Journal of Physical Education and Sport ® (JPES), 18 Supplement issue 1, Art 49, pp. 363 - 365, 2018
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Is there any connection between endurance, explosive strength and speed performance?

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Published online: April 30, 2018
(Accepted for publication March 20, 2018)
DOI:10.7752/jpes.2018.s149

Abstract:
Metabolism of blood lactate and muscle fiber composition are creating for decades basement for determining muscle work and how it can affect sport performance. The main purpose of this research was to verify, whether there exists any correlation between specific intermittent shuttle run test (endurance) with explosive strength and acceleration tests. 19 professional soccer players of Slovak Fortuna league (Age 24.4 ± 4.84, Height 181.75 ± 3.87, Weight 77.50 ± 6.16) participated during pre-season testing of fitness abilities. Intermittent yo-yo test, Squat jump test, Counter-movement jump test and sprints on 5 & 10 meters were used. Pearson correlation revealed, that higher score at intermittent yo-yo test is significantly and objectively linked with higher score at SJ and CMJ test ($p < 0.05$, $r = 0.48$ (SJ), 0.49 (CMJ)). Additionally, intermittent yo-yo test score seems to be linked with lower time at 5 m test, but not at 10 m sprint test ($p < 0.01$, $r = 0.54$). It is questionable, whether these finding were caused by stretch-shortening cycle mechanism or blood-lactate metabolism ability of organism. Partial role might be taken by muscle fiber composition in players and ability of these fibers to accumulate and depriving blood-lactate during activity.
Key Words*:* correlation, endurance, explosive strength, soccer, speed

Introduction

„Studies about metabolism of blood lactate in a plane of physiology and biochemistry are creating huge basement of sources describing muscle work. In a past 10 years, despite more than 200 years lactate era and investigation progress about blood lactate metabolism this topic is more controversial than ever (Bielik, 2014).

According Dovalil et al. (2008), blood lactate is a salt of lactic acid, which is a product of glycogenolysis during no presence of oxygen. Bielik (2014) also arguing, that blood lactate should not be considered as a „suspicious thief", but should be taken as a „key player" of intracellular, local and whole metabolism of organism. Dívald (2009) adding, that maybe exact the fact, that blood lactate settled down in public opinion as a „bad friend" of lactic acid who is „choking" the cell was consequently marked as a trash. Nowadays, almost everybody can measure blood lactate concentration. The guide is very simple, painless, practical and almost same as measuring glucose levels in diabetes patients (Tvrzník, Soumar, Soulek 2004). Máček and Radvanský (2011) confirm, that blood lactate can be measured by capillary taking from a finger heel or earlobe.

Blood lactate is a quality index of intensity, but during its taking it is necessary to avoid increasing of intensity due to possible lactate fluctuation. Paugschová and Pupiš (2007) confirmed, that finding and registering of blood lactate is essential during training optimization, and it is noticeable for judging of training intensity. Important factor is the time of blood taking due to relevance of output data. Bielik (2014) affirm, that during high intensity anaerobic load it is possible to measure the highest blood lactate levels between 5-8 minutes after finishing the activity. During maximal aerobic load it is around 3 minutes after activity. Zang, Zhou, Wu & Yang (2017) are explaining, that individual skeletal muscles in animal body, same as in human body, are heterogeneous, as each of them is comprised by different fiber types. Type I. muscle fibers are rich in mitochondria and have high oxidative metabolism while type II.B fibers have only few mitochondria and high glycolytic metabolic capacity. From this fact we know, that in mucle fiber type I. human body produces less lactate, than it is in type II. B. While we have not found any publication where it was directly correlated muscle fiber type and lactate response, we decided to figure it out by using data from physical tests and comparing them with achieved blood lactate levels during testing of specific endurance test. Therefore the main purpose of this research was to verify, whether there exists any correlation between intermittent yo-yo test score with explosive strength and speed performance. Current evidence says, that lactate is primary end-product of glycolysis at cellular sites remote from mitochondria (Gladden 2008). Wang et al. (2004) is adding, that endurance exercise

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can promote an adaptive muscle fiber transformation and increase of mitochondrial biogenesis by triggering scripted changes in gene expression. From this statements it is quite clear, that if we have great jumper, he is probably unable to be great endurance athlete, but at the same time he will produce more lactate than endurance type soccer player in intermittent recovery test. According Sýkora (2017) and Brűnn (2017) this fact is valid for any sport discipline without similarity of its character of work.

Material & methods

Research took a part during june 2016 at FITfactory training centre in Nemce (Banská Bystrica, Slovakia), where players during several days completed whole preseason testing. Sample consisted of 19 professional soccer players (Age 24.4 ± 4.84, Height 181.75 ± 3.87, Weight 77.50 ± 6.16) of Slovak Fortuna league team (finished in top 5 during season 2016/2017). In order to finding out whether there is or there is not any correlation between endurance, explosive strength and acceleration tests intermittent yo-yo test, myotest squat jump test, myotest counter-movement jump test, 5 and 10 meters sprint test were used. Intermittent yo-yo test evaluates an individual's ability to repeatedly perform intervals over a prolonged period of time, particularly for athletes from sports such as tennis, team handball, basketball and soccer etc. For intermittent yo-yo test we used non-slip, flat surface, marking cones, measuring tape, pre-recorded audio CD, cd player and recording sheets. For completing test, use cones to mark out three lines as per the diagram above; 20 meters and 2.5 (endurance test) or 5 meters (recovery test) apart. The subject starts on or behind the middle line, and begins running 20 m when instructed by the cd. This subject turns and returns to the starting point when signaled by the recorded beep. There is an active recovery period (5 and 10 seconds respectively for the endurance and recovery versions of the test) interjected between every 20 meters (out and back) shuttle, during which the subject must walk or jog around the other cone and return to the starting point. A warning is given when the subject does not complete a successful out and back shuttle in the allocated time, the subject is removed the next time they do not complete a successful shuttle. Myotest is 2D accelerometer with a 500Hz frequency sensing ability. Squat jumps test were realized by performing half squat and stop in position on acoustic signal followed by maximum voluntary vertical jump after another acoustic signal. Players performed 3 jumps each, best jump was evaluated. Same in counter-movement jump test with little difference, when players performed half squat and immediate maximal vertical jump without stop in bottom position. Microgate Polifemo photocells had been used for measuring 5 and 10 meters acceleration tests. Microgate Polifemo photocells work as a coaxial optical system. Also the Polifemo line employs an intelligent link to the timer using the standard 2-wire banana connection. 5 and 10 meters sprint tests were done by performing maximal acceleration on self-cue. For data evaluation Microsoft Excel 2016 and IBM SPSS v19 software had been used for calculating data´ normality, statistical significance and effect size, concretely Shapiro-Wilks´ calculation, Pearson correlation for calculating statistical significance supported by effect size interpretation. We tested, whether there exists any correlation between intermittent yo-yo test and 5 & 10 meters sprint test and also intermittent yo-yo test and explosive strength tests. This research is a part of VEGA 1/0414/15 (Optimization of training and competitive load in individual sports).

Results

For a detecting, whether our data has normal distribution or not we used Shapiro-Wilks´ test calculation in SPSS software and it revealed that all of our tests data has normal distribution. In order to figure out if there are any correlations between intermittent yo-yo test, CMJ, SJ test and sprints tests on 5 & 10 meters we used Pearson correlation calculation via SPSS and results are presented in Figure 1. Since effect size „r“ is already present in correlation matrix, there was no need for its calculation.

	Distance yo-yo intermittent recovery test	SJ	CMJ	5m sprint	10m sprint
Distance yo-yo intermittent recovery test	1				* p < 0.05 ** p < 0.01
SJ	0,483 *	1			
CMJ	0,492 *	0,652 **	1		
5m sprint	-0,544 *	-0,344	-0,679 **	1	
10m sprint	-0,318	-0,318	-0,285	0,368	1

Fig.1 Pearson´ correlation matrix of tested variables

In Figure 1 you can see that between intermittent yo-yo test and SJ test, there is significant weak close linear relation with moderate effect size ($p < 0.05$, $r = 0.48$). Similar result we got with yo-yo test and CMJ jump ($p < 0.05$, $r = 0.49$). It means, that intermittent yo-yo recovery test performance is associated with Squat jump and Counter-movement jump performance. More interesting is our finding, that there is also significant high indirect linear relation between intermittent yo-yo test performance and 5 m sprint performance with large effect size ($p < 0.05$, $r = 0.54$), but in the same time not significant weak indirect linear relation to 10 m sprint

performance. From others variables, there exists significant strong close linear relation between Squat jump performance and Counter-movement jump performance with large effect size ($p < 0.01$, $r = 0.65$) and similar it is between Counter-movement jump and 5m sprint test, where there exists significant strong indirect linear relation with large effect size as well ($p < 0.01$, $r = 0.68$). It only confirms already known findings that explosive strength is affecting short distance acceleration ability.

Dicussion & Conclusions

When it comes about optimization of training process in professional sport, it is highly important to search for possible relations between fitness abilities. These connections could serve as a basement for more-accurately planning and organization of training process and developing crucial abilities responsible for sport performance improvement. Our research showed, that intermittent recovery yo-yo test´s performance is significantly linked to counter-movement jump and squat jump performance and it is bringing interesting finding, that high-endurance performance doesn´t have to necessarily decrease explosive strength ability. This idea support also significant connection between intermittent recovery yo-yo test´s performance and 5 m sprint performance, where it seems, that high endurance performance is decreasing time at 5 m sprint performance. We can only polemize, that specific shuttle run pattern and counter movement jump pattern is fastening the change of direction and stretch-shortening cycle and so soccer player is able to decelerate and accelerate faster also during endurance shuttle run test. This might be linked to I, II A and II B muscle fiber types composition and its ability to contract fast, but also to produce and reduce blood-lactate level during activity. Our research also confirmed theory, that higher level of explosive power has positive impact on acceleration ability.

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