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The Efficiency of Vibration Training on Changes in Strength

Efikasnost vibracionog treninga na promenu snage

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Abstract: *The study aim was to determine the effectiveness of vibration training on changes in strength in individuals of both sexes. Vibration training is a modern form of training that is becoming more and more widespread and frequent, and involves the application of vibrational stimulations of a certain form to cause functional and structural changes. It is used during strength training, where it can act in isolation on individual muscle regions or as whole body vibrational training. These observations provide an opportunity to apply a new method in training to improve the training itself and thus the performance of the athletes. The impact of this training on motor skills, and even strength, as one of the most studied areas, has not been extensively researched. This paper analyzes 14 studies on the effects of vibrational training on the change in power, and the papers are systematically analyzed. A review of research conducted in the field of this training shows that the effects of such training methods show in both professional and recreational athletes. In most of the studies analyzed, training has shown significant changes in power as well as in other motor skills.*

Keywords: *vibration training, motor skills, explosive strength, power.*

Sažetak: *Cilj studije bio je da se utvrdi efikasnost vibracionog treninga na promene snage kod pojedinaca oba pola. Vibracioni trening predstavlja savremeni vid treninga koji je sve masovniji i učestaliji i podrazumeva primenu vibracionih stimulacija određenog oblika s ciljem izazivanja funkcionalnih i strukturalnih promena. Koristi se tokom treninga snage, gde izolovano može delovati na pojedine mišićne regije ili kao vibracioni trening celog tela. Osim što deluje na promenu snage, vibracioni trening takođe utiče na bolje rezultate tokom zagrevanja. Ova zapažanja pružaju mogućnost primene nove metode u treningu kako bi došlo do unapređenja samog treninga, a time i performansi sportista. Uticaj ovog treninga na motoričke sposobnosti, pa i na snagu kao jednu od najproučavanijih oblasti, nije mnogo istraživan. U radu je analizirano 14 istraživanja o efektima vibracionog treninga na promenu snage, radovi su tabelarno prikazani i sistematski obrađeni. Pregledom istraživanja koja su sprovedena iz oblasti ovog treninga pokazuju da efekti ovakvih metoda treniranja postoje kako kod profesionalnih sportista, tako i kod rekreativaca. U najvećem broju istraživanja koje su analizirana, trening je pokazao značajne promene snage, kao i drugih motoričkih sposobnosti.*

Ključne reči: *vibracioni trening, motoričke sposobnosti, snaga, eksplozivna snaga.*

Introduction

Strength is the basic motor ability that has always attracted the most attention of people and professionals. A large number of authors has tried to approach and explain the term of strength. Today, in the literature, strength is generally seen as a qualitative characteristic of a person manifested in a particular movement or exercise (Kukolj, 2006). Strength training has gained enormous popularity over the last two decades, especially because of its role in improving sports performance, enhancing maximum

Uvod

Snaga je bazična motorička sposobnost koja je oduvek privlačila najviše pažnje ljudi i stručnjaka. Veliki broj autora pokušalo je da na najbolji način približi i objasni snagu. Danas se u literaturi snaga uglavnom posmatra kao kvalitativna karakteristika čoveka ispoljena u određenom kretanju, odnosno u određenoj vežbi (Kukolj, 2006). Trening snage je stekao ogromnu popularnost u poslednje dve decenije, posebno zbog svoje uloge u poboljšanju sportskih performansi, pobošljanjem maksimalne snage, brzine, mišićne iz-

strength, speed, muscular endurance, coordination, and balance (Kraemer & Ratamess, 2000). In this regard, the authors note that training to increase muscle strength also increases the success in performing motor tasks (Ignjatovic, Radovanovic, & Stankovic, 2007). This leads to the fact that many athletes from both collective and individual sports see training strengths as the basis of their preparations (Idrizovic, 2001).

Training that increases strength with combined muscle contractions is divided into plyometric and vibration training, according to Radovanovic and Ignjatovic (2009). Vibration training is a modern form of training that is becoming more and more widespread and frequent. Markovic (2005) stipulates that vibration training involves the application of vibrational stimulations of a particular shape to cause functional and structural changes. With the development of technology, training processes were developed, as well as training methods aimed at improving the fitness of the athletes. One of these methods is vibration training. In his research, he shows that the use of vibration training in sports leads to improved jump height and flexibility so that injuries are reduced to some extent (Kunnnenmeyer & Schmidtbleicher, 1997). This type of training is practiced by many European teams from the moment information on vibration training was available to public. It is also used for medical purposes. Vibration training applies vibration stimulations of a particular shape to bring about functional and structural changes (Markovic, 2005). Vibrational stimulation is applied to contracted muscles. The human body exposed to vibration stimuli responds with muscle contraction (Babajic, Bradic, Pojskic, Kovacevic, & Abazovic, 2013). There are two types of vibration training, as stated by Zatsiorsky & Kraemer (2009), namely: strength exercises with added vibrational stimulation and motor tasks performed when vibrating the body. This review aim was to examine the impact of vibration training on strength.

Methodology

To collect as many research papers as possible regarding the effects of vibration training on power changes, the following electronic databases were searched: PubMed, MEDLINE, Google Scholar, SCIndex, and ScienceDirect. Papers from 2000 to 2017 were searched. To be covered by the final analysis, they had to fulfill two criteria: that the research is experimental in nature and that the respondents who were in the adult category were without health problems. The keywords used in the database search were: vibration training, motor skills, explosive strength, power. The review and

držljivosti, koordinacije i ravnoteže (Kraemer & Ratamess, 2000). S tim u vezi, autori primećuju da se treningom za povećanje mišićne snage, povećava i uspešnost u izvođenju motoričkih zadataka (Ignjatović, Radovanović, & Stanković, 2007), što dovodi do toga, da veliki broj sportista iz kolektivnih i iz individualnih sportova trening snage vide kao osnov i srž svojih priprema (Idrizović, 2001).

Trening koji povećava snagu sa kombinovanim mišićnim kontrakcijama deli se na: pliometrijski i vibracioni trening, prema Radovanoviću i Ignjatoviću (2009). Vibracioni trening predstavlja savremeni vid treninga koji je sve masovniji i učestaliji. Marković (2005) daje definiciju da vibracioni trening podrazumeva primenu vibracionih stimulacija određenog oblika s ciljem izazivanja funkcionalnih i strukturalnih promena. Razvojem tehnologije, razvijali su se i trenažni procesi kao i metode treninga čiji su ciljevi bili unapređivanje kondicijske pripremljenosti sportista. Jedan od tih metoda je vibracioni trening. U svojim istraživanjima pokazuje da korišćenje vibracionog treninga u sportu dovodi do poboljšavanja visine skoka i fleksibilnosti, tako da su povrede u oređenoj meri smanjene (Kunnnenmeyer & Schmidtbleicher, 1997). Ovaj vid treninga primenjuju mnoge evropske ekipe od trenutka kada su informacije o vibracionom treningu izašle u javnost. Osim toga koristi se i u medicinske svrhe. Vibracioni trening primenjuje vibracione simulacije određenog oblika sa ciljem kako bi došlo do funkcionalnih i stukovnih promena (Marković, 2005). Na mišiće koji su kontrahovani primenjuje se vibraciona stimulacija. Ljudsko telo izloženo stimulusima vibracija reaguje mišićnom kontrakcijom (Babajić, Bradić, Pojskić, Kovačević, & Abazović, 2013). Postoje dva tipa vibracionog treninga, kako navode Zatsiorsky & Kraemer (2009) i to: vežbe snage sa dodatom vibracionom stimulacijom i motorički zadaci koji se izvode prilikom vibriranja tela. Cilj ovog rada je da, putem pregleda literature prikaže uticaj vibracionog treninga na promenu snage.

Metod

U cilju prikupljanja što većeg broja istraživačkih radova koji su se bavili efektima vibracionog treninga na promene snage, pretražene su sledeće elektronske baze podataka: PubMed, MEDLINE, Google Scholar, SCIndex i ScienceDirect. Pretraživani su radovi od 2000. do 2017. godine. Kako bi bili obuhvaćeni konačnom analizom morali su da ispune dva kriterijuma: da su istraživanja eksperimentalnog karaktera i da su ispitanici koji su činili kategoriju odraslih osoba bez zdravstvenih problema. Ključne reči koje su korišćene prilikom pretrage baza podataka su: vibracioni trening, motoričke sposobnosti, snaga, eksplozivna snaga. Prikaz i analiza istraživačkih radova izvršena je na osnovu: referenci (prvi

analysis of the research papers were performed based on references (first authors and year), several subjects, age categories, groups, gender, experimental program, and duration of the experimental program and research results.

Results

autori i godina), broja ispitanika, uzrasne kategorije, grupe (eksperimentalne i kontrolne), pola (muški, ženski), eksperimentalnog programa i trajanja eksperimentalnog programa, (nedeljno opterećenje), eksperimentalnog tretmana (praćenje motoričkih sposobnosti), i rezultata istraživanja.

Rezultati

Table 1. *Systematic review and characteristics of the research involved*

First author and year	Sample of participants				Experimental program		
	T	Age	Group	G	Duration and frequenc.	Exercise program	Measuring instruments and results
Torvinen, (2002)	56	19-38	1 C 1 E	21 M 35 F	4 m 3-5x weekly	Whole-body VT	E: VS↑, ESDE↑
Rønnestad, (2004)	15	21-41	1 C 1 E	8 M 7 F	5 weeks 2-3x weekly	Whole-body VT Frequency (40Hz)	E: CMJ↑ C:CMJ↑
Delecluse, (2005)	20	17-30	1 E 1 C	13 M 7 F	5 weeks 3x weekly	Whole-body VT Power Plate, Frequency (35-40Hz)	E: IS→, DS→, VKE→ C: IS→, DS→, VKE→
Paradisis, (2007)	24	21,3 ± 1,2	1 E 1 C	12 M 12 F	6 weeks 3x weekly	Whole-body VT Jump and sprint	E: S↓, CMJ↑ C: S→, CMJ→
Hoyo Lora, (2009)	10	18-32	1 E	10 M	/	Whole-body VT Galileo Fitness ® platform	E: SJ↑, CMJ↑
Hoyo Lora, (2010)	12	22,9	1 E	12 M	/	Whole-body VT Galileo Fitness ® platform, Frequency (30Hz)	E: SJ↑ , CMJ↑
Sarshin(2010)	20	21,5 ± 1/4	1 E 1 C	20 M	4 weeks 3 x weekly	Whole-body VT	E: ES↑, B↑ C:ES→, B→
Obradovic, (2010)	36	20 ±6	/	36 M	/	Whole-body VT	E: ESDE↑ C: ESDE→
Melania, (2010)	20	22,6 ± 3,7 – 23,6 ± 4,9	1 C 1 E	20 M	3 weeks 3 x weekly	Whole-body VT especially knees	E: ISE→ C: ISE→
Osawa, (2011)	33	22- 49	1 C 1E	6 M 27 F	7 weeks 3 x weekly	Whole-body VT	E: LE↑ EC↑
Hawkey, (2012)	22	/	1 E 1 C	22 M	6 weeks 1 x weekly	Whole-body VT NEMES Bosco vibrating platform, Frequency (35-40Hz)	E: VS↑ C:VS→
Zivkovic, (2015)	60	21 ± 6	2 E 1 C	60 M	10 weeks 3 x weekly	VT with flexi-bar	E: ESGE↑, ESDE↑ C: ESGE→, ESDE→
Kim, (2016)	28	23,2 ± 2,4 23,5 ± 4,2	1E 1Pl	28 F	8 week 3 x weekly	Whole-body VT Plyometric training	E: Ver.S↑ Pl: Ver.S→
Rønnestad, (2017)	11	/	1 E 1 C	11 F	/	Whole-body VT Frequency (40Hz)	E: MIS↑, SIS↑ C: MIS↑ , SIS↑

Legend: *B-speed; C-control group; CMJ-counter movement jump; DS-dynamic power; E-experimental group; EC-knee extension; ES-explosive strength; ESDE-lower extremity strength; ESGE-explosive upper extremity strength; F-female; G-gender; IS-isometric strength; ISE-isometric extensor strength; LE-lumbar extension; M-male; MIS-maximum output power; S-sprint; SIS-Medium power output; SJ-squat jump; T-total number of respondents; Ver.S-vertical jump; VKE-knee extension velocity; VS- jump height; VT-vibration training*

Tabela 1. *Sistematski pregled i karakteristike uključenih istraživanja*

Prvi autor i godina	Uzorak ispitanika				Eksperimentalni program		
	B	God	Gr	P	Trajanje i učestalost	Program vežbanja	Merni instrumenti i rezultati
Torvinen, (2002)	56	19-38	1K 1E	21 m 35 ž	4 m 3-5x nedeljno	Vibracioni trening celog tela	E: VS↑, SDE↑
Rønnestad, (2004)	15	21-41	1K 1E	8 m 7 ž	5 nedelja 2-3x nedeljno	Vibracioni trening celog tela Frekfencija (40Hz)	E: CMJ↑ K:CMJ↑
Delecluse, (2005)	20	17-30	1E 1K	13 m 7 ž	5 nedelja 3x nedeljno	Vibracioni trening celog tela Na platformi Power Plate Frekfencija (35-40Hz)	E: IS→, DS→, BEK→ K: IS→, DS→, BEK→
Paradisis, (2007)	24	21,3 ± 1,2	1E 1K	12 m 12 ž	6 nedelja 3x nedeljno	Vibracioni trening celog tela Skok i sprint	E: S↓, CMJ↑ K: S→, CMJ→
Hoyo Lora, (2009)	10	18-32	1E	10 m	/	Vibracioni trening celog tela Galileo Fitness® platforma	E: CJ↑, CMJ↑
Hoyo Lora, (2010)	12	22,9	1E	12 m	/	Vibracioni trening celog tela Galileo Fitness® platforma Frekfencija (30Hz)	E: SJ↑, CMJ↑
Sarshin, (2010)	20	21,5 ± 1/4	1 E 1K	20 m	4 nedelje 3 x nedeljno	Vibracioni trening celog tela	E: ES↑, B↑ K:ES→, B→
Obradović, (2010)	36	20 ±6	/	36 m	/	Vibracioni trening celog tela	E: ESDE↑ K: ESDE→
Melania, (2010)	20	22,6– 23,6	1K 1E	20 m	3 nedelje 3 x nedeljno	Vibracioni trening celog tela posebno kolena	E: ISE→ K: ISE→
Osawa, (2011)	33	22- 49	1K 1E	6 m 27 ž	7 nedelja 3 x недељно	Vibracioni trening celog tela	E: LE↑ EK↑
Hawkey, (2012)	22	/	1 E 1K	22 m	6 nedelja 1 x nedeljno	Vibracioni trening celog tela NEMES Bosco vibracionoj platformi Frekfencija (35-40Hz)	E: VS↑ K:VS→
Živković, (2015)	60	21 ± 6 m	2E 1K	60 m	10 nedelja 3 x nedeljno	Vibracioni trening sa flexi-barom	E: ESGE↑, ESDE↑ K: ESGE→, ESDE→
Kim, (2016)	28	23,2 - 23,5	1E 1Pl	28 ž	8 nedelja 3 x nedeljno	Vibracioni trening celog tela Pliometrijski trening	E:Ver.S↑ Pl: Ver.S→
Rønnestad, (2017)	11	/	1E 1K	11 m	/	Vibracioni trening celog tela Frekfencija (40Hz)	E: MIS↑, SIS↑ K: MIS↑, SIS↑

Legenda: *B-broj ispitanika, God-godine ispitanika, Gr-grupe, P-pol, M-muškog pola, Ž-ženskog pola, E- eksperimentalna grupa, K-kontrolna grupa, CMJ-skok iz čučnja sa pripremom, SJ- skok iz čučnja,VS-visina skoka, ESDE-snaga donjih ekstremiteta, IS-izometrijska snaga, DS-dinamička snaga, S-sprint, ISE-izometrijska snaga ekstenzora, ESGE-ekplozivna snaga gornjih ekstremiteta, Ver.S-vertikalni skok, MIS-maksimalna izlazna snaga, SIS-srednja izlazna snaga, ES-eksplozivna snaga, B-brzina, LE-lumbalna ekstenzija, EK-ekstenzija kolena*

The number of respondents in the surveys varied considerably from survey to survey. The smallest number of respondents was 10 (Hoyo Lora, Sañudo Corrales, Carrasco Páez, Martínez Díaz, & Ochiana, 2009) and the largest 60 (Zivkovic, Herodek, Bubanj, Zivkovic & Djosic, 2015). According to the age categories, when it comes to the samples of the youngest and the oldest respondents, they cannot be strictly divided, since the most of the respondents in the large number of surveys that were processed ranged from 20 to 50 years. Such is, for example, a survey by Osawa & Oguma (2011), where the age of the respondents is 22-49 years. Experimental treatment included two groups (control and experimental) in two papers (Torvinen et al., 2002; Rønnestad, 2004), followed by two groups with only the experimental group (Hoyo Lora et al., 2009; Hoyo Lora, Ochiana, Sañudo Corrales, Carrasco Páez, & Martínez Díaz, 2010), ten papers that had both a control and an experimental group (Delecluse, Roelants, Diels, Koninckx, & Verschueren, 2005; Hawkey, 2012; Melania, Graţiela-Flavia, Octavian, Iuliana, & Peter, 2010; Obradovic, Madic, & Pantovic, 2010; Osawa & Oguma, 2011; Paradisis & Zacharoqiannis, 2007; Rønnestad, 2004; Rønnestad, Falch, & Ellefsen, 2017; Sarshin, Mohammadi, Khadam, & Sarshin, 2010; Torvinen et al., 2002), one paper that had two experimental and one control group (Zivkovic et al., 2015), while one paper had one experimental and one plyometric group (Kim & Park, 2016).

Analyzing the papers, it can be concluded that the respondents in one study were females (Kim & Park, 2016), in six studies were males and females (Delecluse et al., 2005; Hoyo Lora et al., 2010; Osawa & amp; Oguma, 2011; Paradisis & Zacharoqiannis, 2007; Rønnestada, 2004; Torvinen et al., 2002), and in 7 studies respondents were males (Hoyo Lora et al., 2009; Hawkey, 2012; Melania et al., 2010; Obradovic et al., 2010; Rønnestad et al., 2017; Sarshin et al., 2010; Zivkovic et al., 2015). The shortest experimental treatment lasted three weeks (Melania et al., 2010), and the longest experimental treatment lasted four months (Torvinen et al., 2002). Some of the studies did not have a precise determination of the duration, such are, for example, the researches by Hoyo Lora et al. (2009); Hoyo Lora et al. (2010); Obradovic et al. (2010); Rønnestad et al. (2017). The effects of the whole-body vibrational training on the explosive power of jump and sprint type - sprint speed (Hoyo Lora et al., 2009; Hoyo Lora et al., 2010; Paradisis & Zacharoqiannis, 2007) have been studied in three studies. In two studies, the impact of vibration training on the rapid achievement of motor performance was studied (Obra-

Broj ispitanika u istraživanjima je prilično varirao. Najmanji broj ispitanika bio je 10 (Hoyo Lora, Sañudo Corrales, Carrasco Páez, Martínez Díaz, & Ochiana, 2009), a najveći 60 (Živković, Herodek, Bubanj, Živković & Đošić, 2015). Prema uzrasnim kategorijama, kada je u pitanju najmlađi i najstariji uzorak ispitanika ne može se striktno podeliti jer je većina ispitnika u velikom broju istraživanja imala od 20 pa do 50 godina. Takvo je na primer istraživanje (Osawa & Oguma, 2011), gde je starosno doba ispitanika od 22 do 49 godina. Eksperimentalnim tretmanom su obuhvaćene dve grupe (kontrolna i eksperimentalna) u dva rada (Torvinen et al., 2002; Rønnestad, 2004), zatim dva rada imaju samo eksperimentalnu grupu (Hoyo Lora et al., 2009; Hoyo Lora, Ochiana, Sañudo Corrales, Carrasco Páez, & Martínez Díaz, 2010), deset radova imaju i kontrolnu i eksperimentalnu grupu (Delecluse, Roelants, Diels, Koninckx, & Verschueren, 2005; Hawkey, 2012; Melania, Graţiela-Flavia, Octavian, Iuliana, & Peter, 2010; Obradović, Madić, i Pantović, 2010; Osawa & Oguma, 2011; Paradisis & Zacharoqiannis, 2007; Rønnestad, 2004; Rønnestad, Falch, & Ellefsen, 2017; Sarshin, Mohammadi, Khadam, & Sarshin, 2010; Torvinen et al., 2002), jedan rad ima dve eksperimentalne i jednu kontrolnu grupu (Živković i sar., 2015), i jedan rad ima jednu eksperimentalnu i jednu pliometrijsku grupu (Kim & Park, 2016).

Analizom radova može se zaključiti da su ipitanici u jednom istraživanju bili ženskog pola (Kim & Park, 2016), kod šest istraživanja su bili i muškog i ženskog pola (Delecluse et al., 2005; Hoyo Lora et al., 2010; Osawa & Oguma, 2011; Paradisis & Zacharoqiannis, 2007; Rønnestada, 2004; Torvinen et al., 2002), a kod 7 istraživanja ispitanici su bili muškog pola (Hoyo Lora et al., 2009; Hawkey, 2012; Melania et al., 2010; Obradović i sar., 2010; Rønnestad et al., 2017; Sarshin et al., 2010; Živković i sar., 2015). Najkraće eksperimentalni tretman traje tri nedelje (Melania et al., 2010), a najduži eksperimentalni tretman trajao je četiri meseca (Torvinen et al., 2002). Pojedina istraživanja nisu imala precizno određenje trajanja, takva su na primer istraživanja (Hoyo Lora et al., 2009; Hoyo Lora et al., 2010; Obradović i sar. 2010; Rønnestad et al., 2017). U tri istraživanja proučavani su učinci vibracijskog treninga celog tela na eksplozivnu snagu tipa skoka i sprinta - brzina sprinta (Hoyo Lora et al., 2009; Hoyo Lora et al., 2010; Paradisis & Zacharoqiannis, 2007). U dva istraživanja proučavan je uticaj vibracionog treninga na brzo postizanje kvaliteta motoričkih perfomansi (Obradović i sar. 2010; Sarshin et al., 2010). U dva istraživanja proučavan je uticaj vibracionog treninga na mišićnu jačinu, mišić-

dovic et al. 2010; Sarshin et al. 2010). The impact of vibrational training on muscle strength, muscular endurance, and neuromuscular activity has been studied in two studies comparing identical conventional training (Delecluse, Roelants, Diels, Koninckx, & Verschueren, 2005; Osawa & Oguma, 2011). One study examined the effects of four-month full-body vibration training on muscular performance and body balance in young, healthy non-athletes (Torvinen et al., 2002). One study evaluated the effect of whole-body vibration exercise and plyometric training on volleyball players (Kim, & Park, 2016). The impact of adding whole body vibration training (WBV) on the warm-up procedure during a later-cycle sprint was examined in one study (Rønnestad et al., 2017). One study examined the chronic effects of whole-body vibration on the strength and strength of the lower extremities, in which vibrational stimulation was added to standard exercise training (Rønnestad, 2004). In one study, the effect of long-term WBV training on the maximum isometric knee strength of rugby players was examined (Melania et al., 2010). One study examined the effect of a six-week vibration training program on a recreationally active population (Hawkey, 2012). One study found the effects of two 10-week programs on changes in explosive parameters, the ability to cause effects by stimulating muscle vibration or isometric training (Zivkovic et al., 2015).

Discussion

Changes were noted in the following surveys: The results of Torvinen et al. (2002) show that under the influence of whole body vibration training (WBV) there was an improvement in jump height by 8.5%. Lower limb strength increased by 3.7% after two months, however, this value decreased after four months. Rønnestad (2004) showed that the experimental group that under the influence of WBV showed positive effects in the maximum strength of 1RM (repetition maximum) (32±9%) and in the countermovement jump height (CMJ) (9.1±5.5%), while the control had a positive effect on the maximum strength 1RM (24.2±3.9%) and statistically significant effect on CMJ jump height (4.2 ±4.2%). Paradisis & Zacharoqiannis (2007) found that under the influence of the WBV the sprinting test recorded displacement of 3.4%. The jump height under the influence of WBV was improved by 3.3% and the explosive strength endurance was advanced by 7.8%. The result of Hoyo Lora et al. (2009) showed an increase in SJ (1.85± 3.85 cm) and CMJ (1.22±3.35cm) post-test immediately after vibration. The post-test value displayed 30 minutes after the jump from

nu snagu, mišićnu izdržljivost i neuromišićnu aktivnost upoređujući sa identičnim konvencionalnim treningom (Delecluse, Roelants, Diels, Koninckx, & Verschueren, 2005; Osawa & Oguma, 2011). U jednom istraživanju je ispitivan uticaj efekata četvoromesečnog vibracionog treninga celog tela na mišićne performanse i ravnotežu tela kod mladih, zdravih nesportista (Torvinen et al., 2002). U jednom istraživanju je vršena procena efekta vežbanja vibracije celog tela i pliometrijskog treninga kod odbojkašica (Kim, & Park, 2016). U jednom istraživanju je ispitivan uticaj dodavanja vibracionog treninga za celo telo (WBV) na proceduru zagrevanja prilikom sprinta kasnijeg ciklusa (Rønnestad et al., 2017). U jednom istraživanju su proučavani hronični efekti vibracije celog tela na jačinu i snagu donjih ekstremiteta u kojoj je vibracioni nadražaj bio dodat standardnom treningu sa opterećenjem (Rønnestad, 2004). U jednom istraživanju je ispitivan efekat dugoročnih WBV treninga na maksimalnu izometrijsku snagu kolena ragbi igračima (Melania et al., 2010). U jednom istraživanju je ispitivan efekat šestonedeljnog programa vibracionog treninga na rekreativno aktivnom stanovništvu (Hawkey, 2012). U jednom istraživanju su utvrđivani efekati dva programa od 10 nedelja na promene parametara eksplozivnosti, mogućnost uzorkvanja efekata stimulacijom vibracije mišića ili izometrijskog treninga (Živković i sar., 2015).

Diskusija

Rezultati Torvinen et al. (2002) pokazuju da je pod uticajem vibracionog treninga za celo telo (WBV) došlo do poboljšanja visine skoka za 8,5%. Snaga donjih ekstremiteta je povećana za 3,7% nakon dva meseca, međutim ova vrednost se smanjila nakon četiri meseca. Rønnestad (2004) je pokazao da je eksperimantalna grupa pod uticajem WBV ostvarila pozitivne efekte na maksimalnu jačinu od 1RM (maksimalni ponovak) (32 ± 9%), te visinu skoka u skoku iz čučnja sa pripremom (CMJ) (9,1 ± 5,5%), dok je kontrola imala pozitivan uticaj na maksimalnu jačinu 1 RM (24,2 ± 3,9%) i statistički značajan uticaj na CMJ visinu skokova (4,2 ± 4,2%). Paradisis & Zacharoqiannis (2007) su utvrdili da je pod uticajem WBV treninga, test sprinterskog trčanja zabeležio pomak od 3,4%. Visina skoka je pod uticajem WBV poboljšana za 3,3 %, a izdržljivost u eksplozivnoj jačini je napredovala za 7,8%. Rezultat Hoyo Lora et al. (2009) je pokazao povećanje SJ (+1.85 ± 3.85 cm) i CMJ (+1.22 ± 3.35 cm) post-testa odmah nakon vibracije. Vrednost post-testa prikazana 30 minuta nakon skoka iz čučnja je iznad vrednosti kod pre-testa, ali i ispod vrednosti neposredno kod post-testa (+0.51 ± 4.37 cm). Kao kontrast, vrednost

the squat was above the value of the pre-test, but also below the immediate post-test value (0.51±4.37 cm). In contrast, the value of the CMJ falls below the pre-test value (-0.15±2.36 cm). Hoyo Lora et al. (2010) achieved an increase in squat jump (SJ) (1.76±4.05cm) and CMJ (1.10±3.20cm) in a post-test performed immediately after vibration. The values of the post-test performed 30 minutes after the jump from the squat remained above those from the pre-test but just below those from the current post-test (0.42±4.43cm). In contrast, the jump values from the squat with the preparation fall below those from the test (0.12±2.45cm). Sarshin et al. (2010) achieved a statistically significant increase in EG with an increase of 7.8% in explosive power (p≤002), and there was a significant difference in the speed of EG (5m: p≤0.001, 10m: p≤0.042 and 20m: p≤0.001) in the post-test. After conducting experimental treatments based on the aforementioned different methods of preparation of the locomotor apparatus for the upcoming maximum muscular effort in the study of domestic authors, it was concluded that the vibration training method is significantly more effective (p=0.01) than the conventional method used (Obradovic et al., 2010). In Osawa & Ogum's (2011) study, vibrational training was found to be better at the level of statistical significance compared to conventional training. Based on the statistical significance (p=0.0001) in the study (Hawkey, 2012), it can be concluded that there was an increase in the height of the jump in the experimental group, before (0.43±0.08m) and after (0.49m±0.08). Analyzing the obtained research results of Živković et al. (2015) found that under the influence of WBV there were changes in the mean values in the explosive power of the upper and lower extremities. Performing preconditioning exercise with WBV at 40 Hz in the study of Rønnestad et al. (2017) resulted in superior maximum output power compared to the preconditioning exercise without WBV (1413 ± 257 V vs 1353 ± 213 V, P = .04) and a tendency toward superior mean output power during the 15 second-out sprint (850 ± 119 V vs 828 ± 101 V, P = .08). Effect size showed a moderate practical effect of WBV without WBV on both strengths - both maximum and mean. Measurement of vertical jump in a study by Kim & Park (2016) found that the WBV group showed significant improvement in vertical jump from the control group.

No changes were observed in the following surveys: The isometric and dynamic strength of the knee flexors and extensors was unchanged (r>0.05) in the whole body vibration training group and the control group. Also, the knee extension rate remained unchanged

CMJ pada ispod vrednosti pre-testa (-0.15 ± 2.36 cm). Hoyo Lora et al. (2010) su ostvarili povećanje u skoku iz čučnja (SJ) (+1.76±4.05cm) i CMJ (+1.10±3.20cm) u post testu koji se sprovodi odmah posle vibracija. Vrednosti post testa izvršenog 30 minuta posle skoka iz čučnja ostale su iznad onih iz pre - testa ali neposredno ispod onih iz trenutnog post-testa (+0.42±4.43cm). Nasuprot tome vrednosti skoka iz čučnja sa pripremom padaju ispod onih iz pre – testa (0.12±2.45cm). Sarshin et al. (2010) su ostvarili statistički značajno uvećanje kod EG sa povećanjem od 7.8% u eksplozivoj snazi (P≤0/002), a javila se i značajna razlika u brzini EG (5m: P≤ 0.001, 10m: P≤0.042 i 20m: P≤0.001) u post testu. Nakon sprovedenih eksperimentalnih tretmana zasnovanih na pomenutim različitim metodama pripreme lokomotornog aparata za nastupajuće maksimalno mišićno naprezanje u istraživanju domaćih autora zaključeno je da je metoda vibracionog treninga značajno efikasnija (na nivou značajnosti 0.01) u odnosu na primenjenu konvencionalnu metodu (Obradović i sar., 2010). U istraživanju Osawa & Oguma (2011) vibracioni trening se pokazao boljim na nivou statističke značajnosti u odnosu na konvencionalni trening. Na osnovu statističke značajnosti (p 0,0001) u istraživanju (Hawkey, 2012) može se konstatovati da je došlo do povećanja visine skoka u eksperimentalnoj grupi (pre - 0,43 ± 0,08m i posle - 0,49m ± 0,08). Analiziranje dobijenih rezultata istraživanja Živković i sar. (2015) utvrdilo je da je pod uticajem WBV došlo do promena u srednjim vrednostima u eksplozivnoj snazi gornjih i donjih ekstremiteta. Izvođenje predkondicionog vežbanja sa WBV na 40 Hz u istraživanju Rønnestad et al. (2017) rezultiralo je superiornom maksimalnom izlaznom snagom u poređenju sa vežbom za predkondicioniranje bez WBV-a (1413 ± 257 V vs 1353 ± 213 V, P = .04) i tendencijom ka superiornom srednjm izlaznom snagom tokom 15 sekunde- out sprint (850 ± 119 V vs 828 ± 101 V, P = .08). Veličina efekata pokazala je umereni praktični efekat WBV-a bez WBV-a na obe snage - kako maksimalnu tako i srednju. Merenje vertikalnog skoka u istraživanju Kim & Park (2016) otkrilo je da grupa vežbanja vibracija celog tela pokazuje značajno poboljšanje vertikalnog skoka od kontrolne grupe.

Izometrijska i dinamička snaga fleksora i ekstenzora kolena nije bila promenjena (R>0.05) u grupi treninga vibracije celog tela i u kontrolnoj grupi. Takođe brzina ekstenzije kolena je ostala nepromenjena (R>0.05). Trajanje početne akcije, rezultat početne brzine, početno ubrzanje i brzina trčanja ostalo je nepromenjeno (R>0.05) u svakoj grupi (Delecluse et al., 2005). Paradisis & Zacharoqiannis (2007) pokazuju da se vreme

(r>0.05). The duration of the initial action, the result of the initial speed, the initial acceleration, and the running speed remained unchanged (r>0.05) in each group (Delecluse et al., 2005). Paradisis & Zacharoqiannis (2007) show that the sprint time in the experimental group decreased: 10m-4.3%, 20m-3%, 40m-2.2%, 50m-2.1% and 60m-2.1%. CMJ height improved by 3.3% (also statistically significant). During the experimental procedure, the control group achieved statistically insignificant moving changes for the sprint speed: 10m-0.7%, 20m-0.6%, 40m-0.4%, 50m-0.4% and 60m-0,3% , while the CMJ height improved by 0.3%. The characteristics of the vibration stimulus are reflected in a frequency of 30 Hz, an amplitude of 2.5 mm, and a vibrational acceleration of 2.28g. Statistically significant differences in CG in the study by Sarshin et al. (2010) were not found (P≥0.05, P≥0.05). Melania et al (2010) found no significant change between pre- and post-intervention values of the same group. There were no significant changes in the isometric strength of the knee extensors between the experimental and control groups. Based on statistical significance (p≥0.01) in the Hawkey (2012) study, it can be concluded that no increase in vertical jump was observed in the control group subjects (before 0.43±0.07m and after 0.41±0.08m). Neither vibration training with Flexi-bar nor isometric training has been found to have a statistically significant effect on the change in the value of the explosive power of the lower extremities (Zivkovic et al., 2015). Kim & Park (2016) research plyometric training showed no significant improvement in vertical jump. Although both whole-body vibration and plyometric training are effective methods, they have different effects on improving isokinetic muscle strength, jumping performance, and balance.

Conclusion

The application of vibration training results in positive changes in the results of explosive power tests. It can be concluded that the use of a vibration exercise program in subjects is an effective method for improving both explosive power and other motor abilities.

If the appropriate type and intensity of vibration training is applied, there is an increase in explosive power. When it comes to the length of the program, it can be concluded that the minimum frequency where there can be an improvement in the results of explosive power is two to three training sessions per week.

A review of the research conducted in the field of this training shows that the effects of such training methods exist with both active athletes and recreational athsprinta u eksperimentalnoj grupi smanjilo: 10m - 4,3%, 20m - 3%, 40m - 2,2%, 50m - 2,1% i 60m - 2,1%. Visina CMJ-a poboljšana je za 3,3% (takođe statistički značajno). Kontrolna grupa je u toku eksperimentalnog postupka ostvarila statistički neznačajne promene koji se kreću, za brzinu sprinta: 10m - 0.7% 20m - 0,6%, 40m - 0,4%, 50m - 0,4% i 60m - 0 , 3%, dok je CMJ visina poboljšana za 0,3%. Karakteristike vibracijskog nadražaja se ogledaju u frekvenciji od 30 Hz, amplitudi od 2,5 mm i vibracionoj akceleraciji od 2,28g. Statistički značajne razlike kod CG u istraživanju Sarshin et al. (2010) nije bilo (P≥0.05, P≥0.05). Melania et al (2010) nisu pronašli značajne promene između vrednosti pre - i postinterventnih vrednosti iste grupe. Nije bilo značajnih promena u izometrijskoj snazi ekstenzora kolena između izvođenja eksperimentalne i kontrolne grupe. Na osnovu statističke značajnosti (p≥0,01) u istraživanju Hawkey (2012) može se konstatovati da nije zabeleženo povećanje vertikalnog skoka kod ispitanika kontrolne grupe (pre - 0,43 ± 0,07m i posle - 0,41 ± 0,08m). Utvrđeno je da ni vibraciona obuka sa Flexi-barom niti izometrijska obuka, ne pokazuju statistički značajan uticaj na promenu vrednosti eksplozivne snage donjih ekstremiteta (Živković, i sar., 2015). Grupa vežbanja u istraživanju Kim & Park (2016) pliometrijskog treninga nije pokazala značajno poboljšanje u vertikalnom skoku. Iako su i vibracije celog tela i pliometrijski trening efikasne metode, imaju različite efekte na poboljšanje izokinetičke snage mišića, performanse skakanja i ravnoteže kod odbojkašica.

Zaključak

Primenom vibracionog treninga dolazi do pozitivnih promena u rezultatima na testovima eksplozivne snage. Može se zaključiti da primena vibracionog programa vežbanja kod ispitanika predstavlja efikasan metod za poboljšanje kako eksplozivne snage, tako i ostalih motoričkih sposobnosti i kod žena i kod muškaraca.

U savremenom sportu koji se razvija iz godine u godinu sve više, nivo fizičke spreme među sportistima se povećava. Ako se primenjuje odgovarajući tip i intenzitet vibracionog treninga, dolazi do povećanja eksplozivne snage. Kada se radi o dužini trajanja programa koji dovodi do poboljšanja eksplozivne snage, na osnovu dosadašnjih studija primetno je u tabeli 1. da su dati programi izvođeni dva do tri puta sedmično u trajanju od četiri sedmice pa do pet meseci.

Pregledom istraživanja koja su sprovedena iz oblasti ovog treninga pokazuju da efekti ovakvih metoda treniranja postoje kako kod aktivnih sportista tako i kod rekreativaca. Rezultati ovog rada mogu koristiti budućim

letes. The results of this work can be utilized by future research to find the most efficient type of vibration training to improve the explosive power that is the dominant motor ability in certain sports (eg as starting acceleration in sprint, athletic high jump, long jump, triple jump…).

istraživanjuma u cilju pronalaženja što efikasnijeg tipa vibracionog treninga, radi poboljšalja eksplozivne snage koja predstavlja dominantnu motorička sposobnost u određenim sportskim disciplinama (npr. kao startno ubrzanje u sprintu, u atletskim skokovima u vis, u dalj, u troskoku…).

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