DOI: 10.7251/SSH1702077S
Paper review

UDC: 796.015.52-055.2
Pregledni rad

Benefits of Strength Training for Elderly Women

Marko DM. Stojanović, Patrik Drid, Dejan Madić, Sergej M.Ostojić
Faculty of Sport and Physical Education, University of Novi Sad, Serbia

Correspondence:
Marko Stojanović
Faculty of sport and physical education, University of Novi Sad
marko.ns.stojanovic@gmail.com

Abstract: The aging process is associated with loss of skeletal muscle mass and increase in intramuscular fat, the latter also defined as muscle attenuation. Muscle weakness, termed sarcopenia and dynapenia, is a normal age-related phenomenon, occurring at a rate of 1% to 5% annually from the age of 30. This rate means that given typical patterns of physical activity, a 70-year-old woman could have 50% to 70% less strength than she had at age 30. Contrary to long held beliefs, the muscles of elderly women (i.e. aged 65 years and older) continue to be adaptable, even into the extremes of old age, particularly if their muscles are significantly overloaded during training. Therefore, effective strengthening practices must be employed to maintain the highest level of function and achieve optimal aging in elderly women. Done regularly (2-3 times a week), strength training preserve bone density, independence and vitality with age. In addition, strength training also has the ability to reduce the risk of osteoporosis and the signs and symptoms of numerous chronic diseases such as heart disease, arthritis and type 2 diabetes, while also improving sleep and reducing depression. Finally, though muscle strength has been recognized as an important predictor for reduced functional performance, emerging evidence suggests that muscle power (the product of force time velocity or the rate of performing work) is highly effective to elicit substantial improvements in maximal mechanical muscle function (rapid force generation, muscle power and muscle strength) and in functional performance in old and very old women.
Keywords: exercise, sarcopenia, muscle power

Introduction

With a significant demographic change in the Balkans and the rest of the world, with regard to the increase in the number of third-person animals, the growing interest of the community is evident in creating effective strategies to cope with muscular atrophy that results from aging. This muscular weakness, defined by the notion of sarcopenia I by Diappenia, represents the normal physiological response of

Dobrobiti treninga snage za žene treće životne dobi

Marko DM. Stojanović, Patrik Drid, Dejan Madić, Sergej M. Ostojić
Fakultet sporta i fizičkog vaspitanja, Univerzitet u Novom Sadu, Srbija

Korespondencija:
Marko Stojanović
Fakultet sporta i fizičkog vaspitanja Novi Sad
marko.ns.stojanovic@gmail.com

Sažetak: Starenje je proces povezan gubitkom mišićne mase i porastom intramuskularnih masti. Mišićna slabost, definisana kao sarkopenija i dinapenija, predstavlja normalan fenomen povezan sa procesom starenja koji se ostvaruje po stopi od 1% do 5% godišnje nakon 30. godine života. Ova stopa zapravo znači da ukoliko se radi o uobičajenom nivou fizičke aktivnosti, 70-godišnja žena će se odlikovati za 50-70% manjim nivoom snage od nivoa koji je imala u 30. godini života. Nasuprot dugogodišnjim verovanjima, mišićno tkivo žena treće životne dobi (npr. starosti 65 godina) je veoma adaptabilno i nastavlja to da bude do duboke starosti, ukoliko su mišići značajno nadopterećeni tokom trenažnih epizoda. Stoga, efektivan trening snage je neophodan u cilju očuvanja visokog nivoa funkcionalnosti i dostizanja optimalne starosti. Redovno sprovođen trening snage (2-3 puta nedeljno) u stanju je da očuva gustinu kostiju, nezavisnost i značajan nivo vitalnosti sa starenjem. Takođe, trening snage je u stanju da smanji rizike za nastanak većeg broja hroničnih oboljenja poput srčanih oboljenja, artritisa i dijabetesa tipa 2, ali i da poboljša kvalitet sna i smanji simptome depresije. Konačno, iako je mišićna snaga prepoznata kao važan prediktor smanjene funkcionalnosti žena treće životne dobi, narastajući broj dokaza ukazuje na to da eksplozivna snaga (proizvod sile i brzine, ili stopa vršenja rada) predstavlja parameter koji direktno utiče na mehaničke osobine mišića (brz prirast sile) i veliki broj parametara funkcionalnih performansi na uzorku žena treće životne dobi.
Ključne reči: vežbanje, sarkopenija, eksplozivna snaga

Uvod

Sa značajnom demografskom promenom na Balkanu ali i celom svetu sa aspekta porasta broja osoba treće živone dobi, evidentan je i narastajući interes zajednice za kreiranjem efikasnih strategija koje bi se nosile sa mišićnom atrofijom koja nastaje kao posledica starenja. Ta mišićna slabost, definisana pojmom sarkopenija i odnedavno dijapenija, predstavlja normalan fiziološki odgo-

the mechanism to the aging process, and occurs at a rate of 1% to 5% per year starting from the age of 30 (Lindel et al., 1997). This practically means that the average person in 70 years of age has a 50-70% lower level of power compared to his 30s. The rate of decline in power levels depends on the level of physical activity, however, people who are less physically active have more pronounced loss of muscle than those who are physically active (Bortz, 2002).

Sarcopenia is a term originally presented by Rosenberg in 1989 (Rosenberg, 1989), and is a loss of muscle mass as a result of aging. However, the meaning of this term often extends to the loss of muscular strength and other parameters of functionality of persons of third age. Although sarcophenia also contributes significantly to the effect of loss of muscle function during the aging process, it is considered necessary to separate these two terms since the loss of muscle mass is not in direct correlation with loss of muscular strength (Clark & Manini, 2008), which is responsible for a greater number neurological peculiarities of the aging process (Clark & Manini, 2008; Duchateau & Enoka, 2002). Consequently, a new term, Diaphenia, was used recently, referring primarily to the loss of muscular strength parameters as a result of aging (Clark & Manini, 2008). Muscle mass declines at a rate between 3% and 8% for every decade of life since the age of 30 (Fleck et al., 2011), which means a loss of about 0.2 kg of muscle mass per year. This loss is increased to 5 to 10% or about 0.4 kg per year after each decade of life of 50 years (Nelson et al., 1994). Muscle metabolism is a very significant part of total basal metabolism and consequently plays a major role in the decline in basal metabolism at the rate of 2-3% per adult life span (Wolfe, 2006). Since basal metabolism makes about 65-70% of daily calorie consumption in the sedentary adult population, the reduction in muscle mass can significantly contribute to the rise in subcutaneous fat tissue in this population (Wolfe, 2006).

Loss of muscle mass and aging is a clinically significant phenomenon on the sample of women because it leads to a decrease in the level of strength and functionality, which has significant consequences for everyday activities. Moreover, loss of muscle mass is a powerful predictor of mortality in the third lifespan (Szulc et al, 2010).

After 60 years of age, the level of explosive power drops significantly more than the level of absolute power at a rate of as much as 3-5% per year, significantly affecting the ability to perform explosive or sudden movements. This loss of explosiveness in the broader sense seems to be the leading cause of a greater number of falls on a sample of people of third age, which in turn strengthens sedentary habits (Bortz, 2002). The loss of

vor mehanizma na process starenja, i javlja se stopom od 1% do 5% godišnje počevši od 30. godine života (Lindel i sar.,1997). Ovo praktično znači da prosečna osoba u 70. godini života ima za 50-70% niži nivo snage u odnosu na svoje 30. godine. Stopa opadanja nivoa snage zavisi svakako i od nivoa fizičke aktivnosti, osobe koje su manje fizički aktivne imaju izraženiju stopu gubljenja mišićne mase od osoba koje su fizički aktivne (Bortz, 2002).

Sarkopenija je termin originalno predstavljen od strane Rozenberga još 1989. godine (Rosenberg, 1989), i predstavlja gubitak mišićne mase kao posledice starenja. Ipak, značenje ovog termina se često proširuje i na gubitak mišićne snage i ostalih parmetara funkconalnosti osoba treće životne dobi. Iako sarkopenija značajno doprinosi i efektu gubitka mišićne funkcije tokom procesa starenja, smatra se da je potrebno razdvojiti ova dva termina s obzirom na to da gubitak mišićne mase nije u direktnoj korelaciji sa gubitkom mišićne snage (Clark i Manini, 2008), za šta je odgovoran veći broj neuroloških specifičnosti procesa starenja (Clark i Manini, 2008; Duchateau i Enoka, 2002). Shodno tome, nedavo je upotrebljen novi termin , dijapenija, koji se odnosi pre svega na gubitak parametara mišićne snage kao posledice starenja (Clark i Manini, 2008). Mišićna masa opada po stopi između 3% i 8% za svaku deceniju života od 30. godine (Fleck i sar., 2011), što prosečno znači gubitak oko 0,2kg mišićne mase godišnje. Ovaj gubitak se povećava na 5 do 10% ili na oko 0,4kg godišnje po svakoj deceniji života od 50. godine (Nelson et al., 1994). Mišićni metabolizam je veoma značajan deo ukupnom bazalnog metabilizma i posledično igra veliku ulogu u padu bazalnog metabolizma po stopi od 2-3% po deceniji života kod odraslih (Wolfe, 2006). S obzirom na to da bazalni metabolizam čini oko 65-70% dnevne kalorijske potrošnje kod sedentarne odrasle populacije, smanjenje mišićne mase može značajno doprineti porastu potkožnog masnog tkiva kod ove populacije (Wolfe, 2006).

Gubitak mišićne mase sa starenjem je klinički značajan fenomen na uzorku žena jer dovodi do smanjenja nivoa snage I funkcionalnosti, što ima značajne posledice po svakodnevne aktivnosti. Štaviše, gubitak mišićne mase je snažan prediktor smrtnosti u trećem životnom dobu (Szulc et al, 2010).

Nakon 60. godine života, nivo eksplozivne snage opada i značajnije od nivoa apsolutne snage, po stopi od čak 3-5% godišnje, značajno negativno utičući na sposobnost izvođenja eksplozivnih ili naglih pokreta. Ovaj gubitak eksplozivnosti u širem smislu je izgleda vodeći uzrok većem broju padova na uzorku osoba treće životne dobi, što posledično učvršćuje sedentarne navike (Bortz, 2002.). Gubitak mišićne mase je posledica smanjenog broja mišćnih vlakana i smanjenim poprečnim presekom

muscle mass is due to a decrease in the number of muscle fibers and a decreased cross-section of the remaining muscle cells, with fast muscle fibers showing a greater downward trend, especially in late life (Andersen, 2003).

Taken together, these results indicate that quantitative and qualitative changes in the muscle structure lead to a progressive decline in overall muscular performance, with the parameters of the explosive power losing faster than the parameters of absolute power. (Skelton et al, 1994; Skelton et al, 2002). From the standpoint of functionality, this leads to a significantly reduced ability to perform daily activities and to a greater subjective sense of effort for common activities (Hortobagyi et al., 2003). It is important to note, however, that while the general ability to perform movement decreases in the third life of the age, the ability to perform rapid and fast turns, such as the ability to maintain an equilibrium position in situations of disturbed balance (Pijnappels et al, 2005), is particularly affected.

Sarcopenia and diaphenia have significantly increased in the last decade or two. (Sayer et al., 2013). Today we still have a shortage of pharmacological studies that indicate effective strategies for treating sarcopenia or diaphenia. On the other hand, the growing number of evidence points to the importance of strength training for people of third age and especially women in the struggle with these two phenomena (Burton & Sumukadas, 2010), since it is established that strength training has a significant impact on all neurological and muscular mechanisms that lead to a rise in power (Duchateau & Enoka, 2002). Thus, a series of fundamental research published in the early 90's of the 20th century by Faltarone et al. (Fiatarone et al., 1990) in prestigious scientific journals (Fiatarone et al., 1994) pointed to the extremely high importance of strength training on the rise strong muscle characteristics, but also a whole set of parameaters of functionality on a sample of people of third age. Thus, the first of these studies has shown that people of third age can increase the level of strong abilities for an incredible 174%, a cross section of 9% and a speed of 48% for 8 weeks of strength training (Fiatarone et al., 1990)! Furthermore, maximum muscle activation has been shown to increase by 49% after 6 weeks of strength training (Kamen & Knight, 2004). And other muscle parameters increase as a result of strength training, such as the size of the muscle cell or stiffness of the tendon (10% and 64%, respectively) (Reeves, Maganaris, & Narici, 2003). 24 week training, supported by increased protein intake, leads to an increase in the cross section of muscle by almost 5% on the third-year female sample. (Chale et al., 2013). With the advent of the 21st century, we know that the muscle fiber has a

preostalih mišićnih ćelija, sa tim da brza mišićna vlakna pokazuju veći trend opadanja, naročito u kasnoj životnoj dobi (Andersen, 2003).

Uzeto zajedno, ovi rezultati ukazuju na to da kvantitativne i kvalitativne promene u strukturi mišića dovode do progresivnog opadanja ukupnih mišićnih performansi pri čemu se parametri eksplozivne snage gube brže od parametara apsolutne snage. (Skelton i sar, 1994; Skelton i sar., 2002). Sa stanovišta funkcionalnosti, ovo dovodi do značajno smanjene sposobnosti za izvođenjem svakodnevnih aktivnosti i do većeg subjektivnog osećaja napora za uobičajene aktivnosti (Hortobagyi i sar., 2003). Važno je ipak napomenuti da iako opšta sposobnst izvođenja kretanja opada u trećoj životnoj dobi, posebno pada sposobnost izvođenja naglih i brzih okreta poput sposobnosti zadržavanja ravnotežnog položaja u situacijama narušene ravnoteže (saplitanje) (Pijnappels i sar.,2005).

Istraživanja sarkopenije i dijapenije su značajno porasla po obimu u poslednjih deceniju ili dve. (Sayer i sar., 2013). Danas imamo još uvek manjak farmakoloških studija koje ukazuju na efikasne strategije tretiranja sarkopenije ili dijapenije. Sa druge strane, narastajući broj dokaza ukazuje na značaj treninga snage na osobama treće životne dobi a naročito žena u borbi sa ova dva fenomena (Burton i Sumukadas, 2010), s obzirom na toda je utvđeno da trening snage ima značajan uticaj na sve neurološke i mišićne mehanizme koji dovode do porasta snage (Duchateau i Enoka, 2002). Tako, serija temeljnih istraživanja publikovanih ranih 90. godina 20. veka od stane Fiataronea i saradnika (Fiatarone i sar., 1990) u prestižnim naučnim časopisima (Fiatarone i sar., 1994) su ukazali na ekstremno veliki značaj treninga snage na porast snažnih karakteristika mišića ali i čitavog seta parametara funkcionalnosti na uzorku osoba treće životne dobi. Tako, prva od ovih studija je pokazala da osobe treće životne dobi mogu da povećaju nivo snažnih sposobnosti za neverovatnih 174%, poprečni presek za 9% i brzinu hoda za 48% tokom 8 nedelja treninga snage (Fiatarone i sar., 1990)! Dalje, pokazano je da maksimalna aktivacija mišića raste za 49% nakon 6 nedelja treninga snage (Kamen i Knight, 2004). I drugi parametri mišića rastu kao posledica treninga snage, poput veličine mišićne ćelije ili krutost tetiva (10% i 64%, redom) (Reeves, Maganaris i Narici, 2003). Trening snage u trajanju od 24 nedelje, podržan porastom unosa proteina dovodi do porasta poprečnog preseka mišića od skoro 5% na uzorku žena treće životne dobi. (Chale i sar., 2013). Sa ulaskom u 21. vek znamo da mišićno vlakno ima značajnu sposobnost hipertrofije (~30% nakon 16 nedelja treninga), promene tipa mišićnog vlakna (IIX u IIA), i ima sposobnost

significant ability of hypertrophy (~ 30% after 16 weeks of training), a change in the type of muscle fiber (IIX in IIA), and has the ability to incorporate additional nuclei into the muscle fiber creating the assumption of muscular hypertrophy (Hikida et al ., 2000). Finally, these adaptations are comparable and similar levels as well as adaptations that force training produces on people younger age. Today, it is generally accepted that the effectiveness of strength training depends on a large number of parameters and that this is one of the main reasons for the variability of the positive effects in the studies. The recent meta-analysis of Peterson and associates dealt with the determination of critical apprentices of strength training in order to achieve positive effects (frequency, duration, intensity, total scope of training, etc.). (Peterson, Rhea, Sen, & Gordon, 2010; Peterson, Sen & Gordon, 2011). The authors have identified two critical parameters that influence the positive adaptations of power training. The first intensity is associated with more pronounced positive effects, and the difference between low to moderate and high intensity leads to an average difference of about 5% (Peterson et al., 2010). Second, the peak volume of strength training, defined as the total number of batches during training, is also associated with more pronounced effects (Peterson et al., 2011). These results indicate that for every 10 additional series after training, people of the third age can expect a 0.5 kg muscle mass increase. (Peterson et al., 2011). It should also be noted that with increasing age, the effect of strength training on the parameters of hypertrophy decreases (Peterson et al., 2011). Some scientists thought that there were so-called "non-responders" among third-age person lifeforce trainees (Bamman, Petrella, Kim, Mayhew, & Cross, 2007); However, recent retrospective studies have found that, although there are significant individual differences among respondents, the level of response and effects of training is directly dependent on the duration of intervention, with more positive effects in longer studies, thereby determining that there are no "non-responders" "(Churchward-Venne et al., 2015).

The benefits of strength training to the health status parameters

The strength training has positive effects on a large number of parameters of the health status of women of third age. Below the text will be listed some of which were most often the subject of quality studies.

An increase in basal metabolism

Power training stimulates protein synthesis and thus achieves a dual effect on metabolic consumption in peace

ugrađivanja dodatnih jedara u mišićno vlakno stvarajući pretpostavku mišićne hipertrofije (Hikida i sar., 2000). Konačno, ove adaptacije su uporedive i sličnog nivoa kao i adaptacije koje trening snage proizvodi na osoba mlađe životne dobi. Danas je opšteprihvaćeno da efikasnost treninga snage zavisi od velikog broja parametara i da je to jedan od osnovnih razloga varijabiliteta pozitivnih efekata u studijama. Nedavna meta analiza Petersona i saradnika bavila se utvrđivanjem kritičnih parametara treninga snage u cilju ostvarivanja pozitivnih efekata (frekvencija, trajanje, intenzitet, ukupni obim treninga i sl). (Peterson, Rhea, Sen i Gordon, 2010; Peterson, Sen i Gordon, 2011). Autori su utvrdili dva kritična parametra koji utiču na pozitivne adaptacije treninga snage. Prvoviši intenzitet je povezan sa izraženijim pozitivnim efektima i razlika između niskog ka umerenom i visokom intenzitetu dovodi do prosečne razlike od oko 5% (Peterson i sar., 2010). Drugo, povećan obim treninga snage, definisan kao ukupni broj serija tokom treninga je takođe povezan sa izraženijim efektima (Peterson i sar., 2011). Ovi rezultati ukazuju na to da za svakih 10 dodatnih serija po treningu osoba treće životne dobi može očekivati porast mišićne mase od 0,5kg. (Peterson i sar., 2011). Takođe, treba naglasiti da sa porastom starosti opada i efekat treninga snage na parametre hipertrofije (Peterson i sar 2011). Neki naučnici u smatrali da postoje i tzv "non-responderi" među osobama treće životne dobi na trenin snage (Bamman, Petrella, Kim, Mayhew i Cross, 2007); Ipak, nedavne retrospektivne studije su utvrdile da iako postoje značajne individualne razlike među ispitanicima, nivo odgovora i efekata treninga je direktno zavistan od dužine trajanja intervencije, sa pozitivnijim efektima koji nastaju u dužim studijama i time utvrđujući da ne postoje osobe koje su "non-responderi"(Churchward-Venne i sar., 2015).

Dobrobiti treninga snage na parametre zdravstvenog statusa

Trening snage ostvaruje pozitivne efekte na veliki broj parametara zdravstvenog statusa žena treće životne dobi. U nastavku teksta biće navedene neke koje su najučestalije bile predmet kvalitetnih studija.

Porast bazalnog metabolizma

Trening snage stimuliše sintezu proteina i tako ostvarue dualni efekat na metaboličku potrošnju u miru (Evans, 2001). Prvo, kao hronični odgovor, porast mišićne mase zahteva i veću potrošnju energije za svakodnevno održavanje. Pokazano je da 1kg mišića dovodi do porasta energetske potrošnje za oko 20 kilokalorija dnevno

(Evans, 2001). First, as a chronic response, an increase in muscle mass requires higher energy consumption for day-to-day maintenance. It has been shown that 1kg of muscle leads to an increase in energy consumption of about 20kg per day (Strasser & Schobersberger, 2011). Furthermore, acutely, strength training leads to a larger number of microtrauma that require large amounts of energy in the process of remodeling and recovery that can last up to 72 hours after training. Studies have shown a statistically significant increase in basal metabolism (7%) several weeks after power training (Van Etten et al., 2007). However, recent studies have shown a similar increase in metabolic consumption (5% to 9%) over a period of 3 days after one session of strength training (Heden, 2011). People who performed intense training efforts increased basal metabolism by 8% (trained) or 9% (untrained respondents) (Hackney, 2002). Based on these studies, it can be noted that strength training leads to an increase in metabolic consumption in peace for about 100 kilocalories.

Reduction of subcutaneous fat tissue

The increased percentage of subcutaneous tissue is associated with a whole range of risks to the health status of third-age women such as increased cholesterol, blood sugar levels, blood pressure, which together increases the risk of type 2 diabetes and cardiovascular disease (Strasser & Schobersberger, 2011) . In their review article, Strasser and Schoberberger conclude that strength training is a recommended procedure in the management of obesity and metabolic disorders. In relation to the percentage of body fat, several studies have shown that after training, strength can increase in weight of a body weight of about 1.4 kg and a simultaneous reduction of 1.8 kg of fat deposits (Westcott et al., 2009). In relation to central obesity that seems to bear higher health risks than the total amount of subcutaneous fat, research has shown a significant loss of abdominal fat on a sample of third-age women (Hunter et al., 2002). Harley et al. (Hurley et al., 1995) have found that potential factors that can lead to the reduction of abdominal subcutaneous tissue as a consequence of strength training are the increase in metabolic consumption in peace, improved insulin sensitivity, and increased sympathetic activity. However, the increase in metabolic consumption in a peace factor that contributes most to the loss of fat tissue. Circular power training for 20 minutes can consume up to 200 kcal and an additional 25% (50 kilicals) during the recovery process during the first 4 hours (Haltom et al., 1999). Moreover, during the next 72 hours, an additional consumption of 100 kilocalories per day can be expected, which makes up about 500 kilocalories of consumption for

(Strasser i Schobersberger, 2011). Dalje, akutno, trening snage dovodi do većeg broja mikrotrauma koje zahtevaju velike količine energije u procesu remodelovanja i oporavka koje može trajati i do 72 sata nakon treninga. Istraživanja su pokazala statistički značajan porast bazalnog metabolizma (7%) nekoliko nedelja nakon treninga snage (Van Etten i sar., 2007). Ipak, skorije studije su pokazale sličan porast metaboličke potrošnje (5% do 9%) u periodu od 3 dan nakon jedne sesije treninga snage (Heden, 2011). Osobe koje su sprovodile intenzivni trening snage su povećale bazalni metabolizam za 8% (trenirani) ili 9% (netrenirani ispitanici) (Hackney, 2002). Na osnovu ovih studija može se konstatovati da trening snage dovodi do porasta metaboličke potrošnje u miru za oko 100 kilokalorija.

Smanjenje potkožnog masnog tkiva

Povećan procenat potkožnog msnog tkiva je povezan sa čitavim nizom rizika po zdravstveni status žena treće životne dobi poput povećanog holesterola, nivoa šećera u krvi, krvnog pritiska, što sve zajedno povećava rizike od nastanka dijabetesa tipa 2 kao i kardiovaskularnih oboljenja (Strasser i Schobersberger, 2011). U svom preglednom članku, Štraser i Šobersberger zaključuju kako treninga snage predstavlja preporučenu proceduru u menadžmentu gojaznosti i metaboličkih poremećaja. U odnosu na procenat masnog tkiva, nekoliko studija je pokazalo da nakon treninga snage može doći do porasta nemasne mase tela od oko 1.4 kg i istovremenog smanjenja 1,8 kg masnih naslaga (Westcott i sar.,2009). U odnosu na centralnu gojaznost koja izgleda nosi veće rizike po zdravstveni status od ukupne količine potkožnog masnog tkiva, istraživanja su pokazala značajan gubitak abdominalnih masti na uzorku žena treće životne dobi (Hunter i sar., 2002). Harli i sar. (Hurley i sar.,1995) su utvrdili da su potencijalni faktori koji mogu dovesti do smanjenja abdominalnog potkožnog tkiva kao posledice treninga snage porast metaboličke potrošnje u miru , poboljšana osetljivost na insulin i povećana simpatetička aktivnost .Ipak, izgleda da je porast metaboličke potrošnje u miru faktor koji najviše doprinosi gubitku masnog tkiva. Kružni trening snage u trajanju od 20 min može potrošiti i do 200 kilikalorija i još dodatnih 25% (50 kilikalorija) tokom procesa oporavka tokom prva 4 sata (Haltom i sar., 1999). Štaviše, tokom naredna 72 sata može se očekivati dodatni utrošak od 100 kiliklorija dnevno , što čini ukupno oko 500 kilokalorija potrošnje za jedan 20-minutni trening snage, pa je moguće potrošiti i do 5000 klokalorija mesečno samo primenjujući dva puta nedeljno ovaj tip treninga.

one 20-minute training effort, so it is possible to spend up to 5000 calories per month only by applying this type of training twice a week.

Type 2 diabetes

With the rise in obesity problems worldwide, there is a simultaneous increase in type 2 diabetes. It is estimated that by the middle of the 21st century, one in three people in the world will suffer from this disease. (Boyle, 2010). In their review work (Flack et al., 2011), the strength training can be an effective strategy for people of third age (both men and women) to counteract the normal decline in the sensitivity of the organism to insulin as a result of aging. This attitude was supported by more studies, including those that showed increased levels of insulin sensitivity and improved glycemic control. As we have already mentioned, strength training leads to a reduction in subcutaneous fat tissue, which can be particularly important in the treatment of diabetes, since it has been shown that insulin sensitivity is associated with the amount of fat in the abdomen (Coon et al., 1992). Analyzing a large number of studies, Flek et al. (20011) concluded that greater intensity and volume strength training seems to be a more effective procedure for increasing insulin sensitivity compared to strength training of intensity and intensity. These recommendations are in line with the recommendations of the American Diabetes Association which state that it is necessary to train all major muscle groups 3 times a week, with progression to three series with 8-10 high-intensity repeats (Sing et al., 2005). Furthermore, Strausser et al. Meta-analysis (Strasser et al., 2010) confirmed that strength training reduces subcutaneous fat and reduces glycosylated hemoglobin (HbA1c) in people with abnormal glucose metabolism. The authors concluded that strength training should be recommended in prevention and management of type 2 diabetes and other metabolic disorders. According to Phillips and Winett 2010, strength training is associated with homeostasis of insulin and glucose primarily through an increase in the cross section of muscle and low body mass, as well as through qualitative improvement of the metabolic functions of the muscles, including increasing the density of glucose conveyor 4 (GLUT4) and amounts of glycogen synthase. Finally, there are indications that strength training is a more desirable training strategy in order to increase insulin sensitivity compared to the long-promoted aerobic type of training (Bweir et al., 2009).

Cardiovascular health

The review work (Strasser & Schobersberger, 2011) concluded that "strength training is at least as effective as

Dijabetes tipa 2

Sa porastom problema gojaznosti na svetskom nivou dolazi i do istovremenog porasta dijabetesa tipa 2. Procene su da će do sredine 21 veka jedna od tri osobe na svetu bolovati od ove bolesti. (Boyle, 2010). U svom preglednom radu (Flack i sar., 2011) zaključuju kako trening snage može predstavljati efikasnu strategiju za osobe treće životne dobi (i muškarce i žene) da se suprotstave normalnom opadanju osetljivosti organizma na insulin kao posledice starenja. Ovaj svoj stav su potkrepili većim brojem studija uključujući i one koje su pokazale povećan nivo osetljivosti na insulin i poboljšanu glikemijsku kontrolu. Kao što smo već napomenuli, trening snage dovodi do smanjenja potkožnog masnog tkiva što može biti posebno značajno i u lečenju dijabetesa jer je pokazano da je insulinska osetljivost povezana sa količinom masnog tkiva u predelu abdomena (Coon i sar., 1992). Analizirajući veći broj studija, Flek i sar (Flack i sar., 2011) su zaključili da trening snage većeg intenziteta i obima izgleda predstavlja efikasniju proceduru za povećanje insulinske osetljivosti u poređenju sa treningom snage manjeg obima i intenziteta.Ove preporuke su u skladu sa preporukama Američke Asocijacije za Dijabetes (American Diabetes Association) koja navodi da je potrebno trenirati sve velike mišićne grupe 3 puta nedeljno , sa progresijom do tri serije sa 8-10 ponavljanja visokog intenziteta (Sing i sar., 2005). Dalje, meta analiza Straser-a i saradnika (Strasser i sar., 2010) je potvrdila da trening snage smanjuje potkožno masno tkivo i smanjuje glikozilovan hemoglobin (HbA1c) kod osoba sa abnormalnim metabolizmom glukoze. Autori su zaključili kako trening snage treba preporučiti u prevenciji i menadžmentu dijabetesa tipa 2 i ostalih metabličkih poremećaja. Prema Filipsu i Vinetu (Phillips & Winett, 2010), Trening snage je povezan sa homeostazom insulina i glukoze pre svega preko porasta poprečnog preseka mišića i nemasne mase tela, kao i preko kvalitativnog poboljšanja metaboličkih funkcija mišića, uključujući povećanje gustine glukoznog transportera 4 (GLUT4) i količine glikogen sintaze. Konačno, postoje i indicije da je trening snage poželjnija strategija treninga u cilju povećanja osetljivosti na insulin u odnosu na dugo promovisan aerobni tip treninga (Bweir i sar., 2009).

Kardiovaskularno zdravlje

Pregledni rad (Strasser i Schobersberger, 2011) je zaključio kako „je trening snage najmanje jednako efikasan kao i trening aerobnog tipa u cilju prevencije kardiovaskularnih oboljenja". Dokazani pozitivni efekti aerobnog tipa treninga na kardiovaskularno zdravlje uključuju

aerobic-type training to prevent cardiovascular disease." The proven positive effects of aerobic training on cardiovascular health include improving body composition, mobilizing visceral fat and subcutaneous fatty tissue, blood pressure reduction, improved cholesterol and triglyceride ratio in blood, and improved blood glucose control. However, an increasing number of studies indicate the same positive effects of strength training on cardiovascular health. (both diastolic and systolic) as a consequence of two or more months of strength training in a sample of third-person individuals (Hurley et al., 2000; Kelley, 1997). One study on a sample of over 16,000 third-age people showed a significant reduction blood pressure as the consequences of applying a 20-minute training session, 2-3 times a week for a period of 10 weeks. The subjects involved in this study were systolic and diastolic blood pressure of 3.2 and 1.4 mm Hg, respectively (Westcott et al, 2009). Those who trained 3 times a week achieved better improvements of 4.6 and 2.2 mm Hg, respectively. According to the American College of Sports Medicine (2009), there is evidence that training in training can increase HDL by 8% to 21%, reduce LDL cholesterol by 13% to 23%, and reduce triglycerides by 11% to 18%. In studies conducted with third-age women, strength training significantly improved the triglyceride, LDL and HDL cholesterol parameters (Fahlman, 2002). A review work from 2009 (Tambalis et al., 2009) found that while strength training itself is a potent agent for the promotion of cardiovascular health, additional positive effects are likely to be expected when this type of training is combined with aerobic training.

Osteoporosis

Research shows that loss of muscle mass is directly related to loss of bone mass (osteopenia). Third-age non-strength training subjects can expect a loss of bone loss of 1% per year (Kemler, 2005). Logically, training for improving muscle mass should produce positive effects on bone density and the vast majority of research confirms this hypothesis. Several longitudinal studies have found an increase in bone density after applying training strengths of 4-24 months. Thus, the meta analysis of Wolf and Sar (Wolfe et al., 1999) showed that strength training could increase the bone density of women of the third age by about 1% per year of training (femoral bone and lumbar spleen samples were taken). Also, the recently published review of Going and Ludermilk (2009) showed that the increase in bone density in women of the third age was in the range of 1-3%. A two-year study (Kerr et al., 2001) showed that programmed strength training resulted in an increase in bone density by 3.2%

poboljšanje telesne kompozicije, mobilizaciju visceralnih masti i potkožnog masnog tkiva, smanjenje krvnog pritiska , poboljšan odnos holesterola i triglicerida u krvi i poboljšanu kontrolu glukoze u krvi. Ipak, narastajući broj studija ukazuje na gotove jednake pozitivne efekte treninga snage na kardiovaskularno zdravlje. Nekoliko studija je autoritativno demonstrirao pozitivne efekte treninga snage na smanjenje krvnog pritiska (kako dijastolnog tako i sistolnog) kao posledice dva ili više meseci treninga snage na uzorku osoba treće životne dobi (Hurley i sar, 2000; Kelley, 1997). Jedna studija na uzorku od preko 16000 osoba i treće životne dobi je pokazala značajno smanjenje krvnog pritiska kao posledice primene treninga snage u trajanju od 20 min dnevno, 2-3 puta nedeljno u periodu od 10 nedelja. Osobe koje su angažovane u ovoj studiji spustile su sistolni i dijastolni krvni pritisak za 3.2 i 1.4 mm Hg, redom (Westcott i sar.,2009). Oni koji su trenirali 3 puta nedeljno ostvarili su i bolja poboljšanja od 4,6 i 2.2 mm Hg, redom. Prema Američkom Koledžu za Sportsku Medicinu (2009), postoje dokazi koji govore da trening snage može povećati HDL za 8% do 21%, Smanjiti LDL holesterol za 13% do 23%, i smanji trigliceride za 11% do 18%. Na stdudiji rađenoj sa ženama treće životne dobi, treninga snage je značajno poboljšao parametre triglicerida, LDL i HDL holesterola (Fahlman, 2002). Pregledni rad iz 2009 (Tambalis i sar., 2009) utvrdio je da iako trening snage sam po sebi predstavlja potentno sredstvo za unapređenje kardiovaskularnog zdravlja, izgleda da se dodatni pozitivni efekti mogu očekivati kada se ovaj tip treninga kombinuje sa aerobnim treningom.

Osteoporoza

Istraživanja pokazuju da je guubitak mišićne mase direktno povezan i sa gubljenjem koštane mase (osteopenija). Osobe treće životne dobi koje ne sprovode trening snage mogu očekivati gubitak koštane mase od 1% godišnje (Kemler, 2005). Logično, trening za poboljšnje mišićne mase trebalo bi da ostvari pozitivne efekte i na koštanu gustinu i velika većina istraživanja potvrđuje ovu hipotezu. Nekoliko longitudinalnih studija utvrdilo je porast koštane gustine nakon primene treninga snage u trajanju od 4-24 meseca. Tako, meta analiza Wolfa i sar (Wolfe i sar., 1999) pokazala je da trening snage može povećati koštanu gustinu žena treće životne dobi za oko 1% po godini treninga (uzimani su uzorci femoralne kosti i lumbalnog dela kičme). Takođe, nedavno objavljen pregledni rad Going i Ludermilka (Going i Laudermilk, 2009) pokazao je da je porast koštane gustine kod žena treće životne dobi u rasponu od 1-3%. Studija koja je tra-

on a sample of third-age women. It seems that strength training is a potent tool for causing a rise in bone density in third-generation women and therefore it is desirable to recommend and implement it. The training effects will be higher if it is done with a higher mechanical load and for a longer duration. However, it should be noted that there seems to be a tendency to lose the effects of bone density on the termination of strength training (Vouri et al., 1994).

Mental health

As far as cognitive abilities are concerned, a large number of irradiation has been conducted on people of the third age (both men and women). A large number of studies were concerned with the impact of strength training (independently or combined with training for the development of aerobic abilities) on cognitive abilities and generally determined very positive effects. In meta analysis (Colcombe and Kramer, 2003), aerobic training supplemented by strength training leads to significantly greater positive effects on the cognitive ability of applying aerobic training independently. Guided by the results of Okonor et al. (O'Connor et al., 2010), complacency, as a global concept of an individual's perception of self, shows relative stability in relation to other parameters of mental health. However, the very positive effects of strength training precisely on this ability have been established in several studies conducted on a sample of third-age individuals (both men and women) (Brown et al., 1986). Furthermore, ten weeks of combined aerobic-type training and strength training lead to a statistically significant improvement in self-esteem, total mood, reducing fatigue and depression in a third-age person group (Anessi and Westcoot, 2004). Singh et al. (Singh et al., 2005) determined the impact of strength training on depression. In this basic study, the researchers found that even after 10 weeks of strength training (three workouts per week), as many as 80% of respondents were no longer in clinical depression. Based on these studies, it seems possible to recommend the use of strength training to improve the mental health of third-age women, with very high prospects for positive effects, but in short-to-moderate studies (6-10 weeks).

Conclusion

Beginning with a progressive loss of muscle mass during the aging process, studies performed using force training consistently show improvements in muscle mass and basal metabolism as a result of strength training, with an additional effect on the loss of subcutaneous fat tissue.

jala 2 godine (Kerr i sar., 2001) pokazala je da programirani trening snage dovodi do porasta koštane gustine za 3,2% na uzorku žena treće životne dobi. Izgleda da je trening snage potentno sredstvo za izazivanje porasta koštane gustine kod žena treće životne dobi i stoga ga je poželjno preporučiti i sprovoditit. Trenažni efekti će biti veći ukoliko se radi sa većim mehaničkim opterećenjem i u dužem vremenskom trajanju. Ipak, treba znati da izgleda postoji tendencija da se sa prekidom treninga snage efekti na koštanu gustinu gube (Vouri i sar., 1994).

Mentalno zdravlje

Što se tiče kognitivnih sposobnosti, veliki broj istraživanja je sproveden na osobama treće životne dobi (i muškarcima i ženama). Veliki broj istraživanja se bavio i uticajem treninga snage (samostalno ili kombinovano sa treningom za razvoj aerobnih sposobnosti) na kognitivne sposobnosti i uglavnom utvrdilo veoma pozitivne efekte. U meta analizi (Colcombe i Kramer, 2003), aerobni trening suplementiran treningom snage dovodi do značajno većih pozitivnih efekata po kognitivne sposobnosti od primene aerobnog treninga samostalno. Vodeći se rezultatima Okonora i sar. (O'Connor i sar., 2010), samozadovoljstvo, kao globalni koncept percepcije pojedinca o sebi, pokazuje relativnu stabilnost u odnosu na ostale parametre mentalnog zdravlja. Ipak, veoma pozitivni efekti treninga snage upravo na ovu sposobnost su utvrđeni u nekoliko istraživanja rađenih na uzorku osoba treće životne dobi (i muškarci i žene) (Brown i sar., 1986). Dalje, deset nedelja kombinovanog treninga aerobnog tipa i treninga snage dovodi do statistički značajnog poboljšanja u samozadovoljstvu (self-esteem), totalnom raspoloženju, smanjuje zamor i osećaj depresije na uzorku osoba treće životne dobi (Anessi and Westcoot, 2004). Sing i sar (Singh i sar., 2005) su utvrđivali uticaj treninga snage na depresiju. U ovoj temeljnoj studiji, istraživači su utvrdili da već nakon 10 nedelja treninga snage (tri treninga nedeljno) čak 80% ispitanika više nije bilo u stanju kliničke depresije. Na osnovu ovih studija, izgleda da je moguće preporučiti primenu treninga snage u cilju poboljšanja mentalnog zdravlja žena treće životne dobi, sa veoma velikim izgledima za pozitivnim efektima već u studijama kratkog do umerenog trajanja (6-10 nedelja).

Zaključak

Počevši od progresivnog gubljenja mišićne mase tokom procesa starenja, studije rađene primenom treninga snage konzistentno pokazuju poboljšanja u mišićnoj masi i bazalnom metabolizmu kao posledice treninga snage , sa dodatnim efektom na gubitak potkožnog masnog tki-

The strength training has proven effective in treating a whole set of functional parameters of third-age people (walking speed, degree of independence, reduced number of falls ...) but also of health status, from improving insulin sensitivity and consequently to treatment of type 2 diabetes, by improving cardiovascular status, bone density and mental health. Finally, although muscle strength has been recognized as an important predictor of reduced functionality, an increasing number of evidence indicates that an explosive force (product of force and velocity, or rate of operation) is a parameter that directly affects the mechanical properties of the muscle (rapid power increment) and a large number of parameters of functional performance on the sample of women of the third age.

va. Trening snage je dokazano efikasan u tretiranju čitavog niza funkcionalnih parametara osoba treće životne dobi (brzine hoda, stepena nezavisnosti, smanjenom broju padova…), ali i zdravstvenog stanja, od poboljšanja osetljivosti na insulin i posledično tretiranju dijabetesa tipa 2, preko poboljšanja kardiovaskularnog statusa, koštane gustine i mentalnog zdravlja. Konačno, iako je mišićna snaga prepoznata kao važan prediktor smanjene funkcionalnosti, narastajući broj dokaza ukazuje da eksplozivna snaga (proizvod sile i brzine, ili stopa vršenja rada) predstavlja parameter koji direktno utiče na mehaničke osobine mišića (brz prirast sile) i veliki broj parametara funkcionalnih performansi na uzorku žena treće životne dobi.

References

American College of Sports Medicine. Position Stand: exercise and physical activity for older adults. Med. Sci. Sports Exerc. 2009; 41:1510-30.

Andersen JL. Muscle fibre type adaptation in the elderly human muscle. Scand J Med Sci Sports 2003; 13(1): 40-7.

Annesi J, Westcott W. Relationship of feeling states after exercise and total mood disturbance over 10 weeks in formerly sedentary women. Percept. Mot. Skills. 2004; 99:107-15.

Bamman MM, Petrella JK, Kim JS, Mayhew DL, Cross JM. Cluster analysis tests the importance of myogenic gene expression during myofiber hypertrophy in humans. J Appl Physiol (1985). 2007; 102(6):2232–2239.

Bortz WM. A conceptual framework of frailty: A review. *J Gerontol Med Sci*. 2002;57A:M283-M288.

Boyle JP. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. Popul. Health Metr. 2010; 8:29.

Brown RD, Harrison JM. The effects of a strength training program on the strength and self-concept of two female age groups. Res. Q. Exerc. Sport. 1986; 57:315-20.

Burton LA, Sumukadas D. Optimal management of sarcopenia. Clin Interv Aging. 2010; 5:217–228.

Chale A, Cloutier GJ, Hau C, Phillips EM, Dallal GE, Fielding RA. Efficacy of whey protein supplementation on resistance exercise-induced changes in lean mass, muscle strength, and physical function in mobility-limited older adults. J Gerontol A Biol Sci Med Sci. 2013; 68(6):682–690.

Churchward-Venne TA, Tieland M, Verdijk LB, Leenders M, Dirks ML, de Groot LC, van Loon LJ. There Are No Nonresponders to Resistance-Type Exercise Training in Older Men and Women. J Am Med Dir Assoc. 2015 1;16(5):400-11.

Clark BC, Manini TM. Sarcopenia =/= dynapenia. J Gerontol A Biol Sci Med Sci. 2008; 63(8):829–834. doi: 63/8/829 [pii]. [PubMed: 18772470]

Colcombe S, Kramer AF. Fitness effects on the cognitive function of older adults: a meta-analytic study. Phychol. Sci. 2003; 14:125-30.

Coon PJ, Rogus EM, Drinkwater D, et al. Role of body fat distribution in the decline in insulin sensitivity and glucose tolerance with age. J. Clin. Endocrinol. Metab. 1992; 75:1125-32.

Duchateau J, Enoka RM. Neural adaptations with chronic activity patterns in able-bodied humans. American journal of physical medicine & rehabilitation/Association of Academic Physiatrists. 2002; 81(11 Suppl):S17–27.

Evans WJ. Protein nutrition and resistance exercise. Can. J. Appl. Physiol. 2001; 26:S141-52.

Fahlman MM, Boardly D, Lambert CP, Flynn MG. Effects of endurance training and resistance training on plasma lipoprotein profiles in elderly women. J. Gerontol. A. Biol. Sci. Med. Sci. 2002; 57:B54YB60.

Fiatarone MA, Marks EC, Ryan ND, Meredith CN, Lipsitz LA, Evans WJ. High-intensity strength training in nonagenarians. Effects on skeletal muscle. JAMA. 1990; 263(22):3029–3034.

Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, Nelson ME, Evans WJ. Exercise training and nutritional supplementation for physical frailty in very elderly people. N Engl J Med. 1994; 330(25):1769–1775.

Flack KD, Davy KP, Huber MAW, et al. Aging, resistance training, and diabetes prevention. J. Aging Res. 2011; 2011:127315.

Flack KD, Davy KP, Huber MAW, et al. Aging, resistance training, and diabetes prevention. J. Aging Res. 2011; 2011:127315.

Hackney KJ, Engels HJ, Gretebeck RJ. Resting energy expenditure and delayed-onset muscle soreness after full-body resistance training with an eccentric concentration. J. Strength Cond. Res. 2008; 22:1602Y9.

Heden T, Lox C, Rose P, et al. One-set resistance training elevates energy expenditure for 72 hours similar to three sets. Eur. J. App. Physiol. 2011; 111:477Y84.

Hikida RS, Staron RS, Hagerman FC, Walsh S, Kaiser E, Shell S, Hervey S. Effects of high-intensity resistance training on untrained older men. II. Muscle fiber characteristics and nucleo-cytoplasmic relationships. J Gerontol A Biol Sci Med Sci. 2000

Hortobagyi T, Mizelle C, Beam S, DeVita P. Old adults perform activities of daily living near their maximal capabilities. J Gerontol A Biol Sci Med Sci 2003; 58(5): M453-M460.

Hunter GR, Bryan DR, Wetzstein CJ, et al. Resistance training and intraabdominal adipose tissue in older men and women. Med. Sci. Sports Exerc. 2002; 34:1025-8.

Hurley B. Strength training in the elderly to enhance health status. Med. Exerc. Nutr. Health. 1995; 4:217-29.

Hurley B. Strength training in the elderly to enhance health status. Med. Exerc. Nutr. Health. 1995; 4:217-29.

Kamen G, Knight CA. Training-related adaptations in motor unit discharge rate in young and older adults. J Gerontol A Biol Sci Med Sci. 2004; 59(12):1334–1338.

Kelley G. Dynamic resistance exercise and resting blood pressure in healthy adults: a meta-analysis. J. Appl. Physiol. 1997; 82:1559-65.

Kemmler WS, Von Stengel S, Weineck J, et al. Exercise effects on menopausal risk factors of early postmenopausal women: 3-yr Erlangen fitness osteoporosis prevention study results. Med. Sci. Sports Exerc. 2005; 37:194-203

Lindel RS, Metter EJ, Lynch NA, et al. Age and gender comparisons of muscle strength in 654 women and men aged 20-93 yr. *J Appl Physiol*. 1997;83:1581-1587

Nelson ME, Fiatarone M, Morganti C., et al. Effects of high-intensity strength training on multiple risk factors for osteoporotic fractures. JAMA.1994; 272:1909- 1914.

Peterson MD, Rhea MR, Sen A, Gordon PM. Resistance exercise for muscular strength in older adults: a meta-analysis. Ageing Res Rev. 2010;

Peterson MD, Sen A, Gordon PM. Influence of resistance exercise on lean body mass in aging adults: a meta-analysis. Med Sci Sports Exerc. 2011; 43(2):249–258

Pijnappels M, Bobbert MF, van Dieen JH). Control of support limb muscles in recovery after tripping in young and older subjects. Exp Brain Res 2005; 160(3): 326-33.

Reeves ND, Maganaris CN, Narici MV. Effect of strength training on human patella tendon mechanical properties of older individuals. J Physiol. 2003; 548(Pt 3):971–981

Rosenberg IH. Summary comments. Am J Clin Nutr. 1989; 50:1231–1233.

Sayer AA, Robinson SM, Patel HP, Shavlakadze T, Cooper C, Grounds MD. New horizons in the pathogenesis, diagnosis and management of sarcopenia. Age Ageing. 2013; 42(2):145–150.

Skelton DA, Greig CA, Davies JM, Young A. Strength, power and related functional ability of healthy people aged 65-89 years. Age Ageing 1994; 23(5): 371-7.

Skelton DA, Kennedy J, Rutherford OM. Explosive power and asymmetry in leg muscle function in frequent fallers and nonfallers aged over 65. Age Ageing 2002; 31(2): 119-25.

Strasser B, Schobersberger W. Evidence of resistance training as a treatment therapy in obesity. J. Obes. 2011; 2011:482564.

Strasser B, Siebert U, Schobersberger W. Resistance training in the treatment of metabolic syndrome. Sports Med. 2010; 40:397-415.

Szulc P, Munoz F, Marchand F, Chapurlat R, Delmas PD. Rapid loss of appendicular skeletal muscle mass is associated with higher all-cause mortality in older men: the prospective MINOS study. Am J Clin Nutr. 2010;91:1227–1236.

Tambalis K, Panagiotakos D, Kavouras S, Sidossis L. Responses of blood lipids to aerobic, resistance and combined aerobic with resistance exercise training: a systematic review of current evidence. Angiology. 2009. 60:614-32.

Van Etten L,Westerterp K, Verstappen F, et al. Effect of an 18-week weighttraining program on energy expenditure and physical activity. J. Appl. Physiol. 1997; 82:298Y304.

Vuori I, Heinonen A, Sievanen H, et al. Effects of unilateral strengt training and detraining on BMD and content in young women: a study of mechanical loading and deloading on human bones. Calcif. Tissue Int. 1994; 54-67.

Westcott WL, Winett RA, Annesi JJ, et al. Prescribing physical activity: applying the ACSM protocols for exercise type, intensity, and duration across 3 training frequencies. Phys. Sportsmed. 2009; 2:51-8.

Westcott WL, Winett RA, Annesi JJ, et al. Prescribing physical activity: applying the ACSM protocols for exercise type, intensity, and duration across 3 training frequencies. Phys. Sportsmed. 2009; 2:51Y8.

Wolfe I, Van Cronenbourg J, Kemper H, et al. The effect of exercise training programs on bone mass: a meta-analysis of published controlled trials in pre and post-menopausal women. Osteoporos. Int. 1999; 9:1-12.

Wolfe RR. The unappreciated role of muscle in health and disease. Am. J. Clin. Nutr. 2006; 84:475-82.

Primljen: 12. mart 2017. / Received: March 12, 2017
Prihvaćen: 10. oktobar 2017. / Accepted: October 10, 2017