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STRENGTH ABILITIES: IMMEDIATE AND DELAYED TRAINING EFFECTS OF ORTHOGONAL MODES OF STRENGTH TRAINING IN BOYS AGED 8 YEARS

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Abstract

The study purpose was to determine the dynamics of training effects of orthogonal modes of strength training in boys aged 8 years.

Materials and methods. The study participants were 48 boys aged 8 years. The experiment was performed using a 2^2 factorial design. The study materials were processed using the IBM SPSS 22 statistical analysis program. Discriminant analysis was performed. The study examined the impact of four variants of strength training loads on the immediate (ITE) and delayed (DTE) training effects of orthogonal modes of strength exercises and rest intervals in 8-year-old boys.

Results. In the first variant of strength training, the largest contribution to the dynamics of training effects is made by the work performed at the first place "exercises to strengthen arm and shoulder muscles"; in the second variant, the largest contribution to the dynamics of training effects is made by the work performed at the third place "exercises to strengthen back muscles"; in the third variant, the largest contribution to the dynamics of training effects is made by the work performed at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places; in the fourth variant, the largest contribution to the dynamics of ITE is made by the work performed at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places. The most significant changes in the DTE are associated with the fourth place's work "exercises to strengthen leg muscles".

Conclusions. The response to strength training load includes immediate and delayed training effects. Thus it can be argued that training effects can be classified using the given battery of tests based on discriminant analysis. The efficiency of discriminant analysis increases when using 2^k FFE active experiments.

Keywords: boys aged 8 years, immediate training effect, delayed training effect, strength training loads, discriminant analysis.

Introduction

The low physical activity level of schoolchildren is the main reason for their health deterioration and requires the development of methodological approaches to physical education in educational institutions (Krutsevych, & Chervotoka, 2019; Bahinska, 2015; Garkusha, 2013). The regulation of physical loads in physical education lessons is one of the factors that ensure the effectiveness of schoolchildren's physical education (Ivashchenko, Khudolii, Iermakov, Veremeenko, & Lopatiev, 2018; Veremeenko, Khudolii, & Ivashchenko, 2019).

The effective use of loads in physical education goes hand in hand with control and targeted regulation of rest intervals between exercises, their repetition and training in general, as well as with management of training effects of exercises (Ivashchenko, 2016; Bosenko, 2016; Veremeenko, 2019). The importance of studying rest intervals between strength exercises is indicated in papers by Arazi, Mirzaei, Sangdevini, and Abadi (2012), Ratamess, Chiarello, Sacco, Hoffman, Faigenbaum, Ross, and Kang (2012), Miranda, Simão, DosSantos-Vigário, DeSalles, Pacheco, and Willardson (2010).

Studies on schoolchildren's physical education focus on the development of strength and coordination skills and on technological approaches to the assessment of training effects of strength training loads in schoolchildren. (Cieślicka, & Ivashchenko, 2017; Ivashchenko, Khudolii, Iermakov, & Prykhodko, 2018).

Technological approaches to the assessment of training effects of strength training loads, pedagogical control of the level of motor fitness in primary school pupils have been studied in a number of works (Ivashchenko, Khudolii, Iermakov, & Harkusha, 2017; Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018; Ivashchenko, 2016). One of the technological approaches is the use of pattern recognition methods (Neimark, & Teklina, 2007, 2012; Ivashchenko, Khudolii, Iermakov, Veremeenko, & Lopatiev, 2018). In research on the effectiveness of strength development, there is an issue of studying single-factor and multi-factor impacts on the formation of immediate and delayed training effects. An aspect of research is studying the laws of regulating strength exercises which result in immediate and delayed training effects, and the obtained data represent time series at each step of discretization (link). A distinctive feature of pattern recognition is that it is a task with an active experiment, and the possibilities of the experiment are almost unlimited and do not require large time or material costs. The experiment planning involves choosing initial conditions, as well as its characteristics, such as a discretization step, duration and accuracy of calculation (Neimark, & Teklina, 2007, 2012). Full factorial experiments of a 2^k type are effective for studying the process of learning and motor abilities development in schoolchildren (Ivashchenko, 2016; Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018).

Therefore, the issue of assessing training effects and managing strength training of primary school pupils is relevant and requires further research.

The study purpose was to determine the dynamics of training effects of orthogonal modes of strength training in boys aged 8 years.

Materials and methods

Study participants

The study participants were boys aged 8 years (n = 48). The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Study organization

To solve the tasks set, theoretical and empirical methods were used: analysis and generalization of scientific and methodological literature; modeling, pedagogical observation and experiment, discriminant analysis.

To determine the dynamics of strength training effects in boys aged 8 years, the study carried out an experiment according to the plan given in Table 1. Variant I of the combined method was used to strengthen arm and shoulder muscles (place I), abdominal muscles (place II), back muscles (place III), and leg muscles (place IV). At each place, the following methods were used: dynamic effort method, maximal effort method, isometric effort method, repeated effort method. The modes of performance for each group, for the indicated places are given in Table 1.

Table 1. Factorial design in studying the influence of different modes of the combined method of strength development (variant I) in primary schoolchildren (X_1 – number of repetitions in a set; X_2 – rest interval, s)

No. of strength load variant	Method	X_1	X_2
I	Dynamic effort method	3-	30-
	Maximal effort method	1-	30-
	Isometric effort method	3-	30-
	Repeated effort method	6-	30-
II	Dynamic effort method	5+	30-
	Maximal effort method	3+	30-
	Isometric effort method	5+	30-
	Repeated effort method	12+	30-
III	Dynamic effort method	3-	60+
	Maximal effort method	1-	60+
	Isometric effort method	3-	60+
	Repeated effort method	6-	60+
IV	Dynamiceffort method	5+	60+
	Maximal effort method	3+	60+
	Isometric effort method	5+	60+
	Repeated effort method	12+	60+

During the experiment, the study recorded the results of the following tests: 1. Push-ups. 2. Speed push-ups, 3 times. 3. Sit-ups in 30 seconds. 4. Trunk lift in 10 seconds. 5. Standing long jump.

On the first day before the experiment, the study recorded the results of Test 2 "Speed push-ups, 3 times", Test 1 "Push-ups", Test 3 "Sit-ups in 30 seconds", Test 4 "Trunk lift in 10 seconds", Test 5 "Standing long jump". After performing the exercises at place I – Tests 2, 1; at place II – Test 3; at place III – Test 4; at place IV – Test 5. After the lesson – Tests 2, 1, 3, 4. Twenty-four hours after training – Tests 2, 1, 3, 4, 5. The dynamics of test results was determined as a percentage relative to the initial level.

Statistical analysis

The study materials were processed using the IBM SPSS 22 statistical analysis program. In the process of discriminant analysis, the researchers created a prognostic model for group membership. This model builds a discriminant function (or, when there are more than two groups – a set of discriminant functions) in the form of a linear combination of predictor variables, which ensures the best division of groups. These functions are built according to a set of observations, for which their group membership is known. These functions can continue to be used for new observations with known values of predictor variables and unknown group membership.

For each canonical discriminant function, the study calculated: eigenvalue, dispersion percentage, canonical correlation, Wilks' Lambda, Chi-square.

Results

The discriminant analysis made it possible to obtain information on the dynamics of the immediate (ITE) and delayed (DTE) training effects of strength exercises with different focus, taking into account their modes. So, after the first mode of strength exercises, the difference between the results of Tests 1, 2, 3, 5 is statistically significant ($p = 0.001$; $p = 0.015$). The dynamics of the results of Test 4 is statistically non-significant ($p = 0.06$). After the second mode of strength exercises, the results of Tests 1, 2, 3, 4 differ statistically significantly ($p = 0.002$; $p = 0.001$). The dynamics of the results of Test 5 is statistically non-significant ($p = 0.364$). After the third mode of strength exercises, the difference between the results of Tests 1, 3, 5 is statistically significant ($p = 0.001$; $p = 0.016$). The dynamics of the results of Tests 2 and 4 is statistically non-significant ($p = 0.058$; $p = 0.053$). After the fourth mode of strength exercises, the results of Tests 1, 3, 5 differ statistically significantly ($p = 0.001$; $p = 0.016$). The dynamics of the results of Tests 2 and 4 is statistically non-significant ($p = 0.058$; $p = 0.053$) (see Table 2).

Thus, there is a statistically significant difference in the effect of strength exercises in 8-year-old boys after the work at stations 1-4, after the class, and after 24 hours, relative to the initial level.

Tables 3-6 show the results of discriminant analysis for a set of data for four variants of strength exercises.

The following data were obtained for the first variant of strength exercises.

The first canonical function explains 97.9% of the variation of results, the second one – 1.3%, which indicates a high informativeness of the first canonical function ($r = 0.936$) (see Table 3, variant I).

The verification of the first function shows its high discriminative ability and value in interpretation with respect to the general population ($\lambda = 0.109$; $p = 0.001$; Table 4, variant I). The first function characterizes the impact of strength training load on the dynamics of test results after the work, after the class, and after 24 hours.

Structure coefficients indicate that the most significant changes in the ITE and DTE are associated with the work at the first place "exercises to strengthen arm and shoulder muscles" ($r = 0.847$, see Table 5, variant 1). During a discriminant analysis, it was found that 70,8% of cases were classified correctly. The analysis of group centroids for the first load variant shows that at the positive pole of the first function,

Table 2. The results of the impact of strength exercises modes on test results of boys aged 8 years (%)

Place	N	Indicators	Terms of recording	Variant I (n = 12)		Variant II (n = 12)		Variant III (n = 12)		Variant IV (n = 12)	
				X	s	X	s	X	s	X	s
Place I "Exercises for arm and shoulder muscles"	1.	Push-ups	before work	100.00							
			after work	84.98	4.737	92.91	7.784	89,25	6,419	93,31	2,104
			after class	84.85	2.190	90.53	6.283	89,25	6,419	86,53	1,765
			after 24 hours	96.57	3.615	94.37	7.551	101,39	3,244	94,81	4,273
			F; p	73.318; 0.001		5.773; 0.002		22.704; 0.001		22.704; 0.001	
	2.	Speed push-ups, 3 times	before work	100.00							
			after work	109.39	6.009	106.56	4.579	105,24	5,706	97,45	5,489
			after class	108.31	7.183	106.42	7.196	105,66	7,077	104,04	7,372
			after 24 hours	102.60	2.164	106.33	5.143	104,20	6,091	102,83	4,295
			F; p	10.667; 0.001		5.847; 0.002		2.691; 0.058		2.691; 0.058	
Place II "Exercises to strengthen abdominal muscles"	3.	Sit-ups in 30 seconds	before work	100.00							
			after work	89.63	6.103	90.46	4.515	92,77	0,857	98,15	2,735
			after class	89.78	3.587	89.10	5.277	95,55	3,301	9,236	2,581
			after 24 hours	95.46	2.141	95.83	2.813	95,55	3,301	9,481	4,273
			F; p	10.806; 0.001		25.181; 0.001		19.076; 0.001		19.076; 0.001	
Place III "Exercises to strengthen back muscles"	4.	Trunk lift in 10 seconds	before work	100.00							
			after work	92.03	6.271	91.94	6.170	94,02	7,074	97,78	3,282
			after class	91.28	6.575	91.54	4.237	93,68	4,785	95,00	3,761
			after 24 hours	97.68	3.460	97.79	3.643	94,64	8,972	94,81	4,273
			F; p	2.654; 0.060		14.469; 0.001		2.758; 0.053		2.758; 0.053	
Place IV "Exercises to strengthen leg muscles"	5.	Standing long jump	before work	100.00							
			after work	100.32	2.408	99.69	2.473	97,06	3,768	98,00	1,644
			after class	98.99	2.282	98.60	2.940	99,17	3,621	99,18	2,309
			after 24 hours	99.96	2.139	99.89	2.590	101,80	4,576	94,81	4,273
			F; p	3.862; 0.015		1.084; 0.364		3.848; 0.016		3.848; 0.016	

there are the centroids of state at the beginning of strength training and 24 hours after the class, at the negative pole – the centroids of training effects after strength training, after the class. Thus, in the response to strength training load, there are immediate and delayed training effects (see Table 6. Fig. 1).

Table 3. Eigenvalues. Boys aged 8 years

Variant	Function	Eigenvalue	% of Variation	Cumulative %	Canonical Correlation
I	1	6.959	97.9	97.9	.935
	2	.094	1.3	99.3	.293
	3	.053	.7	100.0	.223
II	1	2.292	92.1	92.1	.834
	2	.133	5.3	97.4	.343
	3	.065	2.6	100.0	.246
III	1	3.709	77.1	77.1	.887
	2	1.030	21.4	98.5	.712
	3	.074	1.5	100.0	.263
IV	1	21.874	91.4	91.4	.978
	2	1.548	6.5	97.9	.779
	3	.510	2.1	100.0	.581

Table 4. Test of function(s). Boys aged 8 years

Variant	Test of function(s)	Wilks' Lambda	Chi-square	df	Sig.
I	1 through 3	.109	94.143	15	.000
	2 through 3	.869	5.984	8	.649
	3	.950	2.175	3	.537
II	1 through 3	.252	69.633	15	.000
	2 through 3	.829	9.465	8	.305
	3	.939	3.159	3	.368
III	1 through 3	.097	98.978	15	.000
	2 through 3	.459	33.129	8	.000
	3	.931	3.046	3	.385
IV	1 through 3	.011	190.295	15	.000
	2 through 3	.260	57.271	8	.000
	3	.662	17.522	3	.001

The following data were obtained for the second variant of strength exercises.

The first canonical function explains 92.1 % of the variation of results, the second one – 5.3 %, which indicates a high informativeness of the first canonical function (r = 0.834) (see Table 3, variant II).

The verification of the first function shows its high discriminative ability and value in interpretation with respect to the general population (λ = 0.252; p = 0.001; Table 4, variant II). The first function characterizes the impact of strength load on the dynamics of test results after the work, after the class, and after 24 hours.

Structure coefficients indicate that the most significant changes in the ITE and DTE are associated with the work at the third place "exercises to strengthen back muscles" (r = 0.795, see Table 5, variant II). During a discriminant analysis, it was found that 67.9 % of cases were classified correctly. The analysis of group centroids for the first variant shows that at the positive pole of the first function, there are the centroids of state at the beginning of strength training and 24 hours after the class, at the negative pole – the centroids of training effects after strength training, after the

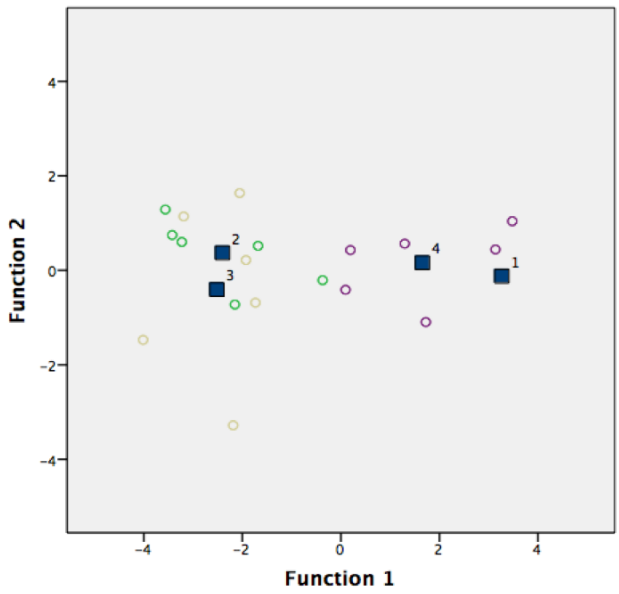

Fig. 1. Dynamics of test results of boys aged 8 years. Load variant I: 1 – before work, 2 – after work, 3 – after class, 4 – after 24 hours

Table 5. Structure matrix. Boys aged 8 years

Indicators	Variant I Function			Variant II Function			Variant III Function			Variant IV Function		
	1	2	3	1	2	3	1	2	3	1	2	3
Push-ups	.847	.058	-.469	.368	-.390	.186	.616	-.360	-.253	.388	.425	.808
Speed push-ups, 3 times	-.319	.307	.107	-.323	.808	.426	-.185	-.183	.542	-.037	-.393	.126
Trunk lift in 10 seconds	.300	.139	.059	.592	.438	-.318	.175	.224	-.549	.061	.398	.516
Standing long jump	.034	.771	.328	.129	.100	.595	.212	-.196	.875	-.065	.326	.873
Sit-ups in 30 seconds	.457	-.317	.710	.795	.122	-.144	.499	.595	.400	.151	.617	.409

Table 6. Functions at group centroids. Boys aged 8 years

Terms of recording	Load variants			
	I	II	III	IV
before work	3.266	2.101	2.254	3.818
after work	-2.403	-1.043	-2.184	-.780
after class	-2.518	-1.636	-1.404	-7.015
after 24 hours	1.655	.578	1.333	3.977

class. Thus, in the response to strength training load, there are immediate and delayed training effects (see Table 6. Fig. 2).

The following data were obtained for the third variant of strength exercises.

The first canonical function explains 77.1 % of the variation of results, the second one – 21.4 %, which indicates a high informativeness of the first and second canonical functions ($r_1 = 0.887$; $r_2 = 0.712$) (see Table 3, variant III).

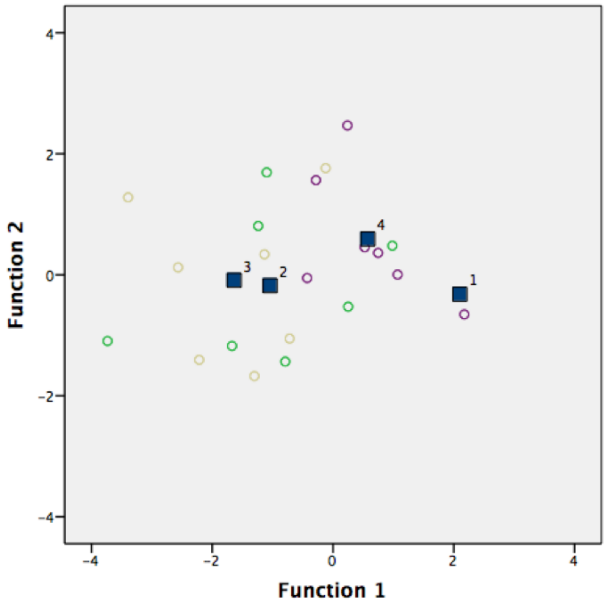

Fig. 2. Dynamics of test results of boys aged 8 years. Load variant II: 1 – before work, 2 – after work, 3 – after class, 4 – after 24 hours

The verification of the first and second functions shows their high discriminative ability and value in interpretation with respect to the general population ($\lambda_1 = 0.097$; $\lambda_2 = 0.459$; $p = 0.001$; Table 4, variant III). The first function characterizes the impact of strength training load on the dynamics of test results after the work, after the class, and after 24 hours, the second function – after the class and 24 hours after training.

Structure coefficients show that the most significant changes in the ITE and DTE are associated with the work at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places ($r_1 = 0.616$, $r_2 = 0.595$, see Table 5, variant III). During a discriminant analysis, it was found that 70.8 % of cases were classified correctly. The analysis of group centroids for the first load variant shows that at the positive pole of the first function, there are the centroids of state at the beginning of strength

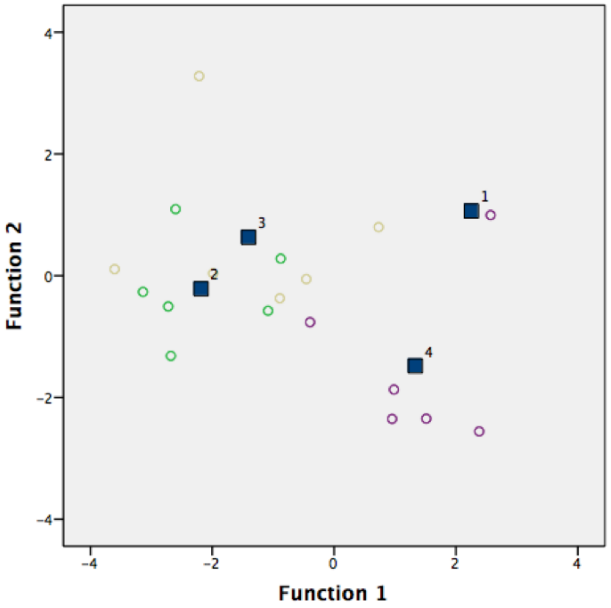

Fig. 3. Dynamics of test results of boys aged 8 years. Load variant III: 1 – before work, 2 – after work, 3 – after class, 4 – after 24 hours

training and 24 hours after the class, at the negative pole – the centroids of training effects after strength training, after the class. Thus, in the response to strength training load, there are immediate and delayed training effects (see Table 6. Fig. 3).

The following data were obtained for the fourth variant of strength exercises.

The first canonical function explains 91.4 % of the variation of results, the second one – 6.5 %, which indicates a high informativeness of the first and second canonical functions ($r_1 = 0.978$; $r_2 = 0.779$) (see Table 3, variant IV).

The verification of the first, second, and third functions shows their high discriminative ability and value in interpretation with respect to the general population ($\lambda_1 = 0.011$; $\lambda_2 = 0.260$; $\lambda_3 = 0.662$; $p = 0.001$; Table 4, variant IV). The first function characterizes the impact of strength training load on the dynamics of test results after the work, after the class, and after 24 hours, the second function – after the class and 24 hours after training, the third one – 24 hours after training.

Structure coefficients indicate that the most significant changes in the ITE and DTE are associated with the first place's "exercises to strengthen arm and shoulder muscles" and the third place's "exercises to strengthen back muscles" ($r_1 = 0.616$, $r_2 = 0.595$, see Table 5, variant IV). The most significant changes in the DTE are associated with the fourth place's work "exercises to strengthen leg muscles" ($r_3 = 0.873$, see Table 5, variant IV). During a discriminant analysis, it was found that 91.7 % of cases were classified correctly. The analysis of group centroids for the fourth variant of load shows that at the positive pole of the first function, there are the centroids of state at the beginning of strength training and 24 hours after the class, at the negative pole – the centroids of training effects after strength training, after the class. Thus, in the response to strength training load, there are immediate and delayed training effects (see Table 6. Fig. 4).

So each of the four load variants influences the formation of training effects of strength exercises. In the first variant, the largest contribution to the dynamics of training effects is

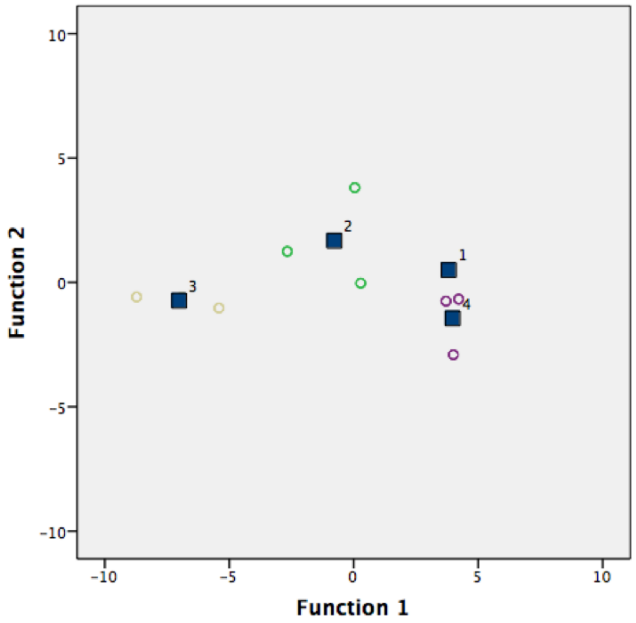

Fig. 4. Dynamics of test results of boys aged 8 years. Load variant IV: 1 – before work, 2 – after work, 3 – after class, 4 – after 24 hours

made by the work performed at the first place "exercises to strengthen arm and shoulder muscles"; in the second variant, the work performed at the third place "exercises to strengthen back muscles"; in the third variant, the work performed at the first place "exercises to strengthen arm and shoulder muscles" and the third place "exercises to strengthen back muscles"; in the fourth variant, the largest contribution to the dynamics of ITE is made by the work performed at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places, to the dynamics of DTE – the work at the fourth place "exercises to strengthen leg muscles".

Discussion

The paper assumed that the conditions of performing strength exercises during physical education classes influence the dynamics of ITE and DTE in boys aged 8 years. It was found that each of the four orthogonal variants of load influences the formation of immediate and delayed training effects of strength exercises.

The results of discriminant analysis specify the data of Ivashchenko (2016), Cieślicka, and Ivashchenko (2017) about the peculiarities of the dynamics of training effects in primary school pupils. The results corroborate the findings of Bosenko (2016), Ivashchenko (2016) about the need to consider the age and gender peculiarities of the development and response to physical load in schoolchildren aged 7-16.

The findings supplement the results of the study by Ivashchenko, Khudolii, Iermakov, Veremeenko, and Lopatiev (2018), Veremeenko, Khudolii, and Ivashchenko (2019), Veremeenko (2019) on the use of strength training in a physical education lesson.

The study specifies the data of Ivashchenko, Khudolii, Iermakov, Chernenko, and Honcharenko (2018), Ivashchenko, Khudolii, Iermakov, and Harkusha (2017), Iedynak, Galamandjuk, Dutchak, Balatska, Herasymchuk, and Mazur (2017) about the peculiarities of influence of different variants of performing physical exercises and rest intervals on schoolchildren's motor fitness.

The findings indicate that the ITE and DTE of strength exercises depend on the initial level of fitness and the total amount of strength training in a physical education lesson. This confirms the conclusion of researchers that primary school pupils' response to strength training load includes immediate, delayed, and cumulative training effects. (Ivashchenko, 2016; Cieślicka, & Ivashchenko, 2017; Balaban, 2018).

In contrast to Arazi, et al. (2012), Ratamess, et al. (2012), Miranda, et al. (2010), the study obtained data on the impact of orthogonal variants of alternation of strength exercises and rest intervals on the training effect of strength training loads. The paper confirmed that the efficiency of discriminant analysis increases when using 2^k FFE active experiments (Neimark, & Teklina, 2012; Correa, Grima, and Tort-Martorell, 2009, 2012; Ivashchenko, et al., 2018).

Conclusion

The response to strength training load includes immediate and delayed training effects. Thus it can be argued that training effects can be classified using the given battery of tests based on discriminant analysis. The efficiency of discriminant analysis increases when using 2^k FFE active experiments.

In the first variant of strength training, the largest contribution to the dynamics of training effects is made by the work performed at the first place "exercises to strengthen arm and shoulder muscles"; in the second variant, the largest contribution to the dynamics of training effects is made by the work performed at the third place "exercises to strengthen back muscles"; in the third variant, the largest contribution to the dynamics of training effects is made by the work performed at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places; in the fourth variant, the largest contribution to the dynamics of ITE is made by the work performed at the first "exercises to strengthen arm and shoulder muscles" and the third "exercises to strengthen back muscles" places. The most significant changes in the DTE are associated with the fourth place's work "exercises to strengthen leg muscles".

Conflict of interest

The authors state no conflict of interest.

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СИЛОВІ ЗДІБНОСТІ: ТЕРМІНОВИЙ І ВІДСТАВЛЕНИЙ ТРЕНУВАЛЬНИЙ ЕФЕКТ ОРТОГОНАЛЬНИХ РЕЖИМІВ СИЛОВИХ НАВАНТАЖЕНЬ У ХЛОПЦІВ 8 РОКІВ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 4 рис., 6 табл., 21 джерело.

Мета дослідження – визначити динаміку тренувальних ефектів ортогональних режимів силових навантажень у хлопців 8 років.

Матеріали і методи. У дослідженні прийняли участь 48 хлопців 8 років. Експеримент був проведений за планом факторного експерименту 2^2. Матеріали дослідження опрацьовані в програмі статистичного аналізу IBM SPSS 22. Здійснений дискримінантний аналіз. Вивчався вплив чотирьох варіантів силового навантаження на терміновий (ТТЕ) і відставлений (ВТЕ) тренувальний ефект ортогональних режимів виконання силових вправ та інтервалів відпочинку у хлопців 8 років.

Результати. У першому варіанті силового навантаження найбільший вклад у динаміку тренувальних ефектів має робота виконана на першому місці «вправи для розвитку сили м'язів рук і плечового поясу»; у другому варіанті найбільший вклад у динаміку тренувальних ефектів має робота виконана на третьому місці «вправи для розвитку сили м'язів спини»; у третьому варіанті найбільший вклад у динаміку тренувальних ефектів має робота виконана на першому «вправи для розвитку сили м'язів рук і плечового поясу» і третьому «вправи для розвитку сили м'язів спини» місцях; у четвертому варіанті найбільший вклад у динаміку ТТЕ має робота виконана на першому «вправи для розвитку сили м'язів рук і плечового поясу» і третьому «вправи для розвитку сили м'язів спини» місцях, найбільш значні зміни ВТЕ пов'язуються з роботою на четвертому місці «вправи для розвитку сили м'язів ніг».

Висновки. В реакції на силове навантаження виділяється терміновий і відставлений тренувальний ефект. Це дає можливість стверджувати, що класифікація тренувальних ефектів можлива за наведеною батареєю тестів на основі дискримінантного аналізу. Ефективність дискримінантного аналізу зростає в разі використання активних експериментів типу ПФЕ 2^k.

Ключові слова: хлопці 8 років, терміновий тренувальний ефект, відставлений тренувальний ефект, силові навантаження, дискримінантний аналіз.

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