The evolution of physical attributes in elite ski racers aged 17 to 20 during the olympic training period

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Abstract

Objective of the study was to investigation of the development of physical attributes in elite ski racers aged 17 to 20 during the Olympic training period.

Методы и организация исследования. The research involved 11 athletes from the junior Russian national ski team, aged between 17 and 20, with a training experience ranging from 5 to 8 years. These athletes, with qualifications ranging from CMS to MS, participated in a series of comprehensive tests as part of the NMO program, which was conducted at the ROC Innovation Center and the Federal State Budgetary Institution FNC VNIIFK. The tests were conducted at the beginning and end of the preparatory period for the 2022-23 and 2023-24 sports seasons. The examination protocol included assessments of the athletes' explosive strength in the upper and lower body, as well as their speed and strength endurance in the upper body. The study employed a variety of research methods, including ergometry with test protocols on a strain gauge platform (performing jumping exercises at maximum power) and a SkiErg ergometer, Concept-2 (USA), which replicates the movement patterns of simultaneous strokes. Additionally, heart rate monitoring and methods of mathematical statistics were employed. The implementation of test protocols, instruments, and methods for monitoring the studied parameters was based on methodological guidelines developed for assessing the development of the key physical attributes of athletes in the national teams of Russia and their immediate reserves.

Results and conclusions. The findings of the comparative examination of the analyzed parameters suggest that a distinctive characteristic of the development of the key physical attributes among ski racers at the conclusion of the preparatory phase of their second year of training is a multilevel rise in the absolute and relative values of the explosive strength of the upper and lower limbs (work in one movement: Aabs. +2,3% and Altn. +1,8%), the legs (strength gradient: Chabs. +3,5% and Jotn. +3,0%), and the hands (power in the 5 PMR test: Nabs. +4,3% and Retn. +3,9%). Simultaneously, the disparities in relation to the model level of the 2022 Olympian are being eliminated, with a pronounced manifestation in the level of explosive arm strength (-7,3% and -7,1%), approaching the lower limit of the model level. However, there remains a significant lag in the level of explosive leg strength (-13,4% and -9,6%) and speed and strength endurance of the arms (-13,5% and -9,5%), particularly in absolute terms, which reflects their dependence on the overall size of the body.

Keywords: *cross-country skiers, age period 17-20 years, stages of the Olympic cycle, physical qualities, dynamics of indicators.*

Introduction. The results of studying the characteristics of the development of the leading physical qualities and abilities of cross-country skiers in the age period of 16-20 years in the annual training cycle made it possible to establish that both at the beginning and at the end of the first year of the preparatory period, physical qualities are characterized by a low level of absolute and relative values of the indicators of explosive strength of the muscles of the arms (ESM) and legs (ESM) and speed-strength endurance of the arms (SSE), which are significantly inferior to the level of model characteristics for adult athletes [1]. Thus, the degree of discrepancy in relation to the model level (in the 2022 KPP) for the absolute (Aabs.) and relative (Arel.) values of the HRV was -8,9% and -4,2%, respectively, for the value of the FGR (force gradient, Jabs. and Jrel.) was -16,3% and -12,2%, and for the value of the SSVR (power in a 5-minute test, Nabs. and Nrel.) was -17,1% and -12,9%. The need for a systematic study of the dynamics of the development of physical qualities of cross-country skiers in the age period of 17-20 years is due not only to the heterochronicity of the age-related development of the qualities and abilities themselves [1, 2], but also to the

fact that the emerging trend of disqualifying Russian athletes, including juniors, from participation in international competitions may lead not only to a decrease in the intensity of the functioning of energy supply systems and the neuromuscular apparatus in the conditions of competitive, but also training activities and, as a consequence of this, lead to a decrease in functional and motor (motor) potential in general.

Objective of the study was to investigation of the development of physical attributes in elite ski racers aged 17 to 20 during the Olympic training period.

Methods and structure of the study. According to the standardized program, at the beginning and end of the preparatory period of two sports seasons 2022-23 and 2023-24, comprehensive examinations were conducted of 11 athletes of the Russian junior national cross-country skiing team aged 17-20, with qualifications from candidate master of sports to master of sports. The study of the dynamics of the development of physical qualities was carried out on the basis of the following research methods: anthropometry, ergometry with testing procedures on a strain gauge platform (performing jumping exercises from two legs with arm swings from a static position corresponding to the start of the push-off (angle in the knee joint 120o) with maximum power) and a SkiErg, Concept-2 (USA) ski ergometer, which allows simulating the work of the arms when moving with a simultaneous step-less stroke (called in the English-language literature «double poling» [5, 6]) with competitive intensity in two modes: a single push-off with the arms with maximum power (test 1) and 5-minute work in competitive mode (test 2). The use of test procedures, means and methods for monitoring the studied physical qualities and indicators of body systems was carried out on the basis of methodological recommendations developed for highly qualified athletes of the Russian national teams and was carried out at the ROC Innovation Center and the Federal State Budgetary Institution Federal Scientific Center of Physical Culture within the framework of stage-by-stage comprehensive examinations at the beginning and end of each preparatory stage of the two-year training [3].

Results of the study and discussion. As a result of the conducted research, data were obtained that allow for a comparative analysis of the dynamics of the formation of leading physical qualities at the end of the preparatory period of two stages of the Olympic training cycle in terms of the magnitude of year-over-year changes in absolute values and the degree of deviation from the model level developed for the XXIV Winter Olympic Games 2022 in Beijing [4].
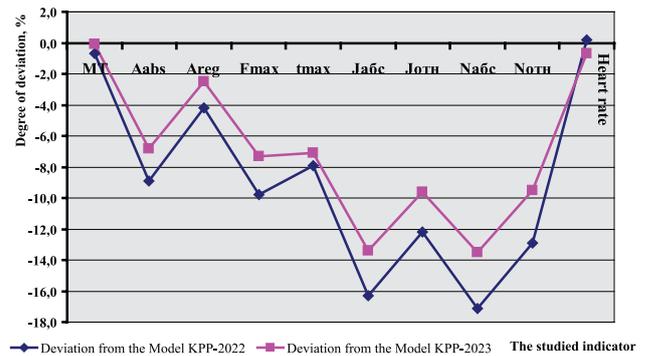
The degree of deviation of the indicators of explosive strength of arms, legs and speed-strength endurance of arms at the end of the preparatory period of two seasons of the Olympic cycle relative to the 2022 Olympian model

The established differences in the studied indicators, presented in the table and in the figure, indicate that a characteristic feature of the formation of explosive arm strength was that with a positive dynamics of year-over-year increase in the absolute (Aabs. + 2,3%) and relative (Arel. + 1,8%) value of work performed in one movement with maximum power, the studied indicators remain behind the model level (ML) in Aabs. = - 6,8% and in Arel. = - 2,5%. There remains a multi-level lag in the development of indicators of explosive leg strength, which is manifested in the degree of deviation from the MU in the absolute and relative value of the strength gradient (Jabs. = -13,4% and Jrel. = -9,6%), with positive year-over-year growth dynamics of the studied indicators (+3,5% and +3,0%, respectively). It should be noted that the year-over-year increase in the strength gradient indicators was ensured by a priority increase in maximum strength (Fmax=+2,8%) against the background of a slight decrease in the time to reach the peak level (tmax=-0,7%), indicating a more conservative dynamics of increasing the speed component of the strength gradient. A multi-level lag is also noted in the degree of deviation from the maximum limit in the development of the speed-strength endurance indicators of the arms: in the absolute and relative value of the work power achieved in the 5-minute test (Nabs. = -13,5% and Nrel. =-9,5%), with positive year-over-year dynamics (+4,3% and +3,9%, respectively), against the background of a decrease in the response of the cardiovascular system to the performed load (HRmax.=184,6 beats/min, Δ=-1,7 beats/min; -0,9%).

Conclusions. The results of the comparative analysis of the studied parameters show that the peculiarity of the dynamics of the development of the

Differences in absolute values and the degree of deviation of indicators of development of physical qualities at the final stage of snowless preparation of the preparatory period of sports seasons 2022/23 and 2023/24 of the Olympic cycle relative to the model of Olympian-2022 (Beijing)

| Study indicator | Weight | Explosive power | | | | | | Speed-strength endurance of arms | | |
| | | Hands | | Legs | | | | | | |
		Aabs.	Arel.	Fmax	tmax	Jabs.	Jrel.	Nabs.	Nrel.	Heart rate
Mean (KPP2022)	71,5	34,83	0,488	167,9	0,210	798,55	11,16	1400,0	19,61	186,4
Standard Deviation	6,2	2,85	0,037	17,6	0,003	89,73	0,74	123,9	1,16	5,6
Mean (KPP2023)	71,9	35,64	0,497	172,6	0,209	826,63	11,50	1459,8	20,36	184,6
Standard Deviation	6,3	3,03	0,042	17,8	0,002	90,74	0,86	117,4	1,60	3,1
Olympian Model -2022 (Beijing)	72,0	38,25	0,510	186,1	0,195	954,4	12,72	1688,0	22,5	186,0
	3,0	1,41	0,026	7,1	0,007	41,7	0,50	76,0	0,9	2,0
Deviation from Model in 2022	-0,7	-8,9	-4,2	-9,8	-7,9	-16,3	-12,2	-17,1	-12,9	0,2
Deviation from Model in 2023	-0,1	-6,8	-2,5	-7,3	-7,1	-13,4	-9,6	-13,5	-9,5	-0,7

leading physical qualities of cross-country skiers at the end of the preparatory period of the second year of the Olympic training cycle is the multi-level year-by-year increase in the absolute and relative values of the explosive strength of the arm muscles (work in one movement: Aabs. +2.3% and Aotn. +1.8%), legs (strength gradient: Jabs. +3.5% and Jotn. +3.0%) and speed-strength endurance of the arms (power in the 5PMR test: Nabs. +4.3% and Notn. +3.9%). At the same time, the elimination of differences in relation to the model level of the 2022 Olympian occurs with a dominant manifestation in the level of explosive strength of the arms (-7.3% and -7.1%, approaching the lower limit of the MU) and the preservation of a pronounced lag in the level of explosive strength of the legs (-13.4% and -9.6%) and speed-strength endurance of the arms (-13.5% and -9.5%), mainly in absolute value, reflecting its dependence on the total size of the body. The obtained results allowed us to formulate the position that the development of physical qualities of 17-20 year old cross-country skiers (in relation to adult athletes) in the second year of the Olympic training cycle occurs mainly due to an increase in absolute and relative values, manifested in the level of explosive strength of the arms, reaching definitive values and maintaining significant differences in relation to the level of indicators of explosive strength of the legs and speed-strength endurance of the arms, which act as a limiting factor in readiness for implementation activities in competitive conditions.

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