Journal of Physical Education and Sport ® (JPES), Vol.20 (1), Art 17, pp. 131 - 137, 2020
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Optimization of the functional and speed-strength training of qualified skiers-racers during the preparatory period

OLEG KAMAEV[1], VIACHESLAV MULYK[2], SERHII KOTLIAR[3], KATERYNA MULYK[4], OLEKSANDRA UTKINA[5] ANDRIY NESTERENKO[6], TETIANA SIDOROVA[7], ALEXANDER TOPORKOV[8], TETIANA GRYNOVA[9]
[1,2,3,4,5,6,7,8, 9] Kharkiv State Academy of Physical Culture, UKRAINE

Published online: January 31, 2020
(Accepted for publication: January 05, 2020)
DOI:10.7752/jpes.2020.01017

Abstract.
Purpose: to determine the most effective methods and means of training and their ratio in the process of strength and functional training of qualified skiers-racers during the preparatory period. Material: The study involved 16 qualified skiers-racers aged 18-22 years. Two groups of 8 athletes were formed, and there were no significant ($p<0,05$) differences in the level of preparedness indicators. In the following research methods were used: analysis and generalization of scientific and methodological information, surveys and questionnaires of experts and athletes, pedagogical observation, testing, pedagogical experiment. Research methods: assessment of special strength qualities and functional fitness of athletes was carried out by specially selected control exercises: to overcome on the roller skaters the lifting of standard length and steepness (5-6° and 500 m) with a maximum intensity with a simultaneous, double pole technique and 1000 meters free style (free skating) "holding" a given tempo of movements during a shift work with the hands on the ski trainer for 30 s ; modified strength test (on a ski simulator) according to the method of V. L. Karpman. Conclusions: The use of dynamic and static exercises after aerobic stress in the training process of skilled athletes has made it possible to reliably increase the speed-strength and functional capabilities of skiers whose manifestation is necessary at the end of the competitive distance.
Keywords: ski races, speed-strength training, testing on a ski simulator, training during the preparatory period.

Introduction

Rapid improvement of the results in modern skiing races requires specialists of constant search for effective changes to the established standards of training techniques for athletes. Modern world practice puts forward new options for constructing a training process, a feasibility study for new approaches to it.

Speed-strength training is an integral part of the training process, aimed at increasing the physical and functional capabilities of athletes and achieving high results in the selected sport. [1, 2, 7, 9, 12].

Comparative analysis of various training programs suggests that improving the efficiency of the training process is due to the implementation of programs that include a deeper and more rational approach to the use of special strength training, the distribution of training loads, the determination of the optimal balance between various training tools [3, 4, 6 , 8, 10, 14]. These problems at the present stage of evolution of ski racing are seen as the most important and require the special attention of all specialists – scientists, coaches and athletes.

Greater attention is paid to strength training in ski racing due to the further intensification of the training process, contributes to the development of skiing: the complication of ski runs, competitions in high-altitude areas, the use of energy-intensive skating moves, the emergence of new types of programs (sprint, team sprint, skiathlon, etc.) what contributes to the ever-growing competition in international competitions.

The speed of a skier-rider when moving over a distance depends on the power of effort when pushing by skis and poles, which make up the speed-strength readiness of an athlete [1, 5, 7, 11, 13, 16].

Today, there is a steady tendency to use speed-strength exercises at the beginning of training sessions, while at the same time in ski races for qualified athletes, the manifestation of these qualities requires at the end of the competition distance, and ultimately determines the sports result.

According to experts, in particular O. I. Kamaev (2000, 2018), V. V. Mulyk (2003, 2016), A. Hemmersbach (2010), S. M. Kotliar (2005, 2017), who believe that the improvement of the training process of skiers-racers is associated with the search for the most effective combinations of loads of varying intensity, the search for new forms of organization of the training process using concentrated training loads of force orientation in special shock microcycles, as well as viewing the content of the preparatory period and the stage of direct preparation to responsible competitions [4, 8, 9, 10].

It has been established that in cross-country skiing with the classic style of repulsion with feet, they have an explosive character (0,17–0,19 s). Pushing with hands when moving at an average competitive speed is

Corresponding Author: TETIANA GRYNOVA, E-mail: tgrynova88@gmail.com

performed in a push-and-explosive mode (0,26–0,28 s). When moving with ridge moves, the work of the arms and legs during repulsion is carried out in a push-and-explosive mode (according to 0,24–0,28 s and 0,28–0,32 s). When overcoming short lifts by a simultaneous two-step speed-skating course, qualified athletes perform repulsion with their arms and legs in an explosive mode (O. I. Kamaev, 2000; G. G. Khokhlov, 2003). Considering the above, during the strength training of skiers-racers, exercises were selected that were performed in a plyometric mode on a ski simulator in an explosive mode [4, 12].

With regard to the functional training of skiers, according to modern data, at all stages of the preparatory period, as well as in direct preparation for competitions, 75-80% of the cyclic load is proposed to be performed in an aerobic mode, not a low-intensity threshold (T. Kosnegard 2011; T. Losnegard 2013; E. Tennessen, 2014) [16, 17, 19].

Studies [9] found that special exercises that are similar in structure to motor competitive actions most affect both the technical and, especially, the functional readiness of athletes. Therefore, the problem of finding new tools and methods for improving the power abilities of skiers-racers is of particular relevance.

Material and methods

Material: The pedagogical experiment was carried out in two experimental groups of 8 athletes each (age 18-22 years, qualification 1 category, Candidate in Masters Of Sport and Masters Of Sport of Ukraine, experience in sports 6-10 years). In order to solve the main task of the study, the training program of experimental groups did not differ in terms of time indicators, and was 14-15 hours in each micro cycle. Also, the volume, intensity of training loads, the ratio and sequence of use of tools and training methods did not have significant differences between the groups that participated in the study.

Research methods: to assess the dynamics of strength indicators, the results of athletes were used in individual exercises that are part of the strength complexes. assessment of special strength qualities and functional fitness of athletes was carried out by specially selected control exercises: to overcome on the roller skaters the lifting of standard length and steepness (5-6° and 500 m) with a maximum intensity with a simultaneous, double pole technique and 1000 meters free style (free skating) “holding” a given tempo of movements during a shift work with the hands on the ski trainer (*Ercolina, SportStar, Concept 2*) for 30 s ; modified strength test (on a ski simulator) according to the method of V.L. Karpman, that allows us to estimate the strength indicator (PWC170). For the analysis of the obtained data, generally accepted statistical processing methods were used in the work. All calculations were carried out according to the program STATISTICA 6.0, SPSS and Excel.

Results of the research

An experimental study was conducted in the base mesocycle of a special preparatory stage of the preparatory period. The mesocycle consisted of six seven-day microcycles: retractor, two – shock, restorative–maintenance, shock, and restorative (Figure 1).

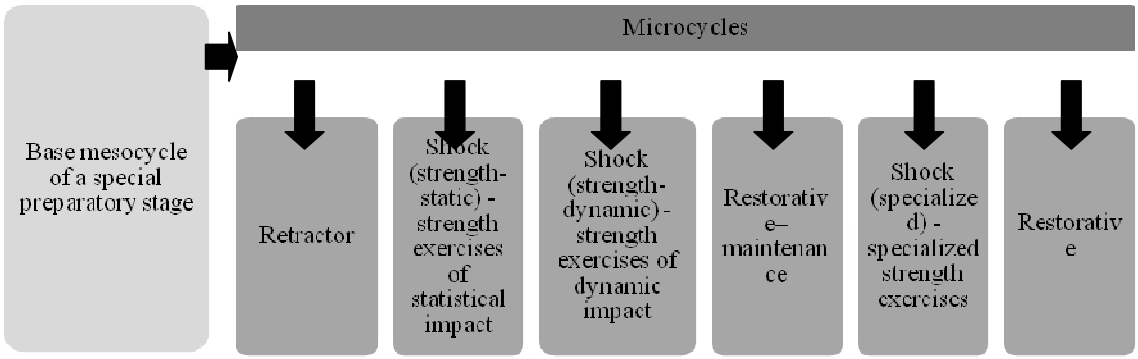


Figure 1. Plan of training of skiers-racers during the study.

The influence of various means of strength, aerobic, mixed and anaerobic orientation was studied in two groups of athletes.

In the first group (group "A") of skiers in one training session, dynamic strength exercises were provided after aerobic exercise.

In the second group (group "B"), in one training session, they included first strength and then aerobic or mixed loads. In both groups in each micro cycle, strength exercises were included in five, and in shock, in six training days.

The percentage of loads of varying intensity was:

– in group "A" – moderate intensity - 75%, variable – 15% and high – 10%;
– in group "B" – moderate – 20%, variable – 60%, high – 20%.

Testing and determining the level of strength and functional preparedness of athletes was carried out before and at the end of the experiment.

Analysis of the results of testing the physical and functional preparedness of skiers at the beginning of the experiment shows that none of the indicators studied were significant among the groups ($p<0,05$) (Table 1).

Table 1

Indicators of physical and functional preparedness of qualified skiers-racers before the experiment (n=12)

Indicators	Group «A»		Group «B»		t	p
	$\overline{x}$ ± m	*V, %*	$\overline{x}$ ± m	*V, %*		
10-fold jump, m	24,50±0,86	7,62	24,64±0,47	5,39	0,14	p>0,05
Squat for 30 s, count. time	28,29±0,41	4,10	27,87±0,32	3,26	0,81	p>0,05
Push-ups for 30 s, count. time	40,93±1,08	7,45	41,56±0,96	6,54	0,44	p>0,05
Torso lifting from a prone position for 30 s, count. time	25,51±0,69	7,64	25,33±0,54	6,04	0,21	p>0,05
Time to overcome the distance of 500 m, s on "double poling" style on roller skaters	95,46±1,47	5,31	96,31±1,38	5,12	0,40	p>0,05
Time to overcome the distance of 1000 m, s by free skating style on roller skaters	126,13±1,59	3,57	124,28±1,74	3,96	0,79	p>0,05
PWC $_{170}$, *c.u.*	15,39±1,47	25,38	15,86±1,34	23,89	0,24	p>0,05

A comparative analysis of the coefficient of variation (V) of the test results allows us to establish that in six of these indicators the athletes of group "A" had higher indices, which indicates their substantial variability and their statistical aggregate, that is, the significant difference in the results of individual athletes of this group.

Thus, the testing performance of skiers from group "B" was more uniform compared to the results of group "A".

After six weeks of training in two variants of the training program, which differed among themselves in different areas of the intensity of the load and the method of development of strength capabilities, athletes of group "A" significantly increased the strength and functional performance. Thus, the skiers of group "A" in three speed-strength exercises of four, compared with the data of the indicators of group "B", had a significantly better result in test exercises: 10-fold jump ($p<0,05$; $t=2,51$), squats for 30 s ($p<0,01$; $t=3,44$), torso lifting from a prone position for 30 s, count. time ($p<0,05$; $t=2,82$) (Table 2).

The results obtained in terms of speed-strength training of athletes of the group "A" allowed to significantly improve the result in relation to the skiers-racers of group "B" when overcoming on the roller skis with a "double poling" style 500 m distance ($p<0,05$; $t=2,62$).

Also, high rates were achieved in the test right PWC_{170} – 21,83 cond. units in group "A" against 17,69 cond. units in group "B" ($p<0,05$; $t=2,43$). At the same time, in two test exercises (push-ups and the time to overcome the 1000 m distance on roller skaters in free skating style) the difference between the data of the athletes of group "A" and group "B" was not reliable ($p>0,05$) (Table 2).

The analysis of changes in the control tests of the studied groups at the preparation stage indicates that the skiers of both groups improved the initial indicators in all test exercises. Comparative analysis allowed to establish that in group "A" the largest percentage of output increase is observed. Thus, as a percentage, the indicated indicator in group "A" ranges from 8,5 to 23,5%, and in group "B" it varies from 1,6 to 11,5% (Figure 2).

Table 2

Indicators of physical and functional preparedness of qualified skiers-racers after the experiment (n=12)

Indicators	Group «A»			Group «B»			t	p
	$\overline{x}$ ± m	*V, %*	Difference %	$\overline{x}$ ± m	*V, %*	Difference %		
10-fold jump, m	26,78±0,43	4,55	+9,3	25,05±0,54	6,06	+1,6	2,51	p<0,05
Squat for 30 s, count. time	31,63±0,53	4,74	+11,8	29,12±0,48	4,67	+4,4	3,44	p<0,01

Push-ups for 30 s, count. time	43,81±0,72	4,56	+9,5	42,28±0,81	5,41	+1,7	1,42	p>0,05
Torso lifting from a prone position for 30 s, count. time	28,84±0,48	4,68	+13,0	26,61±0,62	6,57	+5,0	2,82	p<0,05
Time to overcome the distance of 500 m, s on "double poling" style on roller skaters	88,26±1,44	4,29	-8,5	93,37±1,32	4,05	-6,0	2,62	p<0,05
Time to overcome the distance of 1000 m, s by free skating style on roller skaters	116,38±1,36	3,01	-8,6	120,15±1,68	3,74	-5,0	1,27	p>0,05
PWC $_{170}$, *c.u.*	21,83±0,98	11,85	+23,5	17,69±1,39	20,71	+11,5	2,43	p<0,05

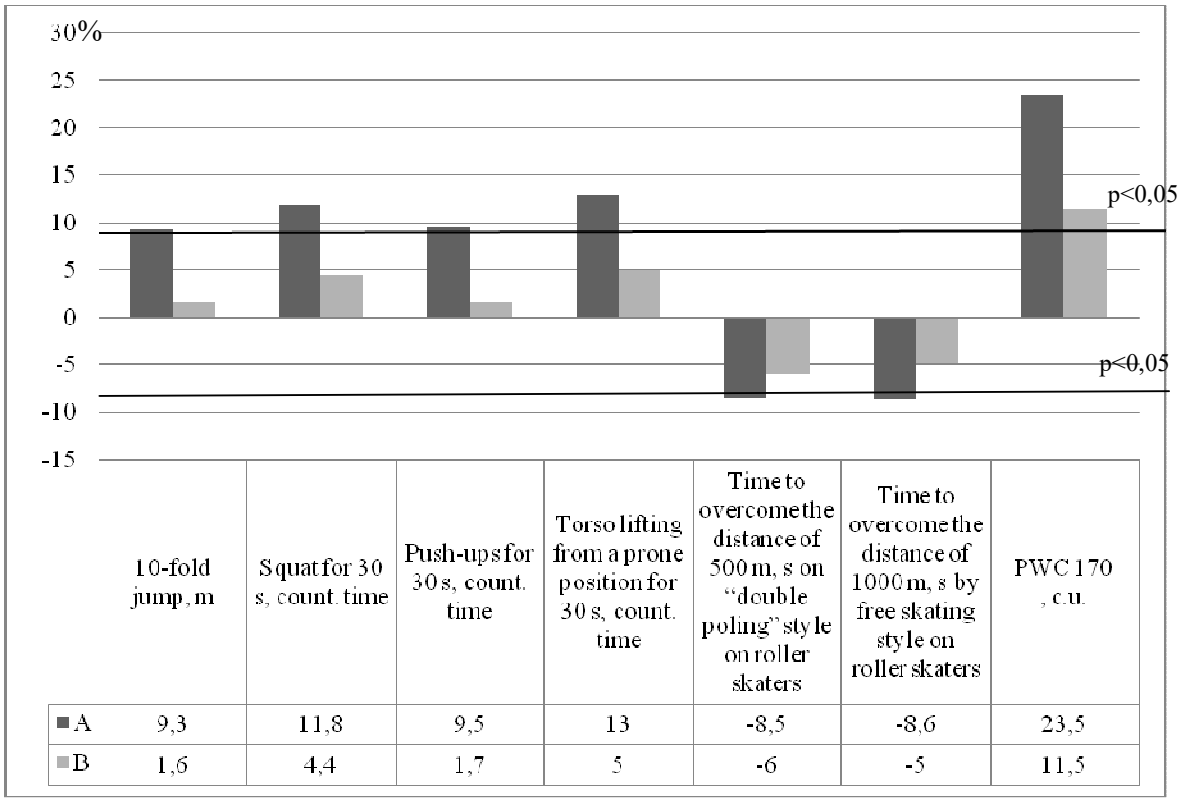
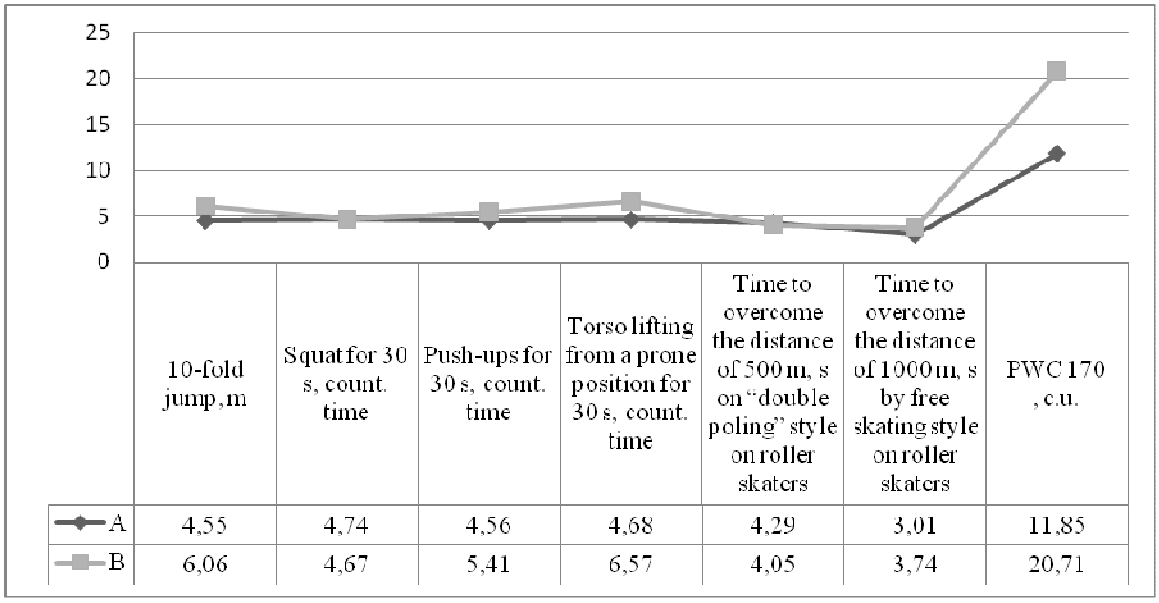


Figure 2. Dynamics of changes in the indicators of control tests of groups "A" and "B" " at the end of the study

Comparison of the coefficient of variation of the test results clearly shows that the skiers of group "A" in each test, this indicator is less than that of athletes of group "B" (Figure 3). The data obtained indicate that in group "A" of skiers-racers, along with a significant improvement in test results, the density and uniformity of indicators increased, and they were investigated.



	10-fold jump, m	Squat for 30 s, count. time	Push-ups for 30 s, count. time	Torso lifting from a prone position for 30 s, count. time	Time to overcome the distance of 500 m, s on "double poling" style on roller skaters	Time to overcome the distance of 1000 m, s by free skating style on roller skaters	PWC 170, c.u.
A	4,55	4,74	4,56	4,68	4,29	3,01	11,85
B	6,06	4,67	5,41	6,57	4,05	3,74	20,71

Figure 3. Comparison of the coefficient of variation (V) of the test results in groups "A" and "B" at the end of the study

Thus, it was established that the use of strength exercises after performing aerobic exercise and static exercises by qualified group A skiers allowed a significant improvement in speed-strength abilities and showed better results in test exercises. Performing most of the loads in the zone of moderate (aerobic) intensity in the first half of the workout in combination with speed-strength exercises in the second half of the workout allowed the athletes of group "A" to significantly increase their level of functional preparedness according to the PWC_{170} test on 23,4% ($p < 0,05$).

The results of the study showed that the training program in the experimental microcycle using dynamic exercises of dynamic and static nature, performed at the end of the training session, allowed to significantly increase the speed-strength capabilities of skilled skiers-racers, is one of the determining factors necessary for the manifestation at the end of the competition distance.

Discussion

The results of the study are a consequence of the construction of the training process, taking into account new approaches to strength and functional training in modern conditions of development of ski racing. The emergence of new types of competitions, a significant increase in the average distance speed significantly intensified the search for the most effective means and methods of training skiers-racers.

Numerous studies have established that the level of sporting achievements in ski racing largely depends on strength, speed-strength qualities and special endurance (G. G. Khokhlov, 2003; A. I. Kamaev, 2004; T. I. Dorofeeva, 2006; V . V. Mulyk, 2016, S. M. Kotliar, 2017; J. Kevil, 1998; T. Losnegard, 2013) [3, 7, 8, 12, 15].

Currently, for the development of strength abilities is quite broad, according to various data, from 8% to 15% of the time allocated to physical training, namely static exercises (V.N. Kurys, 2004; Yu. I. Grishina, 2011; A. Foure 2011; A. Hemmersbach, 2010). It is proved that the performance of static exercise several times increases the duration of stress and the energy cost of muscle work compared to dynamic exercises (J. Wilson, 2010). In addition, static load allows you to locally and intensively affect specific individual muscle groups, including small and deep muscle fibers involved in competitive exercises (V. N. Kurys, 2004; J. Wilson, 2010). At the same time, according to the authors (Y. Grimby, 1992; S. Beiler 2010; T. Kosnegard 2011; A. Foure 2011; E. Tennessen, 2014), it is necessary to take into account the mode of performing static exercises, affecting speed and aerobic capabilities. In this regard, these authors are invited after such loads to perform work with increased speed.

Only when overcoming short lifts and at the exit from a climb by a simultaneous two-step speed-skating course, qualified athletes manifest explosive work (A. I. Kamaev, 2000; G. G. Khokhlov, 2003). Therefore, in the course of strength training of skiers-racers, it is advisable to use exercises that are performed in the plyometric mode, and exercises in ski simulators of a static-dynamic nature, in which, with high muscle tension, hold the breath for 5-10-15 s and then explosive motor action.

The results of studies of the training program in the microcycle using strength exercises of dynamic, static and semi-dynamic nature at the end of training on different days of the microcycle allowed us to significantly improve the speed-strength capabilities of skiers-racers.

This contributed to an increase in the functional readiness of skiers-racers, which was facilitated during the general preparatory stage of the preparatory period to focus on training in the aerobic mode with a heart rate of 140-160 beats min^{-1}. This is not inconsistent with the data (T. Kosnegard 2011; T. Losnegard 2013; E. Tennessen, 2014) that during the preparatory period 70–75% of the cyclic load is recommended to be performed in aerobic mode, does not exceed the "low intensity threshold".

At a special preparatory stage, the emphasis of the load is carried out on the strength-static, strength-dynamic and specialized components of the speed-strength training of qualified skiers.

In drawing up an experimental training program, we took these recommendations into account, which allowed skiers to improve PWC_{170} in a modified strength test on a ski simulator by 23,4% ($p<0,05$).

Thanks

The research was carried out according to the subject of the research work of the chair of Olympic and professional sport of Kharkiv state academy of physical culture for 2016-2020 on the subject "Improvement of training process of sportsmen with limited physical capacities in different types of sport" (No. 0116U008944).

Conclusions

The advanced training program in the basic mesocycle of the specially-preparatory stage is based on six microcycles, including: retractor, two shock, recovery and preparatory, shock and recovery microcycles allowed qualified skiers to riders to significantly increase the speed-strength level (10-fold jump, squats for 30 seconds , torso lifting from a prone position for 30 seconds, $p<0,01$-$0,05$) and functional (PWC_{170}; $p<0,05$) preparedness.

The five-time use in each micro cycle of dynamic, static and semi-dynamic exercises of power orientation at the end of the training allowed to significantly increase the special speed-strength abilities in relation to skiers-racers of the control group in movement on the roller scooters by double poling style (500 m) ($p<0,05$; $t=2,62$)and 1000 m on roller skaters with free skating style($p<0,05$; $t=1,27$).

Conflict of interests

The authors declare that there is no conflict of interests.

References:

1. Viru A., Yurima є T., Smirnova T. (1988). Aerobic exercise. Moscow: Physical Education and Sport, 142 p. ISBN 5-278-00046-5 : 55 к.
2. Grishina Yu. I. (2011). Basics of strength training: to know and be able to. Rostov n / D: Phoenix, 280 p.
3. Dorofeeva T. I. (2006). Integral assessment of physical fitness of skiers-racers. Pedagogy, psychology and biomedical problems of physical education and sport: a scientific monograph edited by prof. Ermakova S.S. Kharkov: KSADA (KIPI). № 8. p. 29-31.
4. Kamaev O. I. (2000). Theoretical and methodological bases of optimization of the system of long-term training of young skiers-racers. [thesis] Dr. ped. sciences. Moscow, 357 p.
5. Kamaev O.I. Analysis of the correlation of the various sides of the preparedness of 18-20-year-old skiers-racers. Pedagogy, psychology and biomedical problems of physical education and sport: a scientific monograph edited by prof. Ermakova S.S. Kharkov: KSADA (KIPI) № 14. p. 65-71.
6. Kotliar S.N. (2005). Definition of functionality with the help of special testing. Physical education of students of creative specialties: Collection of scientific. works ed. Ermakova S.S. Kharkiv: KSADA (KIPI). № 7. p. 28-33.
7. Kotliar S.M., Moiseenko A.V. (2017) Improvement of special physical training of qualified skiers-racers 18-20 years in the preparatory period of the annual macrocycle. Collection of scientific papers of the Kharkov State Academy of Physical Culture. Kharkov: KSAPC, 2017. № 4. p. 126-130
8. Mulyk V.V. (2004). Comparative analysis of the competitive activities of skiers-racers at various distances. Science in the Olympic sport. Kiev: NYPES. № 3, p. 31-38.
9. Mulyk V.V., Nesterenko A.Yu. (2015). Influence of the use of power complexes deft indicators of special muscle strength of the shoulder girdle of athletes of the Paralympic Ukrainian team in ski racing and biathlon during the preparatory period // Slobozhansky collection of scientific and sports bulletin: [science. theor. magazine]. Kharkov: KSAPC, № 3 (47). p. 69-74.
10. Hemmersbach A., Franke S. (2010). Ski race. Equipment. Preparation of skis. Equipment. Training: [translated from the German.]. Murmansk: Tuloma, 2010. 170 с. : ил.
11. Khokhlov G.G. (2002). Analysis of the training structure of skiers-racers. Pedagogy, psychology and biomedical problems of physical education and sport: a scientific monograph edited by prof. Ermakova S.S. Kharkov: : KSADA (KIPI), No. 23. P. 85-92.

12. Khokhlov G.G. (2003). Speed-strength training of qualified skiers-racers in the preparatory period, taking into account their participation in sprint competitions. [thesis] of the candidate. Sciences in the physical. ed. and sports. Kharkiv: 191 p.

13. Beiler S. (2010). Whats is Best Practsce for Training Intensity and Duration Distribution in Endurance Athletes? Int J Sports Physiol Perform 5: 276-291.

14. Grimby Y. (1992) Clinical aspectsw of strength and power training in sport. – Blackwell scientific publications. P. 338-354.

15. Kevil J., Haralumbie Y. (1998). The Aciantation of the Energy supply in Muscle to Phisical Activity Ergonomics, V. 20 №5. 285p.

16. Kosnegard T., Mikkelsen K., Ronnestad B., Hallen J. (2011). The effect of htavy strength training on muscle mass and physical perfomance in elite cross country skiers. Scandf J . Med Sci Sports. 21: 341-389.

17. Losnegard T., Myklebust H., Spencer M., Hallen J. (2013). Seasdonal variations in VO2max , O2 cost, O2-deficit and Perfomance in elit cross-country skiers J Strength Cond Res 27: 1780 – 1790.

18. Foure A., Nordez A., Me Nair H. (2011). Effects of phyometric training on both active and passive parts of the planturflexors series elastic component stiffness of muscle-tendon comnlex. Eur.J. Appl Physiol. 111: 539-548.

19. Tennessen E., Jylta O., Thomas A., Erlend H., Svendsen S., Seiler S. (2014). The Road to Yold: Training and Peaking Characteristics in the Ytar Prior to a Gold Medal Endurance Performance. htts: doi. org |10.1371| journal. Ponc. 0|01 796.

20. Wilson J.M. (2010) Effects of static stretching on energy cost and running enduranct ptrfomanct. Journal of Strength and Conditiong Restarch. V 24(9). P. 2274-2279.