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Effects of Intense Interval Exercise Activity on Muscle Injury Symptoms in Soccer Players

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Abstract

Introduction: Football match is an interval sport, with intense explosive attempts. The purpose of this study was to investigate the effects of a bout of high- intensity interval exercise on muscle injury markers in male soccer players.

Methods: Nineteen male soccer players with mean age: years; BMI: 21.80±2.44 $kg.m^{-2}$ and VO_{2max} 62.16±4.89 $ml.kg^{-1}.min^{-1}$ were selected purposefully and divided randomly into experimental and control groups. Copenhagen football test was taken from experimental group and control group had no activity at that time. 24 hours before and after the test, blood samples were drawn from all subjects to assay creatine kinase (CK) and lactate dehydrogenase (LDH) levels. Data were analyzed using independent sample and paired sample t-tests ($p \leq 0.05$).

Results: The results showed that serum CK ($p=0.001$) and LDH ($p=0.021$) levels increased significantly after the Copenhagen football protocol.

Conclusion: intense interval sports activities, such as what happens in a football match, result in muscle damage in the players. Therefore, such exercises can be used for football players adaptation for the tournament and reduce the recovery time after that. Observing the increased markers of muscular damage due to Copenhagen soccer protocol, indicates that intensive interval exercise like whatever occurs in a soccer match, may lead to muscular damages in players.

Keywords: Exercise, Creatine Kinase, Lactate Dehydrogenase, Soccer

Introduction

The distance striding by a professional football player has been estimated about 10 to 12 kilometers. Several studies have reported that the distance run in this sport is at the highest level among other sports. Due to the duration of the football game, a large part of energy will be produced by aerobic system and the average intensity is close to the anaerobic threshold (2). In fact, during a football match, every 90 seconds a maximum activity takes place, which takes 2-4 seconds. Therefore, football match is an interval sport, with intense explosive attempts (3). At professional levels, exercise will not necessarily be beneficial for human health, as it causes dehydration, fuel depletion, muscle damage, inflammation, and increased free radicals (4). Qaradaghi *et al.* (2013), studied 20 professional football players. They showed significant changes in muscle injury indices after an intense exercise session (5). Due to muscle damage, intracellular proteins enter the bloodstream and in the long run reduce power production, flexibility and muscle speed dynamics (6). It has been shown in a study that sarcomer damage leads to an increase in creatine kinase (CK) in the blood, and this amount remains high until 25 hours after exercise. CK acts as a cell buffer for adenosine triphosphate (ATP) and adenosine diphosphate (ADP) (7). Hard training that causes damage to the muscle cells, will destroy the sarcomer and Z lines and release the CK in the blood, although after the end of the competition or practice, the CK level will return to the rest rate, exercise and

insufficient recovery times lead to further damages (8). Barbosa studied 60 professional soccer players in a research and found out that plasma CK levels will arise at 12 to 20 hours after the play subsequent of training program and will return to base point after 60-65 hours (9). It has also been reported that there is a direct relationship between the amount of cell damage and intense exercise (10); In addition, the levels of CK and LDH determine inflammation, and muscle and cartilage damages (11). Training can significantly increase the amount of this enzyme, and the extent of this increase depends on intensity of exercise (13). CK and LDH are key enzymes in metabolism, and in exercises, their activity increases to produce anaerobic energy. On the other hand, their accumulation in the blood after muscular damage was seen and could be a sign of regional cell death in muscle fibers (12). Therefore, measuring these enzymes in the blood can be a good way to detect muscle damage (14). In recent researches, the principles of specificity and conformity of the training activities to the main competition has been considered and emphasized on the simulation of exercise activity in various sports fields, until the results of the researches are more reliable and can be generalized to the relevant variables at the real match (except psychological variables that are not so manageable), so the present study used the Copenhagen football protocol, which is based on aspects of intensity, duration, and distance run like a real football match. Bendiksen *et al.* (2012) showed that there was no significant difference between the Copenhagen football protocol and a simulated soccer game, due to some physiological responses such as mean heart rate and plasma CK recovery time (15). In previous studies, most of the indicators of cardiac muscle damage and inflammation have been investigated after strength and endurance exercises, while there is not enough information about interval exercises that looks like a real match of football (16). On the other hand, football matches have a lot of spectators in different countries, if the factors which reduce the performance of football players are controlled by scientific research to some extent, various injuries in this sport will be reduced and rapturous races can be seen in this exciting sport, because muscle aches, cramps and suppress are often the factors limiting the performance of soccer players. Finally, these results lead us to examine the effects of an intermittent intensive exercise on CK and LDH levels in male soccer players.

Methods

This article is a practical and semi-experimental research. The statistical population was composed of male football players participating in the first class league of the country. The statistical sample included 19 male soccer players, who were purposefully selected and randomly assigned to experimental and control groups. Entry criteria included two years of experience in football and practice at least three days a week. Also, criteria to exit from research were determined as follows: drug and supplementary usage, smoking, physical inactivity, history of blood diseases or diseases affecting immunity system, and infection and allergic conditions. In order to collect individual characteristic information about the subjects, data sheets and cooperation satisfaction in the research, were provided for the players. Then in order to carry out initial measurements and implement the Copenhagen football protocol, the participants were acquainted with the implementation of the test. The BMI of the subjects was calculated by dividing the weight (kg) into squared height (m^2). Also, the maximum oxygen consumption was evaluated by using Bruce test. The Copenhagen Football Protocol includes two 45-minute activities with a 15-minute break between them. The protocol is divided into 18 periods of 5 minutes to identify individual differences in the intensity of the training. The various parts of the protocol include low, moderate, and severe sections. The recent version of the protocol

includes 5-minute bouts, including 152 meters of walking at speeds of around 6 km / h, 171 m jogging, at speeds of around 8 km / h, 69 m running at speeds of about 12 km /h, 41 m running average speed of 15 km / h, 55 m sprinting with speed of 18 km / h, 40 m sprinting at speeds over 25 km / h, 30 m running backwards at speeds of about 10 km/h and 23 meters running in the rear and side directions at a speed of about 8 kilometers per hour. Sprinting (40 m) was carried out in 20 m shuttle run (15). During the test, players were allowed to drink about a liter of water (17). The test was conducted under the supervision of an experienced football coach. Also, the macronutrient energy content of the subjects was considered based on the dietary recommendations of active adult males (energy: 3250 ± 312 kcal / day, carbohydrates: 6.3 ± 0.7 g / kg body weight per day, Protein: 1.7 ± 0.2 g / kg body weight per day and fat: 1.4 ± 0.3 g / kg body weight per day (18) and two days before the test was performed. The players attended the venue on that day the protocol was executed (after 10 hours of fasting overnight). Blood samples were taken before and 24 hours after the end of the protocol from both groups (10). A standard breakfast had been given to supply their energy (19). Before running the Copenhagen football protocol, the participants completed a 24-hour recall form of energy and macronutrient assessment, which was examined by the Nut Win (Nut Win 2003, Universidad de Sao Paulo, and Brazil) software program. The heart rate was recorded by the polar monitor. Blood samples were placed at 22-25 ° C for 15 minutes at ambient temperature to clot. Subsequently, the blood serum was separated by centrifuging samples at 3500 rpm for 10 minutes. For the next stages, samples were placed at - 70 ° C. Serum muscle damage enzyme activity was measured by Pars Azmoon company kit using a photometric method with Autoanalyzer of Alisun 300, manufactured by Abbott Company. Kolmogorov-Smirnov test was used to ensure that the distribution of data was normal. Independent and paired t-tests were used to assay the between-group and inter-group variations ($p < 0.05$). SPSS software version 22 was used to analyze the data.

Results

Table 1 shows the anthropometric characteristics of the players participating in the research. According to Table 1, it is found that there was no significant difference between the groups in terms of age, height, weight, maximum oxygen consumption and heart rate variables. Then correlation t-test, showed that after performing an exhaustive exercise (Copenhagen football protocol), the levels of CK ($t= -9.48$; $p= 0.01$) and LDH ($t= -10.55$; $p= 0.001$) significantly increased. According to Figures 1 and 2, the difference can be observed in the amount of CK and LDH before and after the test. As shown in Fig. 1, the CK level increased significantly after the test in the experimental group. The amount of LDH after the Copenhagen test increased in the experimental group and reached from 246.86 to 291.83 International unit per liter.

Table 1. Statistical of subject's characteristics description

Variable	Age (year)	Height (cm)	Weight (kg)	Vo_{2max} (ml/kg/min)	HR (b/min)
Mean±SD	21.68±4.16	180.62±6	75.48±7.21	62.16±4.89	165.68±3

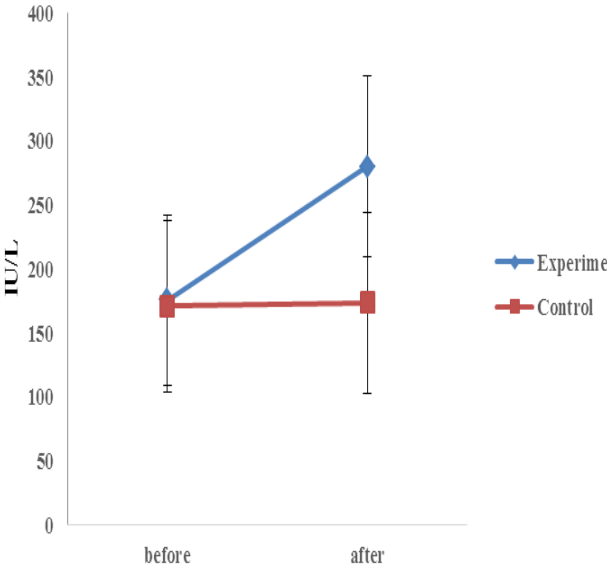

Figure 1. CK in experimental and control groups

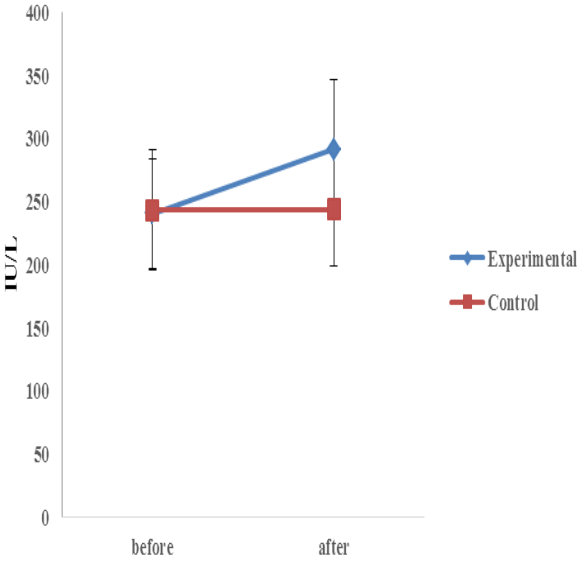

Figure 2. LDH in experimental and control groups

Discussion

In the present study, the results show that an intensive exercise increases the serum levels of CK ($p = 0.01$) and LDH ($p = 0.001$), and it can be stated that after the Copenhagen football protocol, which is a simulation of a football match, the levels of muscle damage biomarkers in athletes are increased. These findings are in line with the results of Paddon *et al.* (2000) (20) and Hadidi *et al.* (2014) (10). Bhagat and his colleagues who studied the effects of a high intensity interval training (HIIT) on the oxidative stress of soccer players showed that HIIT exercises increase oxidative stress, and this kind of training can increase the levels of LDH and CK in subjects slightly (21). The release of these enzymes is directly related to the intensity and duration of exercise. In fact, intense exercises increase the formation of free radicals, and free radicals accumulation, increase the negative effects in the organism and oxidative stress (22). Peroxidation of fats is the most obvious consequence of oxidative stress. Lipid peroxidation results in damage to the cell membrane, which can lead to release of intracellular substance into the bloodstream. One of these compounds is CK, which indicates muscle damage and oxidative stress (23). On the other hand, intense exercises are associated with muscle structure damage; these kinds of training can damage the surface of the sarcoma and the Z lines and release the CK into the blood stream (8). Using appropriate ways of training and recovery methods afterwards, according to the level of fitness of athletes, reduces biochemical changes. It has been shown that 5 to 8 weeks of interval-speedy training leads to increase blood flow and its conductivity in the vessels, increase lactate and H^+ transfer capacity from active muscle, ion regulation, and the operation of the sarcoplasmic reticulum. Although the duration of these adaptations is unknown (6). On the other hand, the research showed that performing intense and prolonged exercises, regardless of the proper recovery time, damaged the muscular fibers during contraction, muscle and connective tissue disruption, and were associated with an inflammatory response, macrophage diffusion, release of CK, LDH, and aspartate

aminotransferase (AST) enzymes. Therefore, pain symptoms, motor limitation, biochemical changes and muscle spasm will appear (24), also it is possible that muscle damage is due to the irreversible stretching of sarcoma, which it is reasonable with respect to the consecutive increase in speed and sudden movements in football play (20). Although, increasing CK, especially during exercise and recovery, reflects the diffusion of proteins from muscle membranes, in addition, factors such as age, gender, body fitness, seasons and type of exercise are associated with an increase in fluctuation of these enzymes (25). In return Megalhaeps *et al.* compared the levels of similar biochemical indices after a friendly game and LIST test and showed that there was no significant difference in the levels of CK. This can be a sign of the difference in the variables in the main game and the LIST test (26). However, further research is required in this area. A study showed that a 12-week 8-minute cycling training did not have a significant effect on LDH and CK enzymes. This may be because the response to one session exercise varies by a training course. However, one session of an exhausting exercise has led to the release of these enzymes into the serum (27). Studies have shown that the risk of continuous oxidative stress in the tournament season can determine the boundary between health and disease in professional football players (28). With these interpretations, it can be concluded that the increase in LDH and CK levels is likely to cause muscle damage in athletes and training program must run based on the intensity and duration of the activity and even the history of athletes. On the other hand, knowing of these threats can help football players to stay in competition field more efficiently.

Ethical issues

This study was approved and supported by the Sport Medicine Research Center, Najafabad Branch of Islamic Azad University.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

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