

RESEARCH REVIEW OF THE DEVELOPMENT OF THE EXPLOSIVE STRENGTH IN BASKETBALL

DUŠAN NIKOLIĆ, MIODRAG KOCIĆ, ANDELA ĐOŠIĆ, MARINA VELIČKOVIĆ

Faculty Sport and Physical Education, University of Niš, Serbia

Correspondence:

*Dusan Nikolic
Faculty Sport and Physical Education
University of Niš
nikolicdusan287@gmail.com*

Abstract: The ultimate performance in every sport, including basketball, is the result of a series of “bricks” stacked in the correct order. One of the dice is definitely an explosive power that is defined as the ability to manifest the maximum power for the maximum short time. The aim of this study was to gather previous studies that dealt with the development of the explosive strength in basketball. Total amount of 49 studies published between 2001 and 2016 was collected and subjected to analysis. The results showed that, for the development of the explosive strength, the plyometric training method is usually used, both with male and female basketball players. Also, the explosive force can be developed by using the complex training; the aquatic plyometric training; a combination of plyometric training and some other kind of training (dynamic stretching, strengthening without weights, sprinting, weight training, training of strength (no lifting)); specific sprint training; SAQ training; skipping rope; training consisting of strength training, different types of stamina and basketball technique; circuit breaker program; circuit training; combination of the sprint training exercises with weights; the plyometric training with additional load and the training of dynamic stretching.

Keywords: basketball, development, explosive strength, motor skills, players, research review.

INTRODUCTION

Basketball consists of a number of explosive movements, such as: short sprints, sudden stops and acceleration of speed, the change in direction of moving, different rebounds, throwing and passing the ball (Nikolić, Kocić, Berić & Jezdimirović, 2015). Explosive power, the ability to generate maximum muscular force in a short period of time (Santos & Janeiro, 2008), is an extremely important motor skill for playing basketball (Lehnert, Hulka, Malý, Fohler & Zahálka, 2013; Zhang, 2013). Vertical jumps, which require an appropriate level of the explosive strength (Bober, Rutkowska-Kucharski, Pietraszewski &

PREGLED ISTRAŽIVANJA RAZVOJA EKSPLOZIVNE SNAGE U KOŠARCI

DUŠAN NIKOLIĆ, MIODRAG KOCIĆ, ANDELA ĐOŠIĆ, MARINA VELIČKOVIĆ

Fakultet sporta i fizičkog vaspitanja, Univerzitet u Nišu, Srbija

Korespondencija:

*Dušan Nikolić
Fakultet sporta i fizičke kulture
Univerzitet u Nišu
nikolicdusan287@gmail.com*

Sažetak: Vrhunski rezultati u svakom sportu, pa tako i u košarci, rezultat su niza „kockica“ poslaganih pravilnim redosledom. Jedna od tih kockica je svakako eksplozivna snaga koja se definiše kao sposobnost ispoljavanja maksimalne snage za maksimalno kratko vreme. Cilj ovog rada bio je da se prikupe dosadašnja istraživanja koja su se bavila razvojem eksplozivne snage u košarci. Prikupljeno je i podvrgnuto analizi ukupno 49 istraživanja objavljenih u periodu od 2001. do 2016. godine. Rezultati su pokazali da se za razvoj eksplozivne snage najčešće koristi pliometrijska metoda treninga, kako kod košarkaša, tako i kod košarkašica. Takođe, eksplozivnu snagu moguće je razviti i: kompleksnim treningom; vodenim pliometrijskim treningom; kombinacijom pliometrijskog treninga i nekog drugog treninga (dinamičko istezanje, vežbe snage bez tegova, sprint; treningom sa tegovima; treningom snage (bez tegova)); specifičnim treningom sprinta; SAQ treningom; preskakanjem konopca; treningom koji se sastoji od treninga snage, različitih tipova izdržljivosti i košarkaške tehnike; circuit breaker programom; kružnim treningom; kombinacijom treninga sprinta sa vežbama sa tegovima; pliometrijskim treningom sa dodatnim opterećenjem i treningom dinamičkog istezanja.

Ključne reči: košarka, razvoj, eksplozivna snaga, motoričke sposobnosti, košarkaši, pregled istraživanja.

Uvod

Košarka se sastoji iz mnogobrojnih eksplozivnih kretnji, kao što su: kratki sprintevi, brza zaustavljanja i ubrzavanja, promene pravca kretanja, različiti skokovi, bacanja i dodavanja lopte (Nikolić, Kocić, Berić & Jezdimirović, 2015). Eksplozivna snaga, sposobnost da se generiše maksimalna mišićna sila u što kraćem vremenskom periodu (Santos & Janeira, 2008), je izuzetno važna motorička sposobnost za bavljenje košarkom (Lehnert, Hulka, Malý, Fohler & Zahálka, 2013; Zhang, 2013). Vertikalni skokovi, koji zahtevaju odgovarajući nivo eksplozivne snage (Bober, Rutkowska-Kucharska,

Lesiecki, 2006), are of great importance for success in sports such as basketball (Nedeljković, 2004; Bobbert, 1990), and are manifested in situations such as jump shot and jump towards the ball (Manojlović & Erčulj, 2013). In men's professional basketball a player has to jump 46 ± 12 times (Castagna, Chaouachi, Rampinini, Chamari & Impellizzeri, 2009), and some authors claim that basketball in the whole match (40min games) takes up to 100 different jumps (Manojlović & Erčulj, 2013). A lot of researches show how important jumps are for basketball as the representatives of the explosive strength. Okur, Tetik & Koc (2013) in a sample of 51 players found that the success of the competition positively correlated with the result in the vertical jump. Šeparović, Alice-partition & Užičanin (2009) in a regression analysis found that jumps, among other indicators of situational efficiency, have a significant impact on the final result of the game finals championship of Bosnia and Herzegovina and the result of the game in the regional basketball league. Jovanović & Jovanović (2006) in the analysis of the 24 best teams participating in the World Championship in 2006 in basketball for seniors in Japan found that a better qualified team, among other things, successfully captured rebounds under the basket of the opponents (rebound).

The subject of this paper is the explosive power of a player. *The aim* of this study was the collection and analysis of the previous studies published on the development of the explosive strength in basketball.

RESEARCH METHODS

For collection, classification and analysis of the targeted research, descriptive methods and theoretical analysis were used, and researches that were done were searched on Google, Google Scholar, PubMed and Kobson. Additional literature in the form of textbooks was also used. The search was limited to works that were published between 2001 and 2016. The keywords used during the search were: ***explosive power, development and basketball***.

RESULTS

For better clarity all the previous studies are presented in Table 1. A total of 49 studies are presented. The smallest number of respondents was in the research Adorable Caparin & Abba (2011) and it amounted to nine participants and the biggest was in the research Bavli (2012) with 91 respondents. In nine of the researches, the respondents were female basketball players (Chang, Hsu, Chen & Lin, 2005; Chaudhary & Jhahharia, 2010; Adibpour, Bakht & Behpour, 2012; Komal & Singh, 2013; Zarić, 2014; Attene at al., 2014; McCormick et al., 2015;

Pietraszewski & Lesiecki, 2006), su od velikog značaja za uspeh u sportu kao što je košarka (Nedeljković, 2004; Bobbert, 1990), a manifestuju se u situacijama kao što su skok šut i skok za odbijenom loptom (Manojlović & Erčulj, 2013). U muškoj profesionalnoj košarci, u toku utakmice igrač načini po 46 ± 12 skoka (Castagna, Chaouachi, Rampinini, Chamari & Impellizzeri, 2009), a neki autori tvrde da košarkaš na celoj utakmici (40min igre) izvodi i do 100 različitih skokova (Manojlović & Erčulj, 2013). Koliko su skokovi, kao reprezentanti eksplozivne snage bitni za košarku govore i mnoga istraživanja. Okur, Tetik & Koc (2013) su na uzorku od 51 košarkaša utvrdili da je uspešnost na takmičenju pozitivno povezana sa rezultatom u vertikalnom skoku. Šeparović, Alić-Partić & Užičanin (2009) su regresijskom analizom utvrdili da skokovi, pored ostalih pokazatelja situacijske efikasnosti, imaju značajan uticaj na konačni rezultat utakmica završnice prvenstva Bosne i Hercegovine i rezultat utakmica u Regionalnoj košarkaškoj ligi. Jovanović & Jovanović (2006) su analizom 24 najboljih reprezentacija učesnica Prvenstva sveta 2006. godine u košarci za seniore u Japanu utvrdili da bolje plasirale reprezentacije, između ostalog, uspešnije hvataju odbijene lopte pod košem protivnika (skok u napadu).

Predmet ovog rada je eksplozivna snaga košarkaša. Cilj ovog rada bio prikupljanje i analiza dosadašnjih istraživanja objavljenih na temu razvoja eksplozivne snage u košarci.

METOD ISTRAŽIVANJA

Za prikupljanje, klasifikaciju i analizu ciljanih istraživanja korišćena je deskriptivna metoda i teorijska analiza, a istraživanja do kojih se došlo pretraživana su na: Google, Google Scholar, PubMed i Kobson. Korišćena je i dopunska literatura u vidu udžbenika. Pretraga je ograničena na radove koji su objavljeni u periodu od 2001. do 2016. godine. Ključne reči koje su korišćene prilikom pretrage su: explosive power, development i basketball.

REZULTATI

Radi boljeg pregleda sva dosadašnja istraživanja predstavljena su u Tabeli 1. Ukupno je predstavljeno 49 istraživanja. Najmanji broj ispitanika bio je u istraživanju Adorable Caparino & Abba (2011) i iznosio je devet ispitanika, a najveći u istraživanju Bavli (2012) a sa 91. ispitanikom. Kod devet istraživanja ispitanici su bili ženskog pola - košarkašice (Chang, Hsu, Chen & Lin, 2005; Chaudhary & Jhahharia, 2010; Adibpour, Bakht & Behpour, 2012; Komal & Singh, 2013; Zarić, 2014; Attene at al., 2014; McCormick at al., 2015; Benis, Rossi, Russo & La

Benis, Rossi, Russo & La Torre, 2015; Khazali & Hematfar, 2015), in two studies they were both male and female (Bavli, 2012; Ramachandran & Pradhan, 2014), and in all other studies they were male. The youngest sample of respondents was in the research of Khazali & Hematfar (2015) and ranged from 11 to 12 years old and the oldest was in the study Morsal at al. (2014) and ranged from 24 to 30 years. The experimental treatment was the shortest in research Ramachandran & Pradhan (2014) and it lasted for two weeks. The experimental treatment lasted longest for 12 weeks and it was the case in *five* studies (Chang, Hsu, Chen & Lin, 2005; Shallaby, 2010; Bavli, 2012; Abraham, 2015; Ademović, 2016). In most of the works the program involved the training exercise 2 to 3 times a week.

Torre, 2015; Khazai & Hematfar, 2015), kod dva istraživanja su bili i muškog i ženskog pola (Bavli, 2012a; Ramachandran & Pradhan, 2014), a kod svih ostalih istraživanja su bili muškog pola. Najmlađi uzorak ispitanika bio je u istraživanju Khazai & Hematfar (2015) i iznosio je od 11 do 12 godina, a najstariji u istraživanju Morsal at al. (2014) i iznosio od 24 do 30 godina. Eksperimentalni tretman je najkraće trajao u istraživanju Ramachandran & Pradhan (2014) i iznosio je dve nedelje. Eksperimentalni tretman je najduže trajao 12 nedelja i to kod *pet* istraživanja (Chang, Hsu, Chen & Lin, 2005; Shallaby, 2010; Bavli, 2012a; Abraham, 2015; Ademović, 2016). U najvećem broju radova program je podrazumevao vežbanje 2 do 3 puta nedeljno.

Tabela 1. Dosadašnja istraživanja ekspozivne snage u košarci (od 2001-2016. godine)

Reference	Uzorak ispitanika				Eksperimentalni tretman			
	N	G.St	P	trajanje	Br. Gr.	mereni parametri	rezultati	razlike između grupa
Matavulj, Kukolj, Ugarkovic, Tihanyi & Janic (2001)	/	J	M	/	K; P ₅₀ ; P ₁₀₀	VvS (CMJ)	povećanje VvS kod obe P grupe	nema razlike između P grupa
Cheng, Lin & Lin (2003)	16	16-19	M	8 nedelja (3x nedeljno)	Ko;T	EsN	poboljšanje eksplozivne snage kod Ko	Ko veći napredak na nekim testovima EsN od T
Chang, Hsu, Chen & Lin (2005)	16	16.53 ± 0.77	Ž	12 nedelja (3x nedeljno)	P ₃₀ ; P ₄₀ ; P ₅₀ ; K	SJ, CMJ i CJ	P i K napredak na CMJ i CJ, nema napretka na SJ	P ₅₀ veći napredak od P ₄₀ i P ₃₀
Zushi (2006)	10	/	M	7 nedelja (3x nedeljno)	P	VvS	značajan napredak	/
Boraczyński & Urmia (2008)	14	20,3 ± 1,9	M	8 nedelja (3x nedeljno)	P	EsN	Napredak EsN	/
Santos & Janeira (2008)	25	14-15	M	10 nedelja (2x nedeljno)	Ko; K	SJ, CMJ, ABA, i MBT	napredak Ko na testovima SJ, ABA i MBT	/
Kukrić, Karalejić, Petrović i Jakovljević (2009)	20	16-17	M	10 nedelja (2x nedeljno)	Ko; K	VvS (CMJ i SJ)	Ko napredak VvS	/
Shaji & Isha (2009)	45	18-25	M	4 nedelje (2x nedeljno)	Di; P; DiP	VvS	povećanje VvS kod Di, P i DiP	DiP veći napredak u VvS od P i Di
Kukrić, Petrović, Dobraš i Guzina (2010)	20	J	M	10 nedelja (2x nedeljno)	P; K	EsN (CMJ i SJ)	P napredak kod CMJ i SJ	/
Chaudhary & Jhajharia (2010)	20	18-22	Ž	6 nedelja	P; K	VvS	P napredak VvS	K nema napredak
King & Cipriani (2010)	32	14-16	M	6 nedelja (2x nedeljno/20-30min)	Psr; Pfr	VvS	Psr napredak u VvS	Pfr nema napredak
Khlifa at al. (2010)	27	/	M	10 nedelja (2-3x nedeljno)	P; K; Po	VvS	P i Po napredak VvS	Po veći napredak od P
Shallaby (2010)	20	16	M	12 nedelja (3x nedeljno/120min)	P; K	VvS	P napredak VvS	P veći u odnosu na K
Tsimahidis et al. (2010)	26	J	M	10 nedelja	K; TSp	VvS (SJ, CMJ i DJ)	TSp napredak na gotovo svim testovima nakon 5 i 10 nedelja	/
Wee, Mudah & Tan (2011)	20	20-23	M	4 nedelja (2x nedeljno)	P; K	VvS	P i K napredak VvS	P veći napredak u od K (11,7% naspram 2,12%)
Santos & Janeira (2011)	24	14-15	M	10 nedelja (2x nedeljno)	P; K	EsN (SJ, CMJ, ABA, DJ)	P napredak EsN	/
Draganović & Marković (2011)	23	J	M	6 nedelja (2x nedeljno)	P; K	VvS	P napredak VvS	VvS poboljšana za 6cm

Adorable Caparino & Abbu (2011)	9	St	M	10 nedelja	P	VvS	povećanje VvS	/
Sharma & Multani (2012)	40	/	M	4 nedelje	P; K	EsN	P napredak EsN	K nema napredak
Asadi & Arazi (2012)	16	19-20	M	6 nedelja (2x nedeljno/55min)	P; K	EsN (VvS i SLJ)	napredak P u EsN	P veći napredak od K
Adibpour, Bakht & Behpour (2012)	16	20.38±3.7	Ž	8 nedelja (3x nedeljno)	Ko; K	VvS	Ko napredak VvS	Ko veći napredak od K
Bavli (2012)a	91	15-17	MŽ	12 nedelja (3x nedeljno)	P; K; Pv	VvS	napredak VvS kod P i Pv	između P i Pv nema razlike / P i Pv veći napredak od K
Bavli (2012)b	24	20,7 ± 2,6	M	6 nedelja	P; K	VvS	P napredak VvS	P veći napredak od K
Arazi, Coetzee & Asadi (2012)	18	18,81 ± 1,46	M	8 nedelja (3x nedeljno/40 min)	P; Pv; K	VvS	Pv i P napredak VvS	nema razlike između Pv i P
Kukrić, Karalejić, Jakovljević Petrović i Mandić (2012)	30	16-17	M	10 nedelja (2x nedeljno)	P; K; Ko	VvS	P i Ko napredak VvS	nema razlike između P i Ko
Andrejić (2012)	21	12-13	M	6 nedelja (2 x nedeljno/90min)	S; Ps	SLJ, VvS, MBT	Ps napredak u VvS, SLJ i MBT; S napredak u MBT	Ps veći napredak od S
Boccolini, Costa & Alberti (2012)	28	/	M	4 nedelje (3x nedeljno/20min)	K; Knp	CMJ (izvođen na jednoj i obe noge)	Knp poboljšanje CMJ na desnoj nozi (7.24%)	K nema napredak
Javorac (2012)	40	16-18	M	10 nedelja (2x nedeljno)	Ko; K	VvS, TrM, SLJ	Ko značajan napredak VvS, TrM, SLJ	Ko veći napredak od K
Santos & Janeira (2012)	25	14-15	M	10 nedelja (2x nedeljno)	T; K	SJ, CMJ, ABA, DJ i MBT	T napredak na svim testovima	/
Komal & Singh (2013)	45	16-18	Ž	8 nedelja	P; K; T	VvS	P i T napredak VvS	P i T veći napredak od K
Zhang (2013)	17	18-24	M	4 nedelje (3x nedeljno/60min)	P	VvS sa leve noge, VvS sa desne noge, VvS - sunožni skok	nema poboljšanja VvS - sunožni skok	poboljšanje VvS sa leve noge i VvS sa desne noge
Asadi (2013)	20	20.1 ± 1.3	M	6 nedelja (2x nedeljno)	P; K	VvS i SLJ	P napredak VvS i SLJ	/
Nabizadeh, Bararpour, Chaleh & Najafnia (2013)	30	19,2	M	8 nedelja (3x nedeljno/20min)	P_{50} , P_{60} , P_{70}	VvS	P ₅₀ , P ₆₀ i P ₇₀ napredak VvS	nema razlike između grupa
Robert & Murugavel (2013)	30	19-25	M	8 nedelja (3x nedeljno)	P; Sp; T	VvS	napredak kod P , Sp i T	P veći napredak od Sp i T
Lehnert, Hülka, Malý, Fohler & Zahálka (2013)	12	24,36 ± 3,9	M	4 nedelje (2x nedeljno) + 2 nedelje (4x nedeljno)	P	EsN	nema poboljšanja EsN	/
Zarić (2014)	13	17.76±0.43	Ž	6 nedelja	E	EsN (SJ, CMJ, CMJ Free arms)	napredak na testu SJ (12,65%)	/
Roden, Lambson & DeBe-liso (2014)	20	juniori	M	6 nedelja (2x nedeljno)	Ko_1 , Ko_2	VvS	Ko ₁ i Ko ₂ napredak VvS (7,7% i 5,1%)	nema razlike između Ko ₁ i Ko ₂ (p = 0,077)
Attene at al. (2014)	36	14,9 ± 0,9	Ž	6 nedelja	P; K	VvS	P i K napredak VvS	P veći napredak od K (15,4% naspram 7,5%)
Ramachandran & Pradhan (2014)	30	20.4 ± 1.73	MŽ	2 nedelje (3x nedeljno)	DiP	VvS, agilnost	poboljšanje agilnosti i VvS	/
Morsal at al. (2014)	30	24-30	M	6 nedelja (3x nedeljno)	P; K	EsN	povećanje EsN	/
Zribi at al. (2014)	51	pube-rtet	M	9 nedelja	P; K	EsN	napredak EsN	/
Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014)	19	16.3±0.5	M	8 nedelja (2x nedeljno)	P; Sp	VvS	P napredak VvS	/
Nageswaran (2014)	30	18-22	M	10 nedelja	P; K; Ko	EsN	P i Ko napredak EsN	Ko veći napredak od P
Ramateerth & Kannur (2014)	21	12-13	M	6 nedelja (2x nedeljno/90min)	S; Ps	VvS, SLJ, MBT	Ps napredak kod VvS, SLJ, MBT	Ps veći napredak od S
Abraham (2015)	80	13-18	M	12 nedelja (3x nedeljno)	P; K; Kt; Bp	EsN i EsR	napredak P , Kt i Bp kod EsN i EsR	/
McCormick at al. (2015)	14	Srš	Ž	6 nedelja	P_{sr} , P_{fr}	EsN (SLJ, VvS, LHT/L, LHT/R)	napredak Psr i Pfr grupe na svim testovima	Psr bolje rezultate u VvS od Pfr , Pfr bolje u LHT/L i LHT/R od Psr
Benis, Rossi, Russo & La Torre (2015)	24	15.9 ± 0.8	Ž	8 nedelja	K; P	VvS	P napredak u VvS	nema napretka kod K

Khazai & Hematfar (2015)	16	11-12	Ž	4 nedelje (3x nedeljno/ 60min)	K; P	VvS	P napredak VvS	/
Ademović (2016)	15	18-26	M	12 nedelja (3x nedeljno/ 90min)	Sk	EsN	napredak EsN	/

Legenda: **N** - ukupan broj ispitanika; **G.St** - godine starosti; **P** - pol ispitanika; **Br.Gr** - broj grupa; **P** - grupa koja je bila podvrgnuta pliometrijskom programu; **K** - kontrolna grupa; **Ko₁** - visoki intenzitet mali broj ponavljanja, **Ko₂** - srednji intenzitet veći broj ponavljanja; **T** - grupa koja je podvrgnuta treningu sa tegovima; **Ko** - grupa koja je bila podvrgnuta kompleksnom treningu; **Ps** - grupa koja je bila podvrgnuta kombinaciji pliometrijskog treninga i treninga snage (bez tegova); **S** - grupa koja je bila podvrgnuta treningu sa vežbama snage (bez tegova); **Sp** - grupa koja je bila podvrgnuta specifičnom treningu sprinta; **Di** - grupa koja je bila podvrgnuta dinamičkom istezanju; **DiP** - grupa koja je bila podvrgnuta kombinaciji dinamičkog istezanja i pliometrijskih vežbi; **Kt** - grupa koja je bila podvrgnuta kružnom treningu; **Bp** - grupa koja je bila podvrgnuta circuit breaker programu; **Po** - grupa koja je bila podvrgnuta pliometrijskom treningu sa dodatnim spoljašnjim opterećenjem u vidu prsluka; **Pv** - grupa koja je bila podvrgnuta vodenom pliometrijskom programu; **Psr** - grupa koja je izvodila pliometrijske skokove u sagitalnoj ravni; **Pfr** - grupa koja je izvodila pliometrijske skokove u frontalnoj ravni; **P₃₀**, **P₄₀**, **P₅₀**, **P₆₀**, **P₇₀** i **P₁₀₀** - grupe koje su bile podvrgnute pliometrijskim dubinskim skokovima sa klupica visina 30, 40, 50, 60, 70 i 100cm; **Sk** - grupa koja je bila podvrgnuta SAQ treningu; **TSp** - grupa koja je bila podvrgnuta kombinaciji sprinta sa vežbama sa tegovima; **KnP** - grupa koja je bila podvrgnuta treningu skokova sa konopcem; **E** - grupa u kojoj se trenajni proces sastojao od treninga snage, različitih tipova izdržljivosti, košarkaške tehnike; **J** - juniori; **St** - studenti; **Srš** - srednjoškolci; **VvS** - visina vertikalnog skoka; **EsN** - eksplozivna snaga nogu; **EsR** - eksplozivna snaga ruku; **CMJ** (Countermovement Jump) - skok iz čučnja sa pripremom; **SJ** (Squat Jump) - skok iz čučnja; **CJ** (Continuous Jump) - ponavljajući skokovi; **ABA** - Abalakov test; **MBT** (Medicine Ball Throw) - bacanje medicinke; **DJ** (Drop Jump) - dubinski skok; **SLJ** (Standing Long Jump) - skok udalj iz mesta; **TrM** - troskok iz mesta; **LHT/L** - lateral hop test left; **LHT/R** - lateral hop test right.

Table 1. Previous studies of the explosive power in basketball (from 2001 to 2016.)

References	Sample of respondents			Experimental treatment				
	N	A	G	duration	No. Gr.	measured parameters	results	differences among groups
Mataulji, Kukulj, Ugarkovic, Tihanyi & Jaric (2001)	/	J	M	/	C; P ₅₀ ; P ₁₀₀	HVJ (CMJ)	increase of HVJ with both P groups	no difference among P groups
Cheng, Lin & Lin (2003)	16	16-19	M	8 weeks (3x a week)	Co;W	ELS	improvement of explosive strength with Co	Co greater improvement at some tests in ELS than T
Chang, Hsu, Chen & Lin (2005)	16	16.53 ± 0.77	F	12 weeks (3x a week)	P ₃₀ ; P ₄₀ ; P ₅₀ ; C	SJ, CMJ and CJ	P and C improvement in CMJ and CJ, no improvement in SJ	P ₅₀ bigger improvement than P ₄₀ and P ₃₀
Zushi (2006)	10	/	M	7 weeks (3x a week)	P	HVJ	great improvement	/
Boraczyński & Urmia (2008)	14	20,3 ± 1,9	M	8 weeks (3x a week)	P	ELS	improvement in ELS	/
Santos & Janeira (2008)	25	14-15	M	10 weeks (2x a week)	Co; C	SJ, CMJ, ABA, and MBT	improvement with Co in tests of SJ, ABA and MBT	/
Kukrić, Karalejić, Petrović i Jakovljević (2009)	20	16-17	M	10 weeks (2x a week)	Co; C	HVJ (CMJ and SJ)	Co improvement in HVJ	/
Shaji & Isha (2009)	45	18-25	M	4 weeks (2x a week)	Ds; P; DSP	HVJ	improvement in HVJ with DS, P and DSP	DSP greater improvement in HVJ Than P and Ds
Kukrić, Petrović, Dobraš i Guzina (2010)	20	J	M	10 weeks (2x a week)	P; C	ELS (CMJ and SJ)	P improvement in CMJ and SJ	/
Chaudhary & Jhajharia (2010)	20	18-22	F	6 weeks	P; C	HVJ	P improvement in HVJ	C no improvement
King & Cipriani (2010)	32	14-16	M	6 weeks (2x a week/ 20-30min)	Psp; Pfp	HVJ	Psp improvement in HVJ	Pfp no improvement
Khlifa at al. (2010)	27	/	M	10 weeks (2-3x a week)	P; C; Po	HVJ	P and Po improvement in HVJ	Po greater improvement than P
Shallaby (2010)	20	16	M	12 weeks (3x a week/ 120min)	P; C	HVJ	P improvement in HVJ	P greater compared to C
Tsimahidis et al. (2010)	26	J	M	10 weeks	C; TSp	HVJ (SJ, CMJ and DJ)	TSp improvement in almost all the tests after 5 and 10 weeks	/

Wee, Mudah & Tan (2011)	20	20-23	M	4 weeks (2x a week)	P; C	HVJ	P and C improvement in HVJ	P greater improvement compared to C (11,7% to 2,12%)
Santos & Janeira (2011)	24	14-15	M	10 weeks (2x a week)	P; C	EIS (SJ, CMJ, ABA, DJ)	P improvement in EIS	/
Draganović & Marković (2011)	23	J	M	6 weeks (2x a week)	P; C	HVJ	P improvement in HVJ	HVJ improved for 6cm
Adorable Caparino & Abbu (2011)	9	St	M	10 weeks	P	HVJ	growth of HVJ	/
Sharma & Multani (2012)	40	/	M	4 weeks	P; C	EIS	P improvement in EIS	C no improvement
Asadi & Arazi (2012)	16	19-20	M	6 weeks (2x a week 55min)	P; C	EIS (HVJ and SLJ)	improvement P in EIS	P greater improvement than C
Adibpour, Bakht & Behpour (2012)	16	20.38±3.7	F	8 week (3x a week)	Co; C	HVJ	Co improvement in HVJ	Co greater improvement than C
Bavli (2012)a	91	15-17	MF	12 weeks (3x a week)	P; C; Pw	HVJ	improvement in HVJ with P and Pw	no difference between P and Pw/ P and Pw greater improvement than C
Bavli (2012)b	24	20,7 ± 2,6	M	6 weeks	P; C	HVJ	P improvement in HVJ	P greater improvement than C
Arazi, Coetzee & Asadi (2012)	18	18,81 ± 1,46	M	8 weeks (3x a week/40 min)	P; Pw; K	HVJ	Pw and P improvement in HVJ	no difference between P and Pw
Kukrić, Karalejić, Jakovljević Petrović i Mandić (2012)	30	16-17	M	10 weeks(2x a week)	P; C; Co	HVJ	P and Co improvement in HVJ	no difference between P and Co
Andrejić (2012)	21	12-13	M	6 weeks(2 x a week/ 90min)	F; Pf	SLJ,HVJ, MBT	Pf improvement in HVJ, SLJ and MBT; F improvement in MBT	Pf greater improvement than F
Boccolini, Costa & Alberti (2012)	28	/	M	4 weeks (3x a week/ 20min)	C; Tjr	CMJ (performed on one and both legs)	Kjr improvement in CMJ of right leg (7.24%)	C no improvement
Javorac (2012)	40	16-18	M	10 weeks (2x a week)	Co; C	HVJ, TjS, SLJ	Co great improvement i HVJ,Tjs, SLJ	Co greater improvement than C
Santos & Janeira (2012)	25	14-15	M	10weeks (2x a week)	W; C	SJ, CMJ, ABA, DJ and MBT	W improvement in all the tests	/
Komal & Singh (2013)	45	16-18	F	8 weeks	P; C; W	HVJ	P and W improvement in HVJ	P and W greater improvement than C
Zhang (2013)	17	18-24	M	4 weeks (3x a week/ 60min)	P	HVJ off the left leg, HVJ off the right leg, HVJ – two feet jump	no improvement in HVJ – two feet jump	improvement in HVJ off left leg and HVJ off right leg
Asadi (2013)	20	20.1 ± 1.3	M	6 weeks (2x a week)	P; C	HVJ and SLJ	P improvement in HVJ and SLJ	/
Nabizadeh, Bararpour, Chaleh & Najafnia (2013)	30	19,2	M	8 weeks (3x a week/ 20min)	P50; P60; P70	HVJ	P50,P60 i P70 improvement in HVJ	no differences among groups
Robert & Murugavel (2013)	30	19-25	M	8 weeks (3x a week)	P; Sp; W	HVJ	improvement with P, Sp and W	P greater improvement than Sp and W
Lehnert, Hůlka, Malý, Fohler & Zahálka (2013)	12	24,36 ± 3,9	M	4 weeks(2x a week) + 2 weeks (4x a week)	P	EIS	no improvements in EIS	/
Zarić (2014)	13	17.76±0.43	F	6 weeks	E	EIS (SJ, CMJ, CMJ Free arms)	improvement in test SJ (12,65%)	/
Roden, Lambson & DeBeliso (2014)	20	juniors	M	6 weeks(2x a week)	Co1; Co2	HVJ	Ko1 and Ko2 improvement in HVJ (7,7% i 5,1%)	no difference between Co1 and Co2 (p = 0,077)
Attene at al. (2014)	36	14,9 ± 0,9	F	6 weeks	P; C	HVJ	P and C improvement in HVJ	P greater improvement than C (15,4% to 7,5%)
Ramachandran & Pradhan (2014)	30	20.4 ± 1.73	M Z	2 weeks (3x a week)	DsP	HVJ, agility	improvement of agility and HVJ	/

Morsal et al. (2014)	30	24-30	M	6 weeks (3x a week)	P; C	EIS	improvement in EIS	/
Zribi et al. (2014)	51	puberty	M	9 weeks	P; C	EIS	improvement in EIS	/
Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014)	19	16.3±0.5	M	8 weeks (2x a week)	P; Sp	HVJ	P improvement in HVJ	/
Nageswaran (2014)	30	18-22	M	10 weeks	P; C; Co	EIS	P and Co improvement in EIS	Co greater improvement than P
Ramateerth & Kannur (2014)	21	12-13	M	6 a week (2x a week/90min)	F; Pf	HvJ, SLJ, MBT	Pf improvement in HVJ, SLJ, MBT	Ps greater improvement than F
Abraham (2015)	80	13-18	M	12 weeks(3x a week)	P; C; Ct; Bp	EIS and EpA	improvement with P, Ct and Bp in EIS and EpA	/
McCormick et al. (2015)	14	HSS	F	6 weeks	Psp; Pfp	EIS (SLJ, HVJ, LHT/L, LHT/R)	improvement Psp and Pfp groups in all the tests	Psp better results in HvJ than Psp, Pfp better in LHT/L i LHT/R than Psp
Benis, Rossi, Russo & La Torre (2015)	24	15.9 ± 0.8	F	8 weeks	C; P	HVJ	P improvement in HVJ	no improvement with C
Khazai & Hematfar (2015)	16	11-12	F	4 weeks (3x a week/60min)	C; P	HVJ	P improvement in HVJ	/
Ademović (2016)	15	18-26	M	12weeks (3x a week/90min)	Sq	EIS	improvement in EIS	/

Legend: N - total number of subjects; A - age; H - half of the respondents; No. G - the number of groups; P - a group that has been subjected to a plyometric program; C - control group; Co1- high intensity low reps, St2-medium intensity greater number of repetitions; W - a group which is subjected to training with weights; Once - a group that has been subjected to a complex training; Pf - the group that had been subjected to a combination of plyometric training and the training force (no lifting); F - a group that was subjected to training with the exercise force (no lifting); Sp - a group that has undergone specific training sprint; Ds - a group that has been subjected to dynamic stretching; Dsp - a group that has been subjected to a combination of dynamic stretching and plyometric exercises; Ct - a group that has been subjected to circuit training; Bp - a group that has been subjected to a circuit breaker program; After - a group that has been subjected to plyometric training with additional external load in the form of vests; Pw - a group that has been subjected to the aquatic plyometric program; Psp - group which is executed plyometric jumps in the sagittal plane; Pfp - group which is executed plyometric jumps in the frontal plane; P30, P40, P50, P60, P70 and P100 - groups which have been subjected to in-depth plyometric jumps from the bench height of 30, 40, 50, 60, 70 and 100cm; Sq - a group that has been subjected SAQ training; TSP - a group that was subjected to combination with sprinting exercises, with weights; KNP - a group that has been subjected to training jumps with a rope; E - group in which the training process composed of strength training, various types of durability, basketball technique; J - juniors; St - students; HSS - high school students; HVJ - height of vertical jump; ELS - explosive leg strength; EPA - explosive power arm; CMJ - countermovement jump; SJ - Squat jump; CJ - Continuous Jump; ABA - Abalak's test; MBT - medicine ball throw; DJ - drop jump (depth jump); SLJ - standing long jump; TRM - triple jump out of the spot; LHT/L - lateral hop test block; LHT/R - right lateral hop test.

DISCUSSION

Numerous studies from Table 1 show that the explosive power of players can be developed with the help of the plyometric training methods. Matavulj Kukulj, Ugarković, Tihanyi & Jarić (2001) found that the plyometric training leads to the improvements in vertical jump of junior basketball players. Similar results were obtained by Kukrić, Petrović, Dobraš and Guzina (2010). The authors found that the plyometric training for a period of 10 weeks (2x weekly), in which the number of exercises and the number of jumps per training increased from week to week, and in which the pause between a series is three, and between the exercises five minutes, leads to an increase in height of the vertical jump of junior basketball players.

DISKUSIJA

Veliki broj istraživanja iz Tabele 1. pokazuje da se eksplozivna snaga košarkaša može razviti uz pomoć *pliometrijske metode* treninga. Matavulj, Kukulj, Ugarković, Tihanyi & Jarić (2001) su utvrdili da pliometrijski trening dovodi do poboljšanja visine vertikalnog skoka kod juniorskih košarkaša. Slične rezultate dobili su i Kukrić, Petrović, Dobraš i Guzina (2010). Autori su utvrdili da pliometrijski trening u trajanju od 10 nedelja (2x nedeljno), u kome se broj vežbi i broj skokova po treningu povećava iz nedelje u nedelju i u kome je pauza između serija tri, između vežbi pet minuta, dovodi do povećanja visine vertikalnog skoka košarkaša juniorskog uzrasta.

Shaji & Isha (2009) found that plyometric training for a period of four weeks (2x per week) leads to the increase in the vertical jump height of basketball players by an average 3,6cm (7.9%), while Wee, Mudah & Tan (2011) found that the increase in height of vertical jump with the aid of plyometric training within the aforementioned time duration amounts to 11.7%. Sharma & Multani (2012) and Zhang (2013) proved that the plyometric training for four weeks leads to an improved vertical jump height on a sample of male basketball players, and Khazali & Hematfar (2015) on a sample of female basketball players.

On the other hand, Asadi & Arazi (2012) found that plyometric training for a period of six weeks (2x per week) leads to significant improvements in the vertical jump of basketball players on average by 23%, while Attene et al. (2014) on a sample of female basketball players determined that the plyometric training for a period of six weeks leads to a significant increase in the height of vertical jump for 15.4%. Similar results were obtained by Draganović & Marković (2011). The authors found that plyometric training within the time of duration leads to an improved vertical jump height of junior basketball players for 6cm. These results show that even though the plyometric training for four weeks leads to an improved vertical jump height of basketball players, the mentioned training method gives better results in the long term.

Zushi (2006) as a method of plyometric training used the depth jump (*drop jump*) and found that the plyometric training for a period of seven weeks (3 times a week) leads to an improved jumping ability of basketball players. That fact that drop jump can be a good plyometric exercise for developing the explosive power of basketball players was also determined by Nabizadeh, Bararpour, Chaleh & Najafnia (2013). The authors have shown that plyometric training for a period of eight weeks (3x weekly / 20min), which consisted of the drop jumps from the bench after which the respondents immediately jumped in advance over a certain obstacle (*drop jump to standing long jump*), resulted in significant improvements of the vertical jump height of basketball players. Similar results were obtained by Asadi & Arazi (2012), but, besides the *drop jump* and *drop jump to standing long jump*, they also used the *squat jump*.

Particular studies have shown that plyometric training should not take long to have positive effects on the development of the explosive power of players. Arazi, Coetzee & Asadi (2012) found that eight weeks of plyometric training performed 3 times per week for a period of 40min results in a significant improvement of the vertical jump height of basketball players. King & Cipriani (2010) found that six weeks of plyometric training which is performed

Shaji & Isha (2009) su utvrdili da pliometrijski trening u trajanju od četiri nedelje (2x nedeljno) dovodi do povećanja visine vertikalnog skoka kod košarkaša u proseku za 3,6cm (7,9%), dok su Wee, Mudah & Tan (2011) utvrdili da povećanje visine vertikalnog skoka uz pomoć pliometrijskog treninga u pomenutom vremenskom trajanju iznosi 11,7%. Da pliometrijski trening u trajanju od četiri nedelje dovodi do poboljšanja visine vertikalnog skoka utvrdili su i Sharma & Multani (2012), kao i Zhang (2013) na uzorku košarkaša, a Khazali & Hematfar (2015) na uzorku košarkašica. S druge strane Asadi & Arazi (2012) su utvrdili da pliometrijski trening u trajanju od šest nedelja (2x nedeljno) dovodi do značajnog poboljšanja visine vertikalnog skoka košarkaša u proseku za 23%, dok su Attene et al. (2014) na uzorku košarkašica utvrdili da pliometrijski trening u trajanju od šest nedelja dovodi do značajnog povećanja visine vertikalnog skoka za 15,4%. Slične rezultate su dobili i Draganović & Marković (2011). Autori su utvrdili da pliometrijski trening u pomenutom vremenskom trajanju dovodi do poboljšanja visine vertikalnog skoka košarkaša juniorskog uzrasta za 6cm. Ovi rezultati pokazuju da iako pliometrijski trening u trajanju od četiri nedelje dovodi do poboljšanja visine vertikalnog skoka košarkaša, bolje rezultate daje pomenuta metoda treninga u dužem vremenskom trajanju.

Zushi (2006) je kao metodu pliometrijskog treninga koristio skok u dubinu (*drop jump*) i utvrdio da pliometrijski trening u trajanju od sedam nedelja (3x nedeljno) dovodi do poboljšanja sposobnosti skakanja košarkaša. Da skok u dubinu (*drop jump*) može biti povoljna pliometrijska vežba za razvoj eksplozivne snage košarkaša utvrdili su i Nabizadeh, Bararpour, Chaleh & Najafnia (2013). Autori su dokazali da pliometrijski trening u trajanju od osam nedelja (3x nedeljno/20min), koji se sastojao od skokova u dubinu sa klupice nakon kojih su ispitanici odmah skakali unapred preko određene prepreke (*drop jump to standing long jump*), doveo do značajnog poboljšanja visine vertikalnog skoka košarkaša. Slične rezultate su dobili i Asadi & Arazi (2012), s tim što su oni pored *drop jump*-a i *drop jump to standing long jump*-a koristili i *squat jump*.

Pojedina istraživanja su pokazala da trening pliometrije ne mora da traje dugo da bi imao pozitivne efekte na razvoj eksplozivne snage košarkaša. Arazi, Coetzee & Asadi (2012) su utvrdili da osam nedelja pliometrijskog treninga koji se izvodi 3x nedeljno u trajanju od 40min dovodi do značajnog poboljšanja visine vertikalnog skoka košarkaša. King & Cipriani (2010) su utvrdili da šest nedelja pliometrijskog treninga koji se izvodi 2x

2x a week for 20 to 30 min results in a significant improvement of vertical jump height of basketball players. Similar results were obtained by Bavli (2012)b who found that plyometric training for 30 min, which is executed right after the basketball training, for a period of six weeks, leads to significant improvements of the vertical jump height of basketball players. Nabizadeh, Bararpour, Chaleh & Najafnia (2013) found that even the 20min plyometric training is enough (eight weeks, 3 times a week) in order to enhance the explosive power of basketball players.

That plyometric training lasting between six and 10 weeks improves the explosive power of basketball players was determined by many other studies shown in Table 1 (Boraczyński & Urnia, 2008; Khelifa et al., 2010; Shalaby, 2010; Santos & Janeira, 2011; Adorable, Caparino & Abbu, 2011; Kukrić, Karalejić, Jakovljević, Petrović & Mandić, 2012; Asadi, 2013; Robert & Murugavel, 2013; Nageswaran, 2014; Zribi et al., 2014; Morsal et al., 2014; Abraham, 2015). In the aforementioned studies, the training was applied 2 to 3 times a week. Khelifa et al. (2010) in a sample of 27 basketball players determined that plyometric exercises with the use of an additional external load in the form of vest (10-11% of the total weight) for 10 weeks (2-3 times per week) caused a significant increase in the height of vertical jump. The authors also found that plyometric exercises with an additional external load are significantly more effective in increasing the height of the vertical jump than the plyometric exercises without an additional load.

The results in Table 1 show that, except for basketball players, plyometric training lasting between six and 12 weeks leads to the development of the explosive strength with female basketball players, too (Chang, Hsu, Chen & Lin, 2005; Chaudhary & Jhajharia, 2010; Bavli, 2012a; Komal & Singh, 2013; Attene et al., 2014; Benis, Rossi, Russo & La Torre, 2015; McCormick et al., 2015).

One of the few studies in which plyometric training has not led to a significant increase in height of the vertical jump of basketball players is the research by Lehnert, Hulka, Malý, Fohler & Zahálka (2013). In their study, the subjects were an average age of 24.36 ± 3.9 years, and the experimental program lasted for six weeks (2x per week from the first to the fourth week of the program and 4x per week in the fifth and sixth week of the program). In the last two weeks, the plyometric exercises for the lower limbs were combined with the resistance training exercises for the upper body on one workout and vice versa. The number of jumps gradually increased during the program. In addition to the plyometric program, the basketball players were still subject to the conditional training exercises that included speed, aerobic endurance, the resistance train-

nedeljno u trajanju od 20 do 30min dovodi do značajnog poboljšanja visine vertikalnog skoka košarkaša. Slične rezultate dobio je i Bavli (2012)b i utvrdio da pliometrijski trening u trajanju od 30min, koji se izvodi odmah nakon košarkaškog treninga, u periodu od šest nedelja, dovodi do značajnog poboljšanja visine vertikalnog skoka košarkaša. Nabizadeh, Bararpour, Chaleh & Najafnia (2013) su utvrdili da je i 20min pliometrijskog treninga dovoljno (osam nedelja, 3x nedeljno) da bi se poboljšala eksplozivna snaga košarkaša.

Da pliometrijski trening u trajanju između šest i 10 nedelja poboljšava eksplozivnu snagu košarkaša utvrdila su još mnoga istraživanja prikazana u Tabeli 1. (Boraczyński & Urnia, 2008; Khelifa et al., 2010; Shalaby, 2010; Santos & Janeira, 2011; Adorable, Caparino & Abbu, 2011; Kukrić, Karalejić, Jakovljević, Petrović & Mandić, 2012; Asadi, 2013; Robert & Murugavel, 2013; Nageswaran, 2014; Zribi et al., 2014; Morsal et al., 2014; Abraham, 2015). U pomenutim istraživanjima trening je sprovedjen 2 do 3 puta nedeljno. Khelifa et al. (2010) su na uzorku od 27 košarkaša utvrdili da pliometrijske vežbe u kojima se koristi dodatno spoljašnje opterećenje u vidu prsluka (10-11% ukupne težine) u trajanju od 10 nedelja (2-3x nedeljno) dovode do značajnog povećanja visine vertikalnog skoka. Autori su takođe utvrdili da su pliometrijske vežbe sa dodatnim spoljašnjim opterećenjem značajno efikasnije u povećanju visine vertikalnog skoka od pliometrijskih vežbi bez dodatnog opterećenja.

Rezultati iz Tabele 1. pokazuju da osim kod košarkaša, pliometrijski trening u trajanju između šest i 12 nedelja dovodi do razvoja eksplozivne snage i kod košarkašica (Chang, Hsu, Chen & Lin, 2005; Chaudhary & Jhajharia, 2010; Bavli, 2012a; Komal & Singh, 2013; Attene et al., 2014; Benis, Rossi, Russo & La Torre, 2015; McCormick et al., 2015).

Jedno od retkih istraživanja u kome pliometrijski trening nije doveo do značajnog povećanja visine vertikalnog skoka košarkaša je istraživanje Lehnert, Hulka, Malý, Fohler & Zahálka (2013). U njihovom istraživanju ispitanici su bili prosečne starosti $24,36 \pm 3,9$ godina, a eksperimentalni program je trajao šest nedelja (2x nedeljno od prve do četvrte nedelje programa i 4x nedeljno u petoj i šestoj nedelji programa). U poslednje dve nedelje pliometrijske vežbe za donje ekstremitete su kombinovane sa vežbama sa opterećenjem za gornje ekstremitete na jednom treningu i obrnuto. Broj skokova se postepeno povećavao tokom programa. Pored pliometrijskog programa košarkaši su i dalje bili izloženi kondicionoj pripremi koja je obuhvatala vežbe brzine, aerobne izdržljivosti, trening sa opterećenjem i td. Do sličnih re-

ing and so on. Similar results were obtained by Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014). In their research, they found that plyometric training for a period of eight weeks (2x per week) does not lead to significant advances of height of the vertical jump of basketball players. It is possible that in the aforementioned studies, due to the scope of the program, the basketball players entered the state of overtraining so there was no progress in the measured ability. In addition to the aforementioned, King & Cipriani (2010) in a sample of basketball players found that the plyometric exercises with jumps in the frontal plane, for a period of six weeks (2x per week / 20-30min), do not lead to improvements in the vertical jump height.

In addition to plyometric training, the *complex training* also proved to be a good method for developing the explosive power of basketball players. Nageswaran (2014) on a sample of basketball players determined that the combination of plyometric training and weight training (*complex training*) for 10 weeks led to a significant improvement of the explosive power. The author also found that the combination leads to significantly better progress in the explosive power than only a plyometric training for 10 weeks. Similar results were obtained by Cheng, Lin & Lin (2003), Santos & Janeira (2008), Kukrić, Karalejić, Petrović and Jakovljević (2009), Javorac (2012), Kukrić, Karalejić, Jakovljević Petrović and Mandić (2012) and Roden, Lambson & DeBeliso (2014) on a sample of basketball players, and Adibpour, Bakht & Behpour (2012) on a sample of female basketball players. Complex training in these studies lasted from 6 to 10 weeks (2-3 times per week).

Some studies have shown that plyometric jumps, except with the exercises with weights (complex training), can be combined with other training methods to develop the explosive power of basketball players. Ramachandran & Pradhan (2014) on a sample of female basketball players found that a combination of plyometric training and the dynamic stretching for a period of two weeks (3 times weekly) leads to significant improvements in vertical jump height. In this study, the dynamic stretching was performed 10min before and after the plyometric exercises that lasted for 30min. Similar results on a sample of basketball players were found by Shaji & Isha (2009) but in their research, the experimental treatment lasted for four weeks (2x per week). The authors also found that the combination provides significantly more progress in the height of the vertical jump than when the plyometric training and dynamic stretching are used separately. The improvement of the explosive power of basketball players can also be a result of combination of plyometric training and strength training (*rubber cord exercises* and *body weight exercises*)

zultata su došli i Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014). Oni su u svom istraživanju utvrdili da pliometrijski trening u trajanju od osam nedelja (2x nedeljno) ne dovodi do značajnog napretka visine vertikalnog skoka kod košarkaša. Moguće je da su pomenutim istraživanjima, zbog obima programa, košarkaši ušli u stanje pretreniranosti pa nije došlo do napretka merene sposobnosti. Pored pomenutog King & Cipriani (2010) su na uzorku košarkaša utvrdili da pliometrijske vežbe sa skokovima u frontalnoj ravni, u trajanju od šest nedelja (2x nedeljno/20-30min), ne dovode do poboljšanja visine vertikalnog skoka.

Pored pliometrijskog treninga i *kompleksni trening* se pokazao kao dobra metoda za razvoj eksplozivne snage košarkaša. Nageswaran (2014) je na uzorku košarkaša utvrdio da trening kombinacije pliometrijskog treninga i treninga sa opterećenjem (*kompleksni trening*) u trajanju od 10 nedelja dovodi do značajnog poboljšanja eksplozivne snage. Autor je takođe utvrdio da pomenuta kombinacija dovodi do značajno boljeg napretka eksplozivne snage nego samo pliometrijski trening u trajanju od 10 nedelja. Slične rezultate dobili su i Cheng, Lin & Lin (2003), Santos & Janeira (2008), Kukrić, Karalejić, Petrović i Jakovljević (2009), Javorac (2012), Kukrić, Karalejić, Jakovljević Petrović i Mandić (2012) i Roden, Lambson & DeBeliso (2014) na uzorku košarkaša, kao i Adibpour, Bakht & Behpour (2012) na uzorku košarkašica. Kompleksni trening u pomenutim istraživanjima trajao je od 6 do 10 nedelja (2-3x nedeljno).

Neka istraživanja su pokazala da se pliometrijski skokovi, osim sa vežbama sa tegovima (kompleksni trening), mogu kombinovati i sa drugim metodama treninga u cilju razvoja eksplozivne snage košarkaša. Ramachandran & Pradhan (2014) su na uzorku košarkašica utvrdili da kombinacija pliometrijskog treninga i dinamičkog istezanja u trajanju od dve nedelje (3x nedeljno) dovodi do značajnog poboljšanja visine vertikalnog skoka. U tom istraživanju dinamičko istezanje je vršeno 10min pre i posle pliometrijskih vežbi koje su trajale 30min. Do sličnih rezultata, na uzorku košarkaša, došli su došli i Shaji & Isha (2009) s tim što je u njihovom istraživanju eksperimentalni tretman trajao četiri nedelje (2x nedeljno). Autori su, takođe, utvrdili da pomenuta kombinacija daje značajno veći napredak visine vertikalnog skoka nego kada se pliometrijski trening i dinamičko istezanje koriste zasebno. Do poboljšanja eksplozivne snage košarkaša može dovesti i kombinacija pliometrijskog treninga i treninga snage (*rubber cord exercises* i *body weight exercises*) u trajanju od 6 nedelja (2x nedeljno). Ta kombinacija daje bolje rezultate u razvoju eksplozivne snage u odno-

for a period of 6 weeks (2x weekly). This combination gives better results in the development of the explosive strength in relation to the strength training when used alone (Andrejić, 2012; Ramateerth & Kannur, 2014).

The strength training with weights also leads to a significant development of the explosive power of basketball players. Santos & Janeira (2012) in a sample of 25 basketball players aged 14-15 years found that the strength training with weights for the upper and lower extremities leads to a significant improvement in the results of the tests: *squat jump*, *countermovement jump*, *Abalak test*, *drop jump* and *medicine ball throw*. Komal & Singh (2013) found that the aforementioned method of training can also be effective in improving the explosive power of even older basketball players (16-18 years) than in the previous survey. Similar results were found by Cheng, Lin & Lin (2003) and Robert & Murugavel (2013). The strength training with weights can develop the explosive power even when combined with the sprint training (Tsimahidis et al., 2010).

In addition to these, some other training methods have proven effective in developing the explosive power of basketball players. Andrejić (2012) found that the strength training without weights (*rubber cord exercises* and *body weight exercises*) for a period of 6 weeks (2x weekly) leads to a significant improvement of the results on the tests of throwing a medicine for basketball players. Bavli (2012) on a sample of male and female basketball players found that the aquatic plyometric training in the period of 12 weeks (3x weekly) leads to significant improvements in the vertical jump height. That the aquatic plyometric training can be a good method to improve the vertical jump height of basketball players was also determined by Arazi, Asadi & Coetzee (2012). Robert & Murugavel (2013) in a sample of basketball players found that *sprint training* for a period of 8 weeks (3 times weekly) leads to significant improvements in the vertical jump height. Ademović (2016) on a sample of basketball players found that SAQ training (speed, agility, quickness, agility, explosive power) for 12 weeks (3 times a week / 90min) leads to a significant development of the explosive strength. Boccolini, Costa and Alberti (2012) in a sample of basketball players found that the *jump training with a rope* for 20 minutes (4 weeks, 3x a week) leads to a significant improvement in the explosive strength. Zarić (2014) on a sample of female basketball players found that a combination of strength training, endurance and basketball techniques for a period of six months, leads to a significant development of the explosive strength. Abraham (2015) on a sample of basketball players found that the *circuit training*, as well as

su na trening snage kad se koristi samostalno (Andrejić, 2012; Ramateerth & Kannur, 2014).

Trening snage sa tegovima, takođe, dovodi do značajnog razvoja eksplozivne snage košarkaša. Santos & Janeira (2012) su na uzorku od 25 košarkaša starosti 14-15 godina utvrdili da trening snage sa tegovima za gornje i donje ekstremitete dovodi do značajnog poboljšanja rezultata na testovima: *squat jump*, *countermovement jump*, *abalakov test*, *drop jump* i *medicine ball throw*. Komal & Singh (2013) su utvrdili da pomenuta metoda treninga može biti efikasna u poboljšanju eksplozivne snage i kod nešto starijih košarkaša (16-18 godina) nego u prethodnom istraživanju. Do sličnih rezultata su došli i Cheng, Lin & Lin (2003) i Robert & Murugavel (2013). Trening snage sa tegovima može razviti eksplozivnu snagu i ukoliko se kombinuje sa treningom sprinta (Tsimahidis et al., 2010).

Pored pomenutih još neke metode treninga su se pokazale efikasnim u razvoju eksplozivne snage košarkaša. Andrejić (2012) je utvrdio da trening snage bez tegova (*rubber cord exercises* i *body weight exercises*) u trajanju od 6 nedelja (2x nedeljno) dovodi do značajnog poboljšanja rezultata na testu bacanje medicine kod košarkaša. Bavli (2012) je na uzorku košarkaša i košarkašica utvrdio da vodeni pliometrijski trening u trajanju od 12 nedelja (3x nedeljno) dovodi do značajnog poboljšanja visine vertikalnog skoka. Da vodeni pliometrijski trening može biti povoljna metoda za poboljšanje visine vertikalnog skoka košarkaša utvrdili su i Arazi, Coetzee & Asadi (2012). Robert & Murugavel (2013) su na uzorku košarkaša utvrdili da *sprinterski trening* u trajanju od 8 nedelja (3x nedeljno) dovodi do značajnog poboljšanja visine vertikalnog skoka. Ademović (2016) je na uzorku košarkaša utvrdio da SAQ trening (speed, agility, quickness - brzina, agilnost, eksplozivna snaga) u trajanju od 12 nedelja (3x nedeljno/90min) dovodi do značajnog razvoja eksplozivne snage. Boccolini, Costa & Alberti (2012) su na uzorku košarkaša utvrdili da je *trening skokova sa konopcem* u trajanju od 20 minuta (4 nedelje-3x nedeljno) dovodi do značajnog poboljšanja eksplozivne snage. Zarić (2014) je na uzorku košarkašica utvrdio da kombinacija treninga snage, izdržljivosti i košarkaške tehnike u trajanju od šest meseci dovodi do značajnog razvoja eksplozivne snage. Abraham (2015) je na uzorku košarkaša utvrdio da *kružni trening*, kao i *circuit breaker program* u trajanju od 12 nedelja (3x nedeljno) dovode do značajnog poboljšanja eksplozivne snage. Shaji & Isha (2009) su na uzorku košarkaša utvrdili da *dinamičko istezanje* u trajanju od 4 nedelje (2x nedeljno) dovodi do značajnog poboljšanja visine vertikalnog skoka.

the *circuit breaker program* for a period of 12 weeks (3x a week) lead to a significant improvement in the explosive strength. Shaji & Isha (2009) in a sample of basketball players found that the *dynamic stretching* for a period of 4 weeks (2x per week) leads to significant improvements in the vertical jump height.

CONCLUSION

Based on the previous researches, it was concluded that for the development of the explosive strength, the usually used method is the *plyometric method of training*, at both male and female basketball players. For the development of the mentioned skills, it is necessary that the training process lasts from four to 12 weeks. In most studies, this training method involved the exercise 2-3 times a week. With regard to the recommendations of the author, the plyometric method should be used cautiously, with prior preparation and with the development of muscular endurance, in order to prevent injuries and overtraining of young basketball players. Another method that has proved effective for developing of the explosive power of basketball players is the *complex training*. The authors believe that the combination of plyometric training and weight training can be more effective than weight training and plyometric training when used separately. *Aquatic plyometric training* may also be a suitable method for developing the explosive power of basketball players. The advantage of water over the coastal plyometric training is that it reduces the muscle pain, stress and injury. A review of past researches shows that, in addition to the aforementioned, the explosive power of basketball players can also be developed with the help of the following training methods: a combination of plyometric training and any other training (dynamic stretching, strength exercises without weights, sprint); weight training; strength training (without weights); specific sprint training; SAQ training (speed, agility, quickness, agility, explosive strength); skipping rope; training consisted of strength training, various types of durability and basketball technique; circuit breaker program; circuit training; a combination of sprint training combined with the exercises with weights; plyometric training with additional load; training of dynamic stretching.

Authorship statement

The authors have contributed equally.

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ZAKLJUČAK

Na osnovu dosadašnjih istraživanja konstatovano je da se za razvoj eksplozivne snage najčešće koristi *pliometrijska metoda treninga*, kako kod košarkaša, tako i kod košarkašica. Da bi došlo do razvoja pomenute sposobnosti neophodno je da trenaži proces traje od četiri do 12 nedelja. U najvećem broju istraživanja ova metoda treninga je podrazumevala vežbanje 2-3 x nedeljno. S obzirom na preporuke autora, pliometrijsku metodu treba koristiti obazrivo, sa prethodnom pripremom i razvojem mišićne izdržljivosti, kako ne bi došlo do povreda i pretreniranosti mladih košarkaša. Još jedna metoda koja se pokazala efikasnom za razvoj eksplozivne snage košarkaša jeste *kompleksni trening*. Autori smatraju da kombinacija pliometrijskog treninga i treninga sa tegovima može biti efikasnija nego trening sa tegovima ili pliometrijski trening kada se koriste zasebno. *Vodeni pliometrijski trening*, takođe, može biti metoda pogodna za razvoj eksplozivne snage košarkaša. Prednost vodenog u odnosu na kopneni pliometrijski trening je u tome što smanjuje bolove u mišićima, stres i povrede. Pregled dosadašnjih istraživanja pokazuje da se, osim pomenutim, eksplozivna snaga košarkaša može razviti i uz pomoć sledećih metoda treninga: kombinacijom pliometrijskog treninga i nekog drugog treninga (dinamičko istezanje, vežbe snage bez tegova, sprint); treningom sa tegovima; treningom snage (bez tegova); specifičnim treningom sprinta; SAQ treningom (speed, agility, quickness - brzina, agilnost, eksplozivna snaga); preskakanjem konopca; treningom koji se sastoji od treninga snage, različitih tipova izdržljivosti i košarkaške tehnike; circuit breaker programom; kružnim treningom; kombinacijom treninga sprinta sa vežbama sa tegovima; pliometrijskim treningom sa dodatnim opterećenjem; treningom dinamičkog istezanja.

Izjava autora

Autori pridonijeli jednako.

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Mi izjavljujemo da nemamo konflikt interesa.

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