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The Impact of a Short-term Creatine Supplement Consumption on Speed Performance and Muscular Strength of Young Soccer Players

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Abstract

Introduction: The current study investigates the impact of Creatine monohydrate supplement as an ergogenic aid on speed and strength performances, as well as on the body composition of the soccer club players.

Material and Methods: 20 soccer club players were selected and then randomly categorized into two homogeneous groups, each consisting of 10 players. One group was considered as the placebo group (control group) and the other one as the consumer of Creatine supplement (empirical group). The performance of the participants was evaluated in a double blind study including sprinting (20-meter and 40-meter running courses, long-term running courses including 60-meter and 100-meter, and 30 frequent 5-second sprints with 10 seconds active rest between each two), and muscular strength in knee extension. The study lasted 7days (a seven-day daily consumption of 0.3 gram of dextrose for every kilogram of body weight in control group and the same amount of monohydrate Creatine by the empirical group.) The natural distribution of the variables was determined by Kolmogorov Smirnov test. Also, Pre-test and post-test results were analyzed using statistical paired T test (in each group) and independent T test (between two groups).

Results: In performance variables, as compared to equal basic state, there was a significant change in the Creatine supplement group, while no significant change was observed in the placebo group ($P \geq 0.05$). The observed changes occurred in the following variables: 20, 60, and 100 meter running courses (seconds) and 1RM knee extension ($P \leq 0.001$), 40-meter running course (seconds) ($P \leq 0.02$), and in the course the participants took in frequent speed performances ($P \leq 0.03$). However, the results of independent t test showed that there was no significant difference in the average distribution of these variables between Creatine and placebo groups.

Discussion and Conclusion: The results revealed that short term Creatine consumption improved the performance of young soccer players in short term sprints (20 and 40 meters), long term sprints (60 and 100), the test evaluating the endurance performance of football players in frequent sprints (30 five-second sprints with a 10-second rest between each two sprints), and muscular strength in knee extension ($P \leq 0.05$).

Key Words: Creatine supplement, Young soccer players, Speed performance, Strength performance

Introduction

There is no doubt that football is one of the most famous and most popular sports in the world. Strength, speed, power and resistance in speed are components of physical fitness which play an important role in the successful implementation of football techniques and tactics. Football includes repetitive and frequent speed activities. An athlete's resistance in repetitive implementation of these activities without being exhausted can be considered as one of the factors in his success [1,2]. A comparison between elite soccer players and those with less abilities revealed that non-aerobic fitness components such as speed, power, strength, and the capacity of lactic acid system can very well differentiate these two groups [3]. Studies which focused on the football matches reported that footballers cover less distance in the second half as compared to the first half. In this regard, Castagna et al (2003) reported that young footballers perform less speed repetitions in the second half as compared to the first one [2, 3]. Mohr et al (2003) also showed that in the last fifteen minutes of a match intelligent adult players are able to perform speed activities [4]. On the other hand, due to the

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nature of football, footballers have high strength of Quadriceps muscles. Tumilty et al (1993) showed there is a positive correlation between the strength of knee extension and the distance the ball covers when shot [3]. Therefore many nutritional components have been proposed to improve the speed and strength performance and also, to improve physiological mechanisms and responses to exercise in footballers. Although studies revealed that many of these components have no impact on the athlete's performance, it is believed that Creatine supplement is one of the most influential nutritional supplements for athletes [4]. In recent years, Creatine supplement has become popular among competitive athletes in most sports, as from 4 athletes who received a medal in 1996 Atlanta Olympics, 3 consumed Creatine supplement. Guine et al (2001) reported that thirty percent of 1349 young footballers consumed Creatine supplement and experienced its effects in faster post-exercise recovery [5]. Bishop (2010) stated that Creatine consumption has increased muscular strength in club footballers. Also, through delaying exhaustion, players are able to exercise more intensively and develop mechanisms beyond the natural capacity of their muscles [6]. Furthermore, Eckerson et al (2008) investigated the effect of 30 days Creatine consumption on non-aerobic capacity and muscular strength of footballers, and showed Creatine consumption increases players' muscular strength in a maximum repetition of knee extension. It also develops the ability of energy production by non-aerobic system [7].

Jeffry et al (2000) also stated that the standard protocol for Creatine consumption is 0.25 to 0.3 grams per kilogram of body weight, based on the amount of Creatine which body can store [8]. Mellberg (2002) also reported Creatine consumption is only effective in certain conditions and not necessarily as it is advertised [9]. Also, it is shown that oral consumption of Creatine monohydrate as a suspension liquid with a dose of 20 to 30 grams per day in a week increases the density of intercellular Creatine and phosphocreatine. As Shawn et al (2010) showed a daily consumption of 20 grams monohydrate Creatine for 2 to 7 days increases the content of muscular Creatine for 10 to 25 percent and the concentration of intercellular phosphocreatine for 20 to 40 percent in young footballers. Consequently, it facilitates the amount of repeated ATP synthesis in extra extensive and short-term exercises [10].

Although ergogenic effects of Creatine supplement consumption (recommended amounts) without harmful influences are reported, there are paradoxical results about the harmful effects of Creatine consumption. As it is reported Creatine supplement consumption increases the possibility of muscle contractions during the match or long-term exercises in football. This effect can be a result of shifted intercellular dynamic which is a result of osmolality increased (hydration cellular process, increasing cellular volume) caused due to the increasing content of muscular fiber [11]. Balson et al (1994) had already shown that the athlete's performance in a 6-kilometer endurance running may deteriorate through Creatine consumption, since it increases the body weight unwantedly [12]. Also, some people might not respond to Creatine consumption. These people are called non-responsive. As the results of the studies carried out by Greenhalf et al (1996) showed, Creatine consumption accompanied by a single sugar like glucose, increases the transmission of Creatine into the muscle even in those who have a high level of muscular Creatine. This is done through improving insulin sensitivity [13].

Since former studies are not cohesive, studies regarding young footballers are few, consuming Creatine is incorrect without a loading protocol, and Creatine consumption recommended doses are not consistent, it seems that investigating the short-term effect of consuming monohydrate Creatine consumption on speed performance (short-term, long-term, interval sprints) and knee muscular strength in young footballers is necessary.

Material and Methods

Statistical Population and Sample

The current study is semi-empirical. It is carried out on young male footballers. 20 club footballers in Urmia were volunteered to take part in this study. These players met the following criteria:

They were not in competitive season, did not have any muscular or joint injuries as approved by a physician, had a 3-year experience of attending in different matches in club, province, region or even nation-wide level, exercised regularly before and during the season, and avoided any sort of doping. Then these players were randomly divided into two equal groups: Creatine supplement and placebo.

Implementation Method

All the steps of the research and tests were completely and accurately explained to the participants in a meeting. They were asked to fill out a written consent form if they were satisfied with attending the research, and then take part in medical experiments to receive the certificate of research attendance.

In the next level, in basic condition and before the program starts, these field variables were measured: height with 1 mm accuracy and weight with 0.1 kg accuracy using digital height and weight measuring machine (Seca, Germany), fat percentage by digital fat-measuring device with 0.1 percent accuracy (Citizen bm 100, Japan), heart beat (beat/min) by digital device (MBO, Germany). Also, maximal oxygen consumption (ml/kg/min) of young footballers was evaluated through submaximal step "katch mcardle" test during three minutes of activity, according to the instruction of this test and the relevant formula [14,15]:

Vo_{2max} (ml/kg/min) =11.33 - (Number of heart beat (min/beat)× 0.42)

In the next phase, participants were randomly divided into two equal groups of 10: Creatine supplement and placebo. Speed and strength performance of players were measured before consuming Creatine supplement and placebo. The participants' time record in 20-meter and 40-meter sprints were used for short-term speed evaluation, and their time record in 60-meter and 100-meter runs were used for long-term speed evaluation. Interval sprint performance was measured using the distance covered in thirty 5-second sprints with 10 second active rest between each two sprints [14]. 1 RM knee extension was used to evaluate knee muscular strength. 1 RM was determined using the following formula [15]:

1 RM= (kg) moved lift/ (1.278 – 0.0278 × number of repetitions)

After the pre-test phase, participants in Creatine supplement group were given 0.3 g Creatine monohydrate powder (Gensen, Italy) for each kg of the body weight. This was done 4 times a day with special 5-gram spoons at 8:00, 13:00, 18:00, 23:00, and lasted for 7 days. Participants in placebo group received the same amount of Dextrose (Germany) which resembled Creatine regarding color, smell, and taste [16]. In the current study, the amount and period of Creatine consumption were determined according the recent studies (especially Veleck's 2004 and Shao's 2006) [18, 17, 19]. Following the Creatine consumption period (on the 8^{th} day), the initial measurements (as post-test) were repeated.

Nutrition Control

It was recommended to the participants in this study to avoid using caffeinated stuff and the medications in the medical list including Metastron, Norandrosterone, and albumin during the period of Creatine supplement consumption and placebo [20]. Also, a 3-day food reminding and self-report methods were used to control the participants' diets [21, 22].

Statistical methods

In order to analyze the data, descriptive statistics were used to measure central and distribution indexes. K-S test was used to determine the normality of the variables' distribution. Also paired and independent t-tests were used to investigate intergroup and intragroup differences (significance level: $P\leq 0.05$). Data were analyzed using SPSS software version 17.

Results

In table 1, features of footballers in Creatine supplement and placebo groups are presented.

Results of K-S test in pre and post-test phases proved the normality of the distribution in all the variables. Table 2 shows the average and standard deviation of dependent variables in pre and post-test phases. Table 3 shows the results of independent t-test.

Table 2 indicates that consuming 0.3 grams of Creatine supplement per kg of the body weight for 7 days significantly improved the records (sec) of 20, 60, and 100 m sprints ($P\leq 0.01$) and 40 m sprint ($P\leq 0.02$). It also significantly increased 1 RM knee extension (kg) ($P\leq 0.01$) and the distance covered in interval sprint performances (m) ($P\leq 0.03$). In the placebo group, however, no significant differences were observed ($P\geq 0.05$).

The results of independent t-test, also, showed no significant difference in the performance variables of Creatine supplement group and placebo group ($P\geq 0.05$), (Table 3).

Table 1: General features of footballers in creatine supplement and placebo groups*

Group	Age (year)	Height (cm)	weight (kg)	Vo_{2max} (ml.min/kg)
Creatine supplement	23/1±3/72	174/3±3/37	66/05±3/46	55/98±3/29
placebo	22/7±4/14	173/2±5/14	65/59±3/11	53/97±5/33

* Information is stated based on average and standard deviation

Table 2: Average and standerd deviation of performance indexes in creatine supplement and placebo groups in pre and post_tests

Variable	Interval	Group	Pre - Test	Post - Test	T Value	P Value
Speed Performances	20 m (sec)	Creatine	3/152 ±0/179	3/09 ±0/20	4/76	†0/001
		Placebo	3/143 ±0/096	3/142 ±0/09	0/264	0/762
	40 m (sec)	Creatine	5/765±0.281	5/703 ±0/312	4/29	†0/002
		Placebo	5/763 ±0/174	5/767±0/164	0/569	0/607
	60 m (sec)	Creatine	8/13 ±0/458	8/04 ±0/451	5/428	†0/001
		Placebo	8/14 ±0/350	8/137 ±0/347	0/586	0/422
	100 m (sec)	Creatine	13/30±0/56	13/21 ±0/57	5/233	†0/001
		Placebo	13/33 ±0/45	13/335 ±0/46	1/339	0/231
Coverd distance in interval sprint performance (m) (30 5-second sprints with 10 sec rest between each 2)		Creatine	914/7 ±33/8	925/8 ±34/9	4/006	†0/003
		Placebo	920/6 ±41/9	922/3±38/6	0/479	0/395
Strength of 1RM knee extension placebo (kg)		Creatine	82/7 ±5/70	85/75 ±6/30	9/278	†0/001
		Placebo	81/95 ±7/22	82/25 ±7/24	0/612	0/465

†
Significant difference at (P≤0. 05) Level

Table 3: Comparing creatine supplement and placebo groups regarding research variables

Variable	Interval	Group	Post - Test *	T Value	P Value
Speed Performances	20 m (sec)	Creatine	3/09 ±0/20	0/713	0/342
		Placebo	3/142 ±0/09		
	40 m (sec)	Creatine	5/703 ±0/312	0/566	0/583
		Placebo	5/767±0/164		
	60 m (sec)	Creatine	8/04 ±0/451	0/544	0/309
		Placebo	8/137 ±0/347		
	100 m (sec)	Creatine	13/21 ±0/57	0/575	0/384
		Placebo	13/335 ±0/46		
Coverd distance in interval sprint performance (m) (30 5-second sprints with 10 sec rest between each 2)		Creatine	925/8 ±34/9	0/115	0/306
		Placebo	922/3±38/6		
Strength of 1RM knee extension placebo (kg)		Creatine	85/75 ±6/30	0/664	0/639
		Placebo	82/25 ±7/24		

* Information is stated based on average and standard deviation

Discussion and Conclusion

The current study was carried out in order to investigate the effects of short-term Creatine supplement consumption as an ergogenic help on the speed and strength performance of young male footballers. In this study, due to consuming Creatine supplement for 7 days (0.3 g per kg of body weight, 4 times a day) short-term speed performance of participants in Creatine supplement group in 20 and 40 sprints, and their long-term speed performance in 60 and 100 m sprints improved significantly. This difference was not observed in the participants in the placebo group who consumed the same amount of placebo.

Comparing the two groups, no difference was found regarding the performance variables. The results of this study confirmed those of the studies by Branch et al (2003), Izquierdo et al (2002), and Azizi (2011), [23, 24, 25]. However, they are not in line with the results of Burke et al (1996) and Rodondo et al (1996), [26, 27]. As Branch et al (2003) showed in investigating 96 researches conducted on the effect of Creatine supplement consumption on speed and strength performance, Creatine supplement consumption may improve speed and strength especially in repetitive exercises [23]. Cox et al (2002) stated that Creatine supplement consumption significantly improved the performance of footballers in eleven 20-meter sprints [28]. Also, Azizi (2011) showed that short-term Creatine supplement consumption (20g every day) in young swimmers significantly improved the speed swimming records [25]. Imamoglu et al (2007) indicated that consuming 20 g of Creatine for 5 days in footballers in the Premier league, not only increased their lean body mass, but also enabled them to move heavier lifts and have better sprint record as compared to their counterparts in the control group [29]. On the other hand, Rodondo et al (1996) showed that short-term Creatine supplement consumption does not have a significant effect on 25- meter, 50-meter, and 100-meter sprints records in athletes under study [27]. It seems that Creatine supplement consumption has an effective role in charging cellular energy and energy transference from mitochondria to metabolism stations where ATP is used through improving the rebuilding of ATP during an athletic activity, rebuilding Pcr in the recovery period to the basic state, and motivating the activity of enzymes including Creatine kinase, Lactate Dehydrogenase, and aspartate aminotransferase. It also delays exhaustion and reduces lactate accumulation, and in this way improves the short-term and long-term sprints performance.

In the current study, knee muscular strength (1 RM knee extension) increased significantly in Creatine consumption group after 7 days of consuming Creatine monohydrate supplement, while no significant difference was observed in the placebo group. Also there was no significant difference in 1 RM knee extension test, comparing the groups. As Ernest et al (1998) stated, 7 days of Creatine supplement consumption, 20 g per day, significantly increased the strength (1 RM chest press) for 2.1 kg as compared to the placebo group [30]. Vanderberge et al (1997), also, showed that Creatine supplement loading (20 g in 5 days) leads to a 25 percent increase of knee extension strength in female footballers compared to placebo group [31]. The results of these studies are in line with the current study. Our findings show that exerting maximal power in explosive movements is not dependent on the amount of intercellular ATP or Pcr as 1 RM knee extension is. To increase power in knee extension, one must exert the maximum strength in a minimum time, which also happens in response to muscular hypertrophy or improving neural adaptations. Since existing ATP or Pcr are not considered limiting factors to explosive movement such as 1 RM knee extension, an athlete should not anticipate that short-term Creatine supplement consumption improves his performance. However, most researches including the current one show that short-term Creatine supplement consumption improves the footballers' performance in 1 RM knee extension [32, 33]. Since a great deal of energy is provided during intensive activities and before the non-aerobic glycolysis process of ATP and Pcr, it seems Creatine supplement consumption through increasing the level of Total Creatine (Tcr) and Free Creatine (Fcr) and phosphocreatine, increases the amount of produced ATP during intensive athletic activity, and through increasing the capacity of strength production by skeleton muscles, leads to the muscular strength improvement. Also, in the current study following 7 days of consuming Creatine supplement, the participants' covered distance in interval sprints. (Thirty, 5-second sprints with 10 seconds rest between each two)improved significantly while there was no significant difference in the control group. Moreover, there was no significant difference in interval sprint performance when the two groups were compared. The results of this study confirm those of Soderlund et al (1994) and Katz et al (1996), but contradict the results of Mujika et al (2000), [34, 35, 36]. Soderlund et al (1994) showed that consuming 20 g Creatine for six days in athlete students, who exercised on an ergometer for five 6-second intervals with 30 second rests between them, increases the level of phosphocreatine, decreases the accumulation of lactic acid and improves their performance significantly [36]. Katz et al (1996), also showed

since Creatine supplement consumption facilitates rebuilding of phosphocreatine consumed in the intervals, it improves the performance in interval sprints [34]. On the other hand, Mujika et al (2000) showed that although short-term Creatine supplement consumption improves the repetition of interval sprint performances, it does not seem this improvement is a result of Creatine supplement consumption [35]. It seems Creatine supplement consumption in interval sprint activities prevents the activity of Phosphofructokinase through rebuilding ATP sources and increasing muscular Pcr and procrastinates at the onset time of non-aerobic Glycolysis and the production of lactic acid. Creatine supplement consumption, also, through increasing Creatine phosphate resources functions as H^+ buffer and procrastinates fatigue in interval sprint activities through reducing adenine nucleotides to inosine monophosphate (IMP) and ammoniac. Although the field studies do not support the ergogenic or performance-improving effects of Creatine supplement, more studies are required regarding Creatine supplement consumption in simulated athletic activities or intensive sports consisting of various frequent intervals like football [34]. All in all, due to the positive effects of Creatine supplement on 20 m, 40 m, 60 m, and 100 m sprints, and also on 30 5-second sprints with 10 sec rest between each 2, and muscular strength in knee extension, and since Creatine supplement is not an illegal stuff and its short-term consumption includes no reported side effects, Creatine consumption is suggested for footballers.

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