Original Article

The relationship between speed factors and agility in sport games

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ABSTRACT

Horička, P., Hianik, J., & Šimonek, J. (2014). The relationship between speed factors and agility in sport games. *J. Hum. Sport Exerc., 9*(1), pp.49-58. This study deals with the issue of various understanding of the term „agility", mainly within the context of team sport games. Under this term complex psychomotor abilities are understood. Their development requires a high degree of neuro-muscular specificity. The development of these abilities are underpinned also by perceptual components including also anticipation and decision-making processes. Authors point to the importance of agility in sport games. They stress the fact that the speed of movement is only one of the components of the complex motor ability called agility. Based on the theoretical analysis authors carried out measurements of basic factors of speed abilities and agility in 14-17-year-old basketball, volleyball and soccer players (n=56). The results showed that no statistical differences were observed in the level of agility tested by Fitro agility test (basketball - p=0.189; volleyball - p=0.949; soccer - p=0.832). Spearmann rank correlation test showed that no significant correlation (p=0.786; p > 0.05) was found between the results of Fitro agility test and Illinois test measuring speed abilities. The results suggest that agility is not simply one of speed abilities. Besides simple reaction speed, acceleration, deceleration accompanied by the change of direction of movement it comprises also perceptual components determined by complex reaction to unexpected, changeable stimuli occurring during a sport game. **Key words**: FITRO AGILITY CHECK, ILLINOIS TEST, SOCCER, BASKETBALL, VOLLEYBALL, SPORTS TRAINING.

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INTRODUCTION

Speed and agility in team sports represent complex psychomotor skills (Verchoshansky, 1996). They involve moving the body as rapidly as possible, but agility has the added dimension of changing direction. Speed is classically defined as the shortest time required for an object to move along a fixed distance, which is the same as velocity, but without specifying the direction (Harman & Garhammer, 2008). In practical terms, it refers to the ability to move the body as quickly as possible over a set distance. However, in reality, the issue is slightly more complex because speed is not constant over the entire distance a can therefore be divided into several phases: acceleration, maintenance of maximum speed and deceleration (Plisk, 2008). Agility is most often defined as the ability to change direction rapidly (Altug et al., 1987). This can take many forms, from simple footwork actions to moving the entire body in the opposite direction while running at a high speed. Thus, agility has a speed component, but it is not the most important component of this trait. The basic definition of agility is too simplistic, because it is now thought to be much more complex involving not only speed, but also balance, coordination, and the ability to react to a change of the environment (Plisk, 2008). Měkota (2000) considers agility to be physical capability, which by its essence belongs among „mixed“ physical capabilities. It is determined by the quality of regulation (CNS) and analysers, as well as the type of muscle fibre. Therefore, agility should be superior to speed, quickness and coordination abilities. In the past, this term used to be understood as the ability to change direction, or to start and stop the movement quickly (Gambetta, 1996; Parsons & Jones, 1998). Similar morphological and biochemical factors of maximal speed, acceleration speed and agility lead some authors to the assumption that the given abilities are related and interdependent. Despite that, Buttifant et al., (1999) did not succeed in finding significant correlation between straight-forward sprinting and agility in two different groups of Australian soccer players. Correlation between agility, acceleration speed and maximal speed was neither found in the group of 106 Australian soccer players (Little & Williams, 2005). Based on these results authors came to the conclusion that agility and speed abilities are different and independent abilities of a sportsman. Moreover, if they are connected with the performance of sport specific skill, inter-correlation decreases even more (Young et al., 2001a). This can be caused also by the fact that training methods of their development are specific for each of the types of speed abilities, thus minimum transfer of qualities between them occurs (Young et al., 2001).

Sheppard and Young (2006) also claim that speed and agility represent independent physical abilities and therefore their development requires high degree of neuro-muscular specificity. Perceptual components, which form their fundament and include also anticipation and decision-making processes, play also an important role in their development (Young et al., 2002). However, they are specific for various kinds of sports and players´ posts. As to Šimonek (2013) agility comprises several universal components described in Figure 1.

When testing agility, one has to take into consideration sudden changes of direction of movement, accelerations and fast stops. This diverse character of movement, which is employed above all in sport games and martial arts, can suggest that other running mechanisms than in typical track sprinters, are employed (Sayers, 2000).

Change of direction performance is relatively independent of straight-line speed performance (Little & Williams, 2005; Young et al., 2001a). Acceleration and deceleration involved in change of direction movements, which in turn underpin agility performance, are therefore specific qualities and should be trained as such (Jeffreys, 2006).

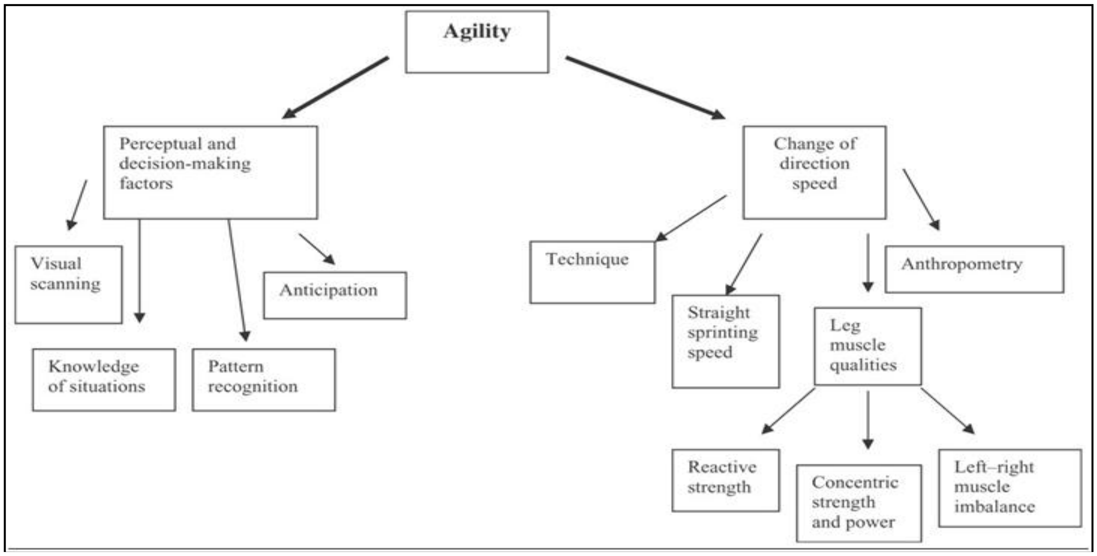

Figure 1. *Universal components of agility (Sheppard & Young, 2006)*

Agility in team sports does not comprise only the ability of changing the direction of movement, but also the capability to anticipate the movement of the opponent, read and react to specific game situations (Gamble, 2013). Due to variable nature of various sport games, where the situation changes every second, movements executed in high frequency and speed, can start from a variety of starting conditions. Exhibition of both speed and agility in team sports occurs in response to game situations (Young et al., 2001a). That means that perception-action coupling and decision-making are critical elements in terms of developing the ability to express speed and agility capabilities under match conditions (Gamble, 2013).

Sheppard & Young (2006) offered a categorical definition of agility: „rapid whole-body movement with change of velocity or direction in response to a stimulus“. In the context of team sports, agility therefore comprises not only change of direction abilities but also perception and decision-making. In much the same way as speed expression, agility in the context of team sports is multifactorial (Gamble, 2011).

In team sports two concepts of agility development are known (Bloomfield et al., 2007). The first one represents training of movement mechanics, where relatively closed skills are employed. Specialized commercially available tools (coordination ladders, mini-obstacles etc.) are frequently used in the training of agility. However, this concept does not include the important component of decision-making and complex reaction. The other concept represents agility development with relatively open skills, where fast changes of direction of movement are executed in training conditions, which are not structured so much and therefore are similar to the match conditions. This implies that agility development in sport games is very important for the optimization of sport preparation of players. Coaches in training should focus on the training means carried out in the development of the speed-strength potential in anaerobic regime, where adaptation begins also as a result of these means executed in maximal as well as submaximal zone of intensity of loading.

The aim of the research was to find out correlation between agility and the ability to simply react, accelerate, decelerate and change the direction of movement. We presumed that there is not significant correlation between the results of 2 tests – Fitro Agility Check (FAC) and Illinois Test executed on young male soccer, basketball and volleyball players (n=56).

MATERIAL AND METHODS

Participants

Participants (n=56 male players, M_{age} = 15.78 years, age range: 14 – 17 years) were randomly recruited from the local basketball (V_{10}), volleyball (V_{13}) and soccer (V_{33}) teams in Nitra.

Procedures

For the testing of speed abilities and agility to simply react, accelerate, decelerate and change the direction of movement Illinois Agility Test (Getchell, 1979) was used. Participants carried out only one trial. Fitro Agility Check (FAC) was used for the measurement of agility (Hamar & Zemková, 2000). Test protocol included 16 randomly generated stimuli appearing on a display in 4 different corners. The tested person had to quickly and adequately react to the stimuli appearing in 4 different corners of the screen by covering the 3 meters distance and stepping on a square mat (35 cm x 35 cm) situated in four corners on the floor (Figure 2).

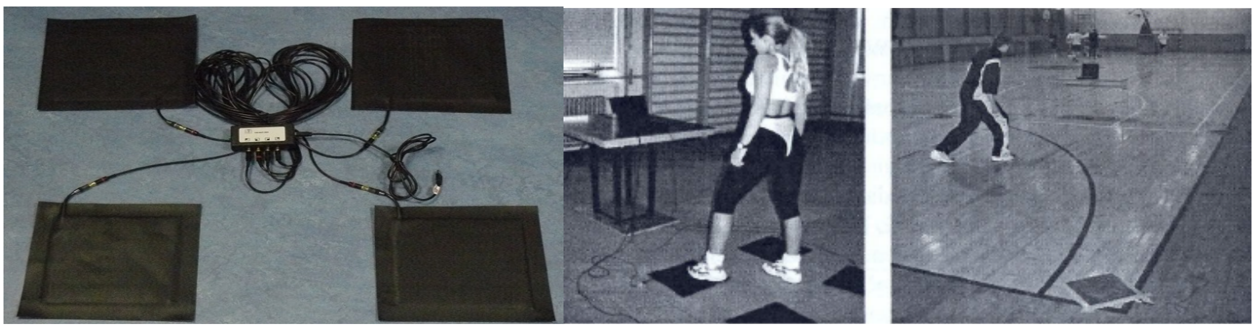

Figure 2. *Fitro agility test (FAC) protocol*

For the measurement of speed abilities in sport games Illinois agility test was used (Figure 3).

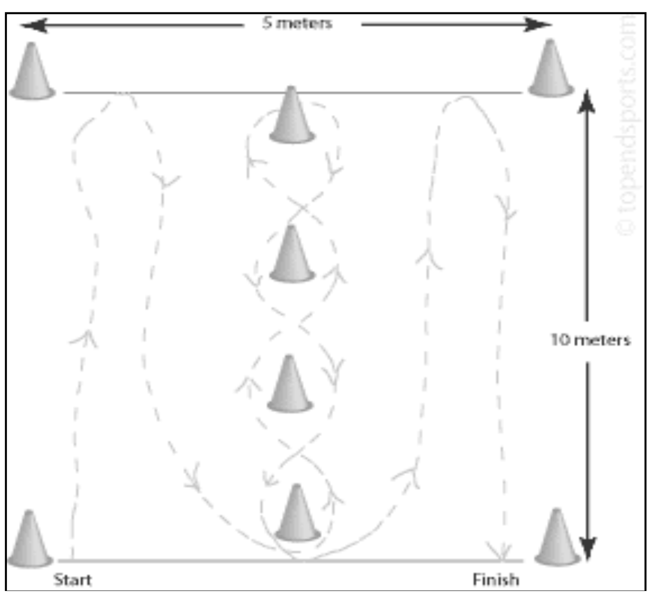

Figure 3. *Illinois Agility Test (Getchell, 1979)*

Statistical Analyses

The obtained data were statistically evaluated using the following statistical methods:

For the evaluation of the rate of variability of values (variances) F- test (Hendl, 2006) was used. We verified whether variance of the value – time (t_s) in FAC was identical in all observed groups of players. Testing the differences between the samples of players in basketball, volleyball and soccer ($V_{b(n=10)}$, $V_{v(n=13)}$ and $V_{s(n=33)}$) was focused on finding the differences between the performances in the observed indicators in Fitro agility check (FAC). Zero hypothesis postulates „zero difference“ between the variances so that: $\mu_1 = \mu_2$.

Based on the results of F – test we evaluated the differences between two sample means of independent sets using non-parametric t- test for two sets. Using statistic module of the programme Excel *p*- value was obtained. In case this value is lower than 0.05 we reject the zero hypothesis.

When evaluating the relationship between the observed variables (FAC vs Illinois) Spearman correlation coefficient r_s ($-1 \leq r_s \leq 1$) was used for correlation analysis (significance level 0.05).

RESULTS

When interpreting the research results it was expected that the performance of players of different sports games in Fitro Agility Check will not be significantly different. Figure 4 shows different variability of values in the observed groups. The highest variance is registered in the values of volleyball players, followed by soccer, while the lowest variance was registered in basketball players. We presume that this fact could be induced by scattered extreme values mostly in volleyball and basketball players.

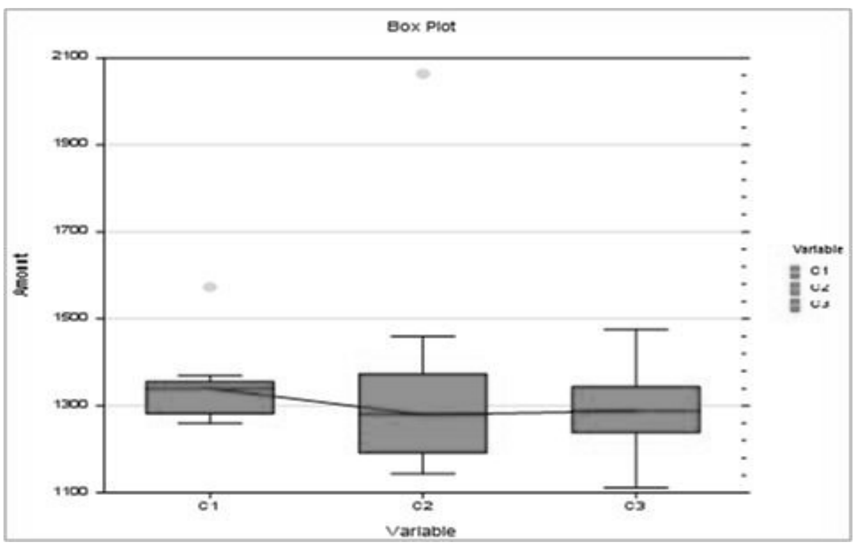

Figure 4. *Variance of performances in Fitro agility check (FAC)*

In case of comparison of the values in FAC in the groups of basketball and volleyball (F-test for variance) the value p=0.000323 was found. Since p< 0.05, t - test with unequal variances was used (Table 1). In the remaining two cases, when comparing the performance of basketball and soccer players (p= 0.51767; Table 2) or volleyball and soccer players (p = 4.80991; Table 3) the value was higher than p> 0.05 so we can state that it was necessary to use t- test with equality of variance.

	basketball	voleyball
Median	1339.30	1333.25
Variance	6435.52	56907.26
n	13	13
Difference	12	12
F	0.1130	
P(F<=f) (1)	0.00032	p< 0.05

	basketball	soccer
Median	1339.30	1286.10
Variance	6435.52	6525.91
n	13	33
Difference	12	32
F	0.9861	
P(F<=f) (1)	0.51767	p> 0.05

	voleyball	soccer
Median	1333.25	1286.10
Variance	56907.26	6525.91
n	13	33
Difference	12	32
F	8.720	
P(F<=f) (1)	4.809	p> 0.05

Tables 1, 2 & 3. *Two-sample F-test for variance*

The following facts follow from the results:

a) Zero hypothesis can be accepted and we state that: „basketball and volleyball players do not statistically differ in the overall level of performance in the test Fitro agility check" /p = 0.931> 0.05/.
b) Zero hypothesis can be accepted: "basketball and soccer players do not statistically differ in the level of performance in the test Fitro agility check" /p = 0.0501> 0.05/. In this case the p value is on the border of the opposite interpretation of the relationship between the performances of both groups.
c) Zero hypothesis can be accepted: „soccer and volleyball players statistically do not differ in the level of overall performance in the test Fitro agility check" /p = 0.3173 > 0.05/.

T-test for two samples showed that players of basketball, volleyball and soccer did not have statistically significantly different level of agility (FAC). With an exception of the performances of basketball and soccer players this statement is unequivocal. Character of movement, mainly its reaction and speed-strength determinants are similar probably in all observed samples, since no significant differences were found between players (Tables 4 - 6).

	basketball	voleyball
Median	15.65	15.63
Variance	6435.522	56907.26
t Stat	0.086782	
P(T<=t) (1)	0.465996	
t crit (1)	1.75305	
P(T<=t) (2)	0.931993	p> 0.05
t crit (2)	2.13145	

	basketball	soccer
Median	15.65	16.44
Variance	6435.522	6525.91
t Stat	2.015004	
P(T<=t) (1)	0.02502	
t crit (1)	1.68023	
P(T<=t) (2)	0.050149	p > 0.05
t crit (2)	2.015368	

	voleyball	soccer
Median	15.63	16.44
Variance	6435.522	6525.91
t Stat	2.015004	
P(T<=t) (1)	0.02502	
t crit (1)	1.68023	
P(T<=t) (2)	0.050149	p > 0.05
t crit (2)	2.015368	

Table 4, 5 & 6. *Two-sample t-test with unequal variances*

When evaluating the potential relationship between the performances in test FAC and Illinois (Spearmann test) significant relationship (significance level 0.05) was not found in the observed parameters in individual groups. The measured p values in basketball players (p = 0.189), volleyball players (p = 0.949) and soccer players (p = 0.832) were clearly above the chosen level of significance (Tables 7 – 9). The above mentioned fact clearly points to the fact that reaction to a stimulus and the following realization of a 3 m sprint are probably limited by other factors than agility, with a well-known course of realization of the movement action. In sport games, however, the sport environs is very dynamic (time, space, game object) and upon solving the game tasks players must adapt quickly to the changing situations.

2-tailed Test		
r_s	DF	*p*
0.4326	11	0.189
		p > 0.05

2-tailed Test		
r_s	DF	*p*
minus 0.022	13	0.948
		p > 0.05

2-tailed Test		
r_s	DF	*p*
0.038	33	0.832
		p > 0.05

Table 7, 8 & 9. *Spearman Rank Correlation*

In the following section we were looking for an answer to the question, whether there exists any relationship between the observed parameters (FAC vs. Illinois) also in case of adding all performances in all sport games. The aim was to eliminate potential differences in the character of performances according to sport specialization and to assess the given relationship between values of players observed as one team (VSG = Vb + Vv + Vf). Also in this case, using the procedure of Spearman (Hendl, 2006) (Table 10) non-linear (Figure 5) and zero character of relationship between the observed values were proved.

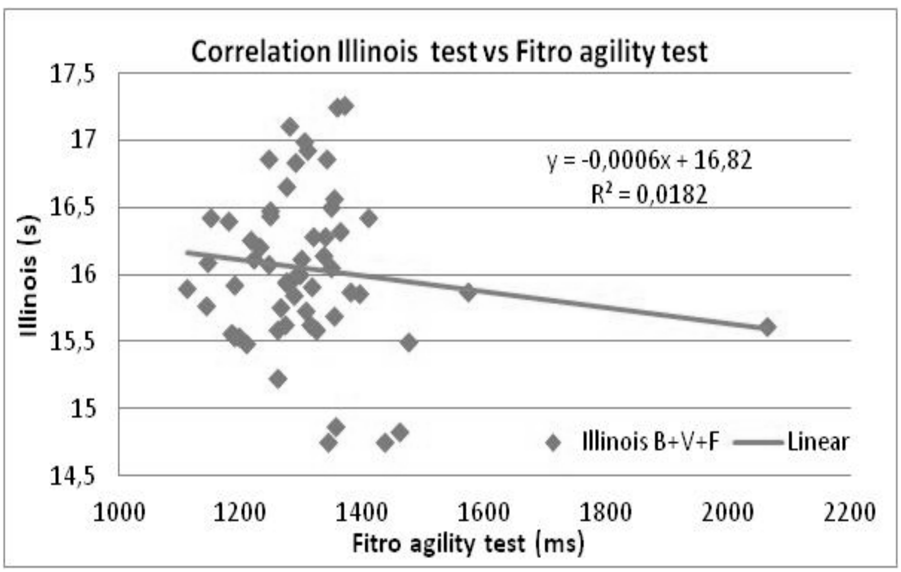

Figure 5. *Correlation Illinois vs Fitro agility*

2-tailed Test		
r_s	DF	*p*
minus 0.037	57	0,786
		p > 0.05

Table 10. *Spearman Rank Correlation*

After eliminating differences between the selected games, performances in the two tests did neither correlate. Reaction ability to the visual stimulus and the following realization of movement of the body to the particular destination in the shortest possible time occurs very frequently in the given kinds of sport games. However, it is very complex structure of perception, coordination, speed-strength abilities and in comparison with the movement without solving any movement task the perception itself has deceleration character with regard to the speed of movement. In agility training for sport games it is therefore necessary to implement adequate stimuli without the task solution known in advance.

DISCUSSION

The results suggest that agility is not simply one of speed abilities. Besides simple reaction speed, acceleration, deceleration accompanied by the change of direction of movement, it comprises also perceptual components determined by complex reaction to unexpected, changeable stimuli occurring during a sport game. Training to develop speed and ability would therefore appear to demand a high degree of neuromuscular specificity. Perceptual components that underpin speed and agility must also be accounted for when developing these qualities, which include also anticipation and decision-making. These constraints will be specific to the sport and playing position. Exhibition of both speed and agility in team sports occurs in response to game situations. It follows that perception-action coupling and decision-making are critical elements in terms of developing the ability to express speed and agility capabilities under match conditions. When developing speed and agility, coaches should apply one of the two possible approaches: one approach involves relatively closed skill practice of movement mechanics, often using specialised commercially available equipment such as ladders, mini-hurdles and resistance belts, others advocate a more open skill approach in which agility movements are conducted in a training environment that is less structured and thereby closer to match conditions (Bloomfield et al., 2007).

There is an increasing body of data that support the efficacy of training interventions to develop both change of direction abilities (Brughelli et al., 2008) and the perceptual and decision-making aspects of agility (Serpell et al., 2011). Authors unite in the statement that in order to develop agility, planned change of direction movements executed in a static practice environment must be progressed to open skill conditions, requiring response to a stimulus.

CONCLUSIONS

Based on the found facts we can state that:

- No significant differences were observed in the level of reaction speed to various stimuli between the players of various sport games (basketball, volleyball and soccer);
- The influence of sport specialization is less marked than the one of training stimuli;
- No significant relationship was found between the level of performance in agility with complex reaction (FAC test) and the speed components tested by Illinois test;
- The above mentioned facts show the dominance of perception in the character of movement action in game situations in sport games and its importance in the development of agility in the sport preparation;
- The means used for agility development in the selected groups of sportsmen caused similar adaptation reactions even without the obvious compliance.
- Based on a review of the current paradigm of agility classifications, training and testing, there is a need within the sporting community to recognize what agility involves, how it is trained and what characteristics are being assessed using existing tests of agility. As noted above, many tests do not

involve decision-making or reactive component and could be better described as change of direction speed tests.

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