ABSTRACT
Aim: In this study we aimed to demonstrate the effects of zinc and/or CoQ10 supplementation on physical performance and muscular injury parameters in young boxers which use both aerobic and anaerobic energy pathways.

Material and Method: The study included 64 healthy male amateur competitive boxers aged between 12-14 years, who were randomly allocated into four groups after the baseline exercise session. Boys were supplemented with zinc or CoQ10 or both or with placebo (Zn-SUP, CoQ10-SUP, Zn-CoQ10 SUP and control groups respectively) for eight weeks. Physical fitness parameters such as endurance, velocity, VO2max, anaerobic power capacity and muscular injury parameters such as CK, CK-MB, LDH and ALP were measured.

Results: Serum CK, CK-MB and LDH activities increased in all groups after fatigue according to resting, however increases were significant for CK and CK-MB in control and Q10-Zn-SUP groups (p < 0.001). Zinc and CoQ10 both improved different physical fitness parameters. ALP levels significantly increased only in control group (p <0.01).

Conclusions: These results show that both CoQ10 and zinc supplementation reduces muscular injury when used separately.

Keywords: coenzyme Q10, zinc supplementation, muscular injury, boxer

ÖZ
Amaç: Bu çalışmada, aerobicik ve anaerobik enerji yolaklarının her ikisini birden kullanan genç boksörlerde çinko ve/veya CoQ10 ilavesinin fiziksel performans ve kas hasarı üzerindeki etkilerini göstermeyi amaçladık.

Gereç ve Yöntem: Çalışmaya, temel egzersiz seansından sonra rastgele dört gruba ayrılan 12-14 yaşları arasında 64 sağlıklı erkek amatör boksör dahil edildi. 4 gruba ayrılan sporculara (Zn-SUP, CoQ10-SUP, Zn-CoQ10 SUP ve kontrol grupları) sekiz hafta boyunca sırasıyla çinko, CoQ10, veya her ikisi birlikte destek amaçlı verildi. Dayanıklılık, hız, VO2max, anaerobik güç kapasitesi gibi fiziksel güç parametreleri ve CK, CK-MB, LDH ve ALP gibi kas hasarını gösteren parametreler çalışıldı.

Bulgular: Serum CK, CK-MB ve LDH aktiviteleri egzersiz sonrası, istirahat durumuna göre tüm gruplarda artması sağlandı, kontrol ve Q10-Zn-SUP gruplarında CK ve CK-MB için artış istatistiksel olarak da anlamli bulundu (p <0.001). Zinc ve CoQ10’un her ikisi de farklı fiziksel güç parametrelerinde artış sağladı. ALP düzeyleri sadece kontrol grubunda anlamli olarak arttı (p <0.01).

Sonuç: Bu sonuçlar hem CoQ10 ve hem çinko desteği olarak ayrı ayrı kullanıldıklarında da kas hasarı azalttıklarını göstermektedir.

Anahtar kelimeler: Koenzim Q 10, çinko ilavesi, kas hasarı, boksör
INTRODUCTION

Young athletes dealing with a sport may be denied the benefits of varied activity while facing additional physical, physiologic, and psychological demands from intense training and competition (1). Excessive stress or overload can lead to tissue breakdown and injury especially in the the rapid growth period during puberty by creating extra tightness and tension in muscles and tendons, making teens more prone to injury (2).

As there appear to be increasing numbers of children who specialize in a sport before and during puberty, there has been a growing interest in research about the relation between exercise, tissue injury and minerals and elements at this age.

Both CoQ₁₀ and zinc are thought to improve physical performance and some elite athletes use both. Nevertheless, the data is not confident and satisfactory. Zinc and coenzyme Q₁₀ (CoQ₁₀) are compounds appear to have a close connection to antioxidant activity. However, there is scarce information about their effects in energy metabolism, on performance. Zinc is an essential micronutrient and is found in almost every cell supports a healthy immune system, aids wound healing, is required in DNA synthesis, is required for growth and development during pregnancy, childhood, and adolescence, and maintains the senses of taste and smell (3,4). Some zinc-containing enzymes, such as carbonic anhydrase and LDH, are involved in intermediary metabolism during exercise. Another zinc-containing enzyme, superoxide dismutase, protects against free radical damage (5,6).

CoQ₁₀ plays several crucial roles in the body; acts as a redox electron carrier in mitochondria, acts as an essential antioxidant and influences the stability of membranes (7-9). It is found in all cell membranes, but most of it is located in mitochondria, the energy producing part of every cell, especially in the heart, brain, kidneys and liver. CoQ₁₀ is essential in producing ATP or fuel on which the body functions. It is also a fat-soluble anti-oxidant and therefore helps boost the body’s immune system by destroying free radicals (10). For these reasons, most sportsmen and women have found CoQ₁₀ to be a natural manner in which to improve performance.

In this study, we aimed to demonstrate the changes in different physical performance and muscular injury parameters with the use of either zinc or CoQ₁₀ in young boxers, those use both aerobic and anaerobic energy pathways. Indeed, we aimed to show the changes in these parameters by using zinc and CoQ₁₀ together for the first time in our knowledge.

MATERIAL and METHODS

Subjects

The study included 64 healthy, voluntary male amateur competitive boxers, aged between 12-14 years. They were all sedentary and all had no training background before. Boys participated into the study after a full explanation of the objectives and their parent’s informed written consent. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and the ethics committee of Erciyes University approved all procedures.

Experimental Design

The experimental approach was designed to evaluate the improvement in physical performance and muscular injury parameters before and after taking zinc and/or CoQ₁₀ in young amateur boxers.

The study was a 8 week single-blinded, intervention trial, composed of 8 week periods of regular boxing exercise and supplementation with pills containing either 60 mg/dL oral CoQ₁₀ (GNC) or 50 mg/dL oral zinc sulphate or both CoQ₁₀ and zinc together or placebo (glucose). After the baseline exercise session the first sampling and anthropometric measurements were done for all subjects and then the participants were randomly allocated to 4 groups according to the supplementation that they take: Zn supplementation group (Zn-SUP), CoQ₁₀ supplementation group (CoQ₁₀-SUP), both CoQ₁₀ and Zn supplementation group (Zn-CoQ₁₀-SUP) and placebo (control) group. All volunteers (including control group) had boxing training 3 days in a week for 8 weeks with a period of 90-120 min while keeping their habitual feeding and nutrition. During exercises, pulses were controlled between 140-160 pulse/min for all boxers with a pulse counter.

Exercise protocol

At the beginning of all trainings, a 10 min warming up was applied to boxers with a target heart rate (THR) 90-130 pulse/min. During the main technical boxing trainings, force, speed, endurance and coordination exercises were done (THRR=120-140 pulse/min).
Reaction time, first acceleration, fast force and coordination exercises of extremities with their own body weight and half, quarter and lower weights. Short, mean and long time anaerobic exercises were also done with their own body weights. After main training, a 20 min cooling down and extremity relaxing exercises were applied.

**Anthropometric Measurements**

The anthropometric measurements were made according to the protocols recommended by different investigators (11-15).

1. The height and weight of the subjects in shorts and no shoes were measured. Height was measured using the Holtain Stadiometer having 0.1 cm sensitivity, and weight was measured using a bascule (Angel) having 0.02 kg sensitivity.

2. Body Mass Index (BMI) was determined using the formula: weight (kg) / height (m)².

3. Body fat % was determined using Skinfold Method. Measurements were taken by a specialized person using Skinfold Calliper (Holtain Ltd, England) having 0.2 mm sensitivity. Triceps, subscapular, abdominal and suprailiac skinfold measurements were obtained. Each skinfold was measured three times and the median value was used for calculation. To determine the fat percentage of the subjects, Durning and Womersley formula was applied.

\[
\text{Fat \% (Triceps+Subscapular+Abdominal+Suprailiac) = } \log X = (4.95/D-4.5) \cdot 100 \\
D = 1.1620 - 0.0630 \cdot X
\]

**Physical fitness**

Physical fitness was determined using the following tests: a) isometric strength: handgrip, knee extension and elbow flexion, b) velocity: shuttle-run, c) back and hamstring flexibility: sit-and-reach test of Wells and Dillon, d) lower limb power: vertical jump, and e) 20 m run/walk test to estimate VO2max (16).

Isometric grip strength, strength of knee extension and elbow flexion were obtained by using the ‘Takei Physical Fitness Test’ dynamometer. After specific stretching and warm-up, three maximal attempts were performed, with an interval of 60 seconds between attempts, and the best result was used for analysis.

The velocity of the subjects was determined using the 30m run test. Measurements were made using a photocell chronometer. With 5 min resting intervals, the test was repeated three times. The lowest time was recorded.

Back and hamstring flexibility was evaluated by the sit-and-reach test. The maximum distance reached (cm), with one hand parallel to the other and the knees extended, was used as an indicator of back and hamstring flexibility.

Lower limb power was measured by the vertical jump test, with assistance of the upper limbs and trunk movement by using the ‘Takei Physical Fitness Test’ dynamometer. The difference between the highest point reached after jumping and total height was used as an indicator of lower limb power.

For all physical fitness tests, the subjects made three attempts and the best result obtained in the tests was used for analysis.

**Aerobic Capacity (Max VO2)**

Max VO2 measurement was made using the Multistage Fitness Test. This test involved continuous running between two lines 20 m apart in time to recorded beeps. The time between recorded beeps decrease each minute (level).

**Anaerobic Power**

Anaerobic power was tested using the Sargent vertical jump test and calculated using the Lewis formula (Fox. & Matthew, 1974).

\[
\text{Anaerobic Power} = \sqrt{4.9 \cdot (\text{Body Weight}) \cdot \sqrt{D}} \\
D = \text{Vertical Jump Height (m)}
\]

**Laboratory assays**

After a 12 h overnight fasting venous blood samples were collected from all participants before any supplementation during resting and after exhaustion exercise. Blood sampling protocol was repeated 8 weeks later after supplemements. Serum creatinine, creatine kinase (CK) and lactate dehydrogenase (LDH) levels were measured by an enzymatic method and creatine kinase MB (CK-MB) levels were measured by immunoinhibition method on an autoanalyser (ARCHITECT c16000, Abbott Diagnostics, Canada, USA). Serum zinc analyses were conducted in a Shimatsu ASC-600 Atomic Absorption Spectrophotometer. Measurements were carried out twice with light at 213 nm wavelength using flame atomization technique and levels are presented as μg/dL.

**Statistical analysis**

The effect of supplementation on variables within each group was evaluated by comparing results after treatment with those at baseline, using paired t-test.
Physical fitness parameters of all groups those administered an eight-week boxing training program were compared before and after supplementation. BMI increased in control and Zinc-SUP groups despite decreasing in Q10-SUP and Q10-Zn-SUP groups, although the difference was not significant in Q10-Zn-SUP group. In all groups anaerobic power capacity increased after exercises but the maximum increases were in Zn-SUP and Q10-Zn-SUP groups (Table 2).

Decrease in body fat % was significant in control, Q10-SUP and Q10-Zn-SUP groups. Max VO2 increased in Q10-SUP and Q10-Zn-SUP groups. Also increase in vertical jumping was significant in Zinc-SUP and Q10-Zn-SUP groups (Table 2). There was no difference between groups for other physical fitness parameters (isometric strength, velocity, back and hamstring flexibility and lower limb power).

### Table 1. Baseline physical characteristics of supplementation and control groups. Data are mean ± SD.

<table>
<thead>
<tr>
<th></th>
<th>Control (n=16)</th>
<th>Zn-Sup (n=16)</th>
<th>CoQ10-Sup (n=16)</th>
<th>Zn-CoQ10 Sup (n=16)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>12.9±0.6</td>
<td>12.8±0.9</td>
<td>13.1±0.6</td>
<td>12.8±0.7</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>145.9±4.9</td>
<td>145.3±5.2</td>
<td>145.4±4.2</td>
<td>144.9±5.7</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>46.4±5.2</td>
<td>44.3±7.6</td>
<td>45.5±5.7</td>
<td>45.1±7.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.8±2.0</td>
<td>21.0±2.1</td>
<td>21.6±2.8</td>
<td>21.5±3.6</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Body fat %</td>
<td>14.6±3.9</td>
<td>16.4±2.4</td>
<td>14.5±3.6</td>
<td>16.1±2.6</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

### Table 2: Comparison of physical fitness parameters of groups. Data are mean± SD.

<table>
<thead>
<tr>
<th></th>
<th>Control (n=16)</th>
<th>Zn-Sup (n=16)</th>
<th>CoQ10-Sup (n=16)</th>
<th>Zn-CoQ10 Sup (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>Baseline</td>
<td>Post-Exercise</td>
<td>Baseline</td>
<td>Post-Exercise</td>
</tr>
<tr>
<td></td>
<td>21.8±2.0</td>
<td>22.7±1.5**</td>
<td>21.0±4.2</td>
<td>21.4±4.7**</td>
</tr>
<tr>
<td><strong>Anaerobic performance</strong></td>
<td>83.9±4.2</td>
<td>85.5±5.2**</td>
<td>81.8±9.3</td>
<td>86.3±9.3**</td>
</tr>
<tr>
<td><strong>Body fat %</strong></td>
<td>14.6±3.9</td>
<td>13.5±3.7**</td>
<td>16.4±2.4</td>
<td>14.2±2.4**</td>
</tr>
<tr>
<td><strong>Vertical jumping (cm)</strong></td>
<td>31.1±2.0</td>
<td>31.0±2.6**</td>
<td>31.0±2.5</td>
<td>33.8±2.3**</td>
</tr>
<tr>
<td><strong>VO2max (ml/kg/min)</strong></td>
<td>39.6±4.1</td>
<td>40.3±4.1**</td>
<td>37.1±2.7</td>
<td>39.1±2.7**</td>
</tr>
</tbody>
</table>

* p<0.05, **p<0.001 and NS=not significant.
Serum zinc levels at baseline were in normal range values in all groups (70-120 μg/dL). After eight-week supplementation and exercise period there was significant increase in serum zinc in Zn-SUP and Q10-Zn-SUP groups (p < 0.01), however a decrease in Q10-SUP (p < 0.05) and control (p < 0.001) (Figure 1). The increase in Q10-Zn-SUP was higher than Zn-SUP group, even though the difference was not significant. Serum CK, CK-MB and LDH activities increased in all groups after fatigue according to resting, however increases were significant for CK and CK-MB in control and Q10-Zn-SUP groups. ALP levels significantly increased only in control group (Table 3).

**DISCUSSION**

**The effect of supplementations on physical fitness and performance parameters**

In this study, VO2max values of the boxers after 8-week Q10 or Zinc-Q10 supplementation were higher than those before supplementation; however the difference was not statistically significant in control and Zn-SUP groups (Table 2). In Co Q10-SUP group anaerobic power was also significantly increased according to baseline. These results indicate that Co Q10 is effective in increasing both anaerobic power and maximal oxygen uptake, which indicates aerobic power in strenuous exercise.

**Table 3: Comparison of enzymatic activities or concentrations of some muscular injury markers**

<table>
<thead>
<tr>
<th>Biochemical Parameters</th>
<th>Control (n=16)</th>
<th>Zn-Sup (n=16)</th>
<th>CoQ10-Sup (n=16)</th>
<th>Zn-CoQ10-Sup (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resting</td>
<td>Post-Exercise</td>
<td>Resting</td>
<td>Post-Exercise</td>
</tr>
<tr>
<td>CK (U/L)</td>
<td>144.8 ± 32.3</td>
<td>269.1 ± 131.2</td>
<td>184.4 ± 61.5</td>
<td>238.1 ± 125.6</td>
</tr>
<tr>
<td>CK-MB (U/L)</td>
<td>24.6 ± 4.6</td>
<td>38.9 ± 9.3**</td>
<td>23.6 ± 9.3</td>
<td>29.5 ± 22.0</td>
</tr>
<tr>
<td>LDH (U/L)</td>
<td>244.6 ± 39.3</td>
<td>253.5 ± 38.9</td>
<td>246.9 ± 38.6</td>
<td>219.9 ± 37.2</td>
</tr>
<tr>
<td>ALP (U/L)</td>
<td>309.4 ± 96.4</td>
<td>323.1 ± 87.1**</td>
<td>296.8 ± 71.5</td>
<td>318.1 ± 71.1</td>
</tr>
</tbody>
</table>

* p < 0.05 and ** p < 0.01 compared with resting.

**Figure 1:** Serum resting zinc concentrations of groups at baseline and after supplementation at the end of eight-week strenuous exercise.
The results from CoQ10 studies on exercise performance have mostly focused on aerobic capacity and exercise induced muscle injury. A study on top-level Finnish cross-country skiers using 90 mg of CoQ10 showed a significant improvement in VO2max and both aerobic and anaerobic performance. In addition, 94% of the treatment group felt they had better recovery (17). Recently Gokbel et al. showed CoQ10 supplementation increased performance, especially anaerobic capacity during repeated bouts of supramaximal exercises in sedentary men (18). In another study, it was shown that CoQ10 could improve work capacity, reduce fatigue during extended cycling tests (19) and tended to increase time to exhaustion (20). Our results are in line with these studies.

There are also some previous studies, which have failed to demonstrate performance-enhancing effects in trained athletes and/or untrained individuals following CoQ10 supplementation (21-23). Recently, Zhou and colleagues investigated the effects of a 4 week CoQ10 supplementation on aerobic power, ventilatory threshold and exercise economy of healthy males. Results showed no significant changes in aerobic performance (VO2max) or exercise economy in response to supplementation. Although CoQ10 concentration was elevated in plasma, no significant increases were observed within muscle. Thus, the authors concluded that the lack of ergogenic benefit was likely due to an inability of supplementation protocol to increase CoQ10 concentration within the muscle (23). In our study, anaerobic power capacity also increased after physical activity in all groups, but the maximum increases were in Zn-SUP and Q10-Zn-SUP groups (Table 2). In addition, increase in vertical jumping was significant in Zinc-SUP and Q10-Zn-SUP groups.

The findings about zinc supplementation was also in concordance with literature (24,25). Krotkiewski et al evaluated muscle strength and endurance in women supplemented with 135 mg Zn/d for 14 day (25). Subjects supplemented with zinc, compared with placebo, had significantly higher dynamic isokinetic strength at angular velocity and isometric endurance.

In the current study, our results showed in all groups there was an increase in muscle endurance parameters determined by isometric strength, velocity, back and hamstring flexibility, lower limb power tests, even though both CoQ10 and Zn supplementation did not statistically differ this increase rate. Also the lack of difference with the placebo group for these parameters may be caused from the selection of group consisted of amateur boxers; those started a heavy physical activity not done regularly before. Physical activity applied in a disciplined order is generally considered to increase physical power like maximum oxygen consumption (VO2max), anaerobic power (26-28), strength of various muscle groups (26,27,29,30), lower limb muscle power and running velocity, back and hamstring flexibility, and to reduce body adiposity (26,30).

The decrease in body fat % takes a great deal of oxygen by converting stored body fat into energy, hence promotes increase in performance (31). In this study BMI increased in control and Zinc-SUP groups (may be caused by appetite and taste increasing effects of zinc) (5,6) in eight-week time despite decreasing in Q10-SUP and Q10-Zn-SUP groups. However, the difference was not significant in Q10-Zn-SUP group. Our study groups were aged between 12-14, which contributes to the puberty age with a rapid increase in height and weight. We believe that the change in BMI seen in control group reflects the rapid changes that can occur during puberty. For that reason to evaluate the changes in BMI in pubescent subjects is a potential confounding factor for this study.

The effect of suplementations on muscle injury
The relation between muscle tiredness and zinc is a topic that also merits attention. Zinc plays a role in building and repairing of muscle as well as energy production. Some zinc-containing enzymes, such as carbonic anhydrase and LDH, are involved in intermediary metabolism during exercise and superoxide dismutase, protects against free radical damage (3,4). Exercise is a stressor that can decrease zinc levels, and thus athletes are at risk for being deficient (32). Boxers doing strenuous exercise are much more sensitive to conditions that would not affect sedentary people, due to the increased demand on their circulatory system. The boxers in this study all had serum zinc levels in normal range at baseline. After eight-week exercise and supplementation period while a decrease in serum zinc concentration was seen in control and CoQ10-SUP groups, there was increase in Zn-SUP and CoQ10-Zn-SUP groups. The lack of muscle injury indicators in Zn-SUP group suggests the protective effect of zinc on muscle function and tiredness. Because zinc is necessary for the activity of some
enzymes in energy metabolism and because exercise decreases muscle zinc levels, muscle injury and tiredness may be decreased by zinc intake.

The existing data about the effect of CoQ10 supplementation on exercise induced muscle damage and oxidative stress are sparse and inconsistent (33). In an in vitro system, tissue slices from animals fed CoQ10 were more resistant to tertbutyl hydroperoxide-induced lipid peroxidation than were those from control animals fed normal diets (34). In addition, Okamoto et al. have showed that CoQ10 protected cultured skeletal muscle. Furthermore, exogenous administration of CoQ10 suppressed hepatic oxidative damage after reperfusion following ischemia (35). Supplementation with CoQ10 decreased initial release of CK and LDH in rats running downhill (36), but had no effect on CK release in human subjects exercised to exhaustion on a cycle ergometer (37). Kon et al. investigated the effect of CoQ10 supplementation on exercise-induced muscular injury of rats and found that exhaustive exercise significantly decreased total CoQ10 concentration in plasma (10). They also showed that 300 mg of CoQ10 may be protective of muscle injury during extended training sessions in Kendo practitioners who trained 5½ hours per day (38). Exhaustive exercise increases energy demand and oxidative stress in tissues, and induces tissue damage. Therefore, CoQ10 in plasma may be distributed to various tissues during exhaustive exercise and there may be a lack of muscle CoQ10 concentration. From these findings, it can be proposed that CoQ10 supplementation has the potential to reduce strenuous exercise-induced tissue injury and oxidative stress. CoQ10 has a structural stabilizing effect on cell membrane phospholipids (39,40). Indeed in its reduced form it acts as an antioxidant (41,42). Therefore, it is quite likely that CoQ10 supplementation increases CoQ10 concentration in muscle cell membranes and reduces strenuous exercise-induced muscular injury by enhancing cell membrane stabilization. And also it might be expected to exert a protective effect against oxidative damage to membranes.

Many researchers have indicated that exercise increases plasma CK and CK-MB activities, which are the most commonly used marker of skeletal muscle damage induced by exercise (43,44). Even though both CoQ10 and Zinc usage in strenuous exercise are studied and suggested to increase performance and decrease muscle damage and fatigue, their supplementation together has not yet been studied in human in our knowledge. In order, both seem to reduce muscular damage and improve performance cause of their antioxidant and membrane stabilizing properties. In the present research, plasma CK and CK-MB activities were higher after exhausting exercise according to resting in all groups, however the increase in CK and CK-MB activities were highest and statistically different in control and CoQ10-Zn-SUP groups (Table 3). This result indicated that muscle damage was induced by exhaustive exercise. However, there was no difference between post-exercise and resting serum CK, CK-MB activities in Zn-SUP and CoQ10-SUP groups. Besides, the increase in ALP was highest in control according to supplemented groups in this study. ALP is found in many tissues and its levels can become elevated 7-14 days after tissue damage or infarction due to ALP produced by fibroblasts and endothelial cells proliferating in new granulation tissue (45). Thus, both lonely zinc and CoQ10 supplementation provided protection against strenuous exercise-induced muscular injury in this study.

We suggest that in Q10-Zn-SUP group despite an increase in both aerobic and anaerobic power, higher CK and CK-MB activities after exercise may be came out from the interaction between CoQ10 and zinc in respect to their physical properties. Zinc absorption is poor and it easily complexes to amino acids, peptides, proteins and nucleotides. Small molecular weight ligands such as amino acids, improve absorption, whereas large molecular weight ligands such as phytic acid reduce absorption, thus decrease its bioavailability (46,47). CoQ10 is a high molecular weight and lipophilic substance which makes it poorly water soluble and consequently leads to low systemic availability (48-50). Therefore, CoQ10 and zinc may form complexes and decrease bioavailability of each other. The higher serum zinc concentration in Q10-Zn-SUP group, even though the given doses of zinc were the same to Zn-SUP and Q10-Zn-SUP groups, supports this hypothesis; which can show poor distribution of zinc into tissues (Fig 1). Further researches are needed about bioavailability of CoQ10 and zinc supplementation together.

In conclusion, we investigated the effect of CoQ10 and/or Zinc supplementation on physical performance and exhaustive exercise-induced injury in young amateur boxers.

The study revealed that both zinc and CoQ10 supplementation increased performance parameters and reduced
The study revealed that both zinc and CoQ10 supplementation increased performance parameters and reduced exhaustive exercise-induced muscular injury at this age. On the other hand, CoQ10 and zinc supplementation together was not able to reduce muscular injury as revealed by higher levels of CK and CK-MB. This may be resulted from the high molecular weight of CoQ10, which is predisposed to make complex with zinc that leads to decreased bioavailability for each one. As a result, supplementation with either zinc or CoQ10 reduces exhaustive exercise-induced muscular injury and improves performance, but they should not be used together as they decrease bioavailability of each other.

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REFERENCES


45. Ravel R. Clinical Laboratory Medicine: Clinical Application of Laboratory Data. ed 4; pp 564-5


