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„L-carnitine -metabolic functions and meaning in humans life.“

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L-Carnitin - metabolische Funktionen und Bedeutung im menschlichen Leben.

Ⓔ

Μεταβολικές λειτουργίες της L-καρνιτίνης και σημασία στην ανθρώπινη ζωή.

Ⓕ

Fonctions métaboliques de la L-carnitine et signification pour la vie humaine.

Ⓖ

Metabolické funkce L-karnitinu a význam v lidském životě.

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[Curr Drug Metab.](#) 2011 Sep;12(7):667-78.

## L-carnitine--metabolic functions and meaning in humans life.

[Pekala J](#), [Patkowska-Sokoła B](#), [Bodkowski R](#), [Jamroz D](#), [Nowakowski P](#), [Lochyński S](#), [Librowski T](#).

Source Department of Bioorganic Chemistry, Faculty of Chemistry, Wrocław University of Technology, Poland.

### Abstract

L-Carnitine is an endogenous molecule involved in fatty acid metabolism, biosynthesized within the human body using amino acids: L-lysine and L-methionine, as substrates. L-Carnitine can also be found in many foods, but red meats, such as beef and lamb, are the best choices for adding carnitine into the diet. Good carnitine sources also include fish, poultry and milk. Essentially, L-carnitine transports the chains of fatty acids into the mitochondrial matrix, thus allowing the cells to break down fat and get energy from the stored fat reserves. Recent studies have started to shed light on the beneficial effects of L-carnitine when used in various clinical therapies. **Because L-carnitine and its esters help reduce oxidative stress, they have been proposed as a treatment for many conditions, i.e. heart failure, angina and weight loss.** For other conditions, such as fatigue or improving exercise performance, L-carnitine appears safe but does not seem to have a significant effect. The presented review of the literature suggests that continued studies are required before L-carnitine administration could be recommended as a routine procedure in the noted disorders. Further research is warranted in order to evaluate the biochemical, pharmacological, and physiological determinants of the response to carnitine supplementation, as well as to determine the potential benefits of carnitine supplements in selected categories of individuals who do not have fatty acid oxidation defects.

PMID: 21561431

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„Single dose administration of L-carnitine improves antioxidant activities in healthy subjects.“

Ⓓ

Die Gabe einer Einzeldosis L-Carnitin verbessert die antioxidative Tätigkeit bei gesunden Probanden.

Ⓖ

„Η χορήγηση μιας δόσης L-καρνιτίνης βελτιώνει την αντιοξειδωτική δράση σε υγιή αντικείμενα.“

Ⓕ

L'administration de L-carnitine en dose unique améliore les activités anti-oxydantes chez les sujets sains.

Ⓒ

Jednorázově podaná dávka L-karnitinu zlepšuje antioxidantní aktivity u zdravých jedinců.

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## Single dose administration of L-carnitine improves antioxidant activities in healthy subjects.

[Cao Y](#), [Qu HJ](#), [Li P](#), [Wang CB](#), [Wang LX](#), [Han ZW](#).

**Source** Department of Pharmacy, the Affiliated Hospital of Medical College, Qingdao University, China.

### Abstract

L-carnitine has been used as a supplement to treat cardiovascular or liver disease. However, there has been little information about the effect of L-carnitine on anti-oxidation capability in healthy human subjects. This study was designed to investigate the correlation between plasma L-carnitine concentration and antioxidant activity. Liquid L-carnitine (2.0 g) was administered orally as a single dose in 12 healthy subjects. Plasma concentration of L-carnitine was detected by HPLC. The baseline concentration of L-carnitine was  $39.14 \pm 5.65$   $\mu\text{mol/L}$ . After single oral administration, the maximum plasma concentration ( $C(\text{max})$ ) and area under the curve ( $\text{AUC}(0-\infty)$ ) were  $84.7 \pm 25.2$   $\mu\text{mol/L}$  and  $2,676.4 \pm 708.3$   $\mu\text{mol/L}\cdot\text{h}$ , respectively. The half-life and the time required to reach the  $C(\text{max})$  was  $60.3 \pm 15.0$  min and  $3.4 \pm 0.46$  h, respectively. There was a gradual increase in plasma concentrations of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), catalase and total antioxidative capacity (T-AOC) in the first 3.5 h following L-carnitine administration. The plasma concentrations of SOD, GSH-Px, catalase and T-AOC returned to baseline levels within 24 h. A positive correlation was found between L-carnitine concentration and the antioxidant index of SOD ( $r = 0.992$ ,  $P < 0.01$ ), GSH-Px ( $r = 0.932$ ,  $P < 0.01$ ), catalase ( $r = 0.972$ ,  $P < 0.01$ ) or T-AOC ( $r = 0.934$ ,  $P < 0.01$ ). In conclusion, L-carnitine increases activities of antioxidant enzymes and the total antioxidant capacity in healthy subjects. It may be useful as a supplementary therapy for chronic illnesses involving excessive oxidative stress.

PMID: 21701126

Free full text

GB

„Oxidative stress parameters in urine from patients with disorders of propionate metabolism: a beneficial effect of L-carnitine supplementation.“

DE

Oxidative Stressparameter im Urin von Patienten mit Störungen des Propionatmetabolismus: eine günstige Wirkung der Nahrungsergänzung mit L-Carnitin.

GR

„Παράμετροι οξειδωτικού στρες σε ούρα ασθενών με διαταραχές στο μεταβολισμό προπιονικού οξέος: μια ευεργετική επίπτωση από τη χορήγηση L-καρνιτίνης.“

FR

Paramètres du stress oxydatif dans l'urine de patients souffrant de troubles du métabolisme du propionate : un effet bénéfique de la supplémentation en L-carnitine.

CZ

„Parametry oxidačního stresu v moči pacientů s poruchami metabolismu propionátů: příznivý účinek suplementace L-karnitinem.“

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[Cell Mol Neurobiol.](#) 2012 Jan;32(1):77-82. doi: 10.1007/s10571-011-9736-8. Epub 2011 Jul 22.

## **Oxidative stress parameters in urine from patients with disorders of propionate metabolism: a beneficial effect of L:-carnitine supplementation.**

[Ribas GS](#), [Biancini GB](#), [Mescka C](#), [Wayhs CY](#), [Sitta A](#), [Wajner M](#), [Vargas CR](#).

Source Programa de Pós-Graduação em Ciências Farmacêuticas, UFRGS, Ipiranga 2752, Porto Alegre, RS, 90610-000, Brazil. grazischmitt@terra.com.br

Propionic (PA) and methylmalonic (MMA) acidurias are inherited disorders caused by deficiency of propionyl-CoA carboxylase and methylmalonyl-CoA mutase, respectively. Affected patients present acute metabolic crises in the neonatal period and long-term neurological deficits. Treatments of these diseases include a protein restricted diet and L: -carnitine supplementation. L-Carnitine is widely used in the therapy of these diseases to prevent secondary L-carnitine deficiency and promote detoxification, and several recent in vitro and in vivo studies have reported antioxidant and antiperoxidative effects of this compound. In this study, **we evaluated the oxidative stress parameters, isoprostane and di-tyrosine levels, and the antioxidant capacity, in urine from patients with PA and MMA at the diagnosis, and during treatment with L: -carnitine and protein-restricted diet.** We verified a significant increase of isoprostanes and di-tyrosine, as well as a significant reduction of the antioxidant capacity in urine from these patients at diagnosis, as compared to controls. **Furthermore, treated patients presented a marked reduction of isoprostanes and di-tyrosine levels in relation to untreated patients.** In addition, patients with higher levels of protein and lipid oxidative damage, determined by di-tyrosine and isoprostanes levels, also presented lower urinary concentrations of total and free L-carnitine. **In conclusion, the present results indicate that treatment with low protein diet and L-carnitine significantly reduces urinary biomarkers of protein and lipid oxidative damage in patients with disorders of propionate metabolism and that L-carnitine supplementation may be specially involved in this protection.**

PMID: 21833551

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„Supplementation of L-carnitine in athletes: does it make sense?“

Ⓓ

Supplementierung von L-Carnitin bei Athleten: ist sie sinnvoll?

Ⓖ

„Συμπληρώματα L-καρνιτίνης σε αθλητές: είναι απαραίτητα;“

Ⓕ

Supplémentation des athlètes en L-carnitine : est-ce sensé ?

Ⓒ

Suplementace L-karnitinem u atletů: má význam?

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[Nutrition](#). 2004 Jul-Aug;20(7-8):709-15.

## **Supplementation of L-carnitine in athletes: does it make sense?**

[Karlic H](#), [Lohninger A](#).

Source Ludwig Boltzmann Institute for Leukemia Research and Hematology, Vienna, Austria. heidrun.karlic@chello.at

### **Abstract**

Studies in athletes have shown that carnitine supplementation may foster exercise performance. As reported in the majority of studies, an increase in maximal oxygen consumption and a lowering of the respiratory quotient indicate that dietary carnitine has the potential to stimulate lipid metabolism. Treatment with L-carnitine also has been shown to induce a significant postexercise decrease in plasma lactate, which is formed and used continuously under fully aerobic conditions. Data from preliminary studies have indicated that L-carnitine supplementation can attenuate the deleterious effects of hypoxic training and speed up recovery from exercise stress. Recent data have indicated that L-carnitine plays a decisive role in the prevention of cellular damage and favorably affects recovery from exercise stress. **Uptake of L-carnitine by blood cells may induce at least three mechanisms:**

- 1) stimulation of hematopoiesis,**
- 2) a dose-dependent inhibition of collagen-induced platelet aggregation, and**
- 3) the prevention of programmed cell death in immune cells.** As recently shown, carnitine has direct effects in regulation of gene expression (i.e., carnitine-acyltransferases) and may also exert effects via modulating intracellular fatty acid concentration. **Thus there is evidence for a beneficial effect of L-carnitine supplementation in training, competition, and recovery from strenuous exercise and in regenerative athletics.**

PMID:15212755

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„L-Carnitine protects plasma components against oxidative alterations.“

Ⓓ

L-Carnitin schützt Plasmakomponenten vor oxidativen Veränderungen.

Ⓔ

Η L-καρνιτίνη προστατεύει τα συστατικά του πλάσματος ενάντια στις οξειδωτικές αλλοιώσεις.

Ⓕ

La L-carnitine protège les composants du plasma contre des altérations oxydatives.

Ⓖ

L-karnitin chrání složky plazmy proti oxidačním změnám.

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[Nutrition](#). 2011 Jun;27(6):693-9. doi: 10.1016/j.nut.2010.06.009. Epub 2010 Sep 24.

## **L-Carnitine protects plasma components against oxidative alterations.**

[Kolodziejczyk J](#), [Saluk-Juszczak J](#), [Wachowicz B](#).

### **Source**

Department of General Biochemistry, University of Lodz, Lodz, Poland.

### **OBJECTIVE:**

L-Carnitine as a dietary supplement has been reported to have a beneficial effect on several cardiovascular risk parameters and exercise capacity, but the biological relevance of its activity is poorly understood. Dietary supplements (including L-carnitine) are often used to foster exercise performance; however, these may affect some pathways of human body metabolism. The aim of this study in vitro was to determine antioxidative properties of L-carnitine (0.1-100  $\mu\text{M}$ ) added to plasma and to assess if L-carnitine might protect plasma proteins and lipids against oxidative/nitrative damage (determined by levels of protein carbonyl groups, thiols, 3-nitrotyrosine formation and thiobarbituric-acid reactive substances generation) caused by 100  $\mu\text{M}$  peroxynitrite (ONOO(-)), a strong physiologic oxidative/nitrative agent.

### **METHODS:**

The level of carbonyl group generation was measured by a colorimetric method. For the estimation of 3-nitrotyrosine formation, a competition enzyme-linked immunosorbent assay was performed. Plasma lipid peroxidation was measured spectrophotometrically as the production of thiobarbituric-acid reactive substances. High-performance liquid chromatography was used to analyze total free thiol groups of plasma proteins and low-molecular-weight thiols (glutathione, cysteine, and homocysteine) in plasma.

### **RESULTS:**

The L-carnitine added to plasma inhibited in vitro ONOO(-)-induced oxidation and nitration of blood plasma proteins. Incubation of plasma with peroxynitrite resulted in the decrease of protein thiols. **L-Carnitine had a protective effect on peroxynitrite-induced decreased -SH level in plasma proteins.** The presence of L-carnitine also prevented the decrease of low-molecular-weight thiols (glutathione, cysteine, and homocysteine) in plasma caused by peroxynitrite and **protected plasma lipids against peroxidation induced by peroxynitrite.**

***CONCLUSIONS:***

**These results demonstrated that L-carnitine possesses antioxidative activity.**

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PMID: 20869209

GB

„New insights concerning the role of carnitine in the regulation of fuel metabolism in skeletal muscle.“

DE

Neue Kenntnisse zur Rolle von Carnitin bei der Regulierung des Energiemetabolismus im Skelettmuskel.

GR

„Νέες ανακαλύψεις που αφορούν το ρόλο της καρνιτίνης στη ρύθμιση του μεταβολισμού καυσίμων στους σκελετικούς μύες.“

FR

Nouveaux progrès relatifs au rôle de la carnitine dans la régulation du métabolisme du carburant dans le muscle du squelette.

CZ

Nové vnímání úlohy karnitinu v regulaci metabolismu látek v kosterních svalech.

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[J Physiol.](#) 2007 Jun 1;581(Pt 2):431-44. Epub 2007 Mar 1.

## **New insights concerning the role of carnitine in the regulation of fuel metabolism in skeletal muscle.**

[Stephens FB](#), [Constantin-Teodosiu D](#), [Greenhaff PL](#).

Source Centre for Integrated Systems Biology and Medicine, School of Biomedical Sciences, Queen's Medical Centre, University of Nottingham, Nottingham NG7 2UH, UK.  
francis.stephens@nottingham.ac.uk

### **Abstract**

In skeletal muscle, carnitine plays an essential role in the translocation of long-chain fatty-acids into the mitochondrial matrix for subsequent beta-oxidation, and in the regulation of the mitochondrial acetyl-CoA/CoASH ratio. Interest in these vital metabolic roles of carnitine in skeletal muscle appears to have waned over the past 25 years. However, recent research has shed new light on the importance of carnitine as a regulator of muscle fuel selection. It has been established that muscle free carnitine availability may be limiting to fat oxidation during high intensity submaximal exercise. Furthermore, increasing muscle total carnitine content in resting healthy humans (via insulin-mediated stimulation of muscle carnitine transport) reduces muscle glycolysis, increases glycogen storage and is accompanied by an apparent increase in fat oxidation. By increasing muscle pyruvate dehydrogenase complex (PDC) activity and acetylcarnitine content at rest, it has also been established that PDC flux and acetyl group availability limits aerobic ATP re-synthesis at the onset of exercise (the acetyl group deficit). **Thus, carnitine plays a vital role in the regulation of muscle fuel metabolism. The demonstration that its availability can be readily manipulated in humans, and impacts on physiological function, will result in renewed business and scientific interest in this compound.**

PMID: 17331998

[Free PMC Article](#)

GB

„The influence of L-carnitine supplementation on the antioxidative abilities of serum and the central nervous system of ethanol-induced rats.“

DE

Der Einfluss einer Supplementierung von L-Carnitin auf die antioxidativen Fähigkeiten von Serum und zentralem Nervensystem bei Ethanol-induzierten Ratten.

GR

„Η επίδραση της χορήγησης L-καρνιτίνης στις αντιοξειδωτικές ικανότητες του ορού και του κεντρικού νευρικού συστήματος ποντικών στα οποία έχει χορηγηθεί αιθανόλη.“

FR

L'influence de la supplémentation en L-carnitine sur les aptitudes anti-oxydatives du sérum et sur le système nerveux central de rats induits à l'éthanol.

CZ

Účinek suplementace L-karnitinem na antioxidační schopnosti séra a centrální nervovou soustavu potkanů ovlivněnou etanolem.

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[Metab Brain Dis.](#) 2010 Dec;25(4):381-9. doi: 10.1007/s11011-010-9217-7. Epub 2010 Nov 12.

## **The influence of L-carnitine supplementation on the antioxidative abilities of serum and the central nervous system of ethanol-induced rats.**

[Augustyniak A](#), [Skrzydłowska E](#).

Source Department of Analytical Chemistry, Medical University of Białystok, Mickiewicza 2a, 15-230, Białystok 8, P. O. Box 14, Poland.

### **Abstract**

The brain is exceptionally susceptible to oxidative stress that may be caused by xenobiotics such as ethanol. Alcohol metabolism is accompanied by enhanced free radical formation and a decrease in antioxidant abilities. However, **L-carnitine appears to have antioxidant properties and the ability to regulate ethanol metabolism.** The present study was designed to estimate the effect of **L-carnitine on the antioxidant capacity of the rat brain and blood serum.** For 5 weeks during the study, L-carnitine was given to rats in the amount of 1.5 g/l of drinking water, and from the second week the rats were intragastrically treated with ethanol. A significant decrease in the activity of antioxidant enzymes (Cu,Zn-SOD, GSH-Px, GSSG-R and CAT) and in the level of non-enzymatic antioxidants (vitamin C, E, A, GSH and GSH-t) as well as a significant increase in the level of GSSG in the brain and blood serum of ethanol intoxicated rats have been demonstrated. It has also been shown that alcohol caused a significant increase in the level of lipid peroxidation products-lipid hydroperoxides, malondialdehyde and 4-hydroxynonenal-and an increase in dityrosine, as well as a decrease in tryptophan-markers of protein oxidative modifications. The administration of L-carnitine to ethanol intoxicated rats partially normalized the activity of the examined enzymes and the level of the above non-enzymatic antioxidants. **Moreover, L-carnitine significantly protects lipids and proteins against oxidative modifications.** In conclusion, it has been proved that L-carnitine protects rat

brain and blood serum against oxidative stress formation and it is possible that this small molecular amine has a similar beneficial effect on the human CNS.

PMID: 21069444

GB

„Effects of L-carnitine against oxidative stress in human hepatocytes: involvement of peroxisome proliferator-activated receptor alpha.“

DE

Die Wirkung von L-Carnitin gegen oxidativen Stress bei menschlichen Hepatozyten: Beteiligung des Peroxisom Proliferator-aktivierten Rezeptors alpha.

GR

Αποτελέσματα της L-καρνιτίνης ενάντια στο οξειδωτικό στρες σε ανθρώπινα ηπατοκύτταρα: συμμετοχή των ενεργοποιημένων υποδοχέων άλφα υπεροξειδοσωμάτων.

FR

Effets de la L-carnitine contre le stress oxydatif dans les hépatocytes humains : implication du récepteur alpha activé par les proliférateurs de péroxisomes.

CZ

Účinky L-karnitinu proti oxidačnímu stresu v lidských hepatocytech: zapojení alfa receptorů aktivovaných proliferátorem peroxizomu.

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[J Biomed Sci.](#) 2012 Mar 21;19:32. doi: 10.1186/1423-0127-19-32.

**Effects of L-carnitine against oxidative stress in human hepatocytes: involvement of peroxisome proliferator-activated receptor alpha.**

[Li JL](#), [Wang QY](#), [Luan HY](#), [Kang ZC](#), [Wang CB](#).

Source Laboratory of Functional Physiology, Binzhou Medical University, Yantai, China. [ljl813@sina.com](mailto:ljl813@sina.com)

**BACKGROUND:**

Excessive oxidative stress and lipid peroxidation have been demonstrated to play important roles in the production of liver damage. L-carnitine is a natural substance and acts as a carrier for fatty acids across the inner mitochondrial membrane for subsequent beta-oxidation. It is also an antioxidant that reduces metabolic stress in the cells. Recent years L-carnitine has been proposed for treatment of various kinds of disease, including liver injury. This study was conducted to evaluate the protective effect of L-carnitine against hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)-induced cytotoxicity in a normal human hepatocyte cell line, HL7702.

**METHODS:**

We analyzed cytotoxicity using MTT assay and lactate dehydrogenase (LDH) release. Antioxidant activity and lipid peroxidation were estimated by reactive oxygen species (ROS) levels, activities and protein expressions of superoxide dismutase (SOD) and catalase (CAT), and malondialdehyde (MDA) formation. Expressions of peroxisome proliferator-activated receptor (PPAR)-alpha and its target genes were evaluated by RT-PCR or western blotting. The role of PPAR-alpha in L-carnitine-enhanced expression of SOD and CAT was also explored. Statistical analysis was performed by a one-way analysis of variance, and its significance was assessed by Dennett's post-hoc test.

**RESULTS:**

The results showed that L-carnitine protected HL7702 cells against cytotoxicity induced by H<sub>2</sub>O<sub>2</sub>. This protection was related to the scavenging of ROS, the promotion of SOD and CAT activity and expression, and the prevention of lipid

peroxidation in cultured HL7702 cells. The decreased expressions of PPAR-alpha, carnitine palmitoyl transferase 1 (CPT1) and acyl-CoA oxidase (ACOX) induced by H<sub>2</sub>O<sub>2</sub> can be attenuated by L-carnitine. Besides, we also found that the promotion of SOD and CAT protein expression induced by L-carnitine was blocked by PPAR-alpha inhibitor MK886.

### ***CONCLUSIONS:***

**Taken together, our findings suggest that L-carnitine could protect HL7702 cells against oxidative stress through the antioxidative effect and the regulation of PPAR-alpha also play an important part in the protective effect.**

PMID: 22435679

PMCID: PMC3338374

[Free PMC Article](#)

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„L-carnitine supplementation: influence upon physiological function.“

Ⓓ

L-Carnitin-Supplementierung: Einfluss auf die physiologische Funktion.

Ⓔ

„Χορήγηση Ι-καρνιτίνης: επίδραση στη λειτουργία των οργάνων.“

Ⓕ

Supplémentation en L-carnitine : influence sur la fonction physiologique.

Ⓖ

„Suplementace L-karnitinem: účinek na fyziologickou funkci.“

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[Curr Sports Med Rep](#). 2008 Jul-Aug;7(4):218-23. doi:  
10.1249/JSR.0b013e318180735c.

## **L-carnitine supplementation: influence upon physiological function.**

[Kraemer WJ](#), [Volek JS](#), [Dunn-Lewis C](#).

**Source** Human Performance Laboratory, Department of Kinesiology, University of Connecticut, Storrs, Connecticut 06269-1110, USA. [william.kraemer@uconn.edu](mailto:william.kraemer@uconn.edu)

### **Abstract**

Carnitine (L-3-hydroxytrimethylamminobutanoate) is a naturally occurring compound that can be synthesized in mammals from the essential amino acids lysine and methionine or ingested through diet. Primary sources of dietary carnitine are red meat and dairy products; however, commercially produced supplements also are available and have been shown to be safe in humans. Carnitine is stored primarily in skeletal muscle, with lower concentrations in plasma. Biologically, carnitine is essential for the transport of long-chain (carbon chain length = 10) fatty acids across the outer- and inner-mitochondrial membranes (carnitine palmitoyltransferase I and II, respectively). Conflicting results characterized the early research focused on L-carnitine supplementation's ability to enhance endurance performance, and studies showed no changes occurred in muscle carnitine levels. Nevertheless, promising findings for its use have been observed for various pathologies, including cardiovascular diseases, which show it might mitigate some negative effects and enhance physical function. Recent studies have focused upon a different paradigm for L-carnitine in regulating hypoxic stress and enhancing recovery from exercise.

PMID: 18607224

GB

„Carnitine insufficiency caused by aging and overnutrition compromises mitochondrial performance and metabolic control.“

DE

Carnitininsuffizienz durch Alterung und Überernährung beeinträchtigt die mitochondriale Leistung und metabolische Kontrolle.

GR

Η ανεπάρκεια καρνιτίνης που οφείλεται στη γήρανση και τον υπερσιτισμό μειώνει την απόδοση των μιτοχονδρίων και το μεταβολικό έλεγχο.

FR

La carence en carnitine provoquée par le vieillissement et la surnutrition compromet la performance des mitochondries et le pilotage métabolique.

CZ

Nedostatek karnitinu způsobený stárnutím a přejídáním má negativní vliv na mitochondriální výkon a metabolickou kontrolu.

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[J Biol Chem.](#) 2009 Aug 21;284(34):22840-52. doi: 10.1074/jbc.M109.032888. Epub 2009 Jun 24.

## **Carnitine insufficiency caused by aging and overnutrition compromises mitochondrial performance and metabolic control.**

[Noland RC](#), [Koves TR](#), [Seiler SE](#), [Lum H](#), [Lust RM](#), [Ilkayeva O](#), [Stevens RD](#), [Hegardt FG](#), [Muoio DM](#).

### **Source**

Sarah W. Stedman Nutrition and Metabolism Center, Duke University, Durham, North Carolina 27710, USA.

### **Abstract**

In addition to its essential role in permitting mitochondrial import and oxidation of long chain fatty acids, carnitine also functions as an acyl group acceptor that facilitates mitochondrial export of excess carbons in the form of acylcarnitines. Recent evidence suggests carnitine requirements increase under conditions of sustained metabolic stress. Accordingly, we hypothesized that carnitine insufficiency might contribute to mitochondrial dysfunction and obesity-related impairments in glucose tolerance. Consistent with this prediction whole body carnitine diminution was identified as a common feature of insulin-resistant states such as advanced age, genetic diabetes, and diet-induced obesity. In rodents fed a lifelong (12 month) high fat diet, compromised carnitine status corresponded with increased skeletal muscle accumulation of acylcarnitine esters and diminished hepatic expression of carnitine biosynthetic genes. Diminished carnitine reserves in muscle of obese rats was accompanied by marked perturbations in mitochondrial fuel metabolism, including low rates of complete fatty acid oxidation, elevated incomplete beta-oxidation, and impaired substrate switching from fatty acid to pyruvate. These mitochondrial abnormalities were reversed by 8 weeks of oral carnitine supplementation, in concert with increased tissue efflux and urinary excretion of acetylcarnitine and improvement of whole body glucose tolerance. Acetylcarnitine is produced by the mitochondrial matrix enzyme, carnitine acetyltransferase (CrAT). A role for this enzyme in combating glucose intolerance was further supported by the finding that CrAT overexpression in primary human skeletal myocytes increased glucose uptake and attenuated lipid-induced

suppression of glucose oxidation. These results implicate carnitine insufficiency and reduced CrAT activity as reversible components of the metabolic syndrome.

PMID:19553674

[Free PMC Article](#)

Ⓒ

„Role of carnitine in the regulation of glucose homeostasis and insulin sensitivity: evidence from in vivo and in vitro studies with carnitine supplementation and carnitine deficiency.“

Ⓓ

Die Rolle von Carnitin bei der Regulierung der Glukose-Homöostase und Insulinsensitivität: Evidenz aus in-vivo- und in-vitro-Studien mit Carnitin-Supplementierung und Carnitinmangel.

Ⓖ

„Ο ρόλος της καρνιτίνης στη ρύθμιση της ομοιόστασης της γλυκόζης και την ευαισθησία στην ινσουλίνη: δείγματα από in vivo και in vitro μελέτες με χορήγηση καρνιτίνης και έλλειψη καρνιτίνης.“

Ⓕ

Le rôle de la carnitine dans la régulation de l'homéostasie du glucose et la sensibilité à l'insuline : indices provenant d'études in vivo et in vitro avec supplémentation en carnitine et carence en carnitine.

Ⓒ

Úloha karnitinu v regulaci glukózové homeostázy a inzulinové citlivosti: důkaz ze studií in vivo a in vitro na suplementaci karnitinem a nedostatek karnitinu.

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[Eur J Nutr.](#) 2012 Feb;51(1):1-18. doi: 10.1007/s00394-011-0284-2. Epub 2011 Dec 2.

## **Role of carnitine in the regulation of glucose homeostasis and insulin sensitivity: evidence from in vivo and in vitro studies with carnitine supplementation and carnitine deficiency.**

[Ringseis R](#), [Keller J](#), [Eder K](#).

**Source** Institute of Animal Nutrition and Nutrition Physiology, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 26-32, 35390 Giessen, Germany.

### **BACKGROUND:**

Although carnitine is best known for its role in the import of long-chain fatty acids (acyl groups) into the mitochondrial matrix for subsequent  $\beta$ -oxidation, carnitine is also necessary for the efflux of acyl groups out of the mitochondria. Since intracellular accumulation of acyl-CoA derivatives has been implicated in the development of insulin resistance, carnitine supplementation has gained attention as a tool for the treatment of insulin resistance. More recent studies even point toward a causative role for carnitine insufficiency in developing insulin resistance during states of chronic metabolic stress, such as obesity, which can be reversed by carnitine supplementation.

### **METHODS:**

The present review provides an overview about data from both animal and human studies reporting effects of either carnitine supplementation or carnitine deficiency on parameters of glucose homeostasis and insulin sensitivity in order to establish the less well-recognized role of carnitine in regulating glucose homeostasis.

### **RESULTS:**

Carnitine supplementation studies in both humans and animals demonstrate an improvement of glucose tolerance, in particular during insulin-resistant states. In contrast, less consistent results are available from animal studies investigating the association between carnitine deficiency and glucose intolerance. The majority of

studies dealing with this question could either find no association or even reported that carnitine deficiency lowers blood glucose and improves insulin sensitivity.

### ***CONCLUSIONS:***

**In view of the abovementioned beneficial effect of carnitine supplementation on glucose tolerance during insulin-resistant states, carnitine supplementation might be an effective tool for improvement of glucose utilization in obese type 2 diabetic patients. However, further studies are necessary to explain the conflicting observations from studies dealing with carnitine deficiency.**

PMID: 22134503

Ⓒ

„Effect of L-carnitine on oxidative stress and platelet activation after major surgery.“

Ⓓ

Die Wirkung von L-Carnitin auf oxidativen Stress und Thrombozytenaktivierung nach größeren Operationen.

Ⓖ

Επίπτωση της L-καρνιτίνης στο οξειδωτικό στρες και την ενεργοποίηση των αιμοπεταλίων μετά από σοβαρή χειρουργική επέμβαση.

Ⓕ

Effet de la L-carnitine sur le stress oxydatif et l'activation plaquettaire après une intervention chirurgicale grave.

Ⓒ

Účinek L-karnitinu na oxidační stres a aktivaci krevních destiček po rozsáhlém chirurgickém výkonu.

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[Acta Anaesthesiol Scand.](#) 2011 Sep;55(8):1022-8. doi: 10.1111/j.1399-6576.2011.02487.x. Epub 2011 Jul 20.

## Effect of L-carnitine on oxidative stress and platelet activation after major surgery.

[Pignatelli P](#), [Tellan G](#), [Marandola M](#), [Carnevale R](#), [Loffredo L](#), [Schillizzi M](#), [Proietti M](#), [Violi F](#), [Chirletti P](#), [Delogu G](#).

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### BACKGROUND:

The surgical/anesthesia trauma is associated with an increased production of reactive oxygen species (ROS). This enhanced oxidative stress leads to cell damage resulting in various complications such as sepsis, myocardial injury and increased mortality. The aim of this study was to investigate the role of antioxidant treatment with l-carnitine in oxidative stress and platelet activation in patients undergoing major abdominal surgery.

### METHODS:

Forty patients scheduled for abdominal surgery were randomly allocated to l-carnitine, administered with a rapid infusion (0.05 g/kg) diluted in 250 ml of saline solution, vs. placebo treatment just before the surgical intervention. At baseline and after treatment, oxidative stress was evaluated by detection of circulating levels of soluble NOX2-derived peptide (sNOX2-dp), a marker of NADPH oxidase activation, and by analyzing platelet ROS formation. Platelet activation was studied by dosing sCD40L.

### RESULTS:

We observed an increase of soluble sNOX2-dp, sCD40L and ROS production in the placebo group compared with the baseline after the surgical intervention. Conversely, in the l-carnitine-treated group, sNOX2-dp, sCD40L and ROS production did not significantly differ from the baseline. A linear correlation analysis showed that  $\Delta$  of ROS correlated with  $\Delta$  of sNOX2 ( $R(s) = 0.817$ ;  $P < 0.001$ ) and  $\Delta$  of sCD40L

( $R(s) = 0.780$ ;  $P < 0.001$ ). Multiple linear regression analysis showed that the only independent predictive variable associated with  $\Delta$  of ROS was  $\Delta$  of serum NOX2 levels ( $SE = 0.05$ ; standardized coefficient  $\beta = 1.075$ ;  $P < 0.001$ ).

### **CONCLUSION:**

**Our findings suggest that l-carnitine could be helpful in modulating oxidative stress and platelet activation during major abdominal surgery-dependent oxidative damage.**

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PMID: 21770897

Ⓒ

„L-Carnitine protects plasma components against oxidative alterations.“

Ⓓ

L-Carnitin schützt Plasmakomponenten gegen oxidative Veränderungen.

Ⓔ

Η L-καρνιτίνη προστατεύει τα συστατικά του πλάσματος ενάντια στις οξειδωτικές αλλοιώσεις.

Ⓕ

La L-carnitine protège les composants du plasma contre des altérations oxydatives.

Ⓖ

L-karnitin chrání složky plazmy proti oxidačním změnám.

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[Nutrition](#). 2011 Jun;27(6):693-9. doi: 10.1016/j.nut.2010.06.009. Epub 2010 Sep 24.

### **L-Carnitine protects plasma components against oxidative alterations.**

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**OBJECTIVE:** L-Carnitine as a dietary supplement has been reported to have a beneficial effect on several cardiovascular risk parameters and exercise capacity, but the biological relevance of its activity is poorly understood. Dietary supplements (including L-carnitine) are often used to foster exercise performance; however, these may affect some pathways of human body metabolism. The aim of this study in vitro was to determine antioxidative properties of L-carnitine (0.1-100  $\mu\text{M}$ ) added to plasma and to assess if L-carnitine might protect plasma proteins and lipids against oxidative/nitrative damage (determined by levels of protein carbonyl groups, thiols, 3-nitrotyrosine formation and thiobarbituric-acid reactive substances generation) caused by 100  $\mu\text{M}$  peroxynitrite (ONOO(-)), a strong physiologic oxidative/nitrative agent.

**METHODS:** The level of carbonyl group generation was measured by a colorimetric method. For the estimation of 3-nitrotyrosine formation, a competition enzyme-linked immunosorbent assay was performed. Plasma lipid peroxidation was measured spectrophotometrically as the production of thiobarbituric-acid reactive substances. High-performance liquid chromatography was used to analyze total free thiol groups of plasma proteins and low-molecular-weight thiols (glutathione, cysteine, and homocysteine) in plasma.

**RESULTS:** The L-carnitine added to plasma inhibited in vitro ONOO(-)-induced oxidation and nitration of blood plasma proteins. Incubation of plasma with peroxynitrite resulted in the decrease of protein thiols. L-Carnitine had a protective effect on peroxynitrite-induced decreased -SH level in plasma proteins. The presence of L-carnitine also prevented the decrease of low-molecular-weight thiols (glutathione, cysteine, and homocysteine) in plasma caused by peroxynitrite and protected plasma lipids against peroxidation induced by peroxynitrite.

## **CONCLUSIONS:**

**These results demonstrated that L-carnitine possesses antioxidative activity.**

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