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MORPHOFUNCTIONAL DETERMINANTS OF THE EFFECTIVENESS OF ONE VERSUS ONE SMALL-SIDED GAMES IN SOCCER PLAYERS

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B. Data collection/entry
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Abstract:

Aim. The aim of this report is to identify variables determining the effectiveness of small football games at subsequent stages of training.

Material and Methods. The study material comprised the results of tests conducted among 42 football players who were assigned to 3 categories: youngsters, younger juniors and seniors. The scope of the study included basic somatic features, selected motor skills tests and specific coordination tests of motor skills recommended for football players. Detailed correlation matrices were calculated using Spearman's signed-rank test between all the analysed variables and the overall game perforance index (OPI). For each training group, morpho-functional profiles were calculated taking variables from previous analyses into account. Variables forming the structure of these models were normalised on the T scale.

Results. 11 statistically significant Spearman's signed-rank correlation coefficients were obtained between game performance indices and the analysed variables. In the 3 training groups of football players, considerable diversity of the internal structure of morpho-functional models was noted. In the group of juniors and seniors, differentiation between features was 1.2 of standard deviation.

Conclusions. In terms of fitness, the influence of circulatory-respiratory endurance and speed ability on the indicator of overall performance for the seniors' game was noted. In turn, taking the neuro-functional side of the players' motor ability into account, correlations with the effectiveness of the game were mainly found within the ability of balance, kinesthetic differentiation and motor adaptation. Such regularities mainly refer to the youngsters and younger juniors.

Introduction

Football is one of the most popular sports in the world due to the number of players actively practicing this game, as well as the huge number of supporters participating in all kinds of competitions [1, 2].

The basic condition for the effectiveness of sports training in football is constantly improving the level of motor, technical and tactical skills of players [3-6]. Many coaches are constantly asking themselves which variables are of greatest importance in training to achieve effectiveness in competitions? The answer seems par-

ticularly difficult when it comes to football, where distinguishing and recognising a group of features that can determine a specific result is extremely complex. In football, open motor structures are dominant. They are performed under time constraints. During the game, players perform both cyclic and acyclic movements in unstable, changing conditions while the body is continuously responding to external stimuli [2, 7].

One of the most often described basic criteria for the selection in football is data regarding the somatic characteristics of players. Preliminary sports selection for this discipline is often the basis for such variables in deciding, for example, about position on the pitch, entrusted tasks for fixed parts of the game, or the performance of various tactical elements during a football match [2, 8-11].

Analysis of the course of a football match allows to state that during competitions, strength- and speed-related efforts are dominant. Anaerobic efforts are associated with single actions [12, 13]. The average time of a sprint is usually 2 to 4 s, and the sections devoted to running are usually shorter than 20 m [14, 15]. Spints comprise 8-10% of the total distance run during a match [14, 16]. The observed maximum values of sprint speed among players are slightly above 30 km/h [16-18]. In turn, aerobic efforts are associated with the total time of the match which is usually 90 minutes. Analyses show that players, on average, cover a distance of 9 to 12 km during a match [14, 15, 17]. According to various studies, mean VO_2max values in highly qualified football players vary – the range quite wide from 48.6 ml/min·kg^{-1} to 77 ml/min·kg^{-1} [19, 20]. Research shows that a high level of VO_2max is positively correlated with the total distance covered during a football match [21].

An important role in football training is also played by neuro-physiological predispositions [22-26]. All coordination skills are extremely important for learning sports techniques and continuous improvement as well as modification during a long training process [27, 28]. These abilities should be shaped in a highly professional way as early as in childhood, due to the efficiency of the nervous system (high mobility and plasticity of nervous processes).

It should be borne in mind, however, that the development of the abovementioned abilities may occur unevenly, therefore, their continuous control is one of the main duties of coaches so as to not neglect the abilities and motor skills of future, highly qualified football players [3].

The aim of this report is to look for variables determining the effectiveness of football players depending on their age and training experience. The following research questions were posed in the work:

1. What is the internal structure of morpho-functional models of football players at particular stages of training?
2. How does the system of variables determining the effectiveness of small one-on-one games change with regard to the age of subjects and with the increase in athletes' level of sports?

Material and methods

The research included 42 players from the following football clubs: MTS Piast Skawina, Wiślanie Jaśkowice and Skawinka Skawina. They were assigned to 3 categories: youngsters D1, younger juniors and seniors [29]. 14 players were tested in each competition group. The average training experience in the youngster group was 3.71 years, with the standard deviation of 0.80. In the younger junior group, the training period was 5.21 years, with the standard deviation of 0.77. The longest training experience was observed in the group of seniors totalling 12.43 years, with 2.23 standard deviation.

Scope of research

The scope of research included basic somatic features: body height, subischial leg length, thigh and lower leg circumferences, body mass, fat mass (FM), lean body mass (LBM) and BMI index. For somatic measurements, Martin-type instruments and the TFB-551 TANITA scale were used. All body mass measurements were performed to the nearest 100 g, while body height was assessed to the nearest 1 mm. Agility is located at the borderline of somatic and functional predispositions, which was tested by the depth of the trunk during a forward bend in a seated position [30].

The subject of analysis were also selected motor fitness tests:

a) Standing long jump [30]. The measurement was conducted using a measuring tape to the nearest 5 cm. Based on the results, the maximal anaerobic work (MPA) was calculated, which can be treated as an approximate measure of maximal anaerobic power of the lower limbs [31].
b) Two-hand over-head 2 kg medicine ball throw. The measurement was performed using a measuring tape to the nearest 10 cm. This test allowed to determine the size of upper limb maximal anaerobic capacity [31].
c) 3 x 5 metre envelope run. During the test, the subject covered the route 3 times as quickly as possible. 2 attempts were made, the better result was recorded.
d) 10 x 3 metre shuttle run. Performed as a test of speed capability. 2 attempts were conducted, the better result was recorded. On the basis of the obtained results, maximal anaerobic power was calculated [33].
e) Standing start 10-m run. Performed as a test of speed ability. Each subject underwent 2 trials, the better result was then analysed.

f) Endurance shuttle run (beep test). Performed as a test of endurance. The result of the test was the distance covered.
g) No. of sit-ups in 30 seconds. This was analysed as the dynamic strength of the abdominal muscles [30]. The result of the test was the number of repetitions.

The scope of research was also supplemented with specific tests of coordinative motor skills recommended for footballers [22]: the ability to combine movements, spatial orientation, sense of movement rhythm, static balance, kinesthetic differentiation, motor adaptation and shifting movement.

In order to evaluate the effectiveness of activities during the game, one-on-one test games were carried out according to the proposals of Ljach and Witkowski [22]. They made it possible to quantify the effectiveness of the players' activities. The 1 x 1 playing pitch was marked on a square plan with a 20-m side, divided into 2 halves. There were 1.5 x 1 m goals on the pitch. The goal only counted if the shot was made from the opponent's half. Each footballer played one another. For the victory in a single competition, 3 points were awarded, for a draw - 1, and for a loss - 0 points. The match between the 2 players lasted 2 minutes, with players changing sides after 1 minute. If the ball left the game square, the game was resumed from the place where it left the pitch. When changing the half and performing penalty kicks, the game was stopped. For each offense, a penalty shot was taken from the middle of the pitch to an empty goal.

Methods of statistical analysis

In order to answer the posed research questions, the following methods of statistical analysis were used:

1. Based on the analysis of one-on-one games (every-one-with-everyone in a given training category), the total number of points scored by individual players for all games was calculated - interpreted as an indicator of overall performance (OPI) both in defence and offense [22]. This indicator was considered to be the leading one, because it best characterises the effectiveness of the players' game.
2. Detailed Spearman's signed-rank correlation matrices were calculated between all analysed variables (in each training group) and the overall performance index (OPI).
3. For further analysis, among all the independent variables, only those showing statistically significant correlations with the performance index were selected, namely: 10 m, 10 x 3 m, beep test, sit-ups, medical ball throw, envelope run, MPA calculated on the basis of the standing long jump, agility, balance, kinesthetic differentiation, motor adaptation. 4. In each training group, morpho-functional profiles were calculated taking variables from previous analyses into account. Variables forming the structure of these models were normalised on the T scale (normalisation for means and standard deviations of the whole material). In addition, the results for the first player on the ranking ("case study") are presented for each group compared to the crossed out profiles.

Results

As mentioned above, on the basis of the significance of Spearman's signed-rank correlation coefficients between the game performance indicators and the analysed variables, the ones that were ultimately used to determine the morpho-functional models were selected. The list of 11 variables is presented in Table 1. Furthermore, the value of variables making up the particular morpho-functional models performed within developmental aspects was subjected to detailed analysis. In order to analyse the stated research problem, separate morpho-functional profiles were created for each training group. The variables selected for the creation of these models were normalised on the T scale. The normalisation conducted in individual training groups gave the average and standard deviation of the whole studied population. The internal structure of models in individual training groups is presented in Table 1 and is graphically illustrated in Figures 1-3. Additionally, in each training group, the standardised results of the player in first position on the ranking were presented, taking the overall performance index (OPI) into account

As can be seen in Figure 1 and Table 1, the average of points on the T scale in the group of youngsters from all 11 variables was 41.91 points. The variation between characteristics is relatively large and is within 1.23 of standard deviation. The following variables are located above average for the module: agility, kinesthetic differentiation and motor adaptation (respectively: 8.49, 7.87 and 1.81 points).

In turn, the results for MPA calculated from the standing long jump are definitely below the average for the module. In the case of this variable, the average results were smaller by as much as 5.06 points than the average for all variables included in the morpho-functional profile of youngsters. In this training group, the results of 2 variables: the beep test and the medicine ball throw were also below the module average. In both cases, the average results were worse than the average for the module by about 3 points. The average results of the other analysed variables are close to the average for the module.

The size of normalised variables for the player in first position on the ranking (in the group of youngsters) is also interesting. The average of all analysed variables was as much as 48.71 points. However, the very large variation among subjects, which totalled 2.8 of standard

Table 1. Structure of the morpho-functional model in the training groups of footballers expressed in points on the T scale

Variable	Youngsters	Youngster 1st in the ranking	Younger juniors	Younger junior 1st in the ranking	Seniors	Senior 1st in the ranking
10-m run	41.73	48.69	58.69	56.08	49.56	58.26
10 x 3 m run	40.47	53.85	52.28	56.61	57.24	61.81
Beep test	38.03	42.35	54.66	60.73	57.29	67.27
Sit-ups	40.05	47.05	56.24	57.20	53.70	60.59
Medicine ball throw	38.47	40.62	52.02	53.92	59.50	66.38
Envelop run	40.63	49.47	56.41	58.84	53.00	59.88
MPA jump	36.85	35.92	54.22	53.24	58.92	59.72
Agility	50.40	65.40	53.06	62.06	47.53	48.73
Balance	40.95	42.34	53.48	63.13	55.81	51.91
Kinesthetic differentiation	49.78	63.82	50.90	74.46	49.41	53.19
Motor adaptation	43.72	46.39	54.30	58.48	52.09	56.75
$\bar{x}$	41.91	48.71	54.20	59.52	54.00	58.59

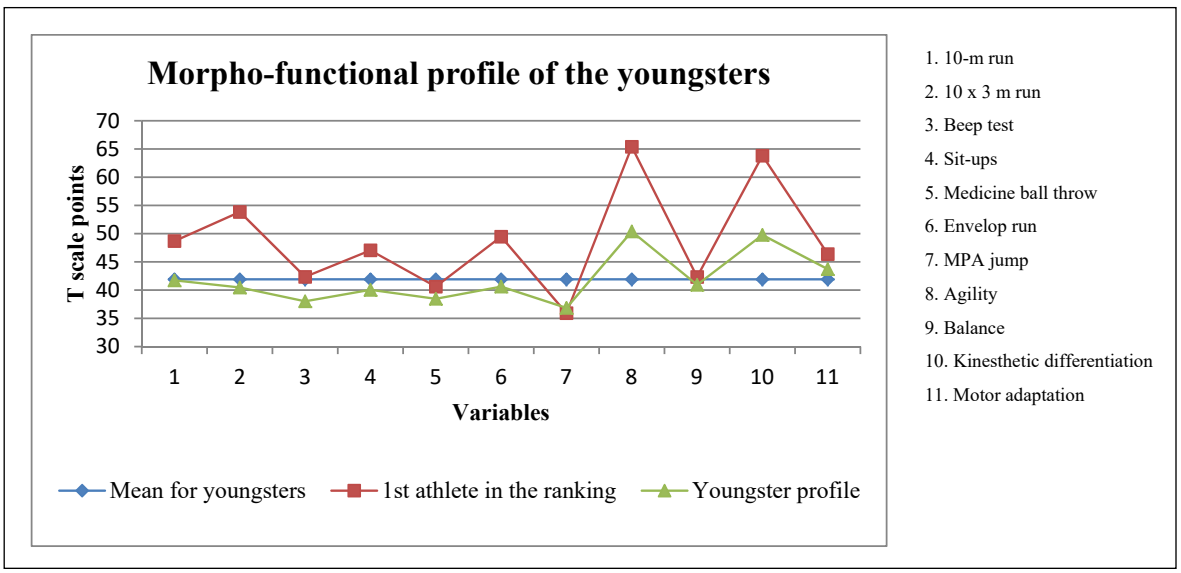

Fig. 1. Profile of variables for the morpho-functional model in the group of youngsters in categories of calendar age

deviation, should be emphasised. As it can be seen from Figure 1, the model participant obtained, in relation to the average module, definitely higher results in the agility and kinesthetic differentiation tests. Out of all the 11 analysed variables, only the results of MPA calculated for the standing long jump are below the average for the youngster module.

Table 1 and Figure 2 present the profile of morpho-functional variables for younger juniors. In this fraction, slightly smaller diversification of the share of particular variables in shaping the sports level is observed. The variation between features is within the range of 0.78 standard deviation. The average of all the analysed variables included in the model was as high as 54.20 points. The results of the 10-m and the envelope runs are definitely above the average for the module (respectively: 4.49 and 2.21 points). On the other hand, the results for kinesthetic differentiation are clearly below the average for the module (50.90 points). The average results for the remaining variables introduced in the morpho-functional model fluctuate within the vicinity of the average level for the analysed training game.

The profile of the first player on the ranking compared to the whole analysed group is also interesting.

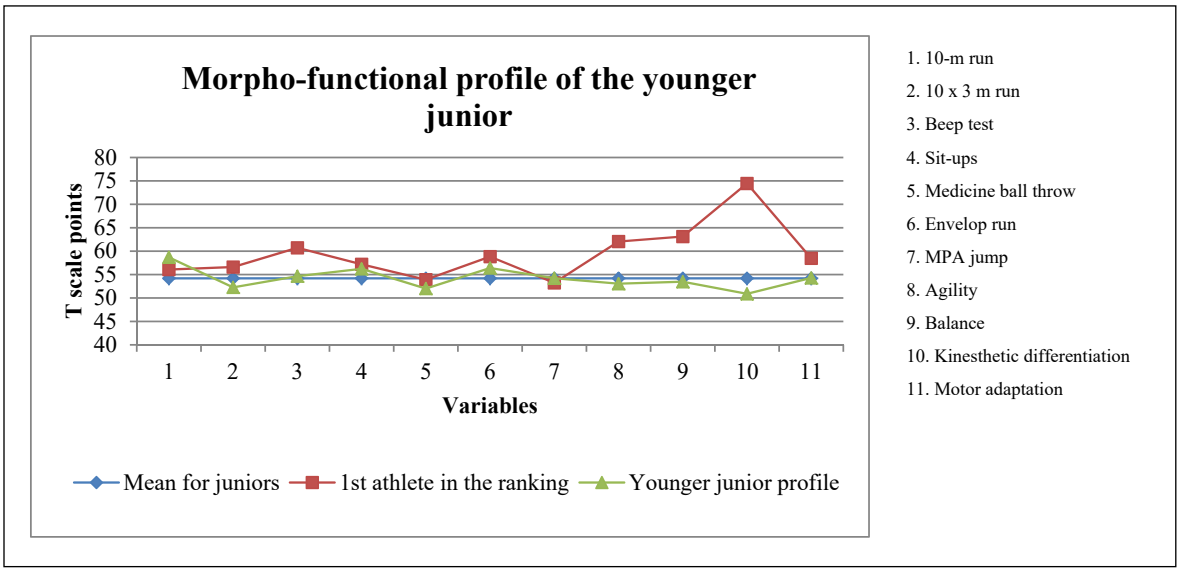

Fig. 2. Profile of variables for the morpho-functional model in the group of younger juniors in categories of calendar age

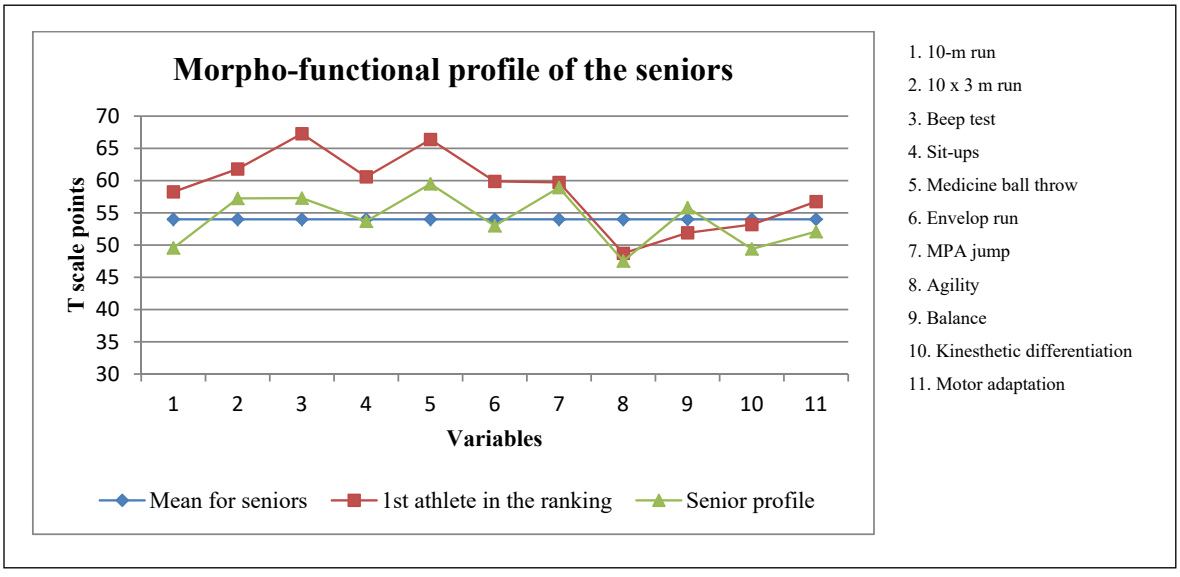

Fig. 3. Profile of variables for the morpho-functional model in the group of seniors in categories of calendar age

The average of all analysed variables was as much as 59.95 points. As it can be seen in Figure 2, the results of kinesthetic differentiation are clearly above the module (74.46 points). The results of the following are also above the average results for younger juniors: balance, agility, beep test. The model player presents the lowest MPA results calculated for the standing long jump (53.24 points).

Yet a different internal structure of the model is observed in the group of seniors. Again, as in the case of youngsters, the diversity between particular variables included in the morpho-functional model is 1.20 of standard deviation. As shown in Figure 3 and Table 1, the average number of points on the T scale in the group of seniors was 54.00 points. It should be emphasised that in this model, there is only a relatively low score for agility (47.53 points). Below the module, averages for the following tests can also be found: 10-m run (49.56 points), kinesthetic differentiation (49.41 points), motor adaptation (52.09 points). As it can be seen in Figure 3, the results of the medicine ball throw and the MPA calculated for the long jump are located far above the module. Such high average values for the first analysed variable are especially surprising. For the morpho-functional

model of seniors, there are still above-average results: beep test and 10 m x 3 m run.

Analysing the morpho-functional profile of the first player on the ranking, it was found that the athlete had a particularly high level of energy-based capabilities (both anaerobic and aerobic). It should also be highlighted that the importance of agility and neuro-physiological capacity decreases in the model. The average of all analysed variables included in the model was as high as 56.65 points in the concerned player.

Discussion

A high sports level is almost synonymous with the fact that players are reliable both in offensive and defensive actions [34, 35]. Thus, in our research, the basis for further analysis was the overall performance index (OPI) both in the defence and offense, determined on the basis of one-on-one test games [22]. Although these types of games differ from the actual sports battle, they require high level of fitness and coordination skills from players [36, 37]. They simulate many situations from a football match and are one of the most popular forms of training used for the comprehensive development of football players [38, 39]. Research shows that test games improve aerobic capacity of footballers [37, 40, 41], speed abilities [1] and coordination [42]. A one-on-one duel occurs very often, and at the same time, it is a quite spectacular part of a football match. Although one-on-one situations are called "uncertain" during a match, players with the highest level of training often undertake these sorts of duels. They are decisive when it comes to ultimate success in sport.

Analysing the morpho-functional profiles calculated in our research among the youngster group and the first-ranked athlete, we can conclude that there is significant variation in the profile of motor skills from which s/he is formed. Recruitment and selection are of great importance here, which determine the level of abilities and somatic traits. The results indicate that co-ordination abilities are important in recruitment. These regularities are particularly visible when analysing the model player's profile. Among co-ordination abilities, kinesthetic differentiation and motor adaptation are definitely above the average for the whole training group. Similar regularities were also obtained by analysing the profile of the first player in the younger junior ranking. Again, above average for the module were: balance, kinesthetic differentiation and motor adaptation. As emphasised by many authors [43-45], proper stimulation of the development of motor coordination leads to raising the athlete's sports level. According to the quoted studies, there is a close relationship between the level of coordinative motor abilities and technical-tactical skills and the effectiveness of sports competition. Their high level can largely determine the outcome of a competition, due to the high complexity of movements and the ability to adapt to changing game conditions [2, 7].

The importance of kinesthetic differentiation of football movements was emphasised by Cięszczyk and Stępiński [46]. In turn, the publication [42] attempted to identify the relationship between motor coordination and the 1 x 1 game. In the above-mentioned work, the authors found that the greatest correlations occur between the one-on-one game and motor adaptation (0.96, $p < 0.05$). In addition, it has generally been observed that a high level of coordination abilities determines effective behaviour during one-on-one duels. Many authors also point to the importance of static and dynamic balance in football [23, 47-49]. A relationship was found between the balance results and sports level. In general, it was stated that players of games at higher levels are characterised by a higher level of balance. It is also postulated to establish normative values for individual training groups.

A definitely different morpho-functional profile was obtained in the group of seniors. According to the authors' research, the analysed coordinative abilities have smaller impact on game effectiveness. Such an image is probably the result of proper training in these abilities, which resulted in their similar level. According to Stula [43], Stuła and Duda [50] and Osman [51], increased coordination training has significant impact on the performance of young athletes as well as future sports championships. In light of the literature quoted in the introduction, it seems that the energy-based individual properties of the body of football players [12-16] have very great impact on the level of sports championships. These regularities are confirmed by our research. Analysis of the senior model allows to conclude that during the competition, endurance-speed efforts dominate. These regularities will particularly indicate the profile of the first player on the ranking.

The issues discussed above refer to the "champion model" in football, they are a refinement of specific observations. The presented models allowed to capture subtle differences between particular variables in terms of their participation in building the analysed models at particular stages of training.

Conclusions

The following conclusions can be drawn on the basis of the presented research results:

1. Large variation was noted in the internal structure of morpho-functional models for individual training groups. Variables determining the effectiveness of small games create characteristic complexes, the content of which is not permanent models.

2. In terms of fitness capacity, first and foremost, the influence of circulatory-respiratory strength and speed ability on the indicator of comprehensive effectiveness of the game of seniors was revealed. In turn, taking the neuro-functional side of the players' motor ability into account, the correlations with one-on-one game effectiveness were mainly located within the abilities of balance, kinesthetic differentiation and motor adaptation. Such regularities refer mainly to youngsters and younger juniors.

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