Journal of Physical Education and Sport ® (JPES), 16(1), Art 24 pp. 146 - 155, 2016
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Influence of exercises and games with ball on coordination abilities of students with disorders of muscular skeletal apparatus

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Published online: March 25, 2016
(Accepted for publication February 26, 2016)
DOI:10.7752/jpes.2016.01024

Abstract:
Purpose: development of approaches to improvement of coordination abilities of students with muscular skeletal apparatus disorders under influence of system of exercises and games with ball.
Material: in the research students with disorders of muscular skeletal apparatus (n=63, 16 – 19 years' age, boys and girls) participated. The research was being carried out during 1.5 years (3 academic semesters). The students had disability of light and average degree. All they were under doctor's supervision and did not have counter indications to physical education. Coordination abilities were tested by attempts to get in target (vertical and horizontal) by ball and by movements' differentiation by power and space characteristics.
Results: we provided approaches to improvement of students' physical fitness and to acquiring new motor skills and abilities, required for adaptation to everyday life. Characteristic feature of changes of applied forces' coordination is repeated mistake of their increasing. Assessment of space orientation showed underestimation of bio-kinematic links' correlation. It was found that the most effective motor functioning rehabilitation mean was worked out by us system of exercises and games with ball, the weight of which changed depending on the tasks to be solved. Exercises and games with small ball turned out to be the most effective for improvement of coordination. They ensure development of fine motor abilities and are the most accessible in space time and power perception of load.
Conclusions: The conducted research witnesses about positive influence of exercises and games with ball on students' coordination abilities. We worked out system of specially selected exercises and games with ball for improvement of motor fitness and motor accuracy of students with disorders of motor muscular apparatus.
Key words: students, muscular skeletal apparatus, physical education, coordination abilities, ball, outdoor games.

Introduction

Physical education of students with disorders of muscular skeletal apparatus (MSA) is regarded by specialists as pedagogic process, oriented on development of main and specific motor abilities, perfection of vitally important motor skills. On this base motor actions' technique is formed as well as moral-will sphere of disabled people is developed (Phelan, & Kinsella, 2014; Baril, 2015; Roulstone, 2015). As a result assessment of life quality is risen жизни (Duvdevany, 2010; Bolach, Prystupa, 2014; Makarova, 2014). In their turn traumas and diseases influence on normal functioning of organism's systems in general and especially on coordination of movements. It results in changes of motor stereotypes and often is followed by psychic tension; de-stabilize life activity and social orientation (Fragala-Pinkham, Haley, Rabin, et al., 2005; Druz, Klimenko, Pomeschikova, 2010; Purzycka, Prusik, Bohdan, et al., 2015). That is why medical-social provisioning of disabled people is so important. In this case inclusive educational medium is an optimal form of ensuring disabled youth with conditions for self expression, self-perfection, self-creation; for realization of equal rights and opportunities, formation of sense of personal significance and usefulness (Makarova, 2012; Sobyanin, & Scherbin, 2012; Zhanneta, K., Irina, S., Tatyana, B., et al., 2015). Less active people, who do not practice recreational or sport functioning, are also less active under everyday loads and in free time (Drygas, Sakłak, Kwaåniewska, 2013; Gorelov, Obvintsev, & Kondakov, 2014; Kozina, 2015; Kozina, Iermakov, Kuzmin, et al., 2016).

It was found that problem of formation of students' physical activity shall consider specific features of psychic and physical condition, future professional functioning (Korobeynikov, & Korobeynikova, 2003; Leyfa, 2013; Podrigalo, Iermakov, Galashko, et al., 2015; Podrigalo, Iermakov, Nosko, et al., 2015). That is why effectiveness of disabling prophylaxis measures is naturally connected with disabled people's adaptation to life in society (Eide, Schür, Ranchod, et al., 2011; Pachomov, Altuchova, Demakova, et al., 2014; Soffer, & Chew, 2015). Questions of physical and social adaptation of people with MSA disorders were researched by many

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authors in the following directions: health related training programs (Zhen, 2015); periodization of many years sports trainings of sportsmen with MSA disorders (Derkach, Yedinak, 2014); methodic of physical rehabilitation of sportsmen with backbone problems (Ilmatov, 2015; Lobko, 2015). The authors showed opportunities of social rehabilitation and increase of life comfort of people with MSA disorders with the help of physical exercises of different orientation.

Many authors note special importance of coordination abilities for people with MSA disorders (Carmeli, Bar-Yossef, Ariav, 2008; Olama, 2008). In all kinds of motor functioning space accuracy of movements plays great role (Liu, 2014; Singh Virendra Kumar, Agashe Chandrakant, 2015; Ivashchenko, Khudolii, Yermakova, 2015). Accuracy Motor acts' accuracy witnesses about coordination level. In opinion of Ilyin (2003) coordination is determined by accuracy of assessment of distance or velocity of sports equipment's movement. Formation accuracy of body links' location in persons with MSDA disorders; assessment of dynamic forces are important issues for better adaptation to life conditions (Law, King, King, et al., 2006; Grammatikopoulos, 2012; Li, Zhao, & Yan, 2009; Qu, Zhang, & Yan, 2010). Tomenko (2011) points at improvement of ability for muscular efforts' differentiation manifested by children with MSA disorders after swimming trainings. Such result can be explained by application targeted impact of physical exercises, directed on formation of the tested quality. Authors used different means of physical education: exercises on specially constructed simulators (Bruder, Blessing, & Wandke, 2014; Hagberg, Hermansson, Fredriksson, et al., 2015), health related swimming (Lee, Sanders, & Payton, 2014; Rovira-Beleta, Cuerva, Pires de Souza, et al., 2015), massage (Henoch, Björkdahl, Darfeldt, et al., 2010; Levandovskaya, & Prusik, 2014; Kondakov, Voloshina, Balysheva, et al., 2015), power-lifting (Kissow, 2015; Zhen, 2015), hippo therapy (Shurtleff, & Engsberg, 2010) and etc. In such cases selection of adequate tests for physical fitness is rather important (Ivashchenko, Yermakova, Cieslicka, et al., 2015; Khudolii, Iermakov, Ananchenko, 2015; Khudolii, Iermakov, Prusik, 2015; Iermakov, Arziutov, Jagiełło, 2016). However, exercises and games with ball have not been widely used in physical education of students with MSA disorders.

Our previous researches were oriented on searching directions of youth's with MSA disorders adaptation through usage of outdoor games and games with ball. Variable and differently oriented motor functioning of students in game with ball is accompanied by positive emotions (Pomeschikova, 2010; Pomeschikova, Terent'eva, 2010; Pomeschikova, Yevtushenko, 2012) and increase interest to physical exercises' practicing (Iermakova, 2014). We have already analyzed impact of exercises and games with ball on coordination of students with MSA disorders (Pomeschikova, 2010). Nevertheless, theoretical and practical development of this question remains to be extremely urgent. Results of our previous researches permitted to find space orientation level of girls-basketball players of 14 years' age. Besides, we determined dependence between indicators of different manifestations of this ability (Pomeschikova, et al., 2012). The received results are to some extent a foundation of our approaches to the present researches. We showed different directions of solution of re-socialization problem for disabled with MSA disorders. Application of different exercises with ball permits to develop all motor qualities. Need in maximal consideration of kinds of disease, degree of MSA disorder, individual specificities of physical load's endurance are noted. (Druz, et al., 2010). We regarded indicators of speed abilities of students with MSA disorders. It was found that application of system of exercises and games with ball increased indicators of movements' frequency in tapping test. We determined indicators of time and simple response to sound, to visual irritator. Besides, we determined indicator of complex response with choice (Pomeschikova, 2010). It was noted that change of indicators of vestibular-sensor responses, considering the character of disorders, show positive tendency in all kinds of disorders. It was found that application of specially selected exercises' system reduced time of feeling of dizziness in boys and girls (Pomeschikova, Lozuchenko, 2011**)**.

By results of the conducted researches we can assume that application of outdoor games and games with balls can increase level of coordination abilities of students with MSA disorders. *The purpose of the work* is to develop approaches to improvement of coordination abilities of students with muscular skeletal apparatus disorders under influence of system of exercises and games with ball.

Material and methods

In the research 63 students with MSA disorders (n=63, 16 – 19 years' age, boys and girls) participated. All they studied in Kharkiv accounting economic college barding school. Main group consisted of 40 students (19 boys and 21 girls); control group was composed of 23 students (10 boys and 13 girls), who had the same MSA disorders. The researches were being carried out during 1.5 years (3 academic semesters).

Analysis of medical reports of the students showed that 75% of them had in-born diseases, 25% – acquired diseases. The students had different diagnosis, connected with disorders and diseases of nervous system, traumas of joints, ligaments and muscles. All students had disability of light and average degree. All students were under doctor's supervision and had no counter indications for physical education.

The researches were approved by Committee on Ethic of Kharkiv State Academy of Physical Culture.

Testing of coordination implied throwing tennis and baseball balls to target for accuracy and differentiation of movements by power and space characteristics.

Accuracy was determined by throws to vertical and horizontal target with tennis and baseball balls. From 2 meters distance the tested fulfilled 10 throws with one arm in circle of 30 cm diameters (the target was located vertically). Then, in the same way he (she) fulfilled 10 throws with one arm in circle of 30 cm diameters (the target was located horizontally, on the floor). Then, he (she) fulfilled 20 throws with basketball ball in circle of 50 cm diameter (the target was located vertically on the wall) form 2 meters' distance and the same in target located horizontally on the floor. Throws out of circle were not considered.

Differentiation of movements by power characteristics was fulfilled with hand dynamometer. We registered accuracy of the set effort, which was 50% from maximal. In standing position the tested pressed dynamometer with maximal force. We determined maximal strength indicator (kg) and calculated force, equal to 50% from maximal. Then, without visual control the tested in the same initial position reproduced the set force with the help of dynamometer, trying to fulfill it as accurate as possible. The value and character of deviation from the set force were considered.

Differentiation of movements by space characteristics was determined as accuracy of reproduction of the set amplitude of movement in elbow joint with the help of kinematic meter by N.M. Zhukovskiy (degrees) (Mogendovich, 1957). The tested took seat with his side towards the device; put his hand on bed of kinematic meter and fulfilled one movement of 20°, controlling it visually. Then he (she) reproduced this movement without visual control (light proof glasses were used). Reproduction of the movement should have been as accurate as possible. The value and direction of error were considered. The, in the same way he (she) fulfilled movements with amplitude of 50° and 70°. For determination of effectiveness of exercises and games with ball usage at lessons the students were divided into main and control groups. During three semesters students of control groups were trained as per physical education program for special educational establishments of Ministry of labor and social protection of Ukraine. Training process in main groups included the offered by us special exercises and outdoor games with ball, oriented on development of coordination of movements.

Preparatory part of physical education trainings included different kinds of walking and run with balls, different complexes of developing exercises with balls (on the spot, in motion, in pairs, in sitting position, in sitting positions in pairs) In these exercises we used tennis balls, volleyball, basketball and beach bouncy balls. Complexes of exercises included 10-12 exercises to be fulfilled slowly. If any of students was unable to fulfill an exercise, other variant of the exercise was selected for him. Main part included individual (every student with own ball) of group exercises (one ball for two or three students). Besides, we used balls of different size and weight. Exercises were fulfilled individually at the wall: dribbling the ball by the wall; different ball passes; throws for accuracy to targets of different sizes from different distances; ball throws with closed eyes. For training of arms' dexterity we practiced ball juggling exercises, dribbling the ball on the spot and in movement. We also used exercises for two or three participants: passes of one or two balls simultaneously; passes of balls of equal or different size and weight. The exercises were fulfilled for time (1 min., 2 min.) for quantity of repetitions (from 5 to 10 times), for accuracy (to get to target from 5 to 10 times). Dosing of exercises was increased gradually. Duration of exercise was influenced by complexity of exercise, temp of fulfillment, initial position; amplitude of movements, interval and character of rest between exercises.

In main part of training we applied 2-3 games with ball (Pomeschikova, 2010). In final part we used breathing exercises with the help of ball, outdoor games for attention. Games for attention were conducted at the spot during not more than 2 minutes. The trainees received home tasks and individual exercises for improvement of their physical condition (Pomeschikova, 2010).

Results of the research

Analysis of the results, received in throws of small and basketball balls in main group showed low level of small ball throws' accuracy to vertical and horizontal target (fig.1.)

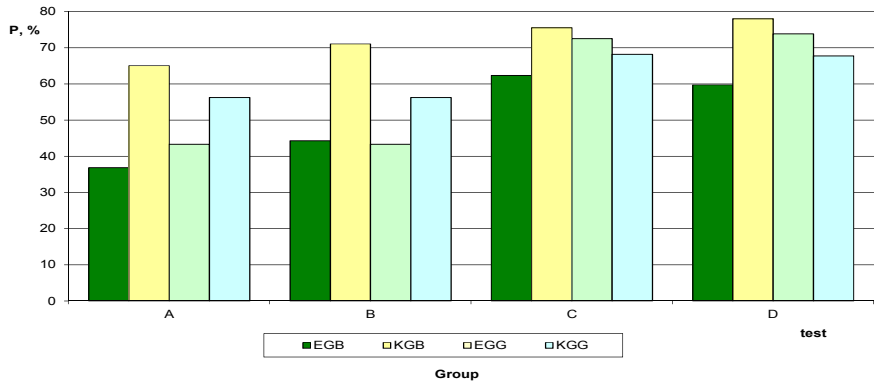

Fig. 1. Indicators of throws' accuracy (%)

EGB – boys of experimental group; KGB – control group's boys; EGG – experimental group's girls; KGG – control group's girls; A – small ball throws to vertical target; B – small ball throws to horizontal target; C – throws by basketball ball to vertical target; D – throws by basketball ball to horizontal target; P – accuracy of throws, %.

Comparison of throw accuracy results (small and basketball balls, boys and girls) of main and control groups did not show any statistically confident results ($p>0.05$). Correlation analysis of throws' accuracy in main and control group permitted to find presence of strong positive correlation between results of small ball throws to vertical and horizontal targets of boys ($r=0.828$) and girls ($r=0.669$); of basketball ball – boys ($r=0.778$) and girls ($r=0.850$) (see table 1).

Table 1. Indicators of correlation analysis of ball throws' accuracy

Throws' accuracy		Small ball		Basketball ball	
		To vertical target	To horizontal target	To vertical target	To horizontal target
		Boys (n=29)			
Small ball	To vertical target	1			
	To horizontal target	0.828	1		
Basketball ball	To vertical target	0.795	0.795	1	
	To horizontal target	0.705	0.681	0.778	1
		Girls (n=34)			
Small ball	To vertical target	1			
	To horizontal target	0.669	1		
Basketball ball	To vertical target	0.424	0.384	1	
	To horizontal target	0.378	0.370	0.850	1

It should also be noted that correlation analysis showed strong positive correlation between throw accuracy (small and basketball balls) to vertical ($r=0.795$) and horizontal ($r=0.681$) targets in boys. Concerning girls there was weak positive correlation between throw accuracy (small and basketball balls) to vertical ($r=0.424$) and horizontal ($r=0.370$) targets (see table 1).

Analysis of trainees' reproduction of the set dynamic force showed the following: value of errors of main group boys was within 6.26 kg, in control group – 5.9 kg. With it deviations from the required indicator were 42.38% and 39.59% respectively. In main group of girls values of error were within 5.3 kg and in control group – 4.3 kg (52.63% and 43.8 % respectively). Comparative analysis of boys' and girls' results showed that error in reproduction of 50% of dynamic effort is less in girls' group than in boys' group. However, the differences are not confident ($p<0.05$).

The results of kinematic metering showed that error in reproduction of movement was 20° – 20.0% in main group of boys; with amplitude of 50° – 16.1%; with amplitude of 70° – 7.8% (see fig.2). In control group of boys these errors were 17.5%; 13%; 10.6%, respectively. With it error in girls' main group in reproduction of 20° movement amplitude was 14.5%; of 50° – 12.7%; of 70° – 9.9%. In control group of girls they were – 11.6%; 9.8%; 9.9%, accordingly (see fig.2.).

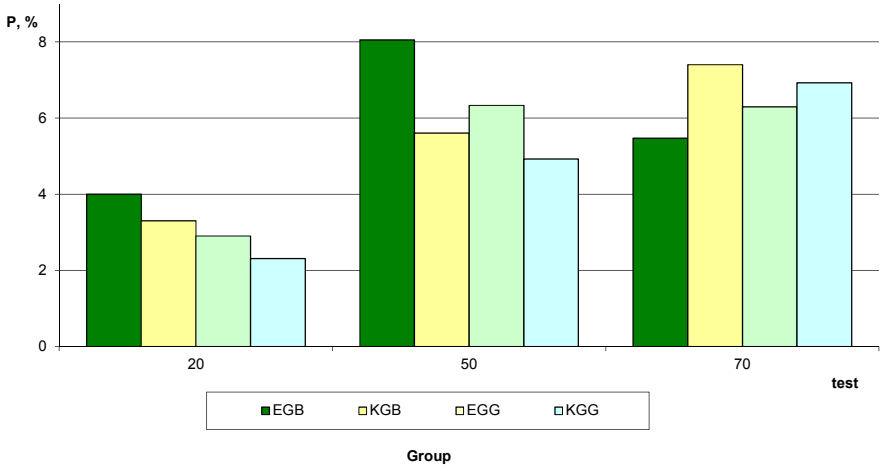

Fig. 2. Error in reproduction of movement amplitudes of the set angles (degrees)

EGB – boys of experimental group; KGB – control group's boys; EGG – experimental group's girls; KGG – control group's girls; 20 – angle of 20 degrees, 50 – angle of 50 degrees, 70 – angle of 70 degrees, P –accuracy of reproduction (%).

Comparative analysis of elbow joints angle movements' accuracy of boys and girls showed that error in reproduction of elbow joints' movement in the set deviations 20°, 50° and 70° is a little less in girls' group than in boys' group. Though the differences were not confident ($p<0.05$). The conducted correlation analysis of

reproduction accuracy by main and control groups' students permitted to find that there was no correlation between accuracy of reproduction of amplitudes of 20°, 50° and 70° (see table 2).

Table 2. Indicators of correlation analysis of reproduction accuracy in elbow joint

Sex	Boys (n=29)			Girls (n=34)		
Angle (degrees)	20	50	70	20	50	70
20	1			1		
50	0.251	1		0.128	1	
70	-0.107	0.079	1	0.197	0.087	1

Indicators of coordination abilities before and after pedagogic experiment are given in table 3. The results shows positive influence of exercises and games with ball on level of coordination abilities of main group students.

Table 3. Indicators of coordination abilities of main group before and after experiment *($\overline{X} \pm m$)*

C	Time	Throws for accuracy (quantity of hits) With small ball (10 attempts)		With basketball ball (20 attempts)		Error1 (kg)	Error2 (degrees)		
		Vr	Hr	Vr	Hr		20°	50°	70°
Boys (n=19)	BE	3.68±0.69	4.42±0.66	12.47±1.04	12.05±1.16	6.26±0.79	4.00±0.54	8.05±1.15	5.47±0.99
	AE	7.79±0.43	8.58±0.31	17.84±0.37	18.42±0.42	3.76±0.79	2.05±0.32	4.05±0.60	3.47±0.95
	t	5.04	5.71	4.85	5.16	2.63	3.10	3.09	1.84
	p	<0.001	<0.001	<0.001	<0.001	<0.05	<0.01	<0.01	>0.05
Girls (n=21)	BE	4.33±0.49	4.76±0.58	14.05±0.81	14.76±0.77	5.29±0.43	2.90±0.35	6.33±0.42	6.29±1.19
	AE	8.19±0.28	9.00±0.27	19.05±0.23	19.38±0.19	1.69±0.19	1.43±0.19	2.38±0.23	4.24±0.76
	t	6.84	6.63	5.94	5.86	7.01	3.70	8.20	1.45
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	>0.05

Notes: C – Contingent; Time – Time of testing; BE – Before experiment; AE – After experiment; Vr – Vertically; Hr – Horizontally; Error1 – Error in reproduction of the set force; Error2 – Error in reproduction of the set amplitude of movement; t – Student's criterion; p – level of significance.

For example, throw accuracy (small and basketball balls) confidently improved in boys ($p<0.001$) and in girls ($p<0.001$). Increment of indicators of throw accuracy with small ball was: to vertical target 4.11 (111.7%), to horizontal – 4.16 (94.1%). In girls these indicators were accordingly: 3.87 hits (89.1%) and 4.24 hits (89.1%). Increment of throws' accuracy (basketball ball) of boys was: to vertical target – 5.37 (43.1%), to horizontal – 6.37 (52.9%). In girls' group these indicators were accordingly: 5 hits (35.6%); 4.62 hits (31.3%).

Reproduction accuracy of the set dynamic force also confidently improved ($p<0.05$). Increment of accuracy in boys' group was 39.9%, in girls' group – 66.9%. At the same time confidently reduced error ($p<0.05$) in reproduction of movement's amplitude in elbow joint: with 20° – boys – by 48.8%, girls – by 50.7%; with 50° – by 49.7% and 62.4%, respectively. Reduction of error in reproduction of 70° angle was in boys' group – by 2°, and in girls' group – by 2.05°. However, with it there were no confident differences ($p>0.05$). Results of control groups' students did not noticeably change in the course of pedagogic experiment.

Discussion

Our researches were fulfilled in the context of recommendations of other specialists about importance of preservation and improvement of physical fitness of youth with MSA disorders for adaptation to everyday life: recreation of already available motor skills and abilities; acquiring of new motor skills and abilities. For recreation of muscular-skeletal apparatus and mobility's increase authors offer the following: dosed walking with different velocity (Eikema, Forrester, & Whitall, 2014); structuralized programs for trainings in water (Macovei, & Mandache, 2014); exercises for correction of posture (Yurchenko, 2012). Positive influence of outdoor games' usage in increasing of health level and adaptation of disabled people is confirmed by researches of other authors (Gutierrez, & García-López, 2012; Hastie, & André, 2012).

Results of our researches continue a number of works, devoted to studying and perfection of physical education of disabled people (Aurora, 2014; Macovei, & Mandache, 2014; Andrejeva, Mockiene, Zukauskiene, 2015). Analysis of initial data of students' with MSA disorders motor functioning and their comparison with indicators of healthy youth permitted to conclude that they were much lower by indicators of coordination abilities. It coincides with data of Mensch, Rameckers, Echteld, et al. (2015), Brown, Burns, Watter, et al. (2015), Demirci, Engin, & Özmen (2012). The authors note that regular physical functioning of disabled students is closely connected with overcoming of difficulties in trainings.

In our research comparison of increment of accuracy with small and basketball balls showed that basketball ball throws showed confident increment of results. However, it was less significant. In our opinion it can be used by insufficient condition of students' muscles. Concerning indicators of space orientation, we registered confident increment of accurate reproduction of movement' amplitude at 20° and 50° in elbow joint without visual control. Indicators at 70° also improved. However, in boys' group these changes were not confident ($p>0.05$) and in girls' group ($p>0.05$). When analyzing ability to accurately reproduce the set movements' amplitudes we found reduction of error: with amplitude of 20° in boys' group up to 1.95°; in girls' group – up to 1.47°; with amplitude of 50° – up to 4° and 3.95°; with amplitude of 70° – up to 2° and 2.05°, accordingly. Such correlation is confirmed by researches of Ilyin (2003). The author found that there are no correlations between accuracy of reproduction of small and large amplitude movements. Actually such correlations are independent and proprioreceptive functions, which are not interconnected. These conclusions are proved also by our results.

Some authors applied method of kinematic metering for study of movements' accuracy of different age healthy people (Vanswearingen, 1983; Nazarenko, 1996). After application of specially selected exercises they also demonstrated increment of ability and it coincides with our researches. Increment of reproduction accuracy of the set force at 50% from maximal in main groups was confident ($p<0.05$) and was: in boys' groups – 3.50 kg; in girls' group – 3.41 kg. It corresponds to increment of accuracy by 39.6% and 66.9%. It should be noted that Tomenko (2011) also registered increment of ability to differentiate muscular efforts within 24–29% in senior school age children with MSA disorders under influence of swimming. Falkova (2002) found increment of this ability up to 4 kg in healthy students after application of individually selected exercises.

Characteristic feature of applied forces' coordination' change and changes in fulfillment of movements is the fact that persons with MSA disorders make regular mistake, mainly, to the side of increasing the force. When assessing space orientation we observed prevailing shift to underestimation of bio-mechanical links' correlation. The worked out by us system of exercises and games with ball (weight of which varied, depending of the tasks) is the most effective rehabilitation mean for persons with MSA disorders. Such result is explained by the fact that the worked out program is widely variable in fulfilling of physical exercises. Analysis of the received results permits to note that for increase of coordination abilities of students with MSA disorders the most effective are exercises and games with ball of small size. In our opinion it is explained by the fact that usage of small ball ensures development of fine motor skills in mode of motor functioning. Such mode of functioning is the most accessible for the tested contingent in space-time and power perception of load.

Conclusions

1. The worked out system of special exercises and games with ball improved coordination abilities of students with MSA disorders. It was expressed in formation of vitally important skills and abilities in the tested contingent; improvement of students' motor fitness and space orientation, their readiness to professional functioning.

2. The conducted research witnesses about positive influence of exercises and games with ball on coordination fitness of students with MSA disorders. As a result we noted positive influence on belief in own actions, uninhibited character of movements, greater adaptation to conditions of everyday life. It permits for us to recommend for physical culture instructors, parents and students to supplement physical education process and independent motor functioning with the worked out system of specially selected exercises and games with ball.

Acknowledgements

The topic of the research is a component of complex program of scientific work of Kharkiv State Academy of Physical Culture. The work was fulfilled in compliance with combined plan of SRW in sphere of physical culture and sports for 2006–2010 of Ministry of Family, Youth and Sports of Ukraine by topic 3.1.4. "Perfection of physical education process in educational establishments of different profile" (state registration number 0106U011983) as well as in compliance with scientific-research project of sport and outdoor games' department for 2011–2015 "Perfection of training process in sport games" (state registration number 0111U003126).

Conflict of interests

The authors declare hat there is no conflict of interests.

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