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Scientific review

THE EFFECTS OF COMPLEX TRAINING ON MOTOR SKILLS

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Dušan Nikolić[1]
Faculty of Sport and Physical Education, University of Niš, Serbia

Miodrag Kocić
Faculty of Sport and Physical Education, University of Niš, Serbia

Dragana Berić
Faculty of Sport and Physical Education, University of Niš, Serbia

Marina Veličković
Faculty of Sport and Physical Education, University of Niš, Serbia

Abstract: Due to the evolution of sports science, as well as monitoring and applying knowledge from other sciences, researchers and trainers are always finding new and acceptable methods for the development of sports skills. One of the most interesting innovations in 20th century training is plyometric training. In addition to plyometric training, in the 70s of the 20th century, researchers have found that weight training can increase power. In the early eighties, it was concluded that combined plyometric training and weight training – or complex training, gives better results than just weight training without plyometric training. The aim of this study was to gather previous studies that have examined the effects of complex training on motor skills on different respondent samples. For collection, classification and analysis of the targeted research, the descriptive methods and theoretical analysis were used and the results that were reached were researched on Google, Google Scholar, PubMed and Kobson. Some 18 researches were found. The results showed that the majority of authors dealt with the effects of complex training on explosive leg strength, while a small number of studies examined the effects of the aforementioned training methods on other motor skills. The results of the reviewed studies have shown that complex training may

[1] ✉ nikolicdusan287@gmail.com

be a suitable method for developing explosive leg strength and the running speed of athletes from different sports.

Keywords: *complex training, the development of motor skills, science, effects, research review*

INTRODUCTION

Top sport is developed at an unusually fast pace. The preparation of athletes is improved, the conditions of the training are changed, the methods and means of training are improved, new rules are introduced, as well as new equipment, facilities and devices. It highlights that a lot of work is dedicated to finding various new options to achieve even bigger records, wins and results. Such rapid progress in sport achievements was attained, on one hand, by improved conditions and increased global competition and on the other hand, by scientific research which is most extensively implemented, particularly that linked to superior preparation and the performances of athletes (Malacko, 1991). The trend of sports development requires the maximum participation of science, both in the selection process and in the organization and implementation of the training process (Popović, Smajić, Molnar and Mašanović, 2009). Thanks to the evolution of sports science as well as monitoring and applying knowledge from other sciences, coaches and athletes are always finding new and acceptable methods for the development of sports abilities (Pavlek, 2009). One of the most interesting innovations in the training of the 20th century is plyometric training. Plyometrics is a word that first appeared in Russian sports literature in 1966. The term plyometrics is bound to many other concepts, such as stress training, speed strength, jumps and elastic reactivity training (Radcliffe and Farentinos, 2003). On the other hand, when it comes to muscle development with the help of weights, earlier it was believed that this way of training leads to restrictions on the range of motions and a decrease of the speed of movement (the myth of the 'muscle obstacle'). This belief continued until shortly after World War II. At the end of World War II, exercising with weights was initially accepted by medical experts and started to be used for rehabilitation purposes, i.e. with injured soldiers. In the seventies of the 20th century it was generally accepted that a properly designed program of weight training not only fails to slow down and restrict the movement of joints, but it can even improve them – thus contributing to an increase in power (De Vries, 1976). In the early eighties, it was concluded that combined plyometric training and weight training - complex training - gives better results than just weight training without plyometric training. Combining good programs increases strength and speed, and reduces the risk of injury (Radcliffe and Farentinos, 2003, Radovanović and Ignjatović, 2009). This led Verkhoshanski to believe that the maximum height in the jump requires the muscles to be able to perform powerful eccentric contraction and

to withstand heavy loads during the amortization stage. He believed that if the muscles are strong eccentrically, they will be able to quickly move from an eccentric contraction to a concentric contraction and accelerate the movement of the body in the desired direction (Radovanović and Ignjatović, 2009). Plyometric training and weight training are, historically speaking, a complement to one another. For example, recommendations were often published that weight training is a good preparation for plyometric training. The recommendations suggest that the implementation of plyometric training should start after a period of preparation that includes four to six weeks of training with weights, several weeks after sprint training or resistance training, after the development of speed and power or after the acquisition of a basic experience of performing jumps (Ebben & Watts, 1998). It is believed that the combination of plyometric training and weight training can be beneficial for the development of strength in athletes. In particular, complex training alternately combines biomechanically similar, high-intensity exercises with weights and plyometric exercises, series to series in the same training (Ebben, 2002). An example of complex training for the upper body is a combination of bench-pressing (bench press) and throwing medicine balls (medicine ball power drops). An example of complex training for the lower part of the body is a combination of a squat with deep jumps (or depth jumps) (Ebben & Blackard, 1997). Verhosanski recommends the pairing of squats with deep squat jumps (Ebben, Jensen & Blackard, 2000). Complex training is recommended for different sports teams, for individual athletes, for the rehabilitation of athletes and the fitness development of athletes (Ebben & Blackard, 1997). A set of high load exercises in training with weights can create some possible neurogenic, myogenic or psychomotor changes. A set of plyometric drills which have similar patterns of movement (biomechanically comparable) and which immediately follow an exercise with weights is believed to optimize the training effect by increasing the excitation of motor neurons, and by an improved inclusion of the nervous system (Ebben, Jensen & Blackard, 2000). The aim of this study was to collect and analyze previous studies that have examined the effects of complex training on the motor skills of different samples of respondents. The goal, based on the results of the previous research, was to analyze and compare the effects of complex training with other training methods and their effects on motor skills. The collection and analysis of works on this subject enables experts in the field of sports training, by reading this article, to become acquainted with the method of training that can be favorable for the development of the motor skills of young athletes.

METHODS

For the collection, classification and analysis of the targeted research, descriptive methods and theoretical analysis were used and the results that

were reached were researched on Google, Google Scholar, PubMed and Kobson. Additional literature in the form of textbooks was also used. The search was limited to the works that studied the effects of complex training on the motor abilities of different individuals. The analyzed scientific studies are published in journals that have a significant impact factor. The keywords used during the search were: *complex training, development and motor skills.*

A THEORETICAL CONSIDERATION OF THE PROBLEM

For clarity, all the previous researches on the topic are presented in Table 1. A total of 18 studies were presented. Each survey has the following parameters: **sample of respondents** (number of subjects, age, gender, sport branch), and the **experimental treatment** (duration of the experiment, the number of groups during the study, the parameters measured, notes, program results the differences between the groups at the end of the experiment). The number of respondents varied from survey to survey. The smallest number of respondents was in the survey by Carvalho, Mourão & Abade (2014) and amounted to 12 participants, and the greatest was in the research by Adams, O'Shea, O'Shea & Climstein (1992), Rahimi & Behpur (2005) and Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi (2006) and amounted to 48 respondents. In one study, the subjects were female (Adibpour, Bakht & Behpour, 2012), in one both male and female (Bauer, Thayer & Baras, 1990), and in all other studies they were male. The youngest sample was in the research by Santos & Janeiro (2008) and they were 14-15 years old, and the oldest were in the study by Adibpour, Bakht & Behpour (2012) and averaged 20.4 ± 3.7 years. The experimental treatment in five studies lasted for **six weeks** (Rahimi & Behpur, 2005; Rahimi, Arshad, Behpur, Boroujerdi-Sadeghi & Rahimi, 2006; Alves, Rebelo, Abrantes & Sampaio, 2010; MacDonald, Lamont, Garner & Jackson, 2013; Roden, Lambson & DeBeliso, 2014), one study was a **seven-week** one (Adams, O'Shea, O'Shea & Climstein, 1992), in three it was an **eight-week** exploration (Blakey & Southard, 1987; Cheng, Lin & Lin, 2003; Adibpour, Bakht & Behpour, 2012), in six researches it was **10 weeks** (Bauer, Thayer & Baras, 1990; Santos & Janeiro, 2008; Kukrić, Karalejić, Petrović and Jakovljević, 2009; Kukrić, Karalejić, Jakovljević, Petrović and Mandić, 2012; Javorac, 2012; Nageswaran, 2014), in three studies it was **12 weeks** (Fatouros et al., 2000; Marques & Gonzales-Badillo, 2006; Carvalho, Mourão & Abade, 2014). In most of the works, the program involved exercising two to three times a week. The sample of respondents was from different sports, and in some researches, the subjects were the students engaged in recreational sports. In eight researches, the subjects were **basketball players** (Carvalho, Mourão & Abade, 2014; Santos & Janeiro,

2008; Kukrić, Karalejić, Petrović and Jakovljević, 2009; Kukrić, Karalejić, Jakovljevic, Petrović and Mandić, 2012; Javorac, 2012; Adibpour, Bakht & Behpour, 2012; Nageswaran, 2014; Roden, Lambson & DeBeliso, 2014), in five researches the subjects were **sports college students** (Blakey & Southard, 1987; Bauer & Baras Thayer, 1990; Adams, O'Shea & O'Shea Climstein, 1992; Fatouros et al., 2000; MacDonald, Lamont, Garner & Jackson, 2013), in two studies involved were **combined-different sports** (Rahimi & Behpur, 2005; Rahimi, Arshad, Behpur, Boroujerdi-Sadeghi & Rahimi, 2006), two studies involved **handball players** (Marques & Gonzales-Badillo, 2006; Carvalho, Mourão & Abade, 2014), and in one research football players (Alves, Rebelo, Abrantes & Sampaio, 2010).

Table 1. *Previous researches on the given topic*

Reference	Sample of respondents				Experimental treatment					
	N	Age	G	Sp.G	Duration	Nb. Gr.	Measured parameters	Notes	Results	Differences between groups
Blakey & Southard (1987)	31	St	M	Rec	8 weeks	1Ko	EsN, Fmax of legs	/	Significant improvement of EsN and Fmax of legs	/
Bauer, Thayer & Baras (1990)	22-15	St	M-F	Rec	10 weeks (3x a week/30min)	1Tt 1Ts 1Kos 1Kot 1P	Vvs, Is	/	Significant improvement in all groups in all measured parameters	No significant difference between groups
Adams, O'Shea, O'Shea & Climstein (1992)	48	St	M	Rec	7 weeks (2x a week)	1T 1P 1Ko 1K	Vvs	/	At T, P and Ko significant increase of Vvs	Ko significantly greater improvement than P and T (10.67cm, 3.81cm, 3.30cm)
Fatouros et al. (2000)	41	/	M	Rec	12 weeks (3x a week)	1P 1T 1Ko 1K	Vvs, Fmax of legs, tF	K without training activity	Ko, P, T significant improvement of all measured skills	Ko significantly greater improvement in Vvs and Fmax of legs than P and T
Cheng, Lin & Lin (2003)	16	16-19	M	Bask	8 weeks (3x a week)	1Ko 1T	EsN, Izd	/	Improvement of EsN at Ko, no improvement of Izd	Ko greater improvement on some tests of explosive strength than T
Rahimi & Behpur (2005)	48	19,2 ± 1,36	M	Com	6 weeks (2x a week)	1Ko 1P 1T 1K	Fmax of legs, Vvs, Sprint on 50yd (45.7m)	K had no activities	Ko, P and T significant improvement of the tested variables	Ko significantly greater improvement than P and T in Vvs and sprint on 50yd
Rahimi, Arshadi, Behpur, Boroujerdi-Sadeghi & Rahimi (2006)	48	19,2 ± 1,36	M	Com	6 weeks (2x a week)	1Ko 1P 1T 1K	Corner speed during 60sec test on bike treadmill	K had no activities	Ko, P and T significant improvement of corner speed	Ko greater improvement of corner speed than P and T
Marques & Gonzales-Badillo (2006)	16		M	Hand	12 weeks	1Ko	Bench press (1RM), squat (4RM), sprint 15 and 30m, CMJ, CMJ+weights of 20kg, CMJ+weights of 40kg and throwing ball speed	Usual handball training continually	Significant improvement in all tests	/
Santos & Janeira (2008)	25	14-15	M	Bask	10 weeks (2x a week)	1Ko 1K	SJ, CMJ, ABA, DJ and MBT	/	Significant improvement Ko on tests SJ, ABA and MBT	/
Kukrić, Karalejić, Petrović, Jakovljević (2009)	20	16-17	M	Bask	10 weeks (2x a week)	1Ko 1K	CMJ and SJ, (Vvs,Fmax, tmax, Fmax/tmax)	/	Ko improvement of Vvs and Fmax at CMJ and SJ, improvement of Fmax/tmax at CMJ	No improvement of tmax

Alves, Rebelo, Abrantes & Sampaio (2010)	23	17.4 ± 0.6	M	Foot	6 weeks	2Ko 1K	SJ, CMJ,sprint 5 and 15 m, agility (505 Agility Test)	Ko1- 1x a week, Ko2-2x a week, K-only football training	Ko1 and Ko2 significant improvement at SJ, sprint on 5 and 15m, no improvement at CMJ, no agility improvement	No significant difference between Ko1 and Ko2 in all tests
Kukrić, Karalejić, Jakovljević, Petrović, Mandić (2012)	30	16-17	M	Bask	10 weeks (2x a week)	1P 1K 1Ko	Vvs	/	P and Ko significant improvement of Vvs	No difference between P and Ko at the end of treatment
Javorac (2012)	40	16-18	M	Bask	10 weeks (2x a week)	1Ko 1K	Vvs, TrM, SLJ	K and Ko-basketball trainings, Ko+ complex training	Ko significant improvement on all three tests	Ko significantly greater improvement than K
Adibpour, Bakht & Behpour (2012)	16	20,38 ±3.7	F	Bask	8 weeks (3x a week)	1Ko 1K	Vvs	/	Significant improvement of Ko in Vvs	Ko significantly greater improvement than K
MacDonald, Lamont, Garner & Jackson (2013)	34	St	M	Rec	6 weeks (2x a week)	1T 1P 1Ko	CMJ, SLJ	Ko program=T program+P program	P and Ko significant improvement on test CMJ, P significant improvement on test SLJ	No significant difference between T, P and Ko at the end of treatment
Nageswaran (2014)	30	18-22	M	Bask	10 weeks	1P 1K 1Ko	EsN	/	P and Ko improvement of EsN	Ko greater improvement than P
Roden, Lambson & DeBeliso (2014)	20	Ju	M	Bask	6 weeks (2x a week)	Ko1 Ko2	Vvs	Ko1-high intensity, small number of repetitions, Ko2-middle intensity, greater number of repetitions	Ko1 and Ko2 significant improvement of Vvs (7.7% and 5.1%)	No significant difference between Ko1 and Ko2 (p = 0,077)
Carvalho, Mourão & Abade (2014)	12	21,6 ± 1,73	M	Hand	12 weeks (3x a week)	1Ko	EsN (SJ, CMJ, CJ(40)), IzS	SJ, CMJ and CJ (40) - 8 variables, IzS - 4 variables	Improvement in 2 from 4 variables of Izs	Improvement in 2 from 8 variables of EsN

Legend: N-total number of subjects; **Age**-age of respondents; **G**-gender of subjects; **Sp.G**-sport branch; **Nb.Gr** - number of groups; **Bask**- basketball players; **Rec** – Recreational students (students of the Faculty of Sport); **Foot** – football players; **Hand** – handball players; **Kom** - from different sports; **P** - group subjected to a plyometric program; **K** - control group; **Ko** - group subjected to complex training; **Ko1** - complex training of high intensity and a small number of repetitions, **Ko2** - complex training of average intensity and a larger number of repetitions; **T** - group subjected to training with weights; **Tt** - group subjected to training with free weights (free weights); **Ts** - group that has undergone training on gym machines; **Kot** - group that has undergone complex training (plyometrics + free weights-free weights); **Kos** - group that has undergone complex training (plyometrics+apparatus exercises in the gym); **St** - students; **Ju** - juniors; **Fmax** - maximum force; **Vvs** - Vertical jump height (the authors failed to provide an accurate description of the test); SJ (*Squat jump*) - jump from a crouch; **CMJ** (*Countermovement Jump*) - squat jump with preparation; **DJ** (*Drop Jump*) - in-depth jump; **ABA** - Abalakov test; **MBT** (*Medicine Ball Throw*) - throwing a medicine ball; **SLJ** (*Standing Long Jump*) - long jump from place; **tmax** – time of embodiments of the maximum force; **Fmax/tmax** - index of explosive strength; **1RM** (1 *repetition maximum*) - represents the maximum load that can be passed through the entire range of movements in a controlled manner with a good posture; **Is** - isokinetic strength; **tF** (*flight time*) - time of flight; **EsN** - explosive leg strength; **Izd** - endurance; **CJ** (*Consecutive Jumps*) - successive leaps; **IzS** - isometric force; **TrM** – triple jump from place.

RESULTS

Most of the research papers presented in Table 1 explored the effects of **complex training** on the following:

- *explosive leg strength* - **17** researches (Blakey & Southard, 1987; Bauer, Thayer & Baras, 1990; Adams, O'Shea, O'Shea & Climstein, 1992; Fatouros et al., 2000; Cheng, Lin & Lin, 2003; Rahimi & Behpur, 2005; Marques & Gonzales-Badillo, 2006; Santos & Janeiro, 2008; Kukrić, Karalejić, Petrović and Jakovljević, 2009; Alves, Rebelo, Abrantes & Sampaio, 2010; Kukrić, Karalejić, Jakovljević, Petrović and Mandić, 2012; Javorac, 2012; Adibpour, Bakht & Behpour, 2012; MacDonald, Lamont, Garner & Jackson, 2013; Nageswaran, 2014; Roden, Lambson & DeBeliso, 2014; Carvalho, Mourão & Abade, 2014);
- *maximum force of leg* - **four** studies (Blakey & Southard, 1987; Fatouros et al., 2000; Rahimi & Behpur, 2005; Marques & Gonzales-Badillo, 2006);
- *speed* - **three** studies (Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006; Marques & Gonzales-Badillo, 2006; Alves, Rebelo, Abrantes & Sampaio, 2010);
- *isometric force* - **two** studies (Bauer, Thayer & Baras, 1990; Carvalho, Mourão & Abade, 2014);
- *explosive strength of upper limbs* - **two** studies (Marques & Gonzales-Badillo, 2006; Santos & Janeiro, 2008);
- *maximum force of the chest muscles, upper extremities and shoulders* (bench press) - **one** study (Marques & Gonzales-Badillo, 2006);
- *endurance* - **one** study (Cheng, Lin & Lin, 2003);
- *agility* - **one** study (Alves, Rebelo, Abrantes & Sampaio, 2010).

In addition to the above, some of the researches:

- *compared the effects of complex training with the effects of plyometric training on the measured parameters* - **eight** studies (Bauer, Thayer & Baras, 1990; Adams, O'Shea, O'Shea & Climstein, 1992; Fatouros et al., 2000; & Rahimi Behpur, 2005; Rahimi, arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006; Kukrić, Karalejić, Jakovljević, Petrović and Mandić, 2012; MacDonald, Lamont, Garner & Jackson, 2013; Nageswaran, 2014);
- *compared the effects of complex training with the effects of the resistance training on the measured parameters* – **seven** studies (see Bauer, Thayer & Baras, 1990; Adams, O'Shea, O'Shea & Climstein, 1992; Fatouros et al., 2000; Cheng, Lin & Lin 2003; Rahimi & Behpur, 2005; Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006; MacDonald, Lamont, Garner & Jackson, 2013);

• *compared the effects of different ways of complex training on the measured parameters* - **three** studies (Bauer, Thayer & Baras, 1990; Alves, Rebelo, Abrantes & Sampaio, 2010; Roden, Lambson & DeBeliso, 2014).

DISCUSSION

The results presented in Table 1. show that the largest number of studies dealt with the effects of complex training on the explosive *strength of legs*. Blakey & Southard (1987) in a sample of 31 subjects (students) found that a combination of the drop jump and resistance training, for a period of eight weeks, led to a significant improvement of explosive leg strength. Bauer, Baras & Thayer (1990), in a sample of 22 male students and 15 female students of the Physical Education Faculty, found that complex training for a period of 10 weeks (3 times per week/30 min) led to a significant improvement of the vertical height of a jump. Adams, O'Shea, O'Shea & Climstein (1992) in a sample of 48 students (male-recreational) found that a combination of squats and plyometric drills for a period of seven weeks (2x weekly) led to a significant improvement of the vertical height of the jump. Fatouros et al. (2000) in a sample of 41 subjects (males) reported that the combination of Olympic weight training (Olypic Style Weightlifting) and plyometrics for a period of 12 weeks (3 times a week) led to a significant improvement of the vertical height of the jump. Cheng Lin & Lin (2003) in a sample of 16 basketball players aged 16 to 19 years found that the combination of plyometric training and weight training for a period of eight weeks (3 times weekly) led to a significant improvement in explosive strength. Rahimi & Behpur (2005) in a sample of 48 students, who were active in different sports, average age 19.27 ± 1.36 years, found that complex training for a period of six weeks (2x per week) led to a significant improvement in the height of the vertical jump. Gonzales & Marques-Badillo (2006) in a sample of 16 handball players found that complex training for a period of 12 weeks, which involves a combination of half squats (3 series, 3-6 repetitions with a load 70-95%) in the succession of vertical jumps and sprint led to a significant improvement in the vertical height jump without a load (CMJ), CMJ with additional weights of 20 kg and CMJ with additional weights of 40kg. Santos & Janeira (2008) in a sample of 25 basketball players of age 14 to 15 years found that complex training for a period of 10 weeks (2x weekly) led to a significant improvement on the tested squat jump (SJ) and Abalakov test (ABA). Kukrić, Karalejić, Petrović and Jakovljević (2009) in a sample of 20 basketball junior players, age 16-17 years, found that the complex training for a period of 10 weeks (2x weekly) led to a significant improvement of the maximum height of the jump, and the

maximum force (Fmax), at jumps CMJ and SJ and significant progress of the explosive strength index (IES) at the CMJ jump. In the above-mentioned research, the trainings consisted of three to five exercises for the leg limbs. Each exercise consisted of a preload, which accounted for 50% - 80% of the maximum. After a preload and 2 min break, a specific exercise with no load was performed. Alves, Rebelo, Abrantes & Sampaio (2010) in a sample of 23 football players, mean age 17.4 ± 0.6 years, found that complex training for a period of six weeks led to a significant improvement in the testing of the squat jump (SJ), but failed to make progress in the test of the counter movement jump (CMJ). Kukrić, Karalejić, Jakovljević and Petrović (2012) in a sample of 30 basketball junior players, age 16-17 years, found that complex training for a period of 10 weeks (2x weekly) led to a significant improvement of the vertical height of the jump. Javorac (2012) on a sample of 40 basketball players of age 16-18 years found that complex training for a period of 10 weeks (2x weekly) led to a significant improvement in the tests: the vertical jump, the triple jump from the step foot and the long jump. Like the research by Kukrić, Karalejić, Petrović and Jakovljević (2009), in this study, the training sessions also consisted of three to five exercises for the leg limbs. Each exercise consisted of a preload, which accounted for 50% - 80% of the maximum. After a preload and a 2 min break, a specific exercise with no load was performed. Adibpour, Bakht & Behpour (2012) in a sample of 16 basketball players, mean age 20.38 ± 3.7, found that a combination of weight training and plyometric training for a period of eight weeks (3 times a week) led to a significant improvement of the vertical jump height. The plyometric exercises involved a side hop, a lay up jump, depth jump, and exercises with weights included leg press lying, calf raises, leg press standing. MacDonald, Lamont, Garner & Jackson (2013) in a sample of 34 university-age amateurs found that a combination of plyometric exercises and strength training with weights for a period of six weeks (2x per week) led to a significant improvement in explosive strength. The exercises with weights implied: the high bar back squat, stiff leg dead lift (dead lift with stiff legs) and standing calf raise (calf raise, exercise for calf muscles), and plyometric exercises: lateral jumps, depth jumps and box jump. Nageswaran (2014) on a sample of 30 basketball players, aged 18 to 22 years, found that complex training for a period of 10 weeks led to a significant improvement of explosive leg strength. Roden, Lambson & DeBeliso (2014) in a sample of 20 junior basketball players found that complex training for a period of six weeks (2x per week) led to significant improvements in the vertical jump height. One of the few studies in which complex training failed to lead to progress of explosive strength is the research by Carvalho, Mourão & Abade (2014). The authors, on a sample of 12 handball players from the Portuguese Handball Major League, mean age 21.6 ± 1.73 years, determined that the combination of weight training and plyometric training in the 12-week period (3 times a

week) failed to lead to a significant improvement in the tests of SJ, CMJ and 40 consecutive jumps.

By further analysis of the results given in Table 1, we can see that complex training, in addition to the positive effect on the explosive power, has a positive effect on the development of *maximum force of the legs* (Blakey & Southard, 1987; Fatouros et al., 2000; Rahimi & Behpur, 2005; Marques & Gonzales-Badillo, 2006); speed (Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006; Marques & Gonzales-Badillo, 2006; Alves, Rebelo, Abrantes & Sampaio, 2010); *isometric force* (Bauer, Thayer & Baras, 1990; Carvalho & Mourão Abad, 2014); *explosive strength of upper extremities* (Marques & Gonzales-Badillo, 2006; Santos & Janeiro, 2008); and the *maximum force of the chest muscles, upper extremities and shoulders* (bench press) (Marques & Gonzales-Badillo, 2006).

Some studies have shown that complex training, however, does not develop durability and agility. Cheng Lin & Lin (2003), on a sample of 16 basketball players aged 16 to 19 years, found that complex training for a period of eight weeks (3 times weekly) failed to lead to significant improvements in durability, while Alves, Rebelo, Abrantes & Sampaio (2010) on a sample of 23 football players, average age 17.4 ± 0.6 years, found that complex training for a period of six weeks failed to lead to significant improvements in agility.

The authors, in addition to the research on the effects of complex training on motor skills, compared the effects of complex with the effects of plyometric training and the effects of weight training. In four studies, the results showed that complex training gives significantly better results in the development of explosive strength than plyometric training (Adams, O'Shea, O'Shea & Climstein, 1992; Fatouros et al., 2000; Rahimi & Behpur, 2005; Nageswaran, 2014), as well as in the development of speed (Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006). On the other hand, in three studies the authors found no significant differences between these methods of training (Bauer, Thayer & Baras, 1990; Kukrić, Karalejić, Jakovljević, Petrović and Mandić, 2012; MacDonald, Lamont, Garner & Jackson, 2013). In four studies the results showed that *complex training* gives significantly better results in the development of explosive strength than *training with weights* (Adams, O'Shea, O'Shea & Climstein, 1992; Fatouros et al., 2000; Cheng, Lin & Lin, 2003; Rahimi & Behpur, 2005), as well as in the development of speed (Rahimi, Arshad, Behpur, Sadeghi-Boroujerdi & Rahimi, 2006). On the other hand, in two studies, the authors found that there is no significant difference between the above mentioned training methods (Bauer, Thayer & Baras, 1990; MacDonald, Lamont, Garner & Jackson, 2013).

Also, the authors in some studies compared different ways of complex training. Bauer, Thayer & Baras (1990) found no differences between the effect of complex training that combines plyometrics with strength exercises with

free weights (free weights) and the effect of complex training that combines plyometrics with strength exercises on machines at the gym, in their impact on the height of the vertical jump. Alves, Rebelo, Abrantes & Sampaio (2010) found no differences in the effects of complex training on vertical jumps, depending on whether they are done once or twice a week. Roden, Lambson & DeBeliso (2014) determined that there is no significant difference in the effects on the development of explosive strength between complex training which involves a high intensity exercise with a small number of repetitions (8-10 repetitions with 80% - 85% of 1RM +10 jumps) and complex training which includes medium intensity with a greater number of repetitions (12-15 repetitions with 60% -70% of 1RM). Although there is no statistically significant difference, there is a difference that can be accidental. Namely, the group which practiced with high intensity and a small number of repetitions improved the vertical height of the jump by 7.7%, and the group which practiced with a lower intensity and a greater number of repetitions by 5.1% ($p = 0.077$).

CONCLUSION

Previous studies have shown that complex training can be a suitable method for the development of the explosive leg strength of athletes from different sports. In order to achieve positive changes, it is necessary that the training process takes from 6 to 12 weeks with two to three workouts per week. This method of training has a positive effect on the development of maximum leg force and running speed. In addition to the above mentioned, several studies show that complex training can develop the explosive strength of the upper limbs, maximal force of the upper limbs and isometric force. However, these motor abilities were the subject of a few studies, so we consider it necessary to carry out additional studies to confirm these results. Agility and endurance were subjects in a single study, and the results showed that complex training fails to lead to improvement of these skills. We believe that one research is not enough in order to bring any conclusions, and there is a need to find more researches that deal with the problem, or make new ones. Some studies suggest that complex training gives significantly better results in the development of explosive leg strength and running speed than plyometric training and weight training when used separately. In contrast, there are few studies that show no differences between these methods of training. With regard to the recommendations of the author, complex training should be used cautiously, with prior preparation and the development of muscle force in order to prevent injuries and overtraining of young athletes. Dosage, planning and programming of training in accordance with the biological growth and development of young athletes is a fundamental prerequisite for this training.

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