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Survey of Synergistic Effect of L-carnitine with Glutamine on Body Composition and Dietary Intake in Soccer Players: A Double-blind, Randomized Clinical Trial

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ABSTRACT

Background: The present study was conducted to investigate the possible effects of L-carnitine and glutamine and their synergistic effects on male soccer athletes. **Methods:** 28 male soccer players (21.1 ± 0.7 y) were enrolled in a randomized pre and post intervention, double-blind design. Before the intervention, their performances were assessed by Bruce protocol, and their body composition was measured with the body composition analyzer. Then, athletes were randomly allocated into four groups: 2 g L-glutamine, 2 g L-carnitine, 2 g L-carnitine + 2 g L-glutamine and placebo. Supplements were prescribed for 21 days and after three weeks, athletes' performances and body composition were re-evaluated. **Results:** The results showed that body weight, body fat percentage, lean muscle mass, and dietary intake made no significant changes in different groups of athletes. In between groups comparison, results did not significantly change in any performance indices. However, in L-carnitine supplement group, the results of pre and post intervention showed that the running distance and maximal oxygen uptake (VO2max) increased significantly while the subjective sense of fatigue decreased significantly. **Conclusions:** Based on our findings, a three-week prescription of separateor combined glutamine and L-carnitine, had no effects on body composition or dietary intake in soccer players. But, the athletes' energy intake was more than the one reported in other studies. Although further studies are required to assess these effects on athletic performance.

Keywords*:* *L-carnitine;L-glutamine; Body composition; Dietary intake;Soccer;Performance*

Introduction

Performance of an athlete is influenced by many factors such as mechanical, physiological, psychological, and nutritional characteristics (Russell and Kingsley, 2014). Body composition also is one of the most important variables

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influencing athletes' health and performance (Lohman et al., 2012). Aligned with this, selection of specific anthropometric parameters, in addition to regular and purposeful athletic exercises, are currently brought to the spotlight to improve performance of athletes (Stølen et al., 2005). Therefore, considering sports in which weight and body composition are important, athletes should attempt to gain the ideal weight and body composition level. To reach this goal and in order to achieve higher degrees of success in athletic competitions different methods can be adopted (Lohman et al., 2012).

Nowadays, soccer is one of the most popular sports in the world, so that more than 200 million men and women are involved in football-related activities worldwide (Andersen et al., 2003, Russell and Kingsley, 2014, Stølen et al., 2005). A soccer player needs physical, physiological, technical, and tactical skills (Bollen, 2000). Evaluation of soccer matches indicates that a soccer player pursues his/her athletic activities in the range of 70%-80% V_{O2}max (Ali et al., 2007, Elizondo et al., 2015). In fact, there are times in a match during which athletes participate in strenuous and heavy activities, and some other times in which their activities are low. A footballer tends to run between 9 to 12 km during a match according to his/her position in the field. Also, a footballer during high-intensity in-season training courses has several rehearsal sessions in a week, or even two sessions in a day.

Although technical and tactical principles are required for footballers' proper performance, achieving the highest attainments without having suitable physical and anthropometric conditions is impossible (Stølen et al., 2005). Despite general popularity of soccer, our knowledge about the impacts left by participation in football training sessions and competitions on athletes' personal health, changes in their biochemical indices, and etc. is still ambiguous. On the other hand, the demanded training sessions make the time required for muscle recovery insufficient, moreover, increase in the pressure of trainings causes severe rhabdomyolysis (Andersen *et al.*, 2003, Lazarim *et al.*, 2009). However, application of different sciences, such as nutrition, might help to improve footballers' abilities (Russell and Kingsley, 2014).

Nutrition factors, as well as technical exercises and tactical skills, play a significant role in soccer, and have outstanding effects on an athlete's performance (Elizondo et al., 2015). In a research, the compounds consumed by footballers during three days before the World Cup competition were examined. Results indicated consumption of nutrition supplements in 57% of subjects. The remarkable point was that some athletes expressed daily use of more than ten supplements (Russell and Kingsley, 2014). Other studies concluded that around 76 to 100 % of athletes consumed a type of such supplements during their exercises and/or competitions (Sobal and Marquart, 1994).

L-carnitine and L-glutamine, because of their roles in body metabolism, have managed to attract some researchers' attention and L-carnitine [(R)-3-hydroxy-4-(trimethylammonium) butyrate] was among these compounds recently. L-carnitine is an endogen compound whose performance in body is known as a metabolic intermediary (Brass, 2000). L-carnitine is a nutrition compound influential in provision of energy for adenosine triphosphate (ATP) formation through transmission of fatty acids across the inner membrane of mitochondria (Sugino et al., 2007).

Total reserve of L-carnitine in a healthy person's body is estimated to be 20 g or 120 mmol (Brass, 2000). 95% of L-carnitine reserves in body are preserved in skeletal muscles and the tissues in which L-carnitine plays a pivotal role in fat oxidation and carbohydrate metabolism, especially during physical activities. Many studies clarified the effects of L-carnitine on athletes' performance and their muscles' contents (Burke et al., 2009). In some previous researches, L-carnitine has been introduced as a fat-burning compound (Hongu and Sachan, 2000). It is hypothesized that L-carnitine affects metabolism of muscles' energy through three biological routes. A potential vasodilation impact of L-carnitine was discussed in other studies (Guzel et al., 2015). Malaguarnera addressed the impact of L-carnitine supplements on physical fatigue in 66 people. Since aging results in the reduction of mental performances, endurance exercises, and brings about movement disorders, L-carnitine, as an important factor in cellular energy metabolism, might be influential in controlling such symptoms. In this study, subjects were divided into two groups, and then received 2 g of levocarnitineor placebo daily for six months. Outcomes showed that consumption of L-carnitine caused a reduction in total mass of fat in the body, an increase in muscle mass, and a facilitation of physical and mental activities so that fatigue diminished in such individuals (Malaguarnera et al., 2007).

L-glutamine is the most frequent amino acid in the body which is known as a neutral amino acid and glucogenic (Castell and Newsholme, 2001, Nieman and Pedersen, 2000). It is supposed that since glutamine exists in the Krebs cycle as an intermediate metabolic compound, its consumption would create a saving in the consumption of L-creatine phosphate and lead to an increase in individuals' athletic endurance (Ghanbarzadeh and Sedaghatpour, 2011, Owen et al., 1985). Few studies, however, have reported an increasing impact of glutamine supplementation on athletes' stamina (Favano et al., 2008, Haub et al., 1997). Yet in another study, a 0.1 g consumption of glutamine for eight weeks proved an increase in bothaerobic and anaerobic performance of footballers (Ghanbarzadeh and Sedaghatpour, 2011).

Most researches dealt with effects of L-carnitine and L-glutamine supplements in athletes, that is evaluation of healthy individuals and professional athletes was among the limitations. In addition, most studies have investigated consumption of these nutrients separately, while limited investigations have examined impact of consumption of a mixture of compounds on metabolic processes and athletes' performance. In other words, athletes' use of two or more complementary products together was scarcely investigated (Sachan and Hongu, 2000). Another study demonstrated that prevalence of amino acid supplements consumption including glutamine in athletes was 32% and that of L-carnitine was 7% (Pearce, 2005). In Iranian athletes, however, prevalence of consumption of L-carnitine was reported to be only 1%, while that of glutamine was 10% (Hozoori *et al.*, 2012).

In the current study, we are going to examine and compare the effects of L-glutamine and L-carnitine supplements on body composition, performance indices, and dietary intake of soccer players.

Materials and Methods

Study design and participants: This was a double-blind, randomized clinical trial which was conducted in a pre/post manner. Participants of this study were soccer players chosen from Shahin Tehran Football Club. Participants, i.e., 28 soccer players were randomly assigned to 4 equal groups: Carnitin, Glutamine, Carnitin-Glutamine, and Placebo group.

Based on previous studies (Malaguarnera *et al.*, 2007, Malaguarnera *et al.*, 2008, Ransone and Lefavi, 1997) the prescribed amount of L-carnitine was 2 g/d, while, that was very varied for L-glutaminein different studies: from 30 milligrams for each kilogram of body weight (Haub et al., 1998, Haub et al., 1997) to 5 g/d (Kerksick et al., 2006). Accordingly, a prescribed amount of 2 g for each compound was selected to be safe. Maltodextrin was determined as the placebo and for the study to be double-blinded, L-carnitine, L-glutamine, and maltodextrin were given in black-colored capsules. Considering the fact that the prescribed amount of each compound was 2 g/d, a consumption of four capsules per day was recommended at breakfast, lunch, evening snack time (5 p.m.), and dinner. According to the prior researches, a 21-day test period was determined for this study (Ransone and Lefavi, 1997, Spiering et al., 2007).

Individuals were supplied with the required instructions to follow their regular meal plan.

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They were asked to avoid consumption of other nutritional supplements and consult with the research team before taking any medicine.

Measurements: In order to assess subjects' performance, they were asked about their fatigue degree in two hours and thirty minutes after taking their identical breakfast at 10 AM both before and after the 21-day period. In order to test athletic performance, subjects were demanded to run on a treadmill for 30 min at 50% maximum oxygen consumption after a 10-minute warm-up session including stretching exercises. When the session ended, indices related to athletes' performance such as running distance, duration, and maximum oxygen consumption were recorded for each subject.

In order to determine anthropometric indices, i.e., body weight, fat, and percentage of body muscles, the In Body 3.0 was employed after subjects' stature was measured by stadiometer. In Body 3.0 is manufactured in South Korea (city and manufacture name) and is an analyzer of body composition based on bioelectrical impedance. Athlete's consumption of energy and macronutrients were evaluated during the research time by using the Daily Food Record Questionnaire and images of regular food containers. Participants were asked to record all the things they consumed within three days before the intervention as well as three final days of the research.

Data analysis: The energy and macronutrients consumed by athletes were assessed by Food Processor II software. SPSS, version 17 was employed to examine the information and analyze data of this research.

Descriptive statistics of the studied quantitative variables were represented in mean scores and standard deviation from mean. In order to compare independent variables such as weight, age, stature, performance indices, and changes in body composition within the subjects, the one-way analysis of variance (ANOVA) was applied. Moreover, paired *t*-test was used to compare means of energy and macronutrients reception, performance indices, and changes in body composition of all subjects before and after the investigation. In all statistical tests, P-value <0.05 was considered to be significant.

Ethical considerations: The Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran, approved this study (IRCT138809282890N1). All subjects were aware of the content of the study and if they agreed to participate, written informed consent was obtained.

Results

All participants who were initially enrolled, completed the trial (**Figure 1**). All players were male soccer players of Shahin Tehran Football Club whose mean and SD of age was 21.1 ± 0.7 y. **Table 1** displays general information of the footballers participated in this study based on their test group.As indicated in **Table 1**, there was no significant difference among means of age, weight, BMI, body fat percentages, maximum oxygen consumption, and participants' athletic records in the four studied groups ($P > 0.05$). This might be indicative of similarity of the individuals in the four studied groups before the intervention.

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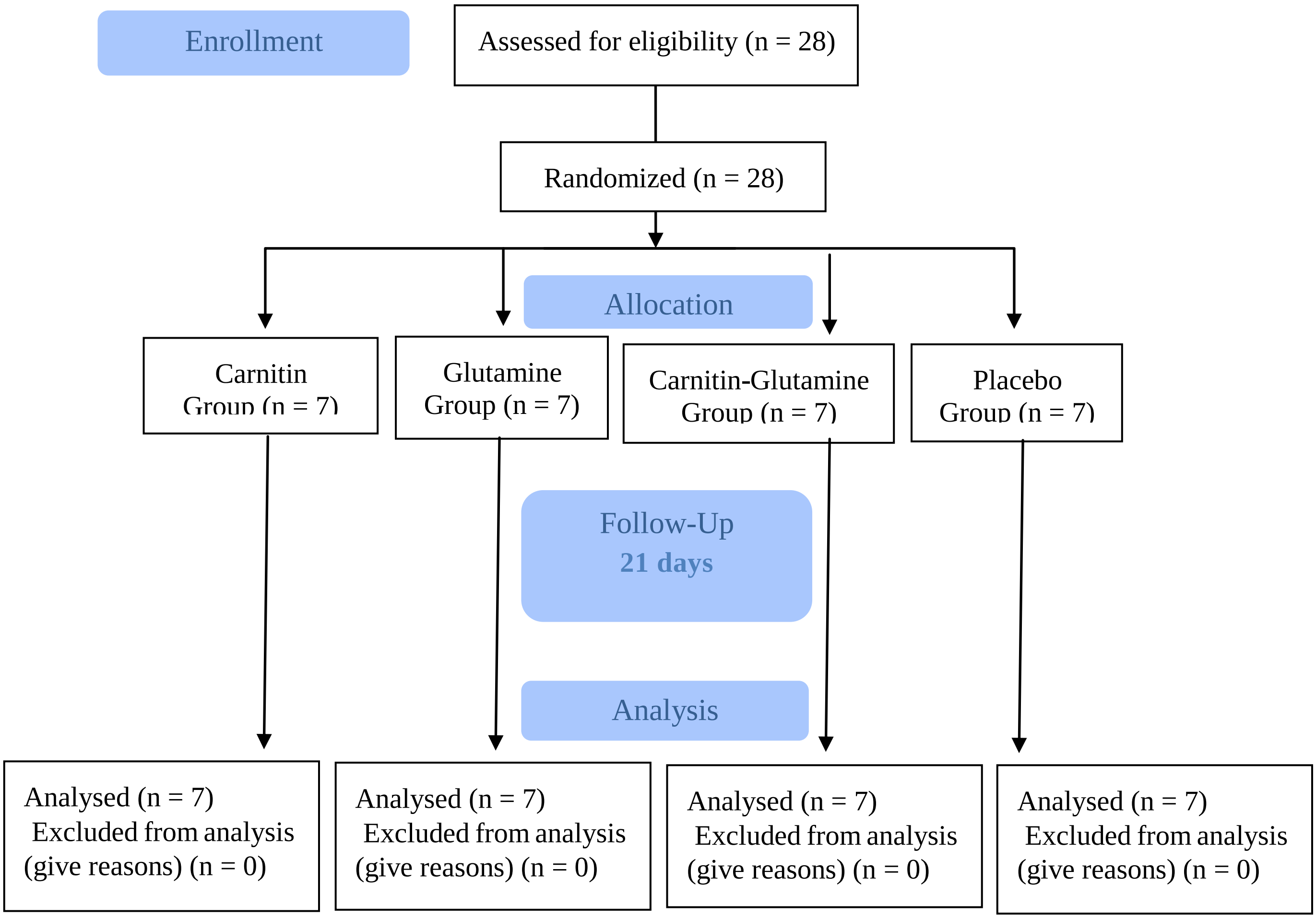

Figure 1. Flow chart of the study

Table 1. Participant's characteristics

Variables/Groups	Placebo	Carnitin-Glutamin	Glutamin	Carnitin	P-value[a]
Age (year)	20.7 ± 0.7	21.2 ± 0.6	21.2 ± 0.6	20.7 ± 0.7	0.558
Height (cm)	171.7 ± 6.0	173.0 ± 4.2	173.0 ± 5.8	175.0 ± 5.1	0.779
Weight (kg)	65.2 ± 7.1	59.9 ± 6.2	61.5 ± 7.6	64.9 ± 4.4	0.353
Body mass index (kg/m²)	22.2 ± 2.8	19.9 ± 1.6	20.5 ± 1.9	21.2 ± 1.4	0.23
Body fat percent (%)	15.5 ± 1.7	12.8 ± 3.1	16.3 ± 3	12.6 ± 3.1	0.302
Vo2max (ml/kg/min)[b]	42.1 ± 7.8	45.7 ± 6.2	47.5 ± 5.8	44.0 ± 5.3	0.604
Training history (months)	56.0 ± 8.1	55.4 ± 5.3	51.7 ± 7.3	52.6 ± 4.8	0.549

[a]:One way ANOVA, [b]:. Maximal oxygen uptake

Findings of energy and macronutrients consumption evaluation: According to the impact of dietary patterns on investigated indices, consumption of energy and macronutrients in participants were evaluated in order to assure that subjects did not make any changes in normal diet during the intervention. Nutrition evaluation of subjects' showed that mean of energy intake was

3540±468 kcal. Each macronutrient including carbohydrates, proteins, and fats had a share of 60, 17, and 23%, in procurement of energy, respectively.

Findings of body composition changes: The information related to body composition changes after the intervention is represented in the **Table 2**. Changes in indices were examined during the intervention course. Results demonstrated that the intervention performed here had no impact on these indices.

Table 2. Comparisons of weight and body composition in 4 groups before and after intervention

Variables/ Groups	Before Intervention	After Intervention	P-value [a]
Weight (kg)			
Carnitin	59.9 ± 6.2	60.7 ± 6.1	0.200
Glutamine	61.5 ± 7.6	61.5 ± 7.8	
Carnitin-Glutamine	64.9 ± 4.4	65.4 ± 4.9	
Placebo	65.2 ± 7.2	65.5 ± 7.1	
Total body water (kg)			
Carnitin	38.2 ± 3.8	39.1 ± 3.9	0.25
Glutamine	37.0 ± 4.6	37.6 ± 4.7	
Carnitin-Glutamine	41.6 ± 2.6	42.3 ± 2.5	
Placebo	39.5 ± 3.0	39.8 ± 3.2	
Total body protein (kg)			
Carnitin	10.3 ± 1.1	10.4 ± 1.2	0.958
Glutamine	10.1 ± 1.2	10.2 ± 1.2	
Carnitin-Glutamine	11.3 ± 0.7	11.4 ± 0.6	
Placebo	10.9 ± 0.9	11.0 ± 0.8	
Total body muscles (kg)			
Carnitin	29.1 ± 3.2	29.7 ± 3.3	0.548
Glutamine	28.4 ± 3.6	28.8 ± 3.4	
Carnitin-Glutamine	32.0 ± 2.1	32.4 ± 2.1	
Placebo	30.9 ± 2.5	31.1 ± 2.4	
Body mass index (kg/m^2)			
Carnitin	19.9 ± 1.6	20.2 ± 1.5	0.202
Glutamine	20.5 ± 1.9	20.5 ± 2.0	
Carnitin-Glutamine	21.2 ± 1.4	21.3 ± 1.5	
Placebo	22.1 ± 2.8	22.2 ± 2.8	
Total body fat (kg)			
Carnitin	7.7 ± 2.2	7.3±1.7	0.623
Glutamine	10.2 ± 2.6	9.3±2.3	
Carnitin-Glutamine	8.2 ± 2.3	7.8±2.6	
Placebo	10.4 ± 5.8	9.9±6.2	
Percent body fat (%)			
Carnitin	12.8 ± 3.1	12.2 ± 2.6	0.391
Glutamine	15.3 ± 3.0	14.9 ± 2.7	
Carnitin-Glutamine	12.5 ± 3.1	11.8 ± 3.7	
Placebo	14.6 ± 7.1	14.9 ± 7.5	

[a]:One way ANOVA

Findings of performance indices: Performance indices including maximum oxygen consumption, maximum distance of running, and subjects' fatigue sense level before and after the intervention were investigated and compared. These results are shown in the **Table 3**. As it was observed, there were no significant differences among the indices in these groups or in each individual group before and after the exercise, except for maximum oxygen consumption and maximum distance of running in

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the group of those who had received L-carnitine. These two indices underwent significant increase after the intervention was conducted.

Table 3. Comparisons of performance indices within and between groups.

Variables/Groups	Carnitine	Glutamine	Carnitin-Glutamine	Placebo	P-value[a]
Vo2 max (ml/kg/min)[b]					
Before	44.0 ± 5.3	45.7 ± 5.8	45.7 ± 2.4	42.1 ± 7.7	0.604
After	45.0 ± 5.0	41.8 ± 4.1	45.1 ± 3.1	42.6 ± 4.7	0.383
P-value[c]	0.038	0.072	0.280	0.798	
Distance (m)					
Before	1020 ± 161	1120 ± 160	1072 ± 83	1005 ± 152	0.441
After	1040 ± 151	1047 ± 98	1078 ± 91	994 ± 148	0.659
P-value	0.036	0.262	0.715	0.681	
Running time (sec)					
Before	753 ± 75	791 ± 71	776 ± 38	745 ± 69	0.538
After	763±75	760±42	779 ± 45	739 ± 77	0.685
P-value	0.192	0.288	0.747	0.545	
Fatigue (mm)					
Before	75.7 ± 17	67.0 ± 13	53.6 ± 30	64.3 ± 8	0.210
After	57.0 ± 19	71.4 ± 11	58.6± 24	61.4 ± 14	0.436
P-value	0.017	0.270	0.655	0.689	

[a]:One-way analysis of variance;; [b]**:** Maximal oxygen uptake; [c]: Paired *t*-test

Discussion

The present study was a double-blind, randomized clinical trial which was conducted to examine the impacts of receiving 2 g of L-glutamine supplement, 2 g of L-carnitine supplement, or a mixture of both on male footballers' dietary intake, performance, and body composition. Findings of this research proved that an intake of two grams of L-glutamine and L-carnitine supplements in separated or combined way for 21 days had no significant effect on body composition, dietary intake, and performance indices. However, there was a substantial increase in maximum oxygen consumption and distance of running after receiving supplements by the subjects who had only received some amounts of L-carnitine.

At the beginning of the research, participants were compared with each other respecting their personal features and anthropometric information. Results of this comparison, which are mentioned in the **Table1**, indicated that there was no significant difference among means of age, stature, weight, BMI, body's fat percentage, VO2Max, and record of subjects' exercise in test groups ($P > 0.05$). This expresses similarity of these four groups respecting their general anthropometric and workout features at the beginning of the study. Further, it shows that the afore mentioned four groups are well comparable and there are no disturbing variables among them.

Four test groups were evaluated respecting their energy, protein, carbohydrate, and fat intake before and after the intervention in order to assess changes in composition of subjects' diets during the intervention term. Comparison of energy and macronutrients intake showed that there was no statistical difference between mean of subjects' energy and macronutrients intake before initiation of intervention and at the end of the intervention ($P > 0.05$). It means that the interventions adopted here had no impact on individuals' dietary intake, and subjects made no change in their daily diets (Mohtadinia et al., 2014).

Regarding the energy intake and percent of macronutrients of the subjects, the results of the present study were different from those reported by Reeves (Reeves and Collins, 2003) and Ruiz (Ruiz et al., 2005). They said that the daily energy intake of footballers were 3,050 and 3,030 kilocalories, respectively. This means that the level of energy intake by the subjects in this study was higher than those reported in the two above-cited investigations. Carbohydrate share in providing the energy required in this study was around 60%, whereas the share of carbohydrate was 57% and 45% in the two afore-mentioned studies, respectively. Thus, while percentage of the carbohydrate in this study was higher than the other two, in this study fat percent in energy was less. Respecting the protein percent, no significant difference was observed between this study and other ones cited above.

This is important to note that the dietary record method is one of the most common methods in evaluation of dietary intake of athletes (Jeacocke and Burke, 2010), and it is used by a number of researchers in different athletic field summing at assessment of athletes' dietary intake. Impact of supplements on body composition and athletic performance

This study addressed the prescription effects of L-glutamine and L-carnitine supplements on body composition in bioelectrical impedance method. Based on the results cited in **Table 2**, none of the prescribed supplements influenced the evaluated indices including weight, muscle mass, and body fat.

Results of this study respecting the fact that L-carnitine intake has no effects on body composition and athletic performance is in line with most prior studies. For example, Kruszweski in his study conducted in bioelectrical impedance analysis method, observed no impact on body composition out of a one-gram daily L-carnitine prescription (Kruszewski, 2011). Also, Izadi et al., in their study on 28 nonathletic healthy persons confirmed that prescription of 3-gram L-carnitine for 21 days did not affect fat metabolism and athletic performance (Eizadi et al., 2010). Osorio, additionally, concluded that L-carnitine intake has no impact on consumption and transference of fat in tissues (Osorio, 2011). According to Hongu (Hongu and Sachan, 2000), it seems that the weight loss observed after 28 days from consumption of L-carnitine supplement is attributed to the synergistic interplays ensuing from simultaneous consumption of L-carnitine, caffeine, and choline.

Most human studies have failed to endorse effectiveness of L-carnitine supplement upon body composition and fat mass (Saper et al., 2004). Some investigations on lab animals have even reported an impact of L-carnitine supplement upon composition of animal bodies (Bacurau et al., 2003). In his study on lab rats, nevertheless, Aoki found that prescription of 28 milligrams of L-carnitine per one-kilogram weight of these animals had no effect on their body composition (Saldanha Aoki et al., 2004).

Recent studies, consequently, have focused on other probable aspects of L-carnitine supplement's effects in sport workouts (like impacts on oxidative stress) (Kolodziejczyk et al., 2011, Şıktar et al., 2011), in such a way that one study provided evidence on impact of L-carnitine supplement on oxidative stress indices (Karlic and Lohninger, 2004).

Nonetheless, there are other studies - like that of Lee - which are indicative of probable impact of L-carnitine supplement on increased lipolysis-related gene expressions (Lee et al., 2006). Wall et al., likewise, in their study on impact of carbohydrates intake on effectiveness of L-carnitine supplement, found that increased carbohydrate consumption would lead to higher concentration of L-carnitine in muscles, thereby foods and diets have notable impacts on effectiveness of supplements (Wall et al., 2011). Accordingly, ambiguities regarding impact of L-carnitine on body composition and metabolism might have their roots in differences in the manner prescriptions are made as well as other points such as increased levels of blood insulin (Maughan et al., 2007). This is also noteworthy that bioavailability of the manner by which oral L-

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carnitine is prescribed is limited and for daily doses of 2 to 6 grams, absorption of only 15% happens (Sobal and Marquart, 1994). A recent study by Naclerio showed that prescription of a compound including carbohydrates (53 grams), whey protein (14.5 g), L-carnitine (1.5 g), and L-glutamine (5 g) for seven days did not have a significant impact on weight and performance of athletes, although, this supplement reduced the fatigue status (Naclerio et al., 2015).

Regarding impacts of glutamine supplement on body composition, results of this study were similar to the outcomes achieved by Kevin (Kevin et al., 2003), Condow (Candow et al., 2001), and Kerksick (Kerksick et al., 2006), who observed no impact left by glutamine supplement on performance and fat-free mass of the body. These results, however, are contrary to those reported by Ghanbarzadeh (Ghanbarzadeh and Sedaghatpour, 2011). Kevin et al., undertook a study to examine the impact of a 0.35-milligram glutamine intake per kilogram weight of the body after a weight loss period on prevention from losing muscle mass. Outcomes of this study showed that there was no significant difference between placebo and glutamine taking groups respecting weight loss, fat mass, and fat-free mass (Kevin et al., 2003).

In the study conducted by Ghanbarzadeh on football athletes, it was found that a combination of aerobic exercises and intake of 0.1 gram of glutamine supplement per kilogram weight of the body for eight weeks could result in an increase in fat-free mass and reduction of body's fat percentage (Ghanbarzadeh and Sedaghatpour, 2011). Such contradictions might be due to the short term of this study or caused by impact of other factors such as dietary patterns of the subjects under investigation. Glutamine is provided by muscle tissues and a suitable concentration of glutamine is required for ammonia synthesis in kidneys, which play an effective role in regulating acid and base amounts in body (Smith and Norris, 2000). Under metabolic acidosis conditions, renal uptake of glutamine for ammonia synthesis is increased. Accordingly, dietary plans that cause metabolic acidosis - such as a four-day program in which more than 24% energy is taken from protein and/or more than 72% energy is provided by fat - bring about an almost 25% reduction in plasma and muscle glutamine (Gleeson, 2008).

Regarding the impacts on athletic performance, similar results were gained by Haub et al., who reported that a glutamine uptake of 0.03 g/kg body weight of the body one hour before the exercise had not considerable impacts on strength performance of males with prior athletic records (Haub et al., 1998). This finding, however, is in conflict with what Kerksick (Kerksick et al., 2006) and Ghanbarzadeh (Ghanbarzadeh and Sedaghatpour, 2011) concluded.

This should not be neglected that effectiveness of a supplement in footballers' performance might be influenced by some factors like the prescribed amounts, consumption manner, individuals' personal accountability, and conflicts with physiological and biochemical changes of a footballer during a match (Russell and Kingsley, 2014). In this study, one of probable reasons for the lack of the supplements effects on body composition and athletes' performance could be short term of intervention. According to Kercksick et al., a 10-week consumption of protein and amino-acid supplements (including glutamine and branched-chain amino acid) caused a substantial boost in athletes' strength and a limited increase in their weight and fat-free body mass (Kerksick et al., 2006).

Level of fatigue is influenced by different reasons ranging from mental factors to required substrate (especially muscle glycogen) (Naclerio et al., 2015). Due to the importance of mental fatigue in athletic strength reduction and accuracy of footballers' shoots (Smith et al., 2016), it is recommended that future studies evaluate the conditions of mental fatigue and mood status in athletes by using standard questionnaires.

This study comes with some limitations; the methodology applied in assessment of body composition might dispossess complete accuracy. For example, the studies conducted on wrestlers indicated that Standard Errors of Estimate (SEEs) in

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both skinfold thicknesses method and bioelectrical impedance analysis have been limited, i.e., 3% to 3.5% (Ackland et al., 2012). Therefore, application of more precise methods such as hydrostatic weighing for complementary evaluations is proposed.

Conclusions

According to findings of this research, a two-gram intake of L-glutamine and L-carnitine supplements in both separated and combined manners for 21 days had no considerable impact on body composition. Although L-glutamine created no significant effect on performance indices, both in separated manner and combined with L-carnitine supplement, intake of L-carnitine provoked increased levels of maximum oxygen consumption and maximum distance of running.

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Author contributions

Hozoori M and Mohtadinia J participated to conception and design of study, managing the project and drafting the manuscript. Kohandani A, Chamari M and Sadeghizadeh Yazdi J participated to acquisition of data, data analysis and drafting the manuscript. Aref hosseini SR participated to laboratory evaluation and drafting the manuscript. All authors read manuscript and they finally verified it.

Conflicts of Interest

The authors whose names are listed immediately below certify that they have no affiliations with or involvement in anyorganization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

References

Ackland TR, et al. 2012. Current status of body composition assessment in sport. *Sports Medicine.***42(3)**: 227.

Ali A, Williams C, Nicholas CW & Foskett A 2007. The influence of carbohydrate-electrolyte ingestion on soccer skill performance. *Medicine and science in sports and exercise.***39(11)**: 1969.

Andersen TE, Larsen Ø, Tenga A, Engebretsen L & Bahr R 2003. Football incident analysis: a new video based method to describe injury mechanisms in professional football. *British Journal of Sports Medicine.***37(3)**: 226-232.

Bacurau RF, et al. 2003. Does exercise training interfere with the effects of l-carnitine supplementation? *Nutrition.***19(4)**: 337-341.

Bollen S 2000. Epidemiology of knee injuries: diagnosis and triage. *British Journal of Sports Medicine.***34(3)**: 227-228.

Brass EP 2000. Supplemental carnitine and exercise. *The American journal of clinical nutrition.***72(2)**: 618s-623s.

Burke LM, Castell LM & Stear SJ 2009. BJSM reviews: A–Z of supplements: dietary supplements, sports nutrition foods and ergogenic aids for health and performance Part 1. *British Journal of Sports Medicine.***43(10)**: 728-729.

Candow DG, Chilibeck PD, Burke DG, Davison SK & Smith-Palmer T 2001. Effect of glutamine supplementation combined with resistance training in young adults. *European journal of applied physiology.***86(2)**: 142-149.

Castell L & Newsholme E 2001. The relation between glutamine and the immunodepression observed in exercise. *Amino acids.***20(1)**: 49-61.

Eizadi M, Eizadi F, Zarifyan A, Eghdami A & Eghdami D 2010. The Effect of Chronic Intake of

L-carnitine L-tartrate on Lipid Metabolism during Aerobic Exercise. *Journal of Kerman University of Medical Sciences.***17(2)**: 113-120.

Elizondo RHT, et al. 2015. Nutritional intake and nutritional status in elite Mexican teenagers soccer players of different ages. *Nutrición hospitalaria: Organo oficial de la Sociedad española de nutrición parenteral y enteral.***32(4)**: 1735-1743.

Favano A, et al. 2008. Peptide glutamine supplementation for tolerance of intermittent exercise in soccer players. *Clinics.***63(1)**: 27-32.

Ghanbarzadeh M & Sedaghatpour M 2011. Effect consumption of Glutamine supplement on aerobic power, anaerobic power and body composition of soccer players. *Journal of Physical Education and Sport.***11(3)**: 313.

Gleeson M 2008. Dosing and efficacy of glutamine supplementation in human exercise and sport training. *The Journal of nutrition.***138(10)**: 2045S-2049S.

Guzel NA, Orer GE, Bircan FS & Cevher SC 2015. Effects of acute L-carnitine supplementation on nitric oxide production and oxidative stress after exhaustive exercise in young soccer players. *The Journal of sports medicine and physical fitness.*

Haub M, Potteiger J, Nau K, Webster MJ & Zebas C 1998. Acute L-glutamine ingestion does not improve maximal effort exercise. *The Journal of sports medicine and physical fitness.***38(3)**: 240-244.

Haub M, Potteiger J, Nau K, Zebas C & Webster M 1997. Delaying the Onset of Fatigue: Influence of L-Glutamine Ingestion1094. *Medicine & Science in Sports & Exercise.***29(5)**: 192.

Hongu N & Sachan DS 2000. Caffeine, carnitine and choline supplementation of rats decreases body fat and serum leptin concentration as does exercise. *The Journal of nutrition.***130(2)**: 152-157.

Hozoori M, Ehteshami M, Haghravan S & Azarpira A 2012. Prevalence, Reasons and Information about Dietary Supplement Consumption in Athletes in Tabriz *Sport Biosciences.***4(12)**: 77-91.

Jeacocke NA & Burke LM 2010. Methods to standardize dietary intake before performance testing. *Int J Sport Nutr Exerc Metab.***20(2)**: 87-103.

Karlic H & Lohninger A 2004. Supplementation of L-carnitine in athletes: does it make sense? *Nutrition.***20(7)**: 709-715.

Kerksick CM, et al. 2006. The effects of protein and amino acid supplementation on performance and training adaptations during ten weeks of resistance training. *The Journal of Strength & Conditioning Research.***20(3)**: 643-653.

Kevin JF, Lund R & Rosene-Treadwell M 2003. Glutamine supplementation did not benefit athletes during short-term weight reduction. *Journal of sports science & medicine.***2(4)**: 163.

Kolodziejczyk J, Saluk-Juszczak J & Wachowicz B 2011. L-Carnitine protects plasma components against oxidative alterations. *Nutrition.***27(6)**: 693-699.

Kruszewski M 2011. Changes in maximal strength and body composition after different methods of developing muscle strength and supplementation with creatine, L-carnitine and HMB. *Biology of Sport.***28(2)**: 145.

Lazarim FL, et al. 2009. The upper values of plasma creatine kinase of professional soccer players during the Brazilian National Championship. *Journal of Science and Medicine in Sport.***12(1)**: 85-90.

Lee M-S, Lee H-J, Lee H-S & Kim Y 2006. L-carnitine stimulates lipolysis via induction of the lipolytic gene expression and suppression of the adipogenic gene expression in 3T3-L1 adipocytes. *Journal of medicinal food.***9(4)**: 468-473.

Lohman TG, et al. 2012. Current Status of Body Composition Assessment in Sport. *Sports Medicine.***42(3)**: 227-249.

Malaguarnera M, et al. 2007. L-Carnitine treatment reduces severity of physical and mental fatigue and increases cognitive functions in centenarians: a randomized and controlled clinical trial. *The American journal of clinical nutrition.***86(6)**: 1738-1744.

Malaguarnera M, et al. 2008. Acetyl L-carnitine (ALC) treatment in elderly patients with fatigue. *Archives of gerontology and geriatrics*.**46(2)**: 181-190.

Maughan RJ, Depiesse F & Geyer H 2007. The use of dietary supplements by athletes. *Journal of Sports Sciences*.**25(S1)**: S103-S113.

Mohtadinia J, et al. 2014. Effects of Carnitine with and without Glutamine Supplementation on Markers of Muscle Damage and Muscle Soreness among Football Players: A Randomized Controlled Clinical Trial. *Galen Medical Journal*.**3(4)**: 207-215.

Naclerio F, Larumbe-Zabala E, Cooper R, Allgrove J & Earnest CP 2015. A multi-ingredient containing carbohydrate, proteins L-glutamine and L-carnitine attenuates fatigue perception with no effect on performance, muscle damage or immunity in soccer players. *PloS one*.**10(4)**: e0125188.

Nieman DC & Pedersen BK 2000. Nutrition and exercise immunology. CRC Press.

Osorio JH 2011. < Supplementation with carnitine for weight loss<: a biochemical approach. *Colombia Médica*.**42(4)**: 529-535.

Owen M, Kregel K, Wall P & Gisolfi C1985. Effects of carbohydrate ingestion on thermoregulation, gastric emptying and plasma volume during exercise in the heat. Abstract. *Medicine and science in sports and exercise*.**17(2)**: 185.

Pearce P 2005. Sports supplements: a modern case of caveat emptor. *Current sports medicine reports*.**4(3)**: 171-178.

Ransone JW & Lefavi RG 1997. The Effects of Dietary L-Carnitine on Anaerobic Exercise Lactate in Elite Male Athletes. *The Journal of Strength & Conditioning Research*.**11(1)**: 4-7.

Reeves S & Collins K 2003. The nutritional and anthropometric status of Gaelic football players. *International journal of sport nutrition and exercise metabolism*.**13**: 539-548.

Ruiz F, et al. 2005. Nutritional intake in soccer players of different ages. *Journal of Sports Sciences*.**23(3)**: 235-242.

Russell M & Kingsley M 2014. The efficacy of acute nutritional interventions on soccer skill performance. *Sports Medicine*.**44(7)**: 957-970.

Sachan DS & Hongu N 2000. Increases in VO 2 max and metabolic markers of fat oxidation by caffeine, carnitine, and choline supplementation in rats. *The Journal of nutritional biochemistry*.**11(10)**: 521-526.

Saldanha Aoki M, et al. 2004. Carnitine supplementation fails to maximize fat mass loss induced by endurance training in rats. *Annals of nutrition and metabolism*.**48(2)**: 90-94.

Saper RB, Eisenberg DM & Phillips RS 2004. Common dietary supplements for weight loss. *American family physician*.**70**: 1731-1740.

Şıktar E, et al. 2011. Protective role of L-carnitine supplementation against exhaustive exercise induced oxidative stress in rats. *European journal of pharmacology*.**668(3)**: 407-413.

Smith DJ & Norris SR 2000. Changes in glutamine and glutamate concentrations for tracking training tolerance. *Medicine and science in sports and exercise*.**32(3)**: 684-689.

Smith MR, et al. 2016. Mental fatigue impairs soccer-specific physical and technical performance. *Medicine & Science in Sports & Exercise*.**48(2)**: 267-276.

Sobal J & Marquart LF 1994. Vitamin/mineral supplement use among high school athletes. *Adolescence*.**29(116)**: 835.

Spiering BA, et al. 2007. Responses of criterion variables to different supplemental doses of L-carnitine L-tartrate. *The Journal of Strength & Conditioning Research*.**21(1)**: 259-264.

Stølen T, Chamari K, Castagna C & Wisløff U 2005. Physiology of soccer. *Sports Medicine*.**35(6)**: 501-536.

Sugino T, Aoyagi S, Shirai T, Kajimoto Y & Kajimoto O 2007. Effects of citric acid and L-carnitine on physical fatigue. *Journal of clinical biochemistry and nutrition*.**41(3)**: 224-230.

Wall BT, et al. 2011. Chronic oral ingestion of l- carnitine and carbohydrate increases muscle carnitine content and alters muscle fuel metabolism during exercise in humans. *The Journal of Physiology*.**589(4)**: 963-973.

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