

Original Article

Discriminant analysis in classification of motor fitness of 9-11 forms' juniors

IVASHCHENKO O.V.¹, YERMAKOVA T.S.², CIEŚLICKA M.³, ŻUKOWSKA H.⁴

^{1,2}H.S. Skovoroda Kharkiv National Pedagogical University, UKRAINE

^{3,4}Kazimierz Wielki University in Bydgoszcz, POLAND

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Abstract:

The purpose of the research is to determine model of classification of senior forms pupils' motor and functional fitness.

The methods of the research: analysis of scientific literature, pedagogic testing and methods of mathematical statistic. Discriminant analysis was used as method of simulation. For assessment of 9 - 11 forms pupils' functional and motor fitness tests of Shtange, Genchi and Serkin as well as motor tests were used. In the research 9 form pupils (n=36), 10 form pupils (n=33), 11 form pupils (n=36) participated.

Results: for classification of age peculiarities of functional and motor fitness of 9-11 forms' juniors discriminant function can be used. Equations of discriminant function permit to correctly classify 91.5% of grouped data. Standardized coefficients of canonic discriminant function permit to determine correlation of variables' contribution to function's result. Variables 9,3 and 6 contribute to canonic function1 most of all: the higher values of these variables are the higher is the value of function. Variables 8,2 and 9 contribute to canonic function2 most of all: the higher values of these variables are the higher is the value of function. The first function explains variation of results by 79.3%, the second – by 20.7%. It witnesses that it is possible to classify age distinctions of 9-11 forms' juniors on the base of testing of their functional, strength and coordination fitness.

Conclusions: structural coefficients of canonic discriminant function witness that in the most substantial way the function is connected with variables № 9, 7 and 6: so essential difference between boys of 9-11 forms' is observed in development of functional state and motor abilities (Serkin's test, speed power, coordination and strength).

Key words: discriminant function; classification; simulation; motor fitness; 9 – 11 forms' juniors.

Introduction

Analysis of scientific-methodic literature witnesses that optimization of physical education in comprehensive school stipulates organization of learning process, in which choice of means, techniques, methods, forms and temp of learning considers peculiarities of pupils' motor and functional fitness, level of their health and physical condition (Baltsevych V.K., Zaporozhanov V.A., 1987; Arshavskij I.A., 1982; Linec M.M., 1997; Liakh V.I., 2000; Bar-Or O., Rouland T., 2009; Krutsevych T.Yu., Bezverkhnya G.V., 2010; Cieślicka M., Napierała M., 2009; Cieslicka Mirosława, Słowiński Mariusz, 2012; Coskun Ali, Sahin Gulsah, 2014; Piccinno Andrea, Colella Dario, 2014; Zaporozhanov V.A., Boraczynski Tomasz, 2015).

Scientific researches state that for optimization of pupils' physical education it is necessary to know specificities of development of their motor skills (Shiian B.M., 2001; Marchenko S.I., 2009; Klug J. et al., 2013), laws of physical exercises' training (Ivashchenko O.V., 1988, 2001; Krutsevych T.Yu., Bezverkhnya G.V., 2010; Khudolii O.M., Iermakov S.S., 2011; Khudolii O.M., Ivashchenko O.V., 2014), and to have knowledge about training and health related effect of physical loads (Bartow G., 1984; Dmitruk K. et al., 2008; Titarenko A.A., Khudolii O.M., 2011; Lynch T., 2013; Iermakova T.S., 2014; Yermakova T.S., 2015) in order to improve motor functioning.

That is why, solution of problem of assessment and revelation of senior pupils' motor and functional fitness is rather urgent.

Material and methods

The purpose of the work — is to determine model of classification of senior forms pupils' motor and functional fitness.

The methods of the research: analysis of scientific literature, pedagogic testing and methods of mathematical statistic.

In planning of the research we used conceptual approaches to working out of scientific researches' programs in physical education and sports (Ashmarin B.A., 1978; Krutsevych T.Yu., 1985; Filin V.P., Rovnij A.S., 1992; Ruslanov D.V. et al., 2011; Zaytsev V.P. et al., 2011; Iermakov S.S. et al., 2011; Khudolii O.M.,

Ivashchenko O.V., 2014).

Testing program includes well known tests (Liakh V.I., 2000; Sergiienko L.P., 2001; De Groot S. et al., 2012; Khudolii O.M., Ivashchenko O.V., 2014): jumps with “adds” (quantity of jumps in the set trajectory), shuttle run 4×9 m (s), pressing ups (times), chin ups (times), hanging on bent arms (s), long jump from the spot (cm).

For assessment of functional condition we used tests by Shtange, Genchi and Serkin (Dubrovskij V.I., 2005; Shiiian B.M., Papusha V.G., 2005; Hayden C., 2008). For assessment of functional and motor fitness of 9-11 forms’ boys we registered results of tests of Shtange, Genchi, Serking and motor tests. In the research 9 form pupils (n=36), 10 form pupils (n=33), 11 form pupils (n=36) participated.

The study protocol was approved by the Ethical Committee of H.S. Skovoroda Kharkiv National Pedagogical University. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

Results of the research

Results of the research are given in table 1. Analysis shows that in results of testing of 9 and 10 forms’ pupils there are statistically confident differences in functional fitness of respiratory and cardio-vascular systems as well as in coordination and power fitness. By functional fitness boys are assessed as healthy but not trained (see table 1).

Table1. Results of analysis of 9-11 forms pupils’ motor and functional fitness

a	Description of tests	Boys of 9 form (n=36)		Boys of 10 form (n=33)		Boys of 11 form (n=36)		Criteria of equality of group mean values		
		X	s	X	s	X	s	ċ	F	p
1	Jumps with “adds” (times)	2.58	.906	3.36	1.24	3.58	1.13	.862	8.19	.001
2	Shuttle run 4×9 m, s	10.65	.685	10.44	1.02	9.33	1.06	.713	20.49	.000
3	Pressing ups (times)	21.55	3.484	15.18	8.90	22.58	9.42	.848	9.17	.000
4	Chin ups (times)	7.30	2.447	6.54	3.83	11.00	5.28	.806	12.29	.000
5	Hanging on bent arms, s	38.58	9.406	26.54	9.73	39.41	11.55	.754	16.63	.000
6	Long jump from the spot, cm	199.22	14.93	168.27	27.67	190.41	22.50	.743	17.67	.000
7	Shtange’s test, s	42.80	7.876	60.72	11.57	46.00	8.24	.587	35.83	.000
8	Genchi’s test, s	30.94	4.886	43.90	7.068	30.00	6.23	.481	55.09	.000
9	Serkin’s test, s	24.19	4.559	41.39	7.09	35.19	5.71	.398	77.21	.000

Analysis witnesses that by results of testing statistically confident differences exist between boys of 9th and 11 forms by results of tests 1, 2, 3 and 9 ($p<0.001$). By functional condition of respiratory and blood circulation functions 11 form’s boys are assessed as healthy but not trained.

Statistically confident differences between 9 and 11 forms pupils are observed in tests, which characterize functional, coordination and power fitness ($p<0.001$). 11 form’s boys have better fitness by results of set of tests ($p<0.001$). 11 form’s boys have better indicators of quickness, static strength, coordination and functional condition of respiratory and blood circulation system.

In tables 2-5 we present results of discriminant analysis, which permit to classify 9-11 forms’ pupils by functional condition and motor fitness.

Table 2. Standardized coefficients of canonic discriminant function

a of test (variables)	Description of tests	Function	
		1	2
1	Jumps with “adds” (times)	.307	-.151

2	Shuttle run 4×9 m, s	-.071	,434
3	Pressing ups (times)	-.508	,020
4	Chin ups (times)	.335	-,221
5	Hanging on bent arms, s	-.182	-,239
6	Long jump from the spot, cm	-.342	,105
7	Shtange's test, s	.188	,184
8	Genchi's test, s	.148	,723
9	Serkin's test, s	.720	-,394

Table 3. Structural coefficients of canonic discriminant function

a of test (variables)	Description of tests	Function	
		1	2
9	Serkin's test, s	.740*	-.159
7	Shtange's test, s	.409*	.299
6	Long jump from the spot, cm	-.328*	-.160
2	Shuttle run 4×9 m, s	-.151	.609*
8	Genchi's test, s	.421	.581*
4	Chin ups (times)	.030	-.499*
5	Hanging on bent arms, s	-.222	-.304*
3	Pressing ups (times)	-.178	-.291*
1	Jumps with "adds" (times)	.208	-.245*

* maximal by absolute value correlation between variables and discriminant functions

In table 4 we give standardized coefficients of canonic discriminant function, which permit to find correlation of variables' contributions to function's result. Variables 9, 3 and 6 contribute to canonic function 1 most of all: the higher values of these variables are the more is function's value. Variables 8, 2 and 9 contribute to canonic function 2 most of all: the higher values of these variables are the more is function's value. The first function explains results' variation by 79.3%, the second –20.7%. It witnesses that it is possible to classify age distinctions between 9-11 forms' boys on the base of functional, power and coordination fitness's testing.

Table 4. Results of classification of groups

		Classifier	Prognosticated belonging to group			Total
			9	10	11	
Output data	Frequency	9.00	35	0	1	36
		10.00	0	10	1	11
		11.00	3	0	9	12
	%	9.00	97.2	.0	2.8	100.0
		10.00	.0	90.9	9.1	100.0
		11.00	25.0	.0	75.0	100.0

Table 5. Functions in groups' centroids

Forms	Function
	1
9 form	-1.298
10 form	3.136
11 form	1.019

In table 3 we give structural coefficients of canonic discriminant function, which are coefficients of variables' correlation with function. For example in the most substantial way the function is connected with variables № 9, 7 and 6: so substantial difference between 9-11 forms' boys is observed in functional condition and motor abilities (Serkin's test, speed-power, coordination and strength).

In table 5 coordinated of centroids for three groups are presented. They permit to interpret canonic function in respect to its role in classification. At negative pole there is centroid for 9th form, at positive pole – centroids for 10th and 11th forms. It witnesses about significant difference in fitness of 9-11 forms' boys.

In table 6 we present results of groups' classification. 91.5 % of output grouped observations are classified correctly.

Thus, canonic, discriminant function can be used for classification of age peculiarities of 9-11 forms' pupils.

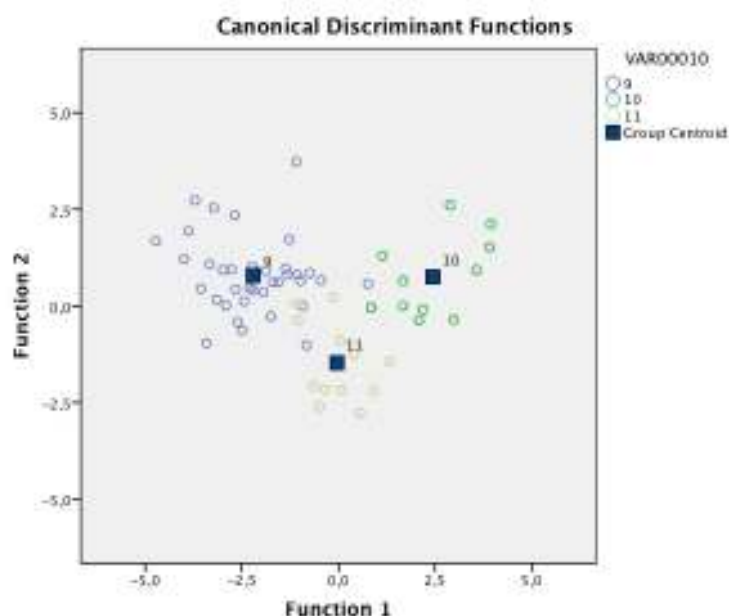


Fig.1. Canonic discriminant functions. Graphic picture of results of 9-11 forms pupils' classification by their motor and functional fitness

For specification of informative level of some indicators we carried out factorial analysis. In table 6 matrix of factorial analysis of 9-11 forms pupils' functional and motor fitness is rendered. In the process of the analysis we marked out three factors, which explain 55.3% of total dispersion of indicators. First factor is connected with indicator of strength. The second is connected with indicators of functional tests. The third factor is connected with indicators of coordination and power fitness. The factor was called coordination fitness. Analysis of groups shows that in 9th form the most informative tests were: Genchi's test, "Hanging on bent arms" (s), "Shuttle run 4x9 m, s".

In analysis of results of 10th form pupils we marked out three factors, which explain 89.2% of indicators total dispersion. The first factor (53.0%) characterizes combination of power and coordination fitness. The second (19.8%) — functional fitness, the third factor (16.3%) specifies the second one. The most informative were "test by Shtange", "test by Genchi", "shuttle run 4x9 m, s".

In analysis of results of 11th form pupils we marked out three factors, which explain 82.0% of indicators total dispersion. The first factor (54.4%) characterizes general level of power, coordination and functional fitness, the second (14.4%) — coordination and power fitness, the third factor (13.7%) — coordination fitness. The most informative were the following tests: "hanging on bent arms, (s)", "jumps with adds (times)" and test by Genchi.

Thus, factorial analysis permitted to specify informative indicators of 9-11 forms pupils' motor and functional fitness.

Table 6. Matrix of factorial analysis of 9-11 forms pupils' motor and functional fitness. Method of rotation: Varimax with standardizing by Keizer.

a	Description of test	9 form (n=36)			10 form (n=33)			11 form (n=36)		
		1	2	3	1	2	3	1	2	3
1	Jumps with "adds" (times)	-.557			.887					.934
2	Shuttle run 4×9 m, s			.828	-.937			-.391	.799	
3	Pressing ups (times)			.620	.915			.932		
4	Chin ups (times)			-.655	.865		-.362	.916		
5	Hanging on bent arms, s	.831			.813		.322	.961		
6	Long jump from the spot, cm	.723			.913			.368	.767	
7	Shtange's test, s		.524			.814	.543	.937		
8	Genchi's test, s		.891				.914	.536		.571
9	Serkin's test, s		.755			.947		.863		
	% of dispersion	18.71	18.52	18.15	53.025	19.89	16.32	54.4	14.48	13.76

Table 7. Matrix of factorial analysis of 9-11 forms pupils' motor and functional fitness. Communities.

a	Description of test	Communities		
		9 form	10 form	11 form
1	Jumps with "adds" (times)	.379	.848	.894
2	Shuttle run 4×9 m, s	.686	.945	.803
3	Pressing ups (times)	.426	.908	.875
4	Chin ups (times)	.461	.883	.839
5	Hanging on bent arms, s	.703	.790	.941
6	Long jump from the spot, cm	.536	.847	.738
7	Shtange's test, s	.374	.977	.878
8	Genchi's test, s	.811	.930	.672
9	Serkin's test, s	.608	.904	.749

Discussion

The received results supplement information about peculiarities of children's and adolescents' motor skills' development (Zieff S.G., 2006; Marchenko S.I., 2009; Titarenko A.A., Khudolii O.M., 2011; Harris J., Leggett G., 2013; Logan S.W. et al., 2014), about possibility to obtain new information with the help of simulation (Ivashchenko O.V., 1988, 2001; Iermakov S.S., 2001, 2010; Khudolii O.M., 2011; Khudolii O.M., Ivashchenko O.V., 2014; Adashevskiy V.M. et al., 2013; Ivashchenko O.V. et al., 2015).

The conducted factorial analysis confirms that it is possible to separate 9th form pupils from 10th and 11th form pupils with the help of mentioned above set of indicators, accented on functional tests and results of speed-power fitness.

So, discriminant analysis permitted to answer the question, how confidently it is possible to separate one form from the other with the help of offered variables; which of these variables influence the most substantially on differentiation of forms; to what form object belongs on the base of discriminant variables.

Conclusions

1. In results of 9-11 forms pupils' testing we observed statistically confident distinctions in functional fitness of respiratory and cardio-vascular systems as well as in coordination and power fitness. By functional fitness the boys were assessed as healthy but not trained.

2. In results of 9th and 11th forms pupils' testing we observed statistically confident differences between them by indicators of tests 1, 2, 3 and 9 ($p < 0.05:0.001$). By functional condition of respiratory and blood circulation functions the boys were assessed as healthy and trained.

3. Statistically confident differences were observed between boys of 10th and 11th forms in tests, which characterize functional, coordination and power fitness ($p < 0.001$). 11th form's boys have better fitness by results of set of tests ($p < 0.001$). They have better indicators of speed and static power, coordination of movements, functional condition of respiratory and cardio-vascular systems.

4. Standardized coefficients of canonic discriminant function permit to determine correlation of contribution of variables in function's result. Variables 9, 3 and 6 contribute most of all to function 1: the higher

values of these variables are the higher is the value of the function. Variables 8, 2 and 9 contribute most of all to function 2: the higher values of these variables are the higher is the value of the function. The first function explains variation of results by 79.3%, the second – by 20.7%. The above mentioned witnesses that it is possible to classify age distinctions of 9-11 forms boys on the base of testing of their functional, power and coordination fitness.

5. Structural coefficients of canonic discriminant function witness that the function is connected most closely with variables № 9, 7 and 6: so, substantial difference between boys of 9th and 11th forms was observed in functional condition and motor skills' levels (Serkin's test, speed power, coordination of movements and strength itself).

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