Songklanakarin J. Sci. Technol.
44 (1), 231-235, Jan. - Feb. 2022

http://www.sjst.psu.ac.th

Original Article

The effects of ubiquinol supplementation on clinical parameters and physical performance of trained men

Sumate Kunching[1*], Thamthiwat Nararatwanchai[1], Thep Chalermchai[1], Karnt Wongsupasawat[1], Phakkarawat Sitiprapaporn[1], and Akkapong Thipsiriset[2]

[1] *School of Anti-aging and Regenerative Medicine, Mae Fah Luang University, Wattana, Bangkok, 10110 Thailand*

[2] *Faculty of Sport Science, Bangkok Thonburi University, Bangkok 10170, Thailand*

Received: 18 May 2021; Revised: 2 July 2021; Accepted: 8 July 2021

Abstract

We report on a randomized double-blind, placebo-controlled parallel-group study, which aimed to investigate the effects of ubiquinol on clinical parameters and physical performance of trained men. Twenty-nine trained men aged 20-30 years who had VO_2max at least 40 ml/kg/min and performed 1RM bench press at least 1.0 times their own body weight were randomly assigned to receive either oral 200 mg daily ubiquinol or identical appearing placebo for a duration of 6 weeks. At the 6-week visit, ubiquinol group had significantly decreased body mass index, percent body fat, systolic and diastolic blood pressures ($p=0.048$, 0.043, 0.005, and 0.0024, respectively) and significantly increased VO_2max (42.1±0.4 to 42.4±0.3 ml/kg/min) compared to the placebo group ($p=0.011$, respectively). In conclusion, daily oral intake of 200 mg ubiquinol supplementation for 6 weeks duration resulted in significantly improved clinical parameters and most importantly had greatly enhanced physical performance by increased aerobic capacity measured as VO_2max in trained men.

Keywords: ubiquinol, reduced CoQ10, clinical parameters, physical performance, trained men

1. Introduction

Ubiquinol, the reduced form of coenzyme Q10, is a lipid soluble, vitamin-like substance, synthesized in the human. Ubiquinol is involved in essential cellular processes of energy production in muscle cells (mitochondria) acting as an electron carrier and proton translocator during adenosine triphosphate production in cellular respiration (Villalba, pez-Lluch, Santos-OcaZa, RodrRguez-Aguilera & Navas, 2001). Ubiquinol supports energy conversion from carbohydrates and fatty acids to adenosine triphosphate and helps muscle cells carry electrons from complexes I and II to complexes III (Crane, 2001). The roles of ubiquinol in energy conversion was reported in the context of its effects on aging processes and cardiovascular system (Sharma, Fonarow, Butler, Ezekowitz & Felker, 2016). A prior study showed that coenzyme Q10 was unable to improve exercise performance, but the newly developed form of coenzyme Q10 as ubiquinol could improve physical performance in healthy volunteers (Hosoe *et al.*, 2007). Plasma ubiquinol levels could be reduced by aging, oxidative stress or excessive exercise. As people get older, reduction of coenzyme Q10 level is related with increased reactive oxygen species levels and leads to poor physical performance (Buffenstein, Yael, Edrey & James, 2008).

When an athlete performs body and muscle movements, the required energy is produced through two metabolic anaerobic metabolism pathways; 1) phosphocreatine, and 2) glycolysis pathways; and in aerobic metabolism by electron transport system (Sokolovas, 2000). Moderate to high-impact intensity workload during exercise, associated with a lack of recovery time for cellular metabolism, leads to decline in the physical performance. This condition is known as “overreach” and is related to

*Corresponding author
Email address: sumate.52@hotmail.com

overproduction of free radicals and reactive oxygen species, and subsequently causes cellular dysfunction and oxidative stress (Sies, 1985). A prior study reported that the high dosage of 200 mg coenzyme Q10 daily over 4-12 weeks could increase coenzyme Q10 level in the muscle cells (Cooke *et al.*, 2008). A study using 120 mg coenzyme Q10 per day dose level given to trained men failed to demonstrate an increase in muscle coenzyme Q10 content (Svensson *et al.*, 1999). Another study showed that the daily 300 mg coenzyme Q10 supplementation significantly increased aerobic capacity, speed and reduced muscular injuries (Kon *et al.*, 2008). The study of Geiß and co-worker showed that only athletes with coenzyme Q10 plasma level greater than 2.5 µg/ml had increased physical performance during exercise. (Geiß, Hamm, Littarru, Folkers & Enzmann, 2004).

Ubiquinol is a critical component in the mitochondrial cellular respiratory process. It is an emerging molecule in sports nutrition. Ubiquinol also has antioxidant and anti-inflammatory properties (Guescini *et al.*, 2017). Hence, vigorous exercise could induce muscle injuries by excessive oxidative stress and inflammatory mediator stimulation. Oral intake of ubiquinol could decrease the free radical markers and reduce the muscle damage leading to a better physical performance in trained men (Kasapis & Thompson, 2005; Zhou *et al.*, 2005). The objectives of this present study were to investigate the effects of ubiquinol on clinical parameters and physical performance of trained men.

2. Materials and Methods

2.1 Study participants

This was a randomized double-blind, placebo-controlled parallel-group study. This study enrolled healthy trained men, aged between 20-30 years at Power Fit Club, Bangkok, Thailand. Inclusion criteria included those participants who had 1) good health without comorbidities, 2) 1-Repetition Maximum (RM) bench press 1.0 time of their body weight, 3) VO_2max at least 40 ml/kg/min, 4) regular aerobic and weight training for longer than 6 months, 5) non-smoker, and 6) refrained from hormone replacement therapy, vitamin and any food supplementations for at least 6 months. Exclusion criteria included diabetes mellitus, hypertension, and cardiovascular disease. Informed consent was obtained from all participants. This study applied computer-generated randomization for intervention allocation. All enrollees were randomly allocated into two groups: ubiquinol or placebo group. All subjects and investigators were blinded to the study intervention.

2.2 Oral supplementation

Ubiquinol (intervention group) contained 200 mg of ubiquinol per capsule (Kaneka QH™ ubiquinol; imported by Great family product group) and placebo (the control) with Maltodextrin 200 mg per capsule. All subjects were advised to take orally 1 capsule (200 mg) once daily after breakfast for a duration of 6 weeks. The placebo and ubiquinol supplement capsules were identical in appearance. Investigational agents were dispensed to study the subjects by research assistants.

2.3 Measurement of study outcomes

2.3.1 Clinical parameters

Body weight was measured by a weighing scale (Tanita, Japan), percent body fat by manual caliper (Body caliper, Italy), and waist-to-hip ratio by measuring tape (Butterfly, China). Resting heart rate, and systolic and diastolic blood pressures were measured using a digital blood pressure measurement device (Omron, Japan).

2.3.2 Physical performance

Body flexibility was measured by standing trunk flexion (Kurt & Pekünlü, 2015), muscular strength was measured by 1RM bench press following the 1RM testing protocol (Earle, 2006), muscular power was measured by vertical jump test (Arthur M., Arthur M. J. & Bailey, 1998), speed was measured by 40-yard sprint (Baechle & Earle, 2008), muscular endurance was measured by 2-minute push-ups following an army protocol (Department of the army, 1998) and aerobic capacity (VO_2max) was measured by a 1.5-mile run test (Fahey, Insel & Roth, 2007).

2.3.4 Statistical analyses

Descriptive data are reported with mean and standard error of the mean in numeric form. In inferential statistics, unpaired t-test and analysis of covariates (ANCOVA) by adjusting the baseline data as covariates, were applied to compare the data between ubiquinol and placebo groups at the baseline and at 6-week visit. Chi-squared or Fisher's exact test was used for categorical data comparisons. For calling statistical significance $p < 0.05$ was required.

3. Results and Discussion

The study protocol was reviewed and approved by IRB-EC of Mae Fah Luang University with EC number 20053-20 on 03/11/2020. There were 34 subjects enrolled. The mean age (with SD) was 23.2±2.2 years (min-max, 20-29 years). There were 5 subjects that withdrew from the study, due to physical discomfort (n=2), or by absence from follow-up visits for any reasons (n=3). Then, there were 29 subjects who completed the study protocol and contributed to the final data analysis: 15 subjects in the ubiquinol group, and 14 subjects in the placebo group.

3.1 Comparison of clinical parameters

At baseline visit, there was no difference of clinical parameters between the ubiquinol and placebo groups ($p>0.05$). At 6-week visit, the ubiquinol group had significantly greater reductions in body mass index, percent body fat, and systolic and diastolic blood pressures, than the placebo group ($p=0.048$, 0.043, 0.005, and 0.0024, respectively). However, there were no differences in body weight, waist-to-hip ratio, and resting heart rate between the two groups at the 6-week visit ($p>0.05$) (Table 1).

Table 1. Comparison of clinical parameters between placebo and ubiquinol groups at the baseline and at the 6-week visit

Clinical parameter [a]	Placebo (n=14)		Ubiquinol (n=15)		p value [b]	p value [c]
	Baseline	6-week	Baseline	6-week		
Age (years)	22.8±2.3		23.5±2.1			0.368
Body weight (kg)	66.7±1.3	67.1±1.3	70.1±1.4	69.6±1.3	0.06	0.105
Body mass index (kg/m^2)	22.8±0.2	23.0±0.2	23.1±0.4	23.0±0.3	0.36	0.048
Waist-to-hip ratio	0.82±0.01	0.82±0.01	0.85±0.01	0.86±0.01	0.07	0.264
Body fat (%)	16.0±0.44	16.2±0.48	16.9±0.6	16.7±0.5	0.07	0.043
Resting heart rate per minute	81±3	80±3	76±3	75±2	0.39	0.281
Systolic blood pressure (mmHg)	123.6±2.2	125.4±2.1	125.3±1.8	123.0±1.4	0.22	0.005
Diastolic blood pressure (mmHg)	83.1±1.4	84.1±1.1	80.9±1.6	79.9±1.3	0.51	0.0024

[a]Footnote 1: Data are expressed as mean ± SEM, where SEM = standard error of the mean
[b]Footnote 2: Independent Student's t-test was used.
[c]Footnote 3: Analysis of covariates (ANCOVA) was tested by adjusting the baseline as covariate.

3.2 Comparison of physical performance

At baseline visit, there was no difference in physical performance between the ubiquinol and placebo groups ($p>0.05$). At 6-week visit, the ubiquinol group had significantly greater increase in aerobic capacity measured as VO_2max than the placebo group ($p=0.011$). There were no differences in muscular strength, muscular endurance, muscular power, flexibility, or speed between the two groups at the 6-week visit ($p>0.05$) (Table 2).

3.3 Adverse effects

No adverse effects were reported.

3.4 Discussion

The major finding of the present study was that daily oral intake of 200 mg ubiquinol supplementation for 6 weeks effected improved clinical parameters and increased physical performance (in the ubiquinol group compared to the placebo group). We found that ubiquinol group had significantly improved clinical parameters including systolic and diastolic blood pressures, which corroborates the study of Digiesi and co-worker in which 100 mg daily CoQ10 supplement reduced systolic blood pressure from 164.5 ± 3.1 to 146.7 ± 4.1 mmHg and diastolic blood pressure from 98.1 ± 1.7 to 86.1 ± 1.3 mmHg ($p < 0.001$) (Digiesi *et al.*, 1994). Belardinelli and co-worker reported that 100 mg daily coenzyme Q10 supplementation with supervised exercise training could reduce blood pressure and improve endothelial function (Belardinelli *et al.*, 2006). The important action of ubiquinol for cardiac disease and hypertension was its vasodilation effect through endothelium and vascular smooth muscles (Kumar, Harharpreet, Pushpa & Varun, 2009). Moreover, the ubiquinol group had significantly improved in other clinical parameters including body mass index and percent body fat, supporting similar findings by Alqadhi and co-worker who reported that 200 mg coenzyme Q10 daily for 6 months significantly decreased the body mass index ($p<0.005$) (Alqadhi, Haidar & Usama, 2016). A study by Zhang *et al.* reported that 120 mg daily of coenzyme Q10 for 24 weeks significantly decreased serum low-density lipoprotein cholesterol level ($p=0.016$) and triglyceride level ($p=0.02$) (Zhang *et al.*, 2017). The possible mechanism of ubiquinol and coenzyme Q10 to improve body mass index and percent body fat may act by oxidative stress inhibition, reducing white adipose tissue content and improving the function of brown adipose tissue by regulating expression of lipid metabolism-related factors (Xu *et al.*, 2017). Ubiquinol is involved in transferring electrons within the mitochondrial oxidative respiratory chain and in ATP cellular energy production during exercise, and this could improve the physical training (Ylikoski, Piirainen, Hanninen & Penttinen, 1997). This mechanism may directly reduce the body mass index and the percent body fat in adults (Willis *et al.*, 2012).

Furthermore, we found that the ubiquinol group had significantly improved physical performance, which was indicated by the aerobic capacity measured as VO_2max. This corroborates a study by Alf and co-worker who found that 300 mg daily ubiquinol supplementation significantly enhanced physical performance measured as maximum power output at 6 weeks in young healthy German olympic athletes (Alf, Schmidt & Siebrecht, 2013). Linnane and co-worker reported that muscle fiber types were affected by CoenzymeQ10, which increased proportion of type IIb (fast twitch) fibers in younger individuals (Linnane *et al.*, 2009). One reasons why ubiquinol could improve physical performance is that it acts as a redox electron carrier and transporter into the mitochondria (Zhou *et al.*, 2005), which is involved in energy production by transported energy from nutrients to produce adenosine triphosphate, the energy storage in cells and for all human life processes (Alf *et al.*, 2013). Coenzyme Q10 had an antioxidant effect, protecting against oxidative damage to lipids, proteins and deoxyribonucleic acid (Littarru & Tiano, 2007) and stimulating overall the muscle tissue metabolism (Linnane *et al.*, 2009). Moreover, oral intake of ubiquinol could decrease muscle damage and improve muscle recovery contributing to the physical fitness of trained men (Kasapis & Thompson, 2005). The strength of this study is an experimental study design with good methodology that minimized biases by a double-blind approach. Limitations of the study were induced by the Coronavirus pandemic outbreak (COVID-19) and the physical discomfort that caused 5 dropout subjects, and a dynamic change in daily physical activity of study subjects in the new normal COVID-19 era.

Table 2. Comparison of physical performance measures between placebo and ubiquinol groups at the baseline and at the 6-week visit

Physical performance [a]	Placebo (n=14)		Ubiquinol (n=15)		p value [b]	p value [c]
	Baseline	6-week	Baseline	6-week		
Muscular strength, 1RM (kg)	79.1±2.8	80.1±2.7	84.2±2.6	83.3±2.3	0.11	0.052
Muscular endurance, push up (rep/2min)	52.6±4.0	53.4±3.7	57.4±3.3	56.5±3.2	0.09	0.08
Muscular power, vertical jump (cm)	39.1±0.5	39.0±0.7	37.7±0.7	38.3±0.6	0.06	0.434
Flexibility (cm)	16.0±1.0	15.7±1.1	13.8±1.0	14.2±1.0	0.07	0.117
Speed, 40-yard sprint (sec)	6.5±0.3	6.6±0.2	7.1±0.3	7.2±0.2	0.14	0.092
Aerobic capacity, VO_2max (ml/kg/min)	42.8±0.4	42.3±0.4	42.1±0.4	42.4±0.3	0.08	0.011

[a]Footnote 1: Data are expressed as mean ± SEM, where SEM = standard error of the mean
[b]Footnote 1: Independent Student's t-test was used.
[c]Footnote 3: Analysis of covariates (ANCOVA) was tested by adjusting the baseline as covariate.

4. Conclusions

This study demonstrated that daily oral intake of 200 mg ubiquinol supplementation for 6 weeks duration significantly decreased body mass index, percent body fat, and systolic and diastolic blood pressures; and most importantly greatly enhanced physical performance by increased aerobic capacity measured as VO_2max over the placebo treatment in trained men. There were no differences between treatment and control in muscular strength, muscular endurance, muscular power, speed, or flexibility effects.

Acknowledgements

The authors gratefully acknowledge the School of anti-Aging and Regenerative Medicine, Mae Fah Luang University. This study was supported and funded by Mae Fah Luang University, Thailand.

References

Alf, D., Schmidt, M. E., & Siebrecht, S. C. (2013). Ubiquinol supplementation enhances peak power production in trained athletes: a double-blind, placebo controlled study. *Journal of the International Society of Sports Nutrition, 10*, 24. doi:10.1186/1550-2783-10-24.

Alqadhi, H., Haidar, M. J. & Usama, S. A. (2016). Response of overweight patients with Oligozoospermia to coenzyme Q10 treatment. *Journal of Pharmacy and Biological Sciences 2016, 11*(2), 63-68.

Arthur, M., Arthur, M. J. & Bailey, B. L. (1998). *Complete conditioning for football*. Champaign, IL: Human Kinetics.

Baechle, T. R. & Earle, R. W (2008). *Essentials of strength training and conditioning* (3rd ed.). USA: Human Kinetics.

Belardinelli, R., Andi, M., Francesca, L., Maridia, S. G., Federica, P. L., & Gian, P. L. (2006). Coenzyme Q10and exercise training in chronic heart failure. *European Heart Journal, 27*, 2675-2681.

Buffenstein, R., Yael, H., Edrey, T. Y. & James M. (2008). The oxidative stress theory of aging: embattledor invincible? Insights from non-traditional model organisms. *American Aging Association, 30*, 99-109.

Cooke, M., Iosia, M., Buford, T., Shelmadine, B., Hudson, G., Kerksick, C., . . . Kreider, R. (2008). Effects of acute and 14-day coenzyme Q10 supplementation on exercise performance in both trained and untrained individuals. *Journal of International Society of Sports Nutrition*, 5(8).

Crane, F. L. (2001). Biochemical functions of coenzyme Q10. *Journal of the American College of Nutrition, 20(6),* 591-598.

Department of the Army. (1998). *Physical fitness training. Field manual* No. 21-20. Washington, DC: Author.

Digiesi, V., Cantini, F., Oradei, A., Bisi, G., Guarino, C., Brocchi, A., . . . Littarru, G. P. (1994). Coenzyme Q10 in essential hypertension. *Molecular Aspects Medicine, 15(Supplement)*, s257-s263.

Earle, R. W. (2006). *Weight training exercise prescription. In essentials of personal training symposium workbook.* Lincoln, NE: National Strength and Conditioning Association Certification Commission.

Fahey, T., Insel, P. & Roth, W. (2007). *Core concepts and labs in physical fitness and wellness* (7th ed.). N.P.: McGraw-Hill.

Geiß, K. R., Hamm, M., Littarru, G. P., Folkers, K. & Enzmann, F. H. (2004). Steigerung der körperlichen Leistungsfähigkeit von Ausdauerathleten mit Hilfen von Q10 Monopräparat. *InEnergie und Schutz Coenzym Q10 Fakten und Perspektivem in der Biologie und Medizin*. Edited by Littarru GP. Rome, Italy: Litografica Iride, 84–86.

Guescini, M., Luca, T., Maria, L. G., Emanuela, P., Sonia, S., Patrik, O., . . . Cinzia, C. (2017). The combination of physical exercise with muscle-directed antioxidants to counteract Sarcopenia: A biomedical rationale for pleiotropic treatment with creatine and coenzyme Q10. *Oxidative Medicine and Cellular Longevity Volume 2017*. doi:10.1155/2017/7083049.

Hosoe, K., Kitano, M., Kishida, H., Kubo, H., Fujii, K. & Kitahara, M. (2007). Study on safety and bioavailability of ubiquinol (Kaneka QH) after single and 4-week multiple oral administration to healthy volunteers. *Regulatory Toxicology Pharmacology, 47*, 19–28.

Kasapis, C. & Thompson, P. D. (2005). The effects of physical activity on serum c-reactive protein and inflammatory markers. A systematic review.

Journal of the American College of Cardiology, *45*(10), 1563–1569.

Kon, M., Tanabe, K., Akimoto, T., Kimura, F., Tanimura, Y., Shimizu, K., . . . Kono, I. (2008). Reducing exercise-induced muscular injury in kendo athletes with supplementation of coenzyme Q10. *The British Journal of Nutrition*, *100*(4), 903–909. doi:10.1017/S0007114508926544

Kumar, A., Harharpreet, K., Pushpa, D. & Varun, M. (2009). Role of coenzyme Q10 (CoQ10) in cardiac disease, hypertension and Meniere-like syndrome. *Pharmacology and Therapeutics*, *124*(3), 259-268.

Kurt, C. & Pekünlü, E. (2015). Acute effect of whole body vibration on isometric strength, squat jump, and flexibility in well-trained combat athletes. *Biology of Sport*, *32*(2), 115-122.

Linnane, A. W., Kopsidas, G., Zhang, C., Yarovaya, N., Kovalenko, S., Papakostopoulos, P., . . . Richardson, M. (2002). Cellular redox activity of coenzyme Q10: effect of CoQ10 supplementation on human skeletal muscle. *Free Radical Research*, *36*(4), 445–453.

Littarru, G. P. & Tiano, L. (2007). Bioenergetic and antioxidant properties of coenzyme Q10: recent developments. *Molecular Biotechnology*, *37*(1), 31-37.

Sharma, A., Fonarow, G. C., Butler, J., Ezekowitz, J. A. & Felker, G. M. (2016). Coenzyme Q10 and heart failure: A state-of-the-art review. *Circulation-Heart Failure*, *9*, e002639.

Sies, H. (1985). *Oxidative stress: Introductory remarks*. London, England: Oxidative Stress Academic Press.

Sokolovas, G. (2000). *Demographic information. In the Olympic trials project (Chapter 1).* Colorado Springs, CO: United States Swimming. Retrieved from http://www.usa-swimming.org/programs/template.pl?opt=news&pubid=941].

Svensson, M., Malm, C., Tonkonogi, M., Ekblom, B., Sjodin, B. & Sahlin, K. (1999). Effect of Q10 supplementation on tissue Q10 levels and adenine nucleotide catabolism during high-intensity exercise. *Journal of International Society of Sports Nutrition*, *9*, 166–180.

Villalba, J. M., pez-Lluch, G. L., Santos-OcaZa, C., RodrRguez-Aguilera, J. C. & Navas, P. (2001). Extramitochondrial functions of coenzyme Q. In V. E. Kagan, & P. J. Quinn, (Eds.), C*oenzyme Q: Molecular mechanisms in health and disease* (pp. 83–94). New York, NY: CRC Press.

Willis, L., Cris, A., Slentz, L. A., Bateman, A., Tamlyn, S., Lucy, W., Piner, C. W (2012). Effects of aerobic and/or resistance training on body mass and fat mass in overweight or obese adults. *Journal of Applied Physiology*, *113*(12), 1831-1837.

Xu, Z., Huo, J., Ding, X., Yang, M., Li, L., Dai, J., . . . Sawashita, J. (2017). Coenzyme Q10 improves lipid metabolism and ameliorates obesity by regulating CaMKII-mediated PDE4 inhibition. *Scientific Reports*, *7*(1), 8253. doi:10.1038/s41598-017-08899-7

Ylikoski, T., Piirainen, J., Hanninen, O., & Penttinen, J. (1997). The effect of coenzyme Q10 on the exercise performance of cross-country skiers. *Molecular Aspects of Medicine*, *18* (Supplement), S283–S290. doi:10.1016/s0098-2997(97)00038-1.

Zhang, P., Yang, C., Guo, H., Wang, J., Lin, S., Li, H., . . . Ling, W. (2018). Treatment of coenzyme Q10 for 24 weeks improves lipid and glycemic profile in dyslipidemic individuals. *Journal of Clinical Lipidology*, *12*(2), 417–427.e5. doi:10.1016/j.jacl.2017.12.006.

Zhou, S., Zhang, Y., Davie, A., Marshall-Gradisnik, S., Hu, H., Wang, J., & Brushett, D. (2005). Muscle and plasma coenzyme Q10 concentration, aerobic power and exercise economy of healthy men in response to four weeks of supplementation. *The Journal of Sports Medicine and Physical Fitness*, *45*(3), 337–346.