



Diagnosics of reactive and running agility in young football players

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract

Authors in their contribution deal with the issue of reactive and running agility in sport. Upon constructing the methods of research we assumed that players' performances in running agility (Illinois test) should increase with the age of soccer players. We expected that we shall not prove this tendency in the level of reaction agility (FAC) with regard to the fact that performance in reaction agility is limited, besides motor, also by other prerequisites such as perception, state of receptors, sensoric and autonomous functions, spinal and supraspinal levels of motor system. We also expected that there will be no proved relationship between these tests' results in any age category. The level of performance in running and reactive agility increases with age; the increase is smooth in running agility and cascaded in reactive agility starting with the 14 yrs. category. We also noted a downward tendency in the correlation between running and reactive agility with increasing age. This decline is most evident from the 14th year of age. The relationship between running and reaction agility was not observed in the study group from the age of 13. Coaches are recommended to switch over to the specific development of agility using the way of weakening anticipation ability of the player and to replace exercises with closed-loop skills by the ones of open-loop skills.

Keywords: reactive agility, running agility, correlation, motor tests, soccer

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INTRODUCTION

Agility is an essential component of sports performance in many sports, especially in sports games and martial arts [1,2]. The traditional definition of agility states that agility includes rapid change-of-direction of movement of an athlete [2]. The new understanding of agility includes two sub-components: rate of speed in the changes of the direction of movement, as well as cognitive factors (figure 1).

In recent studies, agility is defined as "rapid movements of the whole body with a change in the speed or direction of movement in response to the stimuli" [4]. This definition also includes the cognitive skills in determining the level of agility, and it only concerns open-loop skills. Open-loop skills cannot be planned in advance, while closed-loop skills, such as running to bases or on a predetermined running route, and alteration of running speed toward different bases, may be planned in advance and learned, performed automatically without the need to respond to external stimuli [3]. In sports games, the players must accelerate, decelerate and change direction of movement quickly during the match. These movements are mostly a reaction to the stimuli, such as the movement of the ball or the actions of the opponent(s). Taking into account the fact that cognitive components are an integral part of sports performance, which requires a response to the stimulus, the players differ mainly in the ability to "read the game" and respond to these sport-specific stimuli [5-7].

The development of reactive agility is novel and relatively unknown concept to many coaches in Slovakia. The coaches usually work with whole teams, and do not pay enough attention to individualized and specialized training processes for various reasons [8]. Modern sport makes high demands not only on speed and precision of execution of the activities in a game, but especially on decision making, response speed to previously unknown stimuli, and anticipation of the opponent's actions in a way that the player successfully solves each situation in the game in the offensive and defensive phase. The game situations are variable, the player has to be able to identify them in a very short period of time and select the most suitable temporal and spatial solution [9]. The reaction speed when making a choice has a major impact on the quality of performance in a game [10]. When developing these skills, an important role is played by perceptual components, which are the basic building block of these skills and they also include the decision-making and anticipation processes [2]. These are, however, specific for different kinds of sports and player roles. Based on the above, Šimonek [11] and Horička, Hianik and Šimonek [12] claim that agility involves a number of components, which are in principle divided into those linked to decision-making and those determined by the rate of changes in movement direction, acceleration and deceleration (figure 2).

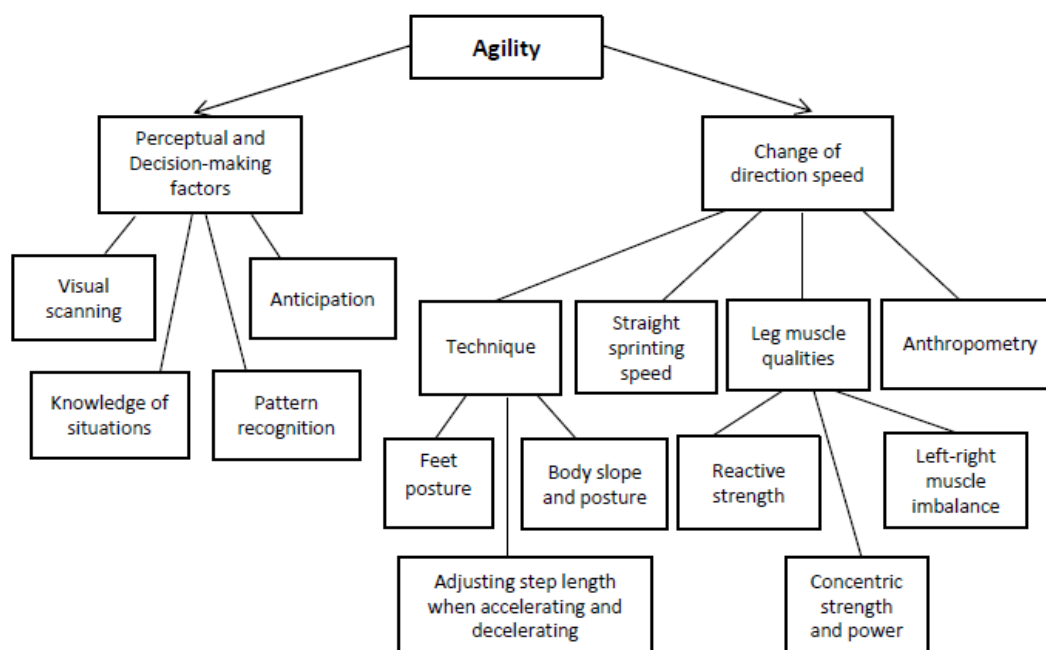
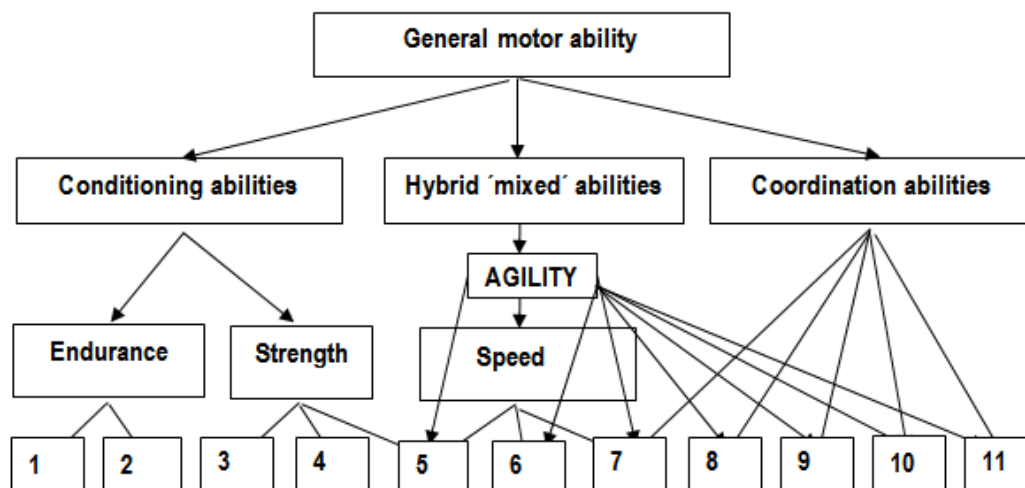


Figure 1. Universal components of agility [3].



Legend: 1 = aerobic endurance; 2 = anaerobic endurance; 3 = strength endurance; 4 = maximum force; 5 = explosive force; 6 = action rate; 7 = reaction rate; 8 = balance ability; 9 = rhythmic ability; 10 = spatial orientation ability; 11 = kinesthetic- differentiation ability.

Figure 2. Hierarchical structure of motor abilities [11].

There is a significant difference between the ability to run and change direction on a known path (the so-called *running agility*, e.g. running around solid objects) and the sport-specific agility skills performed based on the signals in sports games (movement of the ball, opponent or teammates). In the initial stages of agility training, changes of movement directions, which play an important role in the use of agility skills, can be developed by specific predetermined drills around fixed obstacles (bases, slalom poles). This type of runs with the change of direction is basically a repetition of closed-loop skills since the movement is predetermined and it does not require any response to making a choice or decision [3]. *Reactive agility*, according to these authors, is an ability to move and change the direction of motion quickly in response to the previously unknown stimuli. A solid level of both types of agility (running and reactive) requires a combination of speed abilities, dynamic balance, dynamic strength and coordination abilities). The speed of the "perception-action" link and decision-making are the two most critical elements for the development of agility, which integrates the speed abilities and agility in a basketball game [4].

A wide variety of tests to measure the level of ability to change the direction of movement [3-14] is used in different kinds of sports. The test protocols differ in complexity and duration, which also results in varying statistical significance of the correlation of assay scores for the individual criteria in changing the direction of movement [1]. When choosing the assay protocol it is necessary to take into account the following two main aspects: the extent to which the protocol is similar to the requirements of the competitive match, and the existence of standards for the given test, which would provide a possibility to compare the performance achieved by the players.

The most commonly used tests of running agility (which, however, do not include the reactive ability when making a choice) include: L-test, T-test, 22m slalom run and Illinois test [3].

MATERIAL AND METHODS

Participants

The sample consisted of FC Nitra soccer players in four age categories: U12 (V_{13}), U13 (V_{12}), U14 (V_{15}) a U15 (V_{17}). A total of 57 soccer players aged 12 ($n=13$), 13 ($n=12$), 14 ($n=15$) and 15 ($n=17$) participated in the research. The varying numbers in the sets were caused by objective reasons and health, spatial and organizational limitations of our research.



Figure 3. Equipment for Fitro Agility Check

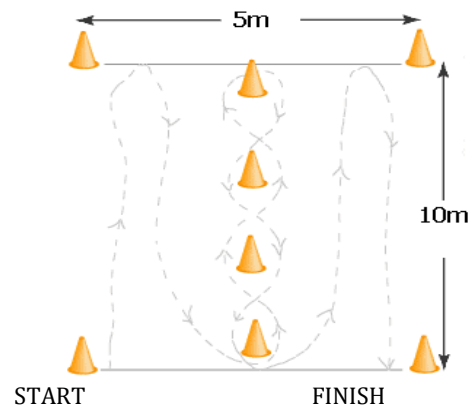


Figure 4. Illinois Agility Test

Procedures

The level of reactive agility of the players was assessed using the Fitro Agility Check device from Fitronic, created at the Department of Sports Medicine UVŠ at FTVŠ UK. The FiTRO Agility Check test device (figure 3) consisted of four "pressure plates" connected to the computer. The test subject (hereinafter TS) stands (dead center) between the 4 square bases (plates) sized 35x35cm, and connected to the computer. When testing the reactive speed and abilities, we distributed the bases 3m away from each other with their closest (internal) boundaries, and each base (plate) acted as a timer. The task of the TS was to respond to the stimuli (visual stimuli displayed on the PC monitor as a red circle on a white background) and step on the respective base as quickly as possible. The stimuli $P_{(16)}$, 4 on each side, were generated randomly by the software in a 2000ms interval. The reaction time was automatically measured by the software [15].

The level of running agility was measured by the Illinois test [16]. The path length was 10 meters and it was 5 meters wide (distance between start and finish). The start and finish line and the two turning points were indicated by 4 cones. Four more cones were placed equidistantly in the middle of the track. The central cones were placed 3.33m from each other. The player ran out when triggered by the signal as indicated in the diagram. The time was measured in seconds (figure 4).

The measurement of time in the Illinois test was performed by precision electronic measuring devices - Witty Witty photocells and Witty timer with an accuracy of 0.01s.

Statistical analysis

When analyzing the experimental data, we tested the differences between the running (Illinois test) and reactive (Fitro Agility Check) agility indicators in all surveyed categories of soccer players. For the assessment of relationship between the monitored variables (Illinois vs FAT), we used the Spearman's correlation coefficient r_s ($-1 \leq r_s \leq 1$) to carry out our correlation analysis in the SPSS statistical software, and we used Spearman's procedure [17]. We have used a 0.01 level of significance. We subsequently analyzed the data and drew our conclusions.

RESULTS

The performance of the players in reactive agility when making a choice (FAC, Tab. 1, figure 5) was not significantly different in the 12-13 yrs. category ($\bar{x} = 1442.66\text{ms}$ and 1436.26ms respectively); however, a significant increase in performance was recorded in the 14 yrs. category ($\bar{x} = 1281.9\text{ms}$). The players in the U15 category even showed a slight decrease in the values of the monitored indicator ($\bar{x} = 1292.26\text{ms}$).

We have recorded the increase in the level of performance in running agility (Illinois test, figure 6) with increasing player age. These increments in average performance can be evaluated as gradual and even ($\bar{x} = 16.77\text{s}$, 16.56s and 16.45s respectively) in the 12-14 yrs. category; however, a significant increase in running speed was recorded only in the U15 category ($\bar{x} = 16.77\text{s}$ and 16.07s respectively).

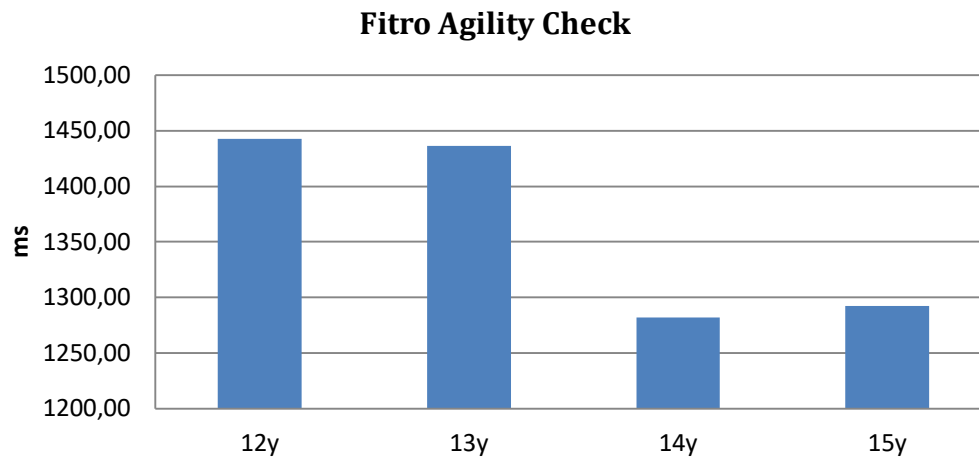


Figure 5. Average results in the Fitro Agility Check test - U12 (n=13), U13 (n=12), U14 (n=15), U15 (n=17).

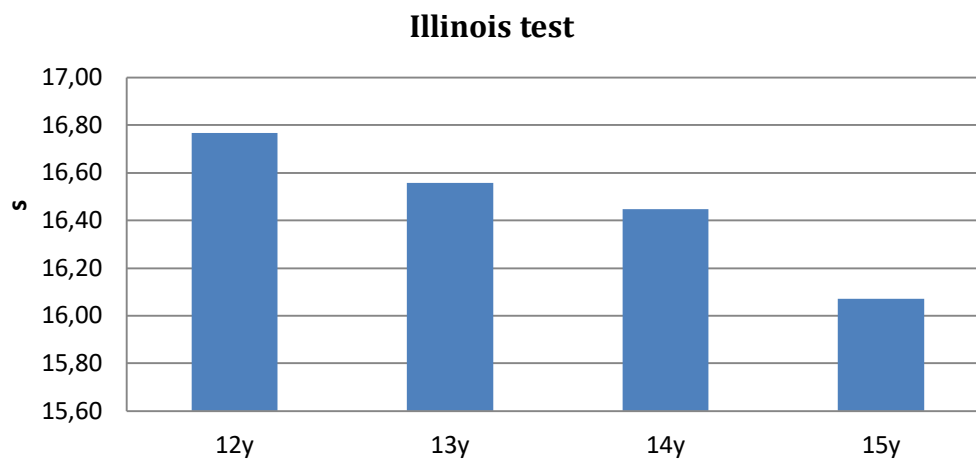


Figure 6. Average results in the Illinois test - U12 (n=13), U13 (n=12), U14 (n=15), U15 (n=17).

The primary values (table 1, figure 7) show the differences in the variance of values in the analyzed sets. The largest variance is noted in the reactive agility (FAC) performance values in the oldest players (U15), and the lowest in the U12 category. In running agility (Illinois test), the greatest variability was observed in the 12 yrs. category and the lowest in the 14 yrs. category (figure 8).

Table 1. Basic characteristics of primary data.

	Illinois test [s]				Fitro Agility test [ms]			
	12r	13r	14r	15r	12r	13r	14r	15r
\bar{x}	16.77	16.56	16.45	16.07	1442.66	1436.26	1281.9	1292.26
min	15.91	15.61	15.78	15.51	1291	1329.37	1150.75	1112
Q 25%	16.37	15.99	16.28	15.87	1372	1396.06	1245.63	1229.75
Me	16.45	16.56	16.45	16.06	1415.62	1428.01	1281.9	1299.75
Q 75%	16.83	16.965	16.62	16.22	1508.75	1491.94	1336.63	1348.5
max	18.43	17.86	17	16.87	1603.37	1537	1408.5	1475

Where establishing the relationship between the running and reactive agility, we used a correlation analysis in the observed categories (table 2).

A significant relationship was only observed in the 12 yrs. category of soccer players ($r=0.791$). A moderate level of dependence (statistically insignificant, $p>0.01$) was observed in the 13 yrs. and 14 yrs. category. Low dependence ($r=-0.390$) was observed in the oldest 15 yrs. category.

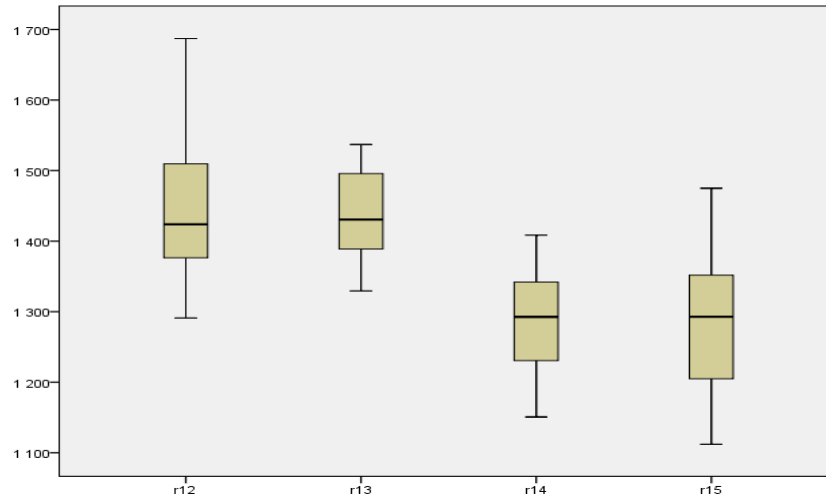


Figure 7. Variance of performance values in the Fitro Agility test (U12 to U15).

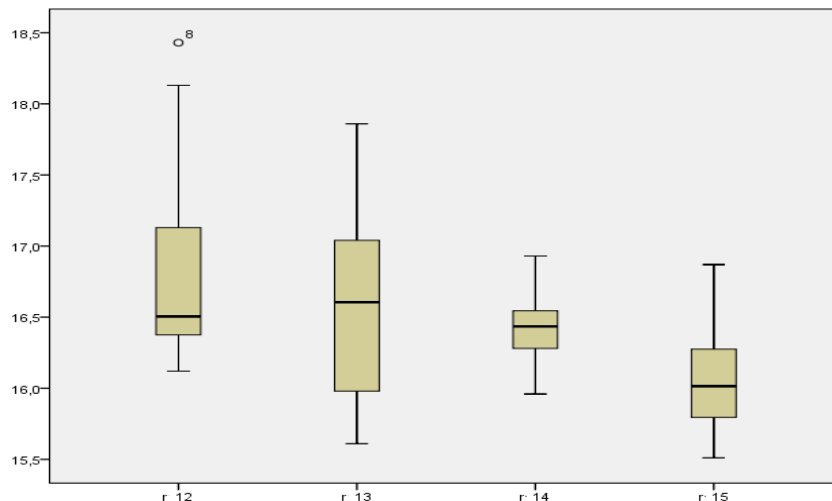


Figure 8. Variance of performance values in the Illinois test (U12 to U15).

Table 2. Spearmann correlation analysis between FAC v Illinois test.

	FAC vs. Illinois							
	12 yrs. old		13 yrs. old		14 yrs. old		15 yrs. old	
Correlation Coefficient	1.00	0.79	1.00	0.66	1.00	0.60	1.00	0.39
P Sig. (2-tailed)	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.12
N	13		12		15		17	
	p<0.01		p>0.01		p>0.01		p>0.01	

DISCUSSION

Results of statistical analysis of obtained data are consisted with our primary hypothesis, where we anticipated that the performance of players in the four categories in Illinois test and Fitro Agility Check will be different given their age and it will increase with age.

An increase in the level of performance in running agility measured by Illinois test can be attributed to the differences in the performance composition of the monitored sets, trainability, functional, somatic and physiological parameters, but may also be determined by the fact that a substantial increase in speed abilities only occurs in children aged 15.

The level of performance in running and reactive agility increases with age; the increase is smooth in running agility and cascaded in reactive agility starting with the 14 yrs. category. We also noted a downward tendency in the correlation between running and reactive agility with increasing age. This decline is most evident from the 14th year of age. The relationship between running and reaction agility was not observed in the study group from the age of 13. Similar results were arrived at by other authors [3,4,13,14,18,19,20]. The differences in the variance of values in the analyzed sets could have been caused by the rarely-occurring extreme values and/or by instability of performance (figures 7 and 8). Given these facts, we conclude that the dependence between the running and reactive agility decreases with age. This fact clearly shows that the response to stimuli and subsequent execution of the movement seem to be limited by other factors such as agility with a previously known structure of movement.

Reaction agility is greatly limited not only by the level of speed abilities, but also by the level of perception, status of perception organs, sensory and autonomic functions, spinal and supraspinal level of the motor system, etc. Their impact on the quality of reaction agility increases with the increasing level of their development. A significant role is played by the ability to respond to the changing visual, auditory and tactile stimuli in the game [6,21].

Running agility with a fixed and predetermined structure of movement is most likely determined by different conditions. The absence of the need to respond to the stimuli and make decisions points to a major influence of innate speed predispositions with a lower possibility for major changes resulting from sports training. The above is, however, hardly applicable in sports games since the course of the game is constantly changing at any moment and the player must react appropriately to this development.

In sports training, we recommend using open-loop skills and focus on the separate development of reaction and running agility.

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