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Coordination Skills Development of Mogul Skiers at the Initial and Preliminary Stages of Basic Training

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Abstract

Purpose: The research is devoted to the problem of coordination skills development of mogul skiers. The purpose of the study is to develop a scientifically grounded program for the development of coordination skills of mogul skiers at the stages of initial and preliminary basic training. Results: The results of the study of coordination skills of mogul skiers depending on their gender, age, sports qualification, training experience and the stage of sports training have been analyzed. The structure of coordination skills of mogul skiers is determined. The program of coordination skills development of mogul skiers at the stages of initial and preliminary basic training, which involves the use of means of general and special coordination skill improvements, methods and methodical techniques as well as ideomotor, sensory motor and motor components of the mechanism of coordination skills has been proposed. Conclusion: The program of coordination skills development of mogul skiers at the stages of initial and preliminary basic training is substantiated. The factor structure of coordinating skills of mogul skiers is defined; the correlation relations between the results in sport of skilled mogul skiers and test scores for assessing the coordination abilities is shown; the lack of sexual differences in the coordination skills development of mogul skiers is determined.

Keywords: coordination skills, mogul skier, the stage of initial training, the stage of preliminary basic training, means, methods.

1. Introduction

Competitive activity requires a high level of arbitrary movement's possession which is executed with high accuracy in the conditions of a shortage of time on the background of nervous-emotional stress [1; 2]. The nature of motor activity in sport with a complex coordination structure of movements, the tendency to complicate the competition programs and the subjectivity of judging cause an increase in the requirements for the athlete's technical skill [3]. Like any other, the process of training how to move and is formed by closely related components: target, incentive and motivational, content, operational and effective, control regulating, evaluative and effective [4]. The quality of performance the technical elements, especially in changing conditions is determined by the perfection of coordination skills [5; 6].

Mogul skiing belongs to complex coordination kinds of sports, and the result in sport of mogul skiers is largely determined by their technical training and coordination skills development. Passing of the mogul courses and the performance of air jumps requires the coordination of movements, muscle sensation, accuracy of spatial orientation, and a sense of rhythm [7; 8].

The problem of coordination skills development is widely represented in modern scientific-methodical literature. A number of scientific studies highlighted the essence and mechanisms of coordination skills development [9; 10], peculiarities of its development and methods of improvement in the training process of representatives of certain sports [11; 12; 13; 14]. At the same time, the problem of the coordination skills development of free style skiers in general and mogul skiers in particular remained beyond the scope of scientific research.

Consequently, the relevance of the study is determined by the specificity and importance of coordination skills in enhancing the technical skills of mogul skiers, as well as the lack of research and peculiarities of its development. The solution to this problem contributes to raising the level of mogul skier's athletic skill development and the further growth of their results in sport at the International Sports Arena.

The purpose of the study is to develop a scientifically grounded program for the coordination skills improvement of mogul skiers at the stages of initial and preliminary basic training.

Objectives of the study

• To study the coordination possibilities of mogul skiers depending on their gender, age, sports qualification, training experience and the stage of the sports training.

• To identify the coordination skills structure of mogul skiers.

• To develop a program for coordination skills development of young mogul skiers at the stages of initial and preliminary basic training and to check its effectiveness.

2. Materials & Methods

The following research methods were used to solve the tasks: the study of literary sources; theoretical analysis and synthesis; questionnaire; pedagogical observation, pedagogical experiment; testing (pedagogical, psychological, and physiological); methods of mathematical statistics.

To determine the experience of trainers in developing the coordination skills of mogul skiers the survey has been conducted. 19 trainers from 6 regions of Ukraine where free style skiing is cultivated have been interviewed. Among the respondents are trainers of Children's and Youth Sport School, Specialized Children's and Youth Sport School of the Olympic Reserve, Sportsmanship High School and two senior trainers of the Ukrainian national team of freestyle skiing.

It was found out that the overwhelming majority (89.5%) of the interviewed trainers considered the development of their coordination skills as the most important condition for improving the technical skills of mogul skiers. It is worth noting that 78.9% of the interviewed experts understand the essence of the concepts of "coordination skills", "general" and "special" coordination skills, and only 21.1% of respondents identified them with other physical qualities or avoided the answer. The majority of respondents (73.7%) systematically solve the problem of coordination abilities in the skills development during the process of mogul skiers training. However, they acknowledge the lack of knowledge about means and methods for improving the coordination skills of mogul skiers.

As a result of the confirmatory experiment, it has been established that coordination skills of mogul skiers could be improved within the age, athletic experience, increased skills in sport and depend on the stage of sports training. The results of our study confirm the position [15] that systematic training and motor experience are that factors which contribute to the perfection of the athlete's coordination skills.

Tests have shown that there is no significant difference between indicators of coordination skills development of boys and girls of the same age, athletic skill level, and athletic training stage with the same training experience. Only in some cases (indicators of static equilibrium, ability to control dynamic and spatial parameters of movements, sensation of rhythm (metronome walking)), there was a significant advantage of girls over boys ($p < 0.05$). Dynamic balance, coordination of movements, ability to control time parameters, orientation in space and sensation of rhythm (sprint at a given rhythm) are significantly ($p < 0.05$) better for boys than for girls. In general, there are no sexual differences in the coordination skills development of mogul skiers.

The amplitude of movement's indicators of the right and left leg and the results of muscle effort of the right and left arm reproduction does not differ significantly ($p > 0.05$).

In mogul skiers there is an advantage of the ability to reproduce and differentiate the large values of the parameters of movements over the small ones and the ability to reproduce the parameters of movements over the differentiation functions ($p < 0,05$). No significant differences between the indicators of the increase and decrease of movement parameters have been observed ($p > 0.05$).

No correlation bonds between proprioceptive functions of muscular effort control, large and small amplitudes of mogul skier's movements are determined. Reliable correlations between the reproduction of a short and long time intervals ($r = 0.465$-0.621); the increase and decrease of the long time interval ($r = 0.446$-0.463); between the reproduction of the direction to the convenient and inconvenient sides ($r = 0,418$-$0,565$) and the increase and decrease of the direction of motion ($r = 0,429$-$0,540$) have been detected.

A factor analysis was carried out to determine the most important coordinating skills for mogul skiers, as well as the specific gravity of tasks and means of their implementation in the annual cycle of mogul skiers training. Factor analysis was subjected to 34 indicators of coordination skills obtained during the testing of mogul skiers as Candidates for Masters of Sports and Masters of Sports.

As a result of factor analysis, a six-component structure of coordination skills for qualified mogul skiers was obtained (Fig. 1). It consists of the following abilities: to manage time parameters of movements,

to orient in space and coordinate the movements (19,3%); to maintain balance (15.2%); to manage dynamic (11.9%) and spatial parameters of movements (9.3%); to an arbitrary relax muscles (8.3%); to sense a rhythm (7.3%).

Correlation analysis of results in sport of skilled mogul skiers and indicators of their coordination skills development revealed high connections (r = 0.679-0.808) in 17.7% of the tests used in our study for evaluation: static and kinetic equilibrium; the ability to reproduce and differentiate the long time intervals; the ability to reproduce and differentiate the dynamic effort with the lower limbs; the ability in space orientation ($p < 0,05$). The indicated tests can be recommended for managing the training of mogul skiers and for selecting into the mogul skiing section.

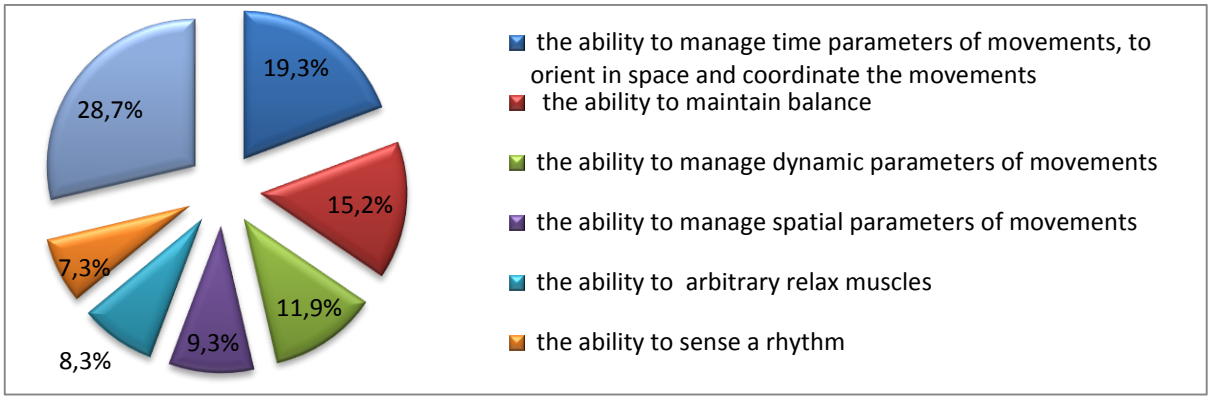

Figure 1. *Structure of coordination skills of mogul skiers (n = 19)*

Most of the sensory systems of the body are involved in the management of movements, the peculiarities of which are determined by the specificity of motor activity [5; 16]. A correlation analysis was carried out to reveal the relationships between the indicators of coordination skills and the state of functioning of individual sensory systems of qualified mogul skiers. Its results indicate that there are high bonds (r = 0.775-0.719) ($p < 0.05$) between the vestibular stability indices and the ability to maintain equilibrium and orientation in space of qualified mogul skiers. The average correlation bonds (r = 0.528-0.613) between vestibular stability indices and static, dynamic equilibrium and coordination of movements have been found ($p < 0.05$).

Significant correlation relations are observed among Candidates for Master of Sports and Masters of Sports between kinestetic sensitivity and the following possibilities: to the reproduction of dynamic efforts by the upper limbs (r = 0.650); to increase the dynamic forces of the upper limbs (r = 0.706); to reproduction (r = 0.618) and differentiation (r = 0.665) of dynamic forces with lower limbs; to orient in space (r = 0.609); to sense the rhythm (r = 0.545); to an arbitrary relax the muscles of the right (r = 0.600) and left (r = 0.710) lower limbs; to reproduce and differentiate the direction and amplitude of movements (r = 0,493-0,513) ($p < 0,05$).

Correlation analysis revealed statistically significant correlations between the accuracy indicators of the visual estimation and the following skills of skilled mogul skiers: orientation in space (r = 0.625); coordination of movements (r = 0,713); reproduction and differentiation of dynamic parameters (r = 0,544-0,564); reproduction and differentiation of spatial parameters of movements (r = 0,543-0,673) ($p < 0,05$).

The data obtained confirms [2] that certain functions of the sensory systems provide coordination of movements and control of motor activity.

Thus, the analysis of literary sources, surveys and the results of the founding experiment revealed the circumstances of the coordination skills development of mogul skiers which formed the basis of their programs for its improvement.

3. Results

On the basis of the theory of the multilevel system of control and regulation of movements at different levels of the central nervous system [16] and the classification of coordination skills [9], the following sequence of coordination skills development is defined: the equilibrium (static, dynamic, statokinetic; the ability to control the dynamic parameters of movements; the ability to control time parameters of

movements; the ability to coordinate movements without moving in space; the ability to control spatial characteristics; the integrated development to control spatial, temporal and dynamic parameters of movements; a sense of rhythm; orientation in space**.**

During the implementation of the author's program, the means of general and special coordination skills development were used; ideomotor, sensory motor and motor components of coordination skills mechanism.

For improving the general coordination skills of mogul skiers some special means were involved: varieties of walking, running, jumping, turnings, throwing the ball, elements of sports games, relay races coordination games, strength exercises with items, exercises in pairs, combined exercises and various obstacles. They were used to enrich the life-saving skills and abilities and motor experience, to influence on some psycho-physiological functions, which provide the optimal control of motor activity and its regulation.

Special coordination skills were developed by the means of mogul skiing. They include: exercises for the development and improvement of technical and tactical actions on alpine and mogul skiing; general development exercises for the development of special coordinating skills of mogul skiers; improving technique adaptations to snow and skis.

In order to systematically use the means of improving special coordination skills of mogul skiers a classification of exercises according to their complexity was developed (Fig. 2). Special means of coordination skills development contain four groups of exercises: on roller skates, on the trampoline, gymnastic and acrobatic exercises and skiing. To the separate group only the Water Ski Jumping, which was practiced only with mogul skiers at the stage of preliminary basic training, was referred.

Development of coordination skills of mogul skiers involves the use of a large number of methodical techniques. To identify the feasibility of its realization in the process of solving certain problems an appropriate analysis scheme, which involves three groups of methodological techniques was developed.

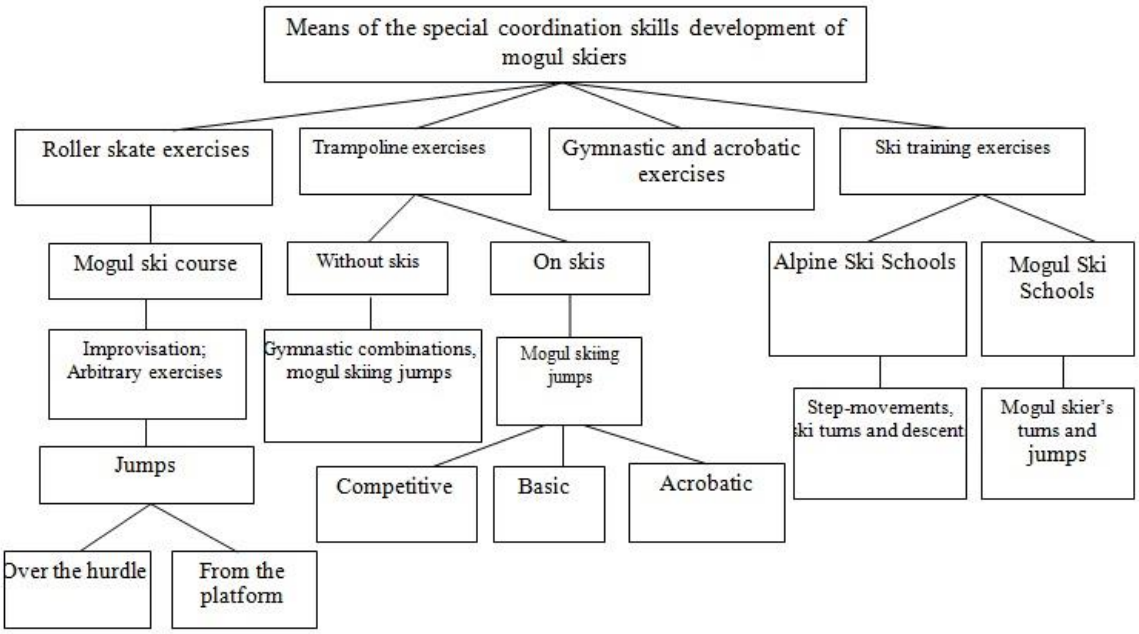

Figure 2. *Means of the special coordination skills development of mogul skiers: its classification*

The first group consists of methodical techniques, which are characterized by the widest use: limitation of visual control; facilitated or complicated conditions; use of urgent information; a state of exhaustion; self-control and self-examination of motor actions; training of sustained attention, elements of novelty.

The second group contains techniques that were practiced in the process of solving the tasks of integrated development of coordination skills: disrupting of the vestibular system; changes in the

environment; verbal and musical accompaniment; contrasting and converging tasks; variation of loadings, additional guides, signals, rectilinear and angular accelerations, use of visual guides.

The third group combines methodical techniques that are appropriate for the development of the only one coordination skill. So, to improve the equilibrium, a reduced, elevated, moving or slip resistance was used; to develop a sense of space a change in direction or amplitude of motion was implemented; to improve the ability to arbitrary relaxation an active relaxation of the muscles was applied.

Another direction of coordinating skills development of mogul skiers was the use of physical exercises to improve the elements of its mechanism: sensomotoric and ideomotoric systems.

The main ways of developing the ideomotor component were: verbal and musical accompaniment; various signal disruptions; variation related to the use of game and competitive methods; self-examination and self-control of motor actions; training of sustained attention, mirror exercises; execution of motor actions and exercises according to the verbal description of the coach; using a verbal description of the actions of another athlete, performing simulation exercises without equipment and with ski equipment; execution of common technical techniques in unusual or unfamiliar (complicated) conditions; arbitrary improvisation of exercises on roller skates for musical accompaniment; idemotor training.

The most common ways of the sensorimotor component development were: disruption of the vestibular system; restriction or without visual or auditory control; reduction and increase of support; verbal and musical accompaniment; rectilinear and angular acceleration; various signal disruptions.

The program for improving coordination skills of mogul skiers was built by taking into account the tasks of sports training periods. Its duration corresponded with the recommendations for the organization of the annual cycle of mogul skiers training. At the stage of initial training the periodization of the mogul skier's sports training was less denominated. The specific gravity of the means for special coordination skills development prevailed at the stage of preliminary basic training in comparison with the initial training stage. The ratio of general and special skills development was determined by the period of athletes training.

In the training process of mogul skiers the special place is given to the game and competitive methods which are used throughout the formative experiment. An important issue of the program was the use of the parallel impact method, which provided for the development of coordination skills in the process of technical and physical training.

In order to test the effectiveness of the experimental program a molding experiment was conducted. The pupils of Ternopil Children's and Youth sports school "Extreme" participated in it. A comparative analysis of the level of coordination skill development of mogul skiers of the experimental and control groups has shown the superiority of the experimental technique over the traditional one. At the beginning of the forming experiment between the coordination skills of the mogul skiers of the control and experimental groups no significant differences were defined ($p > 0.05$).

After the author's program implementation into the training process of mogul skiers at the initial training stage, in the experimental group the largest (37-49%) growth rates of the results occurred in the development of: the static and dynamic balance, rhythm sensation and the ability to arbitrarily relax the muscles (Fig. 3).

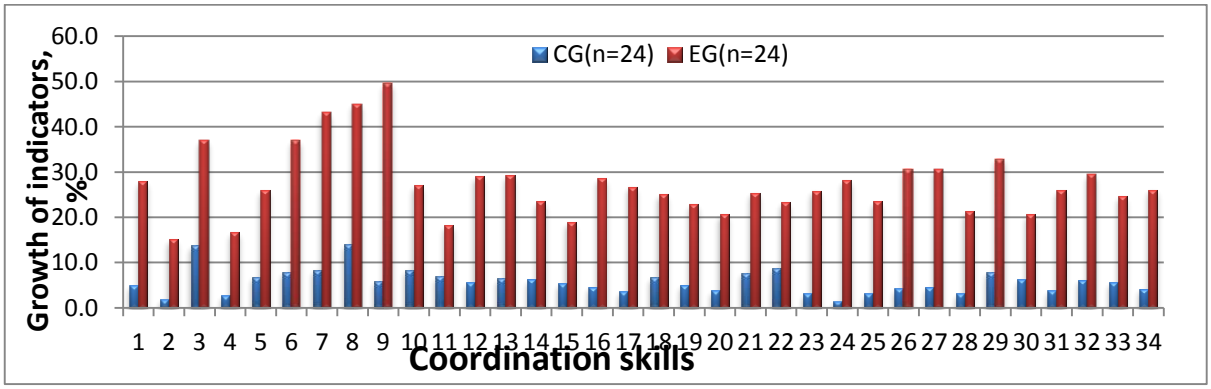

Figure 3. *Changes in indicators of coordination skills development of mogul skiers at the stage of initial training after a pedagogical experiment*

Notes: 1-static equilibrium; 2-dynamic equilibrium; 3-static and kinetic equilibrium; 4-orientation in space; 5-coordination of movements; 6-7-sense of rhythm; 8-9 - an arbitrary relaxation of the muscles of the right and left leg; 10-reproduction of short time interval; 11-12-increase and decrease of the short time interval; 13-reproduction of the long time interval; 14-15-increase and decrease of the long time interval; 16-test exercise; 17-18-reproduction of dynamic efforts by the right and left hand; 19-20-increase and decrease of the dynamic efforts of the hands; 21-22-reproduction and differentiation of the dynamic efforts of the legs; 23-24-reproduction of the small amplitude with right and left leg; 25-26-reproduction of the large amplitude with right and left leg; 27-28-increase and decrease of the small amplitude; 29-30-increase and decrease of the large amplitude; 31-32-reproduction of the direction of movement on a convenient and inconvenient side; 33-34-increase and decrease of the direction of movement.

The initial level of coordination skills development of mogul skiers at the stage of preliminary basic training in the control group was somewhat higher than in the experimental one, but this advantage is statistically not reliable. After the author's program implementation in the training process, the largest (30-43%) growth rates of the coordination skills of mogul skiers of the experimental group was performed in development of: the static equilibrium, coordination of movements, rhythm sensation, ability to reproduce time intervals; the ability to reproduce the muscular effort of the upper limbs and differentiate the muscular effort of the lower limbs; the ability to reproduce the large amplitude and differentiation by amplitude of motions; the ability to control the direction of movement (Fig. 4). The lowest growth rates (13-18%) are in the development of: the dynamic equilibrium; orientation in space; the ability to arbitrarily relax muscles. The increase in the indicators of the remaining coordination skills in the experimental group was 22-29%.

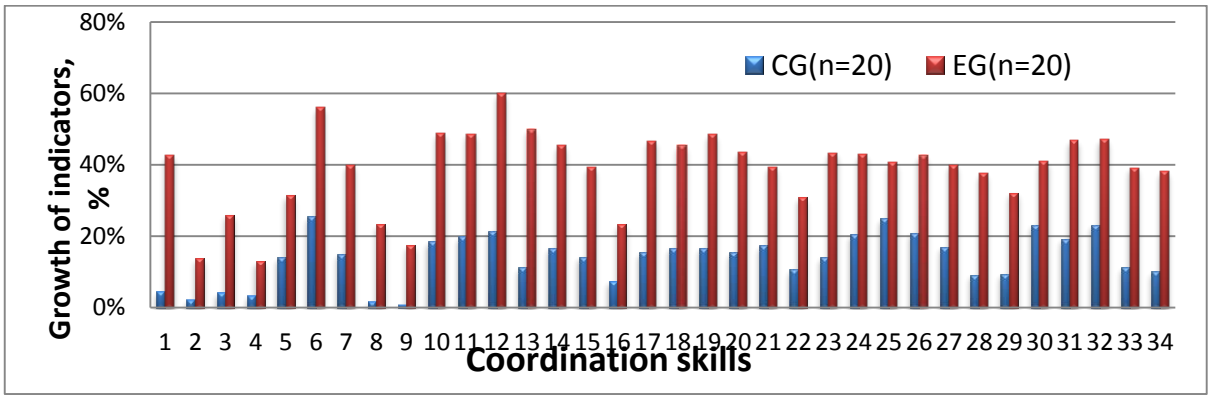

Figure 4. *Changes in indicators of coordination skills development of mogul skiers at the stage of preliminary basic training after a pedagogical experiment*

Note: coordination skills are given in the note to Fig. 3.

In the control group (stage of preliminary basic training), a smaller increase in the indicators of coordination skills was recorded than in the experimental one. The most significant (15-17.1%) positive changes were observed in the assessment of the following abilities: controlling the muscular endurance of the upper limbs; reproduction and reduction of the large amplitude by the lower limbs; reproduction of the direction to the awkward side; the smallest (up to 5%) - in the development of: static, dynamic and static and kinetic equilibrium, orientation in space and the ability to arbitrarily relax muscles. The growth of indicators of other coordination skills development was in the range of 5 to 15%.

Table 1. *Indicators of individual sensory functions development of mogul skiers at the stages of initial and preliminary basic training*

Indicators	Groups	The initial stage of training				The preliminary basic stage of training			
		Before the experiment		After the experiment		Before the experiment		After the experiment	
		Mx±Smx	t1	Mx±Smx	t1	Mx±Smx	t2	Mx±Smx	t2

Vestibular stability, degree of reaction	CG	1,90±0,14	0,31	1,75±0,07	1,70	1,15±0,14	1,43	0,95±0,14	1,1
	EG	1,95±0,14		1,46±0,07	3,90	1,32±0,21		1,00±0,14	2,2
Kinestetic sensitivity, the number of growth degrees	CG	7,67±0,32	0,44	8,04±0,32	1,80	15,11±0,92	0,41	15,6±0,75	1,8
	EG	7,37±0,32		9,25±0,37	5,91	14,95±0,99		17,2±0,77	3,9
Accuracy of the visual estimation, cm	CG	5,39±0,24	0,34	5,21±0,24	1,7	3,31±0,35	0,25	2,96±0,25	1,6
	EG	5,27±0,23		4,47±0,20	5,1	3,20±0,42		2,28±0,33	3,6

Notes: 1) t1 marginal = 2.06 at p <0.05; t1 marginal = 2.79 at p <0.01; t1 marginal = 3.74 at p <0.001;

2) t2 is the marginal = 2.09 at p <0.05; t2 marginal = 2.84 at p <0.01; t2 is the marginal = 3.85 at p <0.001.

The program provides a purposeful impact on the sensory motor component of the coordination skill's mechanism. The analysis of the results of the study of vestibular stability, kinestetic sensitivity and accuracy of the visual estimation showed that no significant differences between the indicators of individual functions of the sensory systems of the control and experimental groups of mogul skiers at the stages of the initial and preliminary basic training to the beginning of the forming experiment were found (p> 0,05) (Table 1)

After completion of the forming experiment the indicators of individual sensory functions of athletes at the stage of initial training have increased in the experimental group in the range of 15.1-25.5% (p <0.05-0.001), and in the control - only by 3.3-7.9 % (p> 0.05). At the stage of preliminary basic training the indicators have improved from 15.1 up to 28.75% (p <0.05-0.001) versus 3.2-17.7% in the control group (p> 0.05).

To determine the impact of the results of the experiment on the technical training of the mogul skiers, we have analyzed the results of their performances at the competitions, which showed that the average indicator of the positions acquired by the mogul skiers of the experimental group at the stage of initial training during the control competitions is in 35% higher than the indicator in the control group. At the preliminary basic stage this difference was 26% (p <0.05).

4. Discussion

The results of our research confirm: in the process of managing the coordination skills development it is important to provide an integrated approach to its diagnosis and to maintain the unity of improving the components of the coordination skills mechanism [17]; the motor experience, age, sports and qualification are the factors of coordination skills development [18]; coordination skills are independent of each other [5]; individual functions of sensory systems provide the coordination of movements and control the motor activity [2].

According to the results of our study the level of the static equilibrium development of mogul skiers is the highest in comparison with the dynamic and static-kinetic balance. Indicators of static and static-kinetic equilibrium are higher in girls, and dynamic - in boys. These facts are confirmed by the results of the sexual characteristics of the equilibrium research development [19]. The purposeful development of coordination skills of athletes increases the sportsmanship and improves the results in sport [11].

In the research a scientifically grounded program for coordination skills development of mogul skiers at the stages of initial and preliminary basic training is studied. The factor structure of coordination skills of mogul skiers, correlation relations between the results in sport of skilled mogul skiers and test scores for assessing coordination skills, the lack of sexual differences in the coordination skills development of mogul skiers are revealed.

5. Conclusions

Coordination abilities of mogul skiers are improving within the age experience and athlete's skills and depend on the stage of training. Indicators for coordination skills development of boys and girls of the same age, athletic skill, sports training groups and with the same training experience do not differ significantly ($p > 0.05$).

The structure of mogul skiers coordination skills is formed by the following abilities: to control the time parameters of movements, to orient in space and coordinate the movements (19,3%), to maintain the equilibrium (15.2%), to manage the dynamic (11.9%) and spatial parameters of movements (9.3%), to arbitrary relax muscles (8,3%), to sense the rhythm (7.6%).

The program of coordination skills development of mogul skiers at the stages of initial and preliminary basic training includes: the preconditions for its improvement; the sequence of coordination skills development; means of general and special skills development, idemotor, sensory motor and motor components of the coordination skills mechanism; the methods and methodical techniques. Its effectiveness is largely depends on the peculiarities of the coordination skills of mogul skiers development (sexual, age, qualification, correlation relations between proprioceptive functions, between functions of sensory systems and indicators of coordination skills, individual psychological features).

The pedagogical experiment has shown the effectiveness of the author's program for coordination skills development of mogul skiers at the initial stage of training. As a result of its implementation the largest (37-49%) growth rates of results in development occurred in the experimental group: static and dynamical equilibrium, a sense of rhythm, the ability to arbitrarily relax muscles. The growth of the remaining indicators is 15-33% ($p < 0,05$-$0,001$). In the control group the increase rate in coordination skills was significantly lower. The largest (14%) positive changes were found in the indicators of static and dynamic equilibrium and in the ability to arbitrarily relax muscles; the indicators of the remaining coordination skills development of the mogul skiers of the control group have increased only by 2-9% ($p > 0.05$).

The realization of an experimental program for the coordination skills development of mogul skiers at the stage of preliminary basic training contributes to a more significant increase in its performance. Thus, in the experimental group, the growth rate of coordination skills was 30-43% in the development of: the static equilibrium, coordination of movements, sensation of rhythm, ability to reproduce the time gaps; the ability to reproduce the muscular effort of the upper limbs and differentiation of the muscular effort of the lower limbs; the ability to reproduce a large amplitude and differentiation of the amplitude of motion; the ability to control the direction of movement. Indicators of the remaining skills development of the experimental group have increased only by 13-29% ($p < 0,05$-$0,001$).

The change in the indicators of mogul skier's coordination skills of the control group at the stage of preliminary basic training is less than in the experimental one. The largest increase (15-17.1%) occurred in the development of such skills: to control muscular effort of the upper limbs; to control the large amplitude; to reproduce the direction to the awkward side. The increase in the indicators of the remaining coordination skills is in the range of 5 to 15% ($p > 0.05$).

Coordination skills of mogul skiers define its result in sport. The average statistic of the positions acquired by the mogul skiers of the experimental group (at the stage of initial training) in the control competitions is in 35% higher than in the control group ($10,6 \pm 0,8$ places vs. $14,3 \pm 0,8$) ($p < 0,05$). Results of mogul skiers at the stage of preliminary basic training indicate that in the experimental group the average indicator of the positions they acquired in the control competitions is in 29% higher than in the control group (9.2 ± 0.8 points against 11.9 ± 0.7) ($p < 0.05$).

Further researches of this problem can be carried out in the following areas: defining the sensitive periods of coordination skills development of mogul skiers; application of motor tests for evaluation of special coordination skills of mogul skiers; determination the relationship between the individual psychological peculiarities of mogul skiers and the level of coordination skills development.

Conflict of interests

The authors declare that there is no conflict of interest.

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