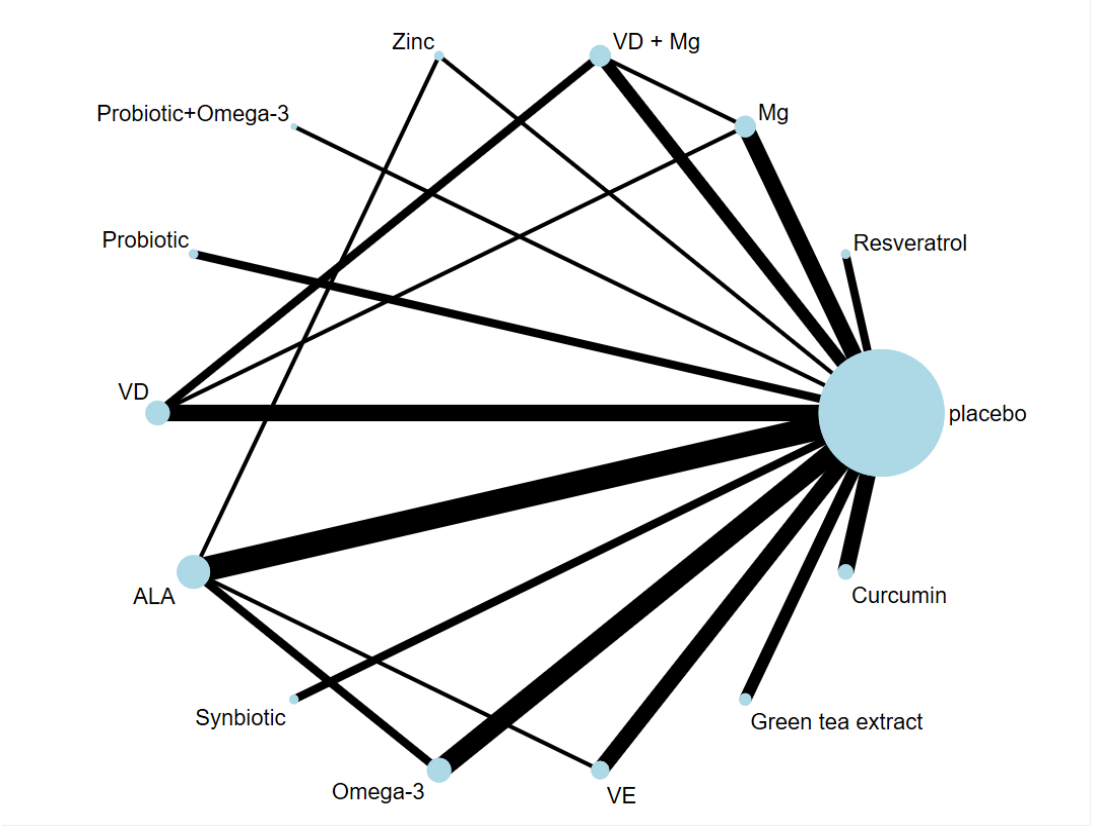
Comparisons	Studies	Participants	Heterogeneity	Mean diff. (95% CI)
TNF-a				
Resveratrol vs Placebo	**1**	**24**	NA	-0.860 (-4.725, 3.005)
Mg vs Placebo	**3**	**128**	(P=0.220), I^2=36.10	-0.099 (-0.757, 0.559)
VD＋Mg vs Placebo	**1**	**50**	NA	-1.060 (-1.983, -0.137)
Zinc vs Placebo	**1**	**22**	NA	0.700 (-0.178, 1.578)
omega-3+Probiotics vs Placebo	**1**	**54**	NA	-6.63(-11.916,-1.344)
Probiotics vs Placebo	**1**	**53**	NA	-1.54 (-2.476, -0.604)
VD vs Placebo	**5**	**527**	(P=0.074), I^2=55.04	-0.403 (-0.956, 0.149)
α-lipoic acid vs Placebo	**6**	**271**	(P<0.001), I^2=93.28	-0.804 (-1.850, 0.242)
Synbiotic vs Placebo	**1**	**30**	NA	-11.04(-20.488,-1.592)
omega-3 vs Placebo	**3**	**142**	(P=0.008), I^2=79.68	-0.653 (-1.936, 0.630)
VE vs Placebo	**3**	**171**	(P<0.001), I^2=92.75	-0.139 (-0.447, 0.168)
Green tea vs Placebo	**4**	**266**	(P=0.789), I^2=0.00	-0.119 (-0.429, 0.191)
Curcumin vs Placebo	**4**	**374**	(P<0.001), I^2=88.51	-0.222 (-0.542, 0.097)

Comparisons	Studies	Participants	Heterogeneity	Mean diff. (95% CI)
		CRP		
Resveratrol vs Placebo	**4**	**205**	(P=0.402), I^2=0.00	0.421 (-0.520, 1.362)
Mg vs Placebo	**5**	**254**	(P=0.228), I^2=0.00	-0.052 (-0.258,0.153)
VD＋Mg vs Placebo	**3**	**180**	(P<0.001),I^2=92.85	-0.343 (-0.825,0.139)
Zinc vs Placebo	**2**	**60**	(P=0.599), I^2=0.00	-0.936(-1.473,-0.399)
α-lipoic acid +Probiotics vs Placebo	**1**	**42**	**NA**	-0.270(-0.319,-0.221)
omega-3+Probiotics vs Placebo	**1**	**30**	**NA**	-0.070 (-1.752, 1.612)
Probiotics vs Placebo	**5**	**302**	(P=0.460), I^2=0.00	-0.210 (-0.251,-0.168)
VD vs Placebo	**4**	**332**	(P=0.407), I^2=24.92	-0.004 (-0.126, 0.118)
α-lipoic acid vs Placebo	**8**	**376**	(P<0.001), I^2=98.36	-0.343 (-0.924, 0.238)
Synbiotic vs Placebo	**5**	**379**	(P=0.180), I^2=40.12	-0.157 (-0.480, 0.166)
omega-3 vs Placebo	**7**	**320**	(P=0.287), I^2=23.53	-0.252 (-0.865, 0.360)
VE vs Placebo	**3**	**160**	(P=0.948), I^2=0.00	-0.617 (-1.265, 0.030)
Green tea vs Placebo	**5**	**240**	(P=0.316), I^2=8.52	-0.808 (-1.174,-0.442)
Curcumin vs Placebo	**3**	**174**	(P=0.006), I^2=86.82	-0.774 (-2.351, 0.803)
Comparisons	**Studies**	**Participants**	**Heterogeneity**	**Mean diff. (95% CI)**
		Leptin		
Resveratrol vs Placebo	**3**	**79**	(P=0.714), I^2=0.00%	0.941 (-4.629, 6.512)
Mg vs Placebo	**1**	**26**	**NA**	-0.12(-4.867, 4.627)
Zinc vs Placebo	**1**	**15**	**NA**	16.10 (-13.063, 45.263)
Probiotics vs Placebo	**1**	**53**	**NA**	-10.040(-16.416,-3.664)
VD vs Placebo	**1**	**201**	**NA**	-1.12 (-6.352, 4.112)
α-lipoic acid vs Placebo	**1**	**40**	**NA**	-3.40 (-7.985, 1.185)
omega-3 vs Placebo	**3**	**155**	(P=0.571), I^2=0.00	2.043 (-2.396, 6.482)
Green tea vs Placebo	**1**	**18**	**NA**	-6.90 (-31.726,17.926)
Comparisons	**Studies**	**Participants**	**Heterogeneity**	**Mean diff. (95% CI)**
		Adiponectin		
Resveratrol vs Placebo	**2**	**144**	(P=0.758), I^2=0.00	-0.085 (-1.488, 1.317)
VD＋Mg vs Placebo	**1**	**46**	**NA**	-0.010 (-0.216, 0.196)
Probiotics vs Placebo	**1**	**53**	**NA**	1.380 (-0.828, 3.588)
VD vs Placebo	**2**	**150**	(P=0.920), I^2=0.00	0.081 (-0.126, 0.287)
α-lipoic acid vs Placebo	**4**	**177**	(P<0.001), I^2=88.38	0.391 (-1.614, 2.396)
Synbiotic vs Placebo	**1**	**72**	**NA**	5.020 (-2.175, 12.215)

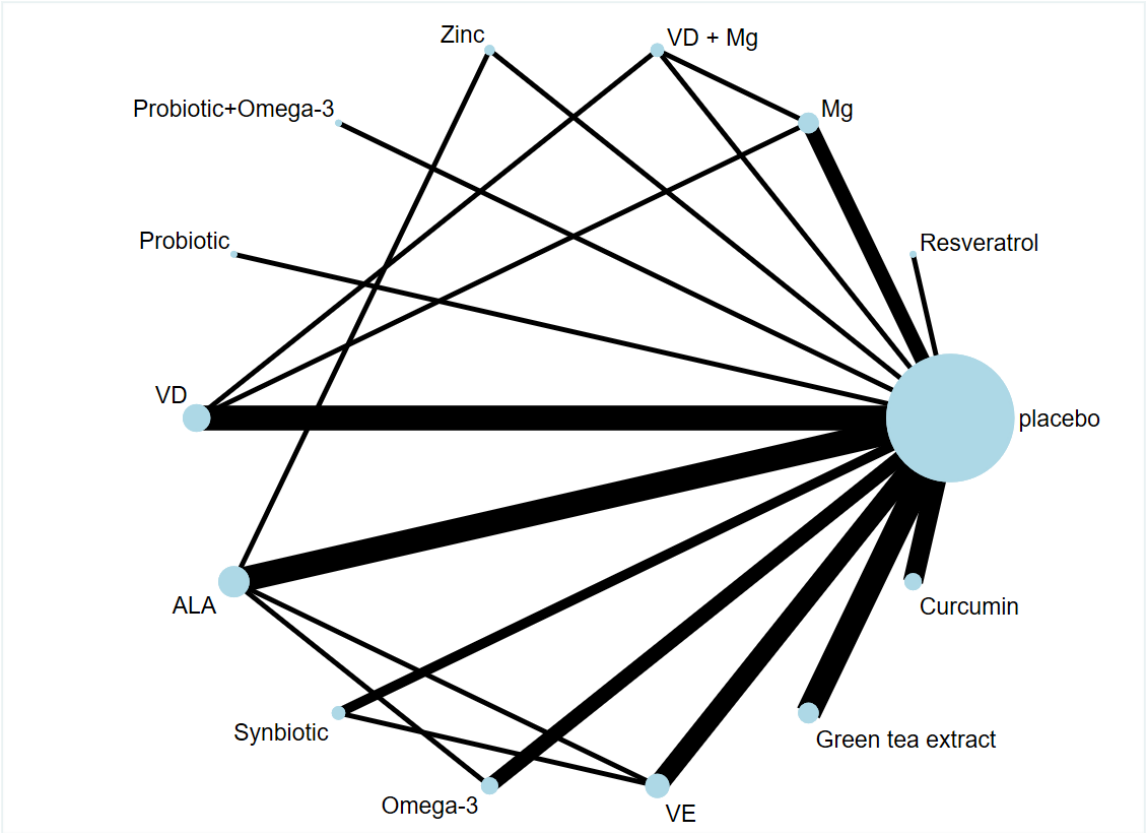
omega-3 vs Placebo	**5**	**235**	(P=0.227), I^2=35.49	-0.434 (-1.755, 0.887)
VE vs Placebo	**1**	**74**	**NA**	1.030 (-1.603, 3.663)
Green tea vs Placebo	**3**	**84**	(P=0.002), I^2=85.45	0.662 (-1.111, 2.434)
Curcumin vs Placebo	**2**	**57**	(P=0.462), I^2=0.00	0.269 (-0.595, 1.133)

Supplementary Figure S1.
Network plot of different nutrition supplements for overweight and obese treatment

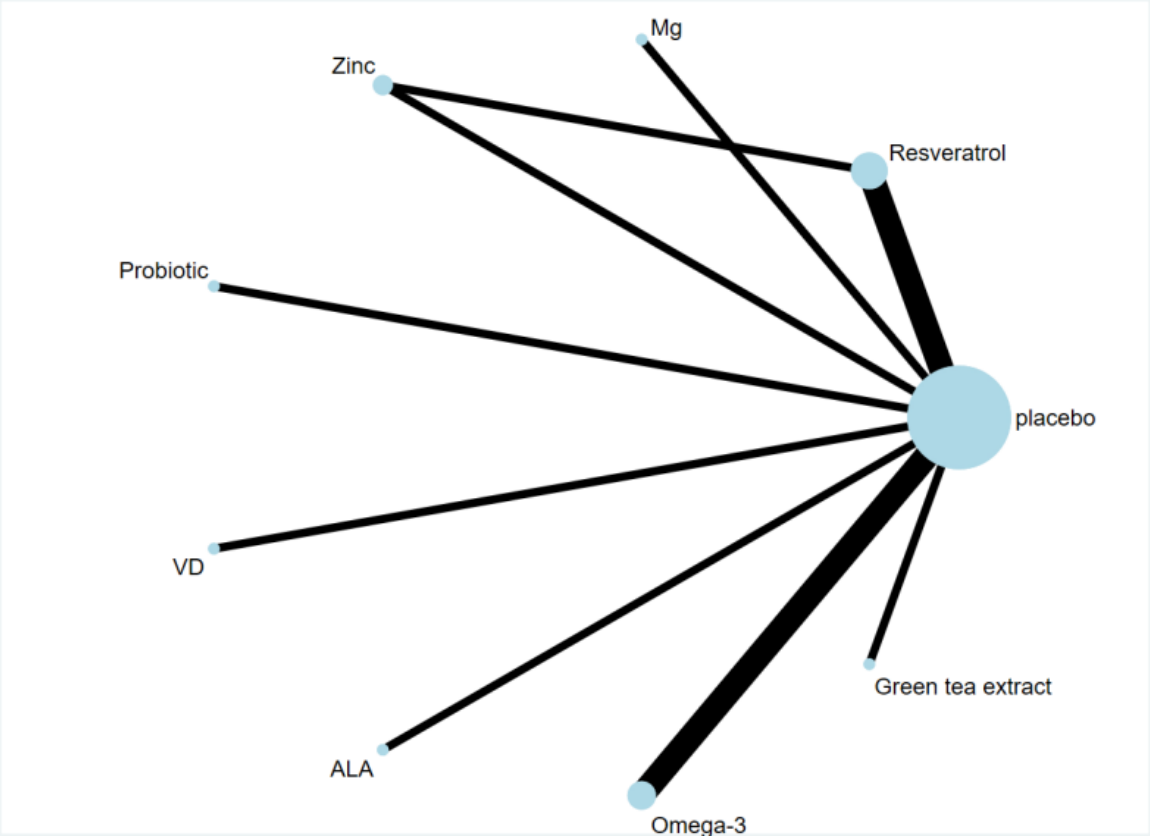
IL-6



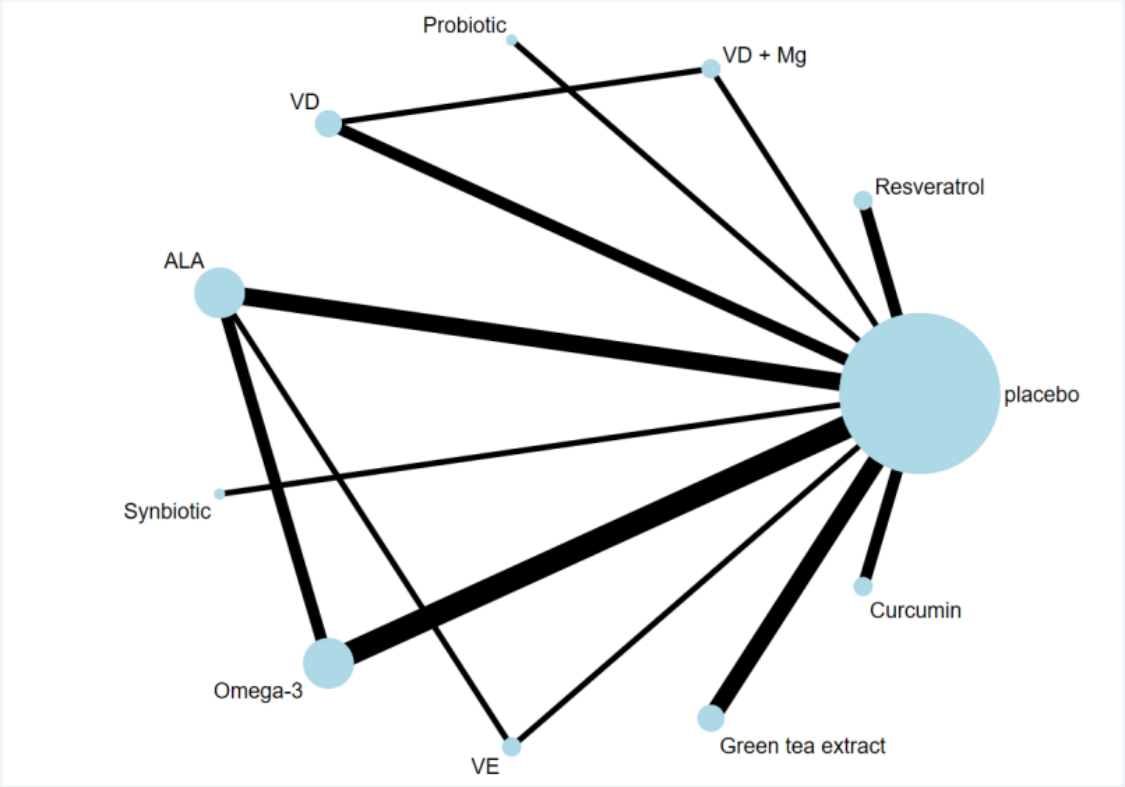
TNF-a



Leptin



Adiponectin



Supplementary Table S3

Inconsistency of IL-6，TNF-α，CRP, leptin, adiponectin, tested by loop-specific heterogeneity estimates, inconsistency model and node splitting analysis

Note:

loop-specific heterogeneity estimates

Loop	IF	seIF	z_value	p_value	CI_95	Loop_Heterog_tau2
		IL-6				
Placebo-Zinc-ALA	1.01	1.06	0.953	0.341	(0.00,3.09)	0.095
Placebo-VD + Mg-VD	0.755	0.601	1.255	0.209	(0.00,1.93)	0.073
Placebo-ALA-Omega-3	0.655	0.465	1.41	0.158	(0.00,1.57)	0.100
Mg-VD + Mg-VD	0.47	0.133	3.542	0.062	(0.00,0.73)	0.000
Placebo-Mg-VD	0.388	0.619	0.626	0.531	(0.00,1.60)	0.046
Placebo-Mg-VD + Mg	0.219	0.32	0.686	0.493	(0.00,0.85)	0.033
Placebo-ALA-VE	0.121	0.935	0.129	0.897	(0.00,1.95)	0.145
		TNF-a				
Placebo-Zinc-ALA	2.30	1.523	1.51	0.131	(0.00,5.29)	0.827
Placebo-ALA-VE	1.259	1.09	1.155	0.248	(0.00,3.40)	0.15
Placebo-Mg-VD	0.731	1.077	0.679	0.497	(0.00,2.84)	0.195
Placebo-Mg-VD + Mg	0.499	0.347	1.438	0.15	(0.00,1.18)	0.00
Placebo-ALA-Omega-3	0.496	1.461	0.34	0.734	(0.00,3.36)	0.795
Placebo-VD + Mg-VD	0.091	0.619	0.146	0.884	(0.00,1.30)	0.153
		CRP				
Placebo-Zinc-ALA	1.156	1.145	1.009	0.313	(0.00,3.40)	0.265
Placebo-Probiotic+Omega-3-Probiotic	1.054	0.531	1.986	0.057	(0.00,2.09)	0.009
Placebo-Probiotic-Synbiotic	0.932	1.145	0.814	0.416	(0.00,3.17)	0.279
Placebo-ALA-VE	0.681	1.156	0.589	0.556	(0.00,2.95)	0.269
Probiotic-ALA-Omega-3	0.601	0.333	1.805	0.071	(0.00,1.25)	0.00
Placebo-Probiotic-Omega-3	0.598	0.68	0.879	0.379	(0.00,1.93)	0.015
Placebo-Probiotic+ALA-ALA	0.473	1.701	0.278	0.781	(0.00,3.81)	0.579
Placebo-ALA-Omega-3	0.426	0.913	0.467	0.641	(0.00,2.22)	0.58
Placebo-VD + Mg-VD	0.414	0.568	0.729	0.466	(0.00,1.53)	0.183
Placebo-Probiotic-ALA	0.271	0.848	0.32	0.749	(0.00,1.93)	0.154
Placebo-Mg-VD + Mg	0.271	1.831	0.148	0.882	(0.00,3.86)	0.336
Placebo-Probiotic+Omega-3-Omega-3	0.225	0.801	0.281	0.779	(0.00,1.79)	0.15
Mg-VD + Mg-VD	0.13	0.051	2.551	0.051	(0.00,0.23)	0.00
Placebo-Probiotic+ALA-Probiotic	0.129	0.585	0.221	0.825	(0.00,1.28)	0.038
Placebo-Mg-VD	0.058	0.71	0.082	0.935	(0.00,1.45)	0.021
		Leptin				
Placebo-Resveratrol-VD + Mg	5.645	8.506	0.664	0.507	(0.00,22.32)	0.00

			Adiponectin			
Placebo-ALA-VE	1.039	0.473	2.196	0.058	(0.00,1.97)	0.00
Placebo-ALA-Omega-3	0.735	3.048	0.241	0.809	(0.00,6.71)	2.826
Placebo-VD + Mg-VD	0.19	0.227	0.837	0.403	(0.00,0.63)	0.00

	Inconsistency model				
	IL-6	**TNF-a**	**CRP**	**Leptin**	**Adiponectin**
chi2	1.21	4.23	8.92	1.10	7.56
Prob > chi2	0.999	0.646	0.962	0.293	0.182

Node splitting analysis							
Side	**Direct**		**Indirect**		**Difference**		
	Coef.	**Std. Err.**	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**	**P>z**
				IL-6			
A C	0.169	0.894	-0.620	3.067	0.789	3.195	0.805
A D	-0.263	1.032	-1.043	2.623	0.780	2.819	0.782
A E	-0.640	1.789	-3.012	3.431	2.372	3.861	0.539
A H	-0.423	0.895	0.541	2.887	-0.964	3.023	0.750
A I	-0.625	0.757	-1.015	1.691	0.390	1.852	0.833
A K	-0.399	0.803	-0.132	1.841	-0.268	2.009	0.894
A L	-0.853	0.915	-1.302	3.459	0.448	3.578	0.900
C D	-0.200	1.787	-0.691	1.581	0.491	2.386	0.837
C H	-0.080	1.786	-0.682	1.436	0.602	2.292	0.793
D H	0.355	1.259	-0.890	2.118	1.245	2.464	0.613
E I	0.960	1.789	-1.412	3.430	2.372	3.861	0.539
I K	0.510	1.264	0.171	1.213	0.339	1.752	0.846
I L	0.031	1.789	-0.311	1.300	0.342	2.212	0.877
				TNF-α			
A C	0.588	0.767	-0.178	2.610	0.766	2.710	0.777
A D	-0.710	1.292	0.611	2.147	-1.321	2.506	0.598
A E	0.900	1.283	-3.340	2.542	4.240	2.852	0.137
A C	0.588	0.767	-0.178	2.610	0.766	2.710	0.777
A H	-0.250	0.567	2.637	2.925	-2.886	2.979	0.333
A I	-0.786	0.584	-0.175	1.388	-0.611	1.506	0.685
A K	-0.175	0.921	-0.592	1.414	0.416	1.687	0.805
A L	-0.031	0.746	-1.798	2.518	1.767	2.625	0.501
C D	-0.310	1.302	-3.196	2.649	2.886	2.979	0.333
C H	0.059	1.315	-1.199	1.114	1.259	1.720	0.464
D H	0.390	1.298	-0.376	2.379	0.766	2.710	0.777
E I	0.200	1.308	-4.040	2.504	4.240	2.852	0.137
I K	0.150	1.292	0.567	1.085	-0.417	1.687	0.805
I L	-0.100	1.280	0.964	1.081	-1.064	1.675	0.525
				CRP			
A C	-0.600	0.434	-0.249	1.589	-0.351	1.647	0.831

A D	-0.546	0.534	-0.832	1.346	0.286	1.448	0.843
A E	-0.888	0.682	-3.441	1.788	2.553	1.913	0.182
A F	-0.290	0.922	-1.127	1.428	0.837	1.700	0.623
A G	-2.010	0.947	-1.122	1.491	-0.888	1.772	0.616
A H	-0.400	0.407	-1.832	1.055	1.433	1.131	0.205
A I	-0.013	0.454	-1.850	1.446	1.837	1.516	0.226
A J	-0.515	0.376	-0.066	0.851	-0.449	0.931	0.629
A K	-1.227	0.425	-0.682	1.826	-0.544	1.875	0.772
A L	-0.260	0.414	-0.526	0.979	0.267	1.061	0.802
A M	-0.216	0.514	-1.072	1.796	0.856	1.867	0.647
C D	-0.260	0.925	0.172	0.789	-0.432	1.216	0.722
C I	-0.060	0.922	0.667	0.712	-0.727	1.165	0.532
D I	0.135	0.646	1.177	1.090	-1.043	1.267	0.411
E J	1.147	0.952	0.360	1.005	0.787	1.396	0.573
F H	0.090	0.923	-0.475	1.609	0.565	1.855	0.761
F J	0.200	0.924	-0.208	1.557	0.408	1.811	0.822
G H	0.740	0.942	2.450	1.638	-1.710	1.895	0.367
G L	1.640	0.974	0.938	1.649	0.702	1.943	0.718
H J	0.110	0.925	0.156	0.573	-0.046	1.088	0.966
H K	0.171	0.906	-1.001	0.638	1.171	1.108	0.291
H L	0.912	0.973	0.052	0.595	0.859	1.141	0.451
J L	-0.145	0.745	0.322	0.591	-0.467	0.952	0.624
J M	-0.566	0.942	0.556	0.699	-1.122	1.171	0.338
			Leptin				
A D	16.100	7.125	29.379	11.793	-13.279	12.823	0.300
B D	20.050	6.740	6.771	12.453	13.279	12.823	0.300
			Adiponectin				
A C	-0.040	1.525	0.340	4.059	-0.380	4.337	0.930
A F	0.450	0.916	-0.895	3.466	1.346	3.582	0.707
A H	0.367	0.778	5.234	3.379	-4.867	3.476	0.162
A I	-0.040	1.534	0.909	3.371	-0.949	3.702	0.798
C E	0.050	1.525	0.430	4.060	-0.380	4.337	0.930
F H	0.848	1.569	-0.209	1.435	1.057	2.133	0.620
F I	-0.070	1.545	-1.019	3.357	0.949	3.702	0.798

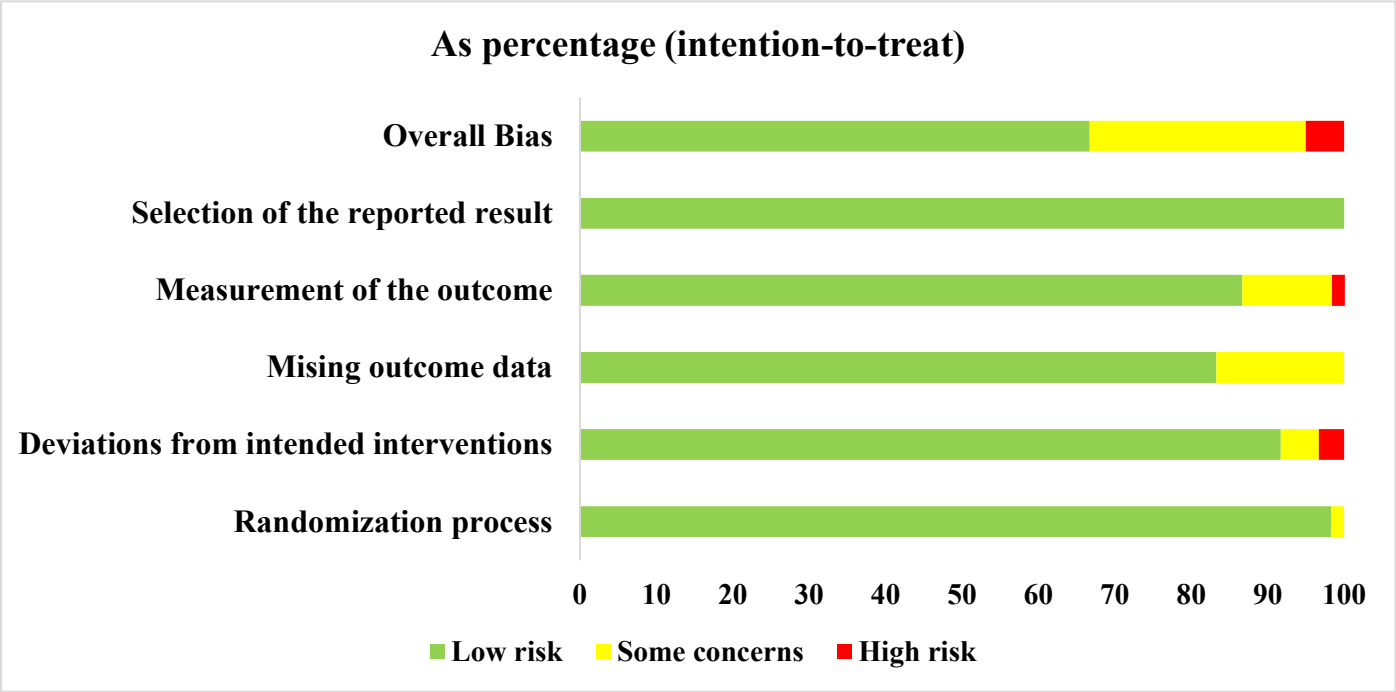
Supplementary Table S4

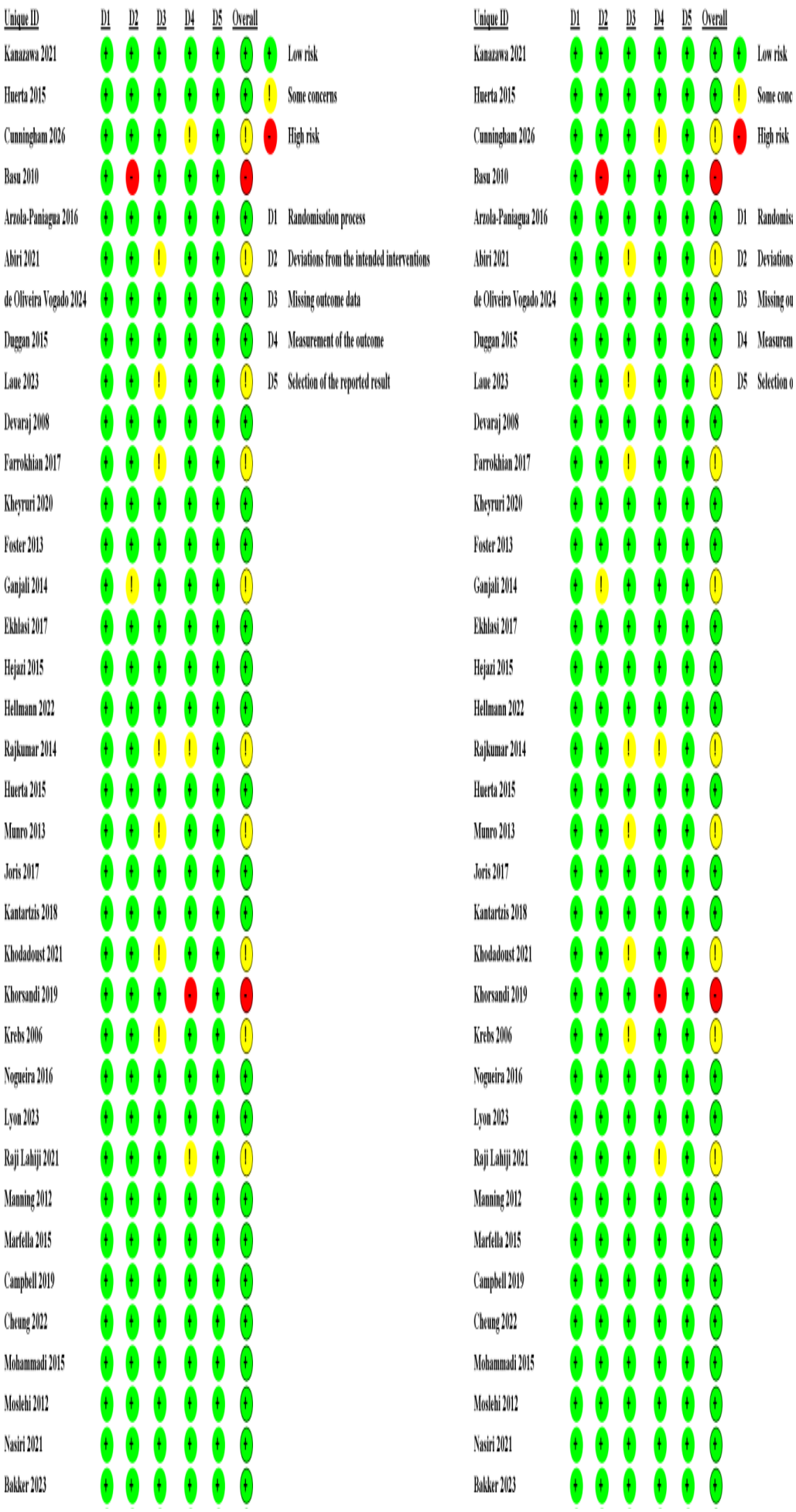
Risk of bias table

StudyID	Randomization process	Deviations from intended interventions	Mising outcome data	Measurement of the outcome	Selection of the reported result	Overall Bias
Kanazawa 2021	Low	Low	Low	Low	Low	Low
Huerta 2015	Low	Low	Low	Low	Low	Low
Cunningham 2026	Low	Low	Low	Some concerns	Low	Some concerns
Basu 2010	Low	High	Low	Low	Low	High
Arzola 2016	Low	Low	Low	Low	Low	Low
Abiri 2021	Low	Low	Some concerns	Low	Low	Some concerns
de Oliveira Vogado 2024	Low	Low	Low	Low	Low	Low
Duggan 2015	Low	Low	Low	Low	Low	Low
Laue 2023	Low	Low	Some concerns	Low	Low	Some concerns
Devaraj 2008	Low	Low	Low	Low	Low	Low
Farrokhian 2017	Low	Low	Some concerns	Low	Low	Some concerns
Kheyruri 2020	Low	Low	Low	Low	Low	Low
Foster 2013	Low	Low	Low	Low	Low	Low
Ganjali 2014	Low	Some concerns	Low	Low	Low	Some concerns
Ekhlasi 2017	Low	Low	Low	Low	Low	Low
Hejazi 2015	Low	Low	Low	Low	Low	Low
Hellmann 2022	Low	Low	Low	Low	Low	Low
Rajkumar 2014	Low	Low	Some concerns	Some concerns	Low	Some concerns
Huerta 2015	Low	Low	Low	Low	Low	Low
Munro 2013	Low	Low	Some concerns	Low	Low	Some concerns
Joris 2017	Low	Low	Low	Low	Low	Low
Kantartzis 2018	Low	Low	Low	Low	Low	Low
Khodadoust 2021	Low	Low	Some concerns	Low	Low	Some concerns
Khorsandi 2019	Low	Low	Low	High	Low	High
Krebs 2006	Low	Low	Some concerns	Low	Low	Some concerns
Nogueira 2016	Low	Low	Low	Low	Low	Low
Lyon 2023	Low	Low	Low	Low	Low	Low
Raji Lahiji 2021	Low	Low	Low	Some concerns	Low	Some concerns
Manning 2012	Low	Low	Low	Low	Low	Low
Marfella 2015	Low	Low	Low	Low	Low	Low
Campbell 2019	Low	Low	Low	Low	Low	Low

Cheung 2022	Low	Low	Low	Low	Low	Low
Mohammadi 2015	Low	Low	Low	Low	Low	Low
Moslehi 2012	Low	Low	Low	Low	Low	Low
Nasiri 2021	Low	Low	Low	Low	Low	Low
Bakker 2023	Low	Low	Low	Low	Low	Low
Kobyliak 2020	Low	Low	Low	Low	Low	Low
Noori 2025	Low	Some concerns	Low	Low	Low	Some concerns
Pauls 2021	Low	Low	Low	Low	Low	Low
Bogdanski 2012	Low	Low	Low	Low	Low	Low
Pervez 2018	Low	Low	Low	Low	Low	Low
Santellano 2024	Some concerns	Low	Low	Some concerns	Low	Some concerns
Poulsen 2012	Low	Low	Low	Low	Low	Low
Bagheri 2020	Low	Low	Some concerns	Low	Low	Some concerns
Rabiei 2018	Low	Low	Some concerns	Some concerns	Low	Some concerns
Sohaei 2019	Low	Low	Low	Low	Low	Low
Chacko 2010	Low	Low	Low	Low	Low	Low
Sardu 2017	Low	Low	Low	Some concerns	Low	Some concerns
Jazayeri-Tehrani 2019	Low	Low	Some concerns	Low	Low	Some concerns
Seyyedebrahimi 2018	Low	Low	Low	Low	Low	Low
Stonehouse 2016	Low	Low	Low	Low	Low	Low
Agbalalah 2022	Low	Low	Low	Low	Low	Low
Tenorio-Jiménez 2019	Low	Low	Low	Low	Low	Low
Walker 2018	Low	Low	Low	Some concerns	Low	Some concerns
Yaikwawong 2024	Low	Low	Low	Low	Low	Low
Zhang 2011	Low	Some concerns	Low	Low	Low	Some concerns
Zittermann 2009	Low	Low	Low	Low	Low	Low
Khosla 2013	Low	Low	Low	Low	Low	Low
Talari 2019	Low	Low	Low	Low	Low	Low
Itariu 2012	Low	High	Low	Low	Low	High

Supplementary Figure S2.
Risk of bias graph



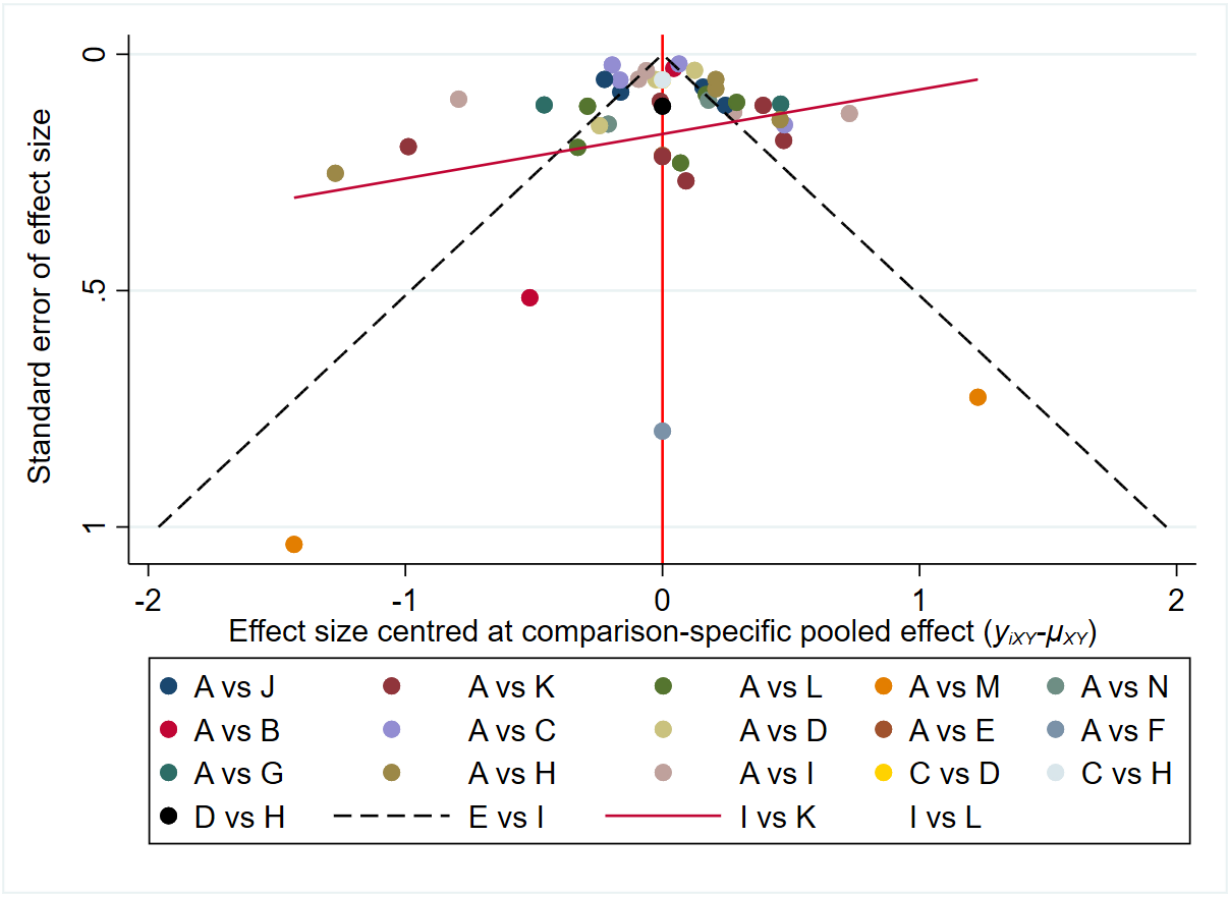


Unique ID
D1
D2
D3
D4
D5
Overall
Kanazawa 2021
Huerta 2015
Cunningham 2026
Basu 2010
Arzola-Paniagua 2016
Abiri 2021
de Oliveira Vogado 2024
Duggan 2015
Laue 2023
Devaraj 2008
Farrokhian 2017
Kheyruri 2020
Foster 2013
Ganjali 2014
Ekhlasi 2017
Hejazi 2015
Hellmann 2022
Rajkumar 2014
Huerta 2015
Munro 2013
Joris 2017
Kantartzis 2018
Khodadoust 2021
Khorsandi 2019
Krebs 2006
Nogueira 2016
Lyon 2023
Raji Lahiji 2021
Manning 2012
Marfella 2015
Campbell 2019
Cheung 2022
Mohammadi 2015
Moslehi 2012
Nasiri 2021
Bakker 2023
Low risk
Some conc
High risk
D1 Randomis
D2 Deviations
D3 Missing ou
D4 Measurem
D5 Selection o

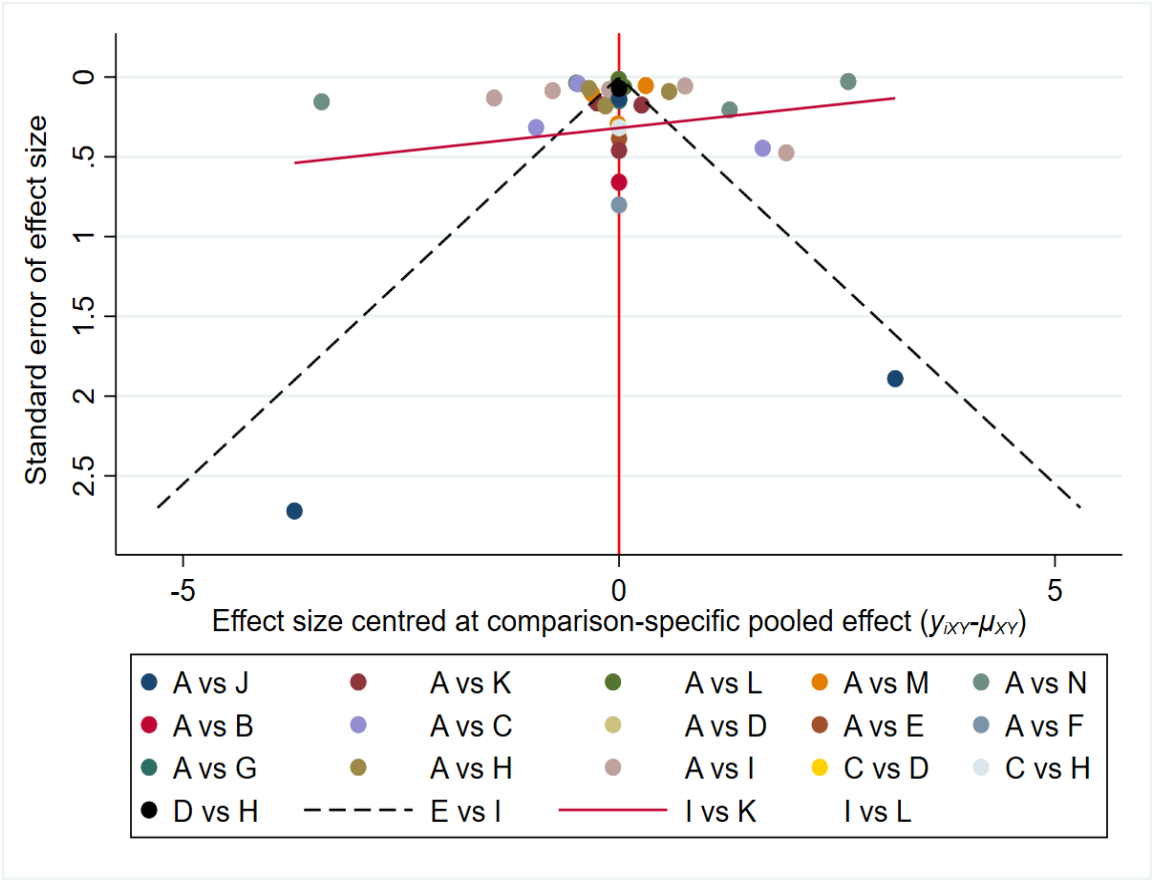
Supplementary Figure S3.

The funnel plot graphics of IL-6, TNF-α,CRP, leptin, and adiponectin in NMA

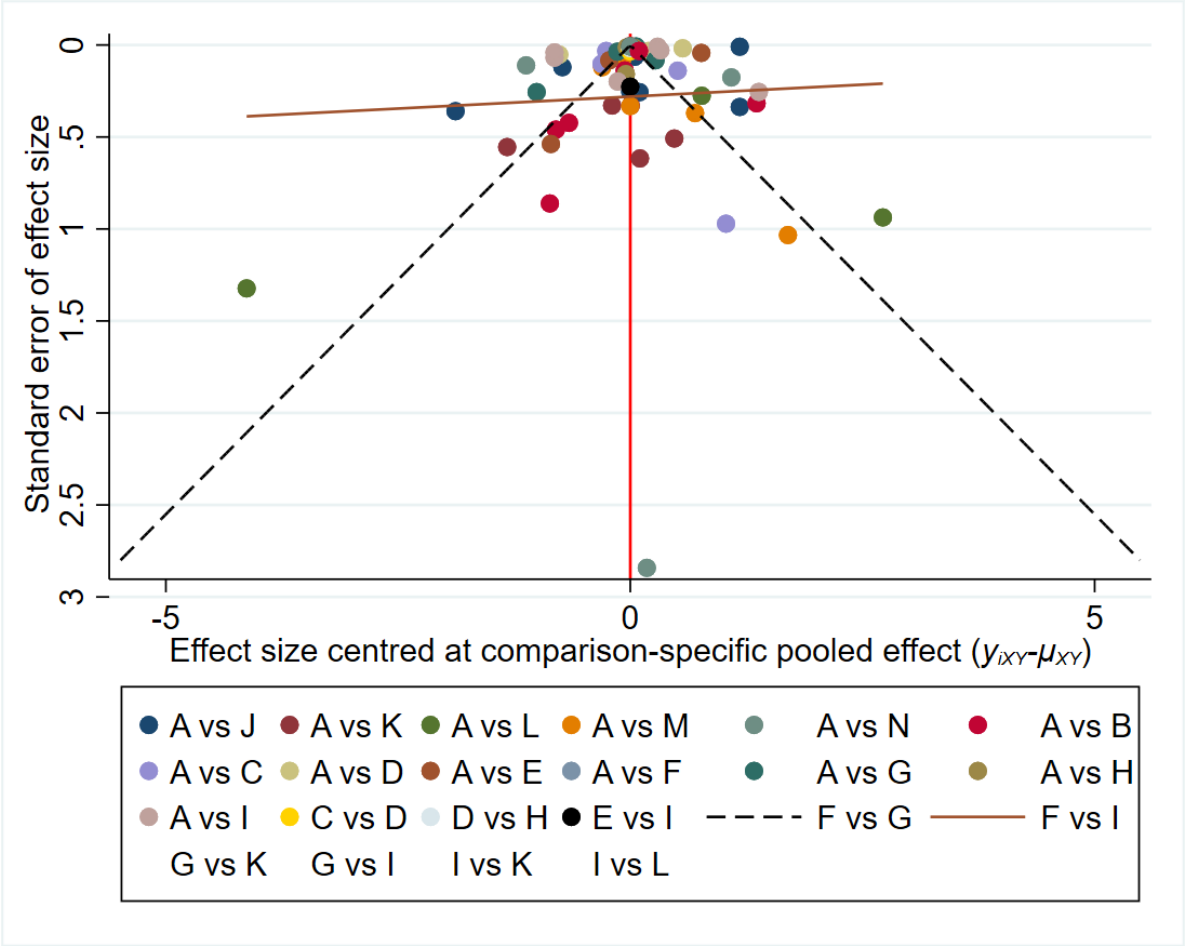
IL-6



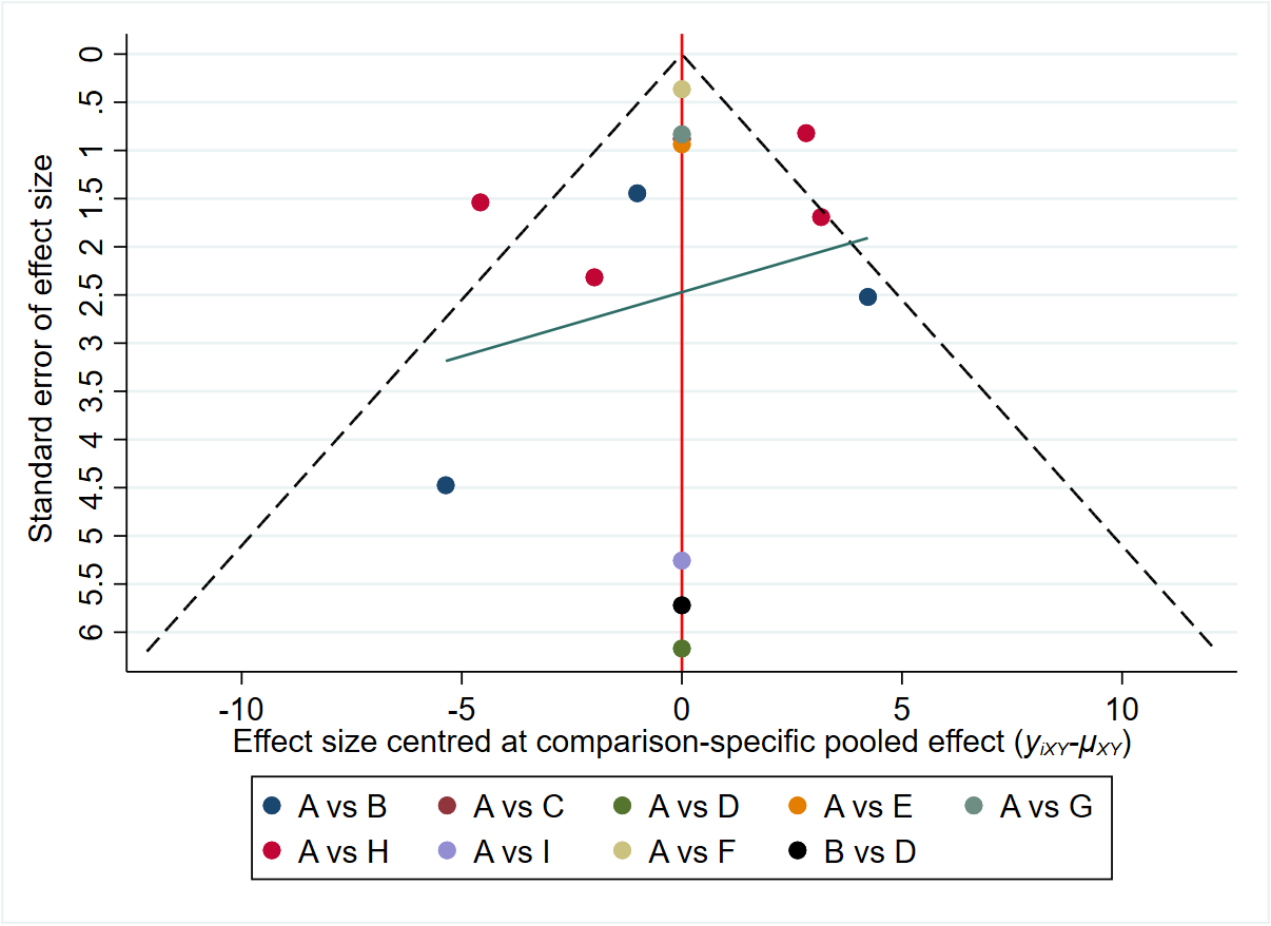
TNF-α


Standard error of effect size
0
.5
1
1.5
2
2.5
-5
0
5
Effect size centred at comparison-specific pooled effect (y_{iXY}-μ_{XY})
A vs J
A vs K
A vs L
A vs M
A vs N
A vs B
A vs C
A vs D
A vs E
A vs F
A vs G
A vs H
A vs I
C vs D
C vs H
D vs H
E vs I
I vs K
I vs L

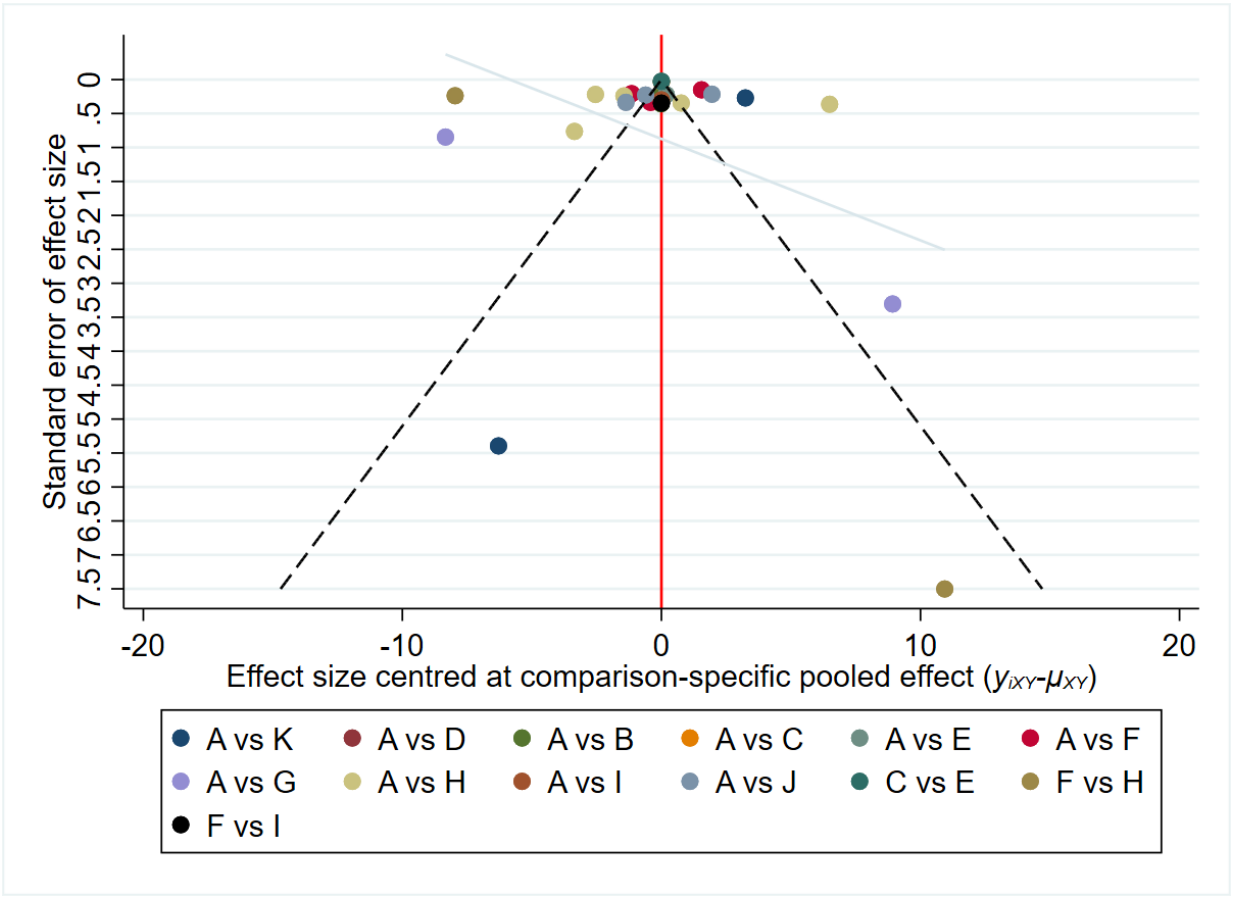
CRP


Standard error of effect size
0
.5
1
1.5
2
2.5
3
-5
0
5
Effect size centred at comparison-specific pooled effect (y_{iXY}-μ_{XY})
A vs J
A vs K
A vs L
A vs M
A vs N
A vs B
A vs C
A vs D
A vs E
A vs F
A vs G
A vs H
A vs I
C vs D
D vs H
E vs I
F vs G
F vs I
G vs K
G vs I
I vs K
I vs L

Leptin



Adiponectin



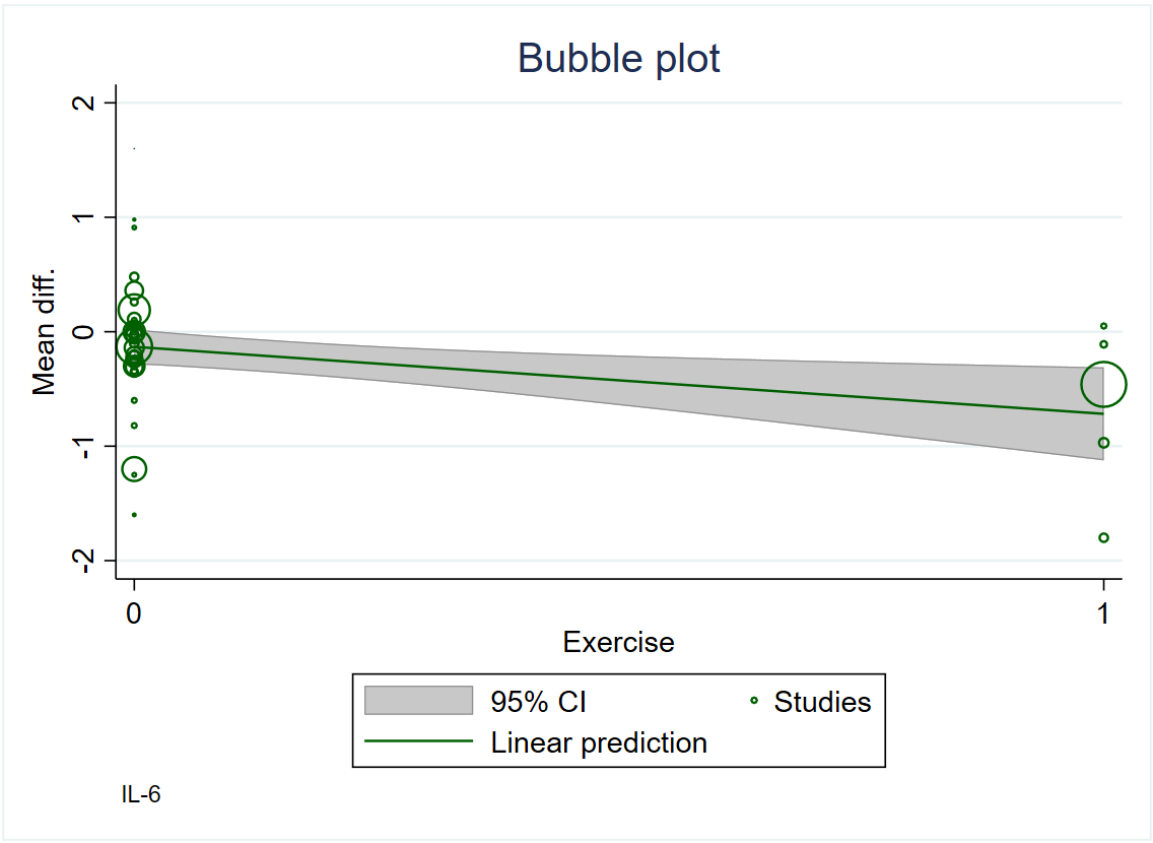
Supplementary Table S5

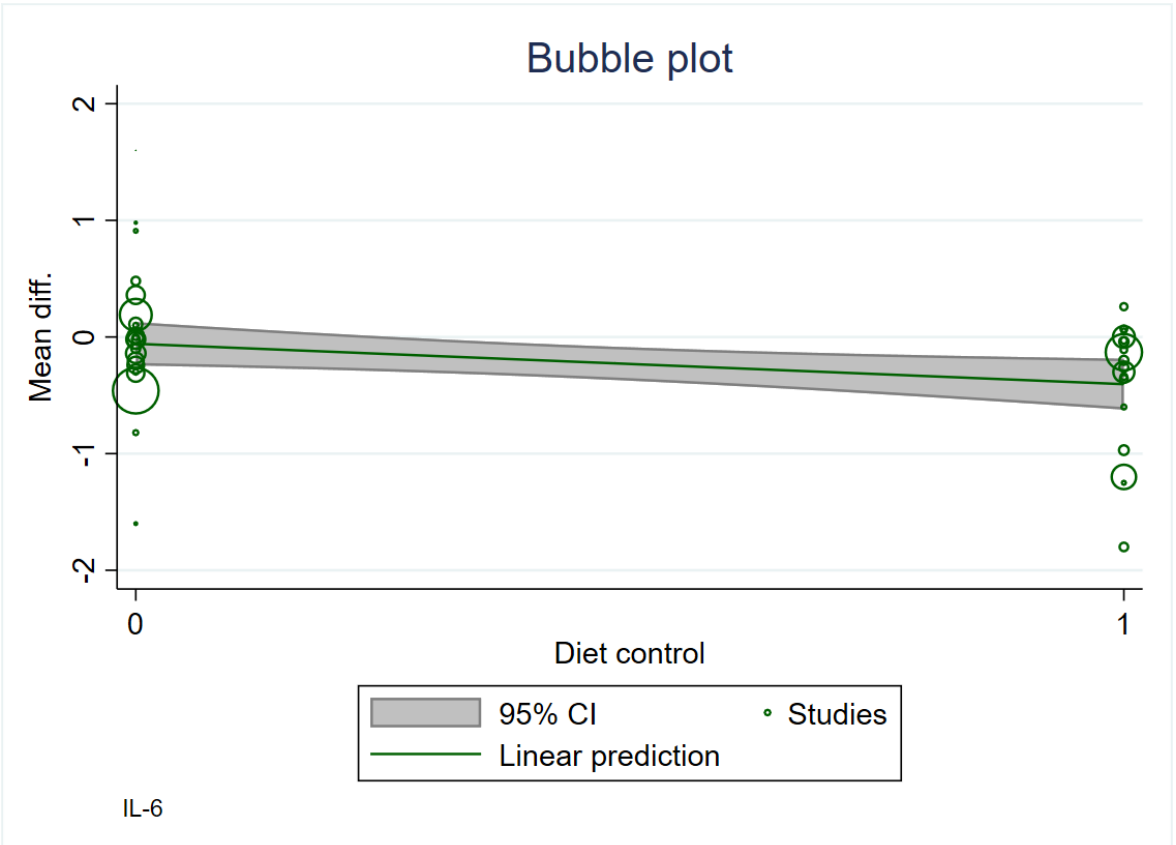
Results of Meta-regression.

IL-6									
	Study (n)	**Coef.**	**SE**	**Z**	**P**	**95% CI**	**R^2 (%)**	**Tau^2**	**I^2 (%)**
Period	36	-0.002	0.006	-0.33	0.738	[-0.013,0.009]	0.00	0.1195	70.74
Age	35	0.009	0.0065	1.4	0.16	[-0.004,0.022]	8.05	0.0811	63.2
Exercise	36	-0.578	0.198	-2.92	0.003	[-0.966, -0.198]	21.86	0.899	62.00
Diet control	36	-0.367	0.142	-2.58	0.01	[-0.646,-0.088]	21.58	0.090	64.27
BMI	35	-0.039	0.0215	-1.82	0.069	[-0.081, 0.003]	13.92	0.102	68.48
Male proportion	34	0.000	0.002	0.11	0.912	[-0.004,0.005]	0.00	0.094	66.70
TNF-α									
	Study (n)	**Coef.**	**SE**	**Z**	**P**	**95% CI**	**R^2 (%)**	**Tau^2**	**I^2 (%)**
Period	29	0.004	0.009	0.460	0.642	[-0.014, 0.023]	0.00	0.388	83.08
Age	28	0.036	0.014	2.650	0.008	[0.009, 0.063]	37.47	0.235	75.30
Exercise	29	0.227	0.618	0.370	0.713	[-0.985, 1.439]	0.00	0.40	85.36
Diet control	29	-0.145	0.318	-0.460	0.649	[-0.768, 0.478]	0.00	0.405	80.43
BMI	28	-0.100	0.054	-1.840	0.066	[-0.207, 0.007]	11.67	0.358	79.32
Male proportion	27	0.001	0.006	0.100	0.921	[-0.010, 0.012]	0.00	0.437	84.51
CRP									
	Study (n)	**Coef.**	**SE**	**Z**	**P**	**95% CI**	**R^2 (%)**	**Tau^2**	**I^2 (%)**
Period	44	-0.008	0.005	-1.72	0.085	[-0.018, 0.001]	7.97	0.113	92.69
Age	42	-0.004	0.006	-0.65	0.517	[-0.016, 0.008]	0.00	0.130	93.77
Exercise	44	-0.484	0.212	-2.28	0.022	[-0.900, -0.068]	18.29	0.100	92.27
Diet control	44	0.014	0.144	0.1	0.924	[-0.268, 0.295]	0.00	0.128	93.57
BMI	43	0.044	0.023	1.92	0.055	[-0.001, 0.089]	6.42	0.121	92.79
Male proportion	41	-0.001	0.003	-0.33	0.74	[-0.006, 0.004]	0.00	0.163	86.71
Adiponectin									
	Study (n)	**Coef.**	**SE**	**Z**	**P**	**95% CI**	**R^2 (%)**	**Tau^2**	**I^2 (%)**
Period	18	-0.001	0.024	-0.02	0.982	[-0.047, 0.046]	0.00	0.883	86.66
Age	17	0.076	0.034	2.26	0.024	[0.010, 0.141]	33.75	0.566	80.86
Exercise	18	1.816	0.740	2.45	0.014	[0.365, 3.267]	31.57	0.577	80.97
Diet control	18	0.473	0.655	0.72	0.470	[-0.811, 1.758]	0.00	0.916	86.79
BMI	16	-0.128	0.085	-1.5	0.133	[-0.294, 0.039]	16.87	0.770	85.60
Male proportion	16	0.024	0.008	3.13	0.002	[0.009, 0.040]	63.91	0.343	72.19

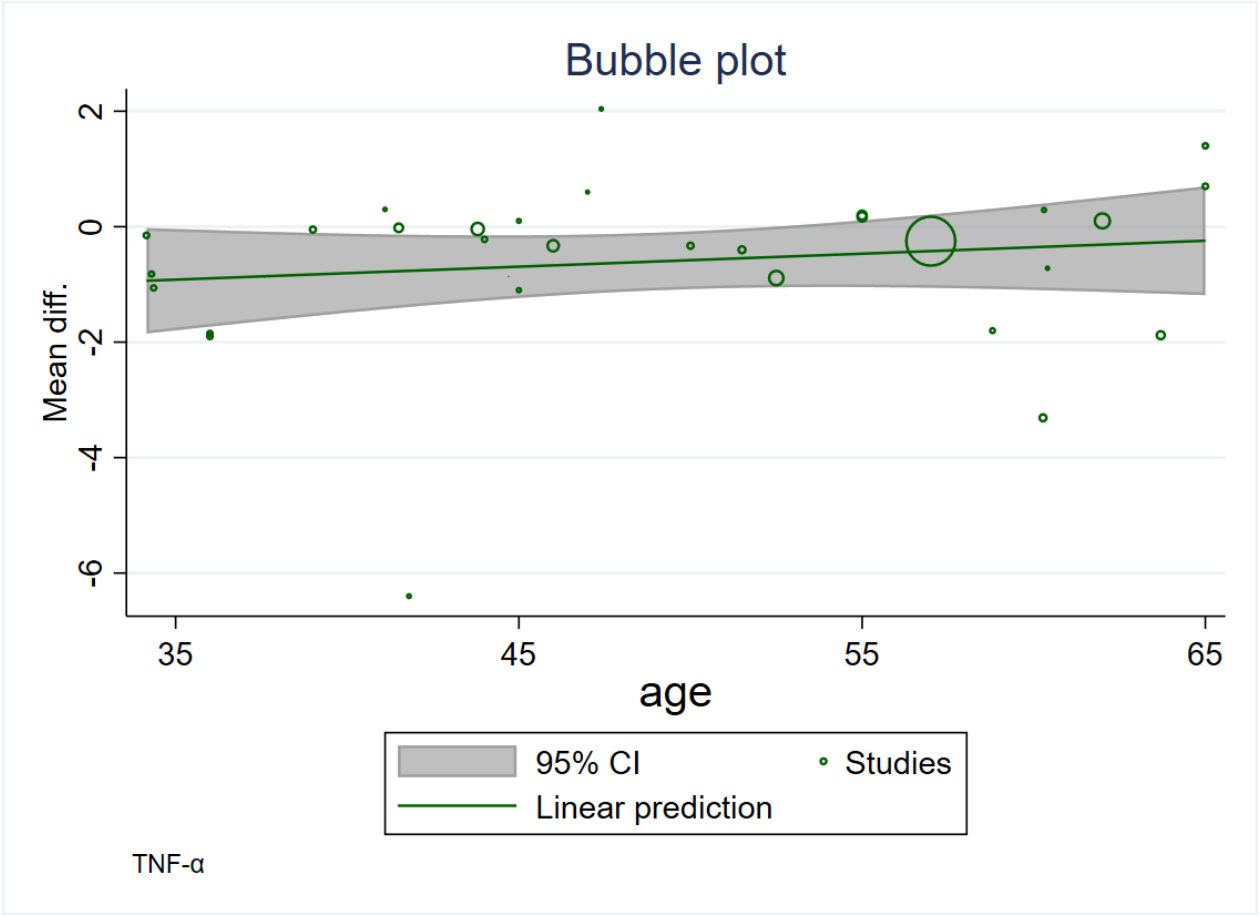
Supplementary Figure S4.
Results of network meta-regression analysis

IL-6

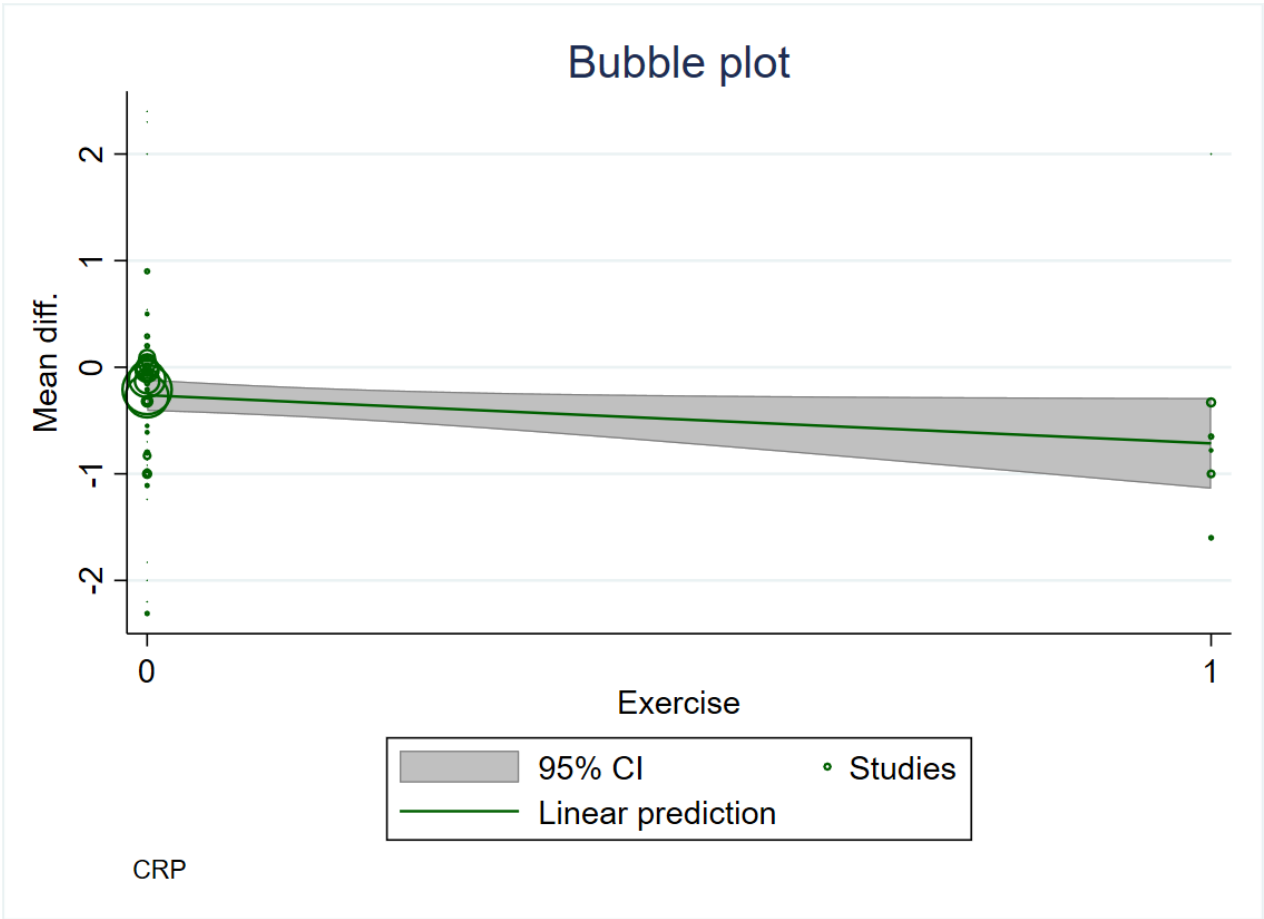




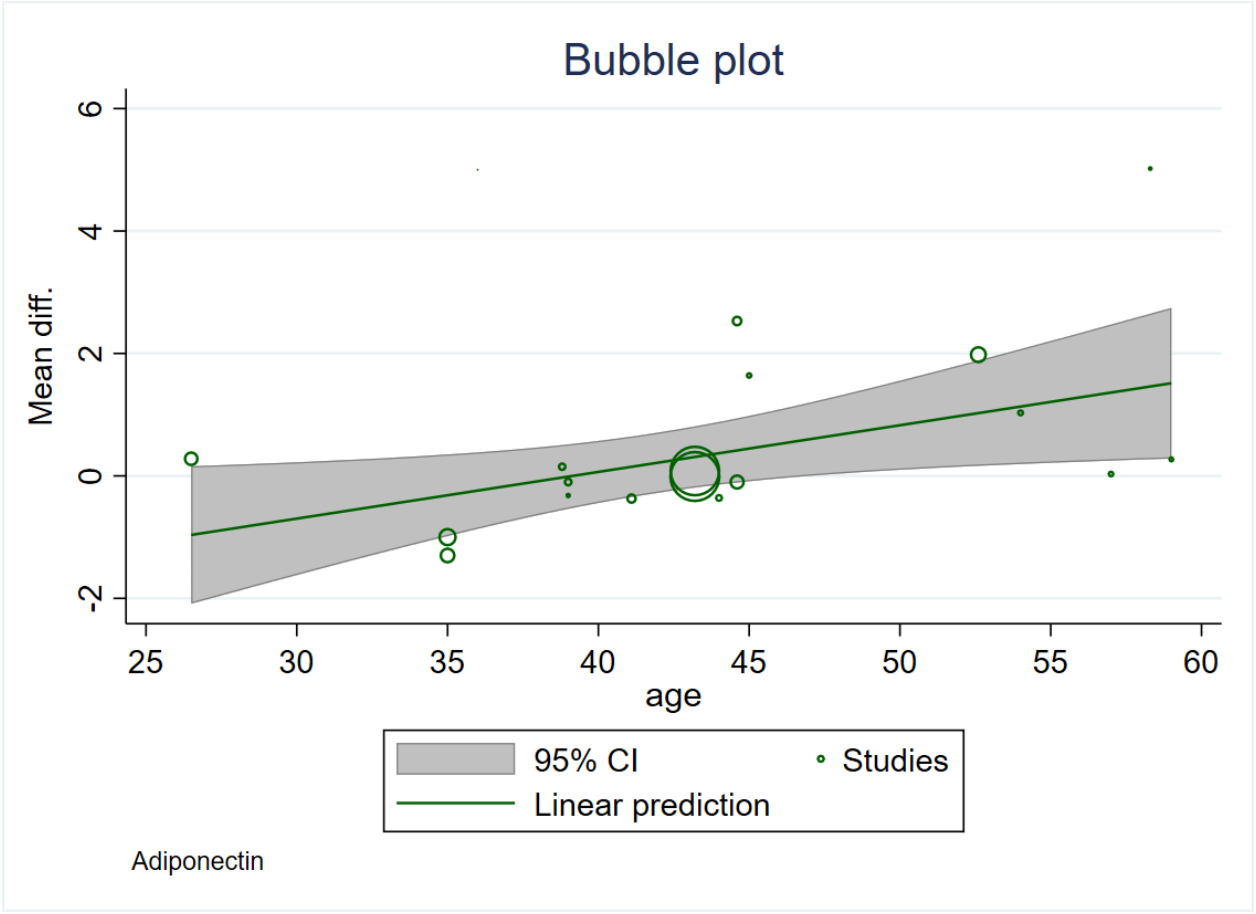
TNF-α


Bubble plot
Mean diff.
2
0
-2
-4
-6
35
45
55
65
age
95% CI
Studies
Linear prediction
TNF-α

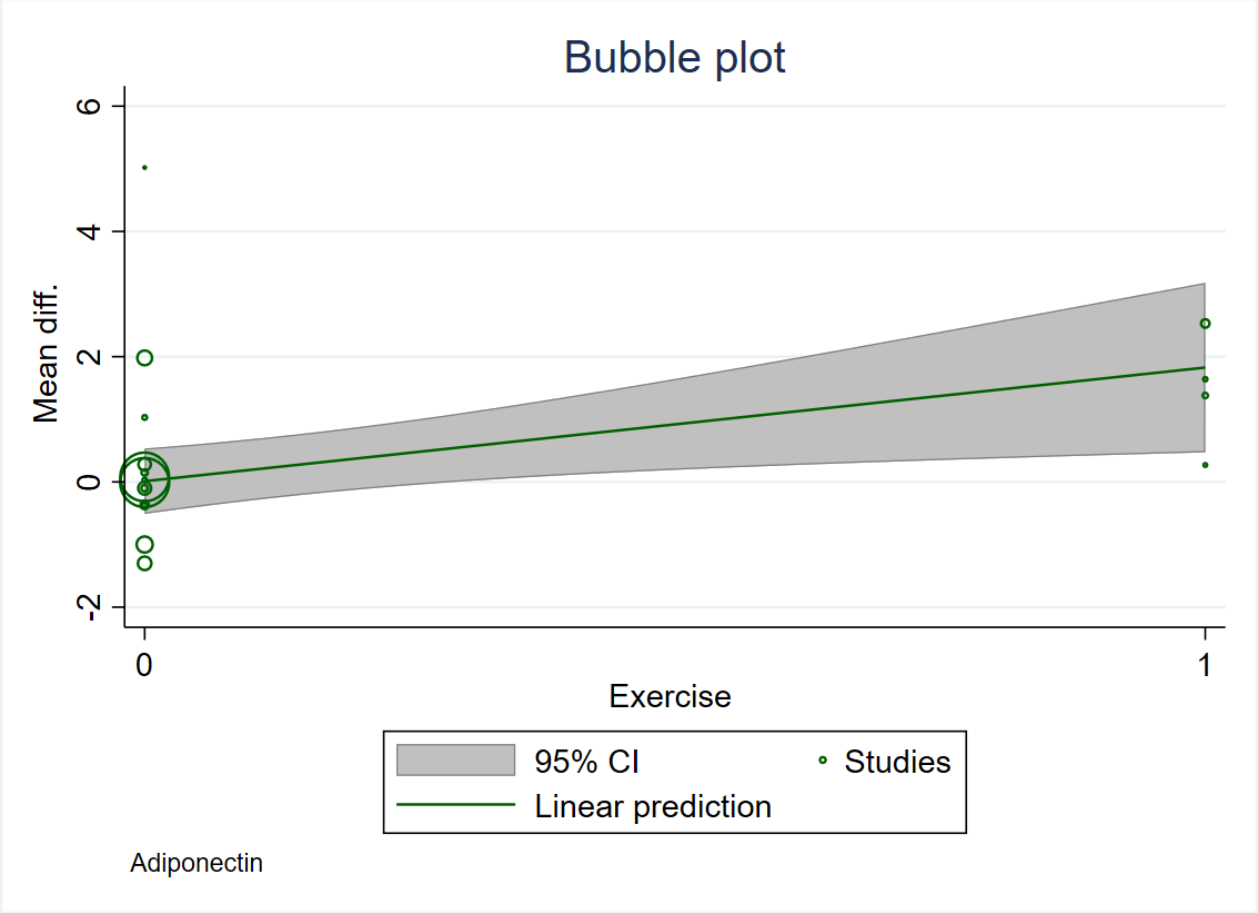
CRP


Bubble plot
Mean diff.
2
1
0
-1
-2
0
1
Exercise
95% CI
Studies
Linear prediction
CRP

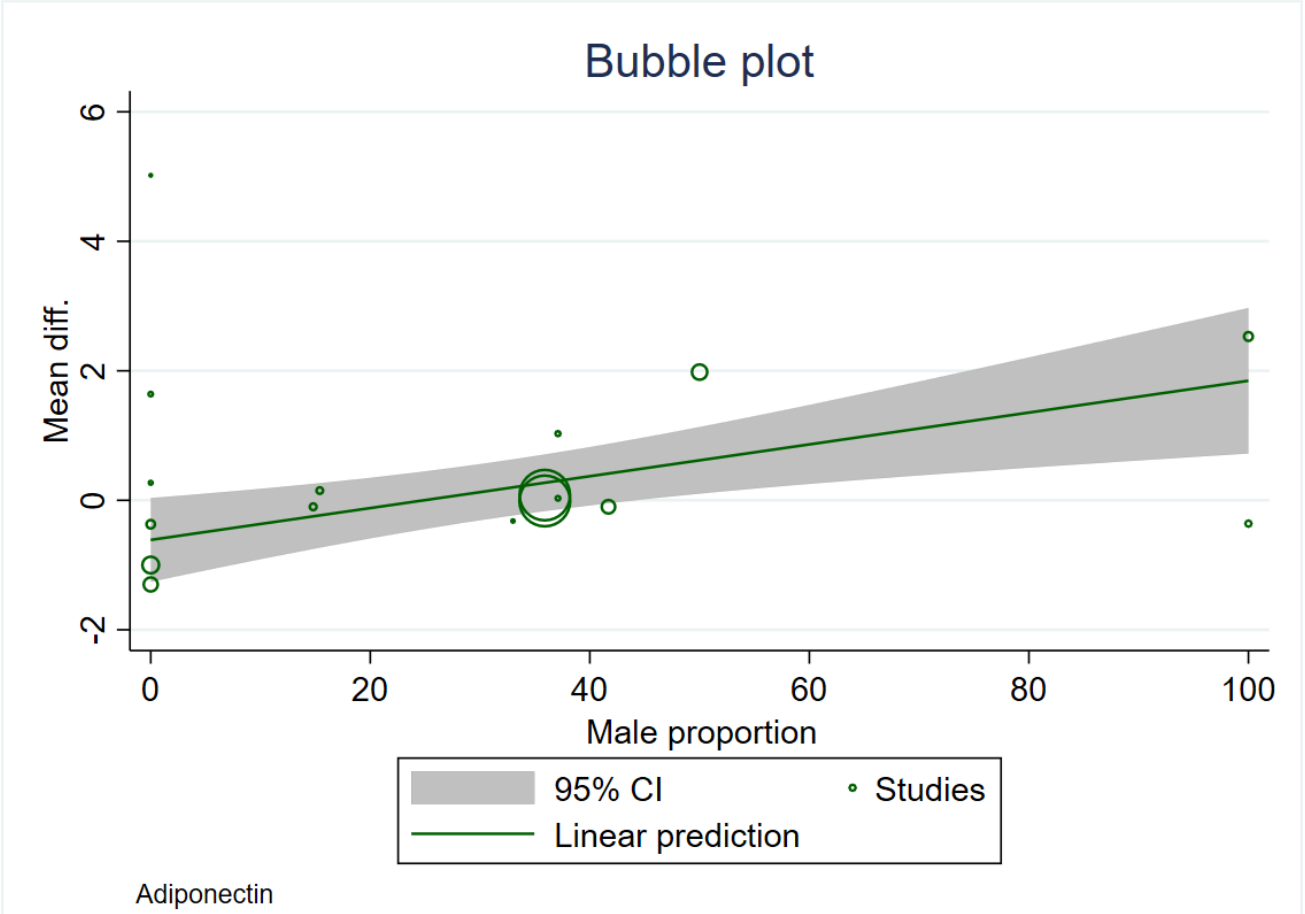
Adiponectin



Adiponectin



Adiponectin



Adiponectin

Supplementary Table S6.

CINeMA assessment of the confidence.

Comparison	Within-study bias	Reporting bias	Indirectness	Imprecision	Heterogeneity	Incoherence	Overall confidence
			IL-6				
Placebo vs Resveratrol	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Mg	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs VD＋Mg	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs Zinc	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs omega-3+Probiotics	No concerns	Low risk	Some concerns	Some concerns	Some concerns	No concerns	**Low**
Placebo vs Probiotics	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs VD	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs α-lipoic acid	No concerns	Low risk	No concerns	No concerns	Major concerns	No concerns	**Low**
Placebo vs Synbiotic	Some concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs omega-3	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs VE	No concerns	Low risk	Some concerns	Some concerns	Some concerns	No concerns	**Low**
Placebo vs Green tea	No concerns	Low risk	No concerns	No concerns	No concerns	No concerns	**High**
Placebo vs Curcumin	No concerns	Low risk	No concerns	No concerns	Some concerns	No concerns	**Moderate**

Comparison	Within-study bias	Reporting bias	Indirectness	Imprecision	Heterogeneity	Incoherence	Overall confidence
			TNF-α				
Placebo vs Resveratrol	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Mg	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs VD＋Mg	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs Zinc	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs omega-3+Probiotics	No concerns	Low risk	Some concerns	No concerns	No concerns	No concerns	**Moderate**
Placebo vs Probiotics	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs VD	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs α-lipoic acid	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Synbiotic	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs omega-3	No concerns	Low risk	Some concerns	No concerns	No concerns	No concerns	**Moderate**
Placebo vs VE	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Green tea	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs Curcumin	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**

Comparison	Within-study bias	Reporting bias	Indirectness	Imprecision	Heterogeneity	Incoherence	Overall confidence
			CRP				
Placebo vs Resveratrol	No concerns	Low risk	Some concerns	Some concerns	Some concerns	No concerns	**Low**
Placebo vs Mg	No concerns	Low risk	No concerns	Some concerns	Some concerns	No concerns	**Moderate**
Placebo vs VD＋Mg	No concerns	Low risk	No concerns	No concerns	Major concerns	No concerns	**Low**
Placebo vs Zinc	No concerns	Low risk	Some concerns	No concerns	Some concerns	Some concerns	**Low**
Placebo vs α-lipoic acid + Probiotics	No concerns	Low risk	No concerns	Some concerns	Some concerns	No concerns	**Moderate**
Placebo vs omega-3+Probiotics	Some concerns	Low risk	Some concerns	No concerns	No concerns	No concerns	**Low**
Placebo vs Probiotics	No concerns	Low risk	Some concerns	No concerns	Some concerns	Some concerns	**Low**
Placebo vs VD	No concerns	Low risk	No concerns	Some concerns	Some concerns	Some concerns	**Moderate**
Placebo vs α-lipoic acid	No concerns	Low risk	No concerns	No concerns	Major concerns	No concerns	**Low**
Placebo vs Synbiotic	Some concerns	Low risk	Some concerns	No concerns	No concerns	No concerns	**Low**
Placebo vs omega-3	Some concerns	Low risk	No concerns	Some concerns	Some concerns	No concerns	**Low**
Placebo vs VE	No concerns	Low risk	Some concerns	No concerns	Major concerns	No concerns	**Very low**
Placebo vs Green tea	Some concerns	Low risk	No concerns	No concerns	Some concerns	No concerns	**Low**
Placebo vs Curcumin	Some concerns	Low risk	Some concerns	No concerns	No concerns	No concerns	**Low**

Comparison	Within-study bias	Reporting bias	Indirectness	Imprecision	Heterogeneity	Incoherence	Overall confidence
			Leptin				
Placebo vs Resveratrol	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Mg	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs Zinc	No concerns	Low risk	Some concerns	Major concerns	No concerns	No concerns	**Very low**
Placebo vs Probiotics	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs VD	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs α-lipoic acid	No concerns	Low risk	No concerns	No concerns	Major concerns	No concerns	**Low**
Placebo vs omega-3	No concerns	Low risk	No concerns	Major concerns	No concerns	No concerns	**Low**
Placebo vs Green tea	No concerns	Low risk	No concerns	No concerns	No concerns	No concerns	**High**

Comparison	Within-study bias	Reporting bias	Indirectness	Imprecision	Heterogeneity	Incoherence	Overall confidence
			Adiponectin				
Placebo vs Resveratrol	No concerns	Low risk	Some concerns	No concerns	Major concerns	Major concerns	**Very low**
Placebo vs VD＋Mg	No concerns	Low risk	No concerns	No concerns	Major concerns	No concerns	**Low**
Placebo vs Probiotics	No concerns	Low risk	Some concerns	No concerns	Some concerns	Major concerns	**Very low**
Placebo vs VD	No concerns	Low risk	No concerns	No concerns	Major concerns	Major concerns	**Very low**
Placebo vs α-lipoic acid	No concerns	Low risk	No concerns	No concerns	Some concerns	No concerns	**Moderate**
Placebo vs Synbiotic	Some concerns	Low risk	No concerns	No concerns	No concerns	Major concerns	**Very low**
Placebo vs omega-3	Some concerns	Low risk	No concerns	No concerns	Some concerns	No concerns	**Low**
Placebo vs VE	No concerns	Low risk	Some concerns	No concerns	Major concerns	No concerns	**Very low**
Placebo vs Green tea	Some concerns	Low risk	No concerns	No concerns	Some concerns	Major concerns	**Very low**
Placebo vs Curcumin	No concerns	Low risk	No concerns	Some concerns	Some concerns	Major concerns	**Very low**