Models of speed development in soccer

Roksana Krosta
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, m.drozd@awf.katowice.pl

Milosz Drozd
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, m.drozd@awf.katowice.pl

Robert Goralczyk
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, m.drozd@awf.katowice.pl

Maciej Kostrzewa
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, m.drozd@awf.katowice.pl

Patricia Fischerova
The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, m.drozd@awf.katowice.pl

See next page for additional authors

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Abstract

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Keywords

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Authors

Roksana Krosta, Milosz Drozd, Robert Goralczyk, Maciej Kostrzewa, Patricia Fischerova, and Angelina Ignatieva

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Roksana Krosta [ABCDEFG]**, Miłosz Drozd** [ADC]**, Robert Góralczyk** [D]**, Maciej Kostrzewa** [BG]**, Patricia Fischerova** [BC]**, Angelina Ignatieva** [BC]

The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland

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Key words: soccer, speed, regression model, motor abilities, motor potential.

INTRODUCTION

Due to its popularity, simplicity of the game, variability of situations and high dynamics, soccer has been the focus of numerous studies. A key issue in this sport is not only tactics but also adequate motor preparation of a player that ensures performance of the tactical tasks.

Analysis of the history of soccer reveals substantial changes in playing styles. Recent years have seen an increase in its speed and changes in the competitive strategies. Consequently, the methodology of soccer playing looks quite different than it used to several years ago and the attempts are being made to maximize motor potential of a player, which involves the use of more effective technical skills in competitive conditions, especially among elite players.

Running speed is a factor that determines the potential of the body to cover a distance as fast as possible. It is consists of three components: reaction speed, movement speed and frequency of movements [1]. The level of these components has a direct impact on the player's effectiveness during the game. Therefore, [2] indicate that the new training concepts in soccer subordinate endurance training to speed and strength conditioning. Sprints often start when the player is moving at a slower speed, also while the player performs numerous changes of direction, characteristic of soccer. Individual running actions often begin, when a player is running to his position or when marking a player from the opposing team. There is also much fighting for the ball in the air. Therefore, it should be emphasized that playing performance in soccer is to a large degree dependent on the ability to accelerate over the first few steps.

Depending on the country and the league particular authors report a different mean distance covered by sprint during a soccer match: it ranges from 215 to 446 m [3], 199 to 290 m [4], 179 to 334 m [5], or 193 to 260 m (Spanish league), 208 to 278 m (English league), 167 to 345m (European league) [6].

Ferro found that the use of specific training methods and modern concepts of periodization may lead to an improvement in different components of speed such as: acceleration, absolute speed and speed endurance, which increase a player'scompetitive value [1].

Speed, which is a complex motor ability, plays a more significant role in contemporary soccer. In a soccer match, speed manifests itself as a complex psychophysical ability to utilize specific technical and tactical skills most effectively and most dynamically under the pressure of opponents and time.

Speed comprises motor and cognitive components, which are closely related in functional terms. The speed of the motor component is controlled by neurophysiological processes (jumping, acceleration, changes in running direction, dynamic cuts, starting speed). The main role of the cognitive component is played by the analytical and decision centres of the cerebral cortex, which receives and processes information (choice of activity, speed of making proper decisions, speed of reaction, speed of perception and prediction). The process of processing and receiving information in the cerebral cortex is invisible: the only visible element is the motion itself and the speed at which the movement is performed. The speed of particular actions during a match depends not only on the players' running speed, but also on their psychomotor aptitude. For instance, delayed perception and assessment of a match situation results in

wrong decisions and choosing inappropriate actions. Therefore, performing a fast but improper movement during the match is ineffective. Before a player runs to the ball, he should analyse the situation and make a certain decision. Without proper analysis, even a fast player cannot utilize this ability, particularly in tight spaces, and under opponents' and time pressure, where an unconventional dummy should be used immediately combined with a change in direction of running, or a dynamic individual action should be performed, completed with an unexpected shot to the goal, a precise pass or cross to a teammate. Players of lower sports levels often move to the open space too quickly or too slowly, and they also cannot utilize the advantage of greater number of players in situations of 2:1, 3:1 or 3:2. This is caused by erroneous assessment of the situation, which leads to wrong decisions and improper choice of actions. During dynamic actions with or without the ball, players are constantly preoccupied by the assessment of the direction and speed of the ball, as well as the movement of players from their own and the opposing team. Under such situations, the main role is played by cognitive processes, which does not mean that the speed of movement is less important and should not be developed. On the contrary, it should be properly and regularly improved as it represents the most basic motor ability responsible for the effectiveness of a player on the field [7].

Unlike such abilities as endurance or muscular strength, speed is largely determined genetically. Therefore, substantial improvements in speed are significantly related to the player's genotype. Accordingly, even long-term and intensive training may not bring improvements in speed. Speed abilities are closely linked to such genetic determinants as high content of fast twitch fibres (type IIx white fibres), ability to excite them selectively, efficiency of nervous processes, especially the ability to switch from excitation to inhibition, which determines the frequency of movements [8]. However, speed is only one of the motor components that determine sports performance in soccer. Beside motor abilities, technical and tactical skills are of great importance in soccer and other team sport games.

This study concentrates only on one aspect of soccer performance, which is running speed. The main objective of this research was to determine a model of the Speed Abilities Development Index (SADI) in selected teams of the top league, the first and the second league in Poland. The second indirect aim was to determine the most important predictors that have the biggest effect on development of this index.

MATERIAL AND METHODS

PARTICIPANTS

We examined a group of randomly selected 60 athletes (age: 24 ± 3 years) from four Polish top-level league teams, four teams of the first league and four teams of the second league. All the measurements were performed in an indoor sports facility. Temperature in the gyms ranged from 22°C to 24°C. The measurements were taken in the morning, from 8:00 to 11:00 a.m. A standard 25-minute warm-up was used before the tests, including running and dynamic stretching exercises. Measurements were made in February, March, and April. The best results were used for further analysis.

TESTS AND MEASUREMENT METHODOLOGIES

The RAST test was used in the study. The test was modified to 6 sprints over 30-m with 25-s rest intervals. The measurements used four photocell systems installed at consecutive distances of the 30-meter distance: 0 m (start), 5 m, 20 m and 30 m.

Each player was also tested for the maximal running speed, which we used for diagnosis of the players' speed potential. A set of photocell systems installed at 0 m, 5 m, 20 m, 30 m was used during the measurements. Reaction time of the study participants was not taken into account since photocells were released automatically at the instant the study participant crossed the starting line. Split times were also measured at the distances between the photocells.

The following independent variables were obtained from the measurements: times at 5 m, 20 m, 30 m, between 520 m, between 530 m, and between 20−30 m. Seven independent variables were determined in total.

STATISTICAL ANALYSIS

In order to solve the research problem considered in this study, we used empirical analysis, a prognostic survey and exploration examinations of an experimental character. The methodologies of model econometrics were used [9]. The initial number of variables was determined based on the contextual analysis. Since the number of variables was high, it was necessary to use an adequate statistical algorithm to obtain the optimal subset. The results of numerous analyses [10−14] have shown that the most effective procedure of optimal choice of the independent variables is the method of determination of the R0 and R1 vectors using the analysis of the matrix of correlation coefficients. This method was used to determine an optimal vector of independent variables. Accordingly, the optimal subset of independent variables that was used for building the biometric model was composed of six variables: sprint times at 5 m, 20 m, 30 m, 530 m, 20−30 m and mean RAST.

The major focus of this study was to determine the Speed Abilities Development Index (SADI) for three best soccer leagues based on the analysed stimulants and destimulants for each studied athleteand to obtain the dependent variable for building regression models [9, 15, 16].

The Speed Abilities Development Index was determined as a dependent variable Y (SADI) using independent variables (stimulants and destimulants) according to the following formula:

$$u_{(ij)} = x_{(ij)} - sr\_x_{(j)}/S_{(xj)}$$

Where:

x_j − stimulant variable

x_i − destimulant variable

Furthermore, all the variables were standardized. The distances from the pattern were determined from the equation:

$$c_i = \sqrt{\sum_{j=1}^{k}\left(u_{ij} - u_j^*\right)^2}$$

This allowed obtaining a taxonomic measure of development (SADI) using the formula:

$$SADI_i = 1 - \frac{c_i}{\bar{c} + 2S(c)}$$

The independent variables determined in the study using the matrix of correlation coefficients and vectors R0 and R1 were also used as input data for the regression model (stepwise regression) which was aimed to explicate the set of variables that has the major effect on the dependent variable Y SADI assigned to individual leagues (as Y1−Y3) and expressed as a regression function.

Analyses were based on the Excel 2010 software from Microsoft Office 2010 PL package and Statistica 8.0 package (Statsoft 2013).

RESULTS

The following results were obtained for the elite soccer teams during the speed tests. The descriptive statistics of all analysed variables for top, first and second leagues are presented in Tables 1−3.

Table 1. Descriptive statistics of variables that characterize the group of the top league players

Variable	N valid	Mean	SD	Skewness	Kurtosis
Best 5 m	20	1.022	0.022	-0.113	-0.942
Best 20 m	20	2.988	0.068	-0.215	-0.145
Best 30 m	20	4.148	0.097	-0.605	-0.386
Best 530 m	20	3.112	0.088	-0.645	-0.421
Best 20-30 m	20	1.155	0.037	-0.949	0.696
Mean RAST	20	4.347	0.077	0.150	-0.592

Table 2. Descriptive statistics of variables that characterize the group of the first league players

Variable	N valid	Mean	SD	Skewness	Kurtosis
Best 5 m	20	1.073	0.048	0.890	0.606
Best 20 m	20	3.077	0.088	-0.171	-0.982
Best 30 m	20	4.206	0.184	-1.577	3.960
Best 530 m	20	2.934	0.642	-1.798	3.707
Best 20-30 m	20	1.364	0.582	1.873	2.008
Mean RAST	20	4.434	0.155	1.189	1.753

Table 3. Descriptive statistics of sprint variables of the second league players

Variable	N valid	Mean	SD	Skewness	Kurtosis
Best 5 m	20	1.070	0.060	0.766	0.892
Best 20 m	20	3.084	0.116	0.416	0.178
Best 30 m	20	4.273	0.165	0.070	-0.085
Best 530 m	20	3.174	0.106	-0.114	-0.165
Best 20-30 m	20	1.464	3.12	0.130	1.873
Mean RAST	20	4.443	0.157	0.032	-0.024

In the groups of elite players, the regression model determined the following predictors of speed as the most important: the best time of 5 to 30 m run, the best time of 20 to 30 m run and mean result of the RAST (Table 4).

In the group of the players from the first and second leagues, the predictors were: sprint time between 20 and 30 m, mean result of the RAST and the time of 5 m sprint (respectively Tables 5−6).

Table 4. Regression model of predictors of speed abilities in the group of top league players for Y – SADI (Y1)

	BETA	B	p level
		1.102679	0.000019
Best 5–30 m	-3.06233	-0.476387	0.010337
Mean Rast	-0.50109	-0.088810	0.036864
Best 20–30 m	-1.83812	-0.673491	0.031928

Note: R = .92154967 R^2 = .902063393; Adjusted R2 = .89943176; F(5.14) = 3.0410 p < .04595;
Standard error of estimation: .01108

Table 5. Regression model of predictors of speed abilities in the first league

	BETA	B	p level
		0.864598	0.00100
Best 20–30 m	-0.985571	-0.114649	0.001
Mean Rast	-0.078636	-0.034380	0.001
Best 5 m	-0.009862	-0.013899	0.031

Note: R = .99972525 R^2 = .99945058; Adjusted R2 = .99934756; F(3.16) = 9701.9 p < 0.0000;
Standard error of estimation: .00173

Table 6. Regression model of predictors of speed abilities in the second league

	BETA	B	p level
		0.864883	0.001
Best 20–30 m	-1.41376	-0.116014	0.001
Mean Rast	-1.06811	-0.031599	0.001
Best 5 m	-0.01421	-0.001086	0.043

Note: R = .99956581 R^2 = .99913180; Adjusted R2 = .99986902; F(3.16) = 6137.7 p < 0.0000;
Standard error of estimation: .00015

Analysis of regression revealed the following models for Y1 (Top league), Y2 (first league) and Y3 (second league):

SADI (Y1) = 1.103 - 0.476best5-30m - 0,673best 20-30m - 0.088meanRast ± 0.174

SADI (Y2) = 0.864 - 0.115 best 20-30m- 0.034meanRast - 0.014best5m ± 0,011

SADI (Y3) = 0.865 - 0.116best20-30m - 0.032meanRast - 0.001best5m ± 0.009

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DISCUSSION

Modelling of variables with consideration for the SADI index as a dependent variable allowed for determination of the most important predictors of speed abilities.

In the groups of top league players, the first and the second leagues, the regression model determined three predictors for Speed Abilities Development Index (SADI). In order to determine the SADI indices of individual classes of particular leagues, the same correlations of variables 2030m sprint, RAST, and the 5m sprint start were used apart from one case in the SADI index for the top league with the variable 530 m sprint included.

The obtained data confirmed the previously presented results, pointing to the fact that the competition at the highest national level is more dynamic, and the athletes are characterized by better speed abilities. It is known that 90% of the energy supply in a soccer game comes from the aerobic system, yet it is anaerobic efforts, especially explosive activities lasting several seconds, which determine success in this sports discipline.

Furthermore, as suggested by Bottinelli et al. [17] and Idrizowić et al. [18], soccer is a game with great physical fitness demands. A good soccer player should be prepared for both short (5 to 20 m) and longer (30 to 50 m) runs at the highest speed possible (instantaneous accelerations from 9 to 10 m/s).

Apart from speed, the results of 5m sprint starts provide feedback for coaches that help develop specific strength abilities in soccer players. The results of 20 and 30 m runs are considered as speed indicators, whereas additional measurements at flying start distances of 520 m and 2030 m reflect the athletes' coordination and inherited speed abilities. The results of this test can inform the athletes and coaches about the strengths and weaknesses in specific physical fitness characteristics. The obtained results can be very informative, and used for annual monitoring of speed abilities. An athlete can compare his results to previous ones and to his personal best. He can also be evaluated in comparison to the whole team. Furthermore, the test may be used as a reliable measure of the athlete's fitness after a rehabilitation program following an injury [19].

An insufficient development of speed in soccer players can be linked to inadequate knowledge and training of coaches, which prevents them from implementation of new training methodologies. As suggested, the problem lies in training methodologies used by Polish teams, especially those from lower leagues, where the training loads do not resemble game-specific exercises; they do not offer variability of intensity, volume and active rest. Another training mistake may lie in a lack of individual training loads [20].

Compared to the athletes from the highest league in Brazil, where the mean 30 m sprint times equal 7.68 m/s, players from Polish leagues reached significantly lower running speeds during a game (top league: 7.23 m/s, the first league 7.14 m/s, the second league 7.02 m/s) [21].

CONCLUSIONS

In conclusion, insignificant variation of particular speed abilities of players from Polish top league, first league and second league suggests that changes in training periodization are needed to ensure a more effective development

of motor abilities among soccer players. Furthermore, this may not only substantially contribute to improvement results obtained by Polish teams but also, compared to the measurements of speed abilities among foreign teams (especially those playing in European cup competitions), indicate the effectiveness of these activities and improve the players. The national leagues would therefore improve level compared to what is observed today.

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