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Original Article

Mathematical basis for the integral development of strength, speed and endurance in sports with complex manifestation of physical qualities

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Abstract:
The aim is to devise a model of integral development of antagonistic physical qualities in sports that require complex manifestation of motor abilities. *Materials*: there were analyzed 32 literary sources for devising the theoretical theses of a model of development of different physical qualities. The elite climbers took part in the pedagogical experiment in order to test the effectiveness of the developed model. There were 26 sportsmen involved in the study (among them were 10 sports masters of international class who specialize in speed climbing, 10 sports masters who specialize in difficulty climbing and 6 world-class climbers. The age of sportsmen was from 19 to 22. *Results*. We developed the concept of an integrated physical training. It, in general, can be applied at any stage of sports perfection. It was found that the components of physical preparedness (strength, speed and endurance) are in inverse interrelations. The data of dependences are hyperbolic. We demonstrated these dependencies (between strength, speed and time limit of acting) are, in generalized form, in the shape of a hyperboloid. We also showed that the inverse interrelations between the components of speed and strength preparedness make difficulty in building of training process. The solution of this problem lies in the gradual alternation of means aimed at the development of contradictory qualities. *Conclusions.* We proved experimentally the effectiveness of the developed model of integral development of physical qualities in training process of elite climbers.
Keywords: model, speed, strength, endurance, physical qualities, climbing.

Introduction

In sports with extremely active motor activity, the results depend on the sportsman's own motor abilities (Fathloun, M., Shephard, R.J., 2010; Bobrovnik, V.I., Tykhonenko, Y.P., 2014; Hermassi, S., Chelly, M.S., Fathloun, M., Shephard, R.J., 2010; Kozina, Z., 2015) [1; 7; 12; 13]. They are the following: athletics (Bobrovnik, V.I., Tykhonenko, Y.P., 2014) [1], swimming (Platonov, V.N., 1986) [23], combat sports (Korobeynikov, G., Korobeynikova, L., 2003; Korobeynikov, G., Mazmanian, K., Korobeynikova, L., Jagiełło, W., 2010; Voronkov, A.V., Nikulin, I.N., Sobyanin, F.I., 2014; Podrigalo, L.V., Iermakov, S.S., Nosko, M.O., Galashko, M.N., Galashko, N.I., 2015) [9; 10; 24; 25; 30], sports games (Brynzak, S.S., Krasnov, V.P., 2013; Zhanneta, K., Irina, S., Tatyana, B., Olena, R., Olena, L., Anna, I., 2015; Sobko, I., 2015) [2; 12; 28] and others (Burke, S.M., DurandBush N., Doell, K., 2010; Kazem, Sotoodeh, Aliakbar, Alizadeh, Bahman, Mirzaei, 2014) [3; 8;]. Results of some of these sports depend primarily on the development of only one physical quality. For example, running and swimming at long distances require priority of endurance [1; 18; 21; 23; 32]. Speed and strength sports require the development of strength and speed. In addition, the optimum combination of which provides the highest demonstration of strength [14; 15; 16; 26]. However, many sports require complex manifestation of all physical qualities. These sports include sport games, combat sports, different multiple-round and many hard-coordinating sports [21; 23; 29]. This causes difficulties in construction of the training process. It happens because some physical properties are antagonistic towards each other [6; 11; 19; 27]. This antagonism lies not only in the energy mechanisms (Yushina, I.A., Nekipelova, E.V., Sirotina, S.S., Sobyanin, F.I., Zhernakova, N.I., 2014; Pachomov, S.P., Altuchova, O.B., Demakova, N.A., Krivoshei, I.V., Kolesnikov, Y.V., Sobyanin, F.I., 2014) [22; 31], but also in the mechanisms of muscle working [20].

There are [5] several ways to supply muscle activity with energy. The question is, how much re-synthesis paths of the energy-supply molecules correlate during special muscle activity (Kozhurkin, A.N., 2012) [17]. This depends on intensity and duration of the task. There is certain sequence of inclusion and prevalence of different ways of re-synthesis of adenosine triphosphoric acid with continued muscle activity: the first 2-3 seconds splits only adenosine triphosphoric acid. Then its re-synthesis begins from 3 to 20 seconds, mostly because of creatine phosphate. Just this energy-supply mechanism makes possible the power-speed work [5; 11]. After 30-40 seconds, glycolysis reaches maximum intensity. Then aerobic oxidation becomes more and more prevalent [5]. Energy transition of muscle activity from anaerobic to aerobic leads to decreasing in the total

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production ATP per unit of time. It is reflected in the reduction of the work power. [11] If sportsmen specialize in some sport primarily with one mechanism of energy-supply, just this mechanism improves. And the development of other energy mechanisms of qualified sportsmen can make slower the development of the main [12; 23]. This raises the complexity of the physical qualities development in sports that require integrated including of various mechanisms of energy-supply of motor activity.

Antagonism in the development of various physical properties exists also in biomechanical rules of muscle activity. So, strength and speed are back-related. This interrelation is like giberbolic curve [5; 11]. Strength and duration as rate and duration of muscle contraction interrelate similarly (Kozhurkin, A.N., 2012) [11].

This provides difficulty in construction of the training process in sports with the necessity of complex development of physical qualities. Therefore, the search for rational ways of cooperation of three main components of physical preparedness (strength, speed and endurance) is a topical task.

The aim is to devise a model of integral development of antagonistic physical qualities in sports that require complex manifestation of motor abilities.

Materials and methods

Methods of the research: theoretical analysis and synthesis of literary sources, induction and deduction, pedagogical, physiological and psychophysiological methods [15], mathematical and statistical methods.

There were analyzed 32 literary sources for devising of theoretical theses of a model of development of different physical qualities. The elite climbers took part in the pedagogical experiment in order to test the effectiveness of the developed model. There were 26 sportsmen involved in the study (among were 10 sports masters of international class who specialize in speed climbing, 10 sports masters who specialize in difficulty climbing and 6 world-class climbers. The age of sportsmen was from 19 to 22.

Results

For more detailed analysis of the integrated physical training of sportsmen we identified the following components: strength, speed and endurance. These data were analyzed according to their interrelation, studying the available data in scientific literature in theoretical and experimental aspects. We found that the components of complex preparedness are in inverse interrelation. So, strength and speed are back-related. This interrelation is like giberbolic curve [5; 11]. Strength and duration as rate and duration of muscle contraction interrelate similarly. This provides difficulty in building of the training process in sports with the necessity of complex development of physical qualities. It is because we need all three aspects of speed and strength preparedness in climbing. Therefore, the search for rational ways of cooperation of three main components of physical preparedness is difficult.

The second point of our model is about the building of a model of speed and strength preparedness in the structural elements of an annual cycle.

The model of integral development physical qualities that is developed with the help of deductive method shows that the construction of appropriate training programs needs to build a dynamics model of the increase of training loads. They are aimed at the development of strength, speed and endurance. For this, we must firstly, determinate the size of incremental increase of work extent aimed at the development of physical qualities; secondly, construct the training process in accordance with the principle of wave-like increase of loads. What is also necessary is to determine the optimal time intervals during the transition to new incremental load extends.

According to the leading experts in the theory and practice of sports [21; 23], the mathematical models are the most appropriate and universal. They are based on fundamental laws of physics and mathematics (taken from the basic sciences).

Koc I.M. [5], using theoretical and experimental data, indicates that we should consider two dependencies during the analysis of interrelations between the physical qualities. They are: "strength and speed" and "strength and duration" of muscle contraction.

According to "strength and speed" dependence (Fig. 1), during the dynamic reduction, strength is inversely proportional to speed of muscle shortening (speed of the movable parts of the body). The higher the speed, the less the strength. Another formulation of this relation is the more external load (resistance, weight), the lower the rate of shortening (motion) and the more the strength. And vice versa, the smaller the external load, the higher the speed and the smaller muscle strength. By multiplying it and the speed of muscle contraction we determine its capacity.

"Strength and duration" dependence of muscle contraction is reflected in the fact that the greater the strength of contractions, the shorter their duration limit. This is true both for the local and regional static and dynamic work, and for the global work.

Time limit of activity is inversely proportional to efforts that are developed by the muscles. When the required strength is less than 20% of maximum strength, static activity can be done for a very long time. There is evidence in scientific literature [11], that in the range of pressure (load) from 20 % to 80 % of the maximum

strength, time limit of static activity decreases with increasing of pressure strength (load) according to the following dependence:

$$t_{\lim} = \frac{K}{F / F_{\max}},$$

where: t_{lim} – time limit of a static activity;
K– constant;
F – pressure strength (load);
F_{max} – maximum strength.

This formula shows that even tiny strength decrease of static reduction leads to significant increase of time length during which this reduction can be continued.

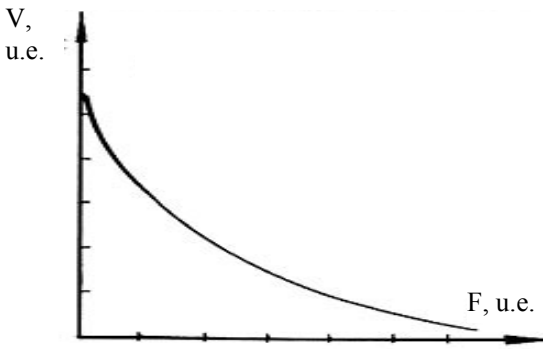

Fig. 1. «Strength and speed» diagram according to H. Ralstone (1949), A. Hill and K. Ober (1950) [5; 11]

V – speed;
F – strength;
u.e. – conditional units

Therefore, we can observe the relation between the expression of different physical qualities in physiology and biomechanics. Strength and speed are inversely interrelated. Endurance defined by time limit of work at given strength or speed of muscle contractions is inversely interrelated to strength, speed or strength of muscles contractions. These dependences are hyperbolic.

If we formulate schematic dependencies between power, speed and time limit for activity performance in general way in the form of a spatial diagram, then the volume of dependency data will look like a hyperboloid. To be more precise, it will look like an upper part of two-lined hyperboloid [16] (Fig. 2).

There are different parts of hyperboloid that correspond to demonstration of various physical qualities marked in figure 2. Thus, the area marked by number 1 corresponds to bigger intensity of speed component in the strength and speed qualities. The area marked by number 2 corresponds to bigger intensity of strength aspect in speed and strength qualities. The area marked by number 3 corresponds to bigger intensity of endurance of strength. The area marked by number 4 corresponds to bigger intensity of endurance of speed.

The difficulty is in finding the optimal mix of resources directed to the development of strength, speed, and speed and strength endurance. That is because the increased use of means, for example, to develop strength, makes slower the development of speed qualities and speed and strength endurance. The means directed to the development of speed makes slower the development of strength and endurance. In the same way, the development of endurance contradicts the development of speed and strength.

The solution of this problem we can see in gradual alternation of means aimed at the development of conflicting qualities. This alternation of increasing or decreasing of the means proportions directed at the development of each quality takes place according to a logarithmic spiral (Fig. 5). This spiral is one of the universal forms to develop the various processes in animate and inanimate nature. The logarithmic or isogonal spiral is a special kind of spirals, often found in the nature. For example, in the animal world of spirals of snail and mollusks shells. All these shapes indicate the natural phenomenon: the winding process is connected with the growth one. Although different species have different physical laws of growth. The mathematical laws are the same. They are all based on a geometric spiral, self-similar curve [4].

Just because the logarithmic spiral is the best form to develop living and non-living systems, we chose to build the selection model of means for speed and strength training. The general scheme of this selection and optimum combination of means for the development of strength and speed is represented by the form of the logarithmic spiral on the hyperboloid. The spiral starts at the base of the hyperboloid and gradually covers more and more of its area. In general, the process of gradual increasing of the workload and optimal alternation of means aimed at the development of speed, strength and endurance, can be represented as follows. At the initial

stage of training process the means for development of various physical qualities are available in approximately equal amounts (starting point of the spiral). Then, with the development of training, there is increasing in the proportion of means directed for the development of any quality (motion of the spiral aside), gradually moving on the other qualities according to the spiral. When we can see clear tendency to a certain specialization, selection of means varies according to this specialization.

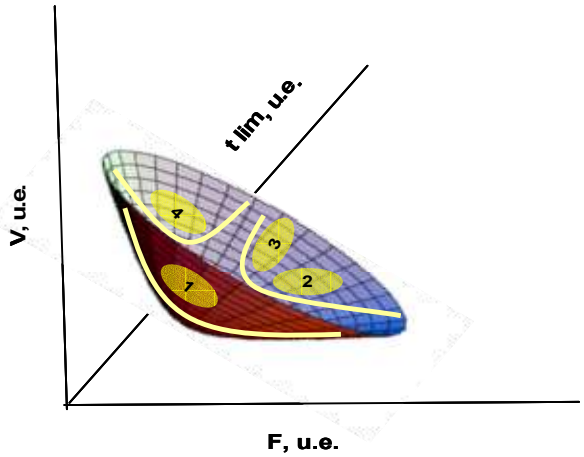

Fig. 2. Interrelation scheme between strength, speed and maximum possible time of muscle activity in the form of the top part of two-lined hyperboloid; different areas of the hyperboloid match the appearance of different physical qualities:

1 – speed and strength qualities (speed aspect is more displayed);
2 – strength endurance (strength aspect is more displayed);
3 – strength endurance (endurance aspect is more displayed);
4 – speed endurance (speed aspect is more displayed);
V – speed;
t lim – time limit for an activity;
F – strength;
u.e. – conditional units

Thus, the amount of means aimed at the development of a component of physical preparedness works according to fluctuational process with increasing amplitude and period. This increasing of means amount aimed at the development of a component of speed and strength preparedness, and the period of this increase is different for sportsmen of different levels of preparedness. The increase of training work at the initial stage of preparation is small, but gradually increases according to the laws of the logarithmic spiral. As the level of sportsmen's qualification raises, the volume of training work practically disappears. It turns into qualitative change of the training process.

In general way, the wave-like process of increasing of the work amount aimed at the development of any aspect of speed and strength preparedness, can be represented as an increasing sinusoidal graph with increasing amplitude and period of fluctuations (Fig. 4). This scheme corresponds to the principles of wave-like rise of loads, presented in the works of the classics of the theory of sports. But, in this case, there is not only increase in the amplitude of a "wave" of fluctuations, but also in its period. In fact, there is increasing according to logarithmic law both on the abscissa axis and ordinate axis. Each next index is equal with the previous one multiplied by a certain number (a constant). We took a number of permanent Apery which is equal to 1.20 [4] on ordinate axis (to reflect the amount of load).

This constant is the sum of inverse to cubes of positive integers.

Moving the body is connected with the movement of sportsman's own weight. As the mass of a body is proportional to the cube of the linear sizes of a body, respectively, the effort required to move the weight of the sportsman's body is also proportional to the cube of the linear sizes of the body. Accordingly, the step of load increasing must be inversely proportional to the initial level of development of physical preparedness.

As the base of a logarithmic scale on the abscissa (a period of load fluctuations aimed at the development of any aspect of speed and strength preparedness), we took an index that indicates the minimum level of super compensation (determining a statistically significant increase of the index). So, we took a constant of Legendre. It is a constant of distribution patterns of prime numbers which is equal to 1.08 [4].

Increasing point of the period involves achieving relatively stable state in the development of physical quality. In other words, it is statistically significant increase of the quality. So, it implies some means to achieve stable development of index, the distribution of which corresponds to certain laws. We took a constant of the

function of prime numbers distribution as a minimum step to increase a period, since this implies the presence of will and achievement of certain stable states, expressed in simple numbers.

Naturally, an infinite increase of training work cannot be. This function has a limit which, in our case, is equal to 6-month or 24-week microcycle (Fig. 4). After that, load stabilization comes. There is some decrease and again gradual increase that we can observe in the annual training cycle.

In this case, we took, as a unit, an initial amount of work aimed at the development of strength and speed qualities affordable for students (sportsmen who perform relatively freely to strong tiredness) at the initial stage of preparation.

In each of the next "wave swing" volume of work, corresponding to the development of the component of speed and strength preparedness, rises to 1.2 times. Duration of the "wave period" rises to 1.08 times (Fig. 3).

In the future, the training process with the development of preparedness of these index may be decreased or increased according to the sportsman's capabilities.

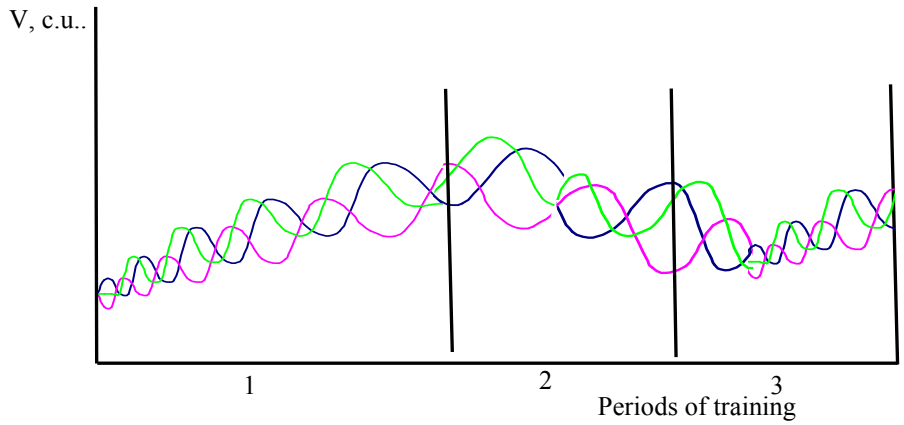

Fig. 3. The distribution model of the resources of strength, speed and endurance at different periods of sportsmen's training:
– srtength; – speed; – endurance
V – volume of loads; 1 – preparation period; 2 – competitive period; 3 – transitional period
c.u. – conditional units

The developed model was applied in the training process of elite climbers. As a result, we proved experimentally the effectiveness of this model. There was found that the application of the model in the experimental group showed improvement in the functional state. There was significant decrease in heart rate during the transition from a lying position to a standing position (from 84,38 ± 12,51 bits per minute to 75.75 ± 10,34 bits per minute ($t = 2.6$, $p < 0.05$), in the difference between the indexes of heart rate in standing and lying position in ortho-test ($t = 2,20$, $p < 0.05$), in the Harvard step-test index (from 85.25 ± 4,70 c.u. to 90,75 ± 2,88 c.u., $t = 4.89$, $p < 0.001$). These changes are unreliable in the control group.

It was found that the use of the author's method of the speed and strength training improves psychophysiological capabilities, strength and mobility of sportsmen's nervous processes.

Discussion

This scheme corresponds to the theory of wave-like increase of loads of different directions, according to L.P. Matveev (1980) [21] and V.N. Platonov (1988) [23], as well as Ju.V. Verhoshansky's theory of concentrated training impact (1998) [29]. According to this, the data of construction patterns of the physical training process extended the appliance of periodization theory of training process L.P. Matveev [21] and V.N. Platonov [23] and Y. Verhoshansky's theory of modular system of strength and speed development [29].

The period of variations of means of training loads is constant in the general theory of sportsmen's training. The same is for amplitude. Only the general volume of load changes. It increases like a wave. We offer a wave-like increasing of the load volume with the changing in amplitude and period of variation according to a logarithmic function. The cyclic alternation of means of various components of physical preparedness is a logarithmic spiral. From this point of view, our model is new and presented for the first time.

The study confirmed and extended O.O. Ryepko's data [26]. These data showed the effectiveness of application of our model of development of the various components of speed and strength of students-climbers' preparation. The developed model is appropriate not only in climbing, but also for other sports that require complex development of physical qualities.

We defined the index of the step-by-step increase in the work volume aimed to develop the components of physical preparedness. There was proposed the model of construction of training process in accordance with

the principle of wave-like increase of loads for which we defined the optimal time intervals while stepwise transition to the new loads volumes.

Our study shows that the amount of means aimed at the development of any component of speed and strength preparedness submits to variational process with increasing amplitude and period. The amplitude and period of variation increasing (increase in means) aimed at the development of a component of speed and strength preparedness. The period of this increase is different for sportsmen of different levels of preparedness. At the beginning of preparation the increase of training work is low. But it increases gradually according to the laws of the logarithmic spiral. As the level of the sportsmen's qualification increases, the growing volume of training work practically disappears. It turns into qualitative change in the training process.

Conclusions

1. There was demonstrated the mathematical model of step-by-step changes of the means amount directed to develop various components of speed and strength preparedness.

2. We showed that the wave-like change in the load volume must be with change in the amplitude and period of fluctuations, according to the logarithmic function. We also defined the optimal time intervals while stepwise transition to the new load volumes for developing of speed, strength and endurance.

3. We experimentally proved the effectiveness of the developed model of the integral development of physical qualities in the training process of elite climbers.

Conflicts of interest. The authors have no conflicts of interest.

References

Bobrovnik, V.I., Tykhonenko, Y.P. (2014). Improvement of strength capacities of middle-distance runners as the major factor of achieving high sports results at the stage of maximal realization of individual capabilities. *Physical education of students*, *3,* 9–17. doi:10.6084/m9.figshare.974477

Brynzak, S.S., Krasnov, V.P. (2013). Role of force training in physical training of student basketball team players. *Physical education of students, 5*, 13–17. doi:10.6084/ m9.figshare.770990

Burke, S.M., DurandBush N., Doell, K. (2010). Exploring feel and motivation with recreational and elite Mount Everest climbers: An ethnographic study. *International Journal of Sport and Exercise Psychology, 8*(4), 373–393. doi:10.1080/1612197X.2010.9671959.

Landsberg, G.S. (1975). *Elementarnyj uchebnik fiziki* [Elementary physics book], Moscow: Science.

Koc, I.M. (1982). *Fiziologiia myshechnoj deiatel'nosti* [Physiology of muscle activity], Moscow: Physical Culture and Sport.

Ivashchenko, O.V., Yermakova, T.S., Cieslicka, M., Muszkieta, R. (2015). Discriminant analysis as method of pedagogic control of 9–11 forms girls' functional and motor fitness. *Journal of Physical Education and Sport, 15*(3), 576–581. doi:10.7752/jpes.2015.03086

Hermassi, S., Chelly, M.S., Fathloun, M., Shephard, R.J. (2010). The effect of heavy-vs. moderate-load training on the development of strength, power, and throwing ball velocity in male handball players. *Journal of Strength and Conditioning Research, 24*(9), 2408-2418. doi:10.1519/JSC.0b013e3181e58d7c.

Kazem, Sotoodeh, Aliakbar, Alizadeh, Bahman, Mirzaei. (2014). The comparison of three type of exercise sequence on maximum strength in untrained young men. *Physical education of students, 5,* 65–69. doi:10.15561/20755279.2014.0512

Korobeynikov, G., Korobeynikova, L. (2003). Physical development and psychical function states in junior schoolchildren. *Bratislavske Lekarske Listy, 104*(3), 125-129.

Korobeynikov, G., Mazmanian, K., Korobeynikova, L., Jagiełło, W. (2010). Psychophysiological states and motivation in elite judokas. *Archives of Budo, 6*(3), 129-136.

Kozak, L.M., Korobeinikova, L.G., Korobeinikov, G.V. (2002). Physical development and status of psychophysiological functions in young school aged children. *Fiziologiia Cheloveka, 28*(2), 35-43.

Zhanneta, K., Irina, S., Tatyana, B., Olena, R., Olena, L., & Anna, I. (2015). The applying of the concept of individualization in sport. *Journal of Physical Education and Sport*, 15(2), 172-177. doi:10.7752/jpes.2015.02027

Kozina, Z. (2015). Recovery functional condition of sportsmen using individual non-traditional means of rehabilitation. *Journal of Physical Education and Sport, 15*(4), 634-639. doi:10.7752/jpes.2015.04096

Kozina, Zh., Ryepko, O.A., Prusik, Kr., Cieślicka, M. (2013). Factor structure of the integrated training of elite athletes – representatives of mountain sports. *Pedagogics, psychology, medicalbiological problems of physical training and sports, 11*, 45–51. doi:10.6084/m9.figshare.815872.

Kozina, Zh.L., Ryepko, O.A., Prusik, Kr., Cieślicka Mirosława. (2013). Psychophysiological possibility of mountaineers and climbers specializing in speed climbing and climbing difficulty. *Pedagogics, psychology, medicalbiological problems of physical training and sports, 10,* 41–46. doi:10.6084/m9.figshare.785784.

Kozina, Zh., Ryepko, O.A., Prusik, Krzysztof, Prusik, Katarzyna, Cieślicka, Mirosława. (2014). Theoretical-methodological study of development of power-speed in climbing. *Physical education of students, 1*, 27–33. doi:10.6084/m9.figshare.903690

Kozhurkin, A.N. (2012). *Teoriia i metodika podtiagivanij* [Theory and methodology of pull-ups], Moscow.

Kutek, T.B. (2015). Features special physical readiness of the qualified jumpers from the takeoff. *Physical education of students, 2,* 3–7. doi:10.15561/20755279.2015.0201

Lahno, O., Hanjukova, O., Cherniavska, O. (2015). Evaluation of the effectiveness of integrated psychomotor development of children in the age from 2 to 4. *Journal of Physical Education and Sport, 15*(4), 793-799. doi:10.7752/jpes.2015.04121

López-Rivera, E., González-Badillo, J.J. (2012). The effects of two maximum grip strength training methods using the same effort duration and different edge depth on grip endurance in elite climbers. *Sports Technology, 5*(3–4), 100–110. doi:10.1080/19346182.2012.716061.

Matveev, L.P. (1991). *Teoriia i metodika fizicheskoj kul'tury* [Theory and methodology of physical training], Moscow: Physical Culture and Sport.

Pachomov, S.P., Altuchova, O.B., Demakova, N.A., Krivoshei, I.V., Kolesnikov, Y.V., Sobyanin, F.I. (2014). Study of cytokines polymorphous loci connections with rise of endometrium proliferative diseases. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5*(6), 1473-1476.

Platonov, V.N. (1986). *Podgotovka vysokokvalificirovannykh sportsmenov* [*Preparedness of highly qualified sportsmen*], Moscow: Physical Culture and Sport.

Podrigalo, L.V., Iermakov, S.S., Nosko, M.O., Galashko, M.N., Galashko, N.I. (2015). Study and analysis of armwrestlers' forearm muscles' strength. *Journal of Physical Education and Sport*, *15*(3), 531–537. doi:10.7752/jpes.2015.03080

Podrigalo, L.V., Iermakov, S.S., Galashko, N.I., Galashko, M.N., Dzhym, V.Y. (2015). Assessment of arm wrestlers' adaptation status on the base of saliva biochemical characteristics in dynamic of competition and training loads. *Journal of Physical Education and Sport*, *15*(4), 849 – 856. doi:10.7752/jpes.2015.04131

Ryepko, O.A. (2013). Features and functionality of speed and power capabilities of elite climbers and various types of rock climbing. *Physical education of students*, *6*, 60–65. doi:10.6084/m9.figshare.840505.

Sergienko, V.N. (2013). Evaluation of integrated testing the maximum force of students aged 17–20 years. *Physical education of students, 4,* 77–81. doi:10.6084/ m9.figshare.681645.

Sobko, I. (2015). An innovative method of managing the training process of qualified basketball players with hearing impairment An innovative method of managing the training process of qualified basketball players with hearing impairment. *Journal of Physical Education and Sport, 15*(4), 97, 640–645. doi:10.7752/jpes.2015.04097.

Verkhoshanskij, I.V. (1988). *Osnovy special'noj fizicheskoj podgotovki sportsmenov* [Fundamentals of special physical preparation of sportsmen], Moscow: Physical Culture and Sport.

Voronkov, A.V., Nikulin, I.N., Sobyanin, F.I. (2014). On the improvement of the control force readiness students engaged arm sport. *Physical education of students, 2*, 3–7. doi:10.6084/m9.figshare.917169.

Yushina, I.A., Nekipelova, E.V., Sirotina, S.S., Sobyanin, F.I., Zhernakova, N.I. (2014). Studying the impact of the genetic polymorphisms of chemokines on the arterial pressure level and kidney function in patient with the chronic glomerulonephritis. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5*(5), 1103-1107.

Zaporozhanov, V.A., Borachinski, T., Nosko, Y.N. (2015). Assessment of children's potentials in dynamic of initial stage of sport training. *Journal of Physical Education and Sport*, *15*(3), 525–530. doi:10.7752/jpes.2015.03079