Palestrica of the third millennium – Civilization and Sport
Vol. 15, no. 3, July-September 2014, 189–192

Coenzyme Q10 action on mental fatigue and energy, in acute physical stress

Acţiunea Coenzimei Q10 asupra oboselii şi energiei mentale, în stresul fizic acut

Ramona Jurcău[1], Ioana Jurcău[2]
[1] *"Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca*
[2] *Pediatric Clinical Hospital, Cluj-Napoca*

Abstract

Background. Coenzyme Q10 (CQ10) is essential for the production of body energy and for the functioning of organs, including the brain.

Aims. The objective was to highlight the influence of CQ10 on the mental fatigue (MF) sensation and on mental energy (ME), in acute physical exercise.

Methods. Untrained volunteer subjects (n=12 men) were subjected to the following protocol: a) the physical stress period (P1): for a week, daily physical exercises consisted of running on a treadmill, for 12 min; b) the treatment period (P2): 21 days of CQ10 administration, under conditions of physical rest; c) the physical stress period (P3): repeating P1. MF and ME were assessed at the following moments: T1 = at the beginning of P1; T2 = at the end of P1; T3 = at the beginning of P3; T4 = at the end of P3. MF and ME were analyzed using Mental Energy and Mental Fatigue Scales. Statistical evaluation was made on the basis of the Student test.

Results. At T2 compared to T1: MF was significantly increased - MF (p=0.005) and ME was significantly diminished (p=0.003). At T4, compared to T2: MF was significantly diminished (p=0.03) and ME was significantly increased (p=0.01). There were no significant differences between: T1-T3, T1-T4.

Conclusions. 1) Under CQ10 influence, MF and ME were significantly modified. 2) CQ10 acted efficiently both on MF and ME. 3) CQ10 efficiency was evidenced in post-exercise stress, at T4. 4) We consider that CQ10 may be useful in modulating MF and ME in acute exercise stress.

Keywords: coenzyme Q10, physical stress, mental fatigue, mental energy.

Rezumat

Introducere. Coenzima Q10 (CQ10) este esenţială în producerea energiei corpului şi pentru funcţionarea organelor, inclusiv a creierului.

Obiective. Obiectivul studiului a fost de a evidenţia influenţa CQ10 asupra senzaţiei de oboseală mentală (OM) şi a energiei mentale (EM), în efortul fizic acut.

Metode. Subiecţii voluntari sedentari aleşi (n=12 bărbaţi) au fost supuşi următorului protocol: a) perioada de stres fizic (P1): o săptămână, zilnic, exerciţii fizice, constând în alergarea pe o bandă rulantă, timp de 12 min; b) perioada de tratament (P2): 21 zile de administrare a CQ10, în condiţii de repaus fizic; c) perioada de stres fizic (P3): reluarea programului T1. OM şi EM au fost evaluate la: T1 = înaintea începerii P1; T2 = la sfârşitul P1; T3 = la începutul P3; T4 = la sfârşitul P3. Au fost evaluate OM şi EM, utilizând Scalele de Oboseală Mentală şi Energie Mentală. Evaluarea statistică s-a făcut pe baza testului Student.

Rezultate. La T2 faţă de T1: OM a fost semnificativ crescută (p=0,005), iar EM (p=0,003) a fost semnificativ scăzută. La T4, faţă de T2: OM a fost semnificativ scăzută (p=0,03), iar EM (p=0,01) a fost semnificativ crescută. Nu au existat diferenţe semnificative între: T1-T3, T1-T4.

Concluzii. 1) Sub influenţa CQ10, OM şi EM au fost semnificativ modificate. 2) CQ10 a acţionat eficient, atât asupra OM, cât şi asupra EM. 3) Eficienţa CQ10 a fost remarcată în perioada post-stres, la T4. 4) Considerăm că CQ10 poate fi utilă în modularea OM şi EM, în stresul de efort fizic acut.

Cuvinte cheie: coenzima Q10, stres fizic, oboseală mentală, energie mentală.

Received: 2014, July, 20; *Accepted for publication:* 2014, September 24;
Address for correspondence: "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj-Napoca 400012, Victor Babes Str. no. 8
E-mail: ramona_mj@yahoo.com

Introduction

Fatigue can be classified as physical or mental (Ishii et al., 2014a) and is defined as a decline in the ability and efficiency of mental and/or physical activities that is caused by excessive mental and/or physical activities. Several studies have identified brain regions in which the level of neural activities is correlated with the subjective level of fatigue (Ishii et al., 2014b).

Ubiquinone, also called Coenzyme Q (CoQ10), is a lipid subject to oxido-reduction cycles (Aussel et al., 2014), which shows an antifatigue effect and has been widely used by athletes to increase physical strength (Maruoka et al., 2014).

The present article continues the authors' previous research concerning the assessment of the relationship between physical effort and various natural products, through personal studies (Jurcău et al., 2013; Jurcău & Jurcău, 2013).

Hypothesis

The use of CoQ10 in exercise and health is a growing issue in practice and research. However, the CoQ10 influence on the sensation of tiredness and mental energy in acute physical exercise has been less explored.

Objectives

We propose the evaluation of the influence of a preparation containing CoQ10 on the mental fatigue (MF) and mental energy (ME) sensation, in acute physical exercise.

Material and methods

Research protocol

a) *Period and place of the research*

The study was approved by the Ethics Commission of the College of Physicians, and measurements were carried out in May 2013, in the Medical Family Office 122 in Cluj-Napoca. The participation of all subjects in the study was voluntary.

b) *Subjects and groups*

The selected subjects were sedentary. Persons with mental disorders, cortisone therapies of any kind and toxic addiction - alcohol, tobacco, drugs, coffee were excluded from the trials.

One group of 12 male subjects, with a mean age of 24.2 ± 4, was evaluated, being subjected to three successive assessment periods.

The participants were asked not to consume alcohol, coffee, not to smoke and not to use any medication or antioxidant the day before and during physical exercise.

c) *Tests applied*

- *Study design*

For stress caused by physical exercise, the model was an intense exercise of running on a treadmill. The protocol was the following: 1) the physical stress period = P1: for a week, daily running on a treadmill Excite + MD Run, for 12 min, at 30 Watt; 2) the treatment period = P2: 21 days of CQ10, under conditions of physical rest; 3) the physical stress period = P3: resuming the P1 programme.

The administered preparation was „CoQ10 Forte", produced by Dacia Plant company, Brașov (1). It was administered daily for three weeks, in a dose of 3 tablets per day at 7.00-13.00-19.00 during P2.

- *The indicators were determined* as follows:

time 1 = first determination, basal (T1) - at the beginning of P1;

time 2 = second determination (T2) - at the end of P1;

time 3 = third determination (T3) - at the beginning of P3;

time 4 = fourth determination (T4) - at the end of P3.

- *Explorations*

The measurements consisted of measuring mental fatigue and mental energy, with the Mental Fatigue and Mental Energy Scale, based on instructions such as „How do you feel now," each scale ranging from 0 to 300 mm; 300 represented the highest degree of mental energy/fatigue.

d) *Statistical processing*

- the results obtained were analyzed using the SPSS 13.0. statistical package.

- for continuous data examination, Student's t test was used.

- the differences were considered significant at a $p< 0.05$.

Results

Note that the *reference time* was considered to be T_1.

a) *Mental fatigue (MF)* (Fig. 1).

At T2 compared to T1, MF was significantly increased: p=0.005. At T4, compared to T2, MF was significantly decreased: p=0.03. There were no significant differences between T1-T3, T1-T4.

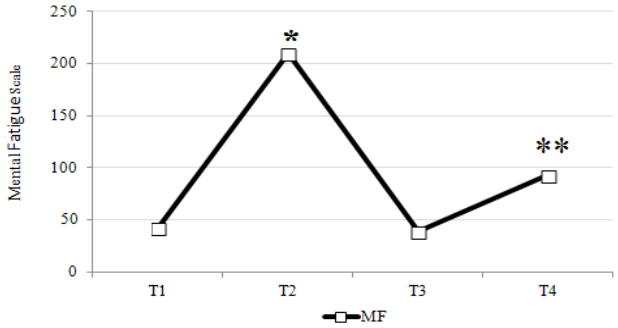

Fig. 1 - Changes of mental fatigue, in physical exercise. *p<0.005, **p<0.03, *=T_2-T_1, **=T_4-T_2

b) Mental energy (ME) (Fig. 1).

At T2 compared to T1, ME was significantly decreased: p=0.005. At T4, compared to T2, MF was significantly increased: p=0.03. There were no significant differences between T1-T3, T1-T4.

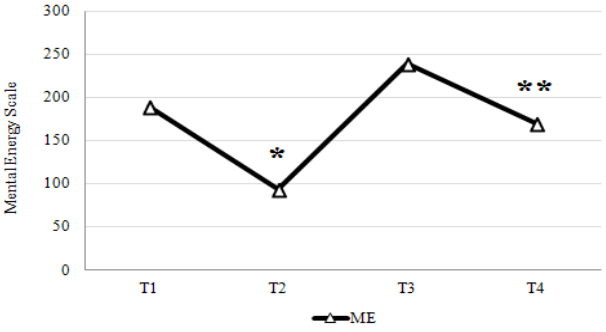

Fig. 2 - Changes of mental energy in physical exercise. *p<0.003, **p<0.01, *=T_2-T_1, **=T_4-T_2

c) Comparison of the pre-CoQ10 therapy *evolution of the analyzed parameters* (Fig. 3).

Physical exercise intensified MF (T2/T1 = 5.1), then lowered ME (T1/T2 = 2.04).

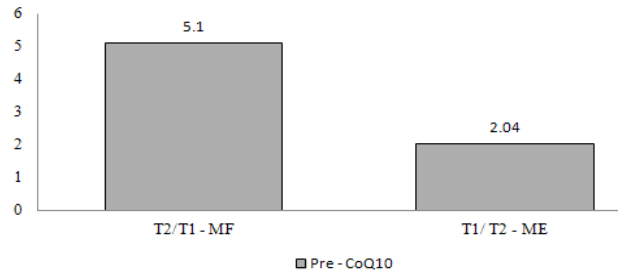

Fig. 3 - Comparison of the pre-CoQ10 therapy evolution of the analyzed parameters.

d) Comparison of the post-CoQ10 therapy *evolution of the analyzed parameters* (Fig. 4).

After CoQ10 therapy, the impact of exercise was greatly reduced compared to pre-CoQ10 therapy both on MF (T4/T3 = 2.4, versus T2/T1 = 5.1) and on ME (T3/T4 = 1.41, versus T1/T2 = 2.04).

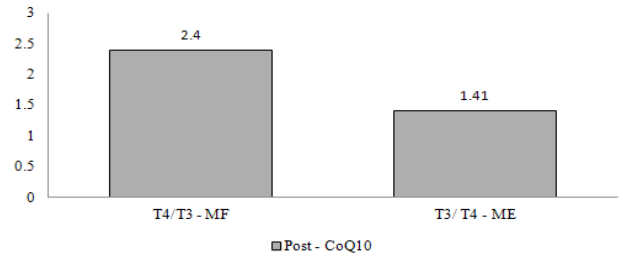

Fig. 4 - Comparison of the post-CoQ10 therapy evolution of the analyzed parameters.

Discussion

CoQ10

CoQ10 functions in the respiratory electron transport chain and plays a pivotal role in energy generating processes (Aussel et al., 2014).

Although extensively studied for decades, recent data on CoQ10 have painted an exciting albeit incomplete picture of the multiple facets of this molecule's function (Laredj et al., 2014).

In addition to its role as a component of the mitochondrial respiratory chain and our only endogenously synthesized lipid-soluble antioxidant, in recent years CoQ10 has been found to have an increasing number of other important functions required for normal metabolic processes (Bentinger et al., 2010).

CoQ10 is also an antioxidant that specifically prevents the oxidation of lipoproteins and the plasma membrane (González-Mariscal et al., 2014).

The CoQ10 - physical exercise relationship. A Pubmed chronological review

CoQ10 supplementation increased total CoQ concentration in slow-twitch muscles, and was useful for reducing exhaustive exercise-induced muscular injury by enhancing stabilization of muscle cell membrane (Kon et al., 2007).

Oral administration of CoQ10 improved subjective fatigue sensation and physical performance during fatigue-inducing workload trials and might prevent unfavorable conditions as a result of physical fatigue (Mizuno et al., 2008).

Studies on CoQ10 and physical exercise have confirmed its effect in improving subjective fatigue sensation and physical performance and in opposing exercise-related damage (Littarru & Tiano, 2010).

According to these results, CoQ10 may show performance-enhancing effects during repeated bouts of supramaximal exercises and CoQ10 might be used as an ergogenic aid (Gökbel et al., 2010).

CoQ10 supplementation partially prevents the increase in lipid peroxidation after repeated short-term supramaximal exercise (Gül et al., 2011).

CoQ10 supplementation before strenuous exercise decreases oxidative stress and modulates inflammatory signaling, reducing subsequent muscle damage (Díaz-Castro et al., 2012).

A relationship is thought to exist between dosage and maintenance of physiological effects associated with the running time (Maruoka et al., 2014).

Fatigue mechanism. A Pubmed chronological review

Mental fatigue manifests as potentially impaired cognitive function and is one of the most significant causes of accidents in modern society. There is accumulating evidence supporting the existence of mental facilitation and inhibition systems. These systems are involved in the neural mechanisms of mental fatigue, modulating the activity of task-related brain regions to regulate cognitive task performance (Ishii et al., 2014a).

Performing a continuous mental fatigue-inducing task causes changes in the activation of the prefrontal cortex, and manifests as an increased beta-frequency power in this brain area as well as sleepiness (Tanaka et al., 2014a).

However, the neural activity evoked when we evaluate our level of fatigue may not be related to the subjective level of fatigue. The posterior cingulate cortex is involved in the neural substrates associated with self-evaluation of physical fatigue (Ishii et al., 2014b).

The CoQ10 - mental fatigue relationship. A Pubmed chronological review

CoQ10 treatment significantly reduces fatigue and improves ergonomic performance during exercise and thus may have a potential in alleviating the exercise intolerance and exhaustion displayed by people with myalgic encephalomyelitis/chronic fatigue syndrome (Morris et al., 2013).

Mental fatigue suppresses activities in the right anterior cingulate cortex during physical fatigue (Tanaka et al., 2014b).

The CoQ10 - mental energy relationship. A Pubmed chronological review

CoQ10 could protect the brain by improving cerebral metabolism (Ren et al., 1994).

CoQ10 offers substantial neuroprotection against ischaemia, trauma, oxidative damage and neurotoxins (Baker & Tarnopolsky, 2003).

CoQ10 therapy involves resistance to oxidative stress

and improved brain bioenergetics (Horecký et al., 2011).

CoQ10 is a mobile electron carrier in the mitochondrial respiratory chain (MRC) with antioxidant and potential neuroprotective activities (Aboul-Fotouh, 2013).

The results we obtained on the action of CoQ10 therapy are consistent with data from recent studies on the use of CoQ10. However, the literature on mental fatigue and mental energy in physical exercise is scarce. The present study brought new data on the benefits of CoQ10 in reducing mental fatigue and increasing mental energy in physical exercise.

Conclusions

1. Under CoQ10 influence, MF and ME were significantly modified.
2. CoQ10 acted efficiently both on MF and ME.
3. CoQ10 efficiency was noticed in post-exercise stress, at T4.
4. We consider that CoQ10 may be useful in modulating MF and ME, in acute exercise stress.

Conflicts of interest

Nothing to declare.

Acknowledgement

We would like to thank: Doctor Alexandrina Fărăgău, for kindly hosting this study in the medical practice she runs, and Eng. Dr. Nicolae Colceriu for botanical counseling and his contribution to statistical data processing.

The financing of the study for the acquisition of the treatments used was obtained from sponsorships.

References

Aboul-Fotouh S. Chronic treatment with coenzyme Q10 reverses restraint stress-induced anhedonia and enhances brain mitochondrial respiratory chain and creatine kinase activities in rats. Behav. Pharmacol. 2013; 24(7):552-560.

Aussel L, Pierrel F, Loiseau L, Lombard M, Fontecave M, Barras F. Biosynthesis and physiology of coenzyme Q in bacteria. Biochim Biophys Acta. 2014;1837(7):1004-1011.

Baker SK, Tarnopolsky MA. Targeting cellular energy production in neurological disorders. Expert Opin Investig Drugs. 2003;12(10):1655-1679.

Bentinger M, Tekle M, Dallner G. Coenzyme Q-biosynthesis and functions. Biochem Biophys Res Commun. 20103;96(1):74-79.

Díaz-Castro J, Guisado R, Kajarabille N, García C, Guisado IM, de Teresa C, Ochoa JJ. Coenzyme Q(10) supplementation ameliorates inflammatory signaling and oxidative stress associated with strenuous exercise. Eur J Nutr. 2012;51(7):791-799.

Gökbel H, Gül I, Belviranl M, Okudan N. The effects of coenzyme Q10 supplementation on performance during repeated bouts of supramaximal exercise in sedentary men. J Strength Cond Res. 2010;24(1):97-102.

González-Mariscal I, García-Testón E, Padilla S, Martín-Montalvo A, Pomares-Viciana T, Vazquez-Fonseca L, Gandolfo-Domínguez P, Santos-Ocaña C. Regulation of coenzyme Q biosynthesis in yeast: a new complex in the block. IUBMB Life. 2014;66(2):63-70.

Gül I, Gökbel H, Belviranli M, Okudan N, Büyükbaş S, Başarali K. Oxidative stress and antioxidant defense in plasma after repeated bouts of supramaximal exercise: the effect of coenzyme Q10. J Sports Med Phys Fitness. 2011;51(2):305-312.

Horecký J, Gvozdjáková A, Kucharská J, Obrenovich ME, Palacios HH, Li Y, Vančová O, Aliev G. Effects of coenzyme Q and creatine supplementation on brain energy metabolism in rats exposed to chronic cerebral hypoperfusion. Curr Alzheimer Res. 2011;8(8):868-875.

Ishii A, Tanaka M, Watanabe Y. Neural mechanisms of mental fatigue. Rev Neurosci. 2014a. [Epub ahead of print]

Ishii A, Tanaka M, Yamano E, Watanabe Y. The neural substrates of physical fatigue sensation to evaluate ourselves: a magnetoencephalography study. Neuroscience. 2014b;261:60-67.

Jurcău R, Colceriu N, Jurcău I. Influence of a Romanian phytotherapic produce called „Antistres", containing Ginseng, on anxiety and salivary Cortisol, in one exam of exams student stress. International Journal of Education and Psychology in the Community (IJEPC). 2013;3(2):38-51.

Jurcău R, Jurcău I. Influence of a green tea extract product on oxidative stress and muscle fatigue sensation in sedentary people subjected to physical exercise. Palestrica Mileniului III. 2013;14(2):90-95.

Kon M, Kimura F, Akimoto T, Tanabe K, Murase Y, Ikemune S, Kono I. Effect of Coenzyme Q10 supplementation on exercise-induced muscular injury of rats. Exerc Immunol Rev. 2007;13:76-88.

Laredj LN, Licitra F, Puccio HM. The molecular genetics of coenzyme Q biosynthesis in health and disease. Biochimie. 2014;100:78-87.

Littarru GP, Tiano L. Clinical aspects of coenzyme Q10: an update. Nutrition. 2010;26(3):250-254.

Maruoka H, Fujii K, Inoue K, Kido S. Long-term Effect of Ubiquinol on Exercise Capacity and the Oxidative Stress Regulation System in SAMP1 Mice. J Phys Ther Sci. 2014;26(3):367-371.

Mizuno K, Tanaka M, Nozaki S, Mizuma H, Ataka S, Tahara T, Sugino T, Shirai T, Kajimoto Y, Kuratsune H, Kajimoto O, Watanabe Y. Antifatigue effects of coenzyme Q10 during physical fatigue. Nutrition. 2008;24(4):293-299.

Morris G, Anderson G, Berk M, Maes M. Coenzyme Q10 depletion in medical and neuropsychiatric disorders: potential repercussions and therapeutic implications. Mol Neurobiol. 2013;48(3):883-903.

Ren Z, Ding W, Su Z, Gu X, Huang H, Liu J, Yan Q, Zhang W, Yu X. Mechanisms of brain injury with deep hypothermic circulatory arrest and protective effects of coenzyme Q10. J Thorac Cardiovasc Surg. 1994;108(1):126-133.

Tanaka M, Ishii A, Watanabe Y. Neural effects of mental fatigue caused by continuous attention load: a magnetoencephalography study. Brain Res. 2014a;1561:60-66.

Tanaka M, Ishii A, Watanabe Y. Neural effect of mental fatigue on physical fatigue: a magnetoencephalography study. Brain Res. 2014b;1542:49-55.

Web sites

(1) http://www.daciaplant.ro/coenzima-q10-forte-112121--p180972.html - accessed on 4.04.2013