Competitive modelling in speed climbing.

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Abstract. The article analyzes the available scientific and methodological literature about training in the discipline of speed climbing. The speed climbing wall is described. It is divided into three parts with different characteristics, to clarify the specifics of the competitive distance. The physiological characteristics of competitive activity in speed climbing were studied.

1 Introduction

Separation of climbing into different disciplines and types of climbing has enough reasons, both physiological and technical. Lead climbing and bouldering have more common characteristics in training, movement, biomechanical and physiological processes. Speed climbing differs significantly from the previously indicated disciplines in most parameters. Much of the scientific work in rock climbing focuses on lead climbing and bouldering. This is due to the historical background for the development of these disciplines. Speed climbing is a younger discipline. And it does not have such a wide distribution in amateur (recreational) climbing.

Competitive activity in any sport is a key aspect of an athlete's activity, demonstrating his training result. In rock climbing, competitive activity is expressed primarily in overcoming a rock route, however, depending on the discipline. There are huge differences in technique, tactics, physiology and biomechanics. Knowledge about the model of competitive activity is the basics for rational and effective planning of an athlete's training.

2 Materials and methods

To form a competitive model, we conducted the following studies:
- Analysis of scientific and methodological literature;
- Description of the speed wall;
- Model of competitive activity in speed climbing;
- Physiological characteristics of speed climbing athletes.

We analyzed the existing researches about the discipline of speed climbing, and identified the main directions and problems of modern research in this area. A total of 8 international researches were analyzed.

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To conduct pedagogical research, we used the following methods: analysis, synthesis, video analysis, methods of mathematical statistics.

To determine the physiological characteristics of climbers specializing in speed climbing we carried out an experiment. We measured the abilities of the cardiovascular system (heart rate monitor) in three modes of the athlete's work: extreme, sub-maximal and moderate. Heart rate was detected using the Polar H10 sensor and the Polar Beat app. The experiment involved 18 members of the adult and youth men's national team of Russia.

3 Results and Discussion

3.1 Analysis of scientific and methodological literature

Many authors agree that cardiovascular performance is one of the most important factors in rock climbing. Sheel talks about the dependence of the heart rate on the difficulty of the route. It is only suitable for the lead climbing. The fear of fall also has a high level of influence on heart rate [1]. There is no such effect on the athlete during speed climbing. The route is always of the same category, as well as climbing time and top roping reduce the fear of falling off.

Giles's work, which combines research on physical traits, anthropometry and physiology, shows the general relationship of these elements with elite climbers. A high correlation of weight to success in climbing, the result of hand dynamometry with the difficulty category was shown. The significance of the cardiovascular system abilities is also shown: blood lactate, blood pressure and heart rate during climbing [2]. All research, unfortunately, only deals with climbing in the lead and bouldering. It limits the use of data for other disciplines. However, the significance of measuring strength indicators, indicators of the cardiovascular system in climbers of various qualifications is confirmed.

The importance of anthropometric characteristics with performance in rock climbing has been repeatedly determined. An analysis of studies from 1993 to 2009 shows a high importance of both body weight and percentage of fat in relation to grip strength. However, like other studies, the data are for climbers who specialize in lead and bouldering [3].

Krawczyk dedicate a lot of researches to the discipline of speed climbing. In one of the researches of elite female rock climbers specializing in speed climbing, he determined significant ($p < 0.01$) anthropometric parameters: height, weight and lean mass. Also in this work, he defined the nature of the competitive work as anaerobic alactate [4]. The author, comparing amateurs of rock climbing with qualified rock climbers specializing in speed climbing, substantiated the significance ($p < 0.01$) of the following tests: sit-ups for 30 seconds. (number of times), jump height, maximum anaerobic power of lower limb. These results show the special features in the qualified speed climbers preparedness [5].

When studying speed climbing, Ozimek found significant relationships at $p < 0.05$ between climbing time and relative power. He suggested using the Margaria-Calamen test to study the power of the lower limb [6].

The model characteristics of young speed climbers were reviewed by Shulga. In his work, he divided speed climbers into 3 types according to anthropometric indicators: high, medium and low. His work gives an understanding of various options for technical and tactical preparedness in speed climbing [7].

3.2 Description of the speed wall

Current scientific research on speed climbing has not addressed the analysis of the competitive route. All training methods are based on the personal experience of coaches

and are not described in the scientific literature. There is a standard scheme, according to which all holds on the route are placed. It makes possible to build on tactical techniques [8,9]. The diagram shows the difference between large holds and foot holds. The generally accepted method is to number large holds in order to make it easier to explain tactics. After analyzing climbing at international competitions, we divided the reference route into three sections: starting, variative and finishing.

3.2.1 Starting section

The highlighted section is characterized by two features: a static starting position of the race participant, and fixed climbing layouts. The detached part lasts up to the 6th hold and ends with the right hand position on it. There are two patterns for passing the starting part: classic and Tomoa skip.

The classic start consists in passing the starting part using a №4 hold. At the same time, the athlete's starting position is tilted diagonally to create inertia in the required direction. In this position, the leg is stands back for a more powerful push to the left.

Tomoa skip consists of skipping a №4 hold and going straight vertically through the starting section. The movement is carried out immediately from №3 to №5 and №6 holds. The starting position is exactly vertical, as is the position of the jogging leg. We do not consider movements with the legs. The direction of movement is set mainly by the hands.

3.2.2 Variative section

Starting from the №6 hold and up to the №16 hold, there is a variable part. There are many options of climbing that depending on the decision of the athlete. Combinations of arm and leg movements, torso pivots, the use of friction, and variations of hand grabs create variability. Errors and failures occur more often on this site than on others.

3.2.3 Finishing section

This section of the speed wall is the only one in which the single option for arm movements is possible. Simultaneous movement of hands to №18 holds, then simultaneous movement of arms to №19 and №20, right and left hands, respectively, after which touching the finish button (Fig. 3). The differences in the finish part are only in the movements of the legs.

3.3 Model of competitive activity in speed climbing

To describe the model of competitive activity we used the following characteristics:
- Time of climbing the distance.
- The number of hand moves (alternately and simultaneously).
- The number of leg moves (using friction and holds).

These characteristics make it possible to determine the ability of an athlete to perform certain moves in a certain period of time.

Table 1. Characteristics of conducting competitive activity at speed at different levels

№	Characteristic	Male	Female
1	Time of climbing the distance, sec.	6,00 (σ=0,23)	8,05 (σ=0,36)
2	The number of hand moves (overall)	16, 67 (σ=0,93)	19, 37 (σ=0,73)
3	The number of hand moves (	9,22 (σ=1,01)	7,34 (σ=1,39)

	alternately)		
4	The number of hand moves (simultaneously)	3,77 (σ=0,75)	6,01 (σ=0,67)
5	The number of leg moves (overall)	17,29 (σ=1,66)	19,47 (σ=1,05)
6	The number of leg moves (using holds)	13,22 (σ=1,14)	15,38 (σ=1,12)
7	The number of leg moves (using friction)	4,06 (σ=0,85)	4,1 (σ=1,06)

During the video analysis, we identified the following sides of technical preparedness: the number of moves with arms and legs in different positions per second, as well as differences in climbing technique for men and women in climbing at speed. Tables 1 show the averaged data based on the video analysis results.

The average value of arm moves in men is 16.67 times. With an average travel time of 6 seconds, we get a value of the number of hand movements per second, equal to 2.78 times / sec. In the same way, we calculated the number of leg moves equal to 2.88 times / sec. In one run, men make 9.22 movements with their hands alternately (55% of all moves) and 3.77 moves with their hands simultaneously. Such a difference in the number of moves can serve as a basis for resume that men need to pay attention to training the physical parameters of the hands and separately and at the same time equally. During the race, men push with their feet using holds much more often (13.22 times) than using friction (4.06 times). This indicates the preference using stable platforms for leg training, suitable for the principle of work on climbing holds.

The female speed climbing technique has other characteristics. The average frequency of arm moves is 2.45 moves / sec. It is 0.32 times less than in men. Similarly, in the moves with the legs, the frequency is 2.53 moves / sec and the difference is 0.35 times. This situation is explained by the general lag in the performance of women and the physiological characteristics of their body. But the difference is obvious between the number of alternate and simultaneous moves. They are equal to 7.34 and 6.01 times, respectively. Simultaneous moves make up 60% of all moves during the climbing. It indicates the need to pay more attention to the development of this type of movement. Leg moves, as in men, are mainly performed with a push using the holds (15.38 times), while only 4.1 times using friction.

3.4 Physiological characteristics of speed climbing athletes.

3.4.1 Anthropometric characteristics

According to many studies reviewed earlier, in rock climbing, anthropometric indicators have big importance. To study the influence of anthropometric indicators, we measured: height, weight, leg length, ape-index. Correlation analysis showed a high relationship of all these indicators with each other. (Table 2) This relationship shows that there is no need to measure all indicators separately, it is enough to measure one useful indicator. A great relationship with the rest was shown by the length of the leg; we will take this indicator in the future as a basis for measurements.

Table 2. Correlation table of the main anthropometric characteristics.

	Leg length, cm	Heigth, cm	Weight, kg	Ape-index, cm
Leg length, cm	1			
Heigth, cm	0,819*	1		
Weight, kg	0,721**	0,661**	1	
Ape-index, cm	0,765*	0,703**	0,550	1

p<0,05**, p<0,01*

Also, when comparing anthropometric indicators with technical ones, we revealed the relationship between the number of using the foot hold (p <0.01) with our own indicators: height (r = -0.886) and leg length (r = -0.792). With less reliability (p <0.05) with the same technical indicator, the following relationships were revealed: weight (r = -0.657) and ape-index (r = -0.773). This suggests that taller athletes with longer legs use fewer foot holds. What is remarkably absent is a significant correlation with general arm and leg movement.

3.4.2 Indicators of the cardiovascular system reaction to the competitive distance

Speed climbing has a sprint character. This is evidenced primarily by the reaction of the organism to the performance of competitive actions. However, it is worth paying special attention to the intensity of climbing the distance, which we divided into 3 types: extreme (Fig. 1), sub-maximal (Fig. 2), moderate (Fig. 3). These types differ in the time of climbing the distance, peak heart rate in the post-work period, as well as the chance of unsuccessful passage of the distance falls, false start, wrong moves).

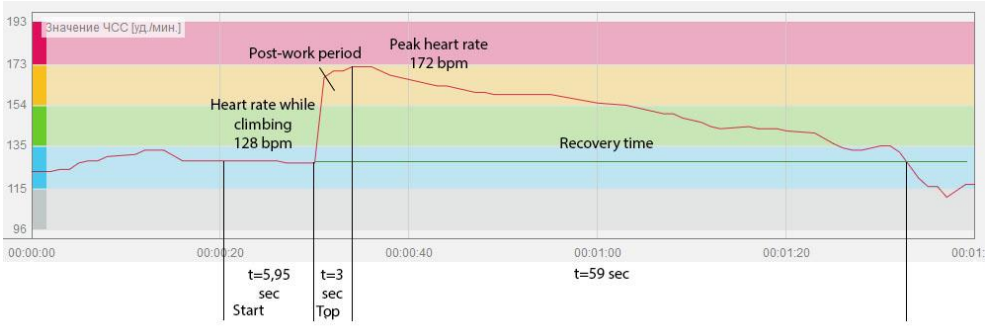

Fig. 1. Heart rate indicators during the extreme intensity on the competition distance.

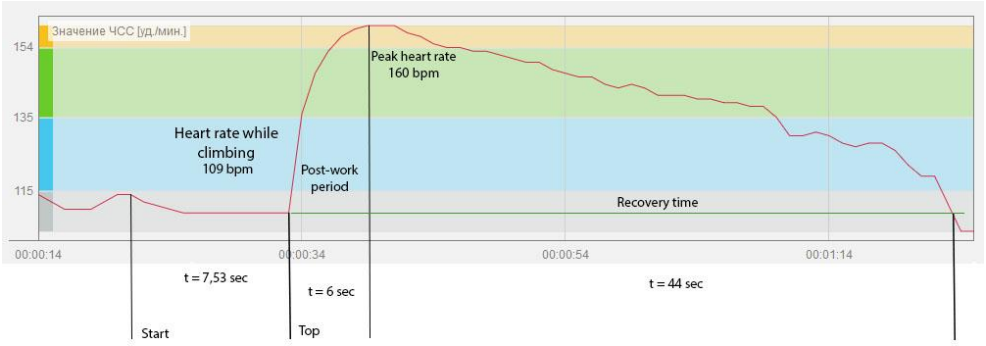

Fig. 2. Heart rate indicators during the sub-maximal intensity on the competition distance.

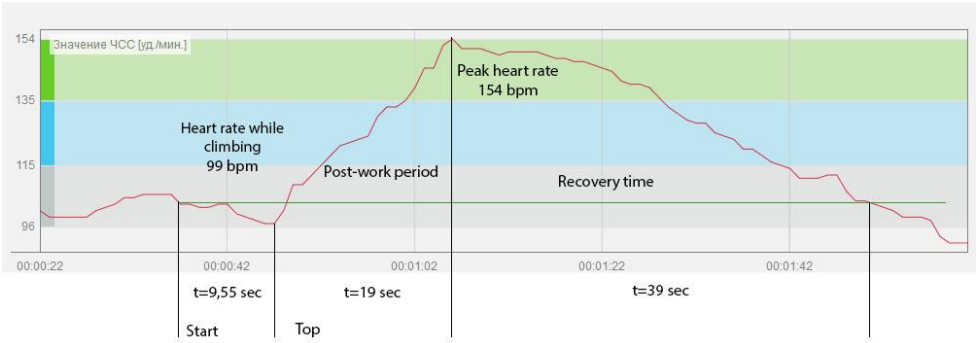

Fig. 3. Heart rate indicators during the moderate intensity on the competition distance.

A lower heart rate and a shorter recovery time allows for longer and more frequent work at a competitive distance. Combined with correct tactical training, the use of these 3 types of intensity will allow you to more accurately build competitive activity.

4 Conclusions

1. The standardized use of the split speed wall will improve the technical and tactical training of speed climbing athletes.
2. Using the obtained data about performance at the beginning and end of the competitive season, it is possible to predict the average climbing time and build a tactical performance plan.
3. Knowledge about physiological characteristics during competitive activity will allow building the functional training of athletes in accordance with the tasks set correctly.

References

1. A. Sheel, Br. J. Srorts Med. **38**, 355 (2004)
2. L. Giles, E. Rhodes, J. Taunton, Sports Med. **36(6)**, 529 (2006)
3. M. Michailov, L. Mladenov, V. Schoffl, Medicina sportive **13(4)**, 230 (2009)
4. M. Krawczyk, M. Ozimek, R. Rokosowski, M. Pociecha, P. Draga, Proceedings of the international Scientific Conference *Society.Integration Education.* Vol. IV, 118 (2018)
5. M. Krawczyk, M. Ozimek, Antropomotoryka. JKES **66(24)**, 25 (2014)
6. M.Ozimek, M. Krawczyk, R. Rokosowski, P. Draga, T. Ambrozy, D. mucha, J. Omorczyk, A. Stanula, M. Pociecha, K. Gorner, Trends in Srport Sciences **3(25)**, 149 (2018)
7. O. Shulga, sport science of Ukraine **1(59)**, 14 (2014)
8. IFSC Speed Licence Rules, **No 4-1**, 27 (2014)
9. A.S. Kuznetsov, Z.M. Kunetsova, Russian Journal of Physical Education and Sport, **14(4)**, 5-7 (2019)