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Original research article

THE EXPLOSIVE POWER OF THE LOWER LIMBS IN BASKETBALL AND HANDBALL PLAYERS

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Ivana Bojić[1], Miodrag Kocić[1], Snežana Stajić[2]

[1]Faculty of Sport and Physical Education, University of Niš, Serbia
[2]Pharmacy and Physiotherapy school, Belgrade, Serbia

Abstract. *Basketball and handball are sports which require almost the same physical abilities. Since horizontal jumps and vertical jumps are the predominant elements of the game in both sports, their successful realization depends on the explosive power of the lower limbs. The aim of this research was to determine the significance of the differences of the explosive power of the lower limbs in basketball and handball players. Thirty participants took part in the research, 15 basketball and 15 handball players, all from Niš. A set of six variables was applied for evaluating the horizontal (3 Hop Test, One Leg Triple Jump and Standing Long Jump Test) and vertical jump (Bosko-Abalakov Jump- CMJ, Vertical Jump - run up and single leg take off and Squat Jump - SJ). The results of the univariate analysis of a single variable (ANOVA) show that basketball players achieved statistically better results in the vertical jump tests, whereas handball players did better in the horizontal jump tests.*

Key words: *explosive power of the lower limbs, basketball and handball players, differences.*

INTRODUCTION

Collective sports, basketball and handball primarily, as well as their competitions, are very popular throughout the world. The players need to have great explosive power of the lower limbs, upper limbs and the shoulders, and the sports themselves significantly improve the cardio-respiratory functions of the players (Pivač, 1998; Jovanović, 1998). The defence and the offence movements, such as passing the ball and shooting, jumps while in motion and standing, sideways movements, fast counter attacks and so on require that players have certain motor abilities in order to react swiftly and efficiently to all the situations that arise in the game (Kalani, 2013). The training processes related to these sports significantly

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Corresponding author: Ivana Bojić
Faculty of Sport and Physical Education, University of Niš, St. Čarnojevića 10a, 18000 Niš, Serbia
Phone: +381 18 510 900 • E-mail: bojicka2003@yahoo.com

improve the development of the different types of strength (explosive, repetitive, etc.) and stamina. Along with that, these training processes consequently bring about the adaptation of the contractile structures which, in turn, results in muscle power and strength enhancement (Kraemer, Fleck & Evans, 1996 in Radovanović & Ignjatović, 2009). Such an outcome comes from the specific characteristics of the sports, since a particular sport and the related training process determine which muscle groups will develop more than others (Seger and Thorstenson, 2000). The motor structures of the movements based on long-lasting repetitions and planking, which are not typical of handball, contribute less to situational success than single or less frequently repeated maximum explosive movements (Rogulj, Srhoj & Banović, 2002). Handball is a very dynamic sport which demands constant changes in the intensity of the motor movements. It is characterised by a large number of movements with sudden changes of direction (sideways and one-direction running), jumps, throws, frequent physical contacts with the opponent, which all largely depend on the muscle strength of the player (Bojić, 2008). Basketball is characterised by situational, complex and non-standard movements with inconsistent rhythm and intensity, which are all determined by the situations that arise in the game. Significant elements in basketball are the efficiency of the movement with and without the ball, manipulating the ball, as well as time-management in the realization of specific motor structures (Stanišić, 2011, 2). To what extent the technical and tactical abilities and knowledge of the game will be manifested largely depends on the motor, morphological, functional, conative and cognitive skills and characteristics of the players. Those skills and characteristics comply with the rules of the game, technical movements, movements with or without the ball, and the team and single player's tactics (Kocić, 2007, 8). According to Žeravica's research (Žeravica in Trininić, 2006), the right combination of the development stages of strength, speed, coordination, agility, balance and technique is responsible for the success of a player's sports career. The above-mentioned characteristics of basketball and handball show that these two sports share almost the same physical abilities. When it comes to the biomechanical structure of movement, as well as the specific techniques of these sports, the most significant motor abilities are strength (the explosive power of the upper and the lower limbs), speed, coordination, agility and aerobic and anaerobic stamina. Since horizontal jumps and vertical jumps are the predominant elements of the game in both sports, their successful realization depends on the explosive power of the lower limbs. The explosive strength of the vertical jump is equally important in both sports. In basketball, the vertical jump dominates because it facilitates the realization of specific technical and tactical elements, in handball both horizontal and vertical jumps are important for achieving the successful realization of the following elements: shooting past the block, defence blocking, shooting while getting into the goalkeeper's line from different players' positions. The significance of the differences of the explosive power of the lower limbs of basketball and handball players, that is, vertical and horizontal jumps in basketball and handball, represents the aim of this research.

THE METHOD

A group of 30 participants took part in the research. They were divided into two subgroups: 15 basketball players from the basketball team 'Konstantin' formed the first subgroup and 15 handball players from the handball team 'Železničar 1949' formed the second. All the participants from both subgroups have been competing in the Serbian Super League. They were all involved in the sport for at least five years and all of them

were between the ages of 18 and 30 at the moment of the research. Each participant had his height and weight taken and body mass index (BMI) calculated. The purpose of the anthropometric (measurement) data was the identification of the examinees. Therefore, they were not subjected to statistical processing. The explosive power of the lower limbs was evaluated by the following tests: 3 Hop Test, One Leg Triple Jump, Bosko-Abalakov Jump - CMJ, Vertical Jump- run up and single leg take off, Standing Long Jump Test and Squat Jump. For estimating the height of the jumps (Bosko- Abalakov Jump - CMJ) the wireless accelerator Myotest was used (Myotest, SA Switzerland) was used with the appropriate software support for evaluating the explosive muscle power (Casartelli, Müller & Maffiuletti, 2010; Bubanj, S et al., 2011). The tensiometric platform Quattro Jump (Quattro Jump, Switzerland) with 'NVM' sensors was used to estimate the time (s) and the peak (kg) of the squat jump. The standard measuring tape was used to estimate the height and length in cm. All the data were statistically processed by the statistical package SPSS (v. 17.0, SPSS Inc, Chicago, Il, USA). For determining intergroup differences, the multivariate analysis of variance (MANOVA) was used and the differences between the groups for each measuring instrument were evaluated by a univariate analysis of a single variance (ANOVA). The statistical level of significance was $p<0.05$.

RESULTS

Table 1 Statistical parameters of the explosive power of the lower limbs in handball players while performing the horizontal jump (measuring instrument – the horizontal jump)

Variable	N	Mean	Min.	Max.	SD	Error	SKEW.	KURT.
Standing Long Jump Test (cm)	15	203.40	182.00	253.00	22.77	5.880	0.726	-0.465
3 Hop Test (cm)	15	630.47	579.00	720.00	41.81	10.795	1.314	1.334
One Leg Triple Jump (cm)	15	620.93	550.00	717.00	41.47	10.707	0.535	1.051

With the group of handball players shown in Table 1, Skewness in a large number of tests shows a slight positive asymmetry (there is a large number of higher results compared to the mean), except for the 3 Hop Test (1.314) with higher values than the borderline ones. The analysis of the basic statistical parameters of the explosive power of the lower limbs while performing the vertical jump among basketball players shown in Table 2 indicates that Skewness in most tests tends to have either a slightly positive or negative asymmetry since its value does not go beyond ±1.00. The kurtosis values in all tests are below 2.75, which indicates platykurtic distribution.

Table 2 Statistical parameters of the explosive power of the lower limbs in basketball players while performing the horizontal jump (measuring instrument – the horizontal jump)

Variable	N	Mean	Min.	Max.	SD	Error	SKEW.	KURT.
Standing Long Jump Test (cm)	15	238.53	216.00	269.00	14.64	3.781	0.653	0.133
3 Hop Test (cm)	15	728.93	655.00	792.00	43.40	11.205	-0.217	-0.696
One Leg Triple Jump (cm)	15	715.20	645.00	812.00	59.63	15.395	0.361	-1.424

Table 3 shows the basic statistical parameters related to the results of the explosive power of the lower limbs in handball players while performing the vertical jump. In a large number of tests, Skewness shows a slight positive or negative asymmetry (indicating that there are numerically higher results than the mean) except for the peak of Squat Jump (SJ- PIK- K 2.239) with slightly higher values than the borderline ones. The kurtosis values are below 2.75, which indicates platykurtic distribution, except for the Squat Jump peak (SJ- PIK- K 6.822) with a clustered distribution.

Table 3 Statistical parameters of the explosive power of the lower limbs in handball players while performing the vertical jump (measuring instrument - the vertical jump)

Variable	N	Mean	Min.	Max.	SD	Error	SKEW.	KURT.
Vertical Jump - run up and single leg take-off (cm)	15	52.33	41.00	67.00	8.36	2.157	0.408	-1.203
Bosco-Abalakov jump height (cm)	15	41.06	31.90	53.40	5.94	1.534	0.787	0.415
Bosco-Abalakov jump power (W)	15	66.07	41.00	100.00	14.57	3.761	0.469	1.112
Bosco-Abalakov jump force (N)	15	31.45	24.60	39.80	3.72	0.960	0.369	0.809
Bosco-Abalakov jump speed (cm/s)	15	274.07	187.00	345.00	45.79	11.824	-0.172	-0.632
Squat Jump SJ - time - K (s)	15	0.27	0.18	0.39	0.07	0.018	0.284	-1.130
SJ – PIK - K (kg)	15	164.61	115.50	293.50	41.51	10.717	2.239	6.822

The analysis of the basic statistical parameters related to the explosive power of the lower limbs in basketball players while performing the vertical jump shown in Table 4 indicates that the Skewness calculated in a large number of tests points to a slight positive or negative asymmetry. The kurtosis values in all the tests are below 2.75, which indicates platykurtic distribution.

Table 4 Statistical parameters of the explosive power of the lower limbs in basketball players while performing the vertical jump (measuring instrument - the vertical jump)

Variable	N	Mean	Min.	Max.	SD	Error	SKEW.	KURT.
Vertical Jump - run up and single leg take-off (cm)	15	72.10	43.00	96.00	15.27	3.943	-0.276	-0.539
Bosco-Abalakov jump height (cm)	15	52.55	40.50	64.10	6.58	1.698	0.158	-0.483
Bosco-Abalakov jump power (W)	15	54.27	27.00	79.00	12.86	3.320	0.030	0.880
Bosco-Abalakov jump force (N)	15	31.75	25.40	36.50	3.35	0.864	-0.675	-0.516
Bosco-Abalakov jump speed (cm/s)	15	225.67	132.00	311.00	52.78	13.627	-0.005	-0.528
Squat Jump SJ - time - K (s)	15	0.30	0.16	0.47	0.08	0.021	0.342	-0.045
SJ – PIK - K (kg)	15	122.97	71.59	155.90	21.34	5.510	-0.567	1.458

A statistically significant difference was determined by calculating the significance of the differences of the levels of the mean values of all the tests (performed among basketball and handball players) (Table 5). The value of Wilks' Lambda Test was .409, which, along with the value of F-relation of 12.52, shows the p-level= .000 significance of the differences. From all the facts stated above, it can be concluded that there are statistically significant differences in the applied system of the tested participant's abilities.

Table 5 Multivariate analysis of a single variable of the explosive power of the lower limbs in basketball and handball players while performing the horizontal jump

Wilks' Lambda	F	p-level
.409	12.52	.000**

The univariate analysis of the variable for the efficiency of the lower limbs explosive power in basketball and handball players while performing the horizontal jump (Table 6) shows that there is a statistically significant difference in all the tests related to the horizontal jump (Standing Long Jump Test .000, 3 Hop Test .000, One Leg Triple Jump .000), on the basis of the F-relation coefficient and the p-level significance.

Table 6 Univariate analysis of a variable of the explosive power of the lower limbs in basketball and handball players while performing the horizontal jump (measuring instrument - the horizontal jump)

Variable	Mean-Handball players	Mean-Basketball players	F	p-level
Standing Long Jump Test (cm)	203.40	238.53	25.26	.000**
3 Hop Test (cm)	630.47	728.93	40.05	.000**
One Leg Triple Jump (cm)	620.93	715.20	25.27	.000**

A statistically significant difference was determined by calculating the significance of the differences of the levels of the mean values of all the tests (performed among basketball and handball players) (Table 7). The value of Wilks' Lambda Test was .531, which, along with the value of F-relation of 3.89, shows the p-level= .000 significance of the differences. From all the facts stated above, it can be concluded that there are statistically significant differences in the applied system of the tested participants' abilities.

Table 7 Multivariate analysis of a single variable of the explosive power of the lower limbs in basketball and handball players while performing the vertical jump

Wilks' Lambda	F	p-level
.174	7.77	.000**

The univariate analysis of a variable of the efficiency of the explosive power of the lower limbs in basketball and handball players while performing the vertical jump (Table 8) shows that there is a statistically significant difference in the following tests: Vertical Jump- run up and single leg take off (.000), Bosko- Abalakov Jump height (.000), Bosko- Abalakov Jump power (.026), Bosko- Abalakov Jump speed (.021) and Squat Jump peak (SJ- PIK- K .002), based on the F-relation coefficient and the p-level significance. Other vertical jump measuring instruments do not show a statistically significant difference.

Table 8 Univariate analysis of a variable of the efficiency of the explosive power of the lower limbs in basketball and handball players while performing the vertical jump

Variable	Mean-Handball players	Mean-Basketball players	F	p-level
Vertical Jump - run up and single leg take-off (cm)	52.33	72.10	19.34	.000**
Bosco-Abalakov jump height (cm)	41.06	52.55	25.20	.000**
Bosco-Abalakov jump power (W)	66.07	54.27	5.53	.026*
Bosco-Abalakov jump force (N)	31.45	31.75	0.05	.818
Bosco-Abalakov jump speed (cm/s)	274.07	225.67	7.20	.012*
Squat Jump				
SJ - time - K (s)	0.27	0.30	1.10	.303
SJ – PIK - K (kg)	164.61	122.97	11.94	.002*

DISCUSSION

The basic anthropometric characteristics of the subgroup of handball players prove its homogeneity in terms of body height and body mass, whereas, when it comes to body composition, the subgroup is homogenous. The explanation for such differences might be found in different positions that players have during the game. The subgroup of basketball players is also homogenous when it comes to body composition. There are significant differences in the anthropometric characteristics of their body height and body mass, which can also be ascribed to the demands of the playing positions on the team, for it is a well documented fact that the left back and middle back players are mostly shorter and lighter than the wing and the line players. When it comes to the explosive power of the lower limbs in handball players while performing the horizontal jump, there are significant differences in the numerical values of all three measuring instruments. The heterogeneity of the participants' body mass justifies the results. The following group of authors, Čupić, Rogulj, Srholj and Čavala (2008) obtained results similar to ours in their research conducted among 20 handball cadets. They discovered significant differences in the explosive power of the lower limbs while the players were performing the horizontal jump. Köklü, Alemdaroğlu, Ünver Koçak, Erol & Findikoğlu (2011) discovered the differences in the explosive power of the lower limbs in basketball players of the First and the Second Turkish League. The similarity in all these results qualifies our players for a professional level of sport. The numerical values of the results of the explosive power of the lower limbs in players while performing the horizontal jump show differences in the six variables applied to the players. The possible reasons for such results might be found in the anthropometric characteristics (body height), genetic predisposition, body composition (BMI), different techniques in performing the jumps, playing position in the team, and the level of the participants' preparedness. Similar results were obtained by Ingebrigsten (2012) among junior handball players. The results of the explosive power of the lower limbs in basketball players while performing the vertical jump also show differences in the six variables used among the participants. As with the first group of participants, the possible reasons for such heterogeneous results might be a genetic

predisposition, the players' preparedness, anthropometric characteristics, the techniques they used while performing jumps, and the playing position in the team. Body composition is also one of the key factors in being a successful player because the excess of fatty tissue has negative effects in certain activities (such as jumping) which demand constant lifting of the body and fighting the force of gravity (Reilly et al., 2000). While examining the explosive power of the lower limbs in the basketball players of the First and the Second Turkish League when they were performing the vertical jump, Köklü, Alemdaroğlu, Ünver Koçak, Erol and Findikoğlu (2011) discovered significant differences in the performance, as well as in the playing position. The multivariate analysis of a variable showed a statistically significant difference in the explosive power of the lower limbs in basketball and handball players while performing the horizontal jump in all the applied variables. Basketball players had better results in all the variables. Such results were not expected since basketball is characterised by vertical jumps and handball by a large number of both vertical and horizontal jumps (such as shooting past the block, defence blocking, shooting while getting into the goalkeeper's line from different players' positions as well as from the counterattack). The possible reasons for such results might be body height (the length of the lower limbs), better physical preparedness and the players' motivation. Basumatary & Lohani (2013) arrived at similar findings in their research, proving that basketball players had better results in performing the horizontal jump than handball players. However, contrary to our results, the following group of authors Gardašević, Jakovljević, Pajić & Preljević (2011) obtained better results of the explosive power of the lower limbs, which were also statistically significant, for handball players, while performing the horizontal jump than basketball players. When it comes to the vertical jump, the multivariate analysis showed a statistically significant difference between basketball and handball players in seven out of 11 variables. Basketball players had statistically better results for the Vertical Jump, Bosko-Abalakov Jump height, and Bosko-Abalkov Jump speed. Handball players had statistically better results in Bosko-Abalakov Jump power, Squat Jump peak and Bosko-Abalakov peak. Such results can be explained by the participants' morphological characteristics (body height and body mass), better motivation, genetic predisposition, as well as the influence of the training process during the testing period. Trikha & Kumar Sharma (2013) arrived at results similar to ours. In their tensiometric platform testing, they concluded that handball players achieved better results in the vertical jump than basketball players. The obtained data can be used by basketball and handball professionals to find a more adequate approach to planning, programming, carrying out and controlling the training process.

CONCLUSION

Basketball and handball are the sports which require almost the same physical abilities. The explosive power of the lower limbs has a significant influence on the realization of a large number of technical and tactical elements, especially when it comes to jumps. Jumps are frequent in all parts of the game (offence and defence) in both basketball and handball. For basketball players the vertical jump is more specific since it enables better realization of technical and tactical elements. For handball players, both the vertical and horizontal jumps are mandatory in performing shooting past the block, defence

blocking, shooting while getting into the goalkeeper's line from different players' positions. The obtained results show that there is a statistically significant difference in the explosive power of the lower limbs between basketball and handball players while performing horizontal and vertical jumps. Handball players had statistically better results in horizontal jump tests and basketball players had better results in vertical jump tests.

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EKSPLOZIVNA SNAGA NOGU KOŠARKAŠA I RUKOMETAŠA

Košarka i rukomet su sportske igre u kojima dominiraju skoro iste fizičke sposobnosti. Obzirom da su skokovi uvis i udalj dosta zastupljeni u igri i košarkaša i rukometaša, za uspešnu realizaciju istih najdominantnija je eksplozivna snaga donjih ekstremiteta. Značajnost razlika u eksplozivnoj snazi nogu košarkaša i rukometaša bio je cilj ovog istraživanja. Na uzorku od 30 ispitanika, 15 košarkaša i 15 rukometaša iz Niša, primenjen je set od šest varijabli za procenu horizontalne (3 Hop Test, One Leg Triple Jump and Standing Long Jump Test) i vertikalne skočnosti (Bosco-Abalakov jump – CMJ, Vertical Jump - run up and single leg take-off and Squat Jump - SJ). Rezultati univarijantne analize varijanse (ANOVA) pokazali su da su košarkaši postigli statistički bolje rezultate u testovima vertikalne a rukometaši u testovima za procenu horizontalne skočnosti.

Ključne reči: *eksplozivna snaga nogu, košarkaši, rukometaši, razlike.*