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Morphological and Motor Characteristics of Croatian First League Female Football Players

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A B S T R A C T

The aim of this study was to determine the structure of morphological and motor characteristics of Croatian first league female football players and their impact on the estimated quality of the players. According to the goal of the research, a sample consisted of 70 Croatian first league female football players. Participants were measured in 18 tests for assessing morphological characteristics, a set of 12 basic motor abilities tests and a set of 7 tests for assessing football-specific motor abilities. Exploratory factor analysis strategy was applied separately to all measured tests: morphological, basic motor abilities and football specific motor abilities. Factor analysis of morphological tests has shown existence of 3 significant latent dimensions that explain 64% of the total variability. Factors are defined as transverse dimensionality of the skeleton and voluminosity (35%), subcutaneous fat tissue (16%) and longitudinal dimensionality of the skeleton (13%). In the area of basic motor abilities, four factors were extracted. The first factor is responsible for the integration of agility and explosive power of legs, i.e. a factor of movement regulation (agility/lower body explosiveness) (23%), the second one defines muscle tone regulation (15%), the third one defines the frequency of leg movements (12%), while the fourth one is recognized as responsible for the manifestation of basic strength, particularly of basic core strength (19%). Two factors were isolated in the space of football-specific motor abilities: football-specific efficiency (53%) and situational football coordination (27%). Furthermore, by use of factor analysis on extracted latent dimensions (morphological, basic and football specific motor abilities) two higher order factors (explaining 87% of common variability) were extracted. They were named morphological-motor factor (54%) and football-specific motor abilities factor (33%). It is assumed that two extracted higher-order factors fully describe morphological and motor status of first league female football players. Furthermore, the linear regression results in latent space showed that the identified factors are very good predictors of female football players quality ($\delta = 0.959$). In doing so, both specific motor abilities factors and the first factor of basic motor abilities as a factor of general motor efficiency have the greatest impact on player quality, and these factors have been identified as most important predictors of player quality in Croatian women's first league and elite female football players in general. Obtained results provide deep insight into the structure of relations between the morphological, motor and specific motor variables and also indicate the importance of such definition of specific motor abilities. Consequently, results explicitly indicate the necessity of early, continuous, and systematic development of football-specific motor abilities in female football players of high competitive level but also, adjusted, to the younger age categories.

Key words: *morphological characteristics, motor characteristics, elite female football player, player quality*

Introduction

Football is an aerobic-anaerobic activity with alternating phases of high loads such as sprinting, rapid changes of direction, jumping and sudden stopping[1,2] and, according to the criteria of structural complexity, it can be classified as a polistructural and complex sport activity[3]. Accordingly, contemporary elite football requires strong and endurable athletes with exceptional motor and functional abilities, and a strong sense of improvisation and cooperation[4–6]. Consequently, regardless of the gender, a set of anthropological characteristics and specific player's abilities to control the system and concept of the game, to control the pace and rhythm of the game as well as one's own bioenergetic capacity and functional status during the game, is responsible for success in football.[3,7–9]

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Researches indicate[2,5,6,10–14] that the hierarchical taxonomy structure of success in football, regardless of the gender, probably contains three cluster of factors. The first cluster consists of the basic anthropological characteristics: health status, morphological characteristics, basic functional abilities, basic motor abilities, intellectual abilities and personality traits. The second group of factors consisted of the specific abilities and knowledge of football players. More precisely, it consisted of technical abilities, football-specific motor abilities, tactical abilities and football knowledge, theoretical knowledge as well as the personality traits which are necessary for micro-social adaptations. The third cluster consisted of situational efficiency and results of various competitions.

Authors[1,6] also state that the most important factors are the motor and functional abilities: speed, explosive power, coordination, agility, precision and flexibility. Principally, there is no motor or functional ability that could be classified as »unnecessary« in terms of success in football. In the basis of those skills lies the efficiency of organ systems, especially the nerve-muscle system which is responsible for the intensity, duration, and movement regulation[1]. Also, it is important to emphasize that while dealing with complex motor problems during the particular game, informational, information-motor and the energetic component of the control and regulation processes are completely involved[6].

As already partly emphasized, motor efficiency and effectiveness in situational conditions, or more precisely, conditions of continuous coordination within a team and opposition to other team is determined by a complex interaction of anthropological, motor, conative and cognitive dimensions. However, it largely depends on various basic motor and football-specific motor abilities of the players**.** In accordance, studies[15,16] indicate that football training and football-specific motor tests should be made as close as possible to situational reality. This is very important mostly because it is often the case that players with excellent results in the tests of basic motor abilities do not manifest those abilities in situational conditions adequately. These facts are one of the indicators of insufficient use of basic and situational football tests when testing football players.

Quality female football players have adequately high levels of football-specific motor abilities which are manifested as performance skills of characteristic football elements[17]. It should be noted that motor knowledge, except the direct impact on the performance quality of specific motor tasks, indirectly affects the dimensions of anthropological status.

Also, it is important to say that researches[18] shows that professional female football players run 28% longer in high intensity than their (also female) colleagues at lower competition levels. That fact further indicates that the conditionality issue of morphological and motor dimension of first league female soccer players should be viewed separately from similar research problems.

It should be underlined that there are very few scientific studies of morphological, motor and football-specific motor abilities of first league female football players, and that fact gives this research additional importance.

Materials and Methods

Study subjects

Sample consisted of 70 Croatian first league female football players of average age 21.7±1.3 years. All participants were examined in the same way, by the same officials. Athletes who had recently suffered from a serious injury were not included in this study.

Instruments

Sample of morphological variables consisted of 18 tests for assessing morphological characteristics. That selection was made under assumption about the existence of four latent dimensions: longitudinal dimensionality of the skeleton, transverse dimensionality of the skeleton, body mass and volume and subcutaneous fat tissue[19] which were measured according to the standard procedures. The measures were as followed: body height, arm length, leg length, hand length, knee diameter, elbow diameter, wrist diameter and hand diameter, body weight, upper arm circumference flexed, upper arm circumference relaxed, thorax circumference, forearm circumference and calf circumference, triceps skinfold, abdominal skinfold, back skinfold and calf skinfold.

Eleven tests of motor abilities were used for assessing basic motor status: standing long jump for assessing explosive power of horizontal jumping type, 20 meter sprint for assessing sprinting explosive power, throwing a 2 kg medicine ball from supine position for assessing throwing explosive power, arm plate tapping and foot tapping for assessing movement frequency, side steps for assessing movement agility, bent arm hang for assessing static strength, sit-ups for assessing repetitive strength, obstacle course backwards for assessing coordination, seated straddle stretch to assess flexibility and one leg standing for assessing coordination.

Football-specific motor abilities were defined by a set of seven tests that have been shown to describe a football game in the context of five existing latent dimensions: precision of target shooting with the ball, ball handling, speed of ball handling, force of a leg kick, and speed of curvilinear running[3]. Tests were selected due to greatest correlation with the extracted latent dimensions: precision of shooting the target with a leg ball kick, precision of shooting the target with a leg head ball kick, distance achieved by a leg kick, distance achieved by a head kick, running with a ball at right angles, hitting the wall with the ball and 20m sprint with the ball. It should be noted that the test were minimally modified due to their application to the population of female football players. All measurements were performed 3 times.

Situational efficiency of female football players was the criterion variable for the regression analysis. It was assessed on a 5-point Likert scale based on 2 criteria[20]:

team quality and individual player's quality within the team.

Description of the football-specific motor tests used in the research:

1. Precision of shooting the target with a leg kick
   The subject stands on a marked line 23 m from the goal with the ball, she starts dribbling the ball and after at least two contacts with the ball, shoots at the goal before reaching the marked line at the distance of 18 m from the goal. The area between the goalposts is divided by rubber bands into 9 equal fields. Points are calculated according to Figure 1. Bold and underlined numbers specify the number of points in case of ball entering the goalposts, that is, the area divided by rubber bands. The other numbers indicate missing the goal but are still scored. The total score is equal to the sum of points won in 3 shots. The whole procedure is videotaped by camera and the number of points won in the area outside the goalposts is evaluated based on the video.

2	**3**	**1**	**0**
3	5	4	2
1	4	3	1
0	2	1	0

Fig. 1. Division of the area between and above the goalposts by points.

2. Precision of shooting the target with a head kick
   The subject stands on a marked line 15 m from the goal with a ball, juggles the ball at least 2 times before she head kicks the ball towards the goal before reaching the marked line at the distance of 10 m from the goal. The whole procedure is videotaped by camera and the number of the points won is calculated as in previously described leg kick.
3. Power of the leg kick
   A point A is marked on the ground where the ball is positioned. The subject takes an approach necessary to forcefully hit the still ball. The ball makes the first contact with the ground in point B. The distance between Points A and B is measured. The test is repeated 3 times and the best result is evaluated.
4. Power of the head kick
   A 2 m line is marked on the ground and the subject stands in front of the line holding the ball in her hand. The subject throws the ball to herself for a jumping head kick, not stepping on the marked line. The distance of the kicked ball is measured. The test is repeated 3 times and the best result is evaluated.
5. Running with a ball at right angles
   The subject stands in front of the marked start line on the right side from the first of the 6 flags. The subject dribbles the ball around the flags as followed: 3 m straight until reaching the first flag, then 2 m right until the next flag, then 2 m straight forward, then 5 m left, again 3 m straight forward, then 3 m right, then 2 m straight to the finish line. The subject passes all the flag from the outer side. The time of performing the task is measured in seconds. The test is repeated 3 times and the best result is evaluated.
6. Hitting the wall with a ball
   The subject stands within the marked $2m^2$ square area facing the wall at the 1 m distance and kicks the ball with a leg kick hitting the wall at the minimum height of 1 m so that after each bounce, the ball lands on the ground at the minimal distance of 1 m from the wall. After each bounce from the ground, the subject kicks the ball in the air shooting the wall. Each correctly performed kick within 20 seconds wins 1 point. The test is repeated 3 times and the average result is evaluated.
7. 20 m sprint with a ball
   A 2 m line is marked on the ground where the ball is positioned. The subject sprints with the ball after a sound signal until reaching the marked line at the 20 m distance. The test is repeated 3 times and the best result is evaluated.

Data analysis

Data analysis methods involved calculating descriptive statistical parameters: arithmetic mean (M), standard deviation (SD), minimum (Min) and maximum (Max) result, skewness coefficient (Skew), kurtosis coefficient (Kurt) and empirical significance of Kolmogorov-Smirnov test. Factor analysis with Scree and/or Guttman-Kaiser criterion was applied to analyze the structure of morphological characteristics, basic and football-specific motor abilities, and within the analysis, varimax rotation was conducted. Player quality prediction was performed by linear regression analysis of extracted and identified latent dimensions.

Due to the determination of higher order factors, for every set of measured tests (morphological, basic motor and football-specific motor) nonorthogonal rotation was applied and varimax factors of obtained oblique latent dimensions were calculated.

Results and Discussion

In Table 1 descriptive statistics of morphological variables for all 70 Croatian female first league soccer players is presented. Due to the calculated significance of the Kolmogorov-Smirnov test, it can be seen that only one variable abdominal skinfold have mild deviation from normal distribution ($p<0.05$) which does indicate that all variables are suitable for further multivariate analysis. By comparing the obtained average values with the results of other researches among female soccer players[21] one can see compatibility of results and that can give better insight into the results of observed population.

Furthermore, Table 2 shows the descriptive statistical indicators of basic motor variables for all subjects. It can be seen that all measured variables are normally dis-

TABLE 1
DESCRIPTIVE STATISTICS OF MORPHOLOGICAL CHARACTERISTICS (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	$\overline{X}$	SD	Min	Max	KS	Skew	Kurt
Body height (cm)	166.78	6.27	152.00	188.00	p>.20	0.38	1.17
Arm length (cm)	72.78	4.23	58.00	81.60	p>.20	–0.77	1.81
Leg length (cm)	99.85	6.22	89.20	121.00	p>.20	1.08	1.23
Hand length (cm)	17.81	1.05	14.50	20.80	p>.20	–0.35	1.03
Knee diameter (cm)	9.97	0.94	6.90	11.80	p>.20	–0.50	0.38
Elbow diameter (cm)	6.34	0.45	4.90	7.20	p<.15	–0.23	0.36
Wrist diameter (cm)	5.19	0.35	3.90	5.90	p<.05	–0.92	1.46
Hand diameter (cm)	7.46	0.39	5.90	8.30	p<.20	–0.79	2.85
Body mass (kg)	60.32	8.07	42.00	82.00	p<.20	0.47	0.27
Upper arm circ. flexed (cm)	27.68	2.49	20.50	34.00	p>.20	–0.04	0.65
Upper arm circ. relaxed (cm)	26.26	2.45	19.50	33.00	p>.20	0.06	1.02
Thorax circumference (cm)	88.21	6.86	68.50	105.00	p>.20	0.24	0.40
Calf circumference (cm)	36.20	2.85	26.50	41.80	p>.20	–0.66	1.31
Forearm circumference (cm)	24.04	2.46	18.00	36.80	p>.20	2.49	11.38
Triceps skinfold (mm)	16.89	3.40	9.33	24.20	p>.20	–0.25	–0.56
Back skinfold (mm)	11.31	2.76	7.00	19.60	p<.15	0.92	0.81
Abdominal skinfold (mm)	20.53	9.50	8.53	76.00	p<.05	3.44	17.15
Calf skinfold (mm)	13.14	3.58	6.13	25.13	p>.20	0.87	1.00

$\overline{X}$ – arithmetic mean, SD – standard deviation, Min – minimal result, Max – maximal result, KS – significance of Kolmogorov-Smirnov test, Skew – coefficient of asymmetry, Kurt – coefficient of kurtosis

tributed and consequently that the observed variables are suitable for further parametric multivariate analysis. It is important to emphasize that from an insight into the literature it can be seen that there is no research on first league female football players who used the same set of basic motor variables, therefore, calculated values that can be taken as referent ones.

In Table 3, descriptive statistic parameters of football-specific motor variables are presented. It can be seen that all variables except hitting the wall with the ball are normally distributed with a satisfactory value of means and relatively small standard deviations. It should be noted that authors did not find studies of motor status of female football players which have used this set of football-specific variables.

Table 4 shows varimax factors of the morphological space of Croatian first league female football players. Three latent dimensions were extracted explaining 64% of variability of the measured morphological variables.

The first factor was identified as the factor of transverse dimensionality of the skeleton and voluminosity

TABLE 2
DESCRIPTIVE STATISTICS OF BASIC MOTOR ABILITIES (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	$\overline{X}$	SD	Min	Max	KS	Skew	Kurt
Standing long jump (cm)	1.89	0.16	1.58	2.30	p>.20	0.07	–0.35
Arm plate tapping (freq)	41.09	5.55	27.00	52.00	p>.20	–0.22	–0.09
20 m sprint (s)#	3.68	0.44	3.00	5.30	p<.10	1.39	3.26
Side steps (s)#	10.53	0.96	8.50	13.00	p>.20	–0.06	–0.31
Bent arm hang (s)	31.20	19.03	1.10	75.25	p>.20	0.30	–0.81
60 seconds sit-ups (freq)	51.74	9.57	23.00	68.00	p<.10	–0.68	–0.09
Obstacle course backwards (s)#	12.00	2.61	7.80	21.19	p<.15	1.44	3.04
Seated straddle stretch (cm)	75.34	11.78	48.00	98.00	p>.20	–0.21	–0.53
Foot tapping (freq)	23.70	1.94	18.00	27.00	p>.20	–0.73	0.25
One leg standing (s)	32.74	23.42	4.67	120.06	p>.20	1.64	3.39
Throwing a 2kg medicine ball (m)	6.24	0.87	4.11	7.90	p>.20	–0.34	–0.30

#variable with opposite metric orientation, $\overline{X}$ – arithmetic mean, SD – standard deviation, Min – minimal result, Max – maximal result, KS – significance of Kolmogorov-Smirnov test, Skew – coefficient of asymmetry, Kurt – coefficient of kurtosis

TABLE 3
DESCRIPTIVE STATISTICS OF FOOTBALL-SPECIFIC ABILITIES (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	$\overline{X}$	SD	Min	Max	KS	Skew	Kurt
Precision of shooting the target with a leg kick (score)	8.53	3.95	1.00	15.00	p<.10	0.07	–1.17
Precision of shooting the target with a head kick (score)	8.24	3.88	2.00	15.00	p<.15	0.17	–1.27
Distance achieved by a leg kick (m)	39.39	11.38	22.00	58.00	p>.20	0.11	–1.21
Distance achieved by a head kick (m)	6.88	1.42	4.15	10.55	p>.20	0.20	0.12
Running with a ball at right angles (s)#	10.09	1.40	8.00	12.90	p>.20	0.31	–0.96
Hitting the wall with the ball (freq)	19.47	5.42	8.00	35.00	p<.05	0.46	0.27
20m sprint with the ball (s)#	4.11	0.54	3.10	5.60	p>.20	0.49	–0.07

#variable with opposite metric orientation, $\overline{X}$ – arithmetic mean, SD – standard deviation, Min – minimal result, Max – maximal result, KS – significance of Kolmogorov-Smirnov test, Skew – coefficient of asymmetry, Kurt – coefficient of kurtosis

TABLE 4
VARIMAX FACTORS OF MORPHOLOGICAL CHARACTERISTICS (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	V1	V2	V3
Body height	0.05	0.07	0.55
Arm length	0.57	–0.43	0.47
Leg length	0.27	–0.01	0.77
Hand length	–0.17	0.12	0.73
Knee diameter	0.77	0.10	–0.04
Elbow diameter	0.74	–0.07	0.16
Wrist diameter	0.69	–0.18	0.34
Hand diameter	0.65	–0.23	0.44
Body mass	0.78	–0.35	0.41
Upper arm circumference flexed	0.85	0.14	–0.03
Upper arm circumference relaxed	0.88	0.27	–0.04
Thorax circumference	0.73	0.33	0.12
Calf circumference	0.77	0.27	–0.16
Forearm circumference	0.42	0.12	0.31
Triceps skinfold	0.15	0.71	0.10
Back skinfold	0.30	0.75	–0.14
Abdominal skinfold	0.44	0.56	–0.23
Calf skinfold	0.05	0.87	0.10
Eigenvalues	6.25	2.89	2.25
% of Variance	35	16	13
Cumulative %	35	51	64

(35%), due to its high projections (0.42–0.88) with all diameters and all circumferences. Furthermore, the second and the third factor of morphological space were identified as subcutaneous fat tissue factor (16%) and longitudinality of the skeleton (13%). It needs to be emphasized here that a scree criterion was used to determine the number of significant principal components. This is so because, based on Guttman-Kaiser criterion, the fourth significant latent dimension was uninterpretable due to small values of projections in all manifest variables.

Obtained results fully describe the real situation. Namely, female football players with large bone width have a large bone volume as well so muscles can grab on easily and muscle tendons have more space for fixating the grab. Therefore, two normally separated dimensions of morphological status, transversality of the skeleton and voluminosity, have been joined into one real existing latent dimension. It can be seen from the results (Table 8) that the extracted factor has a cutoff significance impact on efficiency ($p = 0.07$), and subsequently also on general motor and functional efficiency.

Furthermore, it can be observed in Table 5 that 4 latent dimensions were extracted in the space of basic motor abilities based on GK criterion.

The first latent dimension was identified as the factor of movement regulation (23%), due to the high projections in variables standing long jump and side steps, and it is responsible for the integration of agility and explosive power of legs. The second latent dimension (15%)

TABLE 5
VARIMAX FACTORS OF BASIC MOTOR ABILITIES (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	V1	V2	V3	V4
Standing long jump	0.93	0.14	–0.02	0.11
Arm plate tapping	0.40	0.70	–0.14	0.14
20 m sprint#	–0.47	0.36	0.37	–0.50
Side steps#	–0.92	–0.07	0.03	–0.13
Bent arm hang	0.21	0.26	–0.17	0.70
60 seconds sit-ups	0.12	0.02	–0.01	0.87
Obstacle course backwards#	–0.41	–0.14	0.24	–0.37
Seated straddle stretch	0.03	0.88	–0.01	0.11
Foot tapping	0.12	0.03	–0.85	0.04
One leg standing	0.40	–0.13	0.54	0.10
Throwing a 2kg medicine ball	0.07	0.43	0.25	0.65
Eigenvalues	2.51	1.70	1.32	2.13
% of Variance	23	15	12	19
Cumulative %	23	38	50	69

#variable with opposite metric orientation

was predominantly defined by the flexibility variable (seated straddle stretch) and, to a smaller extent, by the movement frequency of the arms variable (arm plate tapping), which makes this factor responsible primarily for muscle tone regulation. Consequently, second factor was identified as the factor of synergetic regulation and tone regulation mechanism (15%). The third dimension was predominantly defined by movement frequency of the legs variable (12%), while the fourth variable was responsible for strength manifestation, especially of the core (19%). The third and the fourth latent dimension were named factor of balance and coordination of lower extremities (12%), and factor of strength (19%). Due to the polistructural nature and the complexity of football as a team sport, all dimensions of motor status are in constant interaction, and are mutually interwoven as a whole. The first latent dimension covers those manifest variables which are probably of great influence on player quality of elite Croatian female football players. This is most likely the reason why this factor explains the largest portion of variability of the manifest space. Moreover, it can be seen in Table 8 that the first latent dimension extracted has a statistically significant impact on player quality, while the second dimension remains on the cut-off of statistical significance ($p = 0.06$), but with a very small beta coefficient.

By factor analysis of the specific motor abilities space of elite Croatian female football players, two latent dimensions were extracted which explain the total of 80% of variability of the manifest space (Table 6).

TABLE 6
VARIMAX FACTORS OF BASIC FOOTBALL-SPECIFIC MOTOR ABILITIES (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

Variable	V1	V2
Precision of shooting the target with a leg kick	0.96	0.19
Precision of shooting the target with a head kick	0.91	0.17
Distance achieved by a leg kick	0.96	0.18
Distance achieved by a head kick	0.30	0.73
Running with a ball at right angles#	–0.89	–0.34
Hitting the wall with the ball (freq)	0.24	0.74
20m sprint with the ball#	–0.25	–0.77
Eigenvalues	3.68	1.88
% of Variance	53	27
Cumulative %	53	80

#variable with opposite metric orientation

The first latent dimension was named the factor of football-specific efficiency (53%), and the second one the factor of situational football coordination (27%). Precision of the leg kick and the head kick along with power of the kick and agility with a ball are certainly the variables which discriminate first league female football players from players of lower ranks and as such, naturally form a latent dimension with an extremely high percentage of explained variability. The second extracted latent dimension clearly speaks of the element of ball manipulation which is the fundamental element of the football game. It is important to emphasize that variables of specific motor abilities were selected based on highest correlations with variables of latent dimensions which are assumed to fully explain the football game: hitting precision, handling the ball, dribbling speed, power of kicking the ball and curvilinear sprinting speed[3].

Furthermore, with the purpose of generating higher-order factors, extracted latent dimensions were put in an oblique relation and factorized (Table 7).

TABLE 7
VARIMAX FACTORS OF EXTRACTED OBLIQUE FACTORS OF MORFOLOGICAL, BASIC MOTOR AND FOOTBALL SPECIFIC ABILITIES (CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS) (N=70)

	V1	V2
Transverse dimensionality of the skeleton and voluminosity	0.72	0.33
Subcutaneous fat tissue	0.51	–0.29
Longitudinal dimensionality of the skeleton	–0.22	0.02
Movement regulation (agility/ lower body explosiveness)	0.79	0.24
Muscle tone regulation	0.52	0.33
Leg movement frequency	0.12	0.21
Basic strength	–0.13	–0.21
Football efficiency	0.17	0.84
Football coordination	–0.19	0.75
Eigenvalues	4.86	2.97
% of Variance	54	33
Cumulative %	54	87

The results (Table 7) indicate a probable existence of two higher-order factors: a morphological-motor factor and a factor of specific motor abilities, which explain 86% of variability of the first order latent dimensions system. It is necessary to point out that the third extracted dimension of morphological space and the third and fourth dimension of basic motor abilities do not have high projections on either of the extracted factors.

Finally, with the purpose of determining the impact of extracted latent dimensions on the criterion variable of player quality, multiple regression analysis was used (Table 8). It is important to emphasize that player quality is a variable on a five-point Likert scale and it is determined by the use of a strictly specified system[10].

The results (Table 8) unambiguously indicate that the extracted latent dimensions are good predictors of player quality of female football players. Regardless of the existence of unexplained variability in each manifest space, it is evident that the extracted latent dimensions describe the criterion variable well. It is important to emphasize here that variables of specific motor abilities have a statistically significant impact on player quality with the dimension of football-specific efficiency having a partial

TABLE 8
REGRESSION ANALYSIS RESULTS FOR PLAYER QUALITY CRITERION IN THE LATENT SPACE OF MORPHOLOGY, BASIC AND FOOTBALL SPECIFIC MOTORICS OF CROATIAN FIRST LEAGUE FEMALE FOOTBALL PLAYERS (N=70)

FACTOR	r	β	p
Transverse dimensionality of the skeleton and voluminosity – 1	–0.24	–0.06	0.07
Subcutaneous fat tissue – 2	0.15	0.04	0.25
Longitudinal dimensionality of the skeleton – 3	–0.03	–0.01	0.83
Movement regulation (agility/ lower body explosiveness) – 1	0.46	0.28	0.00
Muscle tone regulation – 2	0.24	0.06	0.06
Leg movement frequency – 3	0.08	0.02	0.53
Basic strength – 4	0.23	0.05	0.09
Football efficiency – 1	0.81	0.72	0.00
Football coordination – 2	0.50	0.13	0.00
ρ		0.97	
δ		0.94	p<0.000

r – partial coefficient of correlation, β – regression coefficient, ρ – multiple correlation, δ – coefficient of determination

impact seen trough statistically significant and high coefficient beta. Latent dimensions as predictors explain 94% of variability of the player quality variable.

Conclusion

Obtained results provide a comprehensive insight into the structure of morphological, basic motor and specific motor space of Croatian first league female football players. Results primarily stand out because of their possible applicability in planning and programming, as well as in longitudinal follow up and evaluation of progress in the context of sport-specific treatments in the population of first league female football players. The importance of the specific motor abilities as a predictor of player quality is emphasized. Obtained latent structures of factors, but also of higher-order factors indicate clear hierarchical taxonomy of the explored biomotor status space.

Obtained results particularly point to the importance of such defined space of specific motor abilities. Consequently, results explicitly indicate the necessity of early, continuous, and systematic development of football-specific motor abilities in female football players of high competitive level but also, adjusted, to the younger age categories.

In future research, it would be of significant importance to further analyze the differences of morphological characteristics, basic and specific motor abilities as well as variables of conative space in relation to player quality. Furthermore, with the purpose of attaining a deeper insight into the complex issues described here, it would probably be appropriate to apply non-standard methods such as structural equation modeling (SEM).

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MORFOLOŠKE I MOTORIČKE ZNAČAJKE ELITNIH HRVATSKIH NOGOMETAŠICA

S A Ž E T A K

Cilj ovog rada bio je utvrditi strukturu morfoloških i motoričkih značajki hrvatskih prvoligaških nogometašica te njihov utjecaj na procijenjenu kvalitetu igračica. U skladu s ciljem istraživanja, korišten je uzorak od 70 hrvatskih prvoligaških nogometašica koje su mjerene u 18 morfoloških testova, 11 testova bazične motorike te 7 testova specifične nogometne motorike. Primijenjena je eksplorativna strategija faktorske analize na skup testova morfološkog statusa te bazične i specifične motorike. Faktorskom analizom morfološkog prostora ekstrahirane su 3 latentne dimenzije koje ukupno objašnjavaju 64% varijabiliteta manifestnog prostora a definirane su kao faktor transverzalne dimenzionalnosti skeleta i volumena i mase tijela (35%), potkožno masno tkivo (16%) te longitudinalnost skeleta (13%). U prostoru bazične motorike ekstrahirana su 4 faktora: prvi odgovoran za integraciju agilnosti i eksplozivne snage nogu to jest faktor za regulaciju kretanja (23%), drugi definira regulaciju mišićnog tonusa (15%), treći definira frekvenciju pokreta nogu (12%), dok je četvrti odgovoran za manifestaciju bazične snage posebno trupa (19%). U prostoru specifične motorike je izoliran faktor specifične nogometne učinkovitosti (53%) i faktor situacijske nogometne koordinacije (27%). Faktorskom analizom ekstrahiranih latentnih dimenzija dobivena su dva faktora višeg reda (objašnjavaju 87% zajedničkog varijabiliteta) a imenovani su kao morfološko-motorički faktor (54%) te faktor specifične motorike (33%) i kao takvi u potpunosti opisuju morfološki i motorički status prvoligaških nogometašica. Rezultati regresijske analize u latentnom prostoru su pokazali da su identificirani faktori dobri prediktori igračke kvalitete prvoligaških nogometašica ($\delta=0.94$). Pritom, najveći utjecaj na igračku kvalitetu imaju oba faktora specifične motorike te prvi faktor bazične motorike kao faktor generalne motoričke efikasnosti te su isti vjerojatno ključni prediktori igračke kvalitete hrvatskih prvoligaških nogometašica ali i elitnih nogometašica u cjelini. Dobiveni rezultati daju potpuni uvid u strukturu povezanosti morfoloških, motoričkih i specifičnih motoričkih varijabli te ukazuju na važnost ovako definiranog prostora specifične nogometne motorike. Posljedično rezultati eksplicitno ukazuju na nužnost ranog, kontinuiranog te sustavnog razvijanja specifičnih motoričkih sposobnosti kako kod nogometašica visokog natjecateljskog ranga tako i prilagođeno mlađim uzrasnim kategorijama.