DOI: 10.7251/SSH1901021M
Paper review

UDC: 796.015:373.3/.4-057.874
Pregledni rad

Overview of Training Research With Loading in Unstable Conditions

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Abstract: *The main goal of this research was to review the works that dealt with the effects of strength training in unstable conditions. A transparent survey covered 24 papers that were not older than 10 years. The sample of respondents are young and middle age groups due to similar abilities. Out of 24 papers: 16 papers were with one group in the experiment, 6 papers were with two groups in the experiment and 2 with three groups in the experiment. After the involvement of the musculature: 9 papers treated pectoral musculature, in 10 papers the involvement of the muscles of the lower limbs was processed, 6 papers dealt with the aspect of engaging the back musculature and the same abdomen, 8 papers treated chest musculature and two papers included shoulder musculature in their research. There was no difference in the degrees of promotion on the basis of gender in the articles. The statistical effect of exercise on unstable substrates was expressed in 13 studies, there were no statistically significant effects in 7 studies, while the same effect of the effects achieved by strength exercises on unstable and stable surfaces was found in 4 papers. The work done primarily suggests a positive effect of exercise on unstable substrates in untrained individuals.*

Keywords: *Strength, Force, Swiis ball, Training, Stable and Unstable Substrate.*

Introduction

Keeping the body position is a continuous process of minimal adjustment above the existing base or support. The lower the support, the adjustments must be more precise to maintain the balance. Postural adjustment of the hull or leg, in certain situations, can be initiated before the onset of voluntary hull or upper limb movements (Gantchev & Dimitrova, 1996). Such postural adjustments are considered to be aimed at minimizing

Pregled istraživanja treninga sa opterećenjem pri nestabilnim uslovima

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Apstrakt: *Pregledno istraživanje je obuhvatilo finalno obrađenih 24 radova ne starijih od 10 godina. Uzorak ispitanika su mlada i srednja starosna grupa zbog sličnih sposobnosti. Od 24 radova: 16 radova je sa jednom grupom u eksperimentu, 6 radova je sa dve grupe u eksperimentu i 2 rada sa tri grupe u eksperimentu. Po angažovanosti muskulature: u 9 radova je obrađena grudna muskulatura, u 10 radova je obrađivano angažovanje muskulature donjih ekstremiteta, 6 radova je u svom aspektu imalo angažovanje leđne muskulature i isto toliko abdomena, 8 radova je obrađivalo grudnu muskulaturu i dva rada su obuhvatila u svom istraživanju ramenu muskulaturu. U radovima nije pronađena razlika u stepenima napredovanja na osnovu pola. Statistički efekat vežbanja na nestabilnim podlogama je bio izražen u 13 studija, nije bilo statistički značajnih efekata u 7 studija, dok jednaki učinak efekata postignutim vežbama snage na nestabilnim i stabilnim površinama nalazimo u 4 rada. Obrađeni radovi prvenstveno navode pozitivan efekat vežbanja na nestabilnim podlogama kod neutreniranih osoba.*

Ključne reči: *snaga, sila, švajcarksa lopta, trening, stabilna i nestabilna podloga.*

Uvod

Održavanje položaja tela je kontinuirani proces minimalnih prilagođavanja iznad postojeće baze ili oslonca. Što je oslonac manji, prilagođavanja moraju biti preciznija da bi se održavala ravnoteža. Posturalno prilagođavanje trupa ili nogu, u pojedinim situacijama, može biti inicirano pre početka voljnih pokreta trupa ili gornjih udova (Gantchev & Dimitrova, 1996). Smatra se da ovakva posturalna prilagođavanja imaju za cilj minimovement disturbance disorders. When the substrate is unstable, the change in muscle potentials precedes the moment of application of force, which is designated as "muscular anticipation" (Kornecki, & Siemieński, 2001). This can be explained by the fact that the support structures must first stabilize before the motor movement is efficiently initiated. Additionally, measurements of postural adjustment at different body positions have shown that stabilizing muscles are activated for about 30 ms before muscle activation of the movement (Nouillot & Bouisset, 1992). When a person moves, he or she is usually unaware of the complex neuromuscular processes that control the position of the body. Under stable conditions, the demands of stabilizing the position under the influence of transient, for the movement of related disorders, have been reduced. On the other hand, in a very unstable situation, anticipatory postural adjustments, by themselves, can be considered as sources of disorder, when the center of gravity moves beyond the desired support surface. This anticipatory increase in synergistic muscular activity is documented using a reversed pendulum that induces arm instability (Stokes & Gardner-Morse, 2000).

Using external forces in an effort to maintain a dynamic balance is a key factor of success in most sports and necessity in everyday activities (for example, carrying bags during shopping, wearing a baby, etc.). This stabilization process consists of establishing active muscular controls in minimizing the degree of freedom in one or a series of joints, which results in the stabilization of excessive movement of external objects. Motor skills training, including balance training, increases the sensitivity of the feedback mechanisms and shortens the time to activate the selected muscles by improving the sensitivity of the feeling of position and agonistic and antagonistic muscles (Kollmitzer & Ebenbichler, 2000). Muscles, as the final parts of the mechanism of the sensomotor system, especially contribute to maintaining the balance of the body. The use of various exercises under unstable conditions in order to improve balance and coordination has attracted attention in the past few years. However, their impact on power improvement is largely unproven, partly because of the problematic reliability of current methods for assessing muscle strength in this kind of movement, which limits their practical application. Recently, exercises performed under unstable conditions have become part of the training and rehabilitation programs. Accordingly, their influence on physical abilities and health has attracted the attention of trainers and researchers. Absence of stability can be induced by the substrate or platform on which the exercise is performed

miziranje poremećaja ravnoteže izazvanih pokretima. Kada je podloga nestabilna, promena mišićnih potencijala prethodi momentu apliciranja sile, što se označava kao „mišićna anticipacija" (Kornecki, & Siemieński, 2001). Navedeno se može objasniti činjenicom da se potporne strukture moraju prvo stabilizovati pre nego što se motorni pokret efikasno pobudi. Uz to, merenja posturalnih prilagođavanja pri različitim položajima tela pokazala su da se stabilizirajući mišići aktiviraju oko 30 ms pre mišićne aktivacije pokreta (Nouillot & Bouisset, 1992).

Kada se čovek kreće, najčešće nije svestan složenih neuromišićnih procesa koji kontrolišu položaj tela. Pri stabilnim uslovima, zahtevi stabilizovanja položaja pod dejstvom prolaznih, za pokret vezanih poremećaja, su smanjeni. S druge strane, u vrlo nestabilnoj situaciji, anticipa-torna posturalna prilagođavanja, sama po sebi, mogu se posmatrati kao izvori poremećaja, kada se centar gravitacije (težište) pomeri van željene potporne površine. Ovaj anticipatorni porast sinergističke mišićne aktivnosti je dokumentovan pomoću obrnutog klatna koje indukuje nestabilnost ruke (Stokes & Gardner-Morse, 2000).

Upotreba spoljašnjih sila u pokušaju da se održi dinamička ravnoteža ključan je faktor uspešnosti u većini sportova i nužnost u svakodnevnim aktivnostima (npr. u nošenju torbi tokom kupovine, nošenju bebe itd). Ovaj stabilizacioni proces sastoji se iz uspostavljanja aktivnih mišićnih kontrola u minimiziranju stepena slobode u jednom ili nizu zglobova, što rezultuje stabilizovanjem prevelikog kretanja spoljašnjih objekata. Trening motornih veština, uključujući trening ravnoteže, povećava senzitivnost mehanizama povratne sprege i skraćuje vreme do aktivacije odabranih mišića poboljšavajući senzitivnost osećaja položaja i agonističkih i antagonističkih mišića (Kollmitzer & Ebenbichler, 2000). Mišići, kao završni delovi mehanizma senzomotornog sistema, posebno doprinose održanju ravnoteže tela. Upotreba različitih vežbi pri nestabilnim uslovima u cilju poboljšanja ravnoteže i koordinacije privlači pažnju poslednjih nekoliko godina. Međutim, njihov uticaj na poboljšanje snage je u velikoj meri neproučen, delimično zbog proble-matične pouzdanosti aktuelnih metoda za procenu mišićne snage pri ovakvoj vrsti pokreta, što ograničava njihovu praktičnu primenu. Nedavno su vežbe sa opterećenjem koje se izvode pri nestabilnim uslovima postale deo treninga i programa rehabilitacije. Shodno tome, njihov uticaj na fizičke sposobnosti i zdravlje privukao je pažnju i trenera i istraživača. Odsustvo stabilnosti može poticati od podloge ili platforme na kojoj se vežba izvodi (npr. lopta ili njihajuća ploča) ili iz položaja u kojima se segmenti tela postavljaju van potporne baze tela (npr. jednoručni tego-

(e.g. ball or bumper plate) or from positions in which body segments are placed outside the supporting body (e.g., single-handed weights). However, it must be borne in mind that when a person attempts to apply force in conditions of instability, the maximum forces achieved in stable conditions are not possible due to the significant functions of muscular stabilization. This requires that the number of maximum repetitions be adjusted to compensate for unstable conditions. Studies carried out showed significantly higher electromyographic activity of muscular torso stabilizer during exercise with stress at unstable but stable conditions (Anderson & Behm, 2004; Behm et al., 2005). These findings suggest that unstable conditions in training with a load can facilitate neurological adaptations of muscles of the torso stabilizer, which leads to an improvement in body stability.

Performing movements under unstable conditions results in a decrease in maximum muscle strength due to a decrease in total muscle force, an increase in co-contraction, and a change in muscular coordination (Anderson & Behm, 2005). Although the manifestation of the highest muscular strength is reduced in conditions of instability, the change in the balance of training on an unstable surface can activate the muscles of the extremities and hulls, thereby ensuring greater joint stability. Using unstable platform in strength training should enable the development of higher levels of muscle activation, through increased reliance on their stabilizing functions. As this higher level of muscle activation is achieved with less resistance, this kind of training can have positive effects in rehabilitation of muscles and joints after injury, as well as training specific to certain sports. Since most sports involve a combination of stabilization and force production functions, strength training under unstable conditions provides similar stimuli to the nervous and muscular system, leading to adequate repetitions to physiological adaptations. Power training under unstable conditions can reduce the likelihood of injury to the lower extremities due to increased sensitivity of muscle spindles and better postural control. The first targeted studies have shown that the Swiss ball provides a wide range of movements under unstable conditions, with an optimal starting position of several degrees of active hull extension (Siff, 1991). The Swiss ball (also known as the fitness ball, exercise ball, pilates ball, therapeutic ball, yoga ball, etc.) is an elastic inflatable ball made of soft polyvinyl chloride (PVC). The blowing of air is carried out by a specially designed air pump through an opening that is then closed with a safety plug. The importance of the Swiss ball in rehabilitation is documented in the reeducation of postural muscles as well as in faci-

vi). Ipak, mora se imati u vidu da kada osoba pokuša da aplikuje silu u uslovima nestabilnosti, maksimalne sile koje se postižu u stabilnim uslovima nisu moguće zbog značajnijih funcija mišićne stabilizacije. To zahteva da se broj maksimalnih ponavljanja prilagodi, kako bi se kompenzovali nestabilni uslovi. Studije koje su sprovedene pokazale su znatno veću elektromiografsku aktivnost mišića stabilizatora trupa tokom vežbi sa opterećenjem pri nestabilnim, nego pri stabilnim uslovima (Anderson & Behm, 2004; Behm et al. 2005).. Ovi nalazi sugerišu da nestabilni uslovi pri treningu sa opterećenjem mogu da olakšaju neurološke adaptacije mišića stabilizatora trupa, što dovodi do poboljšanja stabilnosti tela.

Izvođenje pokreta pri nestabilnim uslovima rezultuje smanjenjem maksimalne mišićne snage zbog smanjenja ukupne sile mišića, povećanja ko-kontrakcija i izmene mišićne koordinacije (Anderson & Behm, 2005). Iako je ispoljavanje najveće mišićne snage smanjeno u uslovima nestabilnosti, promena ravnoteže pri treningu na nestabilnoj podlozi može da aktivira mišiće ekstremiteta i trupa i time obezbedi veću stabilnost zglobova. Korišćenje nestabilnih platformi u treningu snage treba da omogući razvoj viših nivoa aktivacije mišića, preko povećanog oslanjanja na njihove stabilizirajuće funkcije. Kako se ovaj viši nivo aktivacije mišića postiže sa manjim otporom, ovakva vrsta treninga može imati pozitivne učinke u rehabilitaciji mišića i zglobova nakon povreda, kao i u treningu specifičnom za određene sportove. Pošto većina sportova podrazumeva kombinaciju funkcija stabilizacije i proizvodnje sile, trening snage pri nestabilnim uslovima obezbeđuje slične nadražaje za nervni i mišićni sistem, dovodeći adekvatnim ponavljanjima do fizioloških adaptacija. Trening snage pri nestabilnim uslovima može smanjiti verovatnoću povreda donjih ekstremiteta zbog povećanja osetljivosti mišićnih vretena i bolje posturalne kontrole. Još su prva ciljana istraživanja pokazala da švajcarska lopta obezbeđuje široki spektar pokreta pri nestabilnim uslovima, sa optimalnom početnom pozicijom od nekoliko stepeni aktivne ekstenzije trupa (Siff, 1991). Švajcarska lopta (poznata i pod nazivima: fitnes lopta, lopta za vežbanje, pilates lopta, terapijska lopta, lopta za jogu itd.) je elastična lopta na naduvavanje napravljena od mekog polivinilhlorida (PVC). Uduvavanje vazduha se vrši posebno oblikovnom vazdušnom pumpom kroz otvor koji se zatim zatvara sigurnosnim čepom. Važnost švajcarske lopte u rehabilitaciji dokumentovana je u reedukaciji posturalnih mišića, kao i u olakšavanju pokreta i posturalnih reakcija kod bolesnika sa neurološkim oštećenjima (Stanforth et al. 1998). Najčešće vežbe sa švajcarskom loptom se litating movement and postural reactions in patients with neurological impairment (Stanforth et al., 1998). The most common exercises with the Swiss ball are characterized by isometric muscular activity, low loads and long periods of muscle contraction, leading to the development of central endurance (Cosio-Lima et al., 2003, Carter et al., 1998). Research with subjects who performed various typical hardening exercises in stable and unstable conditions (the Swiss ball) showed that activation of the lumbosacral and upper lumbar spine lifters, as well as deep abdominal stabilizers, was significantly higher in unstable conditions (Behm et al. 2005). Significantly higher instability of the substrate or platform relative to the usual stable conditions causes the initiation of other mechanisms of neurological and neuromuscular adaptation, which as a result has an increase in muscular strength (Radovanović & Ignjatović). The aim of the research was to review the current research on the effects of stress training in unstable conditions.

Method

A descriptive method, supported by theoretical analysis and generalization, was used to produce the work. This method involves the equal treatment of empirical and theoretical research. The results of the research of foreign scientists were combined. Search research was conducted using the Web of Science, Kobson, Pubmed, and Google Scholar search engine database. The magazines in the field of sports medicine for sports medicine and sports training were searched. Search is limited to studies that have been conducted in the last 10 years. Key words were power, force, swiss ball, training, stable and unstable background.

Results

karakterišu izometrijskom mišićnom aktivnošću, malim opterećenjima i dugim periodima kontrakcije mišića, što vodi razvoju centralne izdržljivosti (Cosio-Lima et al. 2003; Carter et al. 1998). Istraživanje sa subjektima koji su izvodili različite tipične vežbe za jačanje trupa u stabilnim i nestabilnim uslovima (švajcarska lopta) pokazalo je da je aktivacija lumbosakralnog i gornjeg lumbalnog podizača kičme, kao i dubokih abdominalnih stabilizatora, bila znatno veća u nestabilnim uslovima (Behm et al. 2005). Značajno veća nestabilnost podloge ili platforme u odnosu na uobičajne stabilne uslove uzrokuje pokretanje i ostalih mehanizama neurološke i neuromišićne adaptacije, što kao rezultat ima povećanje mišićne snage (Radovanović & Ignjatović). Istraživanje je imalo za cilj da izvrši pregled dosadašnjih istraživanja vezanih za efekte treninga sa opterećenjem pri nestabilnim uslovima.

Metod

Za izradu rada upotrebljena je deskriptivna metoda, potrekpljena teorijskim analizama i uopštavanjem. Ova metoda je podrazumeva ravnopravan tretman empirijskih i teorijskih istraživanja. Objedinili su se rezultati istraživanja stranih naučnika. Pretraga istraživanja sprovedena je korišćenjem baze pretraživača Web of Science, Kobson, Pubmed i Google Scholar. Bili su pretraženi časopisi iz oblasti sportske nauke za sportsku medicinu i sportskog treninga. Pretraga je ograničena na studije koje su sprovedene u poslednjih 10 godina. Ključne reči su bile snaga, sila, švajcarksa lopta, trening, stabilna i nestabilna podloga.

Rezultati

Tabela 1. *Pregled istraživanja u kojima je bio izražen statistički efekat vežbanja na nestabilnim površinama*

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Campbell et al., 2014 [1]	1grupa Benč pres stabilna površina i švajcarska lopta	10 muškaraca, uzrasta 23.9 ± 2.6; težine: 82.8 ± 10.2 kg)	Sa iskustvom 1 godina	Potisak sa grudi 50 % RM i 25 % 1RM	EMG	trupna muskulatura da bi omogućila stabilnost pokazuje povećanu aktivnost prilikom vežbe razdvojenih opterećenja po rukama
Cug et al., 2012 [4]	1 grupa Pregibi trupa, pregibi zadnje lože, čučnjevi	60 studenata Eksperimentalna grupa 43 dečaka i 16 devojaka) Kontrolna grupa 17 studenata (9 dečaka i 8 devojaka) (uzrasta 21.67-23.44; Visina dečaka 174 cm, Visina devojaka164 cm; težina dečaka:71-77kg, devojaka 57kg)	Bez iskustva	10 nedelja, 3 x nedeljno progresivno podižući opterećenja	Izokinetički dinamometar	Trenirana grupa je povećala težinski vrh ekstenzije trupa za 20,1%,, dok je kod kontrolne gruge opalo za 6,8%.Trenirana grupa povećala težinski vrh fleksije trupa trupa za 18,1%,, dok je kod kontrolne gruge opalo za 0,4%. Propriorecepcija u zglobu kolena se povećala za 44.7%.

Granacher et al., 2014 [6]	1 grupa Prednji, bočni i donji deo trupa	27 ispitanika 13 dečaka uzrasta 13.7; visine 168.6;težine: 53.1kg 14 devojčica uzrasta 13.8; visine 169.6;težine 51.4kg	Sa iskustvom	6 nedelja, 3-4 treninga nedeljno, izometrija 3x40-45 s, 3x20-23 ponavljaja	-	Značajan trenažni efekat je postignut u vremenu izvođenja vežbi u razlici pre i posle tretmana, balansu i skokovima. Istraživanje nije dalo rezultata kod statičkih vežbi
Escamilla et al., 2010 [7]	1 grupa Pike sklekovi, pregibi trupa, roll out (abdomen)	18 ispitanika 9 momaka uzrasta 29.9 ± 6; visine: 178.1 ±4.3 cm; težine: 73.3 ± 7.2 kg) 9 devojaka uzrasta 27.7 ±7.7; visine: 165.0 ±7.0 cm; težine: 61.1 ± 7.8 kg)	Bez iskustva	5x8 na nestabilnoj podlozi I 2 na stabilnoj podlozi	EMG	Prva tri mesta u angažovanju muskulature čine vežbe pike, crunch i roll out. Na poslednjem mestu postignutog efekta je sed na švajcarskoj lopti.
Sekendiz et al., 2010 [21]	1 grupa švajcarska lopta snaga trupa, donji deo leđa i donji eksrtremiteti.	21 ispitanica (uzrasta 34 ± 8.09; visine: 163 ±6,91 cm; težine: 64 ± 8.69 kg)	bez iskustva	5 nedelja, 3x15 - 4x25 ponavljaja	-	petonedeljni trenažni program sa švajcarskom loptom uzrokuje značajno povećanje izdržljivosti u snazi ekstenzora trupa nego na podu.
Kohler at al., 2010 [10]	1 grupa potisak sa ramena (ramena i abdomen)	30 ispitanika 24 muškaraca i 6 žena uzrasta 30±8, težine:75±14	1 godina iskustva	3x3 i 2x10 (benč pres/švajcarska lopta)	EMG	kada se povećava intenzitet nestabilnosti, smanjuje se intenzitet opterećenja..
Lawrence & Carlson, 2015 [12]	1 grupa Zadnji čučanj	15 utreniranih muškaraca (uzrasta 24.2 ± 3.4; visine: 170 ±10 cm; težine: 83.4 ± 18.7 kg)	Sa iskustvom	10 X60 %1RM	-	vežbanje na nestabilnoj podlozi uzrokuje veću mišićnu aktivaciju mišića rectus abdominis, external oblique, i soleus
Marín & Hazell, 2014 [13]	1 grupa 4. vrsta podloga (stabilna, nestabina, nistabilna sa vibracijama 30Hz i 50Hz	28 studenata (uzrasta 21.7 ± 1.3; visine: 176.7 ±0.3 cm; težine: 74 ± 6.4 kg	bez iskustva	5 min zagrevanje, 10x zgibovi, butt kicks, skok kolena-grudi, čučnjevi i lateralni iskoraci	EMG	korišćenje vibracija pri 30Hz je povećalo EMG mišića od 20 do 40% od od ostalih vrsta testiranja
Marshall & Desai, 2010 [14]	1 grupa Izdržaji i pregibi trupa, čučnjevi	14ispitanika 7 momaka i 7 devojaka uzrasta 24.1 ± 1.7; visine: 174 ±8 cm; težine: 72.9 ± 13.17 kg	bez iskustva	1 sesija upoznavanje sa vežbajem 2 sesija 3 testiranja	EMG	povećanje aktivnosti mišića triceps bachii za 32,4%, vastus lateralisa za 44,2% i rectus abdominis za 28,5% na vežbi most koristeći švajcarsku loptu
Saeterbakken & Fimland, 2013 [18]	1 group Benč pres švajcarska lopta	16 utreniranih muškaraca (uzrasta22.5 ± 2; visine: 182 ±6 cm;težine: 82 ± 7.8 kg)	Sa iskustvom	6RM opterećenje 85 ± 15.6 kg 72 časa pauza između testova	EMG	najveće vrednosti potiska sa grudi su na stabilnoj površini (podu), a najmanje na švajcarskoj lopti
Nagla, E. (2011) [16]	1 grupa Karate snaga stomaka, leđa i nogu,fleksibilnost u kičmi i statičko dinamičkom balansu.	12 karatiskinja (uzrasta: 18-20; visine: 163.92 ±3.0 cm; težine: 64.77 ± 2.81 kg)	Sa iskustvom 6 godina	8 nedelja pored karatea i švajcarska lopta	EMG	rad sa švajcarskom loptom ima pozitivnog učinka na snagu stomaka, leđa i nogu, fleksibilnost u kičmi i statičko dinamičkom balansu.
Kibele et al., 2014 [8]	2 grupe skokovi i čučnjevi	33 studenta Eksperimentalna grupa:20(uzrasta 24.1 ± 3.1; visine: 182 ±5 cm; težine: 76.1 ± 8.9 kg) Kontrolna grupa: 13(uzrasta: 24.1 ± 4.6; visine: 179 ±5.3 cm; težine: 75.8 ± 8.3 kg)	Sa iskustvom	7 nedelja, 2xnedeljno	-	poboljšanje performansi nekih vrsta skokova, balansa i snagu ekstenzora kolena
Singh et al., 2013 [20]	2 grupe Eksperimentalna 12 muškaraca košarka + švajcarska lopta Kontrolna grupa 12 muškaraca košarka	24 muškarca (uzrasta: 21.54 ± 1.57; visine: 178.2 ±5.6 cm; težine: 66.2 ± 5.41 kg)	Bez iskustva	5 nedelja po 45 minuta na švajcarskoj lopti	-	korišćenje švajcarske lopte može uticati na poboljšanje u koordinacionim aktivnostima

Table 1. *An overview of the research in which the statistical effect of exercise on unstable surfaces was expressed*

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Campbell et al., 2014 [1]	1 group Bench press stable surface and Swiss ball	10 men, age 23.9 ± 2.6; weight: 82.8 ± 10.2 kg)	With 1 year experience	Bench press 50% RM and 25% 1RM	EMG	Muscular torso to provide stability shows an increased activity when exercising separate hand loads
Cug et al., 2012 [4]	1 group Crunch, folding of the rear logs, squats	60 students Experimental group (43 boys and 16 girls) Control group 17 students (9 boys and 8 girls) (ages 21.67-23.44; Height of boys 174 cm, Height of girls 164 cm, weight of boys: 71-77 kg, girls 57 kg)	No experience	10 weeks, 3 x weeks progressively raising	isokinetic load dynamometer	The trained group increased the weight of the hull extension by 20.1%, while the control group decreased it by 6.8%. The target group increased the weight of the hull torso flexion by 18.1%, while the control group decreased it by 0.4%. The proprioception in the knee joint increased by 44.7%.
Granacher et al., 2014 [6]	1 group Front, side and bottom part of the body	27 examinees 13 children age 13.7; height 168.6; weight: 53.1kg 14 girls age 13.8; height 169.6; weight 51.4kg	With experience	6 weeks, 3-4 workouts per week, isometry 3x40-45 s, 3x20-23 repetitions	-	Significant exercise effect was achieved at the time of performing the exercises in the difference before and after treatment, balance and jumps. The study did not provide results in static exercises
Escamilla et al., 2010 [7]	1 group Pike push up, crunch, roll out (abdominal)	18 subjects 9 guys age 29.9 ± 6; height: 178.1 ± 4.3 cm; weight: 73.3 ± 7.2 kg) 9 girls age 27.7 ± 7.7; height: 165.0 ± 7.0 cm; weight: 61.1 ± 7.8 kg)	Without experience	5x8 on an unstable surface I 2 on a stable	EMG	The first three places in the engagement of musculature are dental exercises, crunch and roll out. At the last place, the effect was on the Swiss ball.
Sekendiz et al., 2010 [21]	1 group Swiss ball force torso, lower back and lower extermination	21 respondents (age 34 ± 8.09, height: 163 ± 6.91 cm, weight: 64 ± 8.69 kg)	Without experience	5 weeks, 3x15 - 4x25 reps	-	A five-week training program with a Swiss ball causes a significant increase in endurance in the force of the hull extender than on the floor.
Kohler at al., 2010 [10]	1 group Thrust from the shoulders (shoulders and abdomen)	30 subjects 24 men and 6 women age 30 ± 8, weight: 75 ± 14	1 year experience	3x3 and 2x10 (bench press / swiss ball)	EMG	When the instability increases, the load intensity decreases.
Lawrence & Carlson, 2015 [12]	1 group Back squat	15 trained men (age 24.2 ± 3.4, height: 170 ± 10 cm, weight: 83.4 ± 18.7 kg)	With experience	10 X60 %1RM	-	Exercise on an unstable surface causes more muscular activation of muscles rectus abdominis, external oblique, and soleus
Marín & Hazell, 2014 [13]	1 group 4. type of backing (stable, unstable, vibration-free 30Hz and 50Hz,	28 students (age 21.7 ± 1.3; height: 176.7 ± 0.3 cm; weight: 74 ± 6.4 kg±0.3 cm	Without experience	5 min warming, 10x folds, butt kicks, knee breast, squat and lateral lunge	EMG	Use of vibrations at 30Hz increased EMG muscle 20 to 40% of other types of testing
Marshall & Desai, 2010 [14]	1 group Planks and crunch, squat	14 respondents 7 guys and 7 girls of age 24.1 ± 1.7; height: 174 ± 8 cm; weight: 72.9 ± 13.17 kg	With experience	1 session exercise practice 2 sessions 3 tests	EMG	Increased muscle activity triceps bachii by 32.4%, vastus lateralis by 44.2% and rectus abdominis by 28.5% at the exercise bridge using the Swiss ball
Saeterbakken & Fimland, 2013 [18]	1 group Bench press Swiss ball	16 trained men (ages 22.5 ± 2; height: 182 ± 6 cm; weight: 82 ± 7.8 kg)	With experience	With experience 6RM load 85 ± 15.6 kg 72 hours of pause between tests	EMG	The highest threshold values on the chest are on a stable surface (floor), and at least on the Swiss ball
Nagla, E. (2011) [16]	1 group Karate strength of the stomach, back and leg, spinal flexibility and static dynamic balance.	12 respondents (age: 18-20; height: 163.92 ± 3.0 cm; weight: 64.77 ± 2.81 kg)	With 6 years experience	8 weeks in addition to karate and the Swiss ball	EMG	Work with the Swiss ball has a positive effect on the stomach, back and leg, spinal flexibility and static dynamic balance.

Kibele et al., 2014 [8]	2 groups Jumps and squats	33 students Experimental group: 20 (age 24.1 ± 3.1, height: 182 ± 5 cm, weight: 76.1 ± 8.9 kg) Control group: 13 (age: 24.1 ± 4.6; height: 179 ± 5.3 cm; weight: 75.8 ± 8.3 kg)	With experience	7 weeks, Two days per week	-	Improving the performance of some types of jumps, balance, and strength of the knee extensor
Singh et al., 2013 [20]	2 groups Experimental 12 men basketball + Swiss ball Control group 12 men's basketball	24 men (ages: 21.54 ± 1.57; height: 178.2 ± 5.6 cm; weight: 66.2 ± 5.41 kg)	No experiences	5 weeks by 45 minutes on the Swiss balls	-	The use of Swiss balls can contribute to the improvement in the coordination activity

Tabela 2. *Pregled istraživanja u kojima nije bilo statistički značajnog efekata vežbanja na nestabilnim površinama*

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Goodman et al. 2008 [5]	2 grupe Kontrolna grupa: 1 RM benć pres,Kontrolna grupa: 1 RM švajcarska lopta,Pauza:7dana	13 rekreativaca 10 momaka i 3 devojke uzrasta: 24.1 ± 1.6visine: 176.7 ± 3.0 cmtežine:76.0 ± 3.9 kg	Bez iskustva	1 RM (benč pres/švajcarska lopta	EMG	Rezultat istraživanja pokazuje da nema elektromiografske razlike prilikom rada na obe vrste podloge.
Chulvi-Medrano et al.,2010 [2]	1 grupa Mrtvo dizanje	31 student (uzrasta: 24.0 ± 0,5; visine: 170. ±8.0 cm; težine:79.08 ± 2.37 kg)	Višegodišnje iskustvo	5 sek. Izometrija + 5x70% RM	EMG	vrednosti maksimalne snage i mišićne aktivnosti prilikom mrtve vuče (deadlift) postižu značajnije rezultate prilikom korišćenja stabilne podloge
Chulvi-Medrano et al., 2012 [3]	1 grupa Pod, T-bow i BOSU lopta	30 ispitanika(uzrasta: 24.97 ± 3.09; visine: 175,43 ±30.31 cm; težine: 80.6 ± 6.94 kg)	Sa iskustvom (3.33 ± 1.62g)	8 nedelja, 2x nedeljno trening	-	snaga koja je merena kroz jedan maksimalni ponavljaj i mičićna izdržljivost merena brojem sklekova se nije povećala ni kod jedne grupe vežbanja
Koshida et al., 2008 [11]	2 grupe Kontrolna grupa 1: 1 RM benč pres Kontrolna grupa2: 1 RM švajcarska lopta	20 ispitanika muškog pola (uzrasta: 21.3 ± 1.5 visine: 167.7 ± 7.7 cm težine:75.9 ± 17.5 kg)	-	3x50% 1RM Snaga, sila, brzina	Akcelometar	ponavljaji na nestabilnoj podlozi su za 6% manji u parametru sile i po 10% u parametrima snage i brzine
Pirauá et al., 2017 [17]	1 grupa 3 protokola a) benč pres šipkom, b) stabilna površina letenje bučicama i benč pres šipkom, c) nestabilna povrsina letenje bučicama and barbell bench press.	15 muškaraca(uzrasta: 22.5 ± 2.4; visine: 173,6 ±7,1 cm; težine: 76.03 ± 9.02 kg)	Sa iskustvom, 6 meseci	10 ponavljaja svaka vežba, 30% 1RM letenje bučicama, 60% od 1RM benč pres šipkom	EMG	svi oblici vežbanja povećavaju EMG mišića bez razlika
Saeterbakken & Fimland, 2013 [19]	1 group Čučanj na podu Power daska BOSU lopta	15 muškaraca (uzrasta: 23.3 ± 2.7; visine: 181 ±9 cm; težine: 80.5 ± 8.5 kg)	Sa iskustvom	10 min zagrevanjefleksiju 90 stepeni u zglobu kolena za svaku podlogu, period pauze između promena podloge 4 minuta	EMG	najveću razliku poredeći sa vežbama na fiksnoj podlozi ima rad sa BOSU loptom
Wahl & Behm, 2008 [24]	2 grupe Eksperimentalna i kontrolna 1 RM benč pres i leg pres	16 ispitanika (uzrasta: 26.6 ±7.0visine: 176.7 ±8.0 cm težine: 81.8 ± 9.1 kg)	Sportisti	2-3 ponvaljanja na švajcarskoj lopti, Bosu lopta dina disk	EMG	kod vežbača sa dužim trenažnim stažom zahtevi nestabilnih podloga nisu doveli do statistički značajnih efekata treninga snage

Table 2. *Survey of studies in which there were no statistically significant effects of exercise on unstable surfaces*

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Goodman et al. 2008 [5]	2 groups Control group: 1 RM bench press, Control group: 1 RM Swiss ball, Break: 7 days	13 respondents 10 boys and 3 girls age: 24.1 ± 1.6 Height: 176.7 ± 3.0 cm: 76.0 ± 3.9 kg	No experiences	1 RM press / swiss ball	EMG	The result of the study shows that there is no electromyo-graphic difference when wor-king on both types of substrate.
Chulvi-Medrano et al.,2010 [2]	1 group Dead lift	1 students (ages: 24.0 ± 0.5; height: 170. ± 8.0 cm; weight: 79.08 ± 2.37 kg)	Multi-year expe-rience	5 sec. Isometry + 5x70% RM	EMG	Values of maximum strength and muscle activity in deadlift achieve significant results when using a stable substrate.
Chulvi-Medrano et al., 2012 [3]	1 group Floor, T-bow and BOSU ball	30 subjects (ages: 24.97 ± 3.09; height: 175.43 ± 30.31 cm; weight: 80.6 ± 6.94 kg)	With experience (3.33 ± 1.62y)	8 weeks, 2x week training	-	Measured through one maximum repetition and the muscular endurance measured with the number of joints did not increase in any group of exercises.
Koshida et al., 2008 [11]	2 groups Control group 1: 1 RM bench press Control group2: 1 RM Swiss ball	20 male subjects (ages: 21.3 ± 1.5 height: 167.7 ± 7.7 cm weight: 75.9 ± 17.5 kg)	-	3x50% 1RM Power, force, velocity	Accelerometer	Repetitions on an unstable surface are 6% less in the force parameter and 10% in the parameters of power and speed.
Pirauá et al., 2017 [17]	1 group 3 protocols a) bench press, b) sta-ble surface flying with pumpkins and bench press, c) unstable surfa-ce flying saucers and barbell bench press.	15 men (ages: 22.5 ± 2.4; height: 173.6 ± 7.1 cm; weight: 76.03 ± 9.02 kg)	With 6 months experience	10 repeats each exercise, 30% 1RM fly flies, 60% of 1RM bench press	EMG	All forms of exercise increase EMG muscle without any difference.
Saeterbakken & Fimland, 2013 [19]	1 group Squash on the floor of the Power Board BOSU Ball	15 men (aged: 23.3 ± 2.7; height: 181 ± 9 cm; weight: 80.5 ± 8.5 kg)	With experience	10 min warming up 90 times the flexion in the knee joint for each surface, the breakdown period between the substrate changes by 4 minutes	EMG	With the greatest difference compared to the exercises on the fixed surface, work with the BOSU ball.
Wahl & Behm, 2008 [24]	2 groups Experimental and control 1 RM bench press and leg press	16 respondents (age: 26.6 ± 7.0 grades: 176.7 ± 8.0 cm weight: 81.8 ± 9.1 kg)	Athletes	2-3 swinging on the Swiss ball, Bosu's ball dina disk	EMG	In the practice with a longer tra-ining experience, the demands of unstable backbones did not lead to statistically significant effects of power training.

Tabela 3. *Pregled istraživanja u kojima je postignut jednak učinak efekata vežbama snage na nestabilnim i stabilnim površinama*

Studija	Grupe	Karakteristike (N)	Sportski staž	Eksperimentalni program	Oprema	Rezultat
Sparkes & Behm, 2010 [22]	1 grupa Benč pres, skokovi,balans, bacanje medicinke preko glave na jednoj nozi	18 ispitanika 10 muškaraca (uzrasta: 24.6 ± 5,4; visine: 176.8 ±6.2 cm; težine: 80.2 ± 8.4 kg) 8 devojaka(uzrasta: 24.2 ±6.2; visine: 170.4 ±6.6 cm; težine: 64.1 ± 10.3 kg)	bez iskustva	8 nedelja 2 x10 ponavljaja za svaku vežbu, 3x nedeljno po 1 sat vežbanja	EMG	potvrđuje neuromišićnu adaptaciju korišćenjem nestabilnih podloga kod neutreniraih rekreativaca
Kibele et al., 2009 [8]	2 grupe Eksperimentalna i kontrolna grupa ekstenziju nogu, statič-ka i dinamička ravnote-ža, pregib trupa, skok udalj, šatl ran, i sprint.	40 ispitanika 28 muškaraca (uzrasta: 23.0 ± 2.4; visine: 182.1 ±6.2 cm; težine: 77.5 ± 8.1 kg) 12 devojaka (uzrasta: 22.0 ±1.8; visine: 182.1 ±6.2 cm; težine: 77.5 ± 8.1 kg)	bez prethodno trenažnog isku-stva	7 nedelja 2x nedeljno	-	osim sprinta su sva ostala merenja pokazala poboljšanje rezultata. U testovima hopping test for time (6,2%) i situps (8,9%), rad sa opterećenjem na nestabilnim podlogama je pokazao statistički veće vrednosti
Shankar & Chaurasia, 2012 [23]	3 grupe Kontrolna gru-pa: pregibi trupa i leđna ekstenzija na podu Eksperimentalna pregibi trupa i leđna ekstenzija na švajcarskoj lopti	20 ispitanika Po10 u obe grupe (uzrasta: od 18 do 30 godina)	-	5 nedelja, 3x15 - 4x25 ponavljaja	-	snaga koja je merena kroz jedan maksimalni ponavljaj i mičićna izdržljivost me-rena brojem sklekova se nije povećala ni kod jedne grupe vežbanja

Maté-Muñoz et al. 2014 [15]	3 grupe Zadnji čučanj, benč pres, skokovi	33 studenta Kontrolna grupa 12 (uzrasta: 22.3 ± 2.4; visine: 176 ±7 cm; težine: 75.4 ± 9.9 kg) Eksperimentalna grupa 1 :12 (uzrasta: 21.5 ± 3.03; visine: 178 ±5 cm; težine: 75.7 ± 9.2 kg) Eksperimentalna 2 :12 (uzrasta: 21.8 ± 1.1;visine: 178 ±5 cm; težine: 71.8 ± 6.5 kg)	bez iskustva	7 nedelja 2-3xnedeljno	-	nema razlika između eksperimentalnih grupa

Table 3. *An overview of the research in which the effect of power exercises on unstable and stable surfaces has been achieved equally*

Study	Group	Characteristics (N)	Sports internship	Experimental program	Equipment	Results
Sparkes & Behm, 2010 [22]	1 group Bench press, jumps, balance, throwing the medicine over the head on one leg	18 respondents 10 men (ages: 24.6 ± 5.4, height: 176.8 ± 6.2 cm, weight: 80.2 ± 8.4 kg) 8 girls (age: 24.2 ± 6.2; height: 170.4 ± 6.6 cm; weight: 64.1 ± 10.3 kg)	With experience	8 weeks 2 x 10 reps for each exercise, 3x per week after 1 hour of exercise	EMG	Confirms neuromuscular adaptation using unstable substrates in untrained recreation.
Kibele et al., 2009 [8]	2 groups Experimental and control group leg extension, static and dynamic equilibrium, crunch, jump out, shuttle run, and sprint.	40 respondents 28 men (ages: 23.0 ± 2.4; height: 182.1 ± 6.2 cm; weight: 77.5 ± 8.1 kg) 12 girls (age: 22.0 ± 1.8; height: 182.1 ± 6.2 cm; weight: 77.5 ± 8.1 kg)	Without previous training experience	7 weeks 2x per week	-	Apart from the sprint, all other measurements showed improved results. In hopping tests for time (6.2%) and situps (8.9%), work with stress on unstable substrates showed statistically higher values .
Shankar & Chaurasia, 2012 [23]	3 groups Control group: crunch and back extension on the floor Experimental crunch and back extension to the Swiss ball	20 respondents10 in both groups (ages: 18-30 years)	With experience	5 weeks, 3x15 - 4x25 repetitions	-	The power measured through one maximum repetition and the mechanical endurance measured with the number of joints did not increase in any group of exercises.
Maté-Muñoz et al. 2014 [15]	3 groups Back squat, bench press, jumping	33 students Control group 12 (age: 22.3 ± 2.4; height: 176 ± 7 cm; weight: 75.4 ± 9.9 kg) Experimental group 1: 12 age: 21.5 ± 3.03; height: 178 ± 5 cm; weight: 75.7 ± 9.2 kg) Experimental 2: 12 age: 21.8 ± 1.1; height:178 ± 5 cm; weight:71.8 ± 6.5	With experience	7 weeks 2-3x per week	-	No difference between experimental groups.

In a transparent survey, 24 papers were processed. The papers are not older than 10 years. The sample of respondents is a young and middle age group that can be identified by age according to similar abilities. The fields encompassed are: power, force, role of postural muscles, movement preactivation. The table contains a detailed description of the number of groups by works with exercises, the division of groups into control and experimental with the basic characteristics of age, weight and height, sports experience, equipment used, result and conclusion. Out of 24 papers: 16 papers were with one group in the experiment, 6 papers were with two groups in the experiment and 2 with three groups in the experiment. After the involvement of the musculature: 9 papers treated pectoral musculature, in 10 papers the involvement of the muscles of the lower limbs was processed, 6 papers dealt with the aspect of engaging the back musculature and the same abdomen, 8 papers treated chest musculature and two papers included shoulder musculature in their research. In the section of the work done according to the level of sporting experience and the previous training experience, we can distinguish: 9 papers with respondents who did not have any experience in the exercises, 13 papers with respondents who had different training experience and 2 papers where we did not find any information on the train-

U preglednom istraživanju obrađeno je 24 rada. Radovi su ne stariji od 10 godina. Uzorak ispitanika su mlada i srednja starosna grupa koja se može po starosti identifikovati po sličnim sposobnostima. Obuhvaćena polja su: snaga, sila, uloga posturalne muskulature, preaktivacija pokreta. Tabela sadrži detaljni opis broja grupa po radovima sa vežbama, podelu grupa na kontrolne i eksperimentalne sa osnovni karakteristikama uzrast, težina i visina, sportski staž, korišćenu opremu, rezultat i zaključak. Od 24 radova: 16 radova je sa jednom grupom u eksperimentu, 6 radova je sa dve grupe u eksperimentu i 2 rada sa tri grupe u eksperimentu. Po angažovanosti muskulature: u 9 radova je obrađena grudna muskulatura, u 10 radova je obrađivano angažovanje muskulature donjih ekstremiteta, 6 radova je u svom aspektu imalo angažovanje leđne muskulature i isto toliko abdomena, 8 radova je obrađivalo grudnu muskulaturu i dva rada su obuhvatila u svom istraživanju ramenu muskulaturu. U rubrici obrađenih radova po nivou sportskog staža i pređašnjeg vežbovnog iskustva možemo podeliti na: 9 radova sa ispitanicima koji uopšte nisu imali iskustva u vežbama, 13 radova sa ispitanicima koji su imali različitog trenažnog iskustva i 2 rada gde nismo našli nijedan podatak trenažnog iskustva. Po pitanju korišćenja dijagnostičke opreme prednjači elektromiografska analiza u 13 radova, izokinetičkim dinamomeing experience. Regarding the use of diagnostic equipment, electromyographic analysis was performed in 13 papers, the isokinetic dynamometer was used in 2 laboratories, the accelerometer in one paper and in 9 papers no measuring equipment was used.

Discussion and Conclusion

Designing a training program is a very complex job and resistance training is certainly one of the most demanding, regardless of the type of surface used (stable or unstable). The main findings of this paper were to compare the effects of stress training on stable surfaces with stress-loading in unstable surfaces in power parameters, balance in healthy adolescents, young adults and old adults, students, women with and without experience in exercise. Proponents of stress training on unstable surfaces suggest that such exercises provide advantages over training on stable surfaces, due to the principle of training specificity (i.e., training on unstable devices with unstable requirements in tasks in the sport, fitness, and at the workplace), while a higher degree of instability gives greater stress and therefore a greater possibility in training adaptation of neuromuscular and equilibrium systems. Summarizing the results of the research in exercises on unstable substrates: we find the positive effects of exercise on unstable surfaces on the observed musculature in 16 papers [1, 4,7,8 ,9,10,11,12,13,14,16,18,20,21,22,23], four studies had no effect on musculature in [3,5,6,24], two studies in which muscle values were more significant in exercises on stable surfaces than exercises on unstable surfaces [2,19] , two papers show that there is no difference between work on both types of substrate [15,16]. On the basis of the derived conclusion of the effects of exercise in unstable conditions in comparison with the stable appearance, the statistical effect of exercise on unstable substrates was expressed in 13 studies [1,4,6,7,9,10,12,13,14,16, 18,20,21], there were no statistically significant effects shown in 7 studies [2,3,5,11,17,19,24], while the same effect of the effects achieved by strength exercises on unstable and stable surfaces is found in 4 papers [8,22,23,15].

Based on what has been said so far, it is to be concluded that the articles primarily suggest a positive effect of exercise on unstable substrates in non-active athletes. These are mostly positive effects in untrained and partially recreational people. In cases of research in a sample of respondents who do not have experience with exercises on unstable substrates, the emphasis is primarily on the activation of postural musculature in pre-activation, which largely determines the preparation for performing the movement. In static exercises, the effect

trom su se služili u 2 rada, akcelometrom u jednom radu i u 9 radova nije korišćena merna oprema.

Diskusija i zaključak

Dizajniranje trenažnog programa je veoma složen posao i trening sa otporom je sigurno jedan od najzahtevnijih, bez obzira na vrstu površine koja se koristi (stabilna ili nestabilna). . Glavni nalazi ovog rada su bili da se uporede efektri treninga sa opterećenjem na stabilnim površinama sa treningom sa opterećenjem pri nestabilnim površinama u parametrima snage, ravnoteže kod zdravih adolescenata, mladih odraslih i starih odraslih osoba, studenata, žena sa i bez iskustva u vežbanju. Zagovornici treninga sa opterećenjem na nestabilnim površinama predlažu da takve vežbe pružaju prednosti u odnosu na trening na stabilnim površinama, zbog principa specifičnosti treninga (tj. vežbanja na nestabilnim uređajima sa nestabilnim zahtevima zadataka u sportu, fitnesu i na radnom mestu), dok veći stepen nestabilnosti daje veći stres i time veću mogućnost u treningu adaptacija neuromišićnih i ravnotežnih sistema. Sumirajući rezultate istraživanja pri vežbanjima na nestabilnim podlogama: pozitivne uticaje vežbanja na nestabilnim površinama na praćenu muskulaturu nalazimo u 16 radova [1,4,7,8,9,10,11,12,13,14,16,18,20,21,22,23], četiri istraživanja nisu imali efekta na muskulaturu u [3,5,6,24], dva rada u kome su vrednosti muskulature bile značajnije u vežbama na stabilnim površinama u odnosu na vežbanje na nestabilnim površinama [2,19], dva rada pokazuju da nema razlika između rada na obe vrste podloge [15,16]. Na osnovu izvedenog zaključka efekata prilikom vežbanja u nestabilnim uslovima u poređenju sa stabilnim izgleda ovako: statistički efekat vežbanja na nestabilnim podlogama je bio izražen u 13 studija [1,4,6,7,9,10,12,13,14,16,18 ,20,21], da nije bilo statistički značajnih efekata pokazuju 7 studija [2,3,5,11,17,19,24], dok jednaki učinak efekata postignutim vežbama snage na nestabilnim i stabilnim površinama nalazimo u 4 rada [8,22,23,15].

Na osnovu do sada iznetog, da se zaključiti da radovi prvenstveno navode pozitivan efekat vežbanja na nestabilnim podlogama kod osoba koja nisu aktivni sportisti. Uglavnom se radi o pozitivnim efektima kod neutreniranih i delimično kod rekreativaca. U slučajevima istraživanja kod uzorka ispitanika koji nemaju iskustva sa vežbama na nestabilnim podlogama, pre svega je akcenat na aktivaciju posturalne muskulature u preaktivaciji koja umnogome određuje pripremu za izvođenje pokreta. Pri statičkim vežbama, efekat treninga snage na nestabilnim površinama nije statistički bitan. Nasuprot tome, kod osoba koje su utrenirane, skoro uopšte nema uticaja ova vrsta podloge, posebno imajući u vidu da opterećenje na nestabilnim podlogama mora da bude manje of power training on unstable surfaces is not statistically significant. On the contrary, in those who are tired, there is almost no effect of this kind of substrate, especially given that the load on unstable substrates must be less due to the prevention of injuries. Typically, the authors focused on a load of about 50% of 1RM, and there were attempts to increase or decrease. In case of an increase in load, they indicated a lower number of repetitions and a higher degree of injury potential. In the case of smaller loads (25-30%), we find insufficient engagement of the musculature and do not automatically induce the necessary muscle activation for the statistically valid significance of hyperthrophy. Due to the short time interval in the adjustment process, a certain number of studies per time represented by exercise did not find the statistical significance of exercise on unstable substrates. A number of works showed the same effect of engaging muscles in testing on both surfaces. Several studies point to the problem of difficult conditions for conducting treatment by exercising on unstable substrates due to a disturbed balance situation and the establishment of stability during exercise. From the factual situation one can see the contribution of the collected research in the additional enlightenment of the problem of exercise on unstable surfaces. A step forward will be to use the methodology of these research that will serve to innovate new training tools that will disturb the balance, with the aim of improving partial or total power effects.

The use of different exercises under unstable conditions in order to improve muscle strength, balance and coordination has been increasingly present over the last decade. Although there are results of several conducted studies that support the inclusion of certain exercises under unstable conditions in rehabilitation programs, there is not much reporting on their use in sports training. Also, research conducted during the rehabilitation period cannot be applied to the field of sports training due to different demands for manifesting muscular strength during everyday activities (low loads, slow movements) and sports activities (high load, dynamic movements).

Exercising the highest muscle strength is reduced under conditions of instability, but changing the balance of training on an unstable surface can activate muscles of the extremities and carcasses, thereby ensuring greater stability of the joints. Using unstable platform in strength training should enable the development of higher levels of muscle activation, through increased reliance on their stabilizing functions. The contribution of stress training in unstable conditions can be more pronounced in people who aim at health and rehabilitation and who do not

zbog prevencije od povređivanja. Obično su se autori orijentisali na opterećenje oko 50% 1RM, a bilo je pokušaja i da se poveća ili smanji. U slučaju povećanja opterećenja, ukazivali su na manji broj ponavljaja i veći stepen mogućnosti povreda. U slučaju manjih opterećenja (25-30%) nalazimo nedovoljno angažovanje muskulature i automatski ne izazivanje potrebne aktivacije mišića za statistički validnu značajnost hipretrofije. Određeni broj istraživanja po vremenu zastupljenog vežbanjem, zbog kratkog vremenskog interavala u procesu prilagođavanja, nije našao statističku značajnost vežbanja na nestabilnim podlogama. Jedan broj radova je pokazao isti efekat angažovanja muskulature pri testiranju na obe podloge. Nekoliko istraživanja upućuje na problem otežanih uslova sprovođenja tretmana vežbanjem na nestabilnim podlogama zbog narušenog ravnotežnog stanja i samog uspostavljanja stabiliteta prilikom vežbanja. Iz činjeničnog stanja se može uvideti doprinos prikupljenih istraživanja u dodatom prosvetljenju problema vežbanja na nestabilnim površinama. Korak napred će biti korišćenje metodologije ovih istraživanja koja će poslužiti inoviranju novih sredstava vežbanja kojim će se narušavati ravnoteža, a sve sa ciljem poboljšanja efekata snage parcijalno ili totalno.

Upotreba različitih vežbi pri nestabilnim uslovima u cilju poboljšanja mišićne snage, ravnoteže i koordinacije sve je prisutnija tokom poslednje decenije. Iako postoje rezultati nekoliko sprovedenih studija koji podržavaju uključivanje određenih vežbi pri nestabilnim uslovima u programe rehabilitacije, nema baš puno izveštaji o njihovoj upotrebi u sportskom treningu. Takođe, istraživanja sprovedena u periodu rehabilitacije se ne mogu primeniti na oblast sportskog treninga, zbog različitih zahteva za ispoljavanje mišićne snage tokom svakodnevnih aktivnosti (mala opterećenja, spori pokreti) i sportskih aktivnosti (veliko opterećenje, dinamički pokreti).

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na njihove stabilizirajuće funkcije. Doprinos treninga sa opterećenjem pri nestabilnim uslovima može biti naglašeniji kod osoba kojima su cilj zdravlje i rehabilitacija i koji ne učestvuju u napornim sportskim treninzima i takmičenjima. Zbog svega prethodno navedenog, jasno je uočljivo da u ovoj oblasti treba odgovoriti na mnoga nerešena pitanja. Neophodno je sprovesti istraživanje u kojem će biti ispitani parametari mišićne kontrakcije tokom različitih oblika treninga pri nestabilnim uslovima, kao i dugoročne fiziološke adaptacije, koje su posledica takvog tipa treninga. Takva saznanja mogu poslužiti kao osnova za izradu metoda testiranja i treninga koji bi se primenjivali u sportu i rehabilitaciji. Rezultati istraživanja Panze i saradnika (2014), i Zemkove i saradnika (2010) koji potvrđuju povećanje utroška energije prilikom izvođenja potiska sa grudi na nestabilnim podlogama, dodatno motivišu autora i izazivaju pažnju na neke nove istraživačke radove u ovoj oblasti, a prije svega u smislu koncipiranja treninga sa otporom na nestabilnim podlogama u cilju regulisanja tjelesne težine, odnosno gubitka masti. Na osnovu relativno malog broja studija, smatramo da su naši nalazi preliminarni. Stoga je potrebno dalje istraživanje kako bi se odredila opšta efikasnost treninga sa opterećenjem na nestabilinim uslovima u poređenju sa drugim vrstama treninga. Jednako ili još važnije je potreba da se razjasne specifični efekti treninga sa opterećenjem na nestabilinim uslovima u poređenju sa drugim programima treninga snage (npr. treninga sa opterećenjem na nestabilinim uslovima korišćenjem velikih i malih opterećenja).

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Primljen: 10. april 2019. / Received: April 10, 2019.
Prihvaćen: 27. maj 2019. / Accepted: May 27, 2019.