DARMANA, R., SCANDELLA, M., SALMERON, S., MARTINEZ, E., CAHUZAC, J.P., 2001, Dynamic plantar pressure measurement in children with in toeing and out toeing walking.
HESSELBERG, J.P., STOLT-NIELSEN, A., RINGKJOB R., SJAASTAD, O., 1986, *Electrical stimulation in multiple sclerosis. Comparison of transcutaneous electrical stimulation and epidural spinal cord stimulation.* Appl. Neurophysiol. 49, 4-24.
HAGMAN, F., 2003, Amathematical model analysing the motion of the calcaneus from pressure plate. measurements; CASA PhD projects.
JAVIDAN, M., ELEK, J., PROCHAZKA ,A., 1992, *Attenuation of pathological tremors by functional electrical stimulation. II: Clinical evaluation.* Ann. Biomed. Eng 20, 225-236.
LENMAN A.J, TULLEY, F.M, VRBOVA, G, DIMITRIJEVIC, M.R, TOWLE, J.A, 1989 ***Muscle** fatigue in some neurological disorder*s. Muscle Nerve 12, 938-942.

THE EFFECT OF INJECTING ACUTE L-CARNITINE ON ENDURANCE TIME İN RATS EXPOSED TO DİFFERENT WATER TEMPERATURE

ELIF ŞIKTAR [1], ERDINÇ ŞIKTAR [1], HÜSEYIN EROĞLU[1], YUNUS ÖZTAŞYONAR
[1]Atatürk University, College of Physical Education and Sports, TR-25240-Erzurum-TURKEY

ABSTRACT

Purpose: Carnitine plays an important role in lipid metabolism by transporting long-chain fatty acids into the mitochondria for beta-oxidation. The effect of carnitine on exercise capacity is not clear. The aim of this study was to explain effect of injecting acute L-Carnitine on endurance time in rats exposed to different water temperature.

Material and Methods: Six groups (E18°C, E28°C and E38°C groups made exhaustive swimming CE18°C, CE28°C and CE38°C groups given L-Carnitine and made exhaustive swimming exercises) were formed and a total of 36 Spraque Dawley male rats, weighing 250-300 g were used in this study. In the study, the L-Carnitine was given to the groups 1-1.5 hours before the exercises in the doses of 100 mg/kg by intraperitoneal (I.P.) way. Exhaustive swimming tests were made in a rectangle shaped glass water tank that was 80x60x60 cm^3. The uncoordinated movements and staying under the water for 10 seconds without swimming at the surface were accepted as the exhaustion criteria of the rats.

Results: In the rats of CE18°C group the endurance time increased significantly comparing with the E18°C ($P < 0.01$).There was not significantly different among other groups

Conclusion: This result suggests that carnitine may especially enhance the physical performance doing cold ambient. Carnitine might generate that effect by regulation lipid metabolism and mitocondrial functions.

Keywords: L-Carnitine; endurance time; Exercise; Rat;water temperature.

Introduction

Fat and carbohydrates are the primary metabolic fuels utilised by contracting skeletal muscles during exercise and resting (M.J. Watt, J.F. George, Dj. Heigenhauser, Dyck And L.S. Lawrence, 2002). Thus, it is not suprising that a variety of metabolic and biochemical markers is related to exercise performance and training. Manipulations of bioenergetics have frequently been proposed as strategies to enhance exercise endurance or capacity.The functions of carnitine in skeletal muscle are critical to sustaining normal bioenergetics during exercise (P.E. Brass, W.R. Hiatt, 1998).

L-carnitine (4-*N*-trimethyylammonium-3-hydroxybutyric acid), stored within skeletal muscle tissue as either free or acyl carnitine (F.B. Stephens, D.C. Teodosiu, D. Laithwaite, E.J. Simpson, And L. Paul, P.L. Greenhaff, 2006), is an endogeneus molecule well-established roles in metabolism (E.P. Brass, 2000), and plays important physiological roles shuttling the long-chain fatty acids across the inner mitochondrial membrane for ATP production and β-oxidation in peripheral tissues (İ. Gülçin, 2006). For health and performance the importance of mitochondrial function has been highlighted during the last few years (D. Hood, A. Joseph, 2005). It is well known that oxidation of fatty acids (FA) is augmented and lactate formation is reduced during exercise after endurance training. This is explained by an increased mitochondrial density in skeletal muscle and a concomitant increased activity of oxidative enzymes (J. Holloszy, E. Coyle, 1984).

Impairment of muscle contractility due to fatigue may play a role in determining human performance. Through unclear mechanisms, high carnitine concentrations were shown to delay muscle fatigue and permit improved maintenance of contractile force in studies using in vitro animal systems (M. Dubelaar, C. Lucas, W. Hulsmann, 1991; E. Brass, A. Scarrow, L. Ruff, K. Masterson, Van Lunteren, 1993). The relevance of these observations to human exercise is unknown.

Although some researchers declared that L-carnitine supplement, have benefitial effects on exercise performance (F.B. Stephens, D.C. Teodosiu, And P.L., Greenhaff, 2007; J.S. Volek, W.J. Kraemer, M.R. Rubın, A.L. Gomez, N.A. Ratamess, And P. Gaynor, 2002) the others, clained that taking carnitine before exercise have no effect on performance (C. Greigh, K. Finch, D. Jones, M. Cooper, A. Sargeant, C. Forte, 1987; J.W. Ransone, And R.G. Lefavi, 1997).

Normal body core temperature during exercise varies depending on enviromental conditions, such as the situation of training and acclimatization, the duration and intensity of exercise, and individual differences (H.N. Soultanakıs-Alıgıannı, 2003). During physicial exertion an understanding of thermoregulation is important in protecting athletes from injuries and in managing physicial performance under cold and heat conditions. Thermal stress combined with physical exertion may lead to rise in bady core temperature (C.L. Lim, C. Byrne, J.K. Lee, 2008; G.A. Khomenok, A. Hadid, O.P Bloom, R. Yanovich, T. Erlich, O.R. Tal, A. Peled, Y. Epstein, D.S. Moran, 2008). Many endogenic mechanisms serve in thermoregulation responces (T. Reilly, B. Drust and W. Gregson, 2006). However the literature limited knowledge related to the effects of L-carnitine on the exercise done hypothermic and hyperthermic ambient.

The aim of this study was to determine effect of injecting acute L-Carnitine on endurance time in rats made exhaustive swimming exercise in different water temperature, such as 18 °C, 28 °C and 38 °C.

Material and methods

Animals and Groups

In this study, 36 healthy Spraque Dawley male rats, weighing 250–300 g, 4–6 months of age, provided from Fırat University Experimental Animal Research Center (FUDDAM). The study was carried out in Atatürk University Research Center of Experiment Animals and the study was approved by the Ethical Committee of the Atatürk University (AUHADYEK, Ethical Committee Report No: 2008-51). Protocols used here were in accordance with Guidelines for Ethical Care of Atatürk University Research Center of Experiment Animals.

The rats were kept under special conditions and were sheltered in cages, each with 6 rats, at the room temperature (25ºC), supplying with food (Bayramoğlu Yem Sanayi, Erzurum, Turkey) and water for 12–hour day and night cyclus. The rats were divided into six equal groups. Group 1: The ones that made exhaustive swimming exercises at the temperature of 18°C (E18, n=6). Group 2: Group 2:The ones that made exhaustive swimming exercises at the temperature of 28 °C (E28, n=6), Group 3:The ones that performed exhaustive swimming exercises at the temperature of 38 °C (E38 n=6), Group 4: The ones that were given L-Carnitine and made exhaustive swimming exercises at the temperature of 18 °C (CE 18 n=6), Group 5: The ones that are given L-Carnitine and made exhaustive swimming exercises at the temperature of 28 °C (CE28 n=6), Group 6:The ones that are given L-Carnitine and made exhaustive swimming exercises at the temperature of 38 °C (CE38 n=6) .

Chemicals

L-carnitine was obtained from Sigma (Sigma-Aldrich GmbH, Sternheim, Germany). In the study, the L-Carnitine was given to the groups 1-1.5 hours before the exercises in the doses of 100 mg/kg by intraperitoneal (I.P.) way (U. Panjwani , L. Thakur, S. Singh, B. Amita, S. Singh, P. Banerjee, 2007).

Exercise Protocol

Maximal intensely tired swimming exercises were applied to exercise and L-Carnitine exercise groups in test group (n: 36).

Adaptation Training. For the rats to have adaptation, they were first made to have swimming exercise in a pool, 80 x 60 x 60 cm^3 for 5 minutes during 5 days in water temperature at 26-28ºC (This temperature is the most appropriate for rat metabolism). A resistance of 2200 V and a digital thermometer (GEMO, micro software and PID thermo controlled device) was used to warm up the pool. After swimming exercise, the rats were dried with towels, made to rest for 30 minutes at a warm place and taken to cages.

Exhausted Swimming Exercise. All the rats in exercise group were made swimming at 18 ºC, 28 ºC and 38ºC respectively until they felt tired. The uncoordinated movements and staying under the water for 10 seconds without swimming at the surface were accepted as the exhaustion criteria of the rats (R. Osorio, J. Christofani, V. Almeida, I. Picarro 2003).

Determination of temperatures

American Health Assembly (AHA), approved of normal body temperature as 36.5–37.2°C. The body temperature of rats is the same as those of humans. A naked person can keep body inner temperature fixed between 12.5°C and 55°C in dry weather (20). For the body to feel the heat depends on the temperature of the weather, moisture rate and wind rate. 26–30ºC is the optimal temperature for performance in water sports (21).

In this study the temperature was determined 10ºC more or less than average temperature 28ºC as optimal temperature for performance, under 10ºC hypotermic (18ºC), over 10ºC hipertermic (38ºC). In present study to determine temperature values of water, under 16ºC and over 38ºC posed risk for rats. The rats made to swim at 14 and 39ºC died and had severe complications in 5-10 minutes (three out of six).

Statistical Analysis

The experimental results were performed in triplicate. The data were recorded as mean ± standard deviation and analyzed by SPSS (version 11.5 for Windows 2000, SPSS Inc.). Differences between exercise and carnitine-exercise group was made using by Mann-Whitney U test. Analysis inside of Group was made using by Kruskal -Wallis test and $p<0.05$ was regarded as significant.

Results

Endurance time (minute) betwen exercise and carnitine-exercise groups, taking place in equal water temperature was indicated in **Table 1.** With reference to, endurance time of CE18 group was significant higher than E18 group (P<0.01). When compared E28 group and CE28 group, CE28 group was obtained a increased, but it is wasn't significantly. Additionaly, endurance time wasn't significantly between CE38 group and E38 group.

Table 1. Comparison of endurance time (min.) betwen exercise and carnitine-exercise groups, taking place in equal water temperature.

Groups	*n*	*mean±sd*	*Z*	*P*
E18	6	92.00 ± 21.72	2.722	0.006*
CE18	6	139.00 ± 31.37*		
E28	6	249.00 ± 42.46	1.761	0.078
CE28	6	291.00 ± 35.16		
E38	6	97.00 ± 39.57	0.962	0.336
CE38	6	75.00 ± 39.14		

(*)$P<0.01$

Endurance time (min.) among them exercise and carnitine-exercise groups was presented in **Table 2**. With reference to, endurance time of among exercise groups E28 group veiwed significantly a increase in accordance with E18 group and E38 group ($P<0.05$). If endurance time of among carnitine-exercise groups CE28 group was significant higher than CE18 group and CE38 group ($P<0.05$). Also, CE38 group was significantly lower than CE18 group($P<0.05$).

Table 2. Comparison of endurance time (min.) among them exercise and carnitine-exercise groups .

Groups	*Z*	*P*
E28* - E18	-2.201	.028*
E38 - E18	-.420	.674
E38 - E28*	-2.201	.028*
CE28* - CE18	-2.201	.028*
CE38* - CE18	-2.201	.028*
CE38 - CE28*	-2.201	.028*

(*)$P<0.05$

Discussion

Carnitine is an endogenous compound with well-established functions in cellular metabolism that are clearly important in muscle during exercise (S. Ahmad, H. Robertson, T. Golper, Et Al., 1990). An obligate for optimal mitochondrial fatty acid oxidation, it is a critical source of energy and also protects the cell from acyl-CoA accretion through the generation of acylcarnitines (E.P. Brass, 2000). Therefore, It is not surprising that the use of supplementary carnitine to improve physical performance has become widespread in recent years.

In this study, in rats given L- Carnitine was evaluate endurance time in exhaustive swimming exercise in different water temperature. According to obtained data, L- Carnitine stimulated endurance time at 18^{o}C of water temperature, although there wasn't sgnificantly in favour of L- Carnitine groups on endurance time between exercise and L-Carnitine exercise groups at 28^{o}C and 38^{o}C (**Table 1**). Also, Comparison of among them exercise groups and L-Carnitine exercise groups was determined effect of L-Carnitine at 18^{o}C (**Table 2**).

In the literature, there were different views with respect to the relationship between exercise performance and L- carnitine. Although there are some theoretical points favouring potential ergogenic effects of carnitine supplementation (O. Heinonen, J. Takala, 1994*;* H. Karlic, A. Lohninger, 1996), there is currently no scientific basis for healthy individuals or athletes to use carnitine supplementation to improve exercise performance. (O. Heinonen, 1996, C. Greigh, K. Finch D. Jones, M. Cooper, A. Sargeant, C. Forte, 1987; Christoph Stuessi Æ Pierre Hofer Æ Christian Meier Urs Boutellier. L., 2005).

Slipandi (N. Sılıprandı, F. Dılısa, G. Pıeralısı, P. Rıparı, F. Maccarı, R. Menabo, Ma. Gıamberardıno, 1990), and Vecchiet(L. Vecchıet, F. Dı Lısa, G. Pıeralısı, P. Rıparı, R. Menabo, M. Gıamberardıno, N. Sılıprandı, 1990) noted that ingested 2 g. L-Carnitine before 60 min. exercise decreased blood lactat and increased performance and strenght. Greig et al.(C. Greigh, K. Finch D. Jones, M. Cooper, A. Sargeant, C. Forte, 1987) declared that carnitine supplementation wasn't beneficial effect to exercise performance since the observed effects were small and inconsistent.

The reserches relevant to effect of L-Carnitine on endurance time in the literature are limited number. Likewise, Trappe et. al. (S. Trappe, D. Costill, B. Goodpaster, M. Vukovich, W. Fink, 1994), notifed that L-carnitine supplementation does not provide an ergogenic benefit in performance times in highly trained swimmers. Another study making on thirty-two male rats was pointed out that in exercise endurance time were no changes by supplementation in untrained animals, however endurance times were longer in long-trained supplemented animals than in long-trained non-supplemented.(E. Kim, H. Park, Y. Cha, 2004).

The thermoregulatory mechanisms play important roles in maintaining physiological homeostasis during rest and physical exercise. Physical exertion poses a challenge to thermoregulation by causing a substantial increase in metabolic heat production. However, within a non-thermolytic range, the thermoregulatory mechanisms are capable of adapting to sustain physiological functions under these conditions (L. Chin Leong, C. Byrne, J. Lee, 2008).

Many endogenic mechanisms serve in thermoregulation responces (T. Reilly, B. Drust, And W. Gregson, 2006). However the literature knowledge related to the effects of L- carnitine on the exercise done hot and cold ambient. Jansens et al., (G.P.C. Janssens, J. Buyse, M. Seynaeve, E. Decuypere, And R.D. Wılde, 1998), announced that heat production has decreased in exercising pigeons after L-carnitine supplementation.

Skeleton muscles have used free fatty acids both at rest and during exercise. For this reason, L- Carnitine deficiency may cause to decrease in skeleton muscle functios and in exercise capacity, In humans, cold-induced thermogenesis is attributable to skeletal muscle contractile activity (U. Chu, M. Larsson, T. Moen, S. Rennard And L. Bjermer). Humans initiate this thermogenesis through involuntary shivering or by voluntarily modifying behavior, i.e., increasing physical activity . While certain animals exhibit an increased metabolic heat production by noncontracting tissue (brown adipose tissue) in response to cold exposure. İn cold ambient, in skeleton muscles increase using free fatty acids both at rest and during exercise (A. Strup, 1986; B. Cannon And J. Nedergaard, 2004). For this reason, L- Carnitine deficiency may cause to decrease in skeleton muscle functios and in exercise capacity (S. Gültük, A. Demirkazık, S. Erdal, T. Demir 2007). Exercise intolerance, carnitine palmitoyl-transferase enzyme deficiency (CPT II) has been postulated to depend on low - carbohitrate-high - fat diet, exhaustive exercise, fasting, hypothermia and insomnia (M. Orngreen, R. Ejstrup, J. Vissing, 2003), and especially, it created skeletal muscle damage (A. Gentılı, E. Lannella, F. Mascıopınto, M. Latrofa, L. Gıuntolı, S. Baroncını, 2008). Little is known about energy substrate metabolism and energy utilization in hibernating species under conditions of hypothermia and rewarming. Belke et al (D. Belke, L. Wang, G. Lopaschuk, 1997), reported that total energy substrate metabolic rates were greater in rat than ground squirrel hearts during hypothermia, despite a lower level of work being performed by the rat hearts, indicating that rat hearts are less efficient than ground squirrel hearts during hypothermia. Because of this reasons, in cold water - in view of improved heat production and energy metabolism- increased using fatty acids. this study may say that L- Carnitine supplement helped to energy output at 18ºC water temperature.

Conclusions

In conclusion, according to this study carnitine may especially enhance the physical performanc doing cold ambient. Carnitine might generate that effect by regulation lipid metabolism and mitocondrial functions. Effect of this study Carnitine will inform useful that to be supported by molecular trial and advanced reserches

REFERENCES

ASTRUP, A. 1986, *Thermogenesis in human brown adipose tissue and skeletal muscle induced by sympathomimetic stimulation.* Acta Endocrinol. Suppl. (Copenh.) 278:1–32, 1986. J. 13:626–632, 1999.

AHMAD, S, ROBERTSON, HT, GOLPER, TA, et al., 1990, *Multicenter trial of L-carnitine in maintenance hemodialysis patients. II.* Clinical and biochemical effects. Kidney Int 1990;38:912–8.

BRASS, P.E., HİATT, W.R., 1998, *The role of carnitine and carnitine supplementation during exercise in man and in ındividuals with special needs.* Journal of the American College of Nutrition, Vol.17,No.3, 207-215.

BRASS, E.,P., 2000, *Supplemental carnitine and exercise.* Am j Clin Nutr; 72(suppl): 618-23.

BRASS, E., SCARROW, A., RUFF, L., MASTERSON, K., VAN LUNTEREN, 1993, *E.Carnitine delays rat skeletal muscle fatigue in vitro.* J Appl Physiol 1993;75:1595–600. 260:E189–93.

BROOKS, G.A, FAHEY, T.D, 1985, *Exercise physiology*, Macmillan Publishing Company, New York.

BELKE D., WANG L., LOPASCHUK G., 1997, *Effects of hypothermia on energy metabolism in rat and Richardson's ground squirrel hearts.* J Appl Physiol. 1997;82:1210-1218.

CHRISTOPH, STUESSI Æ PIERRE HOFER Æ CHRISTIAN MEIER URS BOUTELLIER. L-**2005**, *Carnitine and the recovery from exhaustive endurance exercise: a randomised, double-blind, placebo-controlled trial,* Eur J Appl Physiol, 95: 431–435.

CHIN LEONG, L., BYRNE, C., LEE, J., 2008, *Human Thermoregulation and Measurement of Body Temperature in Exercise and Clinical Settings* Ann Acad Med Singapore,;37:347-53.

CANNON, B., and NEDERGAARD, J.2004, *Brown adipose tissue: function and physiological significance.* Physiol. Rev. 84:277–359.

CHU U., LARSSON M., MOEN, T., RENNARD S. AND BJERMER L., *Bronchoscopy and bronchoalveolar lavage findings in cross-country skiers with and without ''ski asthma''.* Eur. Respir.

DUBELAAR, M., LUCAS, C., HULSMANN, W., 1991, *Acute effect of L-carnitine on skeletal muscle force tests in dogs.* Am J Physiol 1991.

GÜLÇİN, İ., 2006, *Antioxidant and antiradical activities of L-carnitine.* Life sciences, 78, 803-811

GREİGH C., FİNCH KM, JONES D., COOPER M., SARGEANT A., FORTE C., 1987, *The effects of oral supplementation with L-Carnitine on maximum and submaximum exercise capacity, Europan* Journal Of Applied Physiology Occupational Physiology, 1987; 56: 457-460.

GENTILI, A., LANNELLA, E., MASCIOPINTO, F., LATROFA, M., GIUNTOLI, L., BARONCINI, S., 2008. *Rhabdomyolysis and respiratory failure rare presantation of carnitine palmityl-transferase II deficiency.* Minerva Anestesiol.;74: 205–8.

GIAMBERARDINO, M., 1990, *Metabolic changes ınduced by exercise in human subjects following l-carnitine administration*, Biochemical At Biophysical Acta, 1034:17-21

GÜLTÜK, S, DEMİRKAZIK, A., ERDAL, S., DEMİR, T., 2007, *Sıçanlarda karnitinin yüzme egzersizinin dayanıklılık süresine etkisi. Erciyes Tıp Dergisi* (Erciyes Medical Journal) 2007;29(2):101-105.

HEİNONEN, O., TAKALA, J., 1994*, Moderate carnitine depletion and long-chain fatty acid oxidation, exercise capacity, and nitrogen balance in the rat.* Pediatr Res. 1994 Sep;36(3):288-92.

HEINONEN, O.J., 1996, *Carnitine and physical exercise*. Sports Med. 22:109-132.

HOOD, D., JOSEPH, A., 2005, *Mechanisms of mitochondrial disease and the role of exercise: a symposium.* Med Sci Sports Exerc 37: 2084–2085, 2005.

HOLLOSZY, J., COYLE, E., 1984*, Adaptations of skeletal muscle to endurance exercise and their metabolic consequences.* J Appl Physiol 56: 831–838, 1984.

JANSSENS, G.P.C., BUYSE, J., SEYNAEVE, M., DECUYPERE, E., AND WILDE, R.D., 1998, *The Reduction of Heat Production in Exercising Pigeons after L-Carnitine Supplementation.* Poultry Science 77:578–584.

KARLİC, H., LOHNİNGER, A. 1996, *Supplementation of L-carnitine in athletes: does it make sense?* Sports Med. Aug;22(2):109-32.

KİM E., PARK H., CHA Y., 2004, *Exercise training and supplementation with carnitine and antioxidants increases carnitine stores, triglyceride utilization, and endurance in exercising rats.* J Nutr Sci Vitaminol (Tokyo). Oct;50(5):335-43.

KHOMENOK,G.A., HADİD, A., BLOOM, O.P, YANOVİCH, R., ERLİCH, T., TAL, O.R., PELED, A., EPSTEİN, Y., MORAN, D.S., 2008, *Hand immersion in cold water alleviating physiological strain and increasing tolerance to uncompensable heat stres.* Eur J Appl Physiol

LİM, C.L., BYRNE, C., LEE, J.K., 2008, *Human thermoregulation and Measurement of body temperature in exercise and clinical settings.* Ann Acad Med Singapore; 37: 347-53

ORNGREEN, M., EJSTRUP, R., VİSSİNG, J., 2003. *Effect of diet on exercise tolerance in carnitine palmitolytrasferase II deficiency.* Neurology; 61:559-561.

OSORİO RAL, CHRİSTOFANİ JS, ALMEİDA VD, PİCARRO IC. 2003, *Swimming of pregnant rats at different water temperatures.* Comparative Biochemistry And Physiology Part A 2003;135;605-61.

PANJWANİ, U., THAKUR, L.P, SİNGH, S.N, AMİTABH , SİNGH SB, BANERJEE PK., 2007, *Effect of l-carnitine supplementation on endurance exercise in normobaric/normoxic and hypobaric/hypoxic conditions.* Wilderness Environ Med. 2007;18(3):169-76

REİLLY, T., DRUST, B., and GREGSON, W., 2006, *Thermoregulation in elite athletes.* Curr Opin Clin Nutr Metab Care 9:666–671.

RANSONE, J.W., and LEFAVİ, R.G., 1997, *The Effects of Dietary L-Carnitine on Anaerobic exercise Lactate in Elite male athletes.* Journal of Strength and Conditioning Research, 1997, 11(1),4-7

SILIPRANDI, N., DILISA, F., PIERALISI, G., RIPARI, P., MACCARI, F., MENABO, R., VECCHIET, L., DI LISA, F., MENABO, R., GIAMBERARDINO, M., SILIPRANDI, N., 1990, *Influence of l-carnitine administration on maximal physical exercise,* Europan Journal Of Applied Physiology Occupational Physiology, 61: 486-490,

STEPHENS, F.B., TEODOSİU, D.C., LAİTHWAİTE, D., SİMPSON, E.J., and PAUL, L. GREENHAFF, P.L., 2006, *An acute ıncrease in skeletal muscle carnitine content alters fuel metabolism in resting human skeletal muscle.* The Journal of Clinical Endocrinology & Metabolism 91(12):5013–5018

SOULTANAKIS-ALIGIANNI, H.N., 2003, *Thermoregulation During Exercise in Pregnancy.* Clınıcal Obstetrıcsandgynecology ,2003,Volume 46, Number 2, 442–455,

TRAPPE, S., COSTILL, D., GOODPASTER, B., VUKOVICH, M., FINK W., 1994, *The effects of L-carnitine supplementation on* *performance during interval swimming.* Int J Sports Med 1994; 15: 181-185.

ÜNAL, M, SICAK VE SOĞUK ORTAMDA EGZERSİZ, 2002, *İstanbul Üniversitesi Tıp Fakültesi Mecmuası,* 65:4, İstanbul

VOLEK, J.S., KRAEMER, W.J., RUBIN, M.R., GOMEZ, A.L., RATAMESS, N.A., AND GAYNOR, P., 2002, *L-Carnitine L-tartrate supplementation favorably affects markers of recovery from exercise stres.* Am J Physiol Endocrinol Metab 282: 474–482,

WATT, MJ., GEORGE, J. F. HEİGENHAUSER, DJ. DYCK and LAWRENCE L.S., 2002, *Intramuscular triacylglycerol, glycogen and acetyl group metabolism during 4 h of moderate exercise in man.* Journal of Physiology, 541.3, pp. 969–978.

SOME DİFFERENCES IN PARAMETERS OF BONE MİNERAL METABOLİSM IN VARİOUS SPORT BRANCHES

NECIP FAZIL KISHALI[1], FATÝH KIYICI[2], GULEDA BURMAOGLU.[2], TAŞ MURAT[2], YAKUP PAKTAS[2], FULYA ERTAN[2]
[1]Physical Education of Sport School, Ataturk University, Erzurum- TURKEY
[2]Gazi University, Ankara, TURKEY

ABSTRACT

Objective

This study was carried out in order to compare the differences of laboratory parameters related to bone metabolism such as alkaline phosphatase (ALP), serum calcium (Ca), magnesium (Mg) and phosphorus (P), in various sport branches.

Material and Method

Serum alkaline phosphatase, calcium and phosphorus, and magnesium levels were measured in 23 skiers, 21 runners, 24 wrestlers, 20 handball, 21 soccers and 30 sedentary living healthy individual.

Results

The groups were matched according to age and sex. As expected, there were no significant differences according to age or the female-male ratio between the athletes and controls subjects (p>0.05).

Serum alkaline phosphatase (ALP), serum calcium (Ca), magnesium (Mg) and phosphorus (P) were determined in the athletes and the healthy control subjects. In all the athletes and controls, routine biochemical parameters including alkaline phosphatase (ALP), serum calcium (Ca), magnesium (Mg) and phosphorus (P) were within normal limits **(Table 1).** The wrestlers had lower levels of calcium compared to control subjects **(p<0,05).** The runners and handball had higher levels of phosphatase compared to control subjects **(P<0,05).** Other parameters had no significant difference between athletes and controls (Table 2).

Conclusion

When compared with control group, it has been found that wrestlers have low level of CA while runners and handball players have high level of P.

Key words*:* Serum alkaline phosphatase, calcium, magnesium, phosphorus and athletes.

Introduction

Serum alkaline phosphatase is a member of a family of zinc metalloprotein enzymes that function to split off a terminal phosphate group from an organic phosphate ester. This enzyme functions in an alkaline environment (optimum pH of 10). Alkaline Phosphatases are a group of enzymes found primarily the liver (isoenzyme ALP-1) and bone (isoenzyme ALP-2). The primary importance of measuring alkaline phosphatase is to check the possibility of bone disease or liver disease. For an adult, 50-75 mg/dl is considered a reasonable optimal range (O. Maldonado, R. Demasi , Y,Maldonado et al. 1998, N. McIntyre, S. Rosalki, 1991, AG,Lieverse, GG. van Essen, GJ, Beukeveld. et al. 1990). Calcium is the basic mineral component of the skeleton and plays major roles in neurologic