Original Article

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Age-related changes of reactive agility in football

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Abstract

The purpose of this investigation is to determine age dynamism of reactive agility in young football players, thus specifying the impact of sport training on the level of reactive agility of players. 112 young male football players playing for the football club in Nitra, Slovakia volunteered to participate in the study. Another goal was to clarify the age dynamics of performances in the monitored groups of football players and to find out the mutual relationship between the two types of agility. Trends in sport performance and relationship of both kinds of agility were observed in 6 teams of different age categories (U11 up to U16). In order to fulfil the aim of the research two different motor tests for running agility (Illinois agility test) and reactive agility (Fitro Agility Check) were selected. For the realization of Fitro Agility Check test, a computer with the necessary hardware and software, and measuring device Fitro Agility Check were used. To evaluate the relationship between the observed variables (Illinois vs FAC), we used Spearman's correlation coefficient rs ($-1 \leq rs \leq 1$) to perform correlation analysis in SSPS statistical software. We used a significance level of 0.01. The results of this study provide evidence of stabilization of performance with the growing age of players at the level of both types of agility and a dynamic increase, especially after the age of 13. Low values of correlation coefficients (from r = - 0.570 to 0.503) indicate indifferent determinants in running and reactive agility. Since low causal-consequential relationship between reactive and running agility was found in the observed football teams, there is a necessity in the sports training to differentiate between specific means for the development of the so-called pre-planned and reactive agility.

Keywords: Pre-planned agility, reactive agility, dynamism of changes, football, Fitro Agility Check, Illinois test

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INTRODUCTION

In recent times, a top sport is characterized by a high sports performance, perfect technique, high level of motor skills and abilities, placing high demands on motor, psychological and physiological aspects of an athlete´s personality. Thus, the question of increasing effectiveness of sports preparation has come to the forefront. The core content of sports preparation gradually passes from quantity to quality, from general to specific means. Trainers and coaches search for more effective means of developing skills and abilities, focusing also on the more effective exploitation of training time. The quality of sports training rests on the exploitations of „sensitive periods“ for the development of motor prerequisites crucial for the given sport.

Sports games require a high level of specific movements, represented by perfect mastering of the technique of individual skills. The abilities to move quickly, to change the direction and speed of movement, while accelerating and decelerating, belong among the core ones. However, the athlete would not be successful if he would not use his cognitive skills to solve the constantly changing game situations in a match. Athletes with a high level of anticipation, mental processes, the speed of decision-making, show predominance at the effectiveness of their motor performance.

In adolescent period individuals come through a dynamic physical and psychic development reflected in the realization of abilities and skills in a match. Understanding the structure of motor activities of a player in football based on objective data is the key point from the point of view of planning adequate stimuli for the training process. The potential value of the objective data for individualized determination of the loading plays very important role, at least for one group of players (e.g. defensemen, midfielders, offensive players), who undergo the same training contents. Time motion analysis is most frequently used for the analysis of the game performance of a player or team in football. It allows for quantifying running actions of the player, and indirectly verify also energy covering of the movement [1].

Football has the character of highly intensive intermittent (interval) activity [2], which is characterized by the long term interrupted exercise, when periods performed in maximum intensity are exchanged by the ones of submaximal intensity [3]. During the match, players have to perform repeated sprints, acceleration, and turns in a short time sequence, which are interrupted only by short intervals of rest during the long time period. These activities are the key factor of the game performance of the player as well as team [4-7]. If we employ only two factors (speed and distance) for the time motion analysis, we underestimate calculation of external loading of the player, since this kind of analysis does not take into consideration some of the basic and specific movements of the football player (turns, accelerations, decelerations etc.) which occur in a football match repeatedly thus causing enormous loading of physical readiness of the player [8,9]. The knowledge of participation of individual player´s activities in the overall time of the player spent on the field as well as the zones of intensity (pulse rate) represents a significant information for fitness trainers, who have to take these data into consideration when tailoring the contents of trainings. As stated by the American coach *Hughie O'Malley* [10] *based on observation of players of the team Everton FC he divided the game activities of players into walking, jogging,* cruising ('running with manifest purpose and effort'), sprinting and backing. About 2/3 of the distance was covered at the low intensities of walking and jogging and around 800 meters sprinting in numerous short bursts of 10-40 meters. From the above presented analysis there appears that the average player changed the direction of movement and speed of movement every *5-6 seconds.*

Several factors have been reported as possibly influencing agility performance [11,12]. Cognitive and perceptual factors are considered the discriminating factor in agility performance; however, the majority of research has focused on the physical aspect [13]. Contrary to the track-and-fielders, athletes in sports games, where agility plays key role, must visually inspect the whole field and constantly react on the variable changing course of the game. The further distinction between track-and-fielders and sport games players is that track-and-fielders can plan their sprinting action, while football players respond by sprinting only during the game and may not be pre-planned. For example, during a football game, approximately 1,300 changes of movements are undertaken in off-the-ball conditions; players perform over 700 turns and swerves at different angles throughout the game [14].

Until recently, agility performance has been considered to be the ability of a player to quickly change the direction and speed of movement. Modern understanding of agility must respect also cognitive and perception factors of agility. The new term „reactive agility“ includes, besides speed abilities, also perception, the state of perception organs, perception and autonomous functions, spinal and supra-spinal level of the motor system. Their influence on the quality of reactive agility increases with the increasing age and level of their development. An important role is played by the ability to react quickly on a visual, audible or tactile signal in the course of the match [15]. Currently, not many research of reactive and running agility in athletes is available. First attempts to clarify the structure of agility and its changes in the course of adolescence have been carried out in various kinds of sport by Horička, Šimonek and Broďáni [16-18]. Horička, Šimonek and Broďáni [18] based on their investigations recommend for the development of reactive agility in sports training in football to apply the development of the so-called „open-loop skills“ and focus on separate development of both reactive and pre-planned agility.

Based on the described premises, the aim of the investigation is to verify our assumption that both running and reactive agility are independent abilities determined by different factors.

MATERIAL AND METHODS

Participants

Trends in sport performance and relationship of running and reactive agility were investigated in 6 teams of different age categories (112 male football players aged 11 to 16 playing for the football club FC Nitra, Slovakia (U11 up to U16 category), volunteered to participate in the research.

The group consisted of 20 players of the U11 category (decimal age 11,17y), 19 players of the U12 category (decimal age 12,26y), 18 players of the U13 category (decimal age 13,41y), 18 players of the U14 category (decimal age 14,27y), 19 players of the category U15 (decimal age 15,14y) and 18 players of the catregory U16 (decimal age 16,37y).
We drew from the assumption that both simple and complex reactive agility are limited by different factors.

Procedures

In order to fulfil the aim of the research, two different motor tests for simple running agility(Illinois agility test) and reactive agility (Fitro Agility Check; [19] were selected. The FAC test was performed to determine the level of the player's ability to respond to a changing stimulus. For the realization of Fitro Agility Check test, a computer with the necessary hardware and software, and measuring device Fitro Agility Check were used. During testing, results of tests were recorded into registering files designed in advance. Testing in individual groups took place after thorough warming up of the organism, at the time of the group training unit. Each category was tested separately. Data collection lasted 2 weeks. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 2000.

Statistical analysis

Having tested all 6 teams the data were statistically processed with statistical software SPSS, MS Excel and interpreted as to the given aims. We determined the dependence of two numerical variables using the nonparametric Spearman correlation coefficient r. The level of significance (probability of rejection of the null hypothesis H0) was chosen $\alpha = 0.01$, resp. 0.05.

RESULTS

Basic characteristics of the measure of position in tests Illinois agility and Fitro agility check are presented in Tables 1 and 2.

When comparing the performance of players in both tests (Illinois test vs. Fitro agility check) according to their age, we can see that there is an increasing trend in the level of performance of players in each age category. An increase in the level of performance in running agility from the initial

18.51 s in category U11 to the level of 16.07 s in category U16 was recorded, which represents an increment of 2.44 s. However, the most dynamic growth was recorded between 12th and 13th year of age (from 17.71 s to 16.77 s). After a slight decrease in the performance in year 14 (on average by 0.13 s) an increase in the level of performance in the test starts after the age of 14 with the peak level at the age of 16 (16.07 s)

When assessing the level of reactive agility in young football players we can state that there is a similar trend in the changes in the level of this indicator (Figure 2). The level of reactive agility remains almost identical in categories U11 and U12 (1687.39 resp. 1687.58 ms), while in the U13 category a rapid growth was recorded (1442.66 ms). Starting from this age category a slight increase in the level of performance was observed up to the category of U16, where the level is markedly the highest (1292.26ms). A gradual increase in the level of performance through the ages 11 and 16, dynamic growth at the age of 13 and peak values at the age of 16 are the common feature of both reactive and running agility. At the age of 13, a person obviously comes to the stabilization of motor and nervous systems, sensory organs and perception. This stabilization is marked mainly in running agility, which is limited mostly by nervous and muscular systems. On the contrary, a gradually increasing trend through ages in reaction agility was observed.

From the point of view of dispersion of values in running agility, a higher incidence of extreme values was recorded in lower age categories, while lower oscillation of values around the mean was observed in higher age categories. A certain consistency in performance in the observed groups (Figure 1) can be seen in the oldest categories (U15 and U16). On the contrary, in younger categories, a higher degree of variability of values (VAR in $16_{Illinois}$ = 0.141 through VAR in $11_{Illinois}$ = 1.061) can be seen. When assessing the degree of stability in Fitro agility check test the tendencies are slightly different. The smallest variance can be seen in the U14 and U11 categories, while the highest in the U12 category (Figure 2). The degree of stability of performance was similar in the oldest categories (U15 and U16). Both types of agility showed common, reduced incidence of extreme values towards older age categories.

Another intention of the latest research by was to find out the existence of a relationship between both kinds of agility in individual age categories (U11 through U16) of football players. The corelation analysis showed the significance of running and reactive agility only in the case of the two lowest observed categories (U11 and U12), in the category U11 even with a negative polarity of the correlation coefficient (r = - 0.048). Low values of correlation coefficients (r = -0.570 through 0.5029) point to indifferent determinants in running and reactive agility. We assess this finding as fundamental. These facts underline the causes of the distinctive dynamism of changes in both types of agility, but also distinctive conditional indicators of changes in agility in individual age categories. Of course, a certain role can be played also by different degree and focus of fitness training and match preparation of individual teams, specifications of players in teams, individual peculiarities of players, or other facts.

Table 1. Basic characteristics of the measure of position - Illinois test

Illinois test	U11	U12	U13	U14	U15	U16
Minimum [s]	16.72	16.615	15.91	15.89	15.78	15.39
Median [s]	18.48	17.44	16.5	17.02	16.44	16.14
Average [s]	18.51	17.71	16.77	16.90	16.45	16,11
Maximum [s]	21.09	19.175	18.43	17.74	17.00	17.16

Table 2. Basic characteristics of the measure of position - Fitro agility check

Fitro agility check	U11	U12	U13	U14	U15	U16
Minimum [ms]	1538.75	1425.94	1291.00	1377.625	1169.982	1112.00
Median [ms]	1657.469	1651.44	1415.625	1416.063	1370.867	1299.75
Average [ms]	1687.39	1680.58	1442.66	1419.95	1393.17	1292.26
Maximum [ms]	2180.313	1984.44	1687.25	1554.625	1541.875	1475.00

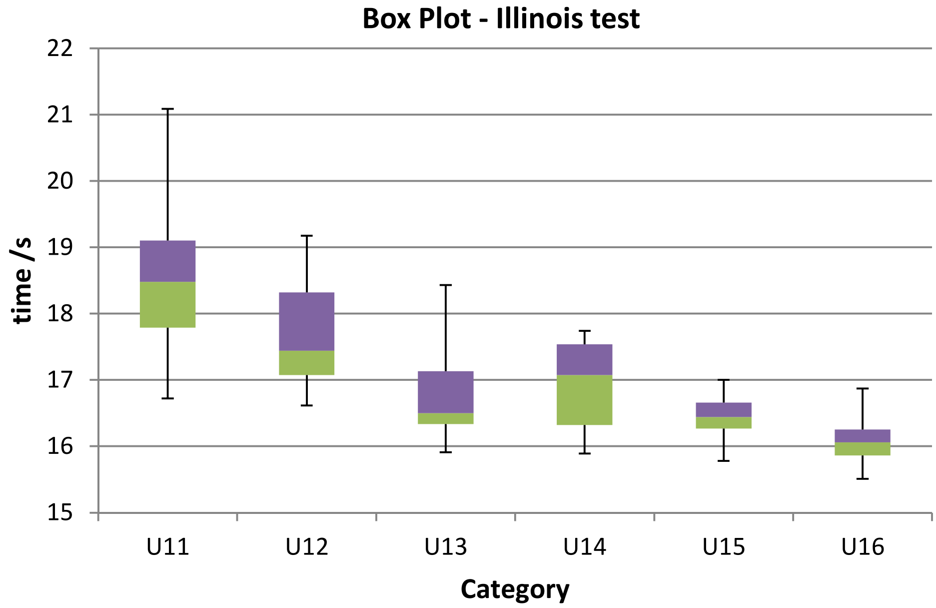

Figure 1. Box Plot - Illinois test

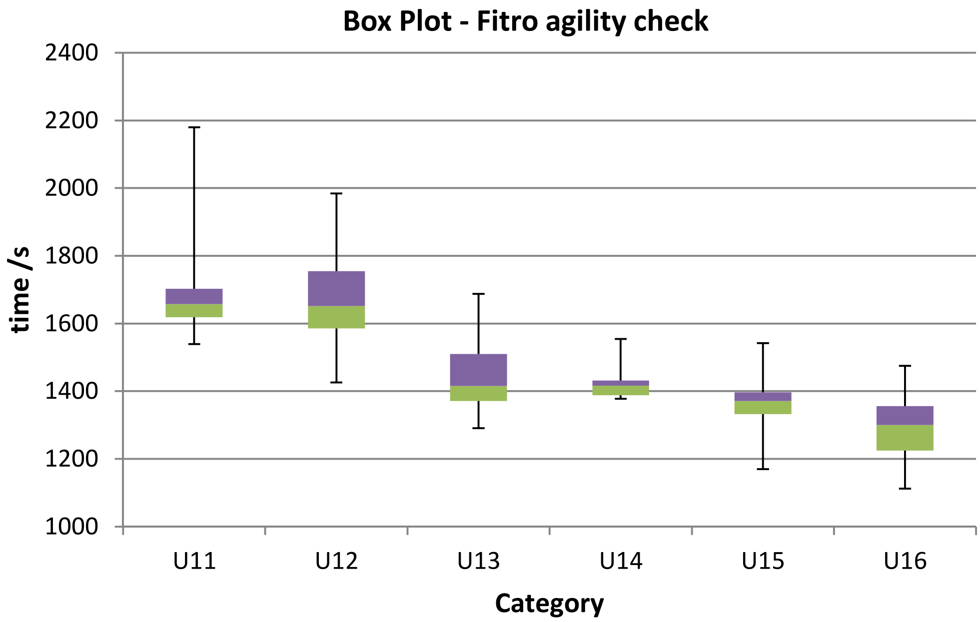

Figure 2. Box Plot - Fitro agility check

Table 3. Correlation Illinois vs Fitro agility check (Spearmann´s rho).

	Fitro agility check test					
	U11	U12	U13	U14	U15	U16
Illinois test	**-0.0481***	**-0.0027***	0.47484	0.50294	-0.5709	-0.199

Level of significance p = 0.05

In a detailed investigation into the characteristics of the relationship between both types of agility, we can observe a noticeable distribution of correlation coefficients in all age categories. This evidenced the low causal-consequential relationship between reactive and running agility in the observed football teams.

DISCUSSION

The purpose of the study was to assess the impact of the specialized sports training on the level of pre-planned and reactive agility of young football players. We were also looking for the relationship between running and reactive agility in order to prove that these are different qualities of players. Reactive agility is influenced by the level of cognition and perception. These are the most decisive intervening components, which play an extremely important role in controlling and realization of fast movements with rapid changes of direction of movement and reaction to a quickly changing stimulus. The dynamic increase in the level of performance in the running and reaction agility of young football players occurs between 12 and 13 years of age, which corresponds to the limit of the development of speed skills in terms of sensitive periods. This massive nature of the level increase is particularly pronounced in reaction agility. This points to different time dynamics of the development of motor and cognitive abilities in children. The low relationship between rate of change of direction (Illinois test) and reaction agility (Fitro Agility Check) suggests that reaction agility does not appear to be strongly associated with the components of maximum running speed. Speed and agility are different physical characteristics and speed training does not seem to adequately improve the speed of changes of direction [13]. Another study [23] examined the effect of physical and cognitive parameters on agility performance. Correlation analysis was used to determine the relationships between various predictive variables (age, weight, body composition, 5-m, 10-m, and 20-m sprint, speed, skill duration, response time, and decision time) and reaction variable (RA). Measurements of the rate of change of direction ($r = 0.43$) had a small to medium correlation with the time of reaction agility, on the contrary, the response time ($r = 0.76$, $P = 0.004$) and decision time ($r = 0.58$, $P = 0.049$) had large to very large relationships with the time of reaction agility. These findings are partly consistent with our results. In further research [23], it was found that athletes using linear acceleration (above 10 m) show greater absolute and relative strength of the lower limbs than athletes using changes of direction. These findings correspond to the assertion that the magnitude of the force contributes to the planned agility [11]. The smaller the changes in direction in agility, the stronger the relationship to linear running speed [25,26]. A player's football activity involves different types of reaction to the ball, teammates and opponents. The level of reactive agility therefore corresponds to the requirements of football. In our group, correlations were found only in the younger categories (Table 3). Our results are in line with the findings of the authors [27], who found low correlations between planned and recreational agility. The cognitive processes involved in the decision-making process reduce the player's speed parameters, which reduces the total time compared to the planned movement.

For the testing of reactive agility we recommend to use tests including not only a movement task but also perception and cognitive tasks. Variability and specificity of focus of fitness trainers on reactive agility is the condition for the improvement of sports performance in football [9,14,17]. It has been shown that basically, it is necessary to differentiate between specific means for the development of the so-called pre-planned and reactive agility [21,22]. Separated development of these independent qualities of the player in football brings the expected effect in the game and coaches should therefore redirect their attention from general development (pre-planned closed-loop exercises) to specific exercises, in which decision-making and perception play an important role [11]. Impact of the sports training on the level of both capabilities is striking, mainly with the onset of adolescence there comes to a fast development of agility. This is connected also with the parallel enhancement of coordination abilities, which have their sensitive periods within this age span.

Our research did not include the effect of the take-off leg on the speed of the movement response during lateral changes of direction, which may be the subject of further research. In any case, not all aspects of a player's agility are clarified. Their research will help the athlete react quickly and perform the necessary movement faster even in match game situations.

CONCLUSION

Football with its numerous motor skills, which should be acquired by the top football player, belongs among the most important sports from the point of view of cultivation of the athlete´s motor profile. In this contribution we intended to point to the inevitability of specialized development of perception and decision-making processes in football players, since fitness trainers in the practice often forget to influence the cognitive processes focusing more to the motor aspect of the movement. Majority of exercises lead up to it. Modern trainer, however, knows the structure of sports performance of the football player and is able to implement perception and cognitive drills regularly into the everyday training routine of young players. Effectiveness of such training will be proved later in the training practice.

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