Journal of Physical Education and Sport ® (JPES), Vol.20 (6), Art 482 pp. 3579 - 3583, 2020
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Importance of continuous strength development in young biathletes in a one-year training cycle during a multi-year training process

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Published online: December 30, 2020
(Accepted for publication: December 15, 2020)
DOI:10.7752/jpes.2020.06482

Abstract.
The article presents a theoretical justification for the need to develop strength in the biathletes from the training groups during the entire one-year training cycle. The authors conducted the study aimed at determining the most effective method to plan the practice load volumeduringa training period for the development of strength and anaerobic strength endurance of various muscle groups. The research involved 56 first-rank biathletes aged 16-18 years having an approximately equal proficiency level in ski-skating techniques and the functional vigor level. The biathletes under study were divided into 3 groups supervised by variouscoaches-instructors and trained according to various training programs. The 1st biathlete group was focused mainlyon the lower limb strength development, the 2nd group – upper extremities, the 3rd group – comprehensive development of all muscle groups, arms, legs, and torso. At the end of the training period, the testing was performed. It showed that the indicators for cross-country and flat-country trainingare significantly higher for the 3rd group of biathletes who have medium and high levels of strength development and anaerobic strength endurance of the muscles of arms, legs and abdomen compared to the 1st and 2nd groups of athletes. The 2nd group of biathletes covered a 10-kilometer distance of the broken ground faster than the 1st group of biathletes. In the flat-country skiing conditions, the 1st group of biathletes with a strong shoulder girdle have an advantage, since they covered the distance faster compared to the 2nd group of biathletes.
Keywords: biathletes, strength of the body muscle groups, anaerobic strength endurance, training period.

Introduction.

Modern biathlon has undergone a number of significant changes related to the addition of new disciplines to the competition program, an increase in the share of sprint and pursuit races. A highly qualified biathlete must have a high skating speed, while overcoming difficult climbs with various lengths and steepness (Bolotin&Bakayev, 2017; Dunaev&Seiranov, 2017; Semennikova, 2020; Priymaket al.,2019; Pavlyuket al.,2020). It is possible todetermine the special physical fitness of a biathlete by analyzing the uphill skating speed and the average lap distance speed. The efficiency of uphill running depends largely on the muscular system strength, since a less trained athlete spends more time on climbing or recovers longer after its overcoming. The external resistance overcoming requires the power capabilities: the higher the resistance, the more power is shown (Priymak&Terentieva, 2017; Gallicchio et al., 2018; Bolotin&Bakayev, 2017; Bolotin&Bakayev, 2019). However, the biathlete often performs repulsive movements, thus, the speed is also important. It shall not be also forgotten that the biathlete overcomes the distance for a long period of time trying to maintain a high strength performance efficiency. Therefore, in order to successfully go through a distance with a significantly large relief, the person needs strength, strength endurance of all muscle groups involvedand their level of fitness that directly affects the physical fatigue and overall running speed of the athlete. It is obvious that it is necessary to increase the diameter of muscle groups, since a larger number of myofibrilsprovides for the more intensive contractility, higher performance, and greatervolume of nutrients. Such a muscle is a basis for its further transformation into the oxidative muscle fibers, that is, increase in the number of mitochondria in the myofibrils (enhancement of its oxidizing capacity) (Przybyła et al.,2016; Bohuslavska et al., 2017; Sagiev et al., 2018). However, the modern literature data analysis has shown that there is not enough information relating to the development of strength and anaerobic strength endurance in the mass grade biathletes during the annual training cycle. There are studies on improving aerobic strength endurance and speed-strength performance of young biathletes (Jin et al., 2013; Aghyppoet al., 2017;Høydal& Nord 2017; Žák et al.,2017). Most of the authors' works are devoted to the strength training of highly qualified biathletes and

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juniors (Bolotin et al., 2018; Ihalainen et al.,2018). Thus, there is a scientific contradiction between the increased requirements for the biathlete strength training (due to the motion state intensification in the field of competitive running and changes in the competition program) and insufficient information about the academical control and planning of training sessions for the development of strength and anaerobic strength endurance in the annual cycle during the long-term training process for the biathletes.

Materials and Methods.

The following methods were used in the study: analysis and generalization of research and methodological literature, lesson observation, pedagogical testing, mathematical statistical methods.

The study was organized at the premises of the Budgetary Institution of the Udmurt Republic "Special Olympic Reserve Biathlon School", Izhevsk.During the period from April to December, 2019, an educational experiment was conducted with participation of 56 first-rank biathletes aged 16-18 years.The research involved 56 first-rank biathletes aged 16-18 years who have approximately equal proficiency level in ski-skating techniques and the functional vigor level. The biathletes under studywere divided into 3 groups supervised by variouscoaches-instructors and trained according to various training programs. Thus,during the entire training period, the 1st group of representatives did exercises for the development of strength and anaerobic strength endurance mainly using the fitness machines in the gym focusing on the lower extremity muscles once a week (barbell squats, pistol squats, weight lunges, etc.).The arms were trained by doing the bar exercises, chinups, push-ups, chair-dips, and using the rubber expanders. For the 2nd group, the strength training sessions were also held once a week, but a large volume of strength involving training in the gym was aimed at developing the muscular strength of the upper extremities (bench presses, sit-up bench presses, weight bar dips, weight pull-ups, lat pulls, etc.). The leg muscles were trained using mainly the jumping exercises with the sole weight, rarely using the insignificant weights. These lessons were aimed to increase aerobic and speed-strength endurance of the legs (alternating feet pushingusing the roller skis, skis, a variety of jumping and static exercisesassimilated from the body conditioning trainings). Representatives from the 3rd group were distinguished by the fact that the strength development trainings were held 2 times a week and aimed at strength development of the muscles of arms, legs and torso.

Results and discussion.

The sensitive period of strength development can be attributed to the age of 15-17 years old, however,it does not mean that strength shall not be developed at an earlier age. It is important to use an individual approach for its development, since one training group, as a rule, includes the athletes with various physical fitness levels due to the different training experience and individual specifications of the physiological body growth. For one adolescent, the push-ups will be a strength developing exercise, since his/her maximum number of repetitions is 6-8 times; for another athlete this exercise will contribute to the anaerobic strength endurancedevelopment, since his/her maximum number of repetitions can be 40 times within 60 seconds. Without doubt, when the young athletes do the weight exercises (dumbbells, barbells, rubber expanders), it is necessary to require compliance with the safety measures, prevent lifting the heavy weights. It is better to make an exercise more complicated by various academic techniques, for example, one-legged squats, one-hand push-up, one-hand pull-ups, etc.

Many authors have found that the absence of strength developing sessions in the training processwithin 30 days reduces its growth indicators in an athlete by 30%. The authors have concluded that strength shall be developed throughout the entire training period (Dunaev and Seiranov, 2017; Sagiev et al., 2018; Bolotin&Bakayev, 2019). The only thing is that for the advanced biathletes and athletes with the higher sports skills,the training sessions during the training period shall be aimed at increasing the strength developmentlevel. During the competitive period, it is important to maintain the strength development level achieved during the snowless period. At a younger age, the growth dynamics in strength indicators will be observed during the competition season that is explained by the physiological growth of the adolescent's body, in particular his/her muscular system.

The adolescents tend to have long limbs, law of verticality, and ill-defined muscle groups. The skeleton of a young athlete is growing rapidly, but the muscular system is slightly behind. Therefore, the strength exercises shall contribute to the harmonious development of the entire muscular system while purposefully affecting each muscle group. The coaches often mistakenly resort to the exercises from the body conditioning area and sports games for endurance and speed-strength capabilities. They pay little attention to the diameter growth of skeletal muscles. During a competitive race, in a situation of overcoming resistance in the form of climbs or poor sliding conditions, it is necessary to make powerful repulsive movements with the body parts. The biathletes with low-level strength indicators make up for the "gap in their fitness level" by increasing the cycle change frequency, "forcing up" the intensity and thereby unnecessarily overexerting the cardiorespiratory system.

Developmentof the ligaments, tendons, and muscle groups due to the strength training helps prevent the sports-related injuries. First of all, it is necessary to pay attention to the vulnerable points, including the back

muscles or foot ligaments. For the most effective strength development and avoidance of the compression spine load, it is recommended to perform anti-gravity exercises in a prone or sitting position.

Our analysis of the training process of young biathletes demonstrated that in practice, the strength training is understood by the coaches as the use of jumping exercises and exercises for the development of comprehensive speed-strength capabilities, speed capabilities and dynamic aerobic endurance, while the strength development exercises are not used enough. If such exercises are used, they are fragmentary, chaotic, without a specific system for their application. The strength exercises assimilated from other sports and areas will reduce the training process monotony and uniformity and remove the mental overload due to the monotonous motor activity. It is known that the frequent use of certain movements leads to overstrain of certain muscle groups, cardiovascular, respiratory and other body systems that limits the athletic development. It will help to avoid early specialization, deterioration of the children's bodies, and provide the basis for further advancement of sports skills. The main educational objectives of strength training sessions during the training of mass-grade biathletes are to contribute to the improvement, strengthening and proper formation of the musculoskeletal and cardiorespiratory systems, to provide a certain basis for further promising increase in the training and competitive loads. At the training stage for the advanced athletes and athletes with the higher sports skills, the educational strength training is mainly focused on improving the sports competitive result.

We have conducted an academic study aimed at aimed at determining the most effective method to plan the practice load volumeduringa training period for the development of strength and anaerobic strength endurance of various muscle groups. At the end of the training period, we conducted the academic testing of 3 biathlete groups using the simulator tests (Table 1). For these tests, we have developed the three-point rating scales (low, medium, high levels). The tests were verified for reliability and informational value. While analyzing the test results, we have found that the first group includes18 biathletes with a low development level of the upper limb and absstrength. This group of athletes also showed the medium and high levels of leg strength development. The biathletes from the second group (18 people) had low indicators of the lower limb strength, medium and high levels of the upper limb strength. The third group included 20 biathletes specified by the average and high values of strength development in all body parts.

Table 1

Strength indicators for the biathletes aged 16-18 years with variousstrength levels of body parts

upper limbs, abs					
Tests	Bar curls with an additional weight of 24 kg, (number of times)	Standing kettlebell press, (number of times)	Bench press equal to the athlete's weight, (number of times)	French bench press, 27 kg, (number of times)	45° bench sit-ups with a load of 5 kg, (number of times)
1 group	2±0,7	1±0,5	1±0,6	3±0,9	6±1,5
2 group	8±1,2	9±1,0	7±0,7	15±1,9	11±1,8
3 group	7±1,2	8±1,2	7±1,2	13±2,1	12±1,7
lowerextremities					
Test	Statnamic barbell squats with a weight equivalent to the athlete's weight, (number of times)	Simulated leg extension, 30 kg, (number of times)	Lying simulated leg curl, 46 kg, (number of times)	Simulated leg splits, 80 kg, (number of times)	Simulated leg reduction, 64 kg, (number of times)
1 group	10±1,6	13±1,8	15±1,6	13±1,9	10±2,1
2 group	6±1,0	8±1,3	5±0,8	5±1,1	4±1,2
3 group	11±1,9	14±1,7	14±2,0	14±1,6	10±2,0

Table 1 shows that the representatives of the 1st group with a reliabilityat ($P<0.05$) have the significantly reduced strength indicators of the arm muscles compared to the biathletes from the 2nd and 3rd groups, by approximately 5-6 times. There were no significant differences between the 2nd and 3rd groups according to these indicators. The test indicatorsassessing the leg strength demonstrate that the 2nd group of biathletes has significantly lower values (on average by 2-3 times) than the representatives of the 1st and 3rd groups.

At the beginning of the competition season, we conducted a special test to review the features of the ski-racing readiness at the distances with various terrain in relation to the persons with various strength development levels of body parts (Table 2)

Table 2

Indicators ofthe cross-country and flat-country skiing forthe biathletes aged 16-18 years with various strength development levels of body parts

Test	1 group	2 group	3 group
Cross-country skiing 10 (km), (s)	1935±38	2037±34*	1802±41
Flat-country skiing 10 (km), (s)	1873±32	1780±29*	1665±34

It was found that the indicators for cross-country and flat-country skiingare significantly higher for the 3rd group of biathletes who have medium and high levels of strength development and anaerobic strength endurance of the muscles of the arms, legs and abs compared to the athletes from the 1st and 2nd groups. It should be noted that the 2nd group of biathletes, who have stronger legs, overcame the 10-kilometer cross-country distance with a significant difference, in contrast to the biathletes from the 1st group, who have high strength indicators of the arm and abs muscles. However, in the flat-country conditions, the biathletes of the 1st group with a strong shoulder girdle have an advantage, since they covered the distance faster in comparison tothe 2nd group of biathletes. Probably, for the mass-grade biathletes it is possibleto consider a tendency to successfully overcome the difficult path profiles and climbs primarily due to the power and frequency of repulsive leg movements, performance of the lower extremity muscles.For the flat-country paths, the significant use of the shoulder girdle is of primarily importance without reduction in its efficiency. It shallbe concluded that the athletes with harmoniously developed strength capabilities of muscle groups of all body parts are the most effective in cross-country skiing among the first-grade biathletes. Therefore, to improve the racing performance level in general, it is necessary to develop a comprehensive academic program of testing and evaluation of strength capabilities of the overall body muscular system for the young biathletes during the long-term training process.

Conclusions.

The training process of young biathletes is overloaded with various training loads, often due to assimilation of the exercises, methods, and session arrangement forms from the training practice of the highly qualified biathletes. It is important to ensure that the biathlete is functionally resistant to fatigue when running in the glycolytic and mixed intensity conditions, has a high performance of the muscular system in the speed-power and strength activity modes, and quickly recovers at the shooting stage and slopes. For this purpose, it is necessary to rely on the scientific studies and to empirically determine the most efficientplanning options for a long-term training process, to identify the optimal exercises and its arrangement methods at the stages of long-term training procedure. It is also important to perform all types of academic control, especially the current and operational control, not only to determine the development level of physical capabilities, but also to identify the strength development state and level of the athlete's body individual muscle groups. It is necessary to develop the training process system to enhance strength capabilities of all muscle groups while considering the age, gender, physical development level and all-round fitness, weaknesses and strengths in the strength-building activities, long-term and one-year training period, as well as the manifestation type of each athlete's muscular strength capabilities (strength, speed).

In the literature, the strength training of biathletes has a general nature, without any accuracy and specificity of information. There is an urgent need to use the various strength exercises, considering the muscular contraction mode, the muscular activity specifics, and the biomechanics of movements. This is possible by assimilation of exercises from the fitness area, powerlifting, gymnastics, etc., however, it is necessary to systematize them in order to increase the body's reserves and enhance the sports skills, to ensure a safe and gradual increase in the body's adaptive responses to the physical exertion (as a certain key to the future).

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