Original Article

Experimental substantiation of the program of the annual cycle of preparation of climbers 16-17 years to the competitive discipline "Climbing Combined"

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Published online: April 30, 2020

(Accepted for publication: April 15, 2020)

DOI:10.7752/jpes.2020.s2174

Abstract

The aim of the study: to develop and experimentally test the integral program of preparation of climbers of 16-17 years in an annual training cycle. **Material and methods.** The study involved 23 qualified climbers - members of the youth team of Ukraine, of which 12 athletes formed an experimental group, 11 - control. The pedagogical experiment was conducted during the year (from September 2018 to September 2019). At the beginning and at the end of the experiment, the athletes were tested for pedagogical tests. Training programs for athletes in the Climbing Combined discipline were built. The program combines the principles of the alternate development of physical qualities with the means that are useful for all types of rock climbing: athletics (development of explosive power, jumping, strengthening of the foot, etc.) and means of developing equilibrium (exercises on unstable supports). **Results.** The use of a training program based on the gradual alternation of tools for the development of various physical qualities, the inclusion of athletics and equilibrium exercises is an effective tool in the training process of rock climbers. As evidenced by the comparison of the passage time of the reference track athletes of the control and experimental groups. The training program applied has brought about positive changes in the test results that characterize the level of climbers' training specializing in climbing speed combined with a significant improvement in fitness specific to athletes specializing in climbing difficulty and bouldering. **Conclusions.** The applied rock climbing training program has helped to improve individual competitive results in the discipline "Climbing Combined" without loss of performance in the main specialization of athletes.

Key Words: climbing, bouldering, speed climbing, lead climbing, Climbing Combined.

Introduction

At the present stage of rock climbing, a situation has emerged that contains some contradictions. With the introduction of Climbing Combined as an Olympic discipline in the 2020 Olympics, the question was: how to achieve high score in Climbing Combined athletes who specialize in certain types of climbing without losing performance in their main form (Lutter, Tischer, El-Sheikh, 2019; Kozina, Uvarova, Kniaz, Kabanska, Kochina, et.al., 2020; Kozina, Uvarova, Kniaz, Chernozub, Shkrebtii, et al., 2020). Rock climbing is included in the Climbing Combined format in the Olympics 2020, combining three different types of rock climbing (Batuev & Robinson, 2019). After 2020, Olympic Climbing Combined in rock climbing will have a slightly different format, and the results in individual rock climbing disciplines will become relevant again (Batuev & Robinson, 2019; Kozina, Uvarova, Kniaz, Kabanska, Kochina, et.al., 2020). But Climbing Combined will not lose its relevance as it has several paths of development: it can remain in the modern format as a separate discipline or move to other formats (a combination of disciplines "Difficulty" and "Bouldering"). In any case, the success is still relevant in some types of rock climbing, and in Climbing Combined. That is why it is important to build a training process in such a way that the universalisation of athletes required to perform in the Climbing Combined does not interfere with, and may have aided, the success of the athlete's core discipline. There are certain difficulties involved in addressing this issue due to different energy supply mechanisms and different patterns of movement in different types of rock climbing (Guo, Wang, Liu, & Hanson, 2019; Limonta, Brighenti, Rampichini, Ce, Schena, & Esposito, 2018).

Different types of climbing activities require the involvement of different energy supply mechanisms and different propulsion programs (Kozina, Repko, Ionova, Boychuk, & Korobeinik, 2016; Ryepko, 2013a; Ryepko, 2013b). This creates a problem in the preparation of athletes to participate in the Olympic discipline

"Climbing Combined". Athletes - representatives of individual disciplines, must master different in the nature of motor activity and mechanism of energy supply competitive discipline. This is quite a challenge for athletes who already have some success in some types of rock climbing (Kozin, 2019; Kozin, Safronov, Kozina, Kniaz, Proskurnia et.al., 2020; Limmer, Buck, de Marees, & Roth, 2019). Moving to another competitive activity is also a problem in terms of increasing the risk of injury from performing non-specific activities to qualified athletes (Buzzacott, Schoeffl, Chimiak., & Schoeffl, 2019; Forrester, Tran, Tennakoon, & Staudenmayer, 2018 ; Michailov, Balas, Tanev, Andonov, Kodeyskaya, & Brown, 2018; Schoeffl., Simon, & Lutter, 2019; Schweizer, & Schweizer, 2019; Schweizer, 2012).

In terms of fitness, different types of rock climbing have different requirements for strength, speed, endurance (Lutter, Hochholzer, Bayer, Schoeffl, 2018; Lutter, Tischer, El-Sheikh, & Schoffl, 2019; Philippe, Filzwieser, Leichtfried, Blank, Haslinger, 2019; Saeterbakken, Loken, Scott, Hermans, Vereide, & Andersen, 2018; Saul, Steinmetz, Lehmann, & Schilling, 2019). This complicates the training process and requires a thorough analysis of the athlete's ability to build training so that the athlete's universalization does not harm his or her narrow specialization. At this stage, they are only honored to receive scientific justification for the rock climbing training program that is common to all types of rock climbing. This provision also applies to the biomechanical structure of movements. The rationale for training programs for elite athletes in some types of rock climbing is not sufficiently presented in the scientific literature. Climber Combined training lacks both the scientific development and the empirical experience of trainers.

In our previous studies (Kozina, Uvarova, Kniaz, Chernozub, Shkrebtii, et al., 2020; Uvarova, Kozina, Kolomiets, Tieniakova, 2019) a regression model was developed to predict an athlete's success in the Climbing Combined discipline based on the results in basic disciplines for the athlete. Regression equations have identified specific values of the minimum ranking position in individual disciplines for athletes specializing in different climbing disciplines to reach the Climbing Combined final. It has been found that athletes who specialize in Difficulty and Bouldering are more likely to score higher in Climbing Combined, as the results in these disciplines are related. For athletes who specialize in the Speed discipline, achieving a high score is a difficult task because the results in the "Speed" discipline are not related to the results in the "Difficulty" and "Bouldering" disciplines and do not significantly affect the result in the multiplicity.

In the context of the continuation of these studies, the issue of developing a rock climber training program in an annual training cycle is relevant. Especially this problem concerns athletes 16-17 years, because at this stage of preparation individual specialization does not yet reach the maximum manifestation, and therefore a possible impact on the universalization of athletes in a specially designed training program in the annual training cycle (Kapkan, Khudolii, Bartiki, 2019; Khudolii, 2019; Khudolii Ivashchenko, Iermakov, Veremeenko, Lopatiev, 2019; Flood, & Cretu, 2018; Schoeffl, Lutter, Schoeffl, 2019).

Based on the above, this study hypothesized that the application of the integrated training program will have a positive impact on the level of integrated training of climbers 16-17 years.

The aim of the study: to develop and experimentally test the integral program of preparation of climbers of 16-17 years in an annual training cycle.

Material and methods

Participants

The study involved 23 qualified climbers - members of the youth team of Ukraine, of which 12 athletes formed an experimental group, 11 - control. The pedagogical experiment was conducted during the year (from September 2018 to September 2019). At the beginning and at the end of the experiment, the athletes were tested for pedagogical tests. The experiment was conducted at the sports complex in Kharkiv, Ukraine.

Experimental protocol

Training programs for athletes in the Climbing Combined discipline were built. The program combines the principles of the alternate development of physical qualities (Kozina, Repko, Ionova, Boychuk, Korobeinik, 2016), Ryepko, 2013a; 2013b) with tools that are useful for all types of rock climbing: athletics (development of explosive power, jumping, strengthening of the foot, etc.) and equilibrium development (exercises on unstable supports) (Fig. 1).

Based on the developed regression model, the prospects for improvement in the discipline "Climbing Combined" for each athlete were determined. The athletes who had the chance to enter the top 20 at the World and European Youth Championships, formed an experimental and control group. The groups trained according to the conventional plan of the youth team of Ukraine, but in the experimental group the conventional program was modified. It included special exercises for the development of qualities that are common to climbing on speed, difficulty and bouldering. For the training of climbers in the discipline Climbing Combined for the development of their universalization, without prejudice to the main specialization, tools that are relevant to representatives of all types of climbing were used. These tools included specific athletics exercises as well as balance development exercises and autogenous training (Kozina, Iermakov, Bartik, Yermakova, Michal, 2018). In addition, the construction of the training process in the annual cycle of training, in mesocycles, microcycles and individual training sessions contained the basic principles of alternating speed-power development tools

developed by Ryepko (2013a, 2013b) and modified by the author. The experimental group trained in the developed program. The control group trained in the program for the seniors of rock-climbing children and youth sports schools of Ukraine. At the beginning and at the end of the experiment, the groups were compared with each other, and the change in the results of the integrated readiness was determined according to the test results. The individual performance of competitions was also analyzed.

Fig. 1. General scheme of the program of preparation of climbers specializing in various disciplines for participation in the discipline "Climbing Combined"

Special testing methods

The following tests were applied to determine the impact of the developed program on the level of the climbers' integral preparedness:

1. Passage of the reference track for speed (s). This test was conducted according to generally accepted competition rules.
2. Long jump from place (m). To determine the length of the jump athlete stood near a straight line on the floor so as not to step on it. With the push of two feet, the athlete made a long jump. Determined the distance of the jump at the nearest landing point.
3. Pulling for 20 s (number). From the starting position "Hanging on the crossbar" the athlete by sound signal did pull-ups as soon as possible within 20 s. Pull-in was considered valid only if the bol was performed according to generally accepted rules.
4. Running at 100 m (s) was conducted from a high start on a sound signal. Running time of 100 m was determined by an electronic sounder.
5. The hang on the right hand (s) was performed on a 1 cm wide hook. The athlete performed the hang on the fingers of the right hand. Fixed the chwas from the moment of capture of the hook to failure.
6. The hang on the left hand (s) was made similarly to the hang on the right hand on a 1 cm wide hook. The athlete performed the hang on the fingers of the left hand. Fixed the chwas from the moment of capture of the hook to failure.

Testing took place at the beginning and end of the pedagogical experiment (September 2018 and September 2019).

Statistical analysis

The digital material obtained during the study was processed using traditional methods of mathematical statistics. Arithmetic mean, S (standard deviation), standard error m were determined for each indicator. Compliance with the normal distribution was checked through the use of the Kolmogorov-Smirnov test; in the absence of a validity error of deviation of the real sample from the normal distribution ($p > 0.05$), the distribution was considered normal. The accuracy of the discrepancies was determined by the Student's t-test, as well as by the nonparametric statistics of Wilcoxon and Martin Whitney. Differences and reliability of correlation coefficients were considered significant at significance level $p < 0.05$. The mathematical processing of the data was performed with the help of Microsoft Excel Excel 2016 data analysis software, SPSS-17.

Results

The results of testing athletes before and after the experiment showed the effectiveness of the developed program of integrated training. The study involved 23 rock climbers who specialize in climbing difficulty and 1252-----

bouldering, the age of athletes 17-18 years; 12 athletes formed the experimental group, 11 - the control group. Prior to the experiment, the groups did not differ significantly ($p > 0.05$) (Table 1). After applying the program of integrated training of athletes during the year, there was a significant increase in the results of the athletes of the experimental group in indicators of speed of running of the reference track ($p < 0,001$) and jogging at 100 m ($p < 0,01$) (test specific for athletes specializing in climbing on speed (Table 2). There was also a significant increase in boulder-specific qualities: a long jump from the spot ($p < 0.05$) and qualities specific to athletes specializing in difficulty climbing: the hang on the right hand arm ($p < 0.05$) and hang on the left arm ($p < 0.05$) (Table. 2). In the control group, the changes are not significant ($p > 0.05$) (Table. 2).

Table 1

Indicators of the integrated preparedness of climbers of the experimental and control groups before and after the experiment

Name of tests	Testing term	Group	Group Statistics					
			N	$\bar{x}$	S	m	t	p
Passage of the reference line for speed, s	BE	E	12	12,06	3,48	1,00	0,305	0,764
		C	11	11,69	1,90	0,57		
	AE	E	12	8,13	1,31	0,38	-3,96	0,001
		C	11	10,56	1,63	0,49		
Long jump from the place, m	BE	E	12	2,17	0,22	0,06	0,485	0,633
		C	11	2,13	0,22	0,07		
	AE	E	12	2,38	0,19	0,06	2,718	0,013
		C	11	2,15	0,21	0,06		
Pulling up for 20 s, quantity	BE	E	12	9,58	1,31	0,38	0,46	0,65
		C	11	9,36	0,92	0,28		
	AE	E	12	11,42	1,16	0,34	3,249	0,004
		C	11	10,00	0,89	0,27		
100m Run, s	BE	E	12	14,56	0,95	0,27	-1,408	0,174
		C	11	15,18	1,16	0,35		
	AE	E	12	13,27	0,81	0,23	-3,415	0,003
		C	11	14,57	1,01	0,31		
Hanging on the right hand, s	BE	E	12	13,67	9,96	2,87	0,723	0,478
		C	11	10,55	10,75	3,24		
	AE	E	12	15,67	3,82	1,10	-1,477	0,045
		C	11	10,55	10,75	3,24		
Hanging on the left hand, s	BE	E	12	11,33	7,71	2,23	-0,66	0,517
		C	11	13,45	7,69	2,32		
	AE	E	12	17,08	6,24	1,80	-1,212	0,039
		C	11	11,09	9,43	2,84		

Note: E - the experimental group; C – the control group; BE - before the experiment; AE - after the experiment

In addition, there were also significant differences between the test scores of the athletes of the experimental and control groups after the experiment ($p < 0.05$) (Table 1).

Thus, the training program applied has brought about positive changes in the test results that characterize the level of training of climbers who specialize in climbing speed in combination with a significant improvement in fitness specific to athletes specializing in climbing difficulty and bouldering. That is, the application of the developed program had a positive effect on the universalization of athletes without worsening the testing characteristics characteristic of their core specialization.

Table 2

Indicators of the integrated preparedness of climbers of the experimental and control groups before and after the experiment

Name of tests	Group	Testing term	Group Statistics					
			N	$\bar{x}$	S	m	t	p
Passage of the reference line for speed, s	E	BE	12	12,06	3,48	1,00	3,659	0,001
		AE	12	8,13	1,31	0,38		
	C	BE	11	11,69	1,90	0,57	1,506	0,148
		AE	11	10,56	1,63	0,49		
Long jump from the place, m	E	BE	12	2,17	0,22	0,06	-2,468	0,022
		AE	12	2,38	0,19	0,06		
	C	BE	11	2,13	0,22	0,07	-0,295	0,771
		AE	11	2,15	0,21	0,06		
Pulling up for 20 s, quantity	E	BE	12	9,58	1,31	0,38	-3,621	0,002
		AE	12	11,42	1,16	0,34		
	C	BE	11	9,36	0,92	0,28	-1,641	0,116

		AE	11	10,00	0,89	0,27		
100m Run, s	E	BE	12	14,56	0,95	0,27	3,56	0,002
		AE	12	13,27	0,81	0,23		
	C	BE	11	15,18	1,16	0,35	1,297	0,209
		AE	11	14,57	1,01	0,31		
Hanging on the right hand, s	E	BE	12	13,67	9,96	2,87	2,598	0,016
		AE	12	15,67	3,82	1,10		
	C	BE	11	10,55	10,75	3,24	0,132	0,96
		AE	11	10,55	10,75	3,24		
Hanging on the left hand, s	E	BE	12	11,33	7,71	2,23	1,483	0,042
		AE	12	17,08	6,24	1,80		
	C	BE	11	13,45	7,69	2,32	0,644	0,527
		AE	11	11,09	9,43	2,84		

Note: E - the experimental group; C – the control group; BE - before the experiment; AE - after the experiment

According to the results of competitions at the youth competitions in 2019, A. A. became the champion of Ukraine in shiidy and Climbing Combined, S. G. - the champion of Ukraine in bouldering, difficulty and Climbing Combined, B. B. - the silver medalist of the Ukrainian Championship in speed and Climbing Combined, bronze in bouldering, L.E. - Ukraine's speed champion.

Discussion

The hypothesis put in this study is quite confirmed. A program has been developed to train young climbers in an annual training cycle, based on the alternate use of the development of various physical qualities, athletics and balance exercises. The program had a positive impact on the level of integral training of young climbers and their success in international and all-Ukrainian competitions.

The theoretical basis for the alternate use of tools for the development of various physical qualities in rock climbing was justified in the work of Ryepko (2013a, 2013b). In our study, the recommendations presented in Ryepko's (2013a, 2013b) work on the regularity of alternation of loads of different directions were applied in the construction of the training cycle in the annual cycle. According to the recommendations of Ryepko (2013a, 2013b), at the beginning of the preparatory period, the means of developing various physical qualities are offered in approximately equal quantities. Then, as training develops, there is an increase in the proportion of funds aimed at the development of any quality, gradually moving into an increase in the proportion of funds aimed at the development of other qualities, often antagonists of the previous. The model presented in the works of Ryepko (2013a, 2013b), Kozina, Repko, Ionova, Boychuk, Korobeinik (2016), is consistent with the theory of wave-like load enhancement of different directions. Because the components of athletes training in, ie strength, speed, endurance, inversely related, there are some difficulties in constructing the training process.

The solution to this problem, according to research by Ryepko (2013a, 2013b), is the gradual alternation of funds aimed at the development of different qualities, and the alternation of increasing or decreasing the proportion of funds aimed at the development of each quality occurs according to a logarithmic spiral. Thus, the amount of funds aimed at developing any component of rock-climbing training in Climbing Combined is subject to an oscillatory process with increasing amplitude and period. The increase in the amplitude and period of oscillation, ie the increase in the amount of funds aimed at the development of any component of preparedness, and the period of this increase, is different in the various structural elements of the annual cycle of training. At the beginning of the preparatory period, the increase in the amount of training work is insignificant, but gradually increases in accordance with the regularities of the logarithmic spiral. As the level of qualification of athletes increases, the increase in the amount of training work practically disappears, and becomes a qualitative change in the training process. In this case, the dynamics of the volume and intensity of funds aimed at the development of strength, speed and endurance, is changing in opposite directions. Thus, the concept presented in the works of Kozina, Repko, Ionova, Boychuk, Korobeinik (2016), Ryepko (2013a; 2013b), Kozina, Shepelenko, Osipov, Kostiukevych, Repko et.al. (2017) confirmed and supplemented the results of the application of the basic provisions in the preparation of rock climbers 16-17 years.

In our study, exercises that jointly influence the development of the leading qualities of representatives of different climbing disciplines were also applied. These are athletics exercises and exercises on unstable platforms. Athletics were used for the purposeful development of speed, strength and endurance. In addition, the general requirement for climbers specializing in all disciplines is the need to develop a kinesthetic analyzer to ensure the ability to maintain equilibrium. For this purpose, exercises on unstable supports were used. Exercise training not only enhances muscle strength, but can also improve the coordination of muscle activity of synergists and antagonists, increasing stability (Yagotin, Degtyarenko, Bosenko, Plisko, & Dolinsky, 2019). Thus, the authors' data regarding the benefits of using exercises on unstable supports were confirmed.

In our study, the program of integrated development of qualities for representatives of different types of climbing was proposed, which combined several components: algorithm of alternation of means of development

of different physical qualities, exercises in athletics, exercises on unstable supports. This combination is new, and its rationale provides the basis for further improvement of the integrated training of rock climbers to combine their universalization and narrow specialization.

Conclusions

It is shown that the use of a training program based on the gradual alternation of tools for the development of various physical qualities p the inclusion of athletics and balance exercises is an effective tool in the training process of rock climbers. As evidenced by the comparison of the passage time of the reference track athletes of the control and experimental groups.

The training program applied has brought about positive changes in the test results that characterize the level of climbers' training specializing in climbing speed combined with a significant improvement in fitness specific to athletes specializing in climbing difficulty and bouldering. The application of the developed program has positively influenced the universalization of athletes without impairing the test indices characteristic of their main specialization.

The rock climber training program promoted the improvement of individual competitive results in the discipline "Climbing Combined" without loss of performance in the main specialization of athletes.

Acknowledgements

The study was conducted in accordance with the research work of Ministry of Education and Science of Ukraine for 2019–2020 «Theoretical and methodological foundations of technology development for the restoration of musculoskeletal system and functional state and prevention of injuries of representatives of different age groups in physical culture and sports» (№ 0119U100634).

Conflict of interest - Authors state that there is no conflict of interest.

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