# PROFILE AND RELATIONSHIP BETWEEN SPEED ABILITIES AND EXPLOSIVE STRENGTH OF LOWER LIMBS AMONG YOUTH SOCCER PLAYERS

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**Keywords:**

- Running at maximum effort,
- Jump test,
- Correlation analysis.

**Abstract:**

Playing performance of a soccer player consists of a wide spectrum of physical activities. A dominant requirement in contemporary soccer is player's speed preparedness.

The aim of the study was to assess the state of speed abilities and explosive strength of lower limbs in youth soccer players and to evaluate the level of their interdependence.

The study enrolled 59 players of U14 and U15 categories. The participants performed tests of speed abilities focused on acceleration speed (5 m and 10 m run with maximal effort from a stationary start position), absolute speed (20 m run with maximal effort from flying start) and speed with changes of direction ( K-test) and a vertical jump test in order to assess explosive strength of lower limbs. The players appeared to have a high level of speed abilities in comparison to results of foreign studies. Correlation analysis showed that there is a linear moderate, up to high correlation between speed manifestations in the running tests and explosive strength of lower limbs. Concerning the test of speed with change of direction, only low association with explosive strength of lower limbs was found. With respect to the nature of this test, we assume that the results may have been more influenced by coordination of movements and running technique in the acceleration phase.

The study was supported by the APVV project 1/0622/15 titled "The effect of regeneration on recovery of the body after aerobic and anaerobic physical load".

## INTRODUCTION

Intermittent nature of physical load in a soccer game puts great demands on players' physical preparedness. Developmental trends in soccer reflect substantial qualitative changes in the game development which are the result of the design and long-term planning of sport training [Bunc, Psotta 2003].

Playing performance of a soccer player consists of a wide spectrum of physical activities ranging from walking, running at various paces, jumping, running backwards, etc. Several authors agree in the opinion that the player's actions with a ball only last for 1 to 3 minutes in a soccer game [Bangsbo 1994; Kollár 2001; Psotta 2006]. According to Bloomfield et al. [2007], the most common physical action is running up to 15 km/h and walking (75 – 90% from the total covered distance); the remaining 10 – 25% of actions is

performed at speed higher than 15 km/h. Buzek et al. [2007] state that an important precondition for effective mastering of soccer player's tasks during the game is the ability to repeat short-term actions at maximal intensity. In contemporary soccer, speed is a significant determinant of playing performance of soccer players and development of speed abilities play a very important role [Hipp 2007].

A soccer game is characterised by very short periods of physical load, usually lasting for 1 to 5 seconds, at high or maximum intensity which alternate with lower intensity periods or rest periods lasting for 5 to 10 seconds. According to Hipp [2007], a soccer player overcomes 100 to 150 sprints of various length during the game. As reported by another author [Psotta 2006], most of sprints bouts in soccer is shorter than 30 m; therefore, speed training shall be primarily focused on components that are crucial in the acceleration phase of sprinting. In the soccer game, 50 – 65 % of all sprints is shorter than 5 m, 75 – 85 % is not longer than 10 m and average length of sprints is 9 m [Psotta 2006].

Constantly increasing demands on individual speed abilities of soccer players, as well as on the speed of cooperation (interaction) among players, may be considered as one of the most important characteristics of contemporary professional soccer [Hipp 2007]. Performance in linear sprinting is the most important component of the offensive phase. The most such sprints are performed without a ball and opponent. Therefore, Faude et al. suggest that testing running speed without the change of direction is an important part of the player's physical preparedness [Faude et al. 2012].

## AIM

The aim of the study is to assess the level of speed abilities and explosive strength of lower limbs among youth soccer players and to evaluate the level of their interdependence.

## METHODS

The screened sample consisted of 59 soccer players of U14 and U15 categories. Participants' average age at the time of measurement was 14.0 ± 0.6 year. Somatic parameters characterising the sample include average body height 161.6 ± 8.6 cm, average body weight 53.5 ± 10.3 kg and average value of BMI 20.3 ± 2.7 $kg.m^{-2}$. All participants took part in the organized form of training process for 4 to 8 years.

Measurements took place in the spring season in May and June. In addition to measurements of somatic parameters, participants were also examined in four tests focused on the level of speed abilities and explosive strength of lower limbs.

After diagnostics of somatic parameters, the tested subjects performed a group warm-up consisting of jogging and dynamic stretching exercises. This part lasted for 15 minutes and was controlled by the coach.

Subsequently, examination of explosive strength of lower limbs was carried out using the vertical jump test on a Fitro jumper device (Fitronic s.r.o., Bratislava, Slovak republic), which lasted for 10 s. The test consists of repeated vertical jumps without the arms during a 10 s period. The participants were instructed to perform jumps at maximum effort without bending knees during the flight phase and with as short contact with the surface during the take-off initialization as possible. The final value entering the analysis was represented by the average value from the three best trials recorded during the given time interval in the jump height (h) and performance in the active phase of the take-off (P).

This section was followed by diagnostics of speed abilities. Acceleration speed was tested in sprinting at 5 and 10 m from a stationary start position. Absolute speed was examined in 20 m flying sprint after a 20 m run-up and, finally, the factor of speed with the change of direction was tested using a K-test. The participants were asked to perform the tests at maximum effort. The beginning of a deceleration phase was marked by a cone located 3

meters behind the last pair of photocells. All tests were carried out in two trials and only the better performance was used for further analysis. Testing was carried out in a „flow'' method when participants stood in a queue and the first person repeated the test after the entire group finished the first trials. Speed abilities were recorded using a BROWER photocells system (Brower Timing System, Draper, USA). This system consists of pairs of photocells that are placed on a tripod and a transmitter depicting performance in the form of time with accuracy of 0.01 s.

Based on the assessment of normality of the obtained data distribution using the Shapiro-Wilk test, we used parametric methods and characteristics of mathematical statistics for further analysis. From the characteristics of descriptive statistics we used the mean ($\bar{x}$) as a measure of central tendency and the standard deviation and standard error of mean as measures of variability. As supplementary data, minimal and maximal values of the players' performances achieved are presented. Correlation analysis between the indicators of explosive strength of lower limbs and results in tests of speed abilities was carried out using the Pearson's correlation coefficient (r). The strength of the association was defined according to Evans et al. [1996], when $r < 0.19$ represents very low, $r < 0.39$ low, $r < 0.59$ moderate, $r < 0.80$ strong and $r \geq 0.80$ very strong association between the variables.

Statistical analysis was processed using Statistica, v.12.0, software (StatSoft, Inc.; Tulsa, USA).

## RESULTS AND DISCUSSION

Table 1 shows the results of normality of data distribution as a predisposition for selecting appropriate statistical procedures. In any of the evaluated parameters we did not find violation of the normal Gaussian distribution of data.

**Table 1** Analysis of normality of data distribution (Shapiro - Willk test)

| | Tests of speed abilities | | | | Vertical jumps | |
|---|---|---|---|---|---|---|
| | 5 m (s) | 10 m (s) | 20 m (s) | K-test (s) | h (cm) | P (W) |
| W | 0.981 | 0.971 | 0.983 | 0.978 | 0.962 | 0.979 |
| p | 0.503 | 0.177 | 0.593 | 0.365 | 0.063 | 0.383 |

***Legend:*** **W** – value of testing criterion; **p** – level of significance

Table 2 depicts descriptive statistical characteristics of participants' performances in particular tests. With regard to a low standard deviation and standard error of mean we can state that there was a high homogeneity of the research group.

In comparison to other studies, our participants achieved a lower average value in the test of acceleration speed, i.e. „running at maximal effort for 5 m from a stationary start position" than it was reported by Alves et al. [2010], who examined youth elite Portuguese soccer players (n= 23, average age = 17.4 ± 0.06 year), similarly as in the comparison with the results found by Malý et al. [2012], who tested the national Czech team of U16 category (n = 22, average age = 15.6 ± 0.4 year). Average values in the mentioned test recorded in these studies were 0.99 s – 1.11 s [Alves et al. 2010] and 1.09 s [Malý a kol. 2012].

In the second test of acceleration speed (running at maximal effort for 10 m from a stationary start position), our participants achieved the average value of 1.93, which is consistent with results from the study by Villanueva et al. [2011], who recorded an identical average performance in the U16 category.

In the test „running at maximal effort from 20 m flying start", as an indicator of absolute speed, our participants achieved poorer performance than players from the national Czech U16 team, whose average value was 2.48 s [Malý a kol. 2012]. On the contrary, our participants achieved better performance than Qatar players of the U14 category (n = 14,

average age 12.7 ± 0.7 year), who achieved the value of 2.85 s; however, this study involved younger players as indicated by their average age. In comparison to the U16 players (n = 22, average age = 14.9 ± 0.6 year), the same authors reported a lower mean value, namely 2.53 s, which means a better performance [Villanueva et al. 2011].

In the test of speed with change of direction (K-test), we recorded worse results than Malý et al. [2012], who reported the average performance at the level of 10.65 s (national Czech team of the U16 category, n = 22, average age = 15.6 year).

**Table 2** Results of descriptive analysis of the monitored indicators of speed abilities and vertical jumps among youth soccer players

| | Tests of speed abilities | | | | Vertical jumps | |
|---|---|---|---|---|---|---|
| | 5 m (s) | 10 m (s) | 20 m (s) | K-test (s) | h (cm) | P (W) |
| $\bar{x}$ | 0.80 | 1.93 | 2.79 | 11.41 | 28.96 | 41.21 |
| SD | 0.06 | 0.11 | 0.23 | 0.60 | 3.47 | 6.36 |
| SE | 0.01 | 0.02 | 0.03 | 0.08 | 0.45 | 0.83 |
| min | 0.69 | 1.64 | 2.32 | 10.2 | 22.9 | 29.8 |
| max | 0.92 | 2.15 | 3.42 | 12.5 | 39.5 | 54.3 |

***Legend:*** $\bar{x}$ – mean value; ***SD*** – standard deviation; ***SE*** – standard error of mean; ***min*** – minimal value; ***max*** – maximal value

Table 3 presents the results of correlation analysis between speed manifestations and explosive strength of lower limbs among youth soccer players. As reported by Villanueva et al., sprinting performance of children and adolescents depends on a number of factors associated with growing and maturation of the body [Villanueva et al. 2011]. One of them is neuromuscular interplay of the engaged muscle groups. When assessing the relationship between the performed tests of speed abilities and indicators of explosive strength of lower limbs, we discovered a low negative correlation between the jump height and performance in the K-test interpreting the level of speed with change of direction. A strong negative association was found between the performance in the active phase of take-off and 20 m flying sprint. In the rest of assessed pairs of indicators (tests of speed manifestations and explosive strength of lower limbs) we recorded a moderate negative correlation.

**Table 3** Results of correlation analysis of vertical jump parameters and speed indicators among youth soccer players (Pearson's correlation coefficient)

| | | Tests of speed abilities | | | |
|---|---|---|---|---|---|
| | | 5 m (s) | 10 m (s) | 20 m (s) | K-test (s) |
| Vertical jumps | h (cm) | -0.504* | -0.564* | -0.583* | -0.129 |
| | P (W) | -0.542* | -0.575* | -0.640* | -0.294* |

***Legend:*** ******* statistical significance of correlation at the level of significance α = 0.05

Overall, the results indicate that explosive strength influences speed with change of direction (K-test) only slightly. Similarly, it appears that the level of speed abilities is more affected by a combination of factors, jump height achieved during the minimal duration of the contact between the foot and the surface, which is characterised as a performance in the active phase of take-off.

## CONCLUSIONS

Running speed is certainly a factor determining the soccer players' performance, especially with respect to the fact that it creates conditions for performing both defensive and offensive game situations.

Results of correlation analysis indicate that performance in tests of running speed is less determined by the jump height. A stronger correlation was found in association between the performance in the active phase of take-off and speed manifestations.

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