The Effects of Daily Coenzyme Q_{10} Supplementation on VO_{2max}, vVO_{2max} and Intermittent Exercise Performance in Soccer Players

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Abstract: The aim of this study is to assess aerobic, anaerobic and performance indexes changes after a short period of coenzyme Q_{10} Supplementation in soccer players. 16 soccer players (Weight 57.1±20.72, height 171.4±4.92, and age 22.30±1.41) randomized and divided into two groups. Where supplement group (N=10) consumed CoQ_{10} supplement (300 mg/day) and placebo group (n=6) consumed placebo. Both of them practiced for 4 weeks and each one 90 minutes. After that, supplement group started to consume CoQ_{10} in amount of 300 mg/day for one month. Findings has been showed that 4-week supplement consumption caused significant changes in VO_{2max} and performance in soccer players, while this intervention did not result in significant effect in body composition, maximum running speed, peak anaerobic power and fatigue index. The major findings of the present study were that 4-week of CoQ_{10} supplement consumption in college soccer players led to increase aerobic power and performance in high intensity aerobic interval test. From the other point of view, these variations were not significant in placebo group. We can conclude that although increase in maximum running speed (vVO_{2max}) was not significant, four weeks of CoQ_{10} supplement consumption may increase in maximal oxygen consumption and performance in college soccer players. Finally, in this case consumption of this supplement could improve player's performance in competition conditions.

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Introduction

People all over the world spend a large amount of money annually to supply and use supplementary Foods that are energy-release supplements. These supplies will result in increase of efficiency, fatigue reduction and change in body mass and shape in athletes. However, the side effects of some of those supplements have proven too (1). CoQ_{10} is solvable in fat and acts like vitamins in function that is composed of one reductive part of oxidative (quinoid) and a peripheral chain of water-shun that is related to the Metabolism of cell energy that is the internal source of oxygen reaction(14,8,6). This compound plays a significant role in energy production and almost all the human body cells can make that and it can act as an antioxidant to help protect cells from free radicals that is capable of breaking the chain, also, the other task of this material is: helping the electron transfer in the chain of mitochondrion Oxidative that will result in ATP production, stability effect, liquid shape and penetrable membrane and cells growth stimulus as well as preventing their death (6, 8). This quality is of high importance because the increase in oxidation in body can result in senility, nerve-degeneration disease, memory inability, cancer and cardiovascular illnesses (16). On the other hand, it is proven that the release of this Co-enzyme in the people above 20 years old, especially people who are in the 3rd decade of their life, gradually diminishes (15). One of the unique qualities of CoQ_{10} is that not like the other compounds inside the body, which is completed and reinforced by special organs like liver by intake of food (8). Therefore, in Medical Sciences, Q_{10} is used as a supplement for curing the chronic illnesses like heart diseases, muscular dystrophy, Parkinson, cancer and diabetics. It has been shown that this element or material can increase the stroke volume, ejection fraction and the exercise capacity in athletes and on the other side, it's insufficiency will result in metabolic pressure and constitutes free-radicals during the high intensity training. Consequently, the CoQ_{10} not only is beneficial for patients, but probably has positive effects on healthy people that might face with shortage of that during their activity (6). In addition, it has been said that the increase of the temperature in muscles during the exercise that caused high rate of metabolism and generates more energy is under the effect of CoQ_{10} (9). For this reason, employing the CoQ_{10} supplement can be effective and increases the body temperature in those who have lower body temperature (12). It has been proven that using CoQ_{10} can increase the exercise economy and maximal oxygen consumption (VO_{2max}) in

athletes (6). On the other hand, 4-8 weeks usage of 60-100 mg per day of CoQ_{10} improves the aerobic power, anaerobic threshold, and performance, post-training recovery in athletes and regular people. Anyway, other research has investigated with the same usage dose report the contradictory results (6). Generally, it has been mentioned that high intensity exercise decreases the level of CoQ_{10} in blood but as a result that how a healthy human body responds to activity by using the CoQ_{10} is inconsistent within the results of researchers (4). By considering all these descriptions, the aim of this study was assessing the effects of CoQ_{10} consumption on the aerobic and anaerobic factors in soccer players.

Materials and Methods

Subjects

Sixteen male soccer players (11) from the First Division League team in Iran gave their informed consent and volunteered to participate in the study, which had the approval of the University of Tehran Ethical Advisory Committee. They completed a health history questionnaire and were informed that they could withdraw from the study at any time, even after giving their written consent. All subjects were in good health, participating in consistent soccer training at least for the past 2 years. In this double-blind study, soccer players are chosen of the age average: 21.87±1.58 and height of 174.06±6.1 and weight 67.05±6.59. None of the players was using drugs such as Warfarin or Estatine or Anti-oxidant E, C that could affect the absorbing of Co Q_{10}, Kaneka Corporation, Osaka, Japan, and Nisshin Pharma Inc., Tokyo, Japan; Supplements and they have been advised not to take any other drug during the study and in addition, none of the players under the study used any kind of sports supplements during the last 6 months (1). The members under study were divided into two separate groups, one using the supplementary drug and the other placebo. In experimental group, 10 people and in control group, 6 people were administered. Both groups were exercising 4 sessions of 90 Min. in a week and all the conditions were alike. Two days after the last exercise, Functional tests (RAST, rigorous intermittent Aerobic Dribbling test (Hoff), Treadmill (VO_{2max} و vVO_{2max})) and body combination of all examines were taken, then the experimental group used CoQ_{10} Supplements with the dose of 300 mg per day for one month (10). Placebo group used wheat flower and authorized edible colors and for this group like the experimental group we provided the exact capsule with 300 mg placebo. The research was conducted before the college seasonal match and this time chosen due to the high stimulation of exercises (2). Individual dietary assessment methodologies include the diet history, 24-hour recall (24-H-RQ), weighed and estimated food records and food frequency questionnaires(19) and on the other hand, as far as the players were at dormitory, their nutrition were highly akin to each other and could be controlled easily. By considering the results of K-S and the Variance of all variables under study was normal and also by referring to statistical test of Independent T there was no difference of height and weight and age. Statistical data Analysis was shown as mean ± S.D and for analysis the mean of the variables under study was used from Independent T test and for comparison of variables from the start and at the end the dependent T and the rate of reliability for data was $p<0.05$. It has shown on Table 1 that there is no meaningful distinction between the two groups (Supplement and placebo).

Table1. Differences between variables before start of study

Variables	Subjects group	Num.	Mean	Standard deviation	P.value[1]
Age(years)	**supplement**	**10**	22.30	1.56	0.174
	placebo	**6**	21.16	1.47	
Height(cm)	**supplement**	**10**	30.175	4.7	0.311
	placebo	**6**	172.00	19.2	
Weight(kg)	**supplement**	**10**	68.14	7.7	0.415
	placebo	**6**	65.25	4.16	
BF(%)	**supplement**	**10**	13.2	2.86	0.919
	placebo	**6**	13.05	1.81	
VO_{2max}(ml/kg/min)	**supplement**	**10**	52.27	3.21	0.506
	placebo	**6**	51.28	1.88	
vVO_{2max}(km/h)	**supplement**	10	16.4	1.26	0.500
	placebo	**6**	15.83	2.04	

Maximum heart rate(beat/min)	**supplement**	**10**	189.9	9.1	0.658
	placebo	**6**	192	8.6	
Peak anaerobic power(w)	**supplement**	**10**	498.81	119.57	0.557
	placebo	**6**	535.5	111.28	
Fatigue index(w/s^{-1})	**supplement**	**10**	7.73	1.97	0.550
	placebo	**6**	8.38	2.22	
Performance test (Hoff test) (m)	**supplement**	**10**	1374.4	95.13	0.758
	placebo	**6**	1361.66	30.76	

1. independent t test

Tests

Weight was measured to the nearest 0.1 kg accuracy, using the digital weighing scales (Seca, Germany) and height was measured to the nearest 0.1 cm, from the subject's head to toe in an upright standing position with five points of his body touching the wall, using Seca Stadiometer (Germany).VO_{2max} and vVO_{2max} were assessed twice, at the beginning (Pre) and at the end (Post) of the 4-week training period, by applying graded treadmill test until exhaustion, using electric treadmill at no inclination. The initial treadmill velocity was 6 km/h and was increased by 2 km/h every 3 minutes. vVO_{2max} is defined as the slowest pace at which one reaches one's maximum oxygen consumption and keep it for one min. Three skinfold thickness measurements were taken on the right side of the body with a Lange skinfold Caliper. The average of these three skinfold thickness measurements was then used to estimate a percent body fat, based on the formula by Jackson and Pollock.

In order to assess maximal anaerobic power and fatigue index, we use the Running-based Anaerobic Sprint Test (RAST) (20). The test consists of six times 35m discontinuous sprints. Each sprint represents a maximal effort with 10 seconds allowed between each sprint for the turnaround. The time for each sprint was used as the criterion score during the RAST. Maximum power was calculated by fastest time and fatigue index was calculated by dividing the difference between maximum power and minimum power by the Total time for the 6 sprints (20).

Performance tests that are specific to soccer match performance were used in the present study. The Hoff track distances (figure 1) have been modified to reach a total distance of exactly 290 m per tour. The player moved a soccer ball through the track by dribbling. The purpose of the test was to cover the maximum distance during a 10 minute period. Each player was informed of the elapsed time at 5 minutes (halfway through the test), and at 9 minutes (when only 1 minute of the test remained). Five subjects were tested at a time. The test starting signal was given for one subject every minute. Thus, the assessor timing the test had 4 minutes for starting the five subjects and then switched to the halfway test signal that occurred in the successive minute for the first player. Then, when the assessor announced the halfway test signal for the fifth player (minute 9), he simultaneously began the last minute signal for the first player. In order to be easily identified, the players wore coloured T shirts that were always assigned in the same order to the players numbered 1 to 5. Four days before the first Hoff test, the subjects performed a pre-test in order to get used to the testing pace so as to obtain maximum performance during the experiment (7).

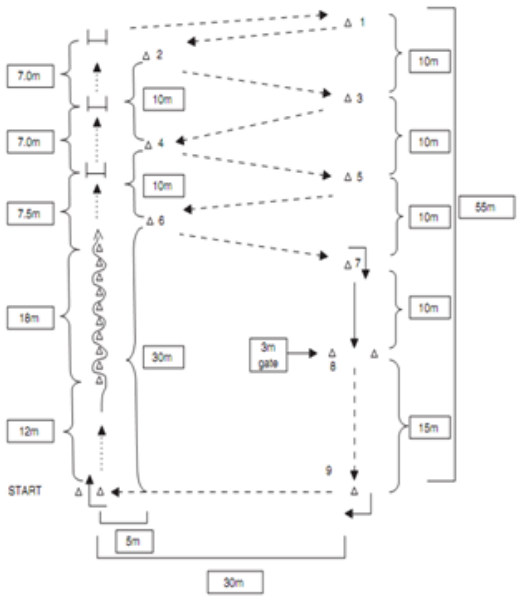

Figure1. Football specific dribbling track for testing endurance performance and VO_{2max}. Backwards running between 8 and 9. Hurdles are only app. 20 cm high. The running path for the players in the track is for the test based on distances that are close to 300m for one round. The track is constructed for the players to reach VO_{2max}(7).

All results are reported as means and standard deviations (SD) calculated by conventional procedures. The Kolmogorov–Smirnov test (K–S test) and independent t test and Levene's test were used to evaluate differences between tests and assess the equality of variances. Differences from pre- to post-training were calculated using a paired t test, with results accepted as significant at $p<0.05$.

Findings has been showed to 4-week supplement consumption caused significant changes in VO_{2max} and performance in soccer players, while this intervention didn't result in significant effect in body composition, maximum running speed, peak anaerobic power and fatigue index. Table 2 lists the descriptive values of variables and mean and standard deviation of players at the beginning and at the end of intervention:

Results

Table2. Values of variables, mean and standard deviation and significant difference.

Variables	Subjects group	Pre-test	Standard deviation	Post-test	Standard deviation	P.value[1]
Weight (kg)	**supplement**	68.14	7.7	68.23	7.42	0.86
	placebo	65.25	4.16	65.13	3.30	0.84
BF(%)	**supplement**	13.2	2.86	12.7	2.8	0.20
	placebo	13.05	1.81	12.88	1.02	0.63
VO_{2max}(ml/kg/min)	**supplement**	52.27	3.21	53.63	2.54	0.003 *
	placebo	51.28	1.88	50.80	2.24	0.35
vVO_{2max} (km/h)	**supplement**	16.4	1.26	17	1.15	0.05*
	placebo	15.83	2.04	15.66	0.81	0.88
Maximum heart rate(beat/min)	**supplement**	189.9	9.1	190.6	6.9	0.59
	placebo	192	8.6	194.5	5.05	0.70
Peak anaerobic power(w)	**supplement**	498.81	119.57	557.54	99.17	0.099
	placebo	535.5	111.28	506.24	59.30	0.43
Fatigue index(w/s^{-1})	**supplement**	7.73	1.97	7.49	1.87	0.27
	placebo	8.38	2.22	8.02	2.06	0.65
Performance test (Hoff test) (m)	**supplement**	1374.4	95.13	1421.5	72.61	0.046 *
	placebo	1361.66	30.76	1342.16	35.55	0.38

BF: Body fat percent. : maximal oxygen uptake.* Significant difference. 1. Paired t test

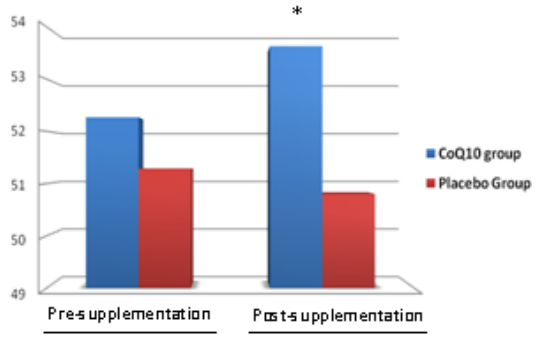

Figure2. Change in VO_{2max} during the supplement consumption. Significant difference was observed for this variable throughout the supplementation in CoQ10 group

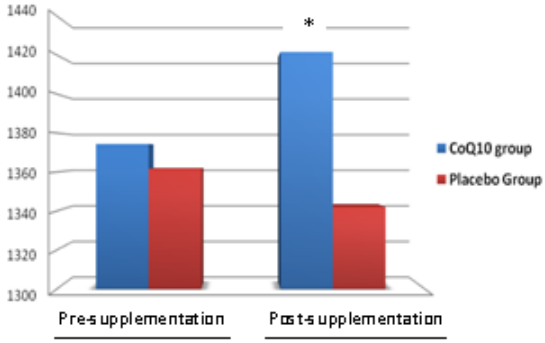

Figure3. Change in Performance test(Hoff test) during the supplement consumption. Significant difference was observed for this variable throughout the supplementation in CoQ10 group

Discussion

The present study was designed to determine the effect of using CoQ_{10} on aerobic and anaerobic metabolism in college soccer players. According to our findings, it has been shown that the weight and body fat percent in players after 4 weeks in supplement group did not significantly change. In placebo group, although the mean was increased, was not noticeable. Based on this, vVO_{2max} in group who used CoQ_{10} increased in compared to placebo Group. Although the performance of the supplement group significantly increased by Hoff Test, it was not same in placebo group.

The most important finding in our study was that Vo_{2ma} in supplement group increased 6 percent. Other authors studied the effect of CoQ_{10} supplement on functional aspects and VO_{2max} in cyclists. According to this, both groups (control and supplement) showed improvements in performance and there was no distinction between the two groups(5). In another study, the use of this supplement caused 7 percent increase in VO_{2max} and 33 percent increase in functional capacity (9). This finding is in agreement with our study findings which showed 20 days compound antioxidant supplement consumption in soccer players caused 1.2 ml/kg/min increased in VO_{2max} (2).Opposite to these studies, Lacksonen and et al. (1995) published the result of their research that indicated the use of CoQ_{10} did not have a positive effect on the aerobic endurance (10). Another study examined the effect of using CoQ_{10} supplement for 2 months and reported insignificant increase in Vo_{2max} from 2.97 to 3.05 ml/kg/min (13). On the other hand, Leelarungrayub and et al.(2010) surveyed the activities of the young swimmers who used 300 mg per day of CoQ_{10} supplement in 12 days. Although these authors did not have control group, they concluded that this amount of CoQ_{10} usage caused 22 percent increase of performance on treadmill and 100 meters swimming (11). Ylikoski and et al. (1997) showed that using 90 gr/dy of CoQ_{10} supplements every day made little increase in VO_{2max} and endurance in cross-country skiers (18). Generally, a possible explanation for positive effect of CoQ_{10} supplement might be that consumption of this supplement may improve VO_{2max} by increasing heart and muscle mitochondrial oxygen consumption (21).These inconsistencies may be due to duration of supplement consumption. As Arent and et al. (2010) declared given a longer period of supplementation, it is conceivable that the cumulative effects would become apparent in variables (2).

Another important finding was that CoQ_{10} supplement caused significant increase in soccer players performance (3.5 percent). These findings of the current study are consistent with those of Cogbel et al(2010) and Mizuno et al.(2008) (14,17) but contrary with Zhaou et al.(2005) and Ostman et al(2011) (23,24). The reason for this is not clear but these discrepancies may be due to in most of the sports, performance is depending on anaerobic power or high VO_{2max} and/or both of them. Then, insignificant changes in either cannot effect on athletes performance (4). In case of peak anaerobic power, several studies is in agreement with our finding showed that chronic and acute consumption of CoQ_{10} for 14-30 days (30-100 mg/dy) cannot significantly change anaerobic power in athletes(2,6). A possible explanation for this might be that CoQ_{10} exist in mitochondria and possibly cannot effect on anaerobic and phosphagen metabolism (6).

As a conclusion, this study showed that using CoQ_{10} supplement for one month very likely can increase the use of oxygen, vVO_{2max} as well as performance of college Soccer players. Therefore, people who use these supplements can improve their capabilities in matches.

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