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ORIGINAL RESEARCH PAPER

TECHNOLOGY TRAINING: ATHLETES USING VIBRATION METHOD AND TECHNICAL MEANS

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Abstract

The core idea behind the article is to work out a set of exercises that will use vibrostimulation combined with traditional power training, and the application of these methods in leisure activities provided to people at various ages. Study aim: 1. determination of frequency parameters under the influence of vibro-mechanical stimulation of human muscles, 2. the combination of vibrostimulation and other coaching methods and trainer's aims to increase power, speed and suppleness of athlete joints. The test results and new technologies worked out will have an opportunity to be used in such scientific and teaching areas as: theory and methodology of sport and physical education, anthropomotorics, kinesiology, biomechanics, but first of all they will provide coaches of various sports disciplines with the sets of ready-made exercises, significantly improving innovative element in athlete coaching.

Key words: *technology, training, vibrostimulation, technical means*

Introduction

Nowadays new social, economic, political and environmental (both ecological and technical) implications require a whole new approach in the field. One of the directions to take on while improving the framework of students' physical education is to implement cutting-edge technologies: technical means, computer systems assisting training and monitoring its performance.

On the basis of firsthand experience, as well as the review of relevant academic resources available, one may indicate the possibility to apply the so-called human engineering in sport as a means of preparing athletes in physical terms.

Drawing up a system of new means and methods does not result in total rejection of the currently applied ones; it should, however, lead to their consistent and rational enhancement, as well as adding variety in the long-term process of training.

The article provides examples of training simulators and other devices which play a part in the development of motor fitness and coordination skills and gives an overview of the methods and technologies implemented, with a view to raising the level of motor skills and sport achievement. Practical guidelines have been indicated on how to put to practical use the vibromechanical stimulation method and also its influence on the body has been examined.

As it is known, long exposure to vibration is unfavorable for a human body and may lead to vibropathology. In the training process of sportsmen vibrostimulation is applied during relatively short periods of time and is not harmful to health (Назаров, 1986; Weber, 1997; Ратов, et al., 2007; Романов, 1983). At work they try to minimize synchronization and resonance of vibration (Скрипко, 2003). During the training process of sportsmen this phenomenon is used for the development of strength, flexibility, and joint mobility (Попов, 2014). But it is necessary to take prophylactic measures during the training process in order to limit the levels of vibration. We have researched and determined the levels of vibration at a stationary vibro training machine of “VMS” for the stimulation of leg muscles and joints (Назаров, 1986) and with a portable vibrostimulator “Junost” for the stimulation of face and head muscles.

High-level of physical education and sport instruction fundamentally calls for the implementation of the more effective activities, means and methods (Starkers, et al., 1995; Trzaskoma 1998; Treadwill, 1988; Wank, et al., 1998), as well as for new technology and the introduction of modern training devices (Frohner, 1995; Horn, Willams & Scott, 2002; Kosmol & Kosmol 1995; Назаров, 1986; Rybakow, 1996; Скрипко, 2003, 2004; Skrypko & Żurek 2010; Wit, 1988). Such devices may be used at every stage of sport instruction, may be useful in teaching movement techniques and developing motor skills regardless of fitness. As well as raising the level of motor skills and sport achievement, the effectiveness of the same means and methods may have an impact on their stability rather than enhancement. Therefore, it is imperative that new means and methods are implemented, or the formerly introduced and applied refined. Sport simulators and other technical devices make it possible for the body to be subject to various intensity loads and demonstrate its reserves.

Professor W. Kuzniecow (1979) analysed maximum psychophysical aptitudes of a man. He went on to describe this direction as the so-called antrophomaximology, which, apart from maximum aptitude, deals with exactness, accuracy and precision of motions as well as their economy. The implementation of technical means enables us to develop all motor skills, raise the individual level of conditioning and ensures harmonious physical growth. It also influences the formulation of motor skills which are instrumental in professional terms (for instance, in defense), health aspects, and allows the functional reserve of the body to be released. The implementation of various technical devices accelerates the acquisition of movement technique (due to the effective realization of the reference principle) and coordination of motions, enables personalization of an individual's training and the selection of exercises. Moreover, it makes it possible to differentiate loads, dynamics and kinematics of particular exercises as well as performing joint movements (Skrypko, 1990 – 2015).

Very important in sports training and the equipment development is volleyball training machine, constructed by professor Ермаков (С.С. Ермаков, 1997). There are different kinds of suspended balls, balls with changed center of gravity, ball passing machines.

Technologies in physical culture and sport are interrelated processes of optimal and effective methods, means and exercises aimed at creating the conditions for achieving the planned sports result in metrology and pedagogical control (Скрипко, 2003).

Technical devices – these are various kinds of accessories, equipment, vehicles and utensils, produced in their vast majority on the basis of an engineering processes, that are used by athletes and their coaches for the purpose of conditioning, diagnostics, competitions of all kinds, for work, by medical staff and by others. Training simulator – it is a technical device which enables one to master, in contrived conditions, movements that recur in a chosen sport (Скрипко, 2003; Skrypko & Żurek 2010). Practically applied training simulators may be divided into: a) Assistant devices such as catapults for firing tennis balls or volleyballs, various kinds of punchballs; b) simple simulators, e.g., bicycle ergometers, kayak ergometers, tracks; c) feedback-oriented simulators, which account for training and research stations, and are equipped in devices transmitting information about the value of forces developed in certain stages of the movement, about the speed of a particular fragment of the motion or the athlete's body reaction to loads (e.g. cardioleader). The former two kinds of training simulators allow multifold repetition of an exercise in standard conditions, facilitating or perhaps enforcing specific movements; the latter makes it possible to adjust the quality and intensity of exercises performed in an ongoing way".

Study aim:

1. Determination of frequency parameters under the influence of vibromechanical stimulation of human muscles.
2. The combination of vibrostimulation and other coaching methods and trainers' aims at increasing power, speed and suppleness of athlete joints.

Methods and material

The basis of the research technique stands on research methods and available apparatus.

Accelometric movement *analysis* system – measurement of acceleration of human biomechanical chains, running track to analyse foot pressure, push off and fly time in the run, polydynamometry – measurement of muscle group power; a device that combines a precision dynamometer allowing to take measurements of singular muscle power, pulsometry. The results will be calculated mathematically and statistically by means of the software such as Statistica 10, vibrometry ("Briul and Kier"), motor tests, and literature analyses.

Twenty highly qualified athletes aged 18 – 25 years were tested. The means given in Table 1 contain a variance coefficient of<10%, $p<0.05$. Table 1 shows acceleration, below the value is converted in decibels (dB).
Organization of research.

We have researched spreading of vibrations along the body on the "leg" training machine from the heel bone in the standing position on the supporting leg: 1. on a shin of a shin-bone; 2. on muscles of the front surface of a hip; 2. on the head and on hip muscles from vibrostimulator "Junost" attached to the hip.

At the zone of application with the vibrating surface in the mentioned above points we determined the vibrovelocity (m/s^2) and recalculated this parameter in dB in the spectrum of frequencies, measured by the vibrometer – 8, 16, 32, 63, 125, 250, 500 and 1000 Hz. The basic frequency of the vibrostimulator was within 20 – 40 Hz.

Detailed objectives: *1.* to find out the character of vibration spreading of different frequencies along the human body at different application points; *2.* to compare the results with the critical permissible levels of vibration in the spectrum of 8 – 1000 Hz.

Results

The human body can be presented in the form of mechanical vibrating model. Frequency of internal vibration of a human body does not depend on a human being himself. It is predetermined by his or her ontogenesis and is within 30 – 35 Hz range. The peculiarity of vibro-mechanical stimulation (VMS) is that vibration spreads mainly along the muscle fibers, what is natural for muscle contractions and not perpendicular as it occurs under massage influence (Назаров, 1986). We researched the vibrations of the body on "leg" training apparatus from the heel bone in the standing position on the supporting leg. The vibrations were registered by a vibrometer 2511 of "Briul and Kier". We researched the effect of vibration on a sportsman depending on the point of application (Скрипко, 2003).

We measured the level of vibro-acceleration at the point of application of vibratod (at the heel bone). At this point vibro-acceleration was 100 decibels with frequency of 25Hz at the average. Reduction of vibration on the frequencies shown by the vibrometer took place from 2 to 5 times on the shin and hip and up to 10 times on the head. In the researched spectrum of frequencies we discovered that the excess of admissible values took place on the shin in the horizontal and vertical plane on the frequencies 16, 31, 63 Hz. On the hip muscles we discovered the reduction of vibration and the admissible values were not exceeded. We observed only a little increase in 16 Hz range along the direction of vibration. We have received the following data (tab. 1).

Table 1

Vibroacceleration at the parts of the body under VMS at the "leg" stimulator with frequency of 25 Hz (medium values; m/s^2, dB)

Parts of body	Ordi-nates	Frequency, Hz							
		8	16	31	63	125	250	500	1000
Shin	X	$14 \cdot 10^{-2}$ 53	$5 \cdot 10^{\circ}$ 84	$4 \cdot 10^{\circ}$ 83	$2 \cdot 10^{\circ}$ 77	$18 \cdot 10^{-1}$ 78	$12 \cdot 10^{-1}$ 72	$20 \cdot 10^{-2}$ 57	$8 \cdot 10^{-2}$ 48
	Y	$16 \cdot 10^{-2}$ 54	$1 \cdot 10^{\circ}$ 91	$7 \cdot 10^{\circ}$ 87	$4 \cdot 10^{\circ}$ 83	$2.5 \cdot 10^{\circ}$ 78	$3 \cdot 10^{\circ}$ 80	$5 \cdot 10^{\circ}$ 84	$3 \cdot 10^{\circ}$ 80
	Z	$16 \cdot 10^{-2}$ 54	$8 \cdot 10^{\circ}$ 88	$5 \cdot 10^{\circ}$ 84	$11 \cdot 10^{-1}$ 71	$4 \cdot 10^{-1}$ 63	$12 \cdot 10^{-2}$ 52	$4 \cdot 10^{-2}$ 43	$30 \cdot 10^{-3}$ 40
Hip	X	$7 \cdot 10^{-2}$ 47	$6 \cdot 10^{-1}$ 66	$5 \cdot 10^{-1}$ 64	$14 \cdot 10^{-2}$ 54	$30 \cdot 10^{-3}$ 40	$15 \cdot 10^{-3}$ 34	$5 \cdot 10^{-3}$ 25	$30 \cdot 10^{-4}$ 20
	Y	$5 \cdot 10^{-2}$ 44	$3 \cdot 10^{-1}$ 61	$2 \cdot 10^{-1}$ 58	$7 \cdot 10^{-2}$ 47	$12 \cdot 10^{-3}$ 32	$4 \cdot 10^{-3}$ 23	$2 \cdot 10^{-3}$ 16	$8 \cdot 10^{-4}$ 8
	Z	$5 \cdot 10^{-2}$ 44	$3 \cdot 10^{-1}$ 60	$15 \cdot 10^{-2}$ 54	$9 \cdot 10^{-2}$ 50	$14 \cdot 10^{-3}$ 33	$12 \cdot 10^{-3}$ 32	$3 \cdot 10^{-3}$ 20	$14 \cdot 10^{-4}$ 14
Head	X	$6 \cdot 10^{-2}$ 46	$4 \cdot 10^{-1}$ 63	$1 \cdot 10\text{-}2$ 51	$6 \cdot 10^{-3}$ 26	$12 \cdot 10^{-4}$ 12	$6 \cdot 10^{-3}$ 26	$18 \cdot 10^{-4}$ 16	$9 \cdot 10^{-4}$ 10
	Y	$1 \cdot 10^{-3}$ 31	$8 \cdot 10^{-1}$ 69	$3 \cdot 10^{-1}$ 60	$2 \cdot 10^{-2}$ 37	$2.5 \cdot 10^{-2}$ 38	$12 \cdot 10^{-3}$ 32	$6 \cdot 10^{-3}$ 26	$2 \cdot 10^{-3}$ 17
	Z	$7 \cdot 10^{-2}$ 47	$6 \cdot 10^{-1}$ 66	$2 \cdot 10^{-1}$ 57	$5 \cdot 10^{-2}$ 45	$4 \cdot 10^{-3}$ 23	$7 \cdot 10^{-3}$ 27	$2.5 \cdot 10^{-3}$ 18	$1 \cdot 10^{-4}$ 11
Critical permis-sible values		63	63	69	75	81	87	93	93

We have measured the vibroacceleration in the zone of contact with vibroplatform (on the heel bone). At this part of the leg the level of vibroacceleration was at the average 100 dB under frequency of 25 Hz.

The determined drop of vibration was 2 – 5 times on the shin and hip and 10 times on the head. At the same time within the researched spectrum of frequencies we determined that the excess of permissible values (shown in the table) was on the shin in the horizontal plane on X and Y axis at frequencies of 16.31, 63 Hz and on vertical component on Z axis. There was a drop of vibration on hip muscles and there was practically no excess of permissible values, but just a little excess within the range of 16 Hz on the X axis that is along the direction of vibration. More radical drop of vibration was determined on the head but vibration was close to permissible in the spectrum of 16 – 31 Hz. It may be explained that the basic frequency of vibrostimulation was close to these values – 25 Hz. There were no vibroacceleration values exceeding permissible under vibrostimulation with frequency of 35 Hz .That means that when we increase the frequency of vibration the vibro effect localizes and drops on the far parts of the body.

It is proved by the following fact. The level of vibration on the head when the hands were stimulated was rather high under stimulation with the frequency of 25 Hz. We registered the excess of permissible doze in the spectrum of 16 – 31 Hz. When we increased the frequency of vibrostimulation up to 35 Hz, there was a drop of vibration 1.5 – 2 times.

When we applied a portable vibrostimulator ‘Junost” to the muscles of the hip, in spite of the lower power of vibration generating, the level of vibration at the vibrodot application point was 16 – 31 Hz within 80 dB. To compare - under vibrostimulation by “leg” vibrator at the application point the level of local vibration was 100 dB.

With the most used frequency of 25 – 30 Hz there is an excess of admissible values in the range close to the basic frequency on the parts of the body within the application points and a considerable reduction while spreading along the body.

VMS of muscles in the lengthwise spreading of vibration is predetermined by both frequency of vibration and the point of application. Under vibrostimulation by typical frequency of 25 Hz in the spectrum of affecting frequencies we noticed an excess of permissible values in the range close to the basic vibration frequency on the parts of the body which are close to the application point and considerably reduce while spreading along the body. The results may be used when it is necessary to find out the modes of vibrostimulation (frequencies, amplitudes, and time) under different postures of the body and application points.

Research has been undertaken to examine the level of vibrations while performing exercises on vibrating training simulator – a stimulus for muscles and joints of lower limbs (Назаров, 1986; Skrypko, 1990 – 2015).

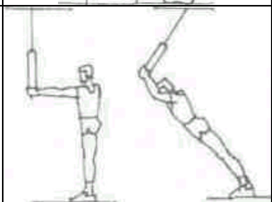
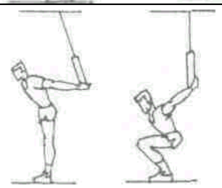
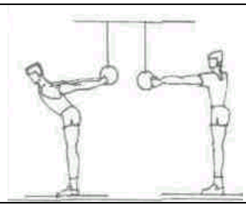
It examined the dispersion of vibrating waves across the body starting from tuber calcanei on the lower limb placed on the vibrating device in an erect position on the other lower limb. The following were subject to research: biceps thigh muscle and quadriceps thigh muscle. On the basis of experiments conducted by independent authors a positive impact was observed regarding dosed vibromechanical stimulation with a specified value of amplitude and activation time of vital body functions. The processes which take place in biological systems as a result of vibrations are characterized by a specific optimal structure. Vibromechanical stimulation influences acceleration of recovery processes to a bigger extent than it is the case during passive rest. It also increases energetic efficiency of muscles, impacts muscle receptors, flexibility and plasticity of joint apparatus and blood vessels. The application of VMS during the training process is instrumental in improving blood circulation in muscle tissues. Therefore, training loads are more bearable if the pulse is stable. Devices facilitating the development of motor skills are called vibrating devices (tab.2).

Table 2

Exercises with the use of vibrating devices
(Скрипко, 2003; Skrypko, Żurek & Łojewski, 2011)

	Exercise	Description	Effect of exercise
1		Erect position on the supporting leg, next to the training simulator, the other leg straightened in the knee-joint, with the foot on the simulator. The athlete executes rhythmical trunk bends sideward.	Quadriceps muscle of thigh stretch. Agility of trunk muscles improves.
2		In a horizontal position, with the back to the floor at the level of lumbosacral joint, hands and legs hang downward loosely.	Mobility of the spine is improved, trunk MM and the frontal plane of thigh MM stretch.
3		Standing on one leg, the other is straightened in the knee and raised, the heel leans against the vibrating part, and one hand holds the belt to keep a balance.	It influences stretching and agility of MM adductor muscles of thigh and mobility in the hip joint.

Table 2 countinion

4		Erect position on the supporting leg facing the simulator, the other leg bent in the knee joint, the foot leans against the simulator. The athlete executes rhythmical deep bends forward.	It develops agility and flexibility in hip and knee joints. It influences the development of mm NN strength.
5		Standing on the supporting leg with the back to the simulator, the other leg bent in the knee joint, against the simulator.	The exercise stretches and stimulates the frontal plane of mm of hip joint.
6		Standing on both legs, RR hold a special belt (or gymnastic wheels) overhead, The athlete aims to maintain the body in the position enforced (hang)	While performing exercise 6, 7 and 8 trunk muscles are stimulated. Agility and joint mobility is developed as well.
7		Standing on both legs, RR hold a special belt (or gymnastic wheels) behind the back. The athlete executes rhythmical sit-ups.	While performing exercise 6, 7 and 8 trunk muscles are stimulated. Agility and joint mobility is developed as well.
8		Standing on both legs, RR hold a special belt (or gymnastic wheels) while they are straightened. The athlete aims to maintain the body in a given position.	While performing exercise 6, 7 and 8 trunk muscles are stimulated. Agility and joint mobility is developed as well.

Sample exercises and results

Force loading and vibromechanical stimulation (VMS) were performed simultaneously. Six leg VMS sessions were carried on in a day over a two-week microcycle. Stimulation session included two exercises.

Exercise 1. From basic (starting) position standing on the front part of the foot of one of the legs on vibrating surface of the stimulator with additional hand support do bending and unbending of an ankle joint. The exercise is done with the resistance that is 70 – 80% of the maximum, the body being inclined as for sprint. Perform 10 ups and downs on the foot. The rate of doing the exercise was one movement in 2s.

Exercise 2. From basic (starting) position with the support of one of the legs on the vibrator surface perform 5 – 6 second effort, the emphasis being put on the possibly rapid intensification. The total duration of exercises in 20 mm (two runs). In the beginning Ex. 1 is done with one approach on each leg in 40s. rest. After one minute recovering Ex. 2 is done with two approaches on each leg, the interval between them being 1 mm. In 5 min the exercise runs are repeated. Vibration frequency of vibrating surface of the vibrator ranges between 16 – 30 Hz depending on the feeling of the highest comfort and the amplitude of vibrations is 4 mm.

The experiment results have shown that after two stimulation sessions maximum strength indicators decreased by 3.4% on average. However already after the third session the cumulative effect of their real increase ($p<0.05$) was observed. Maximum increase became apparent only in a week after VMS course (on average 7.8%). After four months of training the strength indicators exceeded the initial level by 10%, the joint mobility becoming better as well.

The research was done to examine VMS application for developing strength abilities of muscles participating in foot bending as well as VMS influence on the attendant development of flexibility and speed-and-strength abilities of track and field athletes. The sportsmen were trained by using generally accepted (conventional) methods as well as with additional application of specific loads that were done for six sessions during two week microcycles.

The research done has shown the high effectiveness of additional exercises based on the methods proposed by us to develop strength abilities of sportsmen specializing in kinds of sports with speed and strength abilities needed. Speed and strength abilities (up to 7%) are developed along with the development of muscle strength of legs (up to 11%), which led to better results in sprint in combination with special training. These methods are recommended to apply not later than 30 days before the beginning of contest season.

Basing on the scientific facts of evolutional biomechanics - the presence of the periods of accelerated and slowed development of activity systems of a man, personal evolution, the principles of adequate training effects (age and condition aspects) and the determination of morphofunctional system components of a man (conservative and changeable), it can be noted that it is up-to-date technologies that help to detail training programmes and to effectively use them for physical training of a man.

Conditioning programs on an electromechanical track

Detailed conditioning programs have been designed on the basis of the research (Скрипко, 2003) concerning time measurements and the frequency of particular stages of running step and the cardio-vascular system's reaction in runners:

Program 1: initial instruction of running and walking- exercises on the track in a slow, steady pace, with and without the so-called bar. The speed of track's shift is no more than 4 m/s. Practical guidelines: a) walk in a slow pace, the walker holds on to the grips, duration – 30 s, interval – 2 mm, 6 repetitions; b) walk in a faster pace, the walker holds on to grips, then releases the grip, duration – 20 s, interval – 2-3 mm, 4 repetitions; c) run in a steady pace with the bar – 30 s, interval – 2-3 mm, 5 – 6 repetitions; d) run in a steady pace without the bar – 15 s, 3min interval, 4 – 5 repetitions.

Program 2: steady run on a track with and without a bar in three speed zones. Guidelines and practical tips:

exercise 1:

speed, m/s	2	3	4
duration, s	80	60	30

Interval – 3-4 mm, 2 – 3 repetitions;

exercise 2:

speed, m/s	3	4	5
duration, s	60	30	15

Interval – 3-4 mm, 2 – 3 repetitions.

Program 3: near maximum speed training with and without a bar.

exercise 1:

speed, m/s	3	5	7
duration, s	60	20	10

Interval – 3 mm, 2 repetitions;

exercise 2:

speed, m/s	5	7	8
duration, s	25	15	7

Interval- 5 mm, 2-3 repetitions.

Program 4: maximum speed training with a bar.

exercise 1:

speed, m/s	4	6	8
duration, s	60	30	10

Interval – 6 mm, 2 repetitions.

On the basis of the above-mentioned programs one may conclude that the instruction of running technique on a mechanical track may comprise 1 – 2 trainings. Programs 2 and 3 were recommended on a twice weekly basis, program 4 – once weekly. Track training results in increased frequency of steps whilst running, enhanced level of speed-force aptitudes and, consequently, an improvement of time results in short distances. During electromechanical track training the loads which the body is subject to are lesser in comparison to analogous speed results on a field track, whilst the restitution of the frequency of heart contractions retains its level from before the training only about 4 – 5 minutes later.

The proposed article is of a research nature and implementation destined, with its objectives clearly outlined and forecast results provided to assist improvements towards sports mastery. The methods envisaged by the project can be used along with other coaching means and trainers to provide coordinative and fitness readiness, e.g. on various electromechanical run tracks, power trainers frequent in fitness rooms. Testing different muscle groups based on polydynamometry will yield a topographic image of the power of individual muscle groups. On the grounds of the obtained image, it will be possible to find out which muscles are weaker, and subject them to proper coaching so that their physical potential could be increased. With tests being carried out, the application of vibromechanical stimulators might find a wider field of use while their construction can be improved, which will, eventually, give rise to an opportunity to file for a patent right of new devices, coaching technologies and diagnostic methods. On the basis of the conducted research health promoting methods will be offered to increase fitness levels of people of various ages.

The research itself and the implementation of the proposed technologies will open up paths leading up to research and engineering centres, industrial centres in Poland with a view to producing vibrostimulatings devices on a larger scale, which will lead to their being used universally for coaching sports people at various ages.

The core idea behind the article is to work out a set of exercises that will use vibrostimulation combined with traditional power trainers, and the application of these methods in leisure activities provided to people at various ages.

Conclusions

Modern technologies in athletic training make it possible to apply effective methods and programs in the instruction of movement techniques as well as developing motor skills. It presents opportunities for controlled synergy in artificially contrived conditions while executing physical exercises within the entire framework of movements, which are linked to the specificity of a given sport. Application of human engineering in sport in vocational training of athletes reflects interdisciplinary aspects of sport sciences. The arrival of new devices as well as sport specializations justifies the need for more effective means and methods in physical conditioning. Therefore, one may infer that it is advisable to implement training simulators and other technical devices in athletes training. One may also conclude that it is legitimate to continue research in order to design new devices and methods which take into account the specificity of particular sport specializations and monitoring training performance.

With the most used frequency of 25 – 30 Hz there is an excess of admissible values in the range close to the basic frequency on the parts of the body within the application points and a considerable reduction while spreading along the body. VMS of muscles in the lengthwise spreading of vibration is pre-determined by both frequency of vibration and the point of application. Under vibrostimulation by typical frequency of 25 Hz in the spectrum of affecting frequencies we noticed an excess of permissible values in the range close to the basic vibration frequency on the parts of the body which are close to the application point and considerably reduce while spreading along the body. The results may be used when it is necessary to find out the modes of vibrostimulation (frequencies, amplitudes, and time) under different postures of the body and application points.

Vibromechanical stimulation (VMS) is another method which influences acceleration of training and recovery processes. It also increases energetic efficiency of muscles, has a positive impact on muscle receptors, flexibility and plasticity of joint apparatus and blood vessels. The application of VMS in the training process is instrumental in enhancing blood microcirculation in muscle tissues. Therefore, training loads are more bearable if pulse is stable. Its application also improves the level of agility and nimbleness in athletes of various sports (Назаров, 1986; Skrypko & Żurek 2010; Weber, 1997).

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