

Influence of the level of development of motive qualities on the technique of ski styles and shooting of 14-16-year-old biathletes

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Abstract.

Purpose: to define influence of separate motive qualities on technique of performance of ski styles and shooting of 14-16-year-old biathletes. **Material:** 15 leading biathlon coaches of Ukraine participated in researches, among which questionnaire is conducted for the purpose of definition of significant different physical qualities for achievement of the maximum sports results of 14-16-year-old biathletes. The factorial contribution of indicators of motive qualities and functional state as a result of races and shooting of young biathletes aged 14-16 (by results of testing of 21 young biathletes) is defined. The correlation dependence between technique of different skating styles (skating without poling; simultaneous without step; simultaneous single-step; simultaneous two-step; alternate two-step) and shooting in the prone position and shooting in the standing position, and physical qualities and tests of static and dynamic balance of young biathletes at the age of 14, 15 and 16 years is established. **Research methods:** analysis and synthesis of data of special scientifically-methodical literature, polls, questioning, pedagogical testing with determination of the level of development of motive qualities (take-off force by two hands; bending and extension of hands in emphasis, lying for 30 s; triple jump; standing long-jump; shuttle run 4x9 m) and results of shooting (dynamic balance 2, vestibular-static test; tremorography, test of Romberg, test "Biryuk", balance "Lastivka", goniometry, reaction to sound signal, reconstruction of time 5 s, differentiation of effort 50% of max); medicobiological indicators (HR PANO, ANAMC, AMC, MCO). **Conclusions:** the defined correlation interrelations give the chance to develop physical qualities at creation of educational-training classes, which are the main, when carrying out ski, shooting and complex training of young biathletes at the age of 14-16 years.

Keywords: biathletes, shooting, ski styles, balance, functional state.

Introduction

Biathlon is sport with difficult coordination structure of movements which provides connection of movement on skis and shooting which performance needs manifestation of separate motive qualities. Therefore, it is very important to define what motive quality influences the technique of ski styles and shooting after load to a large extent. It will give the chance to develop connection of use of different motive qualities and improvement of elements of technique of ski styles and shooting.

The problem of formation of motive skills is in sports training of young sportsmen near the problem of development of the system of development of physical qualities which would answer the sensitive periods. The formation of elements of technique is based on the basis of development of coordination abilities (Platonov, 2004; Volkov, 1990).

The development of ability to support body balance – ability to balance in static and dynamic positions is one of the necessary annexes to complex development of motive-coordination and directly related other abilities (Cazzola et al., 2016; Hartman, 1999). At movement on skis by skating styles, it is necessary to have the sufficient level of motive qualities which influence carrying out take-off (the upper and lower extremities) and holding of postural pose when sliding. Near of these increase in length of extremities, it is necessary the bigger application of power potential, which will allow carrying out effectively performance of technique of movement on skis (Aghippo, 2001; Mulyk, 2001, 2014;).

At the same time, according to authors (Kozina, Iermakov, Crelu, Kadutskaya, & Sobyenin, 2017), the main methodical tendency at creation of system of trainings by the exercises, which are aimed at improvement of ability to support body balance, consists in gradual, consecutive complication of tasks and conditions of their performance. All this has to go in such direction that they demanded the increasing mobilization of ability optimum to balance in unstable poses, to add them necessary motive firmness, to keep balance contrary to factors which force down (Boloban, 2003; Sergiyenko, 2010).

The most widespread techniques of complication of conditions of shooting in biathlon is reduction of the area of support, introduction of motive support, during performance of physical actions which are connected with shooting and extension of time of preservation of pose in unstable situation.

Material and methods

Material: 15 leading biathlon coaches of Ukraine participated in researches, among which questionnaire is conducted for the purpose of definition of significant different physical qualities for achievement of the maximum sports results of young biathletes at the age of 14-16 years. The factorial contribution of indicators of motive qualities and functional state as a result of cross-country skiing and shooting of young biathletes at the age of 14-16 years (by results of testing 21 young biathletes) is defined. The correlation dependence between technique of different skating styles (skating without poling; simultaneous without step; simultaneous single-step; simultaneous two-step; alternate two-step) and shooting in the prone position and shooting in the standing position, and physical qualities and tests of static and dynamic balance of young biathletes at the age of 14, 15 and 16 years is established.

Research methods: analysis and synthesis of data of special scientifically-methodical literature, polls, questioning, pedagogical testing with determination of the level of development of motive qualities (take-off force by two hands; bending and extension of hands in emphasis, lying for 30 s; triple jump; standing long-jump; shuttle run 4x9 m) and results of shooting (dynamic balance 2, vestibular-static test; tremorography, test of Romberg, test "Biryuk", balance "Lastivka", goniometry, reaction to sound signal, reconstruction of time 5 s, differentiation of effort 50% of max); medicobiological indicators (HR PANO, ANAMC, AMC, MCO); methods of mathematical statistics (mathematic-statistical method of reduction of quantity of variables and establishment of structure of interrelations between the studied indicators – the factorial analysis is used at the solution of task concerning identification of extent of influence of motive qualities, functional state and tests of coordination of movements of the investigated. It is carried out by means of the computer program STATISTICA 6.0 by the method of the main components with finding of the central tendencies of rotation (Varimax raw). The method of the main components was used for identification of the main indicator among the investigated and reduction of quantity of factors which influence it).

Results of the research

The conducted researches (questioning, conversations) with the leading biathlon coaches allowed us to define the importance of separate motive qualities for young biathletes: power endurance – 4,8 points, anaerobic endurance – 4,7 points, aerobic endurance – 4,6 points, speed – 4,5 points, force – 4,1 points; coordination – 4,0 points, dexterity – 3,3 points; flexibility – 3,2 points. As the obtained data testify, power, anaerobic and aerobic endurance have the greatest value in success of competitive activity in biathlon. It is possible to assume what at the same time it means not only actually power, but also high-speed and power abilities as in competition of biathletes pronounced dependence of success in race on speed of performance of take-off by legs and hands, length and frequency of crossovers. Competitive activity in biathlon at movement on skis is connected with rectilinear movement of own body therefore, at the same time the level of indicators of relative force which has to be rather high has the uncommon value. And improvement of force at this direction, likely, needs to be carried out in proportion, covering those groups of muscles which bear the main load during run on distance with rifle, but without the considerable gain of muscular weight. The excess hypertrophy can affect other qualities, such as dexterity, flexibility, speed and to reduce efficiency of competitive activity. Especially negative impact can appear in decrease in indicators of mobility in joints of hands and legs. Quite possibly power endurance plays very essential role in ski race on different slopes in size and steepness. The carried-out analysis allowed us to define the factorial contribution of motive qualities, functional state and tests of coordination of movements to result in race (tab. 1) and shooting (tab. 2) at young biathletes of 14-16 years old.

Table 1

The factorial contribution of indicators of motive qualities and functional state as a result of race on 10 km of young biathletes at the age of 14-16 years

№	Factor	Indicator of the generalized factors	% of contribution
1.	High-speed and power (38,6 %)	- take-off force by two hands - bending and extension of hands in an emphasis, lying for 30 s. - triple jump - standing long jump	18,2 8,7 8,1 3,6
2.	Anaerobic-aerobic endurance (36,2%)	- HR PANO - ANAMC - AMC - MCO	10,1 9,2 9,2 7,7
3.	Coordination of movements (13,7%)	- dynamic balance 2 - vestibular-static test	7,5 6,2
4.	Dexterity (5,8%)	- shuttle run of 4x9 m - dynamic balance 2	4,1 1,7
5.	Other qualities (5,7%)		5,7

Table 2

The factorial contribution of indicators of motive qualities and functional state as a result of shooting in race on 10 km of young biathletes at the age of 14-16 years

№	Factor	Indicator of the generalized factors	% contribution
<i>Shooting in the prone position</i>			
1.	Coordination of movements (41,1%)	- tremorography - differentiation of effort 50% of max - reconstruction of time 5 s	14,1 13,6 13,4
2.	Anaerobic-aerobic endurance (29,9%)	- results of race	29,9
3.	Dexterity (18,1%)	- shuttle run 4x9 m - reaction to sound (light) signal	10,1 8,0
4.	Force (5,8%)	- bending and extension of hands in emphasis, lying	5,8
5.	Flexibility (5,1%)	- goniometry	5,1
<i>Shooting in the standing position</i>			
1.	Coordination of movements (38,2%)	- tremorography - reconstruction of time 5 s - differentiation of effort 50% of max	18,2 10,0 10,0
2.	Anaerobic-aerobic endurance (30,5%)	- race at competitive distance	30,5
3.	Power endurance (20,6%)	- test of Romberg - test "Biryuk" - squat on two legs	8,5 6,6 5,5
4.	Flexibility (6,7%)	- goniometry	6,7
5.	Dexterity (4,0%)	- shuttle run 4x9 m - reaction to sound (light) signal	2,2 1,8

So, the greatest contribution is defined in high-speed and power indicators (38,6% of the general dispersion). The leading generalized factor is take-off force by two hands (18,2%) in all skating ski styles (except the skating style without take-off by ski poles). There are factors almost in equal degree which concern bending and extension of hands in emphasis, lying for 30 s and triple jump (8,7 and 8,1% respectively), in smaller measure standing long-jump (3,6%).

Movement on skis by skating ski styles needs the considerable anaerobic-aerobic endurance (36,2%) due to hard work of cardiovascular and respiratory system of organism of the sportsman among which major factors are HR PANO (10,1%), ANAMC (9,2%), AMC (9,2%), MCO (7,7%) and has variation of contribution of these factors depending on distance length.

Skating ski styles provide the existence of single-support sliding on ski which is defined by effective actions of sensory system which provides coordination of movements (13,7%) and is defined by tests – dynamic balance 2 (7,5%), vestibular-static test (6,2%). In smaller measure dexterity (5,8%) influences on the performance of skating ski styles during the race, which factors are shuttle run of 4x9 m (4,1%) and dynamic balance 2 (1,7%). Other factors (flexibility, force, speed) make 5,7%, and have no significant effect on result in race with use of ski skating styles.

Factors, which influence quality of shooting in biathlon, have static-dynamic characteristics to a large extent. So, the most important motive skill is coordination for shooting in the prone position (41,1%) which is present when performing this exercise. In our researches, factors that influence on shooting in the prone position are indicators of tremorography (14,1%), differentiation of effort of 50% from maximum (13,6%) and accuracy of reconstruction of time 5s (13,4%). It should be noted that the quality of shooting is significantly influenced by load, which precedes it. Therefore, the level of anaerobic-aerobic endurance (29,9%) which is estimated by result of race, is important and which is made by sportsmen during trainings.

Dexterity is also important (18,1%) which is connected, first of all, with speed and accuracy of acceptance of shooting position which factors is shuttle run of 4x9 m (10,1%) and reaction to sound (light) signal (8,0%). Power indicator when shooting in the prone position is less important as holding of rifle is carried out mainly at the expense of tension belt therefore the contribution makes it 5,8% and it is noted by the number of bending and extension of hands in emphasis, lying (5,8%).

Reconstruction of angles of parts of body at the acceptance of starting position and mainly implementation of "applying" and movement of rifle when shooting on 5 targets, depends on flexibility (5,1%) in parts of body which take part in feasible shooting in the standing position. Factor of definition of which is goniometry (5,1%). Coordination of movements (38,2%), on which load after the ski race and changeable meteorological obstacles (wind, snow, fog) influences, has the great value, as well as when shooting in the prone position. Tremorography (18,2%) and reconstruction of rhythm of shooting are factors of determination of coordination abilities at shooting in the standing position (5 s) and differentiation of efforts when shooting (50% of max) – on 10,0%.

Shooting in the standing position is more difficult exercise, especially for young biathletes, therefore the level of anaerobic-aerobic endurance during overcoming distance to firing line is more essential (30,5%) in

relation to shooting in the standing position. Near it, power endurance is very important which is connected with holding of rifles during shooting in the standing position that needs high power endurance (20,6%) which can be defined due to conducting tests of Romberg (8,5%) and "Biryuk" (6,6%) and the number of squats (5,5%).

When carrying out shooting in the standing position, the correct fixing of situation in coxofemoral and elbow joints is important, on which the quality of shooting (6,7%) depends. In this connection, the acceptance of shooting position which can be controlled by the techniques, which are provided by goniometry, is important at trainings. The smallest contribution to quality of shooting in the standing position has dexterity (4,0%) which as well as in shooting in the prone position depends on speed and quality of the acceptance of shooting position which factors are shuttle run of 4x9 m (2,2%) and reaction to sound (light) signal (1,8%).

Thus, the determined by us factorial structure of contribution of different components of motive qualities in ski skating styles and shooting gives the chance to develop and to purposefully use means of training of young biathletes during the annual macrocycle. At the first stage of long-term preparation, it is expedient to acquire the technique of classical ski styles, while on the second it is necessary to take control in new measure of skating ski styles. Issues concerning formation of elements of technique of skating styles and assimilation of elements of shooting in connection with exercise stresses are resolved further, from 14-year age, near the development of motive qualities. Therefore, issues concerning formation of elements of technique of skating ski styles (skating step without poling, simultaneous without step, one-and two-step styles, and alternate two-step skating styles) and shootings in the prone position and in the standing position are resolved near the development of motive qualities.

It is obvious that performance of separate elements of technique needs available of the potential of manifestation of separate motive qualities. The correlation analysis concerning influence of separate motive qualities on performance of ski styles and shooting in biathlon is carried out, demonstrates that it is not identical in different years of trainings (tab. 3).

Table 3

Correlation dependence between technique of different skating ski styles and shooting and physical qualities and tests of static and dynamic balance of young biathletes at the age of 14-16 years

№	Ski styles and shooting	Physical qualities	Control exercises	Coefficient of correlation		
				Years old		
				14	15	16
1	Skating style without poling	high-speed and power, coordination	- triple jump	0,43	0,53	0,71
			- standing long jump	0,42	0,50	0,65
			- balance "Lastivka"	0,51	0,63	0,75
2	Simultaneous without step style	high-speed and power	- take-off force by two hands	0,53	0,66	0,77
			- bending and extension of hands in an emphasis, lying for 30 s	0,54	0,65	0,72
3	Simultaneous single-step skating style	high-speed and power qualities	- take-off force by two hands	0,51	0,62	0,73
			- bending and extension of hands in an emphasis, lying for 30 s	0,48	0,55	0,58
			- dynamic balance 2	0,47	0,54	0,59
4	Simultaneous two-step skating style	high-speed and power, coordination	- take-off force by two hands	0,50	0,59	0,63
			- bending and extension of hands in an emphasis, lying for 30 s	0,48	0,55	0,58
			- vestibular-static test	0,52	0,60	0,65
			- dynamic balance 2	0,51	0,62	0,65
			- shuttle run of 4x9 m	0,46	0,51	0,53
5	Alternate two-step skating style	force, coordination	- bending and extension of hands in an emphasis, lying for 30 s	0,42	0,48	0,51
			- pulling up on a cross-piece	0,40	0,46	0,50
			- balance "Lastivka"	0,49	0,53	0,58
6	Shooting in the prone position	coordination, flexibility	- vestibular-static test	0,53	0,61	0,66
			- goniometry	0,46	0,49	0,60
7	Shooting in the standing position	power endurance, flexibility, coordination of movements	- test of Romberg	0,53	0,61	0,68
			- test "Biryuk"	0,54	0,65	0,72
			- goniometry	0,48	0,52	0,61
			- vestibular-static test	0,50	0,61	0,68

* other physical qualities have no essential correlation with ski styles and shooting (<0,20)

Studies to technique of the skating ski styles begins with mastering of sliding without poling which need manifestation of power qualities of the lower extremities and coordination of movements, especially during take-off and single-support sliding. Indicators of standing long triple jump and the balance test "Lastivka", which in 14-year-old age have correlation of $r=0,43$; $0,42$; $0,51$, were used in our research for determination of these qualities. Further the noted correlation connections increase and reach at the age of 15 years according to $r=0,53$; $0,50$; $0,63$; and at the age of 16 years– $r=0,71$; $0,65$; $0,75$.

The simultaneous without step style depends on high-speed and power qualities of muscles of upper extremities and trunk to a large extent and has gradual increase in correlation with indicator of force of take-off by two hands, from $r=0,53$ (14 years old), to $r=0,66$ (15 years old), and $r=0,77$ (16 years old).

The most difficult performed by young biathletes is the simultaneous single-step skating style which needs in big high-speed and power to the potential for removal of body weight from one extreme situation (sliding on one leg) in the second (sliding on the second leg). Therefore, the correlation level with physical qualities changes as a result of assimilation of this ski style. The level of correlation of the noted ski style with high-speed and power qualities (take-off force two hands) makes at the age of 14– $r=0,51$; at the age of 15– $r=0,62$; at the age of 16– $r=0,73$. Important also in this ski style is holding of body weight during single-support sliding, that is coordination of movements which was measured in our research of the test "Dynamic balance 2".

At the age of 14 years the performance of the simultaneous single-step skating style correlates with indicators "Dynamic balance" ($r=0,47$), at the age of 15 years makes $r=0,54$, and at the age of 16 years $r=0,59$.

Movement by the simultaneous two-step skating ski style needs as manifestation of high-speed and power qualities (when poling and skis), and coordination of the movements connected with holding of postural pose at single-support sliding which needs also manifestation of dexterity.

At the age of 14 years the insignificant level of correlation is determined between this course and indicators of force of take-off by two hands ($r=0,50$), bending and extension of hands, in emphasis, lying for 30 s ($r=0,48$) (high-speed and power qualities), vestibular-static test ($r=0,52$) and dynamic balance ($r=0,51$) and shuttle run 4x9 m ($r=0,46$) (dexterity).

At the age of 15 years the increase in the noted correlation interrelations is defined (according to $r=0,59$; $0,55$; $0,60$; $0,62$; $0,51$). The greatest interrelation between the noted indicators is found out at the age of 16 years that is connected with improvement of technique of the simultaneous two-step skating style and which made $r=0,63$ and $0,65$ (take-off force two hands, bending and extension of hands, in emphasis, lying for 30 s and vestibular-static test ($r=0,65$), dynamic balance 2 ($r=0,65$), shuttle run ($r=0,53$).

The diagonal two-step skating style is used by skiers-biathletes on steep slopes on which it is impossible to move due to simultaneous take-off by ski poles. Therefore, it is necessary to have the power potential for take-off both upper and lower extremities that causes the correlation interrelation with performance of exercise of bending and extension of hands in emphasis lying for 30 s and pulling up on cross. At the same time for the beginning of the research at the age of 14 years the noted interrelation is below average ($r=0,42$; $0,40$), further it something grows (at the age of 15 years – $r=0,48$; $0,46$ respectively; at the age of 16 years – $r=0,51$; $0,50$).

Movement by the noted ski course also needs somewhat manifestation of coordination of movements which is connected with performance of the course to steep slopes. This type of coordination is answered most of all by the test "Lastivka" which correlation increases with growth of power qualities (at the age of 14 years – $r=0,49$; at the age of 15 years – $r=0,53$; at the age of 16 years – $r=0,58$).

The needs for the level of development of physical qualities during shooting in the standing position, what needs holding of pose for shooting, are more significant. We defined the close correlation connection between manifestation of power endurance and tests that are displayed it. So, at the age of 14 years power endurance correlates with indicators of tests of Romberg ($r=0,53$), "Biryuk" ($r=0,54$) and goniometry ($r=0,48$) and vestibular-static test ($r=0,50$). The needs for the level of development of physical qualities during shooting in the standing position what needs holding of pose for shooting are more significant. We defined the close correlation connection between manifestation of power endurance and tests that are displayed it. So, at the age of 14 years power endurance correlates with indicators of tests of Romberg ($r=0,53$), "Biryuk" ($r=0,54$) and goniometry ($r=0,48$) and vestibular-static test ($r=0,50$). At the same time it is defined that the contribution of high-speed force increases in the course of trainings. So, if the correlation interrelation between performance of the ski styles and high-speed and power qualities at the beginning of the researches (14 years old) is $0,43-0,54$, the correlation reaches $0,63-0,77$ at the age of 16 years.

Discussion

The obtained data on the actual contribution of separate motive qualities and indicators which determine their level is necessary factor when planning training process of biathletes. Definition of such ratio of ski-racing, shooting and complex preparation, which would be optimum for each biathlete, is important.

Recently the quality of shooting during competitions at the leading biathletes has no essential difference and movement speed on distance moves to the forefront (Avgustin et al., 2012; Bube et al., 1998; Karlenko et al., 1991; Troianovska, 2015; Zubrilov, 2010, 2013). In this connection there is question both to stabilize quality of shooting, and to increase speed of overcoming distance and carrying out shooting. Therefore, there is the relevant question of complex combination of competitive components of biathlon which needs to be formed at stage of the previous basic preparation (at the age of 14-16 years). The solution of the noted tasks provides use of classes of complex orientation, mainly with the parallel solution of tasks for what it is necessary to define which of them can be combined that is what application of exercises can influence improvement of technique of the ski styles and shooting. The received by us results allow to make complexes of tasks concerning combination of

specific exercises of training of biathletes (ski-racing, shooting, complex) for the formation of successful competitive activity, using correlation dependences during 14, 15 and 16 years old.

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Conclusions

Influence of motive qualities on performance of basic elements of technique of the ski skating styles and shooting is defined.

The most significant dependence of the skating style without take-off by ski poles from indicators of high-speed and power qualities of the lower extremities ($r=0,42-0,71$) and coordination of movements ($r=0,51-0,75$). High-speed and power to quality of muscles of upper extremities significantly influences on performance of simultaneous without step style ($r=0,53-0,77$).

Performance of the simultaneous two-step skating style is influenced by the level of manifestation of high-speed and power qualities ($r=0,48-0,63$) and coordination of movements ($r=0,46-0,65$).

The diagonal two-step skating style needs available power qualities of upper extremities ($r=0,40-0,58$) and coordination of connection of work of hands and legs ($r=0,49-0,58$).

Accurate shooting in the prone position mainly depends on coordination of movements and flexibility, at the same time as standing from power endurance on holding of pose during shooting ($r=0,48-0,68$).

Conflict of interests

The authors declare that there is no conflict of interests.

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