

Original Research

The effects of BCAA and creatine supplementation on anaerobic capacity and ball kicking speed in male football players

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Abstract

Background and objective: The use of nutritional supplements has increased in recent years. This study analyzes the effects of Branched-Chain Amino Acids (BCAA) and creatine (CR) supplementation on anaerobic capacity and ball kicking speed in football players. **Material and methods:** 24 volunteer-active male amateur football players between 18–26 were recruited for this study. Football players were randomly divided into three groups as BCAA (n = 8), CR (n = 8), and placebo (PLA) (n = 8). Experimental groups were given 5 g BCAA and 2 g creatine before and after exercise, whereas the placebo group ingested bran, performance tests and measurements were performed, and results were assessed. **Results:** BCAA group average power (pre: 530.70 ± 53.73 W vs. post: 567.65 ± 66.68 W; $p = 0.028$), CR group minimum power (pre: 413.75 ± 51.13 W vs. post: 462.82 ± 71.93 W; $p = 0.043$) increased, while there were decreases in peak power (pre: 659.34 ± 121.03 W vs. post: 613.20 ± 124.24 W; $p = 0.043$) and fatigue index (pre: 6.55 ± 2.12 W/s vs. post: 4.34 ± 2.37 W/s; $p = 0.043$) parameters of PLA group ($p < 0.05$). There were statistically significant differences in the BCAA group in rest, pre-and post-supplementation; CR group in pre-and post-supplementation; PLA group in rest, pre-and post-supplementation ($p < 0.05$). **Conclusions:** BCAA and creatine consumption do not affect recovery rates in football players regarding obtained data. But, regarding other findings of this study, BCAA and creatine supplementation improves anaerobic capacity, provides strength endurance against fatigue, and prevents the decrement of ball-kicking speed in exhaustion.

Keywords: BCAA; Creatine; Anaerobic capacity; Muscle strength endurance; Ball kicking speed; Recovery

1. Introduction

Football is characterized by its prevalence and popularity in many countries worldwide [1]. Some specific characteristics of sports can determine the importance of a football player. These are particular characteristics, including aerobic endurance, anaerobic endurance, power, and flexibility [2]. During a football match, more than 90% of the performance is supplied by aerobic metabolism, and the estimated anaerobic threshold of a player is 10 km running effort on average. Although the basic physiological, metabolic functions in a football game are supplied by aerobic metabolism, high-level skills such as jumping, kicking, and tackling are anaerobic [3]. Nutrition is necessarily an inseparable part of athletes' training programs. Despite strenuous exercises and training programs that are believed to increase athletes' nutrition requirements dramatically, consuming the proper foods with a balanced diet can meet the nutrition requirements in general. However, not all athletes can fulfill the increasing nutritional needs via natural diets due to some compelling reasons. Therefore, many athletes use natural supplements to overcome the inadequate diet and increase performance [4]. BCAA and creatine are predominant nutritional supplements utilized by football players because of their efficacy in developing

ideal body composition and their proven positive effects on sportive performance [5].

BCAA (leucine, isoleucine, valine) is an essential amino acid for human protein synthesis [6,7]. BCAA is abundantly found in skeletal muscle, and it is also oxidized in skeletal muscle while other amino acids are primarily catabolized in the liver. It contributes to the prevention of protein catabolism and enhances protein synthesis. Several previous studies have suggested that BCAA attenuates muscle soreness and damage, and it also plays a crucial role in recovery. BCAA helps preserve muscle mass in case of protein loss and catabolism, and it also reduces muscle damage and expedites the recovery process after strenuous endurance training. Moreover, BCAA improves the ideal body composition and maintains body performance and function [6,8–10].

Creatine (CR) is one of the nutritional supports providing high benefits, and it has been recently used to enhance athletes' performance [11]. Creatine is a prevalent supplement in sports industry and it is a nutritional support used by athletes to retain energy and gain strength during strenuous exercises. Creatine provides certain benefits for athletes, especially in short and high-intensity training [12,13]. Creatine is a guanidine-based substance that is naturally



produced in the human body. It is typically not an amino acid, but it consists of arginine, glycine, methionine, and it is synthesized from the reaction, including all these three amino acids [14]. Athletes commonly utilize high-intensity exercises and training that require anaerobic performance [15,16].

The regular maintenance of the football players' physical and physiological status depends on the meticulous evaluation of their performance output. High-intensity interval anaerobic and aerobic activities increase blood lactate concentration, which is the main reason for fatigue during a football match. In a study conducted with English Premier League football players, it was discovered that athletes averagely had 19 sprints in a single game which occurred every 4–5 minutes, alteration in the movement happened in every 3.5 seconds, a bout of high-intensity movement was interspaced in every 60 seconds, and thus maximal effort was performed in every 4 minutes as a result [17]. Our study analyzes the BCAA and creatine supplementation effects on anaerobic capacity and ball kicking speed in football players. Football is a high-performance sport, and the players' physiological requirements have to be met for the peak performance. However, not all football players can fulfill physiological and nutritional needs via natural foods, so a supplementation is an option. Therefore, we hypothesized that BCAA and creatine supplementation would enhance anaerobic capacity and prevent decrement in ball kicking speed in exhaustion.

2. Methods

2.1 Research group

A priori test with Gpower 3.1 was used to determine the number of subjects. The power analysis test was conducted following a pilot application which indicated that eight subjects were sufficient per group (Effect Size: 0.87, Actual Power: 0.96). Twenty-four volunteer-active male amateur football players between the ages of 18–26 were recruited for this study (Table 1). Football players were randomly divided into three groups as BCAA ($n = 8$), CR ($n = 8$), and PLA ($n = 8$). Analyses were made using the pre-posttest method in physically identical conditions seven days apart without changing the subjects' daily routines and training programs. Different types of training programs may have induced different effects on players, so all football players followed the identical training program through intervention week to ensure the test's reliability. Inclusion criteria for this study are; being healthy, not having chronic and acute diseases, not having a limitation of movement related to any reason, and signing an informed consent form before testing. For this study, by Sinop University's Human Research Ethics Committee, it was decided that there was no ethical inconvenience, and it was found appropriate (Number: 57452775-050.99-E).

Table 1. Descriptive statistics for participants.

Variable	Group		
	BCAA	CR	PLA
	Mean \pm SD		
Age (year)	21.11 \pm 2.61	20.85 \pm 2.79	19.52 \pm 0.67
Height (cm)	178.00 \pm 4.69	180.00 \pm 5.83	182.00 \pm 11.26
Weight (kg)	73.38 \pm 5.92	70.52 \pm 5.89	73.26 \pm 9.58
BMI (kg/m ²)	23.18 \pm 2.33	21.70 \pm 1.61	21.78 \pm 0.72

SD, standard deviation. Values are mean \pm SD.

2.2 BCAA and CR supplementation

Twenty-four trained football players were randomly divided into three groups as BCAA ($n = 8$), CR ($n = 8$), and PLA ($n = 8$). Experimental groups were given, with proper use and dosage, seven days long 5000 mg BCAA and 2000 mg creatine supplementation daily with researcher supervision (BCAA: 2500 mg 30–40 minutes before training and 2500 mg 1 hour after training. Creatine: 1000 mg 30–40 minutes before training and 1000 mg 1 hour after training). The placebo group was given bran in the same amount and form with the nutritional supplement. Players were instructed to follow their daily routines, training programs, and nutrition regimens, and thus it was aimed to determine the effects of supplementation on athletes with reliable methods. The study was carried out as single-blind. Players were not informed about what substances they ingested. Hence, possible psychological effects which could influence athletic performance were removed in the first place, and the study was conducted in more reliable conditions. Furthermore, the day before the test protocol, players were strictly warned about not drinking alcohol or taking medication and paying attention to their nutrition and rest.

2.3 Running anaerobic sprint test (RAST)

Running anaerobic sprint test (RAST) was used to measure the anaerobic capacity. Before the test, the athletes were weighed. Athletes were asked to warm up before the test to get mentally and physically ready and were given 15 minutes to do so. During the RAST test, each athlete made six consecutive 35-meter sprints by giving 10-second breaks after each sprint. After an athlete started the test by making the first sprint and gave the first 10-second break, the timer device beeped, and the athlete made the second sprint. The test was completed after six consecutive sprints were made in the same way. For results and calculations, the assistant records the time taken for each 35-meter sprint to the nearest hundredth of a second and makes appropriate calculations. Power output for each sprint is found using the following equations:

Velocity = Distance \div Time. Acceleration = Velocity \div Time. Force = Weight \times Acceleration. Power = Force \times Velocity or Power = Weight \times Distance $2 \div$ Time ³ [18].

2.4 Ball speed measurement

In the present study, players' ball kicking speed was determined with Stalker Solo 2 Radar Gun device, 20 meters away from the goal. Following the dominant leg choice, each player was asked to shoot following protocol from the prescribed spot. Thus, the use of the dominant leg was ensured in shootings. The device recording the ball speed was placed right across the shooting spot, nearby and behind the goal, to make sure measurement was made accurately. The shooting player was asked to hit the goal, and each player performed two times, the best score accepted as data. The device took the measurements accurately in a km/h unit.

2.5 Blood lactate test

For the lactate test, a lactate analyzer (Lactate Scout) was used. Blood samples were taken from the ear lobe to measure the lactic acid (LA) level. Each time blood was taken for measurements, needles and test strips were changed. By measuring resting LA levels and LA levels in the 1st, 5th, 10th minutes after the RAST test, subjects' LA levels during recovery were determined.

2.6 Heart rate (HR)

A polar watch (V-800) to measure HR was used. A transmitter was placed in the chest, and HR in the resting and 1st, 3rd, 6th, 9th minutes after the RAST test were determined.

2.7 Height, weight, and body mass index analyses

In the study, athletes' heights were measured through a Seca Height Measuring Device, and the body of the athletes was analyzed using the Inbody 120 Bioimpedance Body Composition Analyzer.

2.8 Experimental design

Using the pre-posttest method, without changing the subjects' daily routines and training programs, some tests and measurements were made in physically identical conditions with seven days apart from each other, and results were assessed. In this study, the heights and weights of players were initially measured. Each player performed the same test protocol two times (before and after seven days of supplementation). Before the performance tests (Running Anaerobic Sprint Test (RAST), Ball Kicking Speed Test), each player's ear lobe was scrubbed with alcohol and dried first, and then blood samples were taken to determine the resting lactate level and rest heart rate was measured right after. After that, each player individually performed the performance tests following the study protocol. During performance tests, each player was initially given 15 minutes of the personal warm-up session, and following the warm-up, players performed consecutively; rested ball kicking speed test, RAST, and repeated ball kicking speed test one more time. Hence, ball kicking speed with peak power,

kicking the ball, and shot on the athletes' target without rest were determined immediately after high-intensity training test protocol.

As soon as the performance test ended, the blood samples were taken at 1st, 5th, and 10th minutes from the ear lobe with identical protocol to assess the recovery speed of the athlete, and heart rate was detected at 1st, 3rd, 6th, and 9th minutes with the help of a transmitter strap on athlete's chest that was sending the heart rate values to the device attached in the arm. The day after the pre-test, players were randomly divided into groups to ingest supplements or placebo, and supplementation was made single-blinded. Football players were given 5 g BCAA and 2 g creatine before and after exercise, whereas the placebo group ingested bran in the same amount and form with the nutritional supplements. Athletes were instructed to follow their nutrition regimens, daily routines, and training programs without changing, and they ingested nutritional supplements or placebo with proper use and dosage for seven days under the researchers' supervision. Data obtained from pre-test and post-test were compared both within-group and between-group, and the effects of nutritional supplement loading were analyzed.

2.9 Statistical analyses

To control if the error terms showed normal distribution, data were checked using the Shapiro-Wilk Normality test, and our data were not normal distribution ($p < 0.05$). Wilcoxon *t*-test was carried out to evaluate pre-post statistical differences of each parameter within time. Kruskal-Wallis test was used to assess the significant differences between groups. The research data obtained were given as the mean and standard deviation (Mean \pm SD), statistical significance was accepted as $p < 0.05$. The statistical analyses were performed using SPSS 22.0 V. statistical package.

3. Results

Regarding anaerobic capacity, BCAA group average power (pre: 530.70 ± 53.73 W vs. post: 567.65 ± 66.68 W; $p = 0.028$), CR group minimum power (pre: 413.75 ± 51.13 W vs. post: 462.82 ± 71.93 W; $p = 0.043$) increased, while there were decreases in peak power (pre: 659.34 ± 121.03 W vs. post: 613.20 ± 124.24 W; $p = 0.043$) and fatigue index (pre: 6.55 ± 2.12 W/s vs. post: 4.34 ± 2.37 W/s; $p = 0.043$) parameters of PLA group ($p < 0.05$). Considering other within-group variables and between-group comparisons of anaerobic capacity, no statistically significant difference was found ($p > 0.05$) (Table 2).

Regarding ball kicking speed parameters, there were statistically significant differences ($p < 0.05$) in BCAA group in rest (pre: 106.40 ± 6.24 km/h vs. post: 104.22 ± 7.21 km/h; $p = 0.046$), pre-supplementation (rest: 106.40 ± 6.24 km/h vs. exhausted: 97.25 ± 8.65 km/h; $p = 0.028$), post-supplementation (rest: 104.22 ± 7.21 km/h vs. exhausted: 98.86 ± 8.55 km/h; $p = 0.028$); CR group pre-

Table 2. Changes in mean values of BCAA, CR, and PLA groups.

Variable		Group		
		BCAA	CR	PLA
Anaerobic capacity	Period	Mean \pm SD		
Maximum power (W)	Pre	654.88 \pm 71.65	678.54 \pm 80.51	659.34 \pm 121.03
	Post	685.36 \pm 86.43	677.82 \pm 57.88	613.20 \pm 124.24*
Minimum power (W)	Pre	409.20 \pm 28.38	413.75 \pm 51.13	442.06 \pm 60.93
	Post	447.71 \pm 38.51	462.82 \pm 71.93*	469.06 \pm 79.31
Average power (W)	Pre	530.70 \pm 53.73	544.85 \pm 48.93	538.30 \pm 84.96
	Post	567.65 \pm 66.68*	567.75 \pm 55.87	533.12 \pm 91.60
Fatigue index (W/s)	Pre	7.34 \pm 2.06	8.12 \pm 2.78	6.55 \pm 2.12
	Post	7.30 \pm 1.83	6.65 \pm 1.40	4.34 \pm 2.37*
Ball speed (km/h)	Period	Mean \pm SD		
Rest	Pre	106.40 \pm 6.24	102.55 \pm 6.11	102.22 \pm 4.60
	Post	104.22 \pm 7.21*	97.22 \pm 7.45	98.19 \pm 3.19*
Exhausted	Pre	97.25 \pm 8.65	89.81 \pm 7.40	89.60 \pm 3.33
	Post	98.86 \pm 8.55	93.52 \pm 6.47	88.60 \pm 4.07
Pre-supplementation	Rest	106.40 \pm 6.24	102.55 \pm 6.11	102.22 \pm 4.60
	Exhausted	97.25 \pm 8.65 [†]	89.81 \pm 7.40 [†]	89.60 \pm 3.33 [†]
Post-supplementation	Rest	104.22 \pm 7.21	97.22 \pm 7.45	98.19 \pm 3.19
	Exhausted	98.86 \pm 8.55 [†]	93.52 \pm 6.47 [†]	88.60 \pm 4.07 [†]

SD, standard deviation; BCAA, branched-chain amino acids group; CR, creatine group; PLA, placebo group; Pre, pre-supplementation period; Post, post-supplementation period. Values are mean \pm SD. *Significant ($p < 0.05$) difference compared with pre- and post-supplementation values. [†]Significant ($p < 0.05$) difference compared with rest and exhausted values.

supplementation (rest: 102.55 \pm 6.11 km/h vs. exhausted: 89.81 \pm 7.40 km/h; $p = 0.018$), post-supplementation (rest: 97.22 \pm 7.45 km/h vs. exhausted: 93.52 \pm 6.47 km/h; $p = 0.028$); PLA group in rest (pre: 102.22 \pm 4.60 km/h vs. post: 98.19 \pm 3.19 km/h; $p = 0.043$), pre-supplementation (rest: 102.22 \pm 4.60 km/h vs. exhausted: 89.60 \pm 3.33 km/h; $p = 0.043$), post-supplementation (rest: 98.19 \pm 3.19 km/h vs. exhausted: 88.60 \pm 4.07 km/h; $p = 0.042$). Considering other within-group variables and between-group comparisons of ball kicking speed, no statistically significant difference was found ($p > 0.05$) (Table 2).

When compared resting heart rates of within-group recovery rates, statistically significant decreases ($p < 0.05$) were observed in BCAA (pre: 62.66 \pm 6.28 bpm vs. post: 55.33 \pm 2.65 bpm; $p = 0.027$) and CR (pre: 67.00 \pm 4.04 bpm vs. post: 60.14 \pm 6.38 bpm; $p = 0.028$) groups. There was no significant difference in the PLA group ($p > 0.05$). Considering other within-group variables and between-group comparisons of recovery rates, no statistically significant difference was found ($p > 0.05$) (Figs. 1,2).

4. Discussion

This current study aimed to investigate the effects of BCAA and creatine supplementation on anaerobic capacity and ball kicking speed in football players. Results showed

that BCAA and creatine supplementation might positively affect anaerobic performance and ball kicking speed in exhaustion. Consumption of nutritional supplements combined with a regular diet is widely recognized to affect athletes' health and sportive performance positively. Athletes use a wide range of nutritional supplements to improve their exercise performance and stay healthy [19]. BCAA and creatine are the prevalent nutritional supplements utilized by football players due to their positive effects on general health status and sportive performance. After reviewing the scientific literature, numerous studies appeared to be conducted previously about BCAA and creatine supplementation in athletes, single or combined with other nutritional supplements. Considering these studies performed by various supplementation methods, it is evident that BCAA and creatine consumptions were directly associated with health and sportive performance indicators such as body composition [7,20], muscle strength and damage [9,14], DOMS [10], high-intensity sprint performance [11], anaerobic performance and capacity [15,16] and endurance performance [6,9,15].

In our study, significance was only observed in BCAA and CR groups regarding the recovery rate data in terms of resting heart rate. Similar results were observed in all three groups. BCAA and creatine can be said to have no positive

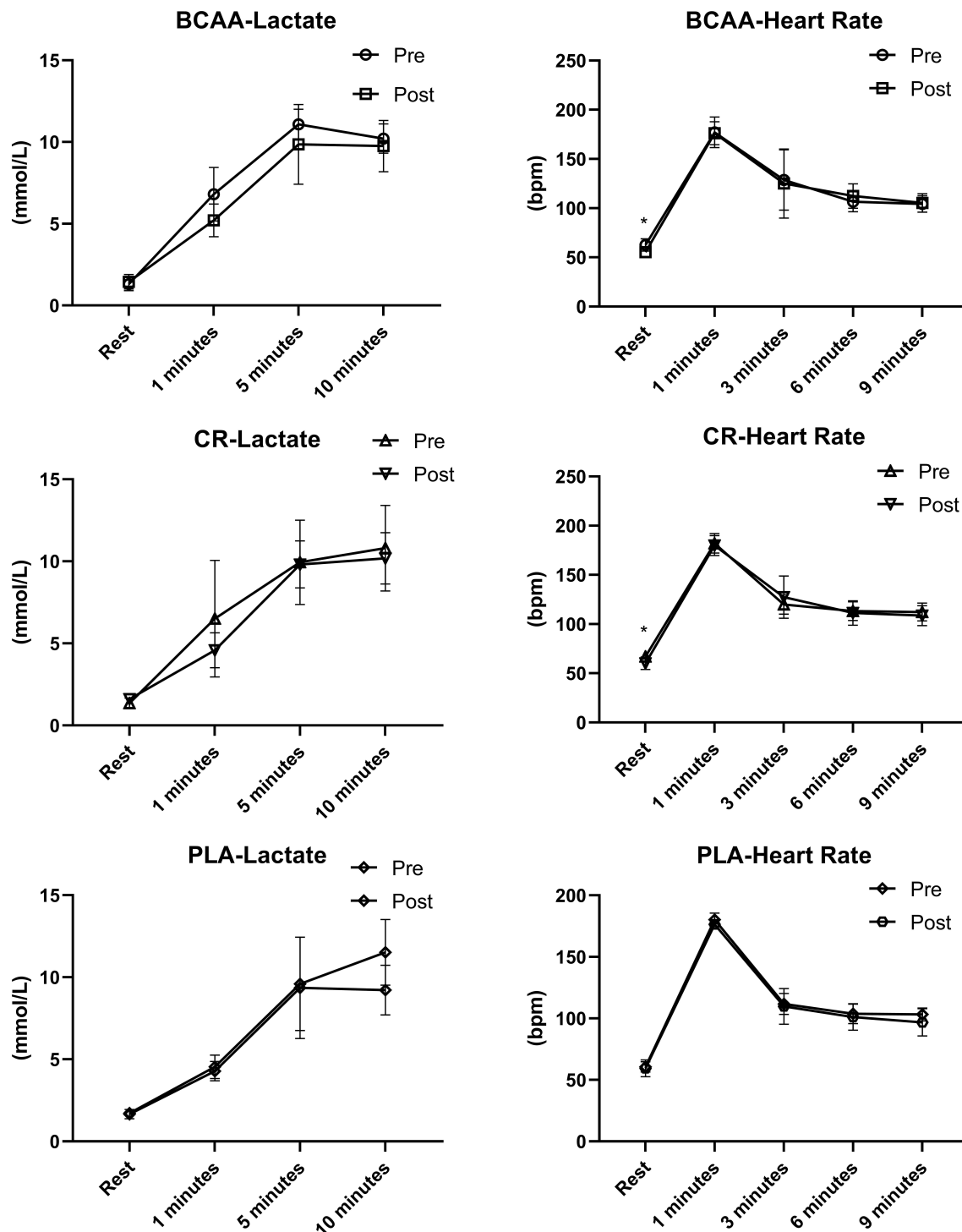


Fig. 1. The heart rate and lactate levels at different time points in rest and after exercise during recovery periods. BCAA, branched-chain amino acids group; CR, creatine group; PLA, placebo group; Pre, pre-supplementation period; Post, post-supplementation period. Values are mean \pm SD. *Significant ($p < 0.05$) difference compared with pre-and post-supplementation values.

effect on recovery rates considering study findings. No statistically significant difference was found in between-group recovery rates. Regarding the other data obtained, BCAA and CR anaerobic capacity and power increased in BCAA and CR groups after supplementation while decreasing the PLA group. In his study conducted with 16 elite male row-

ers, Chwalbińska-Moneta divided athletes into two groups as subject and placebo, and athletes ingested 20 g of daily creatine for five days with endurance training, without any change on their nutrition regimens. Results showed that creatine did not induce any significant alteration in heart rate, there was no significant difference in the two groups'

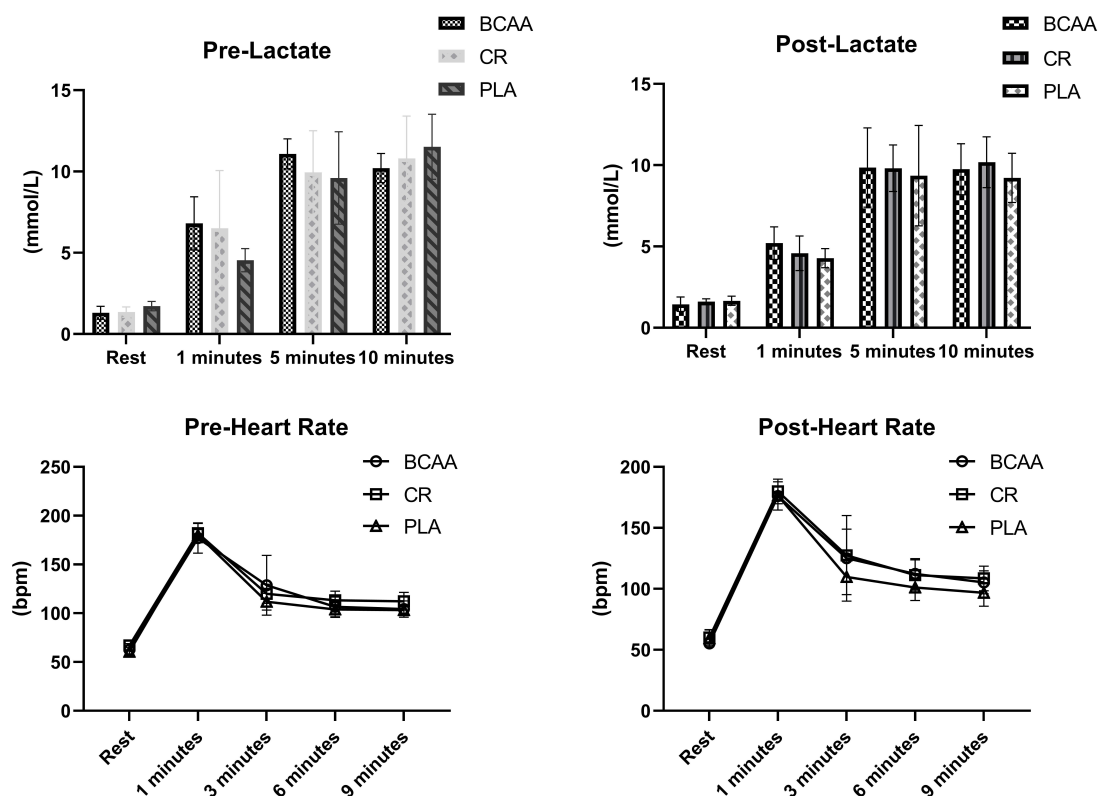


Fig. 2. The heart rate and lactate levels at different time points in rest and after exercise during recovery periods. BCAA, branched-chain amino acids group; CR, creatine group; PLA, placebo group; Pre, pre-supplementation period; Post, post-supplementation period. Values are mean \pm SD. *Significant ($p < 0.05$) difference in pre- and post-supplementation periods between BCAA, CR, and PLA groups.

blood lactic acid levels, but creatine improved endurance and anaerobic performance [21]. Similar to our results, there were no significant differences between lactic acid and heart rate variables, but the anaerobic performance was positively influenced. In another study, researchers made 30 days of phosphate salts (CPS) supplementation combined with 5 g of daily creatine loading to 32 male volunteers, and they found that this supplementation increased body weight but had no effect on the anaerobic capacity increase [16]. This study did not support our results concerning anaerobic capacity. In another study performed with trained university students, researchers suggested that creatine supplementation has a minor positive influence on regional muscle thickness during strength training [14]. In their study, Hoffmann *et al.* [22] discovered that creatine supplementation reduces the rate of fatigue, but there is no significant difference in anaerobic strength performance between subjects and the placebo group. When compared our results to Hoffman *et al.* [22], BCAA and creatine reduced fatigue similarly, while anaerobic capacity was also influenced positively. When other studies conducted by researchers about creatine consumption were analyzed, various results indicated that creatine increases the power, prevents decrement in lower-limb muscle strength of football players, and also has no positive effect on reducing the

skeletal muscle damage and improvement in recovery of athletes and does not influence anaerobic sprint capacity. However, it has positive effects on running capacity, and it provides no significant difference in an anaerobic working capacity. In contrast, it improves the anaerobic mean power [20,23–28]. In our study, creatine consumption positively impacted minimum power and average power while it did not affect recovery levels. Van Hall *et al.* [29], in their study, carried out with ten trained male athletes, split subjects into four groups as control, low dose of BCAA, high dose of BCAA, and tryptophan, and they implemented tryptophan and low-high dose of BCAA loading method. Based on their results, there were no differences in burnout point and heart rate of the athletes concerning four tests, and as a result, any negative or positive effects of BCAA and tryptophan supplementation on athletes were not observed during the prolonged cycle-ergometer exercises. Jang *et al.* [30] conducted three trials with trained wrestlers in their study; athletes were instructed to intake 1st glucose, 2nd glucose + arginine + BCAA, and 3rd water. The peak and mean power were found similar in all three trials. Furthermore, supplementation of carbohydrates with or without arginine and BCAA during the post-game period did not affect performance. Howatson *et al.* [9] conducted 12 trained male athletes in their study and concluded that con-

sumption of BCAA reduces muscle damage and enhances recovery. In contrast with these results, there were no positive effects of BCAA and creatine supplementation on recovery in our study. A significant increase was detected in the average power of the BCAA group and the minimum power of the CR group, whereas the placebo group had a significant decrease in maximum power. Similar results were found in another study, and it was reported that consumption of BCAA might reduce muscle damage and promote muscle protein synthesis [8]. In the study carried out by Shimomura *et al.* [31], it was suggested that BCAA consumption reduced muscle fatigue and muscle soreness, and thus it could be used for muscle recovery after exercise. De Palo *et al.* [32] included 11 male athletes in their research, and their results showed a statistically significant difference in the BCAA group's lactate levels, and thus consumption of BCAA may reduce the post-exercise lactate levels and provides an improvement in energy use. Kim *et al.* [33] performed with 30 male athletes in their study and discovered that consumption of BCAA has no positive influence on lactate levels during endurance exercises, but on the other hand, it may reduce muscle damage. BCAA appeared to have no positive effect on lactic acid in our study. In another study, ten weeks of BCAA supplementation on trained cyclists contributed to an increase in peak power, mean power, and sprint power together with improvements in overall performance [34]. In a similar vein, Jafari *et al.* [35] found that BCAA consumption with endurance training may enhance anaerobic power and post-exercise recovery in trained athletes. Moreover, in another study, researchers similarly identified that consumption of BCAA provides an increase in peak power, mean power, squat jump, and countermovement together with a decrease in muscle soreness [36]. Likewise, peak power and mean power increased in our study. Stoppani *et al.* [37] implemented a supplementation to 30 trained male athletes using BCAA. According to their results, supplementation with BCAA can increase lean muscle mass and muscle strength.

When examined ball kicking speed data, it is understood that better findings for BCAA and CR groups were observed in ball kicking speed at rest and exhaustion compared to the PLA group. Our results demonstrated that BCAA and creatine supplementation had positive influences on ball kicking speed and anaerobic capacity, and thus, the decrement in ball kicking speed was prevented in fatigue. Therefore, our hypothesis was confirmed. Evaluation of the studies related to our topic indicates that many different results existed in the literature. In a study, the subject group ingested creatine whereas the placebo group consumed sucrose drink, and consequently, researchers found that creatine increased muscle strength and upper arm muscle area [38]. A similar study was carried out with 25 healthy male athletes, and subjects were divided into three groups as control, placebo, and creatine to analyze the muscle strength. Creatine did not increase muscle strength as a

result [39]. In another study on swimmers, there was no increase in performance and muscle mass depending on creatine consumption [40]. Researchers split 17 male trained athletes into two groups as BCAA and carbohydrates and performed muscle strength analyses. In this study, researchers suggested that BCAA ingestion preserves lean mass and enhances skeletal muscle performance [6].

Additionally, some researchers discovered that BCAA supplementation increases endurance performance and enhances lipid oxidation during exercise [41,42]. In another study conducted with twenty young resistance-trained males, BCAA attenuates muscle soreness in the BCAA group compared to PLCB following eccentric exercise [43]. Some researchers concluded that creatine supplementation had no significant effect on athletes' anaerobic capacity, whereas others determined that creatine increased muscle power output in elite youth soccer players [44,45]. According to these results, BCAA and creatine supplementation might be said to have positive influences on anaerobic power, resistance against fatigue, strength endurance, and ball kicking speed. Thus, all these findings supported our hypothesis. To our knowledge, this study has a research protocol that was never used previously.

Moreover, ball-kicking speed measurement together with anaerobic capacity and recovery parameters in post BCAA and creatine consumption was performed for the first time. This study was conducted with limited resources, and it only provided insights into anaerobic capacity, recovery, and ball kicking speed. Another limitation of the present study can be said as the number of subjects was 24.

5. Conclusions

BCAA and creatine consumption do not induce any effect on recovery rates in football players regarding obtained data. But, regarding other findings of this study, BCAA and creatine supplementation improves anaerobic capacity, provides strength endurance against fatigue, and prevents the decrement of ball-kicking speed in exhaustion. Further studies are needed to examine the long-term effectiveness of BCAA and creatine supplementation on anaerobic capacity and ball kicking speed.

Author contributions

Conceptualization—AM; methodology—AM and EA; validation—AM, EA, KA and AKY; formal analysis—AM and KA; investigation—AM, EA, KA and AKY; resources—AM; data curation—AM; writing-original draft preparation—AM; writing-review and editing—AM, EA, KA and AKY; visualization—AM and AKY; project administration—AM; funding acquisition—AM. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by Sinop University's Human Research Ethics Committee (Number: 57452775-050.99-E). Informed consent was obtained from all subjects involved in the study.

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Conflict of interest

The authors declare no conflict of interest.

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