Improving the training of young cross-country ski racers at the stage of specialized preparation

https://doi.org/10.65149/eajss.2026.v6i2.a004

[1]Kaynazarov Nurkanat Dulatovich

[1]Uzbekistan state university of physical education and sport, Chirchik, Uzbekistan

Abstract

Purpose: To investigate the characteristics of training organization for young cross-country ski racers at the stage of advanced specialization.

Materials and methods. The experimental study involved 34 skiers aged 14–16 years who had at least 5 years of regular training experience and a sports qualification ranging from the third to the first category. To solve the research objectives, a complex of methods was used: theoretical analysis of specialized literature, survey (questionnaire), observation of the pedagogical process, testing of physical qualities, experimental intervention, and statistical processing of the obtained numerical data.

Results and discussion. The analysis of the training process structure showed that the basic elements for developing explosive strength and speed are: plyometric complexes (depth jumps followed by rebound, jumping lunges), active games including jumping activities, exercises on strength training machines, and work with small external loads (not exceeding 10–15% of the athlete's body weight). The key methods of training organization were identified as the repetition method, interval method, and circuit method. It was revealed that including auxiliary exercises in the training program in the amount of 40–45% of the total training time (compared with the standard 24–27%) leads to a significant improvement in the speed-strength abilities of young athletes. This approach allows harmonious development of the musculature directly involved in skiing movements (statistically significant differences, $p < 0.05$).

Conclusion. The experiment demonstrated that for the effective development of sports mastery among 14–16-year-old skiers at the stage of specialized training, an optimal distribution of training load across preparation sections is required. For the age group of 14–15 years, the recommended ratio of general physical training (GPT), auxiliary, and special training is 45%, 40%, and 15% respectively. For athletes aged 15–16 years, the proportions shift toward greater specialization: 35% (GPT), 45% (auxiliary), and 20% (special training). In addition, to improve endurance and functional capabilities of 15–16-year-old skiers, it is advisable to increase the volume of training loads in the second intensity zone to 38–42%. To stimulate the development of speed-strength qualities, the volume of exercises performed in the fourth and fifth intensity zones should account for 17–23% of the total training volume ($p < 0.05$).

Keywords: young cross-country ski racers, specialized training, training load volume, intensity zones, speed-strength training.

Introduction

The increasing level of competition in modern cross-country skiing, as well as the growing importance of sprint disciplines that require a special approach to increasing training intensity, determines the need to revise existing training methods. As is known, the contribution of aerobic mechanisms to the energy supply of competitive activity varies: in sprint races it is within 70–75%, whereas in long-distance events it reaches 85–95% [1]. Practice shows that when overcoming uphill sections, skiers often develop efforts exceeding the threshold at which maximal oxygen consumption is achieved. Accordingly, the share of anaerobic energy can increase up to 40% in sprint events and range from 10 to 20% in long-distance races [2, 3, 4, 5, 6].

Initial scientific studies on the development of athletes' aerobic capabilities were mainly based on data obtained from physiological testing [7, 8, 9]. Issues related to the analysis of training loads have also been addressed in several studies [10, 11, 12]. However, only a limited number of publications provide a detailed analysis of specific training tools and methods, as well as aspects of technical preparation of young skiers at the stage of advanced specialization [4, 13].

An analysis of specialized literature revealed that the periods of greatest sensitivity of the body to the development of speed-strength abilities occur in girls at the ages of 9–10 and 12–14 years, and in boys at 9–10 and 13–15 years. Researchers emphasize a stable age-related dinamic in the development of these qualities among young skiers. Thus, the total increase in absolute indicators of speed-strength preparedness from 11 to 17 years, taking into account natural growth processes, amounts to approximately 52% [7, 8, 12].

According to several authors [2, 4, 7, 8], progress in the training of cross-country skiers is directly related to the search for new and more effective combinations of loads of varying intensity, the introduction of innovative forms of training organization (in particular, the use of concentrated strength blocks within specialized

microcycles), and the optimization of the structure of the preparatory period and the stage of tapering for major competitions.

Within the framework of this study, particular attention is paid to investigating the effectiveness of using strictly dosed muscular loads performed by a discrete method with variable duration of work intervals as a means of developing special endurance within the annual training cycle. In modern cross-country skiing, there is a clear trend toward intensification of training, as a result of which high-intensity and prolonged loads are already applied at the early stages of long-term athletic development. Such influences place extreme demands on the functional systems of the young athletes' organism. At present, there is no unified opinion regarding the optimal distribution of the volumes of different types of training for this age category, nor have scientifically substantiated parameters for training sessions of various orientations been clearly defined.

Methods

The experimental part of the study was conducted with the participation of 34 young athletes aged 14 to 16 years. All participants had at least five years of regular cross-country skiing training experience and sports qualification levels ranging from the third to the first category. To ensure the reliability of the experiment and the correctness of comparisons, the training programs in the groups were unified in terms of time expenditure: the total training load in each weekly microcycle amounted to 14 –15 hours. The indicators of training volume and intensity, as well as the sequence of alternation and proportions of the applied means and methods in the studied groups, were identical.

The collection of primary information was carried out through the analysis of the practical activities of coaches and the study of reporting and planning documentation. During the research, the following materials were analyzed: 8 annual training plans, 3 working training programs, 12 documents of current planning of the training process, 6 reports of coach-instructors, 40 individual athlete training diaries, and more than 18 competition protocols of various levels and control trials. In addition, methods of pedagogical observation and surveys of coaches and athletes were applied. The dynamics of strength development were assessed based on the results demonstrated by athletes in specific exercises included in the structure of training complexes. To monitor the level of special strength preparedness and functional condition, a set of specially selected control tests was used.

The selection of specific research methods was determined by the formulated aim and objectives of the study, as well as by generally accepted requirements for conducting pedagogical experiments. The following methods were applied in the research: theoretical analysis and synthesis of scientific and methodological literature data, questionnaires and surveys, pedagogical observation, control testing, and a formative pedagogical experiment. The processing of the obtained numerical data was carried out using standard methods of mathematical statistics. All calculations were performed using the software packages STATISTICA 6.0 and Excel.

Results and discussion

The pedagogical experiment was conducted over a period of two years and involved two groups of cross-country skiers aged 14–16 years. The key objective was to experimentally substantiate the effectiveness of using training means of different physiological orientations (strength, aerobic, anaerobic, and mixed), as well as to study the influence of training session structure, differentiated by skiing techniques, on the level of preparedness of young athletes. During the analysis of training diaries and planning documents, it was established that during the preparatory period, along with exercises specific to cross-country skiing, various means of general physical training were actively used. These auxiliary means included swimming, cycling, sports and active games, training on strength machines, and exercises with elastic resistance bands. The analysis of the completeness of recording these activities in athletes' diaries revealed the following distribution: swimming was mentioned in only 39% of the diaries, cycling training in 52%, while active and sports games were recorded in 96% of cases. Work on training machines, as well as imitation (technical) and jumping exercises, were noted in all diaries (100%). A full (100%) record was also observed for all types of cyclic training: cross-country running, skiing and roller skiing, and dynamic imitation exercises.

The study of coaching documentation and athletes' records made it possible to determine the total volume of strength training within the annual cycle. For female athletes, this indicator

Table 1. Main parameters of training loads in the annual cycle of cross-country skiers at the stage of specialized training

Indicator	Preparatory (CG)	Preparatory (EG)	Competitive (CG)	Competitive (EG)	Transitional (CG)		Transitional (EG)	Total (CG)	Total (EG)
Training days	182	99	–	–	30		–	311	–
Training sessions	182	99	–	–	30		–	311	–
Competitions & control trainings	9–10	12–14	–	–	–		–	20–24	–
Theoretical classes	12	12	–	–	4		–	26	–
General physical exercises (min)	3360	3300	1000	900	410		450	4770	4650
Running & cross-country (km)	313	300	163	100	65		100	541	450
Short-distance running (m)	950	1800	600	600	–		–	1550	2400
Jumps (times)	820	1000	75	75	30		200	925	1275
Strength exercises (min)	1300	1500	720	650	450		500	2470	2650
Cycling (km)	320	210	–	–	50		30	770	640
Swimming (min)	110	95	–	–	250		190	360	285
Gymnastics (min)	2150	1900	390	330	265		220	2805	2450
Rowing (min)	650	550	–	–	70		60	720	610
Tourism & hiking (km)	80	60	–	–	20		15	100	75
Zone I (120–130 bpm, %)	40	15	30	40	50		60	120	115
Zone II (130–140 bpm, %)	30	40	20	20	40		20	90	80
Zone III (140–150 bpm, %)	10	10	15	10	10		10	35	30
Zone IV (160–170 bpm, %)	12	15	25	20	–		10	37	45
Zone V (170–180 bpm, %)	8	10	10	10	–		–	18	20
Special physical training (min)	3435	3500	1200	1100	410		400	5045	5000
Roller skiing (km)	390	500	–	–	–		100	390	600
Simulator training (min)	490	600	60	100	–		200	550	900
Cross-country skiing (km)	520	500	1170	1130	–		–	1690	1630
Alpine skiing (min)	530	550	250	200	–		–	780	750
Testing (hours)	9	5	–	–	–		–	16	–
Competition participation	6	10	–	–	–		–	16	–

ranged from 12.5–15% of the total training volume, whereas for male athletes it was higher,

Table 2. General Physical Fitness Indicators of Cross-Country Skiers at the Beginning of the Experiment ($n_k = n_e = 17$)

Indicators	CG ($\bar{X}_k \pm m_k$)	EG ($\bar{X}_e \pm m_e$)	t	p
Multiple jumps (10 jumps), m	25.05 ± 2.25	25.13 ± 2.09	1.14	> 0.05
Triple jump, m	9.73 ± 1.24	9.51 ± 1.35	1.54	> 0.05
Squats in 30 sec, reps	28.4 ± 3.85	27.8 ± 3.42	0.13	> 0.05
Push-ups, reps	55.6 ± 3.16	53.6 ± 3.91	0.26	> 0.05
Pull-ups on bar, reps	18.4 ± 2.47	21.9 ± 2.31	2.01	> 0.05

Table 3. Special Physical Fitness Indicators of Cross-Country Skiers at the Beginning of the Experiment ($n_k = n_e = 17$)

Indicators	CG ($\bar{X}_k \pm m_k$)	EG ($\bar{X}_e \pm m_e$)	t	p
Roller skiing 1000 m (free style), s	125.4 ± 1.71	129.6 ± 1.05	0.46	> 0.05
Roller skiing 500 m (double poling), s	95.5 ± 1.84	99.7 ± 1.89	0.30	> 0.05
Uphill 6–9° (two-step skating technique), 100 m	21.5 ± 1.2	21.6 ± 1.4	0.05	> 0.05
Skating without poles uphill 3–4°, 100 m	45.1 ± 1.5	44.0 ± 1.5	0.52	> 0.05
Double poling uphill 5°, 100 m	48.9 ± 1.6	48.7 ± 1.4	0.09	> 0.05
Skating without poles on flat terrain, 100 m	16.9 ± 1.5	16.6 ± 1.2	0.16	> 0.05
Double poling on flat terrain, 100 m	18.5 ± 1.1	18.6 ± 1.2	0.06	> 0.05
Ski ergometer "Concept 2" (180 s), m	1091.2 ± 12.1	1088.1 ± 13.5	0.17	> 0.05
PWC170 (working capacity), a.u.	15.8 ± 2.34	15.1 ± 1.67	0.22	> 0.05
PFS (psychofunctional state), a.u.	75.5 ± 3.45	71.8 ± 4.56	0.35	> 0.05

amounting to 20–25%.

For the proper selection of training loads, a preliminary analysis of competitive activity was conducted, based on which exercises corresponding to the main biomechanical parameters of the competitive movement (kinematic, dynamic, and energetic characteristics) were selected. The movements identified through biomechanical and pedagogical analysis were tested during the experiment. At the stage of testing, those exercises that, although increasing the strength of certain muscle groups, negatively affected the rational technique of skiing movements were excluded from the complex.

In accordance with the purpose of the study, two groups of athletes were formed. While maintaining approximately equal total parameters of training volume and intensity, the groups differed significantly in the sequence of application and the ratio of different training means, as well as in the skiing and roller-skiing techniques used (data presented in Table 1). The athletes of the control group followed the traditional training structure typical for this stage of preparation. In contrast, the training process in the experimental group was organized according to the author's methodology.

In the experimental group, both skating and classical techniques involved the use of a wide range of training means: general preparatory, auxiliary, special preparatory, and imitation exercises adapted to a specific skiing technique. A characteristic feature of the methodology was the frequent alternation of techniques and corresponding exercise complexes—almost within each individual training session. As a result, during both the first and second years of the experiment, the total training volume performed using skating and classical techniques was distributed approximately equally.

During the analysis of the results of the study aimed at optimizing the training process of cross-country skiers at the stage of advanced specialization, the key criteria for selecting training means and methods were: biological maturity of the organism, individual rates of

Table 4. General physical fitness indicators of cross-country skiers after completion of the experiment

Indicators	CG Before ($\bar{X}_k \pm m_k$)	CG After ($\bar{X}_k \pm m_k$)	EG Before ($\bar{X}_e \pm m_e$)	EG After ($\bar{X}_e \pm m_e$)	Between Groups (t, p)
Multiple jumps (10	25.05 ± 2.25	27.43 ± 2.11	25.13 ± 2.09	29.78 ± 1.34	t = 0.94; p > 0.05
Within-group signifi-	t = 0.77; p > 0.05		t = 1.87; p > 0.1		
Triple jump, m	9.73 ± 1.24	11.13 ± 1.12	9.51 ± 1.15	13.56 ± 1.01	t = 2.11; p < 0.05
Within-group signifi-	t = 0.83; p > 0.05		t = 2.40; p < 0.05		
Squats in 30 s, reps	28.4 ± 3.85	28.7 ± 2.24	27.8 ± 3.42	28.6 ± 1.32	t = 0.04; p > 0.05
Within-group signifi-cance	t = 0.07; p > 0.05		t = 0.22; p > 0.05		
Push-ups, reps	55.6 ± 3.16	60.8 ± 4.12	53.6 ± 3.42	78.3 ± 3.21	t = 3.35; p < 0.01
Within-group signifi-	t = 1.00; p > 0.05		t = 5.27; p < 0.01		
Pull-ups, reps	18.4 ± 2.47	18.7 ± 1.34	21.9 ± 2.31	25.0 ± 3.17	t = 1.83; p > 0.05
Within-group signifi-cance	t = 0.11; p > 0.05		t = 0.79; p > 0.05		

Table 5. Special physical fitness indicators of cross-country skiers after completion of the experiment

Indicators	CG Before ($\bar{X}_k \pm m_k$)	CG After ($\bar{X}_k \pm m_k$)	EG Before ($\bar{X}_e \pm m_e$)	EG After ($\bar{X}_e \pm m_e$)	Between Groups (t, p)
Roller skiing 1000 m (free style), s	125.4 ± 1.71	120.6 ± 1.89	129.6 ± 1.05	118.1 ± 1.11	t = 1.14; p > 0.05
Within-group significance	t = 1.88; p > 0.05		t = 7.53; p < 0.01		
Roller skiing 500 m (double poling), s	95.5 ± 1.84	85.3 ± 2.1	99.7 ± 1.89	79.8 ± 1.2	t = 2.27; p < 0.05
Within-group significance	t = 3.65; p < 0.01		t = 7.23; p < 0.01		
Uphill 6–9° (two-step skating), 100 m	21.5 ± 1.2	19.3 ± 0.8	21.6 ± 1.4	17.6 ± 0.7	t = 1.60; p > 0.05
Within-group significance	t = 1.53; p > 0.05		t = 2.56; p < 0.05		
Skating without poles uphill 3–4°, 100 m	45.1 ± 1.5	43.1 ± 1.5	44.0 ± 1.5	40.4 ± 1.3	t = 1.36; p > 0.05
Within-group significance	t = 0.94; p > 0.05		t = 1.81; p > 0.05		
Double poling uphill 5°, 100 m	48.9 ± 1.6	46.5 ± 1.6	48.7 ± 1.4	44.3 ± 1.5	t = 1.00; p > 0.05
Within-group significance	t = 1.06; p > 0.05		t = 2.14; p < 0.05		
Skating without poles on flat terrain, 100 m	16.9 ± 1.5	15.5 ± 0.7	16.6 ± 1.2	14.8 ± 0.6	t = 0.76; p > 0.05
Within-group significance	t = 0.85; p > 0.05		t = 1.34; p > 0.05		
Double poling on flat terrain, 100 m	18.5 ± 1.1	17.3 ± 0.9	18.6 ± 1.2	16.1 ± 0.5	t = 1.17; p > 0.05
Within-group significance	t = 0.84; p > 0.05		t = 1.92; p > 0.05		
Ski ergometer “Concept 2” (180 s), m	1091.2 ± 12.1	1134.6 ± 11.3	1088.1 ± 13.5	1178.0 ± 9.5	t = 2.94; p < 0.01
Within-group significance	t = 1.92; p < 0.05		t = 7.23; p < 0.01		
PWC170 (a.u.)	15.8 ± 2.34	17.7 ± 1.33	15.1 ± 1.67	19.3 ± 1.03	t = 0.95; p > 0.05
Within-group significance	t = 0.71; p > 0.05		t = 2.14; p < 0.05		
Psychofunctional state (PFS), a.u.	75.5 ± 3.45	77.7 ± 2.13	71.8 ± 4.56	80.9 ± 1.91	t = 1.12; p > 0.05
Within-group significance	t = 0.54; p > 0.05		t = 1.84; p > 0.05		

performance improvement, and the response to the applied training loads. Within the framework of the pedagogical experiment, two strategies for organizing training were compared, which made it possible to identify the specifics of the distribution of training elements taking into account age-related dynamics.

Monitoring of competitive activity was carried out through timing the completion of distance segments (recording the variability of pace and average speed) together with monitoring heart rate variability. During the general preparation period, the dominant position was occupied by methods ensuring a gradual increase in functional capabilities: the continuous (about one-third of the total volume) and variable (more than one-quarter) methods. Cross-country running, imitation exercises on uphill sections, and roller-ski training were used as the main tools for developing special endurance.

Initial testing did not reveal any significant differences between the participants of the control and experimental groups in terms of special qualities and technical mastery. A distinctive feature of the experimental group’s program was the emphasis on the development of speed-strength endurance and the introduction of a modular system of training blocks aimed at the combined improvement of physical capacities and technical skills.

The final measurements of general and special preparedness indicators (data presented in Tables 4 and 5) confirmed the higher effectiveness of the комплекс approach applied in the experimental group. This was reflected in the improvement of the integral indicators of preparedness among the young athletes.

The analysis of experimental data confirms that at the stage of preliminary basic training, the most effective approach is one in which complex training sessions occupy a dominant position, accounting for three quarters to 80% of

Table 6. Competition performance indicators of control and experimental groups of cross-country skiers after the experiment ($n_k = n_e = 17$)

Indicators	CG ($\bar{X}_k \pm m_k$)	EG ($\bar{X}_e \pm m_e$)	t	p
10 km race (classical	2262.3 ± 57.96	2065.4 ± 64.32	2.27	< 0.05
10 km race (skating	1980.2 ± 36.91	1835.6 ± 37.13	2.76	< 0.05
Sprint (classical style,	192.2 ± 8.04	161.8 ± 10.51	2.30	< 0.05
Sprint (skating style,	148.1 ± 4.14	123.3 ± 3.71	4.46	< 0.01

the total training time. The study substantiated the structure of physical training for young cross-country skiers, which includes three key components, each solving specific tasks:

General physical training component (GPT). Its content consists of exercises borrowed from other sports disciplines, as well as general warm-up complexes performed using various methods. The main goal is to ensure comprehensive physical development by engaging the maximum number of muscle groups and functional systems.

Auxiliary training component (APT). This section of training is aimed at improving motor abilities through means that differ from competitive movements in terms of kinematics but simulate the mode of neuromuscular activity and the level of functional stress characteristic of racing.

Specialized training component (SPT). This block is based on the application of exercises that directly replicate competitive movements. Such an approach ensures targeted adaptation of the body to the specific conditions of cross-country skiing, forming the necessary physical capacities.

Conclusion

Based on the conducted experimental study, the following conclusions were formulated regarding the optimization of the training process of young cross-country skiers at the stage of advanced specialization:

It was empirically substantiated that the most effective formation of the foundation of sports mastery is ensured through a differentiated approach to the distribution of training means depending on the age group: For athletes aged 14–15 years, it is advisable to maintain the following balance: the share of general physical training (GPT) – 45%, auxiliary training means – 40%, and special exercises – 15%. For athletes aged 15–16 years, a shift toward greater specialization is recommended: GPT – 35%, auxiliary training – 45%, special training – 20%.

During the study, the most effective set of means for developing explosive strength and power was identified: plyometric complexes (depth jumps followed by rebound, squat jumps), game-based tasks with a jumping component, strength training machines, as well as local external loads weighing up to 10–15% of the athlete's body weight. The leading training organization methods in this case are the repetition, interval, and circuit training methods.

The implementation of the proposed training structure and the use of the identified set of training means at the stage of specialized preparation ensured a comprehensive improvement in performance outcomes. This was expressed in the simultaneous improvement of technical proficiency (with an emphasis on adaptation to a specific skiing technique) and an increase in the level of functional capabilities of the organism through the application of specialized strength exercises.

References

Azhippo, A. Y. (2004). *Orientatsiya trenirovochnogo protsessa kvalifitsirovannykh lyzhnikov-gonshchikov s uchetom individualno-tipologicheskikh osobennostey fizicheskoy podgotovlennosti* [Orientation of the training process of qualified cross-country skiers considering individual-typological features of physical preparedness] (Extended abstract of candidate dissertation). Lviv.

Mulik, V. V. (2003). Kriterii podgotovki trenera v lyzhnom sporte dlya raboty s gruppami nachalnoy podgotovki [Criteria for training coaches in cross-country skiing for work with beginner training groups]. *Pedagogika, psikhologiya i mediko-biologicheskie problemy fizicheskogo vospitaniya i sporta*, (1), 3–9.

Khokhlov, G. G. (2003). *Skorostno-silovaya podgotovka kvalifitsirovannykh lyzhnikov-gonshchikov v podgotovitelnom periode s uchetom ikh uchastiya v sorevnovaniyakh po sprintu* [Speed-strength training of qualified cross-country skiers in the preparatory period considering their participation in sprint competitions] (Extended abstract of candidate dissertation). Kharkiv.

Bell, P. G., Furber, M. J., Van Someren, K. A., Anton-Solanas, A., & Swart, J. (2017). The physiological profile of a multiple Tour de France–winning cyclist. *Medicine & Science in Sports & Exercise, 49*(1), 115–123.

Bourgois, J., Steyaert, A., & Boone, J. (2014). Physiological and anthropometric progression in an international oarsman: A 15-year case study. *International Journal of Sports Physiology and Performance, 9*, 723–726. https://doi.org/10.1123/ijspp.2013-0267

Jones, A. M. (1998). A five-year physiological case study of an Olympic runner. *British Journal of Sports Medicine, 32*, 39–43.

AUTHOR BIOGRAPHY:



Nurkanat Dulatovich KAYNAZAROV

Employment
Researcher at Uzbekistan state university of physical education and sports

Degree
MD

Research interests
Physical education and sport, Theory of physical education, Analyzing of sport competitions

E-mail:
kajnazarov95@gmail.com