LATENT STRUCTURE OF MOTOR AND FUNCTIONAL VARIABLES ON A SAMPLE OF JUNIOR FOOTBALL PLAYERS

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ABSTRACT

Football is a complex sport. Success in football depends on a deep understanding of football players' developmental phases, as well as of the effects of particular motor and functional abilities. This is particularly true for the junior category of football players (age 17-19). The purpose of this research was to determine the latent structure of motor and functional characteristics of junior football players. The sample of subjects comprised 100 football players, juniors of the Croatian First Football League. The variables used for the assessment of motor and functional abilities included 22 tests (6 agility tests, 3 functional ability tests, 1 shot-type explosive power test, 4 sprint tests and 8 isokinetic force tests). A component model of factor analysis was used to determine the latent structure of motor and functional variables. Four latent variables were revealed: primary agility as the first factor, followed by endurance, explosive power and isokinetic force.

Keywords: football, junior players, motor abilities, functional abilities

INTRODUCTION

The complexity of the game puts great challenges before football players with respect to their functional and motor abilities, morphology, technical-tactical preparation and psycho-social status. Meticulous and high-quality planning and programming of the training process is of great importance in the training of junior football players. Juniors are football players aged 17-19. This is the period of late puberty and early adolescence. In puberty, a balance in the development of organs, organ systems and subsystems is being established. Furthermore, the functioning of psycho-motor abilities stabilizes and functional abilities improve in this period (Barnes, 1975). Athletes at 15 to 18 years of age undergo the specialisation phase and face increased demands of training and competitions (Shephard, 1999). The specialisation phase is a phase of major changes. The athletes who were previously subject to a training programme stimulating multifaceted development will now focus on specific exercises for the development of top performance in football. In this phase, athletes should master all the technical elements. Also, physical and psychological demands increase during this phase, including the specific exercise training volume and training intensity. An activity analysis showed that, on average, players sprint every 90 seconds during a football game, with each sprint lasting an average of 1 to 4 seconds (Mohr, Krustrup and Bangsbo, 2003; Rienzi et al., 2000; Reilly and Thomas, 1976). Consequently, stronger emphasis has been placed on conditioning and aerobic-type training. Increased attention has also been given to the tactical and the information component of training, considering the fact that the top-performance phase, whose primary goal is to improve competition efficiency, begins at the age of 19 (Reilly and Gilbourne, 2003). Research in this area is necessary if we strive to improve the quality of training of young football players in accordance with a deeper understanding of the principals governing the development of particular motor and functional abilities.

METHODS

Sample of subjects

The sample of subjects was selected from the population of the Croatian First Football League (1.HNL) players. The sample comprised Croatian First Football League juniors (n=100) of the average height of 179.2 ± 5.2 cm and the average weight of 73.2± 4.1 kg. The conditions for the selection of players from a particular club were: a minimum of 20 matches played in the previous season (both friendly and championship games count), a minimum of 75% practice attendance in the previous season and a minimum of 7 years of football experience.

Sample of variables

For the purpose of the research, the players were subjected to 22 tests for the assessment of motor and functional abilities (6 agility tests, 3 functional ability tests, 1 shot-type explosive power test, 4 sprint tests and 8 isokinetic force tests). The agility tests included: agility 93639 (MAG9OK), forward-backward run (MAG9NN), zigzag run (MAGSLT), zigzag dribble (MAGSLV), 90-degree change-of-direction run (MAG90T), 90-degree change-of-direction dribble (MAG90V). The sprinting ability tests included 5m sprint (SP5), 10m sprint (SP10), 20m sprint (SP20) and 30m sprint (SP30). Shot-type explosive power was assessed using the MESBL penalty shot test. The functional ability tests included 1,500m run (1,500m), Beep test (BEEP) and maximal oxygen uptake (VO2max). Isokinetic testing was carried out at the Medical Examination Centre in Split, on the isokinetic dynamometer Cybex 300. The standardized two-speed muscle strength and muscle endurance test was used. Testing was carried out by a professional educated to use isokinetic dynamometer and the subjects were examined for any contraindications prior to undergoing isokinetic testing. To measure the muscle force, the 60 degree-per-second velocity mode was used, and the 180 degree-per-second velocity mode was used to measure the strength endurance. The following parameters were measured: right quadriceps force (QSD), left quadriceps force (QSL), right quadriceps endurance (QID), left quadriceps endurance (QIL), right leg flexor force (FSD), left leg flexor force (FSL), right leg flexor endurance (FID), left leg flexor endurance (FIL).

Data analysis methods

Data were analysed using the software package Statistica, version 8.0. The first step was to carry out standard analysis of basic statistic parameters of distribution for each variable. For all of the variables and measurements, central and dispersion parameters were calculated: arithmetic mean (AM), standard deviation (SD), minimum (MIN), maximum (MAX), result range (RAN) as well as kurtosis (KURT) and skewness (SKEW) of the distribution. The Kolmogorov - Smirnov test was carried out to test the normality of the distribution. In order to determine the latent structures, the matrix of correlations of morphological tests was subjected to an exploration procedure of the Harold Hoteling component model of factor analysis (1993). The Hotelling model determines linearly independent components from a group of manifest variables based on an unreduced correlation matrix. The number of significant factors was determined using the GK criterion, which defined the orthogonal system of principal components transformed by the varimax normalized orthogonal rotation. According to the GK criterion, the significant number of principal components was used on the basis of their variance, i.e. on the basis of the characteristic values of the correlation matrix. The components with characteristic values that were higher than or equal to 1 were considered significant.

RESULTS AND DISCUSSION

Table 1 shows principal components and their characteristic values, as well as the percentage and cumulative percentage of the variance explained.

Table 1 Principal components (PC), their characteristic values (λ), the percentage of the explained variance (% var) and the cumulative percentage of the explained variance (Cum %).

	λ	% var	Cum%
1	10.93	37.68	37.68
2	5.00	17.23	54.91
3	3.15	10.86	65.77
4	1.92	6.60	72.38

The factor analysis revealed four motor factors. A detailed analysis of the factor structure matrix was used to determine latent dimensions in the background of manifest motor variables of the Croatian First Football League juniors.

Table 1 shows that the latent factors in the motor domain with a characteristic value that was higher than 1 were considered significant. The characteristic value of the final motor factor was 1.92. It is also visible that the four factors listed in the descending order accounted for approximately 37%, 17%, 10%, and 6% of the total variance of manifest variables, respectively.

Table 2 Factor structure matrix on the sample of juniors (F)

		1	2	3	4
1	MAG9OK	**0.75**	0.10	0.08	0.03
2	**MAGNN**	**0.79**	0.01	0.10	0.07
3	**MAGSLT**	**0.80**	0.07	0.10	0.16
4	MAG90T	**0.83**	0.05	0.10	0.12
5	**MAGSLV**	**0.86**	0.08	0.05	0.00
6	**MAG90V**	**0.90**	0.05	0.17	0.04
7	**BEEP**	0.04	**0.84**	0.08	0.01
8	**VO2max**	0.13	**0.82**	-0.02	0.09
9	**1500m**	0.05	**0.81**	-0.07	0.07
10	**Sp5**	0.01	-0.03	**0.86**	0.17
11	**Sp10**	0.09	-0.01	**0.85**	0.24
12	**Sp20**	0.10	-0.14	**0.81**	0.07
13	**Sp30**	-0.04	-0.07	**0.80**	0.10
14	MESBL	0.15	-0.05	**0.89**	0.38
15	**QSD**	-0.12	-0.16	0.05	0.54
16	QSL	-0.11	-0.13	0.05	0.56
17	FSD	0.20	-0.01	0.06	0.73
18	FSL	-0.03	-0.04	-0.08	0.77
19	QID	0.00	-0.02	-0.03	0.81
20	QIL	0.07	0.02	-0.09	0.80
21	FID	-0.05	-0.13	-0.15	0.82
22	FIL	0.11	-0.03	0.10	0.78

Sprint 5m - (SP5); Sprint 10m – (SP10); Sprint 20m – (SP20); Sprint 30m – (SP30); Shot-type explosive power test –(MESBL); right quadriceps force (QSD), left quadriceps force (QSL); right quadriceps endurance (QID), left quadriceps endurance (QIL); right leg flexor force (FSD), left leg flexor force (FSL); right leg flexor endurance (FID), left leg flexor endurance (FIL); *Run1500m – (1500 m); Beep test - (BEEP); Maximal oxygen uptake (VO$_{2max}$)*; MAG9OK - Agility 93639 (MAG90K) *;* MAG9NN –forward-backward run*;* MAGSLT – zigzag run*;* MAG90T - 90-degree change-of-direction run; MAG90V- 90-degree change-of-direction dribble

The highest parallel projections on the first factor were determined for agility variables MAG9OK (0.75), MAGNN (0.79), MAGSLT (0.80), MAG90T (0.83), MAGSLV (0.86), and MAG90V (0.90). This factor was therefore named the football players' agility factor. Agility tests are tests with the best metric characteristics. Agility was therefore identified as the dominant ability affecting football players' success level. The highest parallel projections on the second factor were determined for variables BEEP (0.84), VO2max (0.82) and 1500m (0.81). This factor was therefore identified as the endurance factor of football players. The highest correlation with the third factor was determined for variables SP5 (0.86), SP10 (0.85), SP20 (0.81), SP30 (0.89) and the shot-type power test MESBL. Considering the factor structure, the third factor can be identified as the explosive power factor. The highest correlation with the fourth factor was determined for variables QSD, QSL, FSD, FSL, QID, QIL, FID, and FIL (coefficients ranged from 0.54 to 0.82). Considering the factor structure, the fourth factor can be named the isokinetic force factor.

CONCLUSION

The factor analysis was used to determine the latent structure of motor and functional variables on a sample of Croatian First Football League juniors. The first factor was defined by the following variables: agility 93639, forward-backward run, 90-degree change-of-direction run, 90-degree change-of-direction dribble, zigzag run and zigzag dribble. It was identified as the agility factor. The second factor was determined by the following variables: Beep test, 1500m and VO2max. It was named the endurance factor. The highest correlation

with the third factor was determined for the sprint variables 5m, 10m, 20m and 30m and the shot-type power test MESBL. This factor was identified as the explosive power factor. The fourth factor, defined by variables right and left quadriceps force, right and left quadriceps strength endurance, right and left leg flexor force, and right and left leg flexor strength endurance, was named the isometric force factor. In conclusion, the most important abilities determining success in football are those based on agility, endurance, explosive power and isometric force.

REFERENCES

Barnes, H.V. (1975). Physical growth and development during puberty. *Medical Clinics of North America*, 59, 1305-1317.

Mohr, M., Krustrup, P. and Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. J.ournal of Sports Science, 21, 519–528.

Reilly, T. and D. Gilbourne, V. (2003). Science and football: A review of applied research in the football codes. J.ournal of Sports Science, 21, 693-705.

Reilly, T. and V. Thomas. (1976). A motion analysis of work rate in different positional roles in professional football match-play. Journal of Human Movement Studies, 2, 87–97.

Reilly, T., Reilly, N., Secher, P., Snell, P. and Williams, O. (1990). Football. Physiology of Sports. London: E. & F.N. Spon. 371– 426.

Rienzi, E., B. Bompa, T. Nurmi, J. Carter, and A. Martin. Investigation of anthropometric and work-rate profiles of elite South American International soccer players. J. Sports Med. Phys. Fitness. 40:(2) 162–9. 2000.

Shephard, R.J. (1999). Biology and medicine of soccer: an update. Journal of Sports Science, 17, 757-786.