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Hematologic Effects of Enzyme Q10 Supplements on Basketball Players Applying Combined Training Program

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ABSTRACT The purpose of this paper is to examine the hematological effects of coenzyme Q10 (CoQ10) supplement on athletes within the eight-week combined basketball training program. While in the Q10 non-supplemented group, rest state Eosinophil (109/L) and HCT (Hematocrits) (%) rates before the exercise where the training program ended were identified to increase significantly than the rest state prior to the first exercise at the beginning of the training program, in the group with Q10 supplement, just the Lymphocytes counts (1012/L) rates increased ($P<0.05$). In both groups, in the fatigue state, after exercise where the training program ended, WBC (Leukocyte counts x103), Lymphocytes counts (1012/L), Eosinophil (109/L), HGB Hemoglobin values (g/dl), HCT (Hematocrits) (%) rates were defined to increase significantly than the rest state prior to the first exercise at the beginning of the training program. However, while MCV (Mean corpuscular volume (fL)) values increased significantly in the group with Q10 supplement, a significant decrease was determined in the Q10 non-supplemented group ($P<0.05$). Hematological effects of the coenzyme Q10 supplement on basketball players were observed to be positive in the combined training applications.

INTRODUCTION

WBC or leukocytes are various cell types mediating the body's immune system. They play a role in healing damaged tissue and infection as they circulate in the blood and lymph system (Furth and Cohn 1968). Paulsen et al. (2005) cite that in intensive trainings, it was reported to cause sudden and temporary changes in the number of WBC. It is lately reported that the numbers of total WBC, neutrophil and lymphocytes were higher in the men with low fitness and high obesity levels, compared to men with a high fitness level (Kakanis et al. 2010). Lymphocytes, which have the most dominant mononuclear structure in the blood and form the immune system, eliminate the viruses, bacteria, tumor cells that may occur in the body by recognizing and destroying (Turner et al. 2011). Lymphocytes are classified as natural killers, B Lymphocytes, T Lymphocytes (Pedersen and Nielsen 2013). Pedersen et al. (1997) transmit that a same level of increase in the numbers of neutrophils and lymphocytes after the training was defined and that the increase occurred in response to the inflammatory reactions connected to degeneration in muscle tissues. Zieker et al. (2005) specified that there was an increase in leukocytes, monocytes values and decrease in the numbers of the lymphocytes just after the marathon. Londeann (1978) transmit that a decrease happens in hemoglobin and hematocrit values in parallel with the increasing exercise intensity in athletes, and this condition is known as athletes' anemia.

Old and large blood cells are eliminated during the exercise (Ashenden et al. 1998). Erythrocytes, especially pitted erythrocytes, and the production of young red blood cells were observed to be faster in the athletes (Chatard et al. 1999). In intensive exercises, rapid and transient changes in circulation, in especially the number of the leukocytes were observed (Raastad et al. 2003; Paulsen et al. 2005). Changes emerged as acute just after exercise or in two-phase increasing after a few hours (Gabriel and Kindermann 1997). High-level technical skills are described as complex sports requiring many features of team sports, when considered in terms of tactical skills and physical condition (Saxton et al. 2003). Physical activity affects hematological and biochemical parameters. Aslan et al. transmits that the management of physical reactions, physical and physiological balance, hematological and biochemical level in cardiovascular adaptations play an important role (Aslan et al. 1997). Farias et al. (2015) identified that training positively affects HGB. Physiological conditions, the duration of the training period and type of exercise constitute of the basis of changes (Obminski and Borkowski 2010; Little et al. 2010). Q10 in the interior of the phospholipid bi-layer of the cell membrane is a vitamin-like structure, which is fat-soluble and does not combine with water. Q10 affects the ATP synthesis and increases mitochondrial activity (Turunen et al. 2004; Crane 2001). Folkers and Yamamura transmit that Q10 enzyme supplement is stated to affect physical performance positively in normal healthy adults (Folkers and Yamamura 1986). Some researchers identified that Q10 enzyme supplement had no positive effects in efforts to reduce exercise-induced fatigue (Braun et al. 1991; Weston et al. 1997). The purpose of this study is to research the hematological effects of coenzyme Q10 (CoQ10) supplement on athletes within the eight-week combined basketball training program.

MATERIAL AND METHODS

The study protocol was approved by decision No. 2015/07-167 and dated 22.04.2015 of the Dumlupinar University Faculty of Medicine Ethics Committee. 24 healthy male amateur basketball players with at least 4 years of basketball licenses and maintaining active life in sports (the control group: 21.75 ± 0.52 aged, 192.75±2.44 cm, 93.42±3.65 kg, 25.52±0.36 kg/m^2 BMI; experimental group 22.08±0.53 aged, 191.92±2.37 cm, 94.17±2.4 kg, 25.06±0.59 kg/m^2 BMI) volunteered to participate in the study. The participants did not take in any substances like drug and alcohol before the six months of study and throughout the study. Each participant was informed about the rules that must be followed before the test, supplements to be used, training methods and tests to be applied for eight weeks, and signed an informed consent form prior to participation. After the participants' rest state blood was drawn, a single dose 200mg CoQ10 (GNC, Pittsburg, PA, ABD) in capsules was given to 12 participants daily before exercise during the 8 weeks. The other 12 participants, after drawing rest state blood, were not given any supplements before and after exercise during 8 weeks.

Training Method

Prior to the implementation of all training, 10 to 15 minute warm-up and stretching and cool-down exercises after implementation were completed.

F_1 Strength Training Program

Before the strength training program, individualized strength training cards were formed by recording the 1-Repeat maximal value of participants in the movements that located in the program. In each station, 45-60 seconds rest was applied between sets and 3 sets x 4-6 repeats with eighty to ninety percent of the maximal load lifted. 2-3 minute rest periods were followed between stations. F_1 strength training program consisted of 10 stations, that is:

1. Military Press
2. Leg Extension
3. Bench Press
4. Leg Press
5. Wide-Grip Lat Pulldown
6. Standing Barbell Calf Raise
7. Rowing
8. Leg Curl
9. Biceps Curl
10. Triceps Pushdown.

F_2 Strength Training Program

In the last four weeks before the strength training program, , individualized strength training cards were formed again by recording again the 1-Repeat maximal value of participants in the movements that are located in the program. In each station, the movement determined by 30-45 seconds at the explosive pace was applied 3 sets with sixty to seventy percent of the maximal load lifted. 90 seconds between sets and 2-3 minutes rest periods between stations were followed. The stations used in F_1 strength training program were preferred. AE_1 Aerobic endurance program: 30-45 minutes run was applied at the pulse determined according to the participants with the karvonen formula as follows (Miller et al. 1993), [(22-0 aged)-rest state pulse] x 60%+ rest state pulse = 60 percent jogging pace.

HIIT or High Intensity Interval Training

In the last four weeks, with the pulse determined according to the participants, with the karvonen formula of [(22-0 aged)-rest state pulse] x 80 percent+ rest state pulse =80 percent jogging pace (Miller et al. 1993), three different intensity training program was made including $HIIT_a$ High-intensity Interval Training, 10 repeats x (200 m), $HIIT_b$ High-intensity Interval Training, 10 repeats x (400m), $HIIT_c$ High-intensity Interval Training, and 10 repeats x (600m). 1:2 or 1:3 rest was given between the repeats.

MS Maximum Speed Training

With the pulse determined according to the participants, with the karvonen formula of [(22-0 aged)-rest state pulse] x 90-100 percent + rest state pulse =90-100 percent jogging pace (Miller et al. 1993), three different maximum speed training program was preferred including Maximum Speed Training MSa 10 repeats x (50 m), Maximum Speed Training MSb 10 repeats x (40 m), Maximum Speed Training MSc (10 repeats x (30 m). 1:3 or 1:4 rest was applied.

T&T or Technical and Tactical Training

After 10 minutes warm-up, 1:1, 2:2, 3:3, 4:4 and 5:5 full court dribbling, pass, layup and shot trainings, offence and defense organizations combined trainings (Table 1).

Obtaining the Blood Parameters

Initially, four blood drawing processes were totally carried out in both groups in rest state before exercise and fatigue state after exercise and at the end of 8-week process in rest state before exercise and fatigue state after exercise. The Sysmex XE-5000 blood analyzer was used for the detection of blood values. Hemoglobin (Hb,g/dL), hematocrits (Hct,%), white blood cell count (WBC, 10^3/mm^3), mean corpuscular volume (MCV,fl), Neutrophil counts (10^9/L), Lymphocytes counts (10^{12}/L), Monocytes (10^9/L), and Eosinophil (10^9/L) values were determined.

Statistical Analysis

The SPSS software was used for the statistical analysis of the data obtained. Paired sample t-test was used for the detection of the differences of the participants' parameters to be measured before and after training. Independent t-test was applied for determining the differences between the groups. The level of significance was evaluated as $p < 0.05$.

RESULTS

In the control group (Table 2), in the rest state before exercise at the end of the training program, Eosinophil (10^9/L) and HCT (Hematocrit) values were determined to be significantly different than the rest state before the first exercise at the beginning of the training program ($P<0.05$). In the control group (Table 2), in the fatigue state after exercise at the end of the training program WBC (Leukocyte counts) (x10^3), Lymphocytes counts (10^{12}/L), Eosinophil (10^9/L), HGB Hemoglobin values (g/dl), HCT (Hematocrit) (%) and MCV (Mean corpuscular volume) (fL) values were determined to be significantly different than the fatigue state after the first exercise at the beginning of the training program ($P<0.05$). In the experimental group (Table 3) the rest state Lymphocytes count (10^{12}/L) values before exercise at the end of the training program were found to be significantly different than the rest state, before the first exercise at the beginning of the training program ($P<0.05$). In experimental group (Ta-

Table 1: Training planning

Days	*Application period*	*1st week*	*2nd week*	*3rd week*	*4th week*	*5th week*	*6th week*	*7th week*	*8th week*
Monday	Morning	F_1	F_1	F_1	F_1	F_2	F_2	F_2	F_2
	Evening	AE_1	AE_1	AE_1	AE_1	T&T	T&T	T&T	T&T
Tuesday	Morning	MS^a	MS^a	MS^b	MS^c	$HIIT_a$	$HIIT_a$	$HIIT_a$	$HIIT_a$
	Evening	-	-	-	-	-	-	-	-
Wednesday	Morning	F_1	F_1	F_1	F_1	F_2	F_2	F_2	F_2
	Evening	AE_1	AE_1	AE_1	AE_1	T&T	T&T	T&T	T&T
Thursday	Morning	MS^a	MS^b	MS^b	MS^c	$HIIT_b$	$HIIT_b$	$HIIT_b$	$HIIT_b$
	Evening	-	-	-	-	-	-	-	-
Friday	Morning	F_1	F_1	F_1	F_1	F_2	F_2	F_2	F_2
	Evening	AE_1	AE_1	AE_1	AE_1	T&T	T&T	T&T	T&T
Saturday	Morning	MS^a	MS^b	MS^c	MS^c	$HIIT_c$	$HIIT_c$	$HIIT_c$	$HIIT_c$
	Evening	-	-	-	-	-	-	-	-

F_1 Strength training program; F2 Strength training program
AE_1 Aerobic endurance program; HIIT ^{a,b,c} High-intensity Interval Training
MS ^{a,b,c} Maximum Speed Training; T&T Technical and Tactical Training

Table 2: Q^{10} non-supplemented control group blood values before and after program

Q^{10} Non-supplemented		*Control group rest state blood values before exercise before and after program*				*Control group fatigue state blood values afterexercise before and after program*			
Parameters	*N*	*Group*	*X±SS*	*t*	*P*	*Group*	*X±SS*	*t*	*P*
WBC(Leukocyte	12	$C^{rest\ Pre}$	6.64 ± 1.35	-1.395	0.19	$C^{fatigue\ Pre}$	8.61± 1.31	-4.081	0.002*
counts)(x10^3)	12	$C^{rest\ Post}$	7.07 ± 1.18			$C^{fatigue\ Post}$	10.23± 1.68		
Neutrophil	12	$C^{rest\ Pre}$	3.37 ± 1.08	-0.18	0.861	$C^{fatigue\ Pre}$	4.3 ± 0.9	-0.635	0.538
counts (10^9/L)	12	$C^{rest\ Post}$	3.43 ± 0.88			$C^{fatigue\ Post}$	4.57± 0.67		
Lymphocytes	12	$C^{rest\ Pre}$	2.52 ± 0.77	-0.875	0.4	$C^{fatigue\ Pre}$	3.06 ± 1.01	-4.792	0.001*
counts(10^{12}/L)	12	$C^{rest\ Post}$	2.71 ± 0.45			$C^{fatigue\ Post}$	4.7± 1.15		
Monocytes (109/L)	12	$C^{rest\ Pre}$	0.6 ± 0.19	0.394	0.701	$C^{fatigue\ Pre}$	0.7 ± 0.28	0.152	0.882
	12	$C^{rest\ Post}$	0.58 ± 0.12			$C^{fatigue\ Post}$	0.69± 0.18		
Eosinophil (10^9/L)	12	$C^{rest\ Pre}$	0.15 ± 0.09	-2.828	0.016*	$C^{fatigue\ Pre}$	0.15± 0.79	-3.071	0.011*
	12	$C^{rest\ Post}$	0.35 ± 0.26			$C^{fatigue\ Post}$	0.25± 0.11		
HGB Hemoglobin	12	$C^{rest\ Pre}$	14.3 ± 0.43	-1.593	0.139	$C^{fatigue\ Pre}$	14.3± 0.52	-3.504	0.005*
values (g/dl)	12	$C^{rest\ Post}$	14.5 ± 0.25			$C^{fatigue\ Post}$	14.7± 0.46		
HCT (Hematocrit)	12	$C^{rest\ Pre}$	42.6 ± 0.71	-2.248	0.046*	$C^{fatigue\ Pre}$	42.8± 0.95	-2.531	0.028*
(%)	12	$C^{rest\ Post}$	43.35 ± 1.03			$C^{fatigue\ Post}$	43.74± 1.55		
MCV (Mean	12	$C^{rest\ Pre}$	82.41 ± 1.81	1.909	0.093	$C^{fatigue\ Pre}$	80.74± 2.13	2.798	0.017*
corpuscular	12	$C^{rest\ Post}$	80.39 ± 3.17			$C^{fatigue\ Post}$	78.69± 2.27		
volume (fL)									

(*:P<0.05) $C^{rest\ Post}$: Control group $C^{faitgue\ Post}$: Control group (Training) Fatigue
(Training) Rest Post, $C^{rest\ Pre}$: Control group $C^{Fatigue\ Pre}$: Control group (Training)Fatigue Pre
(Training) Rest Pre Post.

ble 3), in the fatigue state after exercise at the end of the training program WBC (Leukocyte counts)(x10^3), Lymphocytes counts (10^{12}/L), Eosinophil (10^9/L), HGB Hemoglobin values (g/dl),

Table 3: Q^{10} Supplemented experimental group blood values before and after program

Q^{10} Non-supplemented		*Control group rest state blood values before exercise before and after program*				*Control group fatigue state blood values afterexercise before and after program*			
Parameters	*N*	*Group*	*X±SS*	*t*	*P*	*Group*	*X±SS*	*t*	*P*
WBC(Leukocyte	12	$Q^{10\ rest\ Pre}$	6.8±1.17	-0.028	0.978	$Q^{10\ Fatigue\ Pre}$	9.46 ±1.36	-2.772	0.018*
counts)(x10^3)	12	$Q^{10\ rest\ Post}$	6.8±0.66			$Q^{10\ Fatigue\ Post}$	12.35±3.09		
Neutrophil counts	12	$Q^{10\ rest\ Pre}$	3.21±1.03	1034	0.323	$Q^{10\ Fatigue\ Pre}$	5.5±1.99	0.605	0.557
(10^9/L)	12	$Q^{10\ rest\ Post}$	2.96±0.4			$Q^{10\ Fatigue\ Post}$	5.1±1.76		
Lymphocytes	12	$Q^{10\ rest\ Pre}$	2.72±0.59	-7.181	0.001*	$Q^{10\ Fatigue\ Pre}$	2.72±1.49	-4.595	0.001*
counts(10^{12}/L)	12	$Q^{10\ rest\ Post}$	3.04±0.56			$Q^{10\ Fatigue\ Post}$	5.83±1.19		
Monocytes (10^9/L)	12	$Q^{10\ rest\ Pre}$	0. 6±0.079	1.239	0.241	$Q^{10\ Fatigue\ Pre}$	1.08±0.27	-0.103	0.92
	12	$Q^{10\ rest\ Post}$	0.56±0.11			$Q^{10\ Fatigue\ Post}$	1.09±0.27		
Eosinophil (10^9/L)	12	$Q^{10\ rest\ Pre}$	0.24±0.21	-0.804	0.438	$Q^{10\ Fatigue\ Pre}$	0.06±0.04	-5.173	0.001*
	12	$Q^{10\ rest\ Post}$	0.25±0.17			$Q^{10\ Fatigue\ Post}$	0.32±0.16		
HGB Hemoglobin	12	$Q^{10\ rest\ Pre}$	13.4±0.68	0.666	0.519	$Q^{10\ Fatigue\ Pre}$	13.12±0.76	-4.038	0.002*
values (g/dl)	12	$Q^{10\ rest\ Post}$	13.3±0.73			$Q^{10\ Fatigue\ Post}$	13.78±0.62		
HCT (Hematocrit)	12	$Q^{10\ rest\ Pre}$	39.49±1.63	-0.334	0.745	$Q^{10\ Fatigue\ Pre}$	39.06±2.08	-5.738	0.001*
(%)	12	$Q^{10\ rest\ Post}$	39.66±1.96			$Q^{10\ Fatigue\ Post}$	42.14±1.71		
MCV (Mean	12	$Q^{10\ rest\ Pre}$	79.75 ±2.65	0.403	0.695	$Q^{10\ Fatigue\ Pre}$	80.16±2.61	-2.911	0.014*
corpuscular	12	$Q^{10\ rest\ Post}$	79.67±2.58			$Q^{10\ Fatigue\ Post}$	82.3±2.55		
volume (fL)									

(*;P<0,05) $Q^{10\ Rest\ Pre}$: Q^{10} group $Q^{Rest\ Pre}$: Q^{10} group
(Training+Supplement) Rest Pre, (Training+Supplement) Fatigue Pre
$Q^{10\ Fatigue\ Pre}$: Q^{10} group $Q^{Fatigue\ Post}$: Q^{10} group
(Training+Supplement) (Training+Supplement) Fatigue Post

HCT (Hematocrit) (%) and MCV (mean corpuscular volume (fL)) values were found to be significantly different than the fatigue state after the first exercise, at the beginning of the training program (P<0.05).

DISCUSSION

WBC (Leukocyte counts x10^3) (p<0.01) values were observed to have increased after Ghanbari-Niaki et al.'s (2010) acute circular strength training in young women, Avloniti et al. (2007) (p<0.05) competition in elite female soccer players, in the study Iriadam et al. (2003) did on amateur footballers, after exercise depending on exercise intensity in the Bezci et al.'s (2010) paper on the 11 female taekwondo players before and after the 4-week exercise program. In the research, a significant increase occurred in the WBC levels caused by exercise in male athletes in Q10 non-supplemented and Q10 supplemented group in the fatigue state after exercise at the end of the training program, it was supported by the studies above. However, in the Demirci's (2014) study on 15 elite female skier, a decrease in the WBC (p<0.01) values were defined after exercise in the 10 female skier with Q10 supplement. In Santhiago et al.'s (2009) study on 13 male and 10 female swimmers, significant changes were not observed in the WBC values at the end of 14 weeks of intensive and long-term training. Kon et al. (2008) could not find a significant difference in the WBC values at the end of the application for two weeks Q10 supplement, in the 18 elite Japanese kendo athletes.

Demirci et al.'s (2010) studies do not parallel the studies of Kon and colleagues. In the Hulmi et al.'s (2010) study of the 21-week strength training performed on 50 males, an increase was defined in leukocytes (p<0.05) after acute strength training. However, at the end of 21 weeks when evaluated as basal any significant changes were defined. Compared with the literature above, the effect of duration of the training period and loaded exercise intensity on WBC value may be considered. Ghanbari-Niaki et al. (2010) identified a significant level increase in the lymphocyte (p<0.0001) value after circular acute strength training in young women. Avloniti et al. (2007) observed no significant change in the lymphocyte (p>0.05) value after the competition in elite female soccer. Iriadam et al. (2003) defined a decrease in the lymphocytes (p <0.05) values after exercise depending on exercise intensity in the study on amateur footballers. In the research, a significant increase in the lymphocyte levels caused by exercise in male athletes in Q10 non-supplemented and Q10 supplemented group in the fatigue state after exercise at the end of the training program supports the studies of Ghanbari-Niaki et al. (2010) while it does not comply with studies of Avloniti et al. (2007) and Iriadam et al. (2003). Pedersen and Toft (2000) transmit that McCarthy and Dale (1998) expressed that the lymphocyte concentration increased during exercise, fell to pre-exercise levels after prolonged intense exercise, however in the moderato exercise level lymphocyte values increased. The intensity and duration of exercise can be said to affect changes in lymphocyte values. In Bezci and Kaya's (2010) study on 11 taekwondo players 4 weeks before and after the exercise program (p<0.01; HGB-p<0.05; HCT), Tsalis et al.'s (2004) study on 21 female and 21 male swimmers, as a result of medium density and interval load (strength) trainings during 3 months, swimmers' (p<0.001;HGB-p<0.001; HCT), Ibis et al. (2012) in 12 Alpine skiers athletes before and after 12 weeks plyometric training application (p<0.05; HGB-p<0.05; HCT), an increase in the HGB and HCT values were observed in the researches mentioned above. In Menz et al.'s (2015) study increased HGB after three weeks HIIT training like this study. Kilgore et al. (2002) identified an increase in the Hematocrit values between the phase of 1st to 5th week at the end of 6 weeks of strength training with Olympic weightlifters. In the Demirci's study on 15 elite female skiers, blood values before and after exercise were evaluated by giving Q10 supplement. An increase was defined in the HGB (p < 0.05) values of the female skiers with Q10 supplement (Demirci 2014). Mazoochi et al. observed a significant level increase in hematocrits (p<0.001) values in both groups, male athletes applying the continuous and interval training program (Mazoochi et al. 2013). The increase in HGB and HCT values in the Q10 non-supplemented and Q10 supplemented group in the fatigue state after exercise at the end of the research is paralleled to the literature. Ghanbari-Niaki and Tayebi (2013) identified a significant decrease in MCV (p<0.01) value in the study of applying a low-density circular strength training on 20 college men (35% of 1-maximum repeat). Kratz et al. (2002) defined a decrease in MCV values after the race in the study on 37 marathon runners, Iriadam et al. (2003) specified a decrease in MCV ($p<0.05$) value after exercise depending on exercise intensity in the study on amateur footballers. In Toprak et al.'s (2012) study on 12 male athletes applied 12-week strength trainings, MCV ($p<0.05$) value before and after the applied training program and in Romagnoli et al.'s' (2014) study on 12-16 aged youths, MCV (p=0,040) values after percent HR max 70 an hour submaximal aerobic exercise were defined to have increased. Santhiago et al. (2009) observed no significant level change in the HTC (p<0,.05) value at the end of 14 weeks of intensive and long-term training process in the study on 13 male and 10 female swimmers. Demirci (2014) evaluated the blood values before and after exercise during 14 days by giving Q10 supplement in the study on 15 elite female skiers. An increase in MCV ($p < 0.01$) value was identified in female skiers with Q10 supplement. Gnanou et al. (2014) expressed that strenuous exercise caused damage to old RBC (Erythrocytes) structure and the membrane due to hemolysis, and a higher number of young RBC and deformed RBC to be more in circulation may lead to an increase in MCV. In the fatigue state after exercise at the end of the training program, an increase in MCV values in the Q10 non-supplemented groups, but a decrease Q10 supplemented groups were observed. When literature is examined, exercise intensity may make differences in MCV values.

CONCLUSION

Q10 supplement may be thought to affect the performance positively depending on the long period of training and efficacy of loading dosage, in unit training in the course of taking Q10 supplement. Making studies for the effect of Q10 supplement for different training programs is suggested in the literature.

RECOMMENDATIONS

For future studies, female basketball players may be included in the studies. On the other hand, researchers can design with other athletes from other sports about Q10 supplement. Besides, researchers may extend study with another supplement.

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