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SPECIAL PHYSICAL TRAINING IN SUMMER BIATHLON: THE EFFECTIVENESS OF A COMPREHENSIVE 12-WEEK PROGRAM IN YOUNG ATHLETES

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ABOUT ARTICLE

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Abstract: The aim of the study is to evaluate the effectiveness of a comprehensive special physical training program in summer biathlon aimed at developing special endurance, speed-strength qualities, postural stability at the firing line, and shooting accuracy after load. The study involved 24 biathletes aged 16–18 years, divided into an experimental group (n = 12) and a control group (n = 12). The pedagogical experiment lasted 12 weeks during the preparatory period. The experimental program included a larger volume of specific work on roller skis on terrain close to competitive conditions, combined "load-shooting" exercises, speed-strength training of the shoulder girdle and core stabilizer muscles, as well as breathing and postural exercises at the firing line. Methods: analysis of scientific literature, pedagogical observation, control testing, heart rate monitoring, and methods of mathematical statistics. It was found that after the experiment, athletes in the experimental group improved their results in the comprehensive test by 6.9%, in the control test "6 km on roller skis with a rifle" by 4.7%, shooting accuracy after load by 16.3%, time spent at the firing line decreased by 9.2%, and heart rate after 1 minute of recovery decreased by 9.4%. The improvements were statistically significantly higher than in the control group (p

< 0.001–0.013). The obtained data confirm the high effectiveness of a targeted combination of specific cyclic, speed-strength, and shooting training in the summer biathlon system.

Introduction. Summer biathlon is a crucial component of the annual training cycle, as it allows for the maintenance and development of specific motor skills, functional capabilities, and shooting stability outside the snow season. According to current IBU regulations, the summer biathlon program primarily includes roller ski competitions, including World Championships and other sanctioned events [9].

Modern research shows that the role of specific work is increasing in biathlon: elite athletes perform more training sessions on roller skis on terrain close to competitive conditions, pay more attention to the upper shoulder girdle, strength and power, as well as shooting quality under conditions of high functional stress [1]. At the same time, the contribution of the skiing component to the final result in the sprint is dominant: according to competition analysis data, course time can explain up to 84% of the variability in the final result, while the shooting component complements this picture and also has a significant impact [2].

However, in the training system for young biathletes, there remains a contradiction between the overall increase in workload volume and the need for more targeted development of special qualities specifically during the summer period. The literature emphasizes that as athletes transition from the junior level to the elite level, the volume of low-intensity and moderate-intensity specific work increases, as well as the number of shots, especially in combination with cyclic load [6; 7]. For coaches, this means the need for finer periodization of load and the combination of movement and shooting components within a single microcycle.

A separate scientific interest is the question of which components of special training yield the greatest training effect. It has been shown that targeted shooting training combined with psycho-regulation can improve accuracy without significant changes in maximum oxygen consumption [3], and physiological fatigue in qualified biathletes has a greater impact on the time spent at the firing line than on shooting accuracy itself [4]. Consequently, the coach's task is not only to improve general endurance but also to develop a stable technique for "fast entry" to the firing line, an economical breathing pattern, and rational switching after an intense segment of the course.

Purpose of the study is to scientifically substantiate and experimentally test the effectiveness of a comprehensive special physical training program in summer biathlon for young athletes.

Methods. The study was conducted over 12 weeks of the preparatory period (May–July) at the biathlon department of a sports school. The experiment involved 24 athletes aged 16–18 years, with a sports qualification of at least first category. Participants were divided into two groups comparable in age and fitness level: an experimental group (EG, n = 12) and a control group (CG, n = 12).

The control group followed a traditional program that included general cyclic and strength training, as well as a standard volume of shooting exercises. The experimental group, in addition to the basic program, performed a set of special means: 1) interval and variable work on roller skis with a rifle on terrain close to competitive conditions; 2) combined series of "segment on roller skis – prone/standing shooting"; 3) speed-strength exercises for the muscles of the shoulder girdle, core stabilizer muscles, and leg extensors; 4) breathing and postural exercises and stability training for the shooting position at the firing line; 5) monitoring of external and internal load based on heart rate data and session structure.

Results. The following control tests were used: a comprehensive test (3 x 1.5 km on roller skis + two firing lines), the "6 km on roller skis with a rifle" test, shooting accuracy after load (percentage of hits out of 10 shots), time spent at the firing line, and heart rate after 1 minute of recovery after a standard load. Results were processed using a statistical analysis program with Student's t-test at a significance level of $p < 0.05$.

Table 1.

Initial indicators of athletes before the start of the pedagogical experiment (M ± SD)

Indicator	EG (n=12)	KG (n=12)	p
Comprehensive test, s	1030.4 ± 34.5	1028.3 ± 22.1	> 0,05
Roller skis 6 km with rifle, s	1108.6 ± 43.1	1126.7 ± 37.4	> 0,05
Shooting accuracy after load, %	70.5 ± 4.9	71.9 ± 6.1	> 0,05
Time at the firing line, s	31.3 ± 2.4	31.5 ± 2.0	> 0,05
Heart rate after 1 min of recovery, bpm	133.1 ± 6.5	135.2 ± 8.3	> 0,05

Analysis of the initial testing showed the absence of statistically significant intergroup differences across all studied indicators (Table 1), which indicates the correctness of the sample formation and the comparability of the groups at the start of the experiment.

The structure of the experimental program was built around means as close as possible to the competitive activity of summer biathlon. The weekly microcycle included special interval

and combined training sessions, distributed in such a way as to develop both the speed of movement on roller skis and shooting stability after load.

Table 2.

Typical structure of the weekly microcycle of special training in the experimental group

Day	Основное содержание	Направленность	Объём стрельбы	Длительность
Mon	Roller skis 90 min on rugged terrain + "dry" shooting position	Special endurance, postural stability	80-100 выстр./имит.	110-120 min
Tue	Weight room + SkiErg/rubber expanders + balance platform	Speed-strength training, stabilization	40-60	75-90 min
Wed	Intervals 5 x 5 min on roller skis with rifle; after 3rd and 5th segment – shooting	Special work capacity, switching	40-50	95-105 min
Thu	Recovery training: running/roller skis LIT, breathing exercises, coordination	Recovery, technique economization	30-40	60-75 min
Fri	Combined circuit: 3 x (2 km + prone/standing firing line)	Competitive modeling	30-40	80-90 min
Sat	Control start or tempo work 6 km with rifle	Control of special preparedness	10-20	45-60 min
Sun	Rest / active recovery	Recovery	-	-

After completing the 12-week cycle, athletes in the experimental group showed more pronounced positive changes across all tested parameters compared to the control group (Table 3). The most significant differences were found in the comprehensive test, the 6 km roller ski time with a rifle, shooting accuracy after load, and time spent at the firing line.

Table 3.

Dynamics of special preparedness indicators after 12 weeks (M ± SD)

Indicator	EG: before	EG: after	Δ, %	KG: before	KG: after	Δ, %	pΔ
Comprehensive test, s	1030.4 ± 34.5	958.9 ± 33.9	6,9	1028.3 ± 22.1	1000.4 ± 32.0	2,7	< 0,001

Indicator	EG: before	EG: after	Δ, %	KG: before	KG: after	Δ, %	pΔ
Test 6 km with rifle, s	1108.6 ± 43.1	1057.2 ± 45.6	4,7	1126.7 ± 37.4	1110.1 ± 37.5	1,5	< 0,001
Shooting accuracy after load, %	70.5 ± 4.9	81.8 ± 4.5	16,3	71.9 ± 6.1	76.3 ± 7.6	6,1	< 0,001
Time at the firing line, s	31.3 ± 2.4	28.4 ± 2.5	9,2	31.5 ± 2.0	30.8 ± 1.9	2,1	< 0,001
Heart rate after 1 min of recovery, bpm	133.1 ± 6.5	120.7 ± 7.9	9,4	135.2 ± 8.3	128.5 ± 8.6	5,0	< 0,001

The obtained results indicate that the combination of special cyclic work, speed-strength training, and shooting stability exercises provides a higher training effect than the traditional training scheme. This was most evident in the comprehensive test, where the EG improved its result by 6.9% compared to 2.7% in the CG. A significant practical result was also an increase in shooting accuracy after load by 11.4 percentage points in the EG compared to 4.4 percentage points in the CG.

Discussion. It is important to note that the acceleration of work at the firing line was accompanied not by a deterioration but by an improvement in shooting quality. This is consistent with research data according to which, in qualified biathletes, physiological fatigue more often affects the temporal characteristics of work at the firing line than accuracy itself [4]. Consequently, training should be aimed at reducing "excessive" stabilization time and forming a stable respiratory-motor algorithm after an intense segment of the course.

The results of the conducted experiment confirm modern concepts of biathlete training. First, the high effect of specific work on roller skis is explained by the closeness of the motor structure to competitive activity, which corresponds to conclusions about the increasing specialization of elite biathlete training [1]. Second, the pronounced improvement in distance indicators is associated with the development of special endurance and the ability to maintain competitive pace on terrain; the significance of the skiing component was previously demonstrated in the analysis of biathlon sprint [2].

Second, the EG program included not only physical but also coordination-shooting means. Their effectiveness is confirmed by the fact that shooting accuracy after load increased more significantly than in the CG. This fact correlates with publications where a combination of special shooting training with psycho-regulation led to improved accuracy without significant changes in aerobic parameters [3]. Thus, part of the effect should be associated not only with

functional development but also with the improvement of regulatory mechanisms and motor efficiency at the firing line.

Finally, the chosen logic of the microcycle corresponds to modern concepts of long-term biathlete development: as skill increases, the volume of specific low-intensity and moderate-intensity work increases, as well as the number of shots performed in connection with cyclic load [6-8]. For summer biathlon, this is especially important because it is the preparatory period that sets the foundation for future winter competitive form.

The practical meaning of the obtained data is that special physical training means should be selected not in isolation but in a system. If a coach develops only general endurance without including transitional states of "intense work – stabilization – aiming – shot," the training effect is incomplete. Conversely, the inclusion of combined series and load monitoring allows for the formation of a more holistic special work capacity of the athlete.

Conclusion

1. Special physical training in summer biathlon should be built on a combination of specific cyclic load on roller skis, speed-strength training, and shooting exercises after load.
2. A comprehensive 12-week program provides a more pronounced improvement in sport-significant indicators compared to the traditional training scheme: it increases special endurance, reduces time spent at the firing line, improves shooting accuracy, and accelerates recovery.
3. The greatest effectiveness is demonstrated by combined training sessions that model competitive activity: intervals on roller skis with a rifle, circular series of "distance – firing line," exercises for shooting position stability, and respiratory-postural control.
4. For coaching practice, it is advisable to monitor both internal and external load, including heart rate indicators, duration of work, number of shots, and the structure of specific exercises.

Practical recommendations:

- During the preparatory period, include special sessions on roller skis with a rifle on rugged terrain at least 2-3 times per week;
- At least 1-2 times per week, model a competitive fragment with mandatory shooting after an intense segment;
- Use a separate block of speed-strength work for the muscles of the shoulder girdle, core, and legs;
- Monitor not only shooting accuracy but also the time of "entry" to the firing line, time to assume the shooting position, and the speed of heart rate recovery.

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