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Original research article

DIFFERENCES IN EXPLOSIVE STRENGTH OF LEGS BETWEEN FOOTBALL AND FUTSAL PLAYERS

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Abstract. *Football and futsal belong to the group of polystructural activities of a complex character. From the motor aspect, both games are defined by a complex structure, comprised of various movements of the cyclic and acyclic type. Football and futsal are characterized by specific movements of the lower limbs, which are used to regulate possession of the ball (leading, passing) as well as the movement of the torso and hitting the ball with the head. The movement structure is comprised of various activities: running, jumping, turning, reception and shooting the ball. The aim of this research is to establish whether there are statistically significant differences in the explosive strength of the legs in football and futsal players. The analysis involved a sample of 37 participants, divided into two subsamples, the first being senior football players (first lineup) of FC "Radnički" from Niš – 23, and the second being senior futsal players (first lineup) of Futsal Club "Kopernikus" from Niš – 14 participants. The explosive strength of the lower limbs was estimated through the following tests: Squat Jump (SJ), Counter Movement Jump without arms swing (CMJ) and Counter Movement Jump with arms swing (CMJS). The Multivariate Analysis of Variance method(MANOVA) was used to determine the differences between the groups, while the Analysis of Variance method (ANOVA) was used for the differences between the groups in terms of separate measuringt instruments. It has been determined that there are differences in the explosive strength of the legs between football players and futsal players.*

Key words: *football, futsal, explosive strength of the legs, differences.*

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INTRODUCTION

Football and futsal belong to the group of polystructural activities of a complex character. From the motor aspect, both games are defined by a complex structure, comprised of various movements of the cyclic and acyclic type. Football and futsal are characterized by specific movements of the lower limbs, which are used to regulate possession of the ball (leading, passing), as well as the movement of the torso and hitting the ball with the head. The movement structure comprises various activities: running, jumping, turning, reception and shooting the ball. Football and futsal are aerobic-anaerobic sports, with alternating phases of high strain. What is common in football and futsal is that, during the game, both sports belong to high-intensity sports which depend both on the aerobic and anaerobic capacities of the players (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Ben Abdelkrim, El Fazaa, & El Ati, 2007). However, the intensity during a futsal game is approximately 90% of the maximum heart rate (Barbero-Alvarez et al., 2008), while the intensity in football is slightly lower and ranges between 80-90% of the maximum heart rate. In futsal, high-intensity running is represented with 13.7%, while sprint occupies approximately 8.9% during the game (Barbero-Alvarez et al., 2008), unlike football, where these movements account for 11%. Dogramaci & Watsford (2006) stress that futsal players spend 26% during the match in a high-intensive regime, which is the direct consequence of the rules that provide the possibility of more frequent changes than in football. When compared with football, the technical profile of a futsal player is closely connected with the smaller circumference of the ball in futsal, around 30% compared to football, which forces the players to react more precisely and faster in technical terms during ball control and handling (Burns, 2003). In addition, the smaller playing field leads to constant pressure from the opponent so the futsal players are under constant marking and one-to-one play (Vaeyens, Lenoir, Williams, & Philippaerts, 2007). Field dimensions which have been reduced in such a way require the player to quickly make decisions and to possess high sprinting abilities under pressure both in the offense phase and the defense phase (Vaeyens, Lenoir, Williams, & Philippaerts, 2007). The question is whether they need a better agility and change of direction in the movement in order to more easily attain a better position to receive the ball and jeopardize the opponents' goal. Futsal is characterized by complex movement structures of a cyclic and acyclic character, and consists of a set of simple and complex movements under the conditions of cooperation between players during the game (Milanović, Sporiš, Trajković, & Fiorentini, 2011). Football is increasingly developing every day in the sense of increased dynamics, or increase in the activity of the players. This activity is characterized by a great variability when it comes to the intensity of neuro-muscular strain and the character of motor activity (Stolen, Chamari, Castagna, & Wisloff, 2005). Strong sprints, turning, changes of direction, jumps, duels, alternate with the slower, steady running, walking and stopping, and all this is realized in different directions, rhythm and tempo. A footballer's movement is conditioned by constant and unforeseen changes in game situations. Football belongs to the group of the most dynamic sports. The movement structure in this sport contains various types of jumps, sudden changes in direction and direction of movement, constant alternations in attacks and defense which involve frequent stopping and quick sprint. For this reason, explosive strength plays a significant role in resolving almost all the technical – tactical tasks during the game. Furthermore, explosive strength occupies a prominent place in the success specification equation of football. The aim of this research is to establish whether there are statistically significant differences in the explosive strength of the legs in football and futsal players.

THE METHOD

The analysis involved a sample of 37 participants, divided into two subsamples, the first being senior football players (first lineup) of FC "Radnički" from Niš, N=23, and the second being senior futsal players (first lineup) of Futsal Club "Kopernikus" from Niš, N=14 participants. All the participants have professional contract with the clubs that they play for. The measuring instruments for the estimation of the anthropometric characteristics were: height (cm) and mass (kg). The explosive strength of the lower limbs was estimated by an accelerometer Myotest (Sion, Switzerland), through jump height (cm), time (s), segregated from the variable velocity (cm/s), and power (W/kg) in the following tests: Squat Jump (SJ) - vertical jump from the semi-squat position without arms swing (placed on the hips), Counter Movement Jump (CMJ) - vertical jump with countermovement and without arms swing (placed on the hips) and Counter Movement Jump - vertical jump with countermovement and with arms swing (CMJS). In order to reach scientific results, adequate research processes were applied, and they correspond to the nature of the set research goal. The following was calculated: Fundamental descriptive parameters and measurement discrimination (two procedures were performed: Skewness-Skew and Kurtosis-Kurt). The Multivariate Analysis of Variance method (MANOVA) was applied for the determination of differences between the groups, while the Analysis of Variance method (ANOVA) was used for the determination of differences between the groups in terms of separate measuring instruments.

RESULTS

Table1 Fundamental statistical parameters for the estimation of the maximum height of the jump for futsal and football players

	Variables	N	Mean	Min	Max	Sd	Error	Skew	Kurt
Futsal	SJ (cm)	14	34.89	27.8	43.10	4.51	1.204	0.27	-0.69
	CMJ (cm)	14	40.19	30.6	53.60	5.23	1.398	0.92	3.01
	CMJS (cm)	14	46.37	38.7	54.00	4.39	1.174	-0.16	-0.47
Football	SJ (cm)	23	42.08	34.8	48.51	4.03	0.841	-0.03	-0.71
	CMJ(cm)	23	48.98	41.9	59.18	4.37	0.910	0.38	-0.08
	CMJS (cm)	23	58.21	48.0	73.66	6.53	1.362	0.29	-0.22

The results presented in table 1, for the futsal players, in the domain of maximum jump height, indicate that there are no statistically significant deviations in the results from the normal distribution. The Skewness in all the tests indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution, except in the case of CMJ (3.01), where the value was noted above the normal distribution, which represents a leptokurtic or compact distribution. The standard error values in all the tests of explosive strength in the lower extremities indicate that the limits are within normal values and without greater deviations among the participants. The results presented in table 1, for the football players, in the domain of the maximum jump height, indicate that that there are no statistically significant deviations in the results from normal distribution. The Skewness in all the tests

indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution. Unlike futsal players, in the case of football players, the standard measurement error of the maximum jump height is very small, which indicates that the tests are adequate for this population of athletes.

Table 2 Fundamental statistical parameters for the estimation of the maximum time of the jump for a futsal and football players

	Variables	N	Mean	Min	Max	Sd	Error	Skew	Kurt
Futsal	SJ (s)	14	0.57	0.52	0.62	0.03	0.01	-0.34	0.001
	CMJ (s)	14	0.59	0.54	0.63	0.03	0.01	-0.56	-0.26
	CMJS (s)	14	0.63	0.59	0.66	0.03	0.01	-0.49	-1.24
Football	SJ (s)	23	0.58	0.53	0.63	0.03	0.01	-0.12	-0.92
	CMJ(s)	23	0.63	0.58	0.69	0.03	0.01	0.17	-0.24
	CMJS (s)	23	0.68	0.62	0.77	0.04	0.01	0.39	-0.33

The results presented in table 2, for the futsal players, in the domain of the maximum jump time, indicate that that there are no statistically significant deviations in the results from normal distribution. The Skewness in all the tests indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution. In the case of futsal players, the standard error values in all the tests of explosive strength in the lower extremities indicate that the values of the measured tests are highly similar inside the very sample, with very small deviations. The results presented in table 2, for the football players, in the domain of the maximum jump time, indicate that that there are no statistically significant deviations in the results from normal distribution. The Skewness in all the tests indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution.

Table 3 Fundamental statistical parameters for the estimation of the maximum explosive strength for futsal and football players

	Variables	N	Mean	Min	Max	Sd	Error	Skew	Kurt
Futsal	SJ (W/kg)	14	1052.0	959.5	1177.5	67.8	18.12	0.62	-0.6
	CMJ (W/kg)	14	1160.9	1096.6	1275.2	65.0	17.38	0.69	-1.1
	CMJS (W/kg)	14	1297.8	1115.9	1459.9	98.8	26.40	0.15	-0.5
Football	SJ (W/kg)	23	1110.8	925.1	1388.9	109.5	22.83	0.83	0.94
	CMJ(W/kg)	23	1195.4	1000.6	1482.9	115.1	23.99	0.80	0.60
	CMJS (W/kg)	23	1303.3	1094.3	1647.3	136.6	28.47	0.90	0.50

The results presented in table 3, for the futsal players, in the domain of maximum explosive strength, indicate that that there are no statistically significant deviations in the results from normal distribution. The Skewness in all the tests indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution. When compared with the time of the jump, the standard measurement error is slightly higher, but these values do not exceed normal

limits, so we can consider this measurement to have been adequate. The results presented in table 3, for the football player, in the domain of maximum explosive strength, indicate that that there are no statistically significant deviations in the results from normal distribution. The Skewness in all the tests indicates slightly positive or negative asymmetry (of ±1.00). The Kurtosis values indicate results below 2.75, which represents a fuzzy or platykurtic distribution.

Table 4 Multivariate analysis of variance for the maximum jump height between futsal and football players

Wilks' Lambda	F	P-level
.473	12.24	**.000****

By analyzing table 4, which shows the results of testing the relevance of the difference in the level of arithmetic means of all the tests for the maximum height of the jump between the players of futsal and football, a statistically significant difference was determined, as Wilks' Lambda equals .473, which shows the significance of the differences at the level of P-level = .000 with Rao's F Approximation of 12.24. Football players displayed much higher values, which are statistically significant ($p<0.05$) when compared to futsal players, in all the observed variables. The greatest difference in the height of the jump was recorded in the variable CMJS, where the football players realized average values of 58.21 cm compared to futsal players, whose average values were 46.37 cm. Slightly lower differences were recorded with other tests (CMJ and SJ), but a statistically significant difference was recorded at level $p<0.0001$, which means that there is a clear difference between football players and futsal players, irrespective of the similarity between the sports.

Table 5 ANOVA method for the maximum jump height between futsal and football players

Variables	Mean (Futsal)	Mean (Football)	F	P-level
SJ1 (cm)	34.89	42.08	25.36	**.000****
CMJ1 (cm)	40.19	48.98	30.34	**.000****
CMJS1 (cm)	46.37	58.21	35.91	**.000****

Table 5 shows the results of ANOVA method for maximum jump height by comparing the results of arithmetic mean values between futsal players and football players. Based on the coefficient of the F-ratios and their relevance (P-level), it can be concluded that a statistically significant difference between futsal players and football players in the maximum height of the jump has been determined in all the tests: SJ (.000), CMJ (.000) and CMJS (.000). In all the variables of the maximum jump height, the football players realized greater values compared to the futsal players.

Table 6 Multivariate Analysis of Variance of the maximum time of the jump between futsal players and football players

Wilks' Lambda	F	P-level
.553	8.91	**.000****

By analyzing table 6, which shows the results of testing the relevance of the difference in the level of arithmetic means of all the tests for the maximum time of the jump between the players of futsal and football, a statistically significant difference was determined, as Wilks' Lambda equals .557, which shows the significance of the differences at the level of P-level = .000 with Rao's F Approximation of 8.91.

Table 7 Analysis of Variance of the maximum time of the jump between futsal players and football players

Variables	Mean (Futsal)	Mean (Football)	F	P-level
SJ1 (s)	0.57	0.58	2.31	.138
CMJ1 (s)	0.59	0.63	13.87	**.001****
CMJS1 (s)	0.63	0.68	18.98	**.000****

Table 7 shows the results of ANOVA method for maximum jump time by comparing the results of arithmetic mean values between futsal players and football players. Based on the coefficient of the F-ratios and their relevance (P-level), it can be concluded that a statistically significant difference in the maximum time of the jump has been determined between futsal players and football players in the following tests: CMJ (.000) and the CMJS (.000). The football players displayed much higher values, which are statistically significant ($p<0.05$) compared to the futsal players in the tests of the CMJ and CMJS. The greatest difference in the time of the jump was marked in the variable CMJS, where the football players realized the average values of 0.68 s when compared to futsal players, whose average values were 0.63 s. A slightly smaller difference was recorded in test CMJ, but a statistically significant difference was also recorded at the level of $p<0.001$, which indicates that there is an evident difference between football players and futsal players, irrespective of the similarity of the sports. Unlike the tests involving the swinging motion of the arms, the test which does not involve the countermovement motion and arms swing (SJ), did not show a statistically significant difference between the football players and futsal players in the time of the vertical jump.

Table 8 Multivariate analysis of variance for maximum explosive strength between players of futsal and football

Wilks' Lambda	F	P-level
.740	3.86	**.018***

By analyzing table 8, which shows the results of testing the relevance of the difference in the level of arithmetic means of all the tests for the maximum time of the jump between the players of futsal and football, a statistically significant difference was determined, as Wilks' Lambda equals .740, which shows the significance of the differences at the level of P-level = .018 with Rao's F Approximation of 3.86.

Table 9 Analysis of Variance for maximum explosive strength between players of futsal and football

Variables	Mean (Futsal)	Mean (Football)	F	P-level
SJ (W/kg)	1052.02	1110.82	3.25	.080
CMJ (W/kg)	1160.94	1195.40	1.05	.314
CMJS (W/kg)	1297.79	1303.28	0.02	.897

Table 9 shows the results of ANOVA method for the maximum explosive strength by comparing the results of arithmetic means between futsal players and football players. Based on the coefficients of the F-ratios and their relevance (P-level), it can be concluded that there is no statistically significant difference in any test of the maximum explosive strength between futsal players and football players. Unlike the height of the vertical jump and the time spent during the jump, no statistical relevance has been determined in the variables of explosive strength between football players and futsal players. The greatest difference was determined in variable SJ, but this difference is not considered statistically relevant (p=0.080). A small difference was determined in variable CMJ, while futsal players and football players were practically identical in the variables of explosive strength, measured with the test involving countermovement and swinging motion of the arms (CMJS, 1303.28 vs. 1297.79).

DISCUSSION

The mean values between the mass and height of the football players are highly similar to the previously published research (Arnason et al., 2004). On the other hand, futsal players have approximately the same anthropometric measures when compared to the other futsal players of the elite level (Álvarez, D'ottavio, Vera, & Castagna, 2009). Based on the obtained values that the futsal and football players are not different in the parameters of anthropometric characteristics, it can be concluded that the basis for player selection in futsal is still highly similar to the one applied in football. Furthermore, a great number of futsal players were former football players, who later became futsal players through late selection. Barišić (1996) researched the validity of certain anthropometric characteristics for the success of players in football, and stated that this is one of the dimensions that may determine the success of a player in futsal. He further provided the profile for anthropometric characteristics with regard to the playing position, where he precisely defined which playing position suited certain anthropometric characteristics. Based on these results, it may be concluded that our participants possess adequate values for a supreme playing level under the mentioned parameters. Unlike football players, for whom considerable research was done on the topic of anthropometric characteristics, this is not the case for futsal players, so we cannot claim with certainty as to which level and competition rank are occupied by futsal players that have been tested for the purpose of this research. In the factor success structure of football, power represents around 20% of the general motor skills of a certain player. According to the equation of the muscle power, it represents a product of force and the speed of muscle control, so it is very important to develop both components so that the football players or futsal players could adequately display this skill. The explosive strength dimensions may be divided into the

power which involves jumping, sprinting, kicking and throwing. Di Salvo et al. (2007) researched the domain of explosive strength in football players, and determined that defensive players exhibited lower values of explosive strength. The results obtained on the elite sample are similar to the results obtained in this paper on the football player sample. However, the futsal players in this research exhibit lower values of explosive strength with regard to jumping ability, which could ultimately lead to a reduced manifestation of other motor skills. Unlike other research on samples of football players, where the scope of the obtained results was considerably large and represented differentiation with regard to the playing position, futsal players realized a considerably smaller variability of the obtained results, which is the result of the fact that futsal does not have a clear profiling of players with regard to the position in the team. Instead, all the players participate equally in the offensive and defensive phase. Almost all the tested variables for the requirements of this research do not display a great variability between the futsal players and this is ascribed to greatly similar results during the training and the game. The differentiation with regard to the playing position is currently present only in football, while the tactics in the defensive phase and the offensive phase in futsal are highly similar for all the players in the rotation, so the results obtained in such a way are expected. The realized difference between the football and futsal players in the parameters of explosive strength is the consequence of a considerably longer training period of football players, which is directly linked to the degree of exhibiting muscle power. Gorostiaga et al. (2009) also determined that the abilities for exhibiting explosive strength, measured with the vertical jump, are better by 15% in football players, compared to futsal players. Results obtained in such a way are very similar to the results obtained in this research. The results obtained in this way direct us to power training modeling for futsal players when compared to football players as the data indisputably indicates that the explosive strength parameters contain an obvious difference between sports which seem similar at first. The lower values of maximum explosive strength may represent a greater problem in exhibiting key movement activities both in futsal players and football players (Gorostiaga et al., 2009). Wisloeff, Helgerud, & Hoff (1998) determined that the lower values of explosive strength are directly linked to the reduced ability of a player to participate in offensive and defensive actions, especially when it comes to one-on-one play. Considering the fact that futsal is played on a smaller area, where the players are much more directed towards the one-on-one play, both in offense and in defense, it is expected that futsal players display better abilities compared to football players, but these expectations were not realized in this research. We suppose that the initial level of the explosive strength of futsal players, as well as the shorter sports experience of the mentioned, influenced the fact that their explosive strength parameters are at a lower level than that of the football players. In addition, the lower level of exhibiting explosive strength leads to the reduction of exhibiting powerful muscle contractions responsible for shooting, dribbling, blocking, turning, stopping etc. Based on existing research, Jovanovic, Sporis, & Milanovic (2011) concluded that futsal players and football players were also different with regard to the intensity of the strain during the game, but not in motor activities such as agility. Agility is a very important trait both in futsal and football. Based on it, it can be concluded that the players of these two sports are highly familiar in their display of agility. Considering the fact that explosive strength is one of the components which determine agility to a greater extent, it can be considered that futsal players in this research possess far lower abilities for a faster change in direction without losing balance when compared to football players. Possessing good agility reduces the possibility of

injury, influences the improvement of sporting achievements and neutralizing the opponent, i.e. avoiding the opponent by applying a trick with one's body (Foran, 2001), which is greatly present in futsal and football. To be more precise, the afore mentioedn plays a very important role during dribbling and in the position when the players are involved in one-on-one play. The agility also contributes to the ability of successful manipulation with an object, such as the ball (Foran, 2001). The research results show that futsal players and football players possess very different motor skills, such as explosive strength. The results obtained in this research can be explained by the fact that futsal schools have already been formed, although it is a relatively new sport when compared to football, and these schools immediately start with futsal training, which enables early sports specialization. On the other hand, only several years ago, most futsal players were first active in regular football, and later retrained for futsal. Although modern football often involves play on a shorter playing area, which may firstly resemble some form of futsal, they are drastically different in the requirements during the game and the technical and tactical positions of the players (Jovanović et al., 2011). The very technique for the execution of certain elements, such as dribbling, leading the ball and receiving the ball are drastically different between futsal players and football players, and this obviously creates certain differences in the domain of motor abilities.

CONCLUSION

The conclusions reached based on the discussion of the results indicate that, in the work with the tested football players, there is good orientation and selection. What is more, the existence of the differences in the explosive strength of the legs indicates the high quality work in football schools, starting from the lowest selections. Explosive strength represents a significant factor in the football success specification equation. Its dominant role for successfully practicing football makes the issue of these domains current and especially interesting to football experts. The obtained research results complete the theoretical knowledge concerning the difference in the explosive strength of the football and futsal players' legs. Moreover, the results of this research are expected to serve as the model for further research and getting the answer to the questions that this research did not cover. The value of this paper is reflected in the application of the obtained results in everyday training practice. The data obtained in the testing may be useful as a scientifically based starting point for experts in the field of football for the purpose of a more adequate approach to planning, scheduling, execution and control of the training process, while the estimation of the present value of skills will be useful for the selection and guidance to football and futsal players, as well as the making of optimum plans and schedules, and the individual approach in the planning of anthropomotor development.

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RAZLIKE U EKSPLOZIVNOJ SNAZI NOGU IZMEĐU IGRAČA FUDBALA I FUTSALA

Fudbal i futsal spadaju u grupu polistrukturalnih aktivnosti kompleksnog karaktera. Sa motoričkog aspekta, obe igre definiše složena struktura, sastavljena od različitih kretanja cikličnog i acikličnog tipa. Fudbal i futsal karakterišu specifični pokreti donjih ekstremiteta, kojima se reguliše kretanje lopte (vođenje, dodavanje) a takođe i pokreti trupa i udarci po lopti glavom. Strukturu kretanja čine različite aktivnosti: trčanje, skokovi, okreti, prijem i odigravanje lopte. Cilj ovog istraživanja je da se utvrdi da li postoje statistički značajne razlike eksplozivne snage nogu igrača fudbala i futsala. Analiziran je uzorak od 37 ispitanika podeljen u dva subuzorka, prvi igrači fudbala seniori (prvi tim) FK "Radnički" iz Niša-23 i drugi igrači futsala seniori (prvi tim) Kluba malog fudbala "Kopernikus" iz Niša-14 ispitanika. Eksplozivna snaga donjih ekstremiteta je procenjivana sledećim testovima: skok iz čučnja (SJ), skok sa počučnjem bez zamaha ruku (CMJ) i skok sa počučnjem sa zamahom ruku (CMJS). Za utvrđivanje međugrupnih razlika je primenjena multivarijantna analiza varijanse (MANOVA), a razlike između grupa za svaki merni instrument pojedinačno, su utvrđivane univarijantnom analizom varijanse (ANOVA). Utvrđeno je da postoje razlike u eksplozivnoj snazi nogu igrača fudbala i futsala.

Ključne reči: *fudbal, futsal, eksplozivna snaga nogu, razlike*.