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Impacts of coenzyme Q10 supplementation on body composition and exercise performance in overweight and class1 obesity

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Abstract

Although coenzyme Q10 supplementation has been studied in overweight and obese individuals in recent years, its impacts on body composition and exercise performance in overweight and class 1 obese subjects are not well established and are still unclear. This study aimed to determine the impacts of coenzyme Q10 supplementation on body composition and exercise performance in overweight and class 1 obese individuals. This was a double-blinded, placebo-controlled, experimental study. There were 28 overweight and class 1 obesity subjects who had body mass index (BMI) ranging between 23.0-29.9 kg/m^2, randomly assigned to receive either 200 mg of coenzyme Q10 (ubiquinone, experimental group) daily, or identical placebo (maltodextrin, control group) for 6 weeks' duration. Body composition and exercise performance were measured at the baseline and the 6-week visit. The coenzyme Q10 group had showed significantly greater reductions in terms of resting heart rate and systolic blood pressure (p=0.0437 and 0.0164, respectively) and a greater increase in VO_2max (p= 0.0316) than the placebo group at the 6-week visit. Nonetheless, there were no differences in bodyweight, BMI, waist-to-hip ratio, percentage body fat, diastolic blood pressure, muscular strength (hand grip and leg strength), muscular endurance, muscular power, flexibility, or speed (p>0.05). This study demonstrated that the daily oral intake of 200 mg of coenzyme Q10 supplementation for 6 weeks' duration resulted in significantly reduced resting heart rate and systolic blood pressure as well as enhanced exercise performance measured as VO_2max in overweight and class 1 obese subjects.

Keywords: Coenzyme Q10, Ubiquinone, Body composition, Exercise performance, Overweight, Class 1 obesity

1. Introduction

Overweight and obese individuals are common worldwide, and the conditions are defined as an excessive or abnormal fat accumulation in the adipose tissues that mainly impact long-term health status and increase the risk of numerous chronic diseases. More than 1.8 billion people worldwide are overweight and 650 million people are obese [1]. Obesity strongly correlates with the risk of non-communicable diseases (NCDs) including essential hypertension, type 2 diabetes mellitus, metabolic syndrome, ischemic stroke, coronary heart disease, and cancers, which have an effect on quality of life, leading to shorter life expectancy and increased mortality rate. The prevalence rate of the overweight and obese has continued to increase over time affecting approximately 30% of the global population with a negative economic impact [2]. Moreover, previous studies showed that being overweight or obese is strongly associated with poor exercise performance, Shin et al. reported that higher lean mass and bone mineral density were related to better physical performance while higher fat mass was related to poorer physical performance measured in terms of hand grip strength, walking speed, and balance [3]. A study by Lassale et al. revealed that adding a high level of fitness training to participants' physical activities could reduce the risk of chronic disease in healthy obese adults [4]. The reduction of body weight, BMI, and percentage body fat are the main initial endpoints for the treatment of overweight and obese individuals. Despite the limited data to confirm the clinical efficacy and safety of dietary

supplements in weight management, dietary interventions and supplements are currently used as the treatment modalities for overweight and obese individuals.

Ubiquinone, an oxidized form of coenzyme Q10, is a lipid-soluble substance, synthesized in human organs. Coenzyme Q10 acts as an anti-oxidant and plays a crucial role in cellular energy production. Increasing age, diabetes mellitus, and hypertension were significantly associated with low blood levels of coenzyme Q10 which explained increased oxidative stress and decreased exercise performance conditions [5]. A meta-analysis study by Borghi and Cicero reported that daily oral supplementation of 100 mg of coenzyme Q10 for 4 weeks' duration had significantly reduced systolic and diastolic blood pressure in hypertensive patients [6]. Suksomboon et al. reported that the oral intake of coenzyme Q10 for a duration of 12 weeks had significantly reduced levels of cholesterol and triglycerides in the blood, but there were no beneficial effects on fasting plasma glucose and arterial blood pressure [7]. In a study to determine the effect of coenzyme Q10 on body composition, Alqadhi et al. found that the oral intake of 200 mg of coenzyme Q10 for 6 months' duration had significantly reduced BMI and fat mass in idiopathic oligozoospermic patients [8]. Moreover, coenzyme Q10 had beneficial effects on exercise performance, with Linnane et al. reporting that the oral daily intake of 300 mg coenzyme Q10 for 4 weeks' duration had significantly increased the proportion of fast-twitch muscle fibers, improved protein expression, and increased skeletal muscle mass when compared with a placebo [9]. Another study by Alf et al. also supported that the oral intake of coenzyme Q10 for 6 weeks' duration significantly enhanced exercise performance shown in terms of watts/kg bodyweight by bicycle ergometer test in elite athletes [10]. Cooke et al. reported that the oral intake of 200 mg of coenzyme Q10 for 14 days' duration significantly increased plasma coenzyme Q10 levels, resulting in lower serum superoxide dismutase and higher serum malondialdehyde, but there was no beneficial effect on bone mass, lean body mass, or body fat percentage [11]. A study by Mehrdadi et al. indicated that the oral intake of 200 mg of coenzyme Q10 significantly improved insulin sensitivity and decreased waist circumference in comparison to the placebo group [12]. A study by Sumate reported that the oral intake of coenzyme Q10 for 6 weeks significantly enhanced physical fitness in healthy subjects [13].

Based on the available data, it appeared that there were insufficient data in earlier studies to confirm the effects of coenzyme Q10 supplementation on body composition and exercise performance in overweight and class 1 obese populations. This study selected a daily dosage of 200 mg of coenzyme Q10 for 6 weeks' duration because earlier studies had confirmed that 200 mg daily was the minimum effective dosage of coenzyme Q10 which demonstrated clinical benefits with a good safety profile and efficacy in the improvement of body composition, cardiovascular parameters, physical fitness, and an increase in total serum coenzyme Q10 levels [8,11,12,13], while 6 weeks' duration was the minimum proper duration for supplementation that had an impact on physical performance [10,13]. Therefore, being overweight or obese was strongly associated with poor body composition and exercise performance. There was insufficient evidence to confirm the benefits of coenzyme Q10 supplementation on body composition, cardiovascular parameters, and exercise performance in overweight and class 1 obese subjects. From significant previous evidence, this present study aimed to investigate the clinical impacts of coenzyme Q10 supplementation on body composition and exercise performance in the overweight and class 1 obese.

2. Materials and methods

2.1 Study participants

This was a double-blinded, placebo-controlled experimental study which enrolled twenty-eight overweight and class 1 obese subjects, aged 20 to 30 years, at Chatuchak Park, Bangkok, Thailand. The inclusion criteria of this study included those participants who had: 1) BMI range from 23.0 to 29.9 kg/m^2, 2) regular aerobic training for longer than 6 months, and 3) refrained from hormone replacement therapy and dietary supplementation for longer than 4 weeks. Exclusion criteria excluded those participants who currently had persistent muscular, bone, or joint injuries. Informed consent was obtained and signed by the study participants. Based on a previous study by Ogawa et al., by setting the probability of a type I error at 5%, a total number of 15 subjects per group were required [14]. This study applied a computer-generated randomization technique for study interventions allocation. All enrollees were randomized into two groups: one was to receive coenzyme Q10 and the other was an identical placebo group. Coenzyme Q10 (experimental group) contained 200 mg of ubiquinone per capsule (UBIDECARENONE KANEKA, JAPAN, which was imported by Great Family Product Group) and the identical placebo contained 200 mg of maltodextrin per capsule (control group). All subjects were advised to orally intake 1 capsule, once daily, with breakfast for a duration of 6 weeks. Investigational supplements were dispensed to study subjects by research assistants on the enrollment visit. All study subjects and investigators were blinded to study interventions. The study protocol was reviewed and approved by IRB-EC of Mae Fah Luang University with EC number 20059-20 on 05 October 2020 prior to the enrollment of study subjects.

2.2 Measurement of study outcomes

Body Mass Index (BMI) is a value derived from body weight in kilograms divided by the square of height in meters (kg/m^2). Overweight is defined as a BMI range from 23.0 to 24.9 kg/m^2 and class 1 obesity is defined as a BMI range from 25.0 to 29.9 kg/m^2 [15]. Bodyweight was measured by weight scale, percentage body fat was measured by skinfold caliper, waist-to-hip ratio was measured by plastic measuring tape, and resting heart rate, systolic, and diastolic blood pressure were measured by digital blood pressure machine. The details of outcome measurements followed the recommendations of the National Strength and Conditioning Association (NSCA) that could determine the proper order of tests and the duration of rest periods between testing to ensure test reliability as follows: 1) non-fatiguing tests in this study were bodyweight, waist-to-hip ratio, skinfold measurement (body fat percentage), resting heart rate, blood pressure, and standing trunk flexion test (flexibility); 2) maximum strength and power tests in this study were hand grip, leg strength test, and vertical jump test with rest periods between tests of at least 5 mins; 3) speed test in this study was a 40-yard sprint with a rest period between tests of at least 5 mins; 4) muscular endurance test in this study was a 2-min push up test with rest periods between tests of at least 5 mins, and 5) aerobic capacity test in this study was a 12-min running test for VO_2max [16]. Before starting the tests, all participants performed stretching and warm-up protocols, then after finishing the tests all participants performed cool-down protocols for muscular injury prevention. All these tests were measured between 4 p.m. and 7 p.m. to avoid the heat and dehydration.

2.3 Statistical analyses

Descriptive data were reported as frequency and percentage in categorical data and as arithmetic means and standard deviation in continuous data. In inferential statistics, an un-paired t-test was applied to compare the data variables between coenzyme Q10 and the placebo group at the baseline and at the 6-week visit for continuous data. Chi-square and Fisher's exact test were used to compare the categorical data. A significance level indicated by a p <0.05 was acceptable.

3. Results

Table 1 Comparison of clinical parameters between the coenzyme Q10 and placebo groups at the baseline and 6-week visit in overweight and class 1 obese healthy subjects

Clinical parameters	Placebo (n=14)		Coenzyme Q10 (n=14)		p-value*	p-value**
	Baseline	6-week	Baseline	6-week		
Age (years)	24.5±2.6		26.1±2.7		0.1262	
Body weight (kg)	73.8±8.4	74.1±8.8	76.3±8.6	75.8±8.8	0.4210	0.6102
Body mass index (kg/m^2)	25.7±2.0	25.6±2.0	26.1±2.3	25.8±2.4	0.5975	0.8525
Waist-to-hip ratio	0.88±0.06	0.89±0.07	0.90±0.07	0.90±0.07	0.4746	0.6412
Body fat (%)	26.2±4.9	26.2±4.9	28.1±5.5	27.6±5.4	0.3393	0.4666
Resting heart rate (bpm)	82.9±5.9	82.9±6.1	79.7±6.8	77.9±6.4	0.1826	0.0437
Systolic blood pressure (mmHg)	132.9±5.1	132.6±6.3	129.5±5.2	127.1±4.9	0.0857	0.0164
Diastolic blood pressure (mmHg)	83.3±3.8	83.1±3.4	85.3±3.3	84.6±2.7	0.1336	0.2275

Data expressed in the means ± SD, SD = standard deviation
*Independent student t test was used.
**Independent student t test was used.

Table 2 Comparison of exercise performance between the coenzyme Q10 and placebo groups at the baseline and 6-week visit in overweight and class 1 obese healthy subjects.

Exercise performance	Placebo (n=14)		Coenzyme Q10 (n=14)		p-value *	p-value **
	Baseline	6-week	Baseline	6-week		
Muscular strength I, hand grip (kg)	32.4±7.5	32.8±6.2	36.3±6.7	36.1±6.7	0.1454	0.1939
Muscular strength II, leg strength (kg)	118.2±48.5	117.9±47.9	109.1±44.1	113.6±43.8	0.5949	0.8068
Muscular endurance, 2-min push up	29.1±12.4	29.1±12.1	32.3±12.7	37.6±12.5	0.5007	0.0787
Muscular power, vertical jump (cm)	34.3±6.1	35.2±6.2	31.9±6.9	32.2±7.2	0.3282	0.2537
Flexibility (cm)	12.1±3.8	12.6±3.2	9.7±3.8	10.3±3.3	0.1036	0.0749
Speed, 40-yard sprint (seconds)	7.5±0.81	7.3±0.76	7.8±0.72	7.5±0.47	0.2453	0.4331
Aerobic capacity, VO_2max (ml/kg/min)	29.4±6.4	29.7±7.2	32.4±5.9	35.7±6.8	0.1833	0.0316

Data expressed in the means ± SD, SD = standard deviation
*Independent student t test was used.
**Independent student t test was used.

At the baseline visit, there were 30 subjects screened and enrolled. The average mean age was 25.3±2.7 years (min-max, 21-29 years). There were 2 subjects who withdrew from the study due to physical discomfort (n=1), and failure to make the follow-up visit for any reason (n=1). Then, there were 28 subjects who completed

the study protocols for final data analysis: 14 subjects in the coenzyme Q10 group and 14 subjects in the placebo group.

3.1 Comparison of clinical parameters between the coenzyme Q10 and placebo groups

All clinical parameters at the baseline and 6-week visit in both groups are shown in Table 1. There were no differences between the 2 groups at the baseline for all clinical parameters ($p>0.05$). At the 6-week visit, the coenzyme Q10 group showed significantly greater reductions in terms of resting heart rate (79.7±6.8 to 77.9±6.4 bpm) and systolic blood pressure (129.5±5.2 to 127.1±4.9 mmHg) than the placebo group ($p=0.0437$ and 0.0164, respectively). However, there was no difference in body weight, BMI, waist-to-hip ratio, percentage body fat, or diastolic blood pressure ($p>0.05$) (Table 1).

3.2 Comparison of exercise performance parameters between coenzyme Q10 and the placebo group

Table 2 presents no differences for exercise performance parameters at the baseline between the 2 groups ($p>0.05$). At the 6-week visit, the coenzyme Q10 group showed a significantly greater increase in terms of aerobic capacity measured as VO_2max (32.4±5.9 to 35.7±6.8 ml/kg/min) compared to the placebo group ($p=0.0316$). However, there was no difference in muscular strength (hand grip and leg strength), muscular endurance, muscular power, flexibility, or speed at the 6-week visit ($p>0.05$). There were no adverse effects reported.

4. Discussion

The present study aimed to investigate the impacts of coenzyme Q10 supplementation on body composition, cardiovascular parameters, and exercise performance using a daily oral intake of 200 mg of oxidized form coenzyme Q10 (ubiquinone) for 6 weeks' duration. Our results indicated that the coenzyme Q10 group significantly improved in terms of body composition, including resting heart rate and systolic blood pressure. The possible mechanism of coenzyme Q10 for improving these parameters might be explained by the vasodilating effect through decreased peripheral resistance in the vasculature [17]. A meta-analysis study by Borghi and Cicero demonstrated that the daily oral intake of coenzyme Q10 for 4 weeks' duration resulted in significantly reduced resting heart rate and blood pressure in hypertensive patients [6], which was supported by a study from Singh et al. who reported that coenzyme Q10 could lower systolic blood pressure and reduce left ventricular mass and wall thickness after myocardial infraction [18]. Moreover, coenzyme Q10 was a strong antioxidant dietary supplement which was able to counteract vasoconstriction and lower blood pressure [19]. A study by Belardinelli et al. reported that the daily oral intake of 100 mg of coenzyme Q10 supplement combined with supervised exercise training significantly decreased resting heart rate [20]. Digiesi et al. also indicated that the daily oral intake of coenzyme Q10 supplementation significantly reduced both systolic and diastolic blood pressure in hypertensive patients [21].

This study showed that the coenzyme Q10 group showed significantly enhanced exercise performance measured as aerobic capacity (VO_2max) when compared to the placebo group. The possible mechanism of coenzyme Q10 for enhancing aerobic capacity involves the fact that coenzyme Q10 is a critical component of the electron transport chain in mitochondria, which is linked to the generation of energy in the cells. Coenzyme Q10 reduced muscle cell inflammation and damage, decreased cellular oxidative stress, enhanced the functions of the electron transport chain, and increased cellular energy function and ATP production in mitochondria [22]. A previous study by Alf et al. provided evidence that the daily oral intake of 300 mg of coenzyme Q10 for a 6-week period significantly improved exercise performance shown as watts/kg bodyweight by bicycle ergometer test in elite athletes [10]. Linnane et al. reported that the oral daily intake of 300 mg of coenzyme Q10 for 4 weeks' duration had significantly increased the proportion of fast-twitch muscle fibers, improved protein expression, and increased skeletal muscle mass when compared with the placebo group [9]. A study by Demirci and Nevzat reported that 14 days of coenzyme Q10 supplementation significantly enhanced VO_2max and respiratory parameters in male skiers [23].

Nevertheless, our study failed to demonstrate the benefits of coenzyme Q10 on bodyweight, BMI, waist-to-hip ratio, percentage body fat, diastolic blood pressure, muscular strength (hand grip and leg strength), muscular endurance, muscular power, flexibility, and speed. The main reason was due to the short duration (6 weeks) of the study period which would be inadequate for muscle cells to adapt to physical stress. A study by Ritti-Dias et al. reported that a period of at least 8 weeks' duration in a weight training program was sufficient to significantly promote muscular strength and power in healthy male subjects [24]. A study by Bourgeois et al. reported that the greatest duration to improve muscle strength and skeletal muscle adaptations was 9 weeks [25] which was similar to the findings of Redondo et al. who found that a 12-week strength training program could improve maximal and explosive strength in male fencers [26]. Moreover, it was shown that the small amount of

coenzyme Q10 (200 mg/day) proved to be an insufficient dosage to affect body composition and exercise performance parameters in overweight and class 1 obese subjects. A study by Ebrahimi et al. reported that the oral intake of 200 mg of coenzyme Q10 did not change the level of grip strength and peak power [27]. Moazen et al. reported that the intake of 200 mg of coenzyme Q10 per day decreased only systolic but not diastolic blood pressure [28]. Cooke et al. found evidence that the daily oral intake of 200 mg of coenzyme Q10 did not significantly improve bodyweight, body fat percentage, and lean body mass [11].

The new findings of this study were that the daily oral intake of 200 mg of coenzyme Q10 (ubiquinone) for 6 weeks' duration significantly improved body composition in terms of resting heart rate and systolic blood pressure, and enhanced exercise performance measured as VO_2max in overweight and class 1 obese subjects. The strengths of this study were its experimental study design with a good methodology and the minimization of bias by using a blinding technique. Limitations were the small sample size with 2 dropout subjects (6.7%), and no objective monitoring of adverse effects, medication compliance, or the daily physical activities of study participants. Furthermore, the current situation with the coronavirus disease 2019 (COVID-19) outbreak must be taken into consideration.

5. Conclusion

This present study has shown that the daily supplementation of 200 mg of oxidized form coenzyme Q10 (ubiquinone) for 6 weeks' duration significantly reduced resting heart rate and systolic blood pressure, and enhanced exercise performance measured as VO_2max when compared to the placebo in overweight and class 1 obese subjects.

6. Ethical approval

This study protocol was reviewed and approved by IRB-EC of Mae Fah Luang University with EC number 20059-20 on 05 October 2020.

7. Acknowledgements

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8. Conflict of interests

The authors declare no conflicts of interest.

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