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

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ABSTRACT

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. Sensitivity of some developmental phases, especially puberty (cadets, aged 14-16), makes the training process even more demanding. It is essential to understand the characteristics of young football players' developmental and growth phases and to plan and programme the respective training process accordingly. The purpose of this research was to determine the latent structure of motor and functional characteristics of cadet football players. The sample of subjects comprised 100 football players, cadets of the Croatian First Football League (1.HNL). 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. The background of motor and functional abilities was identified as consisting of five factors: primary agility, endurance, explosive power, isokinetic force and secondary agility.

Keywords: Croatian football, cadets, motor abilities, functional abilities

INTRODUCTION

Football is a complex sport requiring a high level of motor and functional abilities. Consequently, planning and programming of football training is very challenging. Further challenge is posed by specific demands of football sport preparation, which must be properly understood, especially when it comes to younger age groups (Hedrick, 1999). Cadets are players aged 14 to 16 – the age overlapping with puberty. 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). At the age of 15 or 16, pre-puberty characteristics in most young football players fade out (Bompa, 2000). Bone calcification processes are almost complete, with the exception of the long limb bones. The muscle system builds up, the muscle tone and the muscle strength increase, as well as the general work ability. Coordination of movement increases again and approaches the adulthood level. The heart muscle structures gradually strengthen and the pre-puberty imbalance between the heart mass and volume and the heart volume and blood vessel width disappears (Wang, 1995). At the cadet age competitive training is introduced. The selection criteria for this age group include: a talent for the football game, speed criteria, functional abilities, coordination and accuracy, psycho-social and other criteria (Beunen et al., 1988). Conditioning of cadets should focus on increasing psycho-motor abilities, especially those that reach the development threshold early on (speed, coordination, accuracy, balance and explosive power), as well as on re-establishing coordination abilities and flexibility, which were reduced in puberty. Conditioning of cadet football players is particularly important considering the distance (6,780 m) a cadet football player covers during a football match and considering the fact that high-intensity activities account for 16% of this distance (Castagna, Impellizzeri, Cecchini, Rampinini and Barbero Alvarez, 2006). On average, players sprint every 90 seconds during a match, with each sprint lasting an average of 1 to 4 seconds (Mohr, Krustrup and Bangsbo, 2003; Rienzi et al., 2000; Reilly and Thomas, 1976). This is the reason why sprint-type explosive power was, for the purpose of this research, measured in 5m, 10m, 20m and 30m sprints. In addition to 5m, 10m, 20m and 30m sprints, the 30m dribbling speed was measured. All strength dimensions (sprint-type, jump-type and kick-type explosive power) measured in this research were controlled by the excitation intensity regulation mechanism.

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 cadets (n=100) of the average height of 177.2 ± 5.1 cm and the average weight of 71.2± 4.5 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 counted), 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 for Windows, 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
5	1.42	4.91	77.29

The factor analysis revealed five 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 cadets. 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 1.42. It is also visible that the five factors listed in the descending order accounted for approximately 37%, 17%, 10%, 6%, and 4% of the total variance of manifest variables, respectively.

Table 2 shows correlations between manifest variables, i.e. the total variance of manifest variables explained by five isolated factors.

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

		1	2	3	4	5
1	**MAG9OK**	0.15	0.00	0.18	0.13	**0.75**
2	**MAGNN**	0.12	0.11	0.20	0.07	**0.79**
3	**MAGSLT**	**0.80**	0.07	0.05	0.16	0.13
4	**MAG90T**	**0.83**	0.35	0.10	0.12	0.05
5	**MAGSLV**	**0.86**	0.18	0.05	0.00	-0.03
6	**MAG90V**	0.01	0.15	0.17	0.04	**0.90**
7	**BEEP**	0.04	**0.92**	0.18	0.01	0.05
8	**VO2MAX**	0.13	**0.92**	-0.02	0.09	0.01
9	**1500M.**	0.05	**0.91**	-0.17	0.07	0.09
10	**SP5**	0.01	-0.13	**0.76**	0.17	0.10
11	**SP10**	0.09	-0.01	**0.65**	0.24	-0.04
12	**SP20**	0.10	-0.14	**0.81**	0.17	0.15
13	**SP30**	-0.04	-0.07	**0.80**	0.10	-0.16
14	**MESBL**	0.15	-0.45	0.15	0.38	-0.13
15	**QSD**	-0.12	-0.16	-0.12	**0.54**	-0.01
16	**QSL**	-0.11	-0.13	0.05	**0.56**	-0.04
17	**FSD**	0.20	-0.01	0.06	**0.73**	-0.02
18	**FSL**	-0.03	-0.04	-0.08	**0.77**	0.02
19	**QID**	0.00	-0.02	-0.03	**0.81**	-0.13
20	**QIL**	0.07	0.02	-0.09	**0.80**	-0.03
21	**FID**	-0.05	-0.13	-0.15	**0.82**	-0.25
22	**FIL**	0.11	-0.03	0.10	**0.78**	0.01

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 (VO2max); 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 factor analysis clearly revealed five stable factors on the sample of 100 cadets of the Croatian First Football League. The highest parallel projections on the first factor were determined for agility variables MAGSLT (0.80), MAG90T (0.83), MAGSLV (0.86). This factor was thus named the primary agility factor of football players. The highest parallel projections on the second factor were determined for variables BEEP (0.90), VO2max (0.92) and 1500m (0.93). This factor was therefore identified as the endurance factor of football players. The highest correlation with the third factor was determined for variables SP5 (0.76), SP10 (0.65), SP20 (0.80), and SP30 (0.81). 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, FID, FIL, QID, QIL, QID, and QIL, ranging from 0.56 to 0.82. Considering the factor structure, the fourth factor can be identified as the isokinetic force factor. The highest correlation with the fifth factor was determined for variables MAG9OK (0.75), MAGNN (0.79) and MAG90V (0.90). The fifth factor can therefore be identified as the secondary agility factor.

In the motor domain, a great variability was observed. Developmental and growth processes that take place at this age can account for this variability. Such a structure of cadets' latent domain clearly suggests the importance of agility for the cadet age group. The tests comprising the fifth factor focus on dribbling techniques, which are crucial for both situational efficiency and success in agility tests.

CONCLUSION

Five latent dimensions were revealed in the background of motor and functional abilities of cadet football players: primary agility, endurance, explosive power, isokinetic force and secondary agility. Primary agility, as the first factor, is determined by the following variables: zigzag run, 90-degree change-of-direction run, zigzag dribble. The second factor, endurance, is defined by three variables: beep test, VO2max and 1500 test. Explosive power, as the third factor, is defined by 5m, 10m, 20m and 30m sprint variables. The forth factor of isokinetic power is defined by the following variables: right and left quadriceps force, right and left flexor force, right and left quadriceps endurance, right and left flexor endurance. The fifth factor, secondary agility, is defined by the following variables: forward-backward run, agility 93639, 90-degree change-of-direction dribble. The fact that agility was revealed in two separate latent dimensions is indicative of the vital role that agility has in manifest motor variables in the cadet sample. Such a structure of cadets' latent domain clearly suggests the importance of agility for the cadet age group. The tests comprising the fifth factor focus on dribbling techniques, which are crucial in both situational efficiency and success in agility tests. Therefore, agility tests can be useful in the selection process of the cadets for the junior category. Agility is present in all of the skills that are utilised in football and it also increases the ability of players to transform those skills, which affects the process of learning new motor skills. This supports the case for using the agility training in the cadet age group in order to achieve a positive transfer of the agility dimension on the improvement of situational efficiency.

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