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Review

Effect of Q10 supplementation on body weight and body mass index: A systematic review and meta-analysis of randomized controlled clinical trials

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ABSTRACT

Aims: This meta-analysis study was carried out to assess the effects of coenzyme Q10 supplementation on body weight and body mass index of patients in randomized controlled clinical trial studies.
Materials and methods: A comprehensive systematic search of literature was performed through ISI web of sciences, PubMed, Scopus and Cochrane library databases up to February 2018 which was supplemented by manual search of the references list of included studies. From a total of 1579 identified articles, only 17 trials with 14 and 14 effect-sizes were included for pooling the effects of co-enzyme Q10 supplementation on body weight and body mass index, respectively.
Results: Results of random-effect size meta-analysis showed that supplementation with coenzyme Q10 had no significant decreasing effects on body weight (WMD: 0.28 kg; 95% CI = −0.91, 1.47; P = 0.64) and BMI (WMD: −0.03; 95% CI = −0.4, 0.34; P = 0.86) of study participants. Subgroup analysis revealed that dosage of Q10 and trial duration could not differ the results of Q10 supplementation.
Conclusion: Results of this meta-analysis study failed to show any beneficial effect of coenzyme Q10 supplementation on body weight and BMI of patients in clinical trial studies.

1. Introduction

Obesity is a major public health problem with increasing worldwide prevalence and it is a well-known risk factor for incidence of several chronic diseases especially diabetes type 2, hypertension and coronary heart disease [1]. Beneficial effects of micronutrients supplementation on weight management had been proved in clinical trial studies [2,3]. Coenzyme Q10 (CoQ10) or ubiquinone is a vitamin-like important micro-nutrient for cellular energy regulation which exists in electron transport chain of mitochondria and plays crucial role for ATP production in the cells [4]. It is also involves in oxidative pathways through increasing the production of antioxidant enzyme superoxide dismutase (SOD) which can reduce lipid peroxidation levels [5]. Serum level of this co-enzyme is decreases in patients with poor glycemic control and obese people [6,7]. Coenzyme Q10 can has anti-adipogenic properties via inhibition of adipocytes differentiation and it can increase energy expenditure and fat oxidation [8]. Effects of coenzyme Q10 supplementation on weight management had been investigated in clinical trial studies. One study showed that 12 weeks supplementation with 200 mg/day coenzyme Q10 could decrease significantly weight, BMI and waist circumference of diabetic type 2 patients [9]. Another study on non-alcoholic fatty liver disease (NAFLD) patients showed that 4 weeks supplementation with 100 mg/day Q10 could decrease significantly waist circumference, while it had no significant reducing effect on BMI parameter of these patients [10]. Other clinical trial studies on non-alcoholic fatty liver disease (NAFLD) and metabolic syndrome patients revealed that 12 and 8 weeks supplementation with 100 mg/day Q10 had no significant decreasing effects on anthropometric indices of these patients [11,12]. Because of these conflicting results, this meta-analysis study was performed with the aim of pooling the effects of co-enzyme Q10 supplementation on body weight and BMI of patients in clinical trial studies.

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2. Materials and methods

2.1. Search strategy

PRISMA guidelines was adopted to perform this systematic review and meta-analysis. Comprehensive systematic search of literature was done through PubMed, Scopus, Cochrane and ISI web of sciences up to February 2018 with the following search items in title, abstract and keywords: ("Coenzyme Q10″ OR ″ CoQ10″ OR ″ ubiquinone") AND ("Overweight" OR ″ weight" OR ″ adiposity " OR "obesity" OR "weight loss" OR ″ BMI" OR "body mass index"). Conference papers were searched in Scopus and ISI Web of Science databases. Manually search in reference lists of included studies also was done to find relevant trials to the topic and there was no restriction on language or time of publication.

2.2. Study selection

Studies included if they were randomized controlled clinical trials that comparing the effect of Q10 supplementation on subject's weights and body mass index, and reported the mean or median values of weight and BMI changes in intervention and control groups. Trials with co-supplementation of Q10 with other nutrients, studies with not enough data for calculating the weight or BMI changes of participants at the end of study and those with no control or placebo group were excluded.

2.3. Data extraction and quality control

After removing duplicated findings, titles and abstracts of remaining articles were screened by two independent authors (YN, MZ) to find more potentially relevant trials to the topic. Selected articles in this stage were retrieved for eligibility and assessed for quality by Jadad scale. This scale scores trials according the following criteria: randomization, description and appropriateness of randomization method, blindness, method of blinding and description and reasons of dropouts or withdrawals [13]. Any discrepancy between authors discussed to reach in consensus or solved by the third author (EY). Predefined data sheet form was used to extracting needed information from the selected studies. Following characteristics of studies and population were extracted from studies: first author's name, Journal and year of publication, country origin and design of study, age, sex, dose of Q10 supplementation, trial duration, health condition, weight and BMI of participants.

2.4. Data synthesis and statistical analysis

All statistical analyses in this study were performed using Stata software (version 12; Stata Corp LP, College Station, Texas, USA). The mean difference (MD) and the standard deviation (SD) was used as the main measure for assessing the effect of Q10 supplementation on weight and BMI of study populations. To calculate pooled effect size with 95% confidence interval (CI), the fixed effects or random effects models in presence of heterogeneity were used. Cochran's Q-test at $P < 0.05$ level of significance was performed to assess possible heterogeneity between studies and the percentage of heterogeneity was calculated by using I^2 test. Subgroup analysis according to dosage of Q10 supplementation and trial duration was performed for finding the possible sources of heterogeneity. To assess publication bias, funnel plot analysis, Begg and Egger's regression tests were performed. In all statistical analyses, level of significance was set at $P < 0.05$.

3. Results

3.1. Search results and study selection

Of 2273 articles and conference papers were founded through systematic search of 4 databases, 694 of them excluded because of being duplicated. Two independent authors screened titles and abstracts of 1579 remained articles for finding more relevant articles to the topic. Subsequently, the full text of 34 articles were retrieved and 9 articles were selected because of having inclusion criteria of this meta-analysis. Eight articles were added from manual searching of reference list of mentioned included studies. Finally, 17 studies with 19 effect-sizes included for meta-analysis of the effect of Q10 supplementation on body weight (14 trials) and body mass index (14 trials). All the included studies were randomized and placebo controlled trials. The flowchart of study selection is shown in Fig. 1.

3.2. Study characteristics

Trials included in this meta-analysis had been conducted in Iran [9–11,14–21], Australia [22], China [23], Turkey [24], Finland [25] and Denmark [26] between the years of 1998 and 2018 with a total of 399 and 393 individual participants in the treatment and control groups, respectively. Mean age of participants in supplementation group were in the range of 19.8–67.7 and in the control group were in the range of 19.8–70.1. The duration week of trials were between 4 and 25.5 weeks with the average of 10.76 weeks. Dosage of Q10 supplementation were in the range of 100–300 mg/day with the median of 100 mg/day. According to the Jadad scale, six studies received score 3, six studies scored 4 and five studies scored 3. Characteristics of the included trials are summarized in Table 1.

3.3. Meta-analysis and subgroup analyses

Pooled effect sizes in meta-analysis of the effects of Q10 supplementation on body weight and BMI calculated in 14 and 14 trials, respectively. Results of random-effects model meta-analysis showed no significant effects of Q10 supplementation on body weight (WMD: 0.28 kg; 95% CI = −0.91, 1.47; $P = 0.64$; test for heterogeneity: $P = 1.0$ and $I^2 = 0.0\%$ Fig. 2) and BMI (WMD: −0.03; 95% CI = −0.4, 0.34; $P = 0.86$; test for heterogeneity: $P = 1.0$ and $I^2 = 0.0\%$ Fig. 3) of study participants. Results of subgroup analysis did not show any significant different effects of Q10 supplementation based on trial duration and dosage subgroups on body weight and body mass index. Results of subgroup analysis are shown in Table 2.

3.4. Publication bias

No publication biases were reported by Begg test ($P = 0.95$ for body weight, $P = 0.62$ for BMI) and Egger's test ($P = 0.59$ for body weight, $P = 0.1$ for BMI). The funnel plots are shown in Fig. 4.

4. Discussion

The aim of this meta-analysis study were to assess the effects of Q10 supplementation on anthropometric indices of patients in clinical trial studies. The results showed that Q10 had no significant decreasing effects on body weight and BMI of participants. Coenzyme Q10 or ubiquinone is a fat-soluble compound which can be synthesized endogenously in the human body in mevalonate cycle from acetyl-COA or be acquired between 3 and 5 mg/day from foods especially nuts, fish, meat and poultry [27]. Although consuming large doses of this coenzyme up to 1200 mg/day has no

toxicity [28], the needed dose of Q10 for attaining its cardiovascular benefits ranged from 100 to 200 mg/day [29,30]. However, Q10 supplementation in these dosages or short durations administered in included studies in this meta-analysis cannot affect successfully anthropometric indices of patients. It seems that the main function of coenzyme Q10 in the cell mitochondria is conferred through its antioxidant properties via increasing the activity of antioxidant enzymes which can neutralize reactive oxygen species [5] and it cannot influence energy expenditure profoundly. The main regulator of human body weight in long time is energy balance exists between energy intake from diet and energy expended in daily activities and the efficacy of other interventions alone in treatment of obesity seems to be clinically not impressive without restriction of energy intake or increasing physical activity level.

One possible mechanism explaining probable beneficial effect of Q10 supplementation on obesity is its inhibitory effect on adipocyte differentiation [8]. This inhibition induces probably through AMPK-mediated PPARα pathway. Coenzyme Q10 can increase the phosphorylation of AMPK through increasing the activity of Ca^{2+}/calmodulin-dependent protein kinase [31]. Q10 also can decrease gene expression of enzymes fatty acid synthase and acetyl-CoA carboxylase responsible for endogen lipid synthesis of the human and increase the gene expression of proteins responsible for higher energy expenditure including uncoupling protein-1 (UCP1) and carnitine-palmitoyl transferase 1 [32].

One important limitation of this study is the significant heterogeneity seen between included studies in the meta-analysis. Although subgroup analyses based on dosage of Q10 and study duration were performed, the results showed that these factors cannot affect the results of Q10 supplementation and are not the source of heterogeneity. Different population studies included in this meta-analysis is a probable reason for this heterogeneity. Because the majority of participated patients were overweight people (9 trials versus 2 and 3 trials on normal weight and obese

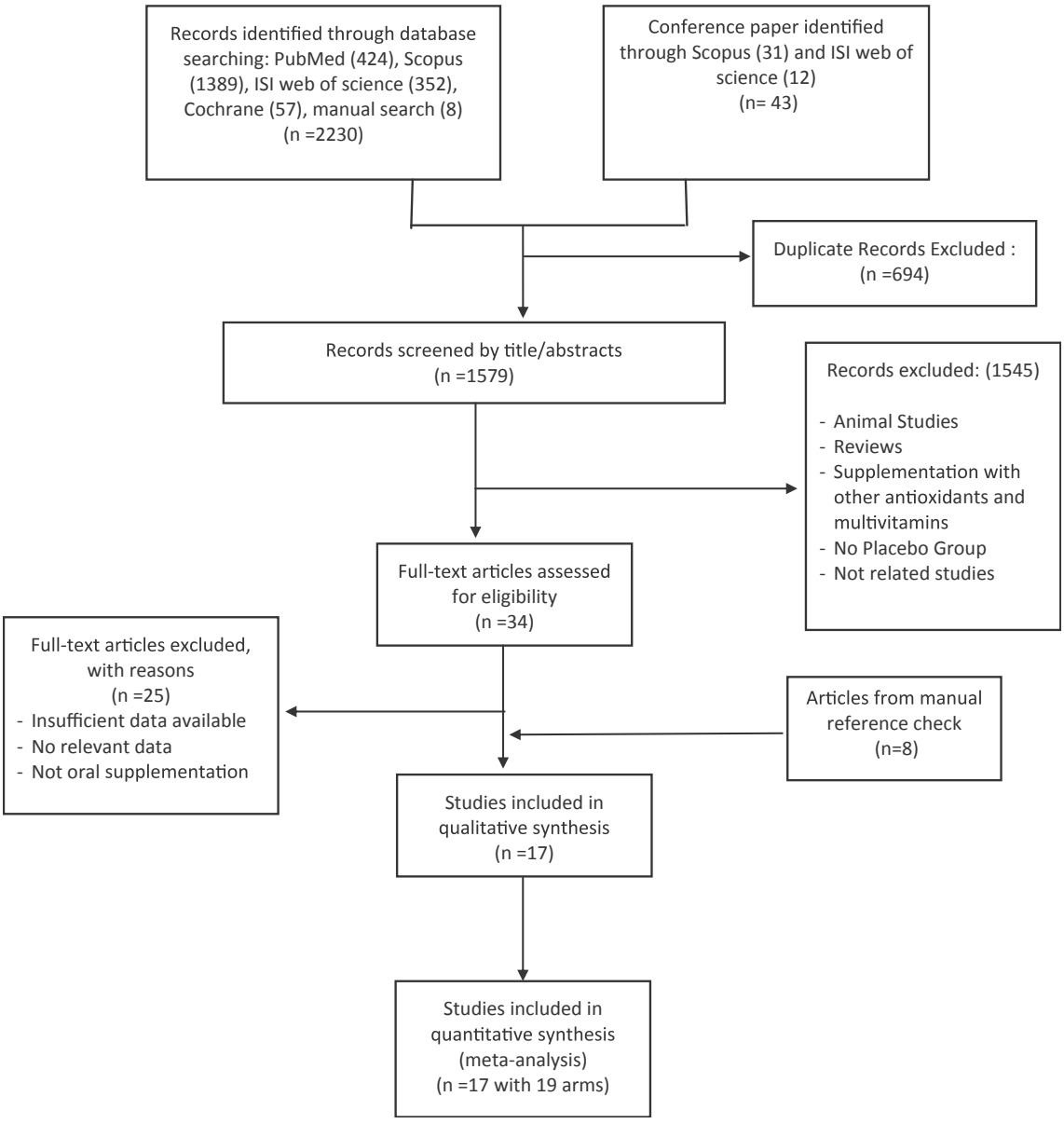

Fig. 1. Flowchart of study selection for inclusion trials in the systematic review.

Table 1
Characteristics of included studies.

Jaded score	Mean age (control/intervention)	outcome	Trial Duration	Intervention (name and daily dose)	sex	Sample size (control/intervention)	Study design	Health status	Country	Publication year	Authors (Ref)
3	35.5/35.5	Body Weight	13 weeks	CoQ10/100 mg	M/F	17/17	R/PC/DB	Patients with Type 1 Diabetes	Denmark	1998	J. E. Henriksen
3	64/65	BMI	25.5 weeks	CoQ10/100 mg	M/F	11/12	R/PC/DB	Patients with type 2 diabetes	Finland	1999	J.G. Eriksson
3	19.8/19.8	Body Weight	8 weeks	CoQ10/100 mg	M	7/7	R/PC/DB	Healthy men	Turkey	2009	H.Gokbel
5	58.6/55.4	Body Weight	8 weeks	CoQ10/200 mg	M/F	15/21	R/PC/DB	Nondiabetic men and women with chronic renal impairment	Australia	2009	TA. Moria(a)
5	53.3/56.9	Body Weight	8 weeks	CoQ10/200 mg	M/F	20/18	R/PC/DB	Nondiabetic men and women with chronic renal impairment	Australia	2009	TA. Moria(b)
4	51.6/53.5	BMI	13 weeks	CoQ10/100 mg	M/F	13/13	R/PC/DB	Hemodialysis Patients	Iran	2011	M.Shojaei(a)
4	55.3/52.8	BMI	13 weeks	CoQ10/100 mg	M/F	12/14	R/PC/DB	Hemodialysis Patients	Iran	2011	M.Shojaei(b)
5	70.1/67.7	BMI	8 weeks	CoQ10/300 mg	M/F	28/28	R/PC/DB	patients with ischaemic left ventricular systolic dysfunction	China	2011	YL. Dai
3	21.16/22.3	Body weight	4 weeks	CoQ10/300 mg	M	6/10	R/PC/DB	Soccer Player	Iran	2013	N.Gharahdaghi
4	61/60	Body weight, BMI	12 weeks	CoQ10/200 mg	M/F	26/26	R/PC/DB	Patients With Hyperlipidemia and Myocardial Infarction	Iran	2014	M.Mohseni
3	42.18/42.73	BMI	4 weeks	CoQ10/100 mg	M/F	21/20	R/PC/DB	Patients with Nonalcoholic Fatty Liver Disease	Iran	2014	MA.Farhangi
5	50.57/48.77	Body weight, BMI	8 weeks	CoQ10/100 mg	M/F	23/22	R/PC/DB	patients with rheumatoid arthritis	Iran	2015	H.Abdollahzad
3	NR	Body weight, BMI	12 weeks	CoQ10/100 mg	M/F	21/20	R/PC/DB	Patients with Nonalcoholic Fatty Liver Disease	Iran	2015	F.Farsi
5	59.9/65.9	Body weight, BMI	8 weeks	CoQ10/100 mg	M/F	30/30	R/PC/DB	patients with metabolic syndrome	Iran	2015	F.Raygan
4	47.1/45.2	Body weight, BMI	12 weeks	CoQ10/200 mg	M/F	33/31	R/PC/DB	patients with Type 2 Diabetes	Iran	2015	M. J. Hosseinzadeh-Attar.
5	25.3/24.5	Body weight, BMI	12 weeks	CoQ10/100 mg	F	30/30	R/PC/DB	women with polycystic ovary syndrome	Iran	2016	M. Samimi
4	24.7/24.9	Body weight, BMI	12 weeks	CoQ10/100 mg	F	20/20	R/PC/DB	women with polycystic ovary syndrome	Iran	2017	E.Rahmani
4	53.68/52.97	Body weight, BMI	12 weeks	CoQ10/100 mg	F	35/35	R/PC/DB	Women with Type 2 Diabetes	Iran	2017	M.Gholami
4	61.6/61.1	Body weight, BMI	12 weeks	CoQ10/100 mg	M/F	25/25	R/PC/DB	Patients With Diabetic Nephropathy	Iran	2018	T.Gholnari

people, respectively), we were not able to sub-divide the results of meta-analysis based on weight status of the participants. The lack of enough information regarding energy intake and physical activity of study participants are other limitations of this study which can influence the results of Q10 supplementation.

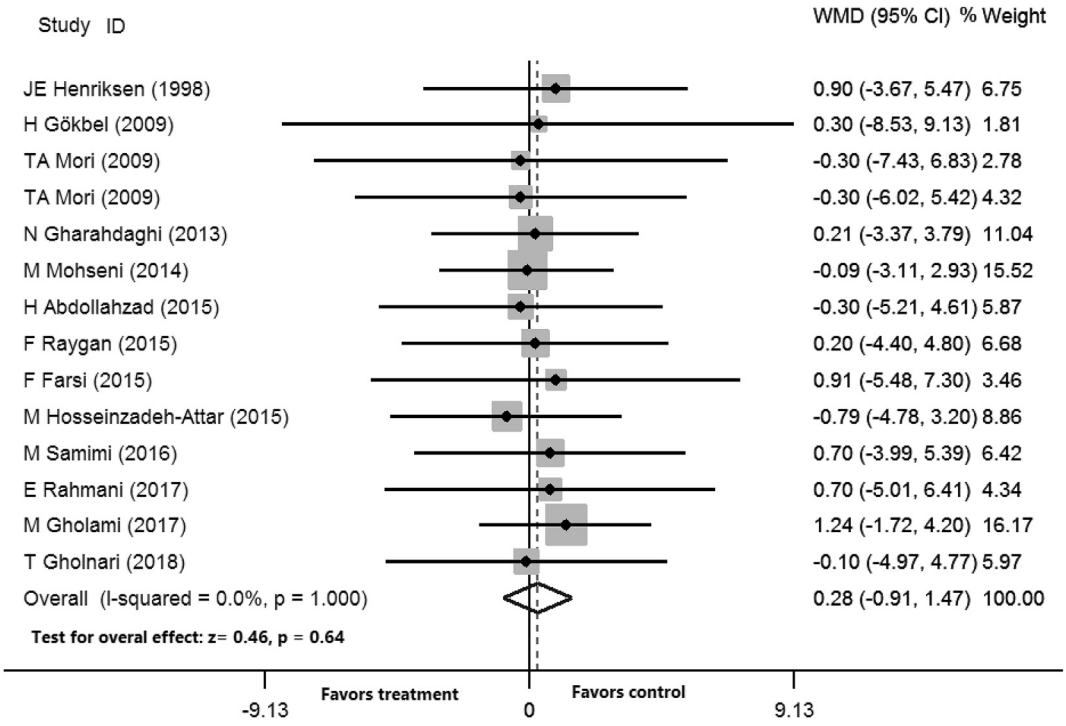

Fig. 2. Pooled effect size of Q10 supplementation on body weight (Kg). WMD, weighted mean difference.

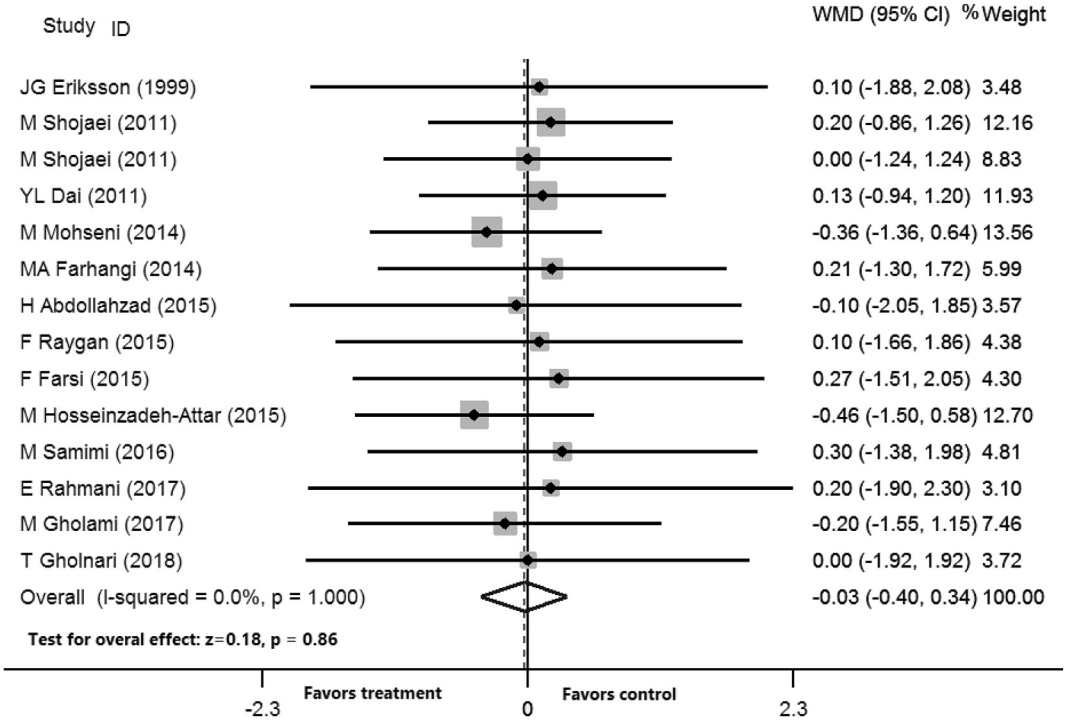

Fig. 3. Pooled effect size of Q10 supplementation on body mass index. WMD, weighted mean difference.

Table 2
Subgroup analysis of the effects of Q10 supplementation on body weight and body mass index.

	No	MD (95% CI)	P within group	P-heterogeneity	I^2
Body weight					
dosage					
≤100 mg	9	0.6(-0.93, 2.2)	0.42	1.0	0.0%
>100 mg	5	−0.19(-2.01, 1.63)	0.83	0.99	0.0%
Duration week					
<12 weeks	6	0.009 (−2.07, 2.09)	0.99	1.00	0.0%
≥12 weeks	8	0.41 (−1.03, 1.85)	0.57	0.99	0.0%
Body mass index					
dosage					
≤100 mg	11	0.09(-0.37,0.56)	0.39	1.0	0.0%
>100 mg	3	−0.24(-0.83, 0.35)	0.79	0.7	0.0%
Duration week					
<12 weeks	4	0.1 (−0.6, 0.83)	0.7	0.99	0.0%
≥12 weeks	10	−0.08(-0.5, 0.3)	0.76	0.99	0.0%

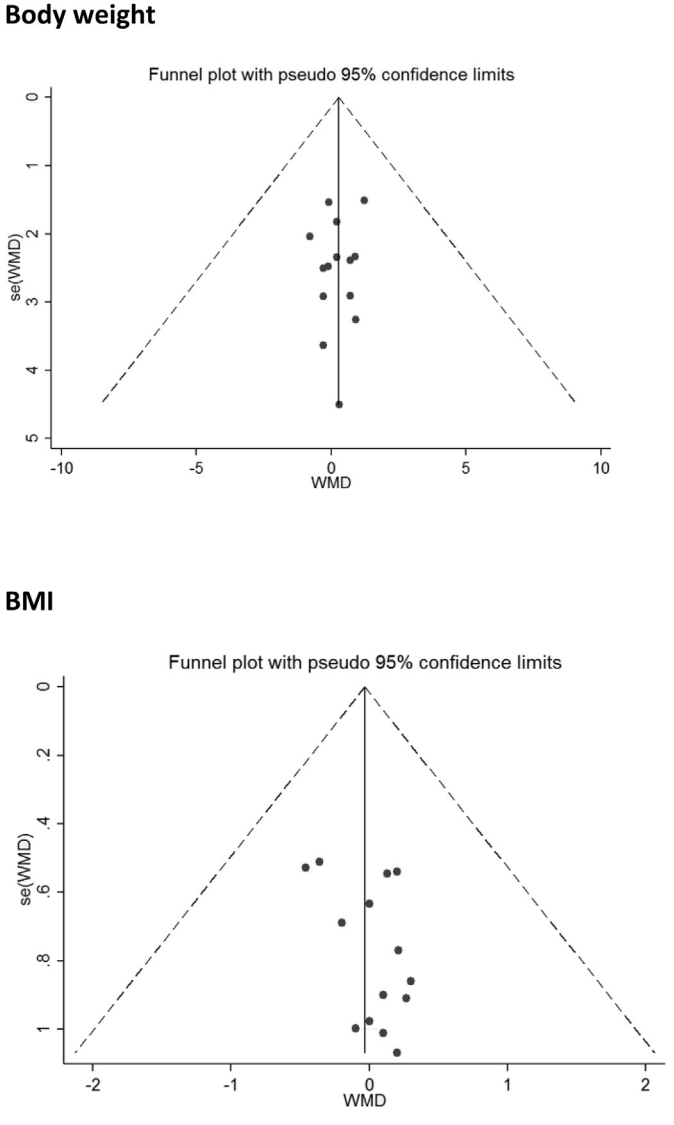

Fig. 4. Funnel plots.

5. Conclusions

In conclusion, results of current meta-analysis study showed that coenzyme Q10 supplementation cannot affect significantly weight status of patients and its administration alone probably is not a useful strategy for achieving meaningful weight loss.

Conflicts of interest

The authors declare that they have no conflict of interest.

Author contributions

EF designed and searched systematically for the study. MZ and YN reviewed and selected the articles and extracted data from articles under the supervision of EY. SS and EF performed data analysis and interpretation. EY and SS drafted the manuscript. EF and MM revised the article for important intellectual content.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.01.047.

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