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VIBRATION TRAINING: OLD-NEW CHALLENGES AND PRACTICAL APPLICATION

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Abstract:
The need to get 'fit' has resulted in a planetary fitness centre expansion, which has by the principle of cause and effect brought out a massive number of different fitness exercising programmes, methods, equipment and props, with an aim to achieve better and faster training results, i.e. the wanted transformational anthropological status. The new fitness programs are emerging almost every day, which in spite of a vast marketing support and a current publicity are forgotten very fast. Within those conditions, in order to achieve satisfaction and trust of your clients, the offered programmes need to produce wanted effects in regards to the transformation of targeted abilities or characteristics of those who perform exercises. This presents constant challenges to the fitness industry, along with the obligation to seek for optimum, scientifically accepted and proven exercising methods. It is because of those reasons that the professional fitness centres are interested in introducing and applying only proven training methods, using highly sophisticated and technologically advanced equipment. This paper deals with a detail analysis of vibration training methods as one of the three methods which have been developed through a research designed for the astronauts. It was released into public after the fall of the "Berlin Wall 1989" and opening the secret USSR and USA documents. The current research defines the related units starting from epistemology of the vibration training, its application as an alternative to developing conditional capacities (strength, muscle endurance, increasing mobility, elasticity, muscle coordination and the balance between reduced pain and muscle tone, increasing peripheral circulation, etc.) clinical use in physiotherapy and vibration training (in regards to strength increase, power, flexibility, mineral bone density, increased cardio-vascular functions as well as reducing pain) and vibration

training as one of the means to athlete recovery (body's regeneration processes) so as to prevent negative training effects (the development of overtraining and chronic fatigue). Each of the units will contain information which is relevant to the theory and practice in sport, recreation and convalescence of athletes and patients.

Keywords: vibration training, fitness, conditional capacities, convalescence

Introduction

At the end of XIX century, Dr John Harvey Kellogg started using vibration chair platforms as a part of wellness programme for clinical healing. The vibrations produced 60 cycles per second, for the lower and upper spine with an aim to heal constipation, headache and the pain in the lumbar spine (Herodek, Atanasković, & Jakovljević, 2009).

From a historical perspective, there were several attempts to use the vibration stimulation as a therapeutical model (Mester, and co-authors, 1999.). Some scientists place vibration training in a group of experimental methods together with electro stimulation (Zatsiorsky, & Kraemer, 2009). However, the recent predecessor of modern vibration training was a rhythmical neurostimulation (RNS). In former East Germany doctor Biermann conducted experiments which were designed to study the vibration massage effects. He described them as “cyclical vibrations”, which are capable to improve the general joints condition (Biermann, 1960). Later, this kind of research has found its way to the countries of the Eastern Block (USSR), as a part of space programme for suspending negative antigravity effects in regards to muscle function, as well as atrophy of muscle and bone structure in astronauts. They have recognised the potential of vibration stimulation on sport and developed vibration system training for the Olympic Athletes, thus affecting their development of strength and flexibility.

Dr. Vladimir Nazarov, Russian sport scientist was at the time one of the first to develop the vibration technology trainings, and later he constructed a biomechanical stimulation (BMS) himself. In regards to the whole body vibration equipment, a subject needs to stand so that the biomechanical stimulation is applied directly on a specific muscle or tendon. In his first publication dr. Nazarov stated that vibration used as such has potential to prevent osteoporosis and to strengthen the exposed bones (Vrcić, Kovačević, and Abazović, 2016). Later he used this technology when working with athletes and determined that during the exposure this type of training increases the height of a jump, strength and flexibility, while decreasing the injury rate. As a result of those tests, in former USSR vibration was introduced in several sports, and after the fall of communism in USSR, the vibration technology reached the public as one of the modes for athlete training, and made its way to Europe. After the Fall of the Berlin Wall in 1989, the greater number of European athletes started using this mode of training in order to increase their sport results, therefore one can state that the application of vibrations has found its way to medical, clinical and rehabilitation fields of study, even the space programmes ESA and NASA, which developed a vibration training as an alternative to neutralising negative gravitational effects on astronauts' locomotor system. Using these devices, the astronauts practiced with low frequency and low amplitude vibration. However, the embargo which was placed on these types of research has led to a low number of similar experiments, which resulted in reinserting interest in the vibration training application in sport training and recreational exercising (Vrcić, and co-author 2016).

Epistemology of Vibration Training

One of the problems which every coach is facing when programming the training is the selection of exercises. In that regard, coaches have a great number of exercises to their disposal: free weights, exercise equipment, walk with an extra load, jumps, exercises using your own body weight, etc. Training which is to develop muscle strength (power) can be divided into two groups: training with different type of muscle contraction, and training with combined muscle contractions. Training for the development of muscle strength (power) with a combined muscle contractions can be divided into: plyometric and vibration training (Radovanović, & Ignjatović, 2009). The development of contemporary training technology resulted in increasing the number of different training methods, which are intended for the improvement of athletes' condition, and vibration training is one of those models.

The latest studies indicate the growing possibility of an application of vibration training, or to be specific a whole body vibration WBV training, which is fully conducted on vibration platform (Marković, & Gregov, 2005; Gusso, Munns, Colle, Derraik, Biggs, Cutfield, & Hofman, 2016). Characteristics of the vibration include the vibration application method, vibration amplitude and frequency (determined by the nerve and muscle system load intensity of vibration forces). Exercising protocol is characterised as a total training load, an aspect and a type of exercises applied. Biomechanical parameters which determine its intensity are amplitude, frequency and magnitude of oscillations. The oscillation range of each movement is determined by amplitude (total distance in mm), vibrations, repetition range of oscillation cycle is determined by vibration frequency (measured in Hz), while the acceleration indicates the vibration magnitude (Cardinale & Bosco, 2003.).

Depending on the aim and character of the vibration training, it is necessary to pay special attention to the aforementioned factors which determine vibration load on central nervous system (CNS). Therefore, the application of vibration training in fitness can and must be strictly monitored, or in other words, coaches that apply vibration trainings must be acquainted and have special education in applying optimum vibration stimulation, combined with adequate training operator, if we are to expect preferred effects, i.e. to use all the advantages which this training method has to offer (Vrcić, et al. 2016). Fitness centres almost exclusively offer the whole body vibration training, and in regards to the vibration equipment we distinguish horizontal, vertical and pivotal vibration. Whether or not the type of vibration mechanism causes similar effects and offers physiological answers, has so far remained unknown and demands for further research (Wilcock, Whatman, Harris, & Keogh, 2009). All in all, the most common equipment are those with vertical type of vibration, while it is a lot more seldom that fitness centres acquire equipment that produce pivotal vibrations. The horizontal vibrations have so far been used for rehabilitation and clinical purposes. As had already been stated, fitness centres apply vibration platform trainings, in which case vibration is applied indirectly on a treated muscle, meaning that vibration is transferred from the source of a vibration to targeted muscle, through a part of a body which is connected to vibration source, for example during the quadriceps training a subject can stand on a vibration platform which oscillates vertically, while at the same time performing exercises (like squats). Performing this type of training, vibration is transferred from the platform and through the lower extremities all the way up to the quadriceps. This kind of method is called Whole Body Vibration Training. Some authors (Marković, & Gregov, 2005) define vibration training as a systematic application of a specific stimulation, amplitude and frequency on a previously activated muscle or muscle group, with an aim to cause functional (qualitative) and structural (quantitative) changes.

If applied indirectly the vibration or the whole body vibration training is used most commonly during the power and strength training for the lower extremity. As a matter of fact, researchers are aware that the vibration which is applied indirectly on a treated muscle is transferred from the source of the vibration to the treated muscle through the part of the body connected to the vibration source, which can cause for the vibration forces (amplitude and frequency) to be nonlinearly reduced from the soft tissues while transferring the vibrations to the targeted muscle (Mester, Spitzenpfeil, & Yue, 2002; Pamukoff, Pietrosimone, Lewek, Ryan, Weinhold, Lee, & Blackburn, 2016). In that sense, it is logical to expect that those leg muscles, treated by indirect vibration and the closest to the source, will bear the most load of the vibration stimulation. Therefore, it is necessary to pay close attention to the reduction of vibration stimulation while increasing the distance between the vibration source and treated muscle or muscle group. It makes no sense, for example to perform biceps training while standing on a vibration platform and at the same time expect a significantly greater muscle activation of the treated muscle, as opposed to the same training performed without the application of such vibration stimulation (Herodek, Atanasković, & Jakovljević, 2009)

Application of vibration training in fitness - alternative to the development of conditional capacities

With the commercials on the available vibration devices in the nineties, their intensive application commenced, however it did not happen in controlled conditions in regards to different sport and recreational exercises. This of course opens up new opportunities for the marketing agencies, which try to benefit from training technology that has so far remained hidden to the public. Such campaigns are based on certain scientific discoveries that often use incomplete or unverified information. As the market of vibration equipment is now quite developed, every manufacturer is trying to draw the attention of potential clients, using some "new" modes offered by the device. Such aggressive campaign has led to a number of misconceptions within the field of vibration training, creating an image that it is quite enough to turn on the vibration device, stand on it, and everything else will happen on its own, and that the effects will be achieved quickly and in great magnitudes (Vrcić, Kovačević, & Abazović, 2016).

Based on the analysis of the available scientific discoveries, vibration training is a suitable method for increasing the power and strength of muscle endurance, improving the mobility and elasticity of muscles and tendons, reducing pain and tension of muscles, improving muscle coordination and balance, improving peripheral circulation and indicating positive results in fighting osteoporosis.

Generally speaking, the use of vibration training can be divided into two great fields, i.e. the field of sport and recreational exercises (Havkey, 2012; Maeda, Urabe, Sasadai, Miyamoto, Murakami, & Kato, 2015; Kurt, & Pekünlü, 2015), and in clinical and physiotherapeutic procedures (Lou, McNamara, Moranet al. 2005, Perchthaler, Hauser, Heitkamp, Hein, & Grau, 2015). As the field of modern fitness is very wide and encompasses a great number of user profiles who need different services and treatments to improving their condition capacities and their health status, vibration devices have found their way in regards to both segments of its impact. Likewise, the two aspects in contemporary training and recovery are often intertwined, therefore the common practice is that the vibration stimulation is applied in regards to producing different results for one client in fitness centre, for example vibration training intended for the development of power and strength combined with the recovery of the client.

Vibration training is based on exact physical parameters which determine a total training load, and is performed on high technology training equipment, i.e. vibration platform. In those circumstances, fitness centres have an opportunity to use the individually designed vibration trainings in order to offer their clients optimum conditions in acquiring expected results, which likewise secures the clints' trust. The benefits of vibration training are reflected as such that vibration platform represents the revolutionary technology, because it is possible to place an optimum load on locomotor apparatus of those who perform the exercise, minimising the load on joints, tendons and ligaments (Mahieu and co-authors., 2006). As a matter of fact, the positive effects produced as a result of vibration training respect the same biological and physiological body laws, such as any other form of training. The only difference is in the nature of the muscle stimulation, and not the way the human body reacts. This is likewise a reason why whole body vibration training is suitable to people which find it hard to train, either due to old age, sickness, body weight or injury. It is likewise suitable to athletes who wish to improve their performances (Cochrane, Legg, & Hooker, 2004; Cohrane & Stannard, 2005; Mahieu and co-authors, 2006.). Based on these notions one can say that vibration training reflects a whole range of strengths as opposed to other fitness programmes, which includes a lesser amount of invested time and faster accomplishments of training goals. In acute situations, it can be very useful for nerve and muscle athlete preparations intended for faster and stronger movement (Jordan, Norris, Smith, & Herzog, 2005; Perchthaler, Hauser, Heitkamp, Hein, & Grau, 2015). The most researched parameters during the use of vibration platform, in the acute situations, is referred to the current increase in flexibility, as well as in case of parameters of explosive and elastic strengths of the lower extremity muscles (Cardinale, & Lim 2003; Cochrane, & Stannard, 2005; William, Sands, McNeal, Stone, & 2006; Jacobs & Burns, 2009; Saito, Ando, & Akima, 2016.). In acute situations, vibration training can be successfully used for the purpose of "warm up" or physiological athlete's body introduction into the workload, primarily by enhancing flexible properties (Sands, et al., 2006.). Therefore, the vibration platform is most commonly used in cases when it is necessary to quickly and efficiently perform the repetitive preparation of the locomotor apparatus during the competitions, in which case the vibration training has proven as an efficient alternative opposed to athlete's standard warm up activities (Barrett, Carter, Small, & Lovell, 2009).

For the past ten years, whole body vibration training has become a popular method in developing power and strength, above all in case of lower extremities. The results of the study on the effects of this training method, regardless of acute or chronic, have justified for the further need of this method in the conditional preparation of athletes. In regards to that, the current discoveries on the change of the whole body vibration indicate that this method can cause significant positive acute (Curry, & Clelland, 1981; Rittweger, 2003; Humphries, Warman, Purton, Doyle, & Dugan 2004; Armstrong, Grinnell, & Warren, 2010) and chronic (Issurin &Tenenbaum, 1999; Delecluse, Roelants, & Verschueren 2003; Paradisis & Zacharoqiannis, 2007.) effects on muscle power and strength. On the other side, it seems that the speed is not significantly increased by vibration training (Wilcock, et al. 2009.). However, the effects of vibration training, intended for the development of power and strength, depend on the characteristics of vibration (method of application, amplitude and frequency) and exercising protocols (the type of training, intensity and volume) applied. Amplitude and frequency of the vibration determine the size of the load by which the vibration affects the nerve-muscle system (Lou, McNamara, Moran, et al. 2005).

Whether we are dealing with short term or long term impact on muscle power and strength, there is a possibility to draw some useful conclusions. Despite the fact that the research methodology, which studied acute and residually acute effects, is much different in regards to all the parameters, such as vibration characteristics, exercises applied and the time necessary for the effects to take place after the vibration for residual acute studies has been applied (from 2 to 60 minutes), one can conclude that there is a potential increase in power and strength of the lower extremities during the short term application of vibration stimulation. Studies on chronic effects, which have researched the effects of whole body vibration training on the power and strength, indicate that the maximum strength of the lower extremity muscles (measured by back squats) is significantly improved (Rubio-Arias, Esteban, Martínez, Ramos-Campo, Mendizábal, Berdejo-Del-Fresno, & Jiménez-Díaz, 2015). However, the accomplished effects ranged between 1% to even 86%, with an average effect accomplished at 32%. Likewise, maximum isometric strength has been improved in the range from 2,5% to 36%, while the average effect was 24%. Chronic effects on the explosive strength, type of a jump, measured during the "contracted concentrated regime" (squat jump), and "eccentrically concentrated regime of muscle contractions" (counter movement jump) indicate the improvement in the range from 2% to 15,4 %, while an average effect is at 7% for the squat jump. Similar results indicate that the improvement of counter movement jump ranges from 1% to 12%, and that the average effect equals to 7,8%. Based on the recent research discoveries of the whole body vibration training, it is evident that no significant differences have been determined in regards to the character and the size of the effect between men and women, i.e. this method has an equal effect on both genders (Sañudo, Feria, Carrasco, de Hoyo, Santos, & Gamboa, 2012).

When it comes to the optimum duration of the training programme, based on the analysis of recently conducted studies, it is possible to distinguish general principles which should be adhered to when planning the future training protocol. Even though the duration of vibration training in application has so far varied from 9 days (Cochrane, Legg, & Hooker, et al., 2004.), to even 6-8 months (Torvinen, Kannus, Sievänen, et al. 2003; Hawkey, 2012), based on the results of the research conducted on athletes (Isurin, Lieberman, & Tenenbaum.,1994; Mester, Kleinöder, & Yue, 2006) it is recommendable to apply the vibration training from 2 to 4 weeks, while the number of trainings per week can vary from 2 to 4.

The size of the vibration stimulation on the muscle system, and the size of accomplished effects depend on the characteristics of vibration stimulation, which should be kept in mind when designing vibration training protocol. Based on the results of the conducted research one can conclude that the vibration training with lower frequencies (30-50 Hz) has greater acute and chronic effect on muscle power and strength as opposed to the same training which uses higher frequencies, likewise representing the optimum frequency range (Novotny, Eckhoff, Eby, Call, Nuckley, & Lowe, 2013). Other parameter of vibration stimulation is the vibration amplitude. Therefore, based on previous studies one can conclude that the vibration amplitude has to be on the border (2 to 4 mm), in order to efficiently activate the treated muscle. Most of the commercial vibration devices offer adjustments specifically within the range of amplitude, so it is necessary to adjust the vibration protocol in regards to the current condition and the aims of each client individually.

Even though research which combine the whole body vibration training with weight training are still scarce, there are justified reasons for its application in case of amateurs or athletes (Hawkey, 2012). It is proven that the four weeks whole body vibration training, performed in addition to the standard weight training very efficiently improves the power and strength of lower extremities, and has even proven to be superior in regards to the traditional weight training programme. These results indicate the specificity of vibration training, and should be taken into consideration during the design of training protocol. There are several theories which discuss the positive effects of vibration on muscle function (Vrcić, et al. 2016).

- First mentioning is of structural adaptation, which is one of the primary body responses to the weight trainings. In that sense vibration forces cause increased load on the athlete's muscle system, which can in addition induce physiological processes responsible for muscle hypertrophy.
- The second theory is related to nerve factors, which are most probably connected with the sensitivity increase of the stretch reflex, which initiates muscle contraction (Cardinale & Bosco, 2003; Roelantsm, Delecluse, & Verschueren, 2004.).
- The third theory supposes that the vibration training can induce the adaptation of the endocrine system. The responses to the vibration stimulation can

sporadically induce specific hormonal responses, which are reflected as an increase of testosterone and growth hormone (Cardinale & Bosco, 2003.).

Apart from the power and strength training, the flexibility is the capacity which has in the case of scientific literature been most commonly explored, while in practice most commonly applied in the conditions of vibration stimulation. Truth be told, the flexibility training in combination with vibration stimulation has been applied most commonly in sport (Cloak, Lane, & Wyon, 2016), but that segment of sport practice is a subject of interest of a great number of amateur and their fitness and condition coaches (Vrcić, et al. 2015).

In the available literature, the combined vibration protocols are most often discussed, specifically those that apply strength exercises combined with different static and dynamic stretching, with additional vibration stimulation. Studies, which determined and compared the effects of different programmes for the development of flexibility in combination with whole body vibration training, are seldom.

However, it has been proven that passive stretching in combination with vibration training in duration of four weeks produces significantly superior results as opposed to the static stretching performed separately. If we continue the discussion, based on the discoveries of previously conducted studies, Vrcić et al. (2015), the following three significant physiological mechanisms are responsible for the improvement of flexible skills:

- One of them can be assigned to improving the local blood flow, produced as a result of indirect application of vibration stimulation. Such improvement follows additional increase of body heath, which likewise contributes to the improvement of muscle elasticity. This finally results in the increase of the movement volume during the performance of stretching exercises.
- As a second mechanism, authors talk about neural response, which is reflected in regards to the vibration training having a potential to cause tonic vibration reflex (TVR). Likewise, acute soft tissue deformation when exposed to vibration can produce activation of muscle receptors in charge of detecting the change in the length of a muscle, which induces the improvement of complete stretching reflex arc.
- As a third reason, authors state the fact that vibration training has a potential to induce proprioceptive reflex, while at the same time inhibiting the sensation of pain. Such neurological mechanisms can cause elongated static positions, when the first signs of discomfort occur prior to the vibration training, resulting in increased values of the movement amplitude volume.

Regarding the characteristics of vibration stimulation, it is evident that the lower amplitudes have been applied most of the time (most often 1mm) and higher frequencies above 45Hz, while the exercises and the duration of vibration are significantly different in all conducted research so far. However, it is necessary to pay attention to the specificity of the effects during the vibration training, i.e. expect the greatest effects during the statistic stretching positions with the application of vibration. Based on the current research in the field of vibration training, one can discuss physiological factors responsible in order to adapt processes of vibration training application. The earlier studies have proven that the vibration training causes neurological response known as tonic vibration reflex (Pantović, Obradović, & Jakšić, 2010). Tonic vibration reflex can be induced by placing muscle tendons to the vibration sources, which in most cases of experimental protocols is an electronic device with a vibrating platform in the range from 30 to 100Hz. Such harmonically and controlled vibrations activate the skin receptors and tendons, and most importantly muscle endings, neurone signalling and an increased activation of muscle fibres via big moto neurones. Muscle endings send out signals to the spinal cord via afferent nerve endings which on the other hand activate monosynaptic and polysynaptic reflex arc inducing muscle contraction.

Physiotherapeutic and clinical application of vibration training

Whole body vibration research (WBV) indicated that the vibration application during physical exercises can bring numerous advantages for the individuals ranging from elite athletes to physically inactive people (Travis, & Cllander, 1994; Nordlund & Thorstensson, 2007; Wilcock, Whatman, Harris, & Keogh, 2009.) in regards to increasing strength, power, flexibility and bones' mineral density, improving cardio-vascular functions, as well as reducing the pain.

Physiotherapeutic and clinical application of whole body vibration training has been primarily performed on physically inactive and older population. In that sense the dominant research has been the one dealing with the effect of vibration stimulation on bone density i.e. "fight against osteoporosis", and likewise including a range of side effects (back pain, balance and walking difficulties and other) which such patients exibit (Garman and co-authors, 2007; Ozcivici, Garman, & Judex, 2007; Novotny, Eckhoff, Eby, Call, Nuckley, & Lowe, 2013). According to the recent discoveries (Frost, 1990.), mechanical stimulation should be different than the everyday stimulations (patients with diagnosed osteoporosis). Some authors claim that the stimulation magnitude is not relevant if the frequency and distribution of the load is increased, and that this effect can induce osteogenesis effect. Related to this, there is a great number of studies which have tried to determine the effects of the whole body vibration training on people (Russo, Lauretani, Bandinelli, et al. 2003; Ward, Alsop, Caultonet et al. 2004; Gilsanz, Wren, Sanchez, et al. 2006; Pitukcheewanont, & Safani, 2006), and even on animals (Rubin, Recker, Cullen et al. 2001.; Oxlund, Ortoft, Andreassen, et al., 2003.). The low bone density and osteoporosis represent health issues for most of the population, that is, for the individuals with physical, neurological and movement difficulties. The changes in the bone structure, primarily the decrease of the bone density, predispose that this population will have greater issues with bone fractures, because the bone tissue needs a mechanical stimulation in order to remain healthy (Frost, 1994.), while the main reason of the bone density, which is apparent in these people, is a reduced body activity (hyperkinesia).

Considering that the deterioration of the bone tissue is not exclusively caused due to the level of physical activity, but due to the "monotony" of the muscle dynamics. (Rubin, Recker, Cullen, Ryaby, Mc Cabe, & Mc Leod, 2004.), whole body vibration training, when it comes to people diagnosed with osteoporosis, is the primary focus of the study because it can contain or even in some cases when applied properly, improve the bone structure. Apart from osteogenesis, vibration training improves muscle strength and balance (Bosco & Cardinale, 1999; Runge, Rehfeld, & Resnicek and co-authors., 2000.; Torvinen, Kannus, Sievänen, et al. 2002.). Likewise, positive effects of vibration training have been perceived even in patients with chronic back pain. Iwamoto, Takeda, Sato, et Uzawa (2005.) had an aim to establish effects of vibration trainings on the bone density in women in post menopause, while chronic back pain was one of the criteria for participating in the treatment. All subjects have felt a relief in their leg and back muscles after a 12 month treatment, and have even declared reduced pain in the area of lumbar spine. The result of this research has indicated that the pain in the lumbar spine has been significantly (statistically significant) reduced in the group which has apart from the alendronate therapy been subject to the vibration training, as opposed to the group which solely was subject to pharmaceutical therapy (alendronate). One could say that the whole body vibration training in combination with the pharmaceutical therapy causes reduction of pain on the lumbar spine, apart when only the medicine is applied. Because of the stated facts, whole body vibration training is considered as a potential mean for intervention, that is fight against osteoporosis (Eisman, 2001.; Rubin, Judex, & Qin, 2006.), and is likewise suitable for the stated population. Gravitational force, muscle force and the reflex force which have an effect on the human skeleton every day, also effect the modelling and remodelling of the bone, thus one might conclude that the increase in the bone density is connected to the long term physical activity (Snow-Harter, Bouxsein, Lewis, Carter, & Marcus, 1992). Some authors (Taaffe, Robinson, Snow, Marcus, 1997; Marcus, 2001.) claim that the high intensity training has positive effects on the bone density even if that is the case of well-trained athletes, however it is questionable whether or not people who have been diagnosed with the osteoporosis should (and are to be allowed) be exposed to the high intensity load (Vrcić, et al. 2016).

Generally speaking, in order to reach the appropriate protocol in deciding which are the successful treatments of osteoporosis, and considering that there is a relatively small number of studies conducted that deal with this issue (long term studies are required to be conducted on a larger sample, all with an aim to establish optimum parameters of the vibration (frequency from 12 to 60 Hz and a vertical type amplitude from 0,7 to 11 mm which determine the magnitude, and the duration of the vibration), which could help heal the patients with osteoporosis and improve the quality of their lives (Zafar, Alghadir, Anwer, & Al-Eisa, 2015).

Based on all of the above, one can conclude that the whole body vibration training is relatively new and a promising method for fighting the osteoporosis. It has been proven that the whole body vibration training has a positive effect on the bone density, increases power and strength, quality of walk and balance. All of these factors together have an effect on reducing the frequency of falls, and reducing the risk of bone fractures.

Vibration training as a mean of recovery

In the era of professional and elite sport, and most commonly in the process of recreational exercise, achieving the elite sport results, that is maximising the development of motor and functional abilities, is one of the main aims of sport training. In these conditions, athletes and elite amateurs are facing increased training and competition pressure, which inevitably cause stress and lead adaptation mechanisms to the edge of physiological abilities. In order to speed up adaptation processes of the body and avoid negative effects of the training (excessive training, overload, chronic fatigue), it is necessary to monitor that elite athletes have adequate recovery, and the same goes for amateurs (Kosar, Candow, & Putland 2012). Proper recovery speeds up regeneration, allows efficient flow of positive adaptation changes by reducing the possibility of acute and chronic form of excessive training, which lead to the supercompensation (Viru, 1995, according to Vrcić and co-authors 2016). Scientific research in the field of recovery brings new discoveries and methods, which speed up regeneration processes within the body. It is quite common that scientific literature states how "vibration recovers" i.e. the use of vibration stimulation, has an aim to speed up the regeneration in the body. When it comes to the application of vibration stimulation for the recovery and if we take into account the research conducted so far, it is not yet quite clear what kind of characteristics for which population should the vibration stimulation have. According to the research of earlier studies, it is important to note that this type of recovery has been conducted on people in training, but due to the size of the vibration stimulation, it was of too much intensity for the people that did not train. As indicated by Lamont, Cramer, Bemben, et al. (2009.), the frequency commonly used is from 50 Hz, with 4-6mm amplitude. Even though the whole body vibration training, aimed towards recovery, is applicable in different populations and individuals of different "qualitative" levels of motor ability, it seems that its application is justified and that it gives the desired results in regards to athletes of higher and high elite rank. Some authors (Cheung, Hume, & Maxwell. 2003; Rhea, Bunker, Marínet al., 2009; Lau, & Nosaka, 2011; Kosar, Candow, & Putland., 2012.) claim that different methods of recovery such as different kinds of massages, cryotherapy, stretching and ultrasound are not efficient in removing lactate which tends to appear after physical activity. The same authors along with some others (Bakhtiary, Safavi-Farokhi, & Aminian- Far, 2007; Aminian-Far, Hadian, Olyaei, et al., 2011.), state that the whole body vibration training, even though it has not been fully researched, regarding the recovery is a potential intervention, which speeds up the recovery of intensive physical activity.

Conclusion

According to trends, which have been evident for the past decades, fitness has been in general characterised as one of the fast growing segments of human activity, which allows for fitness to be perceived as a serious, and above all a very profitable industry. Based on all of the above stated one can conclude that the vibration training which has been "hidden from the public at the beginning" is very much spread in all spheres of sport practice, ranging from athletes of high and low competition rang to amateurs. Therefore, vibration training is considered as training on a platform which works on a principle of vibration, resulting in getting the body out of balance by inducing it to react to every vibration in a form of reflex muscle contraction, from 25 to 50 times per second. Vibration training is useful for many reasons. Apart from the momentary improvement of circulation and lymphatic drainage, results are likewise visible in other outcomes, such as: improvement of body posture, better mobility, reducing cellulite, increasing bone density, removing pain and muscle soreness, and contributing to a faster recovery of injuries. This represents a true revolution in training, because now we can place an optimum pressure on a human skeleton by minimising the load on joints, tendons and ligaments. It has been scientifically proven that mechanical receptors in the tendons react to this stimulation by activating a significantly greater number of muscle fibres (up 98%) in relation to the classical exercises. Contractions affect the increase in the muscle strength, it speeds up circulation and general body endurance is increased, and all that for just 20 minutes of exercise, three times a week. It is precisely for that reason that one cannot wonder at the fact that vibration training can within minimum time produce maximum results in exercising. Due to the good results of the vibration training application this method of exercise is recommended and used in fitness for the development of condition capacities and during the athlete recovery.

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