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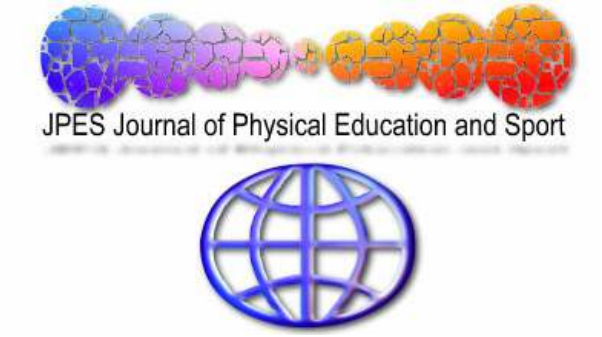

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ORIGINAL RESEARCH

THE RELATIONSHIP BETWEEN AEROBIC POWER AND REPEATED SPRINT ABILITY IN YOUNG SOCCER PLAYERS WITH DIFFERENT LEVELS OF VO_2 MAX

Rostam Alizadeh [1], Fariborz Hovanloo [2], Ali Mohammad Safania[1]
[1] MSc sport physiology, Shahid Beheshti University G.C., Zip Code 1983963113, Evin, Tehran, Iran
[2] Assistance prof .Physical Education Faculty, Shahid Beheshti University G.C., Zip Code 1983963113,Evin, Tehran, Iran
[3] Assistance prof. Islamic Azad University,Ayatollah Amoli Branch, Zip Code 46178-678

[1] **Corresponding Author**: **Ali Mohammad Safania**, physical education faculty of Islamic Azad University, Ayatollah Amoli Branch. Zip Code 46178-678 Amol, Mazanderan, Iran
Tel: 00981212552137, Email: a.m.safania@iauamol.ac.ir

Abstract

In some team sports such as soccer which is interval, athletes need to prepare themselves immediately for the next activity. Therefore it is very important to have enough information on characteristics of recovery phase and quick recovery to the first situation and to have the minimum speed reduction. The purpose of this study was to determine the relationship between aerobic power and repeated sprint ability (RSA or decrement index) in young soccer players in three different levels of Vo_2max. Methods: For this reason 41 volunteers were divided in to three groups with different levels of Vo_2max $ml.kg^{-1}.min^{-1}$ low 37.22 ± 2.3 (n= 18, age 17.1 ± 0.9 year, height 170.6 ± 0.76 cm, weight 67.1 ± 5.05 kg) medium 46.46± 1.97 $ml.kg^{-1}.min^{-1}$ (n= 13, age 17.6± 0.76 year, height 173.8 ± 4.84 cm, weight 65.9 ± 4.92 kg) and high 55.63 ± 1.52 $ml.kg^{-1}.min^{-1}$ (n=10, age 17.4 ±0.69 year, height 177 ± 3.23 cm, weight 71.4 ± 3.94 kg). To determine Vo_2max a graded exercise test until volitional exhaustion on treadmill was used, and also RAST was used to measure RSA. The lactate accumulation was measured before and after RSA protocol. Pearson's correlation was used to determine the correlation between the aerobic power and RSA. The results indicated that there are significant relationship between Vo_2max and decremental index in low Vo_2max group (r= 0.86, p= 0.001), no significant relationship medium Vo_2max group (r= 0.14, p= 0.63) and negative significant relationship in high Vo_2max group (r= - 0.64, p= 0.04). There are no significant relationship between Lactate accumulation and decremental index in medium (r= 0.005, p= 0.98) and high Vo_2max groups (r=0.27, p= 0.45). Discussion: It is possible that the recovery of inter muscular resources relates to aerobic ability, but there are other factors effective in RSA rather than Vo_2max and Lactate accumulation. The current study showed a normal curved relationship between Vo_2max and RSA.

Key Words: Vo_2max, Repeated Sprint Ability, lactate, Soccer Player

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Introduction

The essential requisite of success in most of team sports such as soccer is speedy performance (1). In soccer which is an intermittent play, the athletes should prepare themselves for the next activity quickly thus it is important to know the characteristics of recovery period to initial position. In this way, repeated sprint ability as quick as possible is a determinant of quality and level of athletes' plays. Researches on soccer matches report that players (young and adult) pass less distance in second half of play compared to first one, certainly this decrease of distance has an effect on players speed(2). Castagna et al. (2003) reported that young soccer players in second half of the play have less repeated sprints than first half (3). In other study it was reported that the ability of elite adult players for repeated sprint activity in last 15 minutes of match is 43% less than first 15 minutes (4). Relatively few information is available about fatigue and metabolism mechanism process in those team sports with the characteristic of repeated and short time vigorous exercises and limited recovery phase. Since energy production and recovery in rest phases after intermittent activities is done in aerobic way (5), so aerobic power can be a determinant of repeated sprint activity. Although there are many researches on physiological factors of sports with intermittent nature, some fitness components such as repeated sprint ability in these team sports have been represented as weak and trivial, thus few studies there are about this subject. It should be noted, of course, that research on this matter is very difficult since speedy repetitions nature in team sports is unpredictable. For example, in a soccer match there are more than 1000 different movements with approximate time interval of 6s (6) and recovery phase medium ranging from 3 seconds to 2 minutes (7). By review of literature, researches performed in two last decades can be categorized into three groups: 1) researches indicating significant relationship (8-13), 2) researches indicating medium significant relationship (14-15) and, 3) researches reporting no significant relationship (16-20), but because sprint duration, number of sprint repetition, recovery duration, type of exercise, mode of exercise and training status are very important in evaluation of this kind of fitness and since these factors were different in previous researches, thus comparing their results seems impossible. In addition, since most previous researches used laboratory specific protocols and with regard to the fact that intensity of exercise is unpredictable and constantly changing in team sports, so it is recommended that field tests validity of which is evaluated can be used for evaluation of repeated sprint activities (16). Also in most studies related to body metabolism recovery time, often longer periods (more than 24s) have been used and shorter periods (less than 10s) which are more compatible with real condition of team sports have not been covered (21). Therefore this study by using a field protocol including 6 repetitions of sprint (35m) with maximum effort and 10s recovery between repetitions which are more compatible with soccer performance, aims to answer following question: is there a significant relationship between aerobic power and repeated sprint ability in young soccer players with different levels of Vo_2 max?

Research Methodology

Subjects and the Method of Subject Selection

Subjects were 41 soccer players of national football team and Tehran premier league teams with different levels of Vo_2max. These subjects were categorized into three groups according to criterion of Vo_2max suggested by Tomlin and Wenger (2002) and Brown et al, (2006): 1) first group consisted of 10 ones with high Vo_2 max (55.63 ± 1.52), 2) second group consisted of 13 ones with medium Vo_2max (46.46± 1.97) and, 3) third group consisted of 18 ones with low Vo_2max 37.22 ± 2.3). It should be mentioned that all subjects participated and were studied in the way of available.

Data Collection Method

Subjects stated their consents for participating in the research after being informed of the way of protocol implementation and possible dangers and problems. After measuring weight and height, all subjects performed aerobic protocol from 9.30 to 11.30 on treadmill in physical education institute laboratory of science, research and technology ministry considering at least 48 hours after last performed match and/or after very energetic exercise. In addition, all subjects became familiar with test procedure and way of working on treadmill before performing aerobic protocol in order to determine Vo_2max, and they were asked to continue the test until reaching to exhaustion state. Then, repeated sprint ability test was performed after 48 hours and lactate accumulation in pre-test and post test was measured. Repeated sprint ability test used in this research, was

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RAST[2] field test, validity and consistency of which have been proved (23). In addition, subjects' feed were free and there was no control and all test were performed in the matches' season.

Vo_2max Test Implementation Method

In this test, each subject performed pre-exercise for 3 minutes with 4km/h speed on treadmill. Then main activity were performed with 8km/h speed and 1km increased per each 2min. until speed reached to 16km/h, then slope of device increased 1 degree per each 2min. until subjects reached to exhaustion state. After reaching to this state, subject performed recovery with 4km/h speed for 3min. then heart pulses were recorded (24). In order to ensure achieving Vo_2 max in subjects, one of the following conditions should be gained (12): 1- heart pulses equals to 95% of maximum heart pulse, 2- ratio of respiratory exchange equals to 1/1, 3- diagram of oxygen consumption and heart rate (VO_2/HR) reaches to steady state, 4- exhaustion state declaration by subject. Vo_2 max was measured by using Ergospirometry (model: 600 ZAN) (respiratory gases analysis).

RAST Test Implementation Method

This test included 6 repetitions of sprint with highest power in a 35m distance and rest time interval of 10s between each effort. Subjects performed light and extension pre-exercises for 10min. before test. In order to gain optimal result in this test, subjects were asked to avoid dividing energy between repetitions and perform each activity with highest effort. Time recorded for each repetition was informed to subject to motivate him for utilizing his highest effort while performing the activity. Variables measured in RAST test are as following: 1- best time of sprint activities (the fastest time of running among 6 repetitions), 2- sum of sprint activities time (sum of 6 repetitions of 35m running time), 3- speed reduction index (12).

$$*RSA = \frac{\text{Best time of sprint activities} \times \text{the repetitions of number}}{\text{Sum of sprint activities time}} \times 100$$

* Unlike fatigue index in RAST test, if speed decremental index is bigger it shows better performance of subject.

Lactate Level Measurement Method

Blood sample of right index finger tip was collected before and 3 minutes after repeated sprint activity test in order to accumulate subjects' lactate and by using lactate meter device (product of German, ce 0483 lactate scout) it was measured. For this purpose, right index finger of subject was washed with water and dried, then it was disinfected by alcohol-contained cotton and finally lactate was measured, by calculating the time period that subject came to blood sampling place after finishing of the last 35m repetition, lactate measurement time last 3min. after repeated sprint ability test.

Statistical Method

Descriptive statistics (mean and standard deviation) and Kolmogorov-Smirnov test (K-S) were used in order to samples condition description and data normality examination respectively. For testing research hypotheses and information analysis, Pearson correlation coefficient was used. Statistical analysis was performed by using SPSS15 software and in $P<0.05$ significance level.

Research results

Table (2) shows the mean and standard deviation of measured parameters. Table (3) represents results of statistical analysis by using Pearson's method. As it can be seen in this table, the level of significance of Pearson's correlation test is with the group with low Vo_2max ($r=0.86, p=0.001$) indicating there is significant relationship between aerobic power and repeated sprint ability in young soccer players with low Vo_2max. Also with regard to statistical calculations of table (3), correlation coefficient is in the group with medium Vo_2max between aerobic power and repeated sprint ability ($r=0.14$, $p=0.63$) and repeated sprint ability with lactate

[2] Running-based Anaerobic Sprint Test

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accumulation level (r=0.005, p=0.98), which means there is no significant relationship between aerobic power with repeated sprint ability and lactate accumulation level with repeated sprint ability in young soccer players with medium Vo_2max. Statistical data represented in table (3) determine the relationship between aerobic power and repeated sprint ability in high Vo_2max group (r=-0.64, p=-0.04). Therefore there is negative relationship between aerobic power and repeated sprint ability in young soccer players with high Vo_2max. With regard to statistical data of table (3) significance level of correlation test is between repeated sprint ability and lactate accumulation (r=-0.27, p=-0.45) which suggests there is no significant relationship between repeated sprint ability with lactate accumulation in soccer players with high Vo_2max.

Discussion

Results indicate that there is positive significant relationship between Vo_2max and RSA in group with low aerobic power (r=0.86, p=0.001). Although generally aerobic system is involved in long activities with low intensity, it has an important role in energetic activities lasting just few seconds. When we are performing 6s speedy repetitions, consumed oxygen increases rapidly in the beginning of the activity (24), so that this increase continues to next repeated sprint activity (24-26) and it can reach to about 70 percent of Vo_2max.

When performing vigorous intermittent activities, increase in Vo_2max between repeated sprints causes Vo2max phosphocreatine recovery increase (27), result of which is power maintenance increase in next repetitions. Tomlin and Wenger (2002) found the same maximum power in two groups of non-professional female soccer players with medium and low Vo_2 max, but the group with medium aerobic power has less decrease in performance ability when repeated sprints (13).

In this study we didn't observe any significant relationship between aerobic power and repeated sprint ability in people with medium Vo_2 max statistically (r=9.14, p=0.63). Hoffman's (1997) research on 197 soldiers showed that just having preliminary level of aerobic fitness suffices for required recovery, thus it can be said that even more Vo_2max may have not more benefit for recovery (10). It seems that Vo_2 max index is a weak predictor for phosphocreatine recovery and it is applicable more in people with high aerobic power for determining difference in phosphocreatine recovery percent, because such people possibly have high phosphocreatine level in the beginning so it seems that in an equally time they have more phosphocreatine recovery. Thus when people have Vo_2 max more than medium level, other factors are more important in phosphocreatine recovery and recovery phase than Vo_2max.

One of the findings of this study is negative significant relationship between aerobic power and repeated sprint ability in people with high Vo_2max (r=0.64, p=0.04). There are some evidents suggesting phosphocreatine discharge is dependent to exercise condition as well as to duration of repeated sprint activity (21). Although this was not studied in athletes of team sports, Hirvonen et al discussed that phosphocreatine discharge is more in a group of sprint runners compared to athletes running with lower speed that can be due to such reasons as consistency to sprint activities in former group and Vo_2max increase because of sprint exercises (28). Seiler et al, (2002) showed that the shorter bout duration in sprint activities, the more increase in Vo_2 max because work hardness decreases (29). Rozenek et al, (2007) reported that sprint activities with high intensity and short duration can lead to speed improvement and Vo_2 max increase if have active recovery phases, so that athlete can perform strength activity with higher speeds (30). Sport science experts believe that performance depends on capacity of using high energy phosphates (ATP,PC) at the beginning of repeated sprints, two enzymes, Miokinase (ATP recovery enzyme of ADP) and creatine phosphokinase enzyme(PCr breakdown responsible) have the main role. Miokinase creatine phosphokinase and increase is low following sprint activities in elite athletes and their body can consume phosphocreatine better with lower fitness (28). Phospho ferocto-kinase(main current regulator from glucose 6-phosphate to Pyruvate), lactate dehydrogenase (causing Pyruvate transformation to lactate) and glycogen phosphorylase (causing glycogen movement from muscle supply into glycolytic paths) enzymes increase after repeated sprint activities. Glycolytic enzymes activities increase that is possible in repeated sprint activities, can be responsible for improvement of athletes' performance that use repeated sprints in their training program (31, 32). A characteristic of this study is the evaluation method of this kind of fitness, since duration of each repeated sprint activity, the number of speedy repetitions, duration of recovery, recovery kind, subjects sport field and age range of subjects are the identical, so comparison of three groups with regard to their aerobic power level is possible and generally results of this study indicate that there is a relationship between Vo_2max and repeated sprint ability in the form of normal curve.

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One of the findings of this study is that there is no significant relationship between lactate accumulation and speed maintenance ability in repeated sprint activities in young soccer players with high and medium Vo_2 max. Tesch et al, (1983) reported that there is significant correlation between capillary supply and blood lactate concentration. They also suggested increase in capillary supply leads to improving lactate removal improvement (33), therefore theoretically it was expected to find a significant relationship between lactate accumulation and RSA in young soccer player in this study, but the findings of this study didn't prove this prediction. The study by Bishop et al, (2004) is the only one finding a relationship between lactate accumulation and RSA. This research performed on 34 non-athlete women. They find a significant relationship between these two factors (9). The disagreement between this study and Bishop's research can be due to exercise level of their subjects. As it was noted above, Bishop's subjects were non-athletes and have lower Vo_2max. Tomlin and Wenger (2001) stated since H^+ accumulation causes fatigue, so H^+ accumulation reduction can provide desired environment with more capacity of contractibility, which in this way, lactate should be removed from muscles quickly by means of an effective aerobic system (34). Therefore it seems that the reason for not finding relationship between lactate level and speed reduction index is possibly shorter repeated sprint activities and recovery phase indicating that the main used resource of energy was phosphocreatine, thus lactate concentration was low. In addition, lactate measurement time is a determinant and important variable in blood lactate release (34), that in this study we sampled 3 minutes after test, but Bishop et al, (2004) didn't mention the lactate measurement time duration after repeated sprint activity test. One of the reasons of difference between non-significant relationship level in two groups with high and medium Vo_2 max can be consistency with speedy exercises. Hydrogen ion is a form of lactic acid which is fatigue causing factor in high intensity exercises. However we know that skeleton muscles compensate change in PH by different buffering mechanisms such as, phosphate, protein hemoglobin and bicarbonate chemical buffer in red globule. In addition, findings of different researches indicate that sprint activity causes improving muscular buffering ability (33).

Conclusion Generally results of this study indicate that there is a relationship between Vo_2max and repeated sprint ability in the form of normal curve. Researches show that high level players are very fast runners during a 90 minutes match, they often run 2.5 to 3.5 km distance in average with anaerobic threshold of 1.5 to 2.5km and 600 to 1200m (35). Thus it is recommended trainer consider specially sprint exercises in physical fitness program planning, because movement speed or play rhythm has become more speedy in modern football in last recent years and players can run faster, perform technical skills with higher speed and better make tactical decisions, thus speed or lack of it is the direct responsible for many wins and losses. Also it should not be forgotten that continuous exercises would not be adequate for athletes' needs during match after reaching to e medium aerobic fitness (36, 37).

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Table1: physical characteristics of low (n=18), moderate (n=13) and high (n=10) aerobic power groups.

Variable Index	*Group*	*Mean*	*SD*	*MAX*	*MIN*
Age (years)	Vo_2max low	**17/11**	**0/90**	**19**	**16**
	Vo_2max mod	**17/61**	**0/76**	**19**	**17**
	Vo_2max high	**17/40**	**0/69**	**18**	**16**
Height (cm)	Vo_2max low	**170/61**	**5/34**	**182**	**160**
	Vo_2max mod	**173/84**	**4/84**	**181**	**167**
	Vo_2max high	**177**	**3/23**	**191**	**169**
Body mass (kg)	Vo_2max low	**67/11**	**5/05**	**74**	**57**
	Vo_2max mod	**65/92**	**4/97**	**73**	**58**
	Vo_2max high	**71/40**	**3/94**	**78**	66

Table2: Results (MEAN, SD, MAX, MIN) of variable of the groups.

Variable Index	*Group*	*Mean*	*SD*	*MAX*	*MIN*
Vo_2 max (ml/kg/min)	Vo_2max low	**37/22**	**2/30**	**40/5**	**34/30**
	Vo_2max mod	**46/46**	**1/97**	**49**	**43/20**
	Vo_2max high	**55/63**	**1/52**	**57/5**	**52/90**
Decrement (%)	Vo_2max low	**0/922**	**0/027**	**0/969**	**0/884**
	Vo_2max mod	**0/930**	**0/021**	**0/952**	**0/888**
	Vo_2max high	**0/960**	**0/006**	**0/973**	**0/953**
Total time (s)	Vo_2max low	**40/56**	**3/50**	**46/64**	**35/14**
	Vo_2max mod	**34/77**	**0/56**	**35/45**	**33/50**
	Vo_2max high	**33/47**	**0/99**	**35/41**	**32/28**
Best time (s)	Vo_2max low	**6/22**	**0/39**	**6/94**	**6/5**
	Vo_2max mod	**5/39**	**0/14**	**5/62**	**5/14**
	Vo_2max high	**5/34**	**0/13**	**5/56**	**5/15**
Lactate pre test (mmol)	Vo_2max low	---	--	--	--
	Vo_2max mod	**1/85**	**0/57**	**2/70**	**1/10**
	Vo_2max high	**1/73**	**0/64**	**2/90**	**1/10**
Lactate post test (mmol)	Vo_2max low	---	--	--	--
	Vo_2max mod	**9/00**	**1/49**	**10/9**	**5/80**
	Vo_2max high	**6/97**	**0/81**	**8/2**	5/60

Table3: Correlation coefficients between vo_2max, lactate and RSA test performance indices in three groups.

Variable Index	*Groups*	*r*	*v*	*p*
Vo_2max	Vo_2max low	**0/86**	**0/73**	**0/001**
	Vo_2max mod	**0/14**	**0/02**	**0/63**
RSA	Vo_2max high	**-0/64**	**0/41**	**0/04**
RSA	Vo_2max low	---	---	--
	Vo_2max mod	**0/005**	**0/001**	**0/98**
Lactate	Vo_2max high	**0/27**	**0/07**	0/45