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The effect of Coenzyme Q10 intake on some functional and biochemical variables and aerobic endurance in advanced basketball players.

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Abstract

Coenzyme Q10, a naturally occurring antioxidant, is believed to play a significant role in cellular energy production and protection against oxidative stress. This study aimed to investigate the efficacy of Coenzyme Q10 supplementation on various functional and biochemical variables, as well as aerobic capacity in basketball players. An experimental design was employed, and the sample consisted of basketball players from the University of Mustansiriya team, who were divided into a control and an experimental group. The control group received a placebo in the form of capsules, while the experimental group was given Coenzyme Q10 supplementation for 10 weeks. The main results indicate that Coenzyme Q10 supplementation had a positive effect on the variables studied. The researcher recommended that coaches pay attention to providing players with essential supplements, including Coenzyme Q10.

Keywords: Coenzyme Q10 – Functional – Biochemical – Aerobic Endurance.

1-Introduction

The high demands of basketball on the physical and mental capabilities of athletes drive coaches and specialists to seek energy-generating aids, such as nutritional supplements. While nutritional supplements serve various purposes worldwide, only 5% are designed for high-performance athletes to complement their diet and enhance metabolic function and performance, a field of significant importance [(Rawson, E. S., Miles, M. P., & Larson-Meyer, D. E. (2018)(, Peeling, P., Castell, L. M., Derave, W., de Hon, O., & Burke, L. M. (2019)]. The safe use of nutritional supplements becomes crucial as a viable and reliable method to meet the high nutritional requirements that cannot be obtained solely from your daily diet and improve athletic performance [Maughan, R. J., & Shirreffs, S. M. (2012) ,(Vitale, K., & Getzin, A. (2019)].

Coenzyme Q10 has gained attention for its potential role in improving athletic performance due to its involvement in mitochondrial energy production and its antioxidant properties. Numerous researchers have explored the use of this supplement in various studies on athletes and non-athletes. One such study, "The effects of Coenzyme Q10 on biochemical markers and physical performance in team sport athletes" by Matthews Santos de Souza Fernandez et al. [Fernandez, M. S. de S., et al. (2023)], summarized the effects of CoQ10 supplementation on metabolic and biochemical outcomes and performance in athletes. The study concluded that CoQ10 supplementation in athletes leads to significant improvements in antioxidant activity and performance while reducing oxidative stress.

Similarly, a study by Sepideh Talebi, Mohammad Hossein Pourgharib Shahi et al., titled "The effects of Coenzyme Q10 on biochemical markers and physical performance in team sport athletes," aimed to elucidate the dose-dependent effect of Coenzyme Q10 (CoQ10) supplementation on exercise-induced muscle damage (EIMD), physical performance, and oxidative stress in adults [Talebi, S., Pourgharib Shahi (2024)].

This research stems from the hypothesis that Coenzyme Q10 supplementation can positively influence certain functional and biochemical variables, potentially improving some physical abilities in basketball players, including aerobic endurance. Hence, the significance of research using this supplement to assist team members in energy production and maintaining optimal performance in basketball.

Search problem:

Basketball is a demanding sport that requires a combination of anaerobic and aerobic energy, as well as agility. Coenzyme Q10 is a natural energy booster that can help increase energy levels and vitality. This research aims to answer the question: Does Coenzyme Q10 supplementation have an effect on various functional and biochemical variables, providing energy for basketball players?"

Research Objectives:

1-To determine the effect of Coenzyme Q10 supplementation on the various functional variables such as biochemical and aerobic endurance variables in the study sample.

Research Assumptions:

1-There are statistically significant differences between pre and posttest measurements on the control group in some functional biochemical and aerobic endurance variables.

2-There are statistically significant differences between the pre- and post-measurements of the experimental group in some biochemical and aerobic functional endurance variables.

Research Areas:

Sample of the Study: Basketball team of Mustansiriya University, College of Physical Education and Sports Sciences.

Time: From 3/1/2023 to 7/5/2023.

Location of the study: Outdoor basketball courts at Al-Mustansiriya University.

Terminology: "Coenzyme Q10 is a vitamin-like substance, and its effects in the body resemble those of vitamin E. It increases mitochondrial activity and acts as an antioxidant in both mitochondria and cell membranes, as well as producing energy in every cell of the body. Although CoQ10 is found in meat and fish, its content in such foods is very low, so its synthetic form is used as a dietary supplement "(Lass A & Sohal RS:1998, 352, 229–236). Coenzyme Q10 is a fat-soluble vitamin-like compound that seems to have many health benefits, participating in cellular energy production and functioning as an antioxidant. These properties make it beneficial for maintaining cells and for prevention and treatment "(Coenzyme Q10: Is There a Clinical Role and a Case for Measurement? (Clin Biochem Rev J).

2-Field procedures for research:

2-1 Research Methodology:

The researcher used the experimental method due to its suitability for the nature of the study. The experimental method is defined as the intentional change controlled by the researcher, within a specific set of conditions affecting issues and events, while monitoring and interpreting all changes.

2-2 Research Sample:

The sample consisted of 10 players from the University of Mustansiriya, College of Physical Education and Sports Sciences basketball team. The participants were randomly divided into two groups: a control group and an experimental group, with 5 players in each group.

data table (1) Sample Homogeneity

Variables	Unit of Measurement	Mean	Standard Deviation	Skewness
Height	Cm	176.8	7.260	0.289247
Weight	Kg	74.2	7.598	0.092127
Age	Years	20.8	2.057	0.145808
The sample is homogeneous if the value of the skewness coefficient is confined to (± ١).				

Table (1) shows that the research sample is homogeneous in the indicators (height–weight–and age) as the values of the skewness coefficient are as follows 0.289247/0.092127/0.145808, and all these values are confined between (±١). This indicates that "the closer the skewness values are to (±١)., the more normally distributed the scores are. However, if they exceed or fall short of this range, it means that there is an error in the sample selection.

2-3 Devices Used and Means of Information Collection:

-**Devices Used:** (Basketball Court, Basketballs, Medical Scale for Measuring Height and Weight, Sterile Medical Syringes, Blood Storage Tubes, Blood Sample Holder, Medical Cotton and Sterilizing Materials)

-**Means of Information Collection:** (Arabic and Foreign Sources, Personal Interviews, Tests and Measurements, International Information Network (Internet), Laboratory Results Form, Expert Opinion Forms, Supporting Work Team

2-4 Specification of the measurements and tests used in the research:

To determine the appropriate tests and measurements for this study, the researcher conducted an extensive literature review. This involved collecting and analysing a wide range of scientific articles and online resources. As a result of this process, the following tests were deemed suitable:"

2-4-1 Functional and Biochemical Tests: (Vo_2max, SPo_2, H B, RBC, Pulse Rate).

-Maximum Oxygen Consumption Test (VO_2MAX)

-**Test Objective:** To measure maximum oxygen consumption (VO_2MAX)

-**Equipment and Tools:** (Fitmate Pro System, Treadmills, Sanitary paper for cleaning breathing masks, Disinfectant solution for sterilizing breathing masks, Personal electronic scale with measurement unit (kg) and its components, Metal tape measure for height measurement).

-Procedures and Performance Specifications:

After measuring the height and weight of each player and prior to commencing the test, the individual conducting the test shall clean the breathing mask used for VO_2MAX measurement with a disinfectant solution, connect the components of the (Fitmate pro) device, and secure the pulse strap on the chest of the test subject. Additionally, a Bluetooth pulse signal receiver shall be installed in the (Fitmate pro) device. Following this, the test subject's information, including name, date of birth (day, month, year), gender, height (in cm), and weight (mass in kg), shall be entered into the device, and the type of test to be conducted, which is VO_2MAX, shall be selected. Subsequently, the breathing mask shall be firmly secured over the mouth and nose using the designated straps around the head, ensuring that there is no air leakage from the mask. The test subject shall then step onto the treadmill and begin running gradually with an increase in speed, while the individual conducting the test controls the speed increase on the treadmill from a specific button, starting from (4.5) to (12) km/h. The (Fitmate pro) device is equipped with a small screen that displays a graphical box indicating the pulse and maximum oxygen consumption (VO_2MAX) ratios, which will be monitored by the evaluator.

-Conditions:

١-It must be ensured that the subject is in a normal state before starting the test, and to identify their maximum pulse from the equation (220 - age in years).

٢-Attention should be paid to increasing the load gradient by controlling the speed on the treadmill at the fifth and seventh minute and monitoring the pulse, and observing the subject when they reach a state of exhaustion and are unable to continue running on the treadmill.

٣-Stopping the treadmill should be done by gradually reducing the speed.

٤-Device readings are accepted when the subject reaches (84%) or more of the maximum pulse.

٥-After the test, the breathing mask should be cleaned with a disinfectant solution and dried with paper towels.

٦-The total test duration is (16) minutes as indicated on the device display or until completion based on the subject's request to stop due to inability to continue.

-Registration:

The device provides a comprehensive reading strip for measurements related to (maximum oxygen consumption measurement) VO_2MAX and some physiological indicators and results of anthropometric equations.

-**Unit of measurement:** millilitres \kg\minute

2-4-2 Physical Test (Aerobic Endurance)

-3000m Running Test

Objective of the test: Measure endurance

Tools used: Stopwatch – Visual signal to start

Location: Athletics track

Performance description: The player stands behind the starting line, and upon receiving the starting signal, they run.

Recording: The player's time is recorded from the moment the starting signal is given until they cross the finish line to the nearest 1/100 second.

2-5 Field Research Procedures:

2-5-1 Pilot Study: A pilot study was conducted on Tuesday, January 1, 2023, with the assistance of the research team, involving two players who were later excluded from the research sample. The primary objectives of this pilot study were:

1-To verify the suitability of the tests and measurements.

2-To familiarize the participants with the testing procedures and to identify and rectify any potential issues that might arise during the testing process.

3-To ensure the proper functioning of the equipment and instruments used.

4-To determine the time required to conduct the tests.

5-To familiarize the research team with the nature of the measurements and their efficiency.

6-To establish the sequence of measurements and tests.

2-5-2 Pre-tests: Pre-tests and measurements were conducted on Wednesday, January 4, 2023, at 10:00 AM. Blood samples were collected from the players while seated, with the assistance of a medical assistant. The blood samples were placed in special tubes and stored in a cooler after being drawn. The tubes were labelled with the players' names and numbers and then sent to the laboratory for analysis. On the same day, a 3000-meter endurance test was conducted. The following day, Thursday, January 5, 2023, a VO2 max test was conducted according to the established protocol.

2-6 Main Experiment: The main experiment was conducted on Sunday, January 8, 2023. The control group received a placebo capsule daily throughout the week, one hour before each training session. This protocol was followed for the entire 10-week training program, which consisted of three training sessions per week. The experimental group, on the other hand, received a Coenzyme Q10 (200 mg) capsule daily, also taken one hour before each training session. The training program was designed and supervised by the coach.

2-7 Post-tests: Post-tests were conducted on Sunday and Monday, March 18-19, 2023, under the same conditions as the pre-tests. Blood samples were collected from the players, followed by a VO_2max test. On the following day, Monday, March 19, 2023, a physical endurance test was conducted.

2-8 Statistical methods used: (Arithmetic mean, Standard deviation, Paired samples t-test, Independent samples t-test, Skewness).

3-Presentation, analysis, and discussion of results:

3-1 Comparison of Pre- and Post-test Results in the Control Group:

Table (2) shows the results obtained before and after the intervention for the control group.

Variables	Unit of measurement	Pre		Post		Calculated T value	T value Tabulation	significance
		$\bar{x}$	s	$\bar{x}$	S			
VO_2max	ml/kg/min	٤٤,٠	2.58	٤٣,٦	٢.٥٦	٠,٦٧٤	2.132	No sign.
Pulse Rate	beats/min	١٨٢.٨	2.16	١٧٨,٧	176.2	٠,٢٤٨		No sign.
HB	g/100 ml	١٤,٣	٠,٩٩	٤,٢٢	٠,٨٨	١,١٨		No sign.
RBC	million/μL	٥,٧٨	٠,٤٣	٥,٤١	٠,٣٩	٠,٨٨		No sign.
SpO2	%	٩٨,٣٢	0.311	٩٨,٤٤	0.270	٠,٧٦		No sign.
3000/m /run	Sec	١٢,٦	٣,٩	١٣,١١	٥,١١	٢,٢٢		No sign.
Under a significance level of 0.05 and a degree of freedom of n-1								

According to Table 2, when comparing the pre- and post-test measurements and assessments of the control group, no statistically significant differences were observed for the variables under investigation. The mean Vo2max value for the pre-test was 44.0 with a standard deviation of 2.58, while the post-test mean was 43.6 with a standard deviation of 2.56. The calculated t-value for this comparison was 0.674. However, the critical t-value at the chosen significance level was 2.132. Since the calculated t-value did not exceed the critical t-value, the observed difference was not considered statistically significant. Similarly, for the Pulse Rate variable, the pre-test mean was 182.8 with a standard deviation of 2.16, and the post-test mean was 178.7 with a standard deviation of 176.2. The calculated t-value was 0.248, which was also smaller than the critical t-value of 2.132. Therefore, the difference in Pulse Rate between the pre- and post-tests was not

Regarding the haemoglobin (Hb) variable, the mean pre-test value was 14.3 with a standard deviation of 0.99, while the mean post-test value was 14.22 with a standard deviation of 0.88. The calculated t-value was 1.18, and the critical t-value was 2.353. Since the calculated t-value is smaller than the critical t-value, the difference was not significant. Similarly, for the RBC count, the mean pre-test value was 5.78 with a standard deviation of 0.43, and the mean post-test value was 5.41 with a standard deviation of 0.39. The calculated t-value was 0.88, and the critical t-value was 2.132. Again, the difference was not significant.

Regarding the SpO_2 measurement, the mean pre-test value was 98.32 with a standard deviation of 0.311, while the mean post-test value was 98.44 with a standard deviation of 0.270. The calculated t-value was 0.76, and the critical t-value was 2.132. Since the calculated t-value is smaller than the critical t-value, the difference was not significant. Similarly, for the 3000m running test, the mean pre-test time was 12.6 minutes with a standard deviation of 3.9 minutes, while the mean post-test time was 13.11 minutes with a standard deviation of 0.270 minutes. The calculated t-value was 5.11, and the critical t-value was 2.132. However, there seems to be a calculation error here, as a t-value of 5.11 would indicate a significant difference.

3-2 Presentation and analysis of the results of the pre- and post-tests of the experimental sample

Table (3) Results of the pre- and post-tests for the experimental sample

Variables	Unit of measurement	pre		post		Calculated T value	T value Tabulation	significance
		x̄	s	x̄	s			
VO2max	ml/kg/min	٤٧,٢	١,٨٤	٥٥,٨	٢.٦٤	٤,٦٤	2.132	sign.
Pulse Rate	beats/min	١٧٨,٢	١,١٢	182.7	٢,٥٦	2.137		sign.
HB	g/100 ml	١٣,٦	٢,١٠٦	٦,٦٦	٣,٢٢	2.630		sign.
RBC	million/µL	٤,٧٨	٠,٣١٤	٤,٩٠	٠,٣٧١	٠,٤١٠		No sign.
SpO2	%	٩٦.٤	٠,٣٨	٩٨,٢	٠,٣٢	١,٥٢		No sign.
3000/m /run	Sec	١٣,٢٢	٣,٣٨	١١,٠٨	٢,٨	٢,٣٥٨		sign.
Under a significance level of 0.05 and a degree of freedom of n-1								

According to Table 3, the experimental group showed statistically significant differences between the pre- and post-test measurements and assessments for the studied variables. The mean pre-test Vo2max was 47.2 with a standard deviation of 1.84, while the mean post-test Vo2max was 55.8 with a standard deviation of 2.64. The calculated t-value was 2.64, which was greater than the critical t-value of 2.132, indicating a significant difference. Similarly, for the Pulse Rate variable, the mean pre-test value was 178.2 with a standard deviation of 1.12, and the mean post-test value was 182.7 with a standard deviation of 2.56. The calculated t-value was 2.137, which was also greater than the critical t-value of 2.132, indicating a significant difference.

Regarding the haemoglobin (Hb) variable, the mean pre-test value was 13.6 with a standard deviation of 2.106, while the mean post-test value was 16.66 with a standard deviation of 3.22. The calculated t-value was 2.630, which was greater than the critical t-value of 2.132, indicating a significant difference. For the RBC count, the mean pre-test value was 4.78 with a standard deviation of 0.314, and the mean post-test value was 4.90 with a standard deviation of 0.371. The calculated t-value was 0.410, which was smaller than the critical t-value of 2.132, indicating no significant difference. For the SpO2 measurement, the mean pre-test value was 96.4 with a standard deviation of 0.38, while the mean post-test value was 98.2 with a standard deviation of 0.32. The calculated t-value was 1.52, which was smaller than the critical t-value of 2.132, indicating no significant difference. Finally, for the 3000m running test, the mean pre-test time was 13.22 minutes with a standard deviation of 3.38 minutes, and the mean post-test time was 11.08 minutes with a standard deviation of 2.8 minutes. The calculated t-value was 2.358, which was greater than the critical t-value of 2.132, indicating a significant difference.

٣-٣ presentation and analysis of the results of post-post tests and measurements for the control and experimental samples:

Table (4) Results of post-post tests and measurements for the control and experimental samples.

Variables	Unit of measurement	Post control		postexperimental		Calculated T value	T value Tabulation	significance
		$\bar{x}$	s	$\bar{x}$	s			
VO2max	ml/kg/min	٤٣,٦	٢.٥٦	٥٥,٨	٢.٦٤	٢,٧١	٢.٣٠٦	sign.
Pulse Rate	beats/min	١٧٨,٧	١,٧٦	١٨٢,٨	٢,٥٦	2.331		sign.
HB	g/100 ml	٤,٢٢	٠,٨٨	٦,٦٦	٣,٢٢	2.882		sign.
RBC	million/μL	٥,٤١	٠,٣٩	٤,٩٠	٠,٣٧١	٠.٢٥٣		No sign.
SpO2	%	٩٨,٤٤	0.270	٩٨,٢	٠,٣٢	1.060		No sign.
3000/m /run	sec	١٣,١١	٥,١١	١١,٠٨	٢,٨	2.319		sign.
Significant under the significance level of 0.05 and degree of freedom n-2								

Table 4 shows that there were statistically significant differences between the control and experimental groups in the post-test measurements of the studied variables. For Vo2max, the mean post-test value for the control group was 43.6 with a standard deviation of 2.56, while the mean for the experimental group was 55.8 with a standard deviation of 2.64. The calculated t-value of 2.71 was greater than the critical t-value of 2.306, indicating a significant difference. Similarly, for the Pulse Rate, the mean post-test value for the control group was 178.7 with a standard deviation of 1.76, and for the experimental group, it was 182.8 with a standard deviation of 2.56. The calculated t-value of 2.331 was also greater than the critical t-value, indicating a significant difference.

Regarding the blood haemoglobin (Hb) variable, the mean post-test value for the control group was 14.22 with a standard deviation of 0.88, while for the experimental group, it was 16.66 with a standard deviation of 3.22. The calculated t-value of 2.882 was greater than the critical t-value of 2.306, indicating a significant difference.

For the RBC count, the mean post-test value for the control group was 5.41 with a standard deviation of 0.39, and for the experimental group, it was 4.90 with a standard deviation of 0.371. The calculated t-value of 0.253 was less than the critical t-value of 2.306, indicating no significant difference.

For the SpO2 measurement, the mean post-test value for the control group was 98.44 with a standard deviation of 0.270, and for the experimental group, it was 98.2 with a standard deviation of 0.32. The calculated t-value of 1.060 was less than the critical t-value of 2.306, indicating no significant difference.

Regarding the 3000m running test, the mean post-test time for the control group was 13.11 minutes with a standard deviation of 5.11 minutes, and for the experimental group, it was 11.08 minutes with a standard deviation of 2.8 minutes. The calculated t-value of 2.31٩ was greater than the critical t-value of 2.306, indicating a significant difference.

3-4 Discussion of results:

By examining Data table 4, we observe significant differences in VO_2 max measurements, favoring the experimental group. The researcher attributes these differences to the CoQ10 nutritional supplement administered to the experimental group.

Scientific literature indicates a correlation between the coenzyme Q10 (CoQ10) and maximal oxygen consumption (VO_2 max). CoQ10 plays a crucial role in intracellular energy production, particularly within the mitochondria, which are responsible for generating energy. When CoQ10 levels are adequate, mitochondria can function more efficiently, leading to improved utilization of oxygen and its conversion into energy. This aligns with a study by "Ylikoski et al. ( ) that CoQ10 supplementation at a dose of 90 mg for 12 weeks resulted in a small but significant increase in VO2 max among skiers compared to the placebo control group.(Ylikoski, T, Piirainen, J, Hanninen, O, and Penttinen, J.٢٠١٩).

Performance enhancement can be achieved through a combination of increased efficiency, effectiveness, and supplementation, which aligns with the study's objective. Therefore, CoQ10 can contribute to an increase in VO_2max, a measure of the body's efficiency in utilizing oxygen during exercise.

It is important to note that the biological effects of reactive oxygen species (ROS) depend not only on their quantities but also on their chemical nature, intracellular and tissue location, and rates of formation and decay. ROS serve as primary regulators of cellular functions, inducing adaptive responses when produced in limited quantities but causing damage when produced in excess, leading to oxidative stress and cellular dysfunction (Sies H. Oxidative Stress: 1985. pp. 1-8).

"CoQ10 is a fat-soluble, vitamin-like compound found ubiquitously in nature, playing a key role in cellular bioenergetics by acting as a coenzyme in the mitochondrial respiratory chain to supply cells with energy (Bhagavan H.N., Chopra R.K.003)(Ernster L., Dallner G. Biochemical, 10.1016/0925-4439 (95) 00028-3).

Regarding heart rate measurements, there were significant statistical differences in post-measurement, favoring the experimental group. The researcher attributes these significant differences to the Coenzyme Q10 supplement, as CoQ10 is known to increase VO_2max, consequently leading to an increase in pulse rate. This implies a strong correlation between maximal oxygen consumption (VO_2max) and heart rate. In fact, heart rate is commonly used as a factor to estimate VO_2max. When the body's demand for oxygen increases during exercise, heart rate increases to deliver more oxygen to the muscles.

During physical exercise, heart rate increases, as does the rate of oxygen delivery to the body. Because these two are linked, both maximal oxygen consumption (VO_2max) and heart rate are valuable tools used to assess an individual's cardiovascular fitness level. "This means that as oxygen pulse increases, it indicates an improvement in the efficiency of the systems and their ability to extract oxygen "(Muhammad Hassan Allawi and Abu Al-Ala Abdel Fattah: 1984, p. 224) from the blood. In general, the higher the VO_2max, the higher the maximum heart rate a person can reach. One of the factors affecting VO2 max is heart rate, as one of the signs of reaching VO2 max is a heart rate increase exceeding 180 beats per minute

"Regarding the measurement of HB (Hgb), the researcher noted, through Data table (4), a significant difference in favor of the post-measurement for the experimental group. The researcher attributes this increase to the fact that continuous exercise training increases the body's demand for oxygen. This sends a signal to the kidneys to produce erythropoietin, a hormone responsible for increasing the production of red blood cells that carry haemoglobin. Consequently, the level of haemoglobin in the blood gradually increases with regular training.

This increase can also be attributed to the fact that the enzyme CoQ10 works to increase VO2 max and consequently increase the heart rate, which increases the demand for oxygen and thus increases the level of haemoglobin in the blood."

"Regarding the measurement of SpO2, the differences were not significant and favored the post-test of the experimental group. The researcher attributed the non-significant differences to the close mean values between the control and experimental groups, knowing that the ratio is within normal limits in the blood. The oxygen saturation for the post-test of the experimental group, according to the mean values, was higher than that of the control group. This is attributed to the effect of the nutritional supplement on the maximum oxygen consumption (VO_2max). As the VO_2max increases, oxygen consumption during exercise increases. Over time with training, adaptations occur in the body's capacity, especially the muscles, to use oxygen efficiently. As stated in, (Bastawisi Ahmed: 1999, p. 86)" The efficiency of muscular work is related to the presence of a high percentage of oxygen in the muscles."

As for the 3000m running test, the differences were significant in the post-tests and in favor of the post-test of the experimental group. The researcher attributed these differences to the effect of the Coenzyme Q10 supplement given to the experimental group. One of the most important benefits of Coenzyme Q10 is that it helps convert food into energy. This energy is essential for aerobic exercise, such as running and cycling. Many studies suggest that Coenzyme Q10 may help improve aerobic exercise performance. It helps improve aerobic endurance in several ways. First, it helps produce energy in cells, allowing you to continue exercising for longer. Second, it helps reduce oxidative stress caused by strenuous exercise. Oxidative stress can damage cells and lead to fatigue."CoQ10 works as an antioxidant and removes free radicals, increases the vital energy of the mitochondria, and improves aerobic capacity (G. Morris, G. Anderson, M. Berk, M. Maes, Mol. Neurobiol. 48 (3) (2013) 883–903)(A.M. Remes, E.V. Liimatta, S. Winqvist, U. Tolonen, J. Ranua, K. Reinikainen, I.E. Hassinen, K. Majamaa, Neurology 59 (8) (2002) 1275–1277).

4-Conclusions and recommendations:

4-1 Conclusions:

1-There was a positive effect of coenzyme Q10 supplementation on VO2 max in the study participants.

2-Coenzyme Q10 supplementation had a positive effect on aerobic endurance

3-Coenzyme Q10 supplementation had a positive effect on bothfunctional variables, heart rate and haemoglobin

4-functional variables, heart rate and haemoglobincount (RBC) or oxygen saturation (SpO2)

4-2 Recommendations:

1-Using Coenzyme Q10 as a supplement alongside training programs in team and individual sports.

2-Conducting similar studies on other sports using Coenzyme Q10 supplementation

3-Measuring the effects of Coenzyme Q10 on other functional and biochemical variables that were not measured in this study.

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