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METHODOLOGICAL APPROACHES TO PEDAGOGICAL CONTROL OF MOTOR READINESS OF GIRLS AGED 6-10

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Abstract
The objective is to determine methodological approaches to pedagogical control of motor readiness of girls aged 6-10.
Materials and methods. The participants in the experiment were girls aged 6 (n = 36), aged 7 (n = 48), aged 8 (n = 57), aged 9 (n = 38), aged 10 (n = 46). To achieve the tasks set, the research relied on the following methods: analysis of scientific and methodological literature, pedagogical testing and methods of mathematical statistics. The testing program consisted of well-known tests. As a modeling method, the research used factor and discriminant analyses.
Results. The analysis of the factor and discriminant model of motor readiness has provided information necessary for making decisions in physical education management, as well as for developing effective physical training programs for girls aged 6-10.
Conclusions. The girls aged 6-10 show a multifactorial structure of motor readiness. By analyzing the common features, the research has defined informative tests of motor readiness control for each age group. During the analysis, the research has calculated the canonical discriminant function coefficients (non-standardized), which act as the factors of specified variable values included in the discriminant functions. On their basis, it is possible to classify the girls by their level of motor readiness according to the age, which is of practical value.
Keywords: pedagogical control, motor abilities, factor analysis, discriminant analysis, girls aged 6-10.

Introduction

The issue of motor activity and health promotion is relevant for both Ukraine and Europe [Piccinno & Colella, 2014; Coskun & Sahin, 2014; Vaskov, 2016]. Researchers focus their attention on innovative approaches to physical education, as well as on the implementation of a differentiated approach to children and adolescents' physical education. Health promotion and improvement of children and adolescents' efficiency depend on optimal motor activity provided by school physical education [Krucevich, Trachuk, Napadij, 2016; Bodnar, 2014] .

The objective of physical education of school-aged children is to teach them motor actions and to develop their motor abilities [Vaskov, 2016, Arziutov, Iermakov, Bartik, Nosko, Cynarski, 2016; Khudoli, Ivashchenko, & Chernenko, 2015]. Researchers address the teaching process in terms of organization [Krucevich et al., 2016; Chernenko, 2015; Ivashchenko, 2016; Ekberg, 2016] and motivation for motor activity: the better exercises are learned, the more motor activity they provoke [Xu, & Ke, 2014; Darnis, & Lafont, 2015]. The objects of study are the connections between teaching efficiency and motor activity: teaching achievements promote the increase in motor activity [Al-Ravashdeh Abdel Baset, Kozina, Bazilyuk, & Ilnickaya, 2015; Lang, Feldmeth, Brand, Holsboer-Trachsler, Pühse, & Gerber, 2017], cognitive and motor teaching [Chatzipanteli, Digelidis, Karatzoglidis, & Dean, 2016; Altunsoz, & Goodway 2016; Koh, Ong, & Camiré, 2016], the impact of motor readiness on teaching effectiveness [Ivashchenko, 2017; Khudolii, 2011], the impact of physical loads on teaching effectiveness [Ivashchenko, Kapkan, 2015; Kapkan, 2015].

Researchers address the development of motor abilities in children and adolescents in terms of their learning readiness [Ivashchenko, 2017a, b]. The analysis of canonical discriminant function coefficients indicates that the system of physical education of schoolchildren has a hierarchical structure, in which the development of motor abilities is subject to the formation of motor skills [Ivashchenko, 2016].

One of the conditions for improving the effectiveness of schoolchildren's physical education is to organize pedagogical control at physical culture classes [Ivashchenko, 2016; Ivashchenko, & Kapkan,

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2016]. The effectiveness of pedagogical control depends on the availability of a control object and informative indicators that characterize the change in its state [Ivashchenko, Mushketa, Khudolii, & Iermakov, 2014; Ivashchenko, Pashkevich, & Krinin, 2014; Ivashchenko, Ceslicka, Khudolii, & Iermakov, 2014]. Recent publications have found that modeling is an effective method to obtain new information on conducting current and final control based on testing children and adolescents' motor readiness [Ivashchenko, & Shepelenko, 2014; Khudolii, & Ivashchenko, 2014; Ivashchenko, Khudolii, Yermakova, Iermakov, Nosko, & Nosko, 2016]. Among the methods of statistical modeling are factor and discriminant analyses. The data of scientific literature prove their effectiveness [Vlasov, Demichkovskyy, Ivashchenko, Lopatiev, Pitin, Pjanylo, & Khudolii, 2016; Khudolii, Ivashchenko, Iermakov, & Rumba, 2016; Ivashchenko, Khudolii, Iermakov, Lochbaum, Cieslicka, Zukow, Nosko, & Yermakova, 2016]. The studies mentioned show the need to search for methodological approaches to address the issues of schoolchildren's motor readiness and its pedagogical control.

Let us consider the peculiarities of motor readiness of girls aged 6-10 and the possibility to obtain new information based on factor and discriminant analyses of their motor abilities level.

The objective is to determine methodological approaches to pedagogical control of motor readiness of girls aged 6-10.

Material & methods

Participants: the participants in the experiment were girls aged 6 (n = 36), aged 7 (n = 48), aged 8 (n = 57), aged 9 (n = 38), aged 10 (n = 46).

The research related to human use complies with all the relevant national regulations, institutional policies and the tenets of the Declaration of Helsinki (WMA Declaration of Helsinki, 2016). The University Ethics Committee approved the research protocol.

Organization of the research: To achieve the objective outlined, the research used the following methods: analysis of scientific literature, pedagogical testing and methods of mathematical statistics. As a modeling method, the research used a factor analysis.

The testing program consisted of well-known tests [Ivashchenko, 2017]. To assess the girls' motor readiness, the research registered the results of the following motor tests: "Static stance on one foot (sec.)"; "Walking along segments of hexagon (steps)"; "Combined movements of arms, torso and legs (errors)"; "Walking along straight line after 5 rotations, deviations (cm)"; "Shuttle run 4×9 m (sec.)"; "30 m run (sec.)"; "Frequency of arms' movements (times)"; "Catching of falling Dietrich's stick (cm)"; "Long jump from the spot (cm)"; "300 meters' run (sec.)"; "Arms' bending and unbending in mixed hanging on rope (times)"; "Torso rising in sitting position during 1 minute (times)"; "Torso bending from sitting position (cm)"; "Index assessment of backbone mobility"; "Index assessment of shoulder joints' mobility".

Statistical analysis: the statistical anlysis program IBM SPSS 20 processed the research materials. The research conducted both factor and discriminant analyses. In the factor analysis, it used the model of principle components: Varimax with Kaiser Normalization. For every variable, the following values were calculated: average values, standard deviations, t-test criterion for independent samples.

In the discriminant analysis, the research formed a prognostic model of group belonging. This model builds a discriminant function (or if there are more than two groups — a set of discriminant functions) in the form of a linear combination of predictor variables that ensures the best groups' division. These functions are built by a set of observations, for which group belonging is known. Further, these functions can be used for new observations with known values of predictor variables and unknown group belonging.

For every variable, the research calculated the following data: average values, standard deviations, single-factor dispersion analysis for every variable (Box's M test, in-group correlation matrix, in-group covariance matrix, covariance matrices for separate groups, general covariance matrix). For every canonic discriminant function, the research calculated: eigenvalue, dispersion percentage, canonic correlation, Wilks' lambda, Chi-square. For every step, it calculated: prior probabilities, Fisher's function coefficients, non-standardized function coefficients, Wilks' lambda for every canonical function.

Results

The analysis of the results showed statistically reliable differences between the average group testing results in the following tests:

coordination: tests 1-5 demonstrate age-related statistically reliable differences in the testing results. The results are improved in test 1 "Static stance on one foot (sec.)" ($p < 0.001$), test 2 "Walking along segments of hexagon" ($p < 0.001$), test 4 "Walking along straight line after 5 rotations, deviations (cm)" ($p < 0.001$), test 5 "Shuttle run 4×9 m (sec.)" ($p < 0.001$), test 3 "Combined movements of arms, torso and legs (errors)" ($p < 0.1$). Test 3 shows the lowest dynamics of the results. The exercise "Combined movements of arms, torso and legs" is difficult for the girls aged 6-10;

dexterity: dexterity tests demonstrate an age-related statistically reliable dynamics. The results are improved

Table 1. Factor analysis matrix for girls aged 6 (n = 36). Invocation method: Varimax with Kaiser Normalization

Test No.	Description of test	Components					Common features (h^2)
		1	2	3	4	5	
1	Static stance on one foot (sec.)	-.743					.627
2	Walking along segments of hexagon (steps)		.841		.305	-.375	.961
3	Combined movements of arms, torso and legs (errors)	.814	.302				.808
4	Walking along straight line after 5 rotations, deviations (cm)				-.896		.946
5	Shuttle run 4×9 m (sec.)			-.799		.487	.902
6	30 m run (sec.)	-.391		.515		.495	.675
7	Frequency of arms' movements (times)		-.311	.840			.876
8	Catching of falling Dietrich's stick (cm)	-.521	.505	.334			.660
9	Long jump from the spot (cm)			.816	.302		.788
10	300 meters' run (sec.)		.864				.808
11	Arms' bending and unbending in mixed hanging on rope (times)				.908		.894
12	Torso rising in sitting position during 1 minute (times)					.907	.884
13	Torso bending from sitting position (cm)	.893					.926
14	Index assessment of backbone mobility	.717	-.390				.736
15	Index assessment of shoulder joints' mobility		-.811			-.438	.931

in test 6 "30 m run" ($p < 0.001$), test 7 "Frequency of arms' movements" ($p < 0.001$), tests 8 "Catching of falling Dietrich's stick (cm)" ($p < 0.001$). Test 6 "30 m run" shows the highest dynamics of the results;

strength abilities: test 9 "Long jump from the spot (cm)" ($p < 0.001$), test 11 "Arms' bending and unbending in mixed hanging on rope (times)" ($p < 0.001$) demonstrate a statistically reliable dynamics of the results;

endurance: test 10 "300 meters' run" ($p < 0.001$), test 12 "Torso rising in sitting position during 1 minute (times)" ($p < 0.001$) demonstrate a statistically reliable dynamics of the results;

flexibility: tests 14-15 demonstrate an age-related positive statistically reliable dynamics of the testing results. In test 13 "Torso bending from sitting position", the dynamics of the results is statistically unreliable.

Thus, the research has observed age-related changes in the indicators of coordination and strength readiness, endurance, dexterity, flexibility. The proposed battery of tests can be used for the final control of motor readiness of girls aged 6-10.

To determine the informative indicators of motor readiness of girls aged 6-10, the research has conducted a factor analysis (see Table 1-5).

By analyzing the results of the girls aged 6, the research determined five factors explaining 82.824% of dispersion variation.

The first factor (informative value 20.475%) is most highly correlated with the results of the following tests: test 13 "Torso bending from sitting position" (.893), test 3 "Combined movements of arms, torso and legs" (.814), test 1 "Static stance on one foot" (-.743), test 14 "Index assessment of backbone mobility (bridge)" (.717). The factor characterizes the development of flexibility and coordination of movements.

The second factor (informative value 19.493%) is most highly correlated with the results of the following tests: test 10 "300 meters' run" (.864), test 2 "Walking along segments of hexagon" (.841), test 15 "Index assessment of shoulder joints' mobility" (-.811). The factor characterizes the development of endurance and coordination of movements.

The third factor (informative value 17.222%) is most highly correlated with the results of the following tests: test 7 "Frequency of arms' movements" (.840), test 9 "Long jump from the spot" (.816), test 5 "Shuttle run 4×9 m" (-.799). The factor was named the integrated development of dexterity, speed strength and general coordination.

The fourth factor (informative value 13.104%) is most highly correlated with the results of the following tests: test 11 "Arms' bending and unbending in mixed hanging on rope" (.908), test. 4 "Walking along straight line after 5 rotations, deviations" (-0.896). The factor was named strength readiness and vestibular stability.

The fifth factor (informative value 12.530%) is most highly correlated with the results of the following tests: test 12 "Torso rising in sitting position during 1 minute" (.907) and characterizes strength endurance. The factor was named strength endurance.

Consequently, the factor model of motor readiness includes the integrated development of flexibility and coordination of movements (factor 1), endurance and coordination of movements (factor 2), dexterity,

Table 2. Factor analysis matrix for girls aged 7 (n = 36). Invocation method: Varimax with Kaiser's Normalization

Test No.	Description of test	Components						Common features (h^2)
		1	2	3	4	5	6	
1	Static stance on one foot (sec.)	-.325	.569					.545
2	Walking along segments of hexagon (steps)					.653		.638
3	Combined movements of arms, torso and legs (errors)				-.853			.792
4	Walking along straight line after 5 rotations, deviations (cm)			.806				.735
5	Shuttle run 4×9 m (sec.)	.636						.498
6	30 m run (sec.)	.727					-.317	.681
7	Frequency of arms' movements (times)					.767		.739
8	Catching of falling Dietrich's stick (cm)				.682	.431		.816
9	Long jump from the spot (cm)	-.786				-.302		.719
10	300 meters' run (sec.)	.455	.685					.736
11	Arms' bending and unbending in mixed hanging on rope (times)		.541	.375				.604
12	Torso rising in sitting position during 1 minute (times)	-.617						.593
13	Torso bending from sitting position (cm)		.785				-.301	.761
14	Index assessment of backbone mobility			.706				.584
15	Index assessment of shoulder joints' mobility						.860	.775

speed strength and general coordination (factor 3), strength and vestibular stability (factor 4), strength endurance (factor 5). The analysis of common features (h^2) showed that the most informative tests to assess motor readiness of the girls aged 6 are: test 2 "Walking along segments of hexagon" (.961), test 4 "Walking along straight line after 5 rotations, deviations" (-0.946), test 15 "Index assessment of shoulder joints' mobility" (-.931).

By analyzing the results of the girls aged 7, the research determined six factors explaining 68.111% of dispersion variation.

The first factor (informative value 16.253%) is most highly correlated with the results of the following tests: test 9 "Long jump from the spot" (-.786), test 6 "30 m run" (.727), test 5 "Shuttle run 4×9 m" (.636). The factor characterizes the development of speed strength, dexterity and general coordination of movements. The factor is integrated and a priority.

The second factor (informative value 12.576%) is most highly correlated with the results of the following tests: test 13 "Torso bending from sitting position" (.785), test 10 "300 meters' run" (.685), test 1 "Static stance on one foot" (.569). The factor characterizes the development of flexibility, endurance and coordination of movements.

The third factor (informative value 11.060%) is most highly correlated with the results of the following tests: test 4 "Walking along straight line after 5 rotations, deviations" (.806), test 14 "Index assessment of backbone mobility" (.706). The factor was named vestibular stability.

The fourth factor (informative value 9.825%) is most highly correlated with the results of the following tests: test 3 "Combined movements of arms, torso and legs" (-.853), test 8 "Catching of falling Dietrich's stick (cm)" (.682). The factor was named dexterity. The factor characterizes the development of coordination of movements and dexterity.

The fifth factor (informative value 9.696%) is most highly correlated with the results of the following tests: test 7 "Frequency of arms' movements" (.767), test 2 "Walking along segments of hexagon" (.653). The factor characterizes the development of dexterity and coordination of movements.

The sixth factor (informative value 8.699%) is most highly correlated with the results of the following tests: test 15 "Index assessment of shoulder joints' mobility" (.860). The factor characterizes the development of flexibility.

Consequently, the factor model of motor readiness of the girls aged 7 includes the integrated development of motor abilities (factor 1, 2), coordination (factor 3, 4, 5), flexibility (factor 6). The analysis of common features (h^2) showed that the most informative tests to assess motor readiness of the girls aged 7 are: test 8 "Catching of falling Dietrich's stick (cm)" (.816), test 3 "Combined movements of arms, torso and legs" (.792), test 15 "Index assessment of shoulder joints' mobility" (.775), test 13 "Torso bending from sitting position" (.761).

By analyzing the results of the girls aged 8, the research determined five factors explaining 70.665% of dispersion variation.

The first factor (informative value 18.051%) is most highly correlated with the results of the following

Table 3. Factor analysis matrix for girls aged 8 (n = 57). Invocation method: Varimax with Kaiser's Normalization

Test №	Description of test	Components						Common features (h^2)
		1	2	3	4	5	6	
1	Static stance on one foot (sec.)		.817					.754
2	Walking along segments of hexagon (steps)		.829					.748
3	Combined movements of arms, torso and legs (errors)		.713					.660
4	Walking along straight line after 5 rotations, deviations (cm)					.761		.630
5	Shuttle run 4×9 m (sec.)	.806						.764
6	30 m run (sec.)	.831						.708
7	Frequency of arms' movements (times)					-.683	-.408	.760
8	Catching of falling Dietrich's stick (cm)	.373		.683	-.396			.818
9	Long jump from the spot (cm)	-.647						.658
10	300 meters' run (sec.)				.765			.780
11	Arms' bending and unbending in mixed hanging on rope (times)	-.328					.847	.858
12	Torso rising in sitting position during 1 minute (times)	-.698					.351	.665
13	Torso bending from sitting position (cm)			-.647				.569
14	Index assessment of backbone mobility				.672	.316		.610
15	Index assessment of shoulder joints' mobility			.686	.331			.621

tests: test 6 "30 m run" (.831), test 5 "Shuttle run 4×9 m" (.806), test 12 "Torso rising in sitting position during 1 minute" (-.698). The factor characterizes the development of dexterity, coordination abilities and strength endurance.

The second factor (informative value 13.987%) is most highly correlated with the results of the following tests: test 2 "Walking along segments of hexagon" (.829), test 1 "Static stance on one foot" (.817), test 3 "Combined movements of arms, torso and legs" (.713). The factor characterizes the development of coordination abilities.

The third factor (informative value 10.491%) is most highly correlated with the results of the following tests: test 15 "Index assessment of shoulder joints' mobility" (.686), test 8 "Catching of falling Dietrich's stick" (.683), test 13 "Torso bending from sitting position" (-.647). The factor was named flexibility.

The fourth factor (informative value 10.124%) is most highly correlated with the results of the following tests: test 10 "300 meters' run" (.765), test 14 "Index assessment of backbone mobility (bridge)" (.672). The factor was named endurance.

The fifth factor (informative value 9.285%) is most highly correlated with the results of the following tests: test 4 "Walking along straight line after 5 rotations, deviations" (.761), test 7 "Frequency of arms' movements" (-.683). The factor was named coordination of movements.

The sixth factor (informative value 8.727%) is most highly correlated with the results of the following tests: test 11 "Arms' bending and unbending in mixed hanging on rope" (.847). The factor was named strength readiness.

Consequently, the factor model of motor readiness of the girls aged 8 includes the integrated development of dexterity, coordination abilities and strength endurance (factor 1), coordination abilities (factor 2, 5), flexibility (factor 3), endurance (factor 4), strength (factor 6). The analysis of common features (h2) showed that the most informative tests to assess motor readiness of the girls aged 8 are: test 11 "Arms' bending and unbending in mixed hanging on rope" (.858), test 8 "Catching of falling Dietrich's stick" (.818), test 1 "Static stance on one foot" (.754).

By analyzing the results of the girls aged 9, the research determined five factors explaining 64.657% of dispersion variation.

The first factor (informative value 16.610%) is most highly correlated with the results of the following tests: test 9 "Long jump from the spot" (.776), test 11 "Arms' bending and unbending in mixed hanging on rope" (.776), test 13 "Torso bending from sitting position" (.739). The factor characterizes the development of strength abilities and flexibility.

The second factor (informative value 13.762%) is most highly correlated with the results of the following tests: test 3 "Combined movements of arms, torso and legs" (-.694), test 6 "30 m run" (.633). The factor characterizes the development of coordination of movements and dexterity.

The third factor (informative value 12.926%) is most highly correlated with the results of the following

Table 4. Factor analysis matrix for girls aged 9 (n = 38). Invocation method: Varimax with Kaiser's Normalization

Test №	Description of test	Components					Common features (h^2)
		1	2	3	4	5	
1	Static stance on one foot (sec.)					-.904	.868
2	Walking along segments of hexagon (steps)				.848		.822
3	Combined movements of arms, torso and legs (errors)		-.694				.534
4	Walking along straight line after 5 rotations, deviations (cm)			.701			.579
5	Shuttle run 4×9 m (sec.)	-.453			.661	.334	.806
6	30 m run (sec.)		.633			.347	.616
7	Frequency of arms' movements (times)		-.464	-.325			.358
8	Catching of falling Dietrich's stick (cm)			.586			.400
9	Long jump from the spot (cm)	.776					.706
10	300 meters' run (sec.)	-.457	.580				.700
11	Arms' bending and unbending in mixed hanging on rope (times)	.776					.655
12	Torso rising in sitting position during 1 minute (times)	.411	-.354		.551		.626
13	Torso bending from sitting position (cm)	.739		-.379		.342	.840
14	Index assessment of backbone mobility		.587	.304	-.359		.576
15	Index assessment of shoulder joints' mobility			.747			.614

tests: test 15 "Index assessment of shoulder joints' mobility" (.747), test 4 "Walking along straight line after 5 rotations, deviations (cm)" (.701). The factor characterizes the development of flexibility and coordination of movements.

The fourth factor (informative value 11.699%) is most highly correlated with the results of the following tests: test 2 "Walking along segments of hexagon" (.848), test 5 "Shuttle run 4×9 m" (.661). The factor was named coordination of movements.

The fifth factor (informative value 9.660%) is most highly correlated with the results of the following tests: test 1 "Static stance on one foot" (-.904) and characterizes the development of coordination. The factor was named coordination.

Consequently, the factor model of motor readiness of the girls aged 9 includes the development of strength abilities and flexibility (factor 1), development of coordination of movements and dexterity (factor 2), development of flexibility and coordination of movements (factor 3), coordination (factor 4, 5). The analysis of common features (h2) showed that the most informative tests to assess motor readiness of the girls aged 9 are: test 1 "Static stance on one foot" (.868), test 2 "Walking along segments of hexagon" (.822), test 13 "Torso bending from sitting position" (.840).

By analyzing the results of the girls aged 10, the research determined six factors explaining 77.158% of dispersion variation.

The first factor (informative value 15.629%) is most highly correlated with the results of the following tests: test 3 "Combined movements of arms, torso and legs" (.904), test 2 "Walking along segments of hexagon (steps)" (.800). The factor characterizes the development of coordination abilities.

The second factor (informative value 15.016%) is most highly correlated with the results of the following tests: test 6 "30 m run" (.871), test 9 "Long jump from the spot" (.569), test 14 "Index assessment of backbone mobility (bridge)" (-.864). The factor characterizes the integrated development of dexterity, speed strength and flexibility.

The third factor (informative value 13.162%) is most highly correlated with the results of the following tests: test 15 "Index assessment of shoulder joints' mobility" (.928), test 13 "Torso bending from sitting position" (-.673). The factor characterizes the development of flexibility.

The fourth factor (informative value 12.200%) is most highly correlated with the results of the following tests: test 11 "Arms' bending and unbending in mixed hanging on rope" (.897), test 1 "Static stance on one foot" (.486). The factor was named strength and coordination readiness.

The fifth factor (informative value 11.821%) is most highly correlated with the results of the following tests: test 4 "Walking along straight line after 5 rotations, deviations" (-.803), test 7 "Frequency of arms' movements" (.732) and characterizes the development of coordination and dexterity.

The sixth factor (informative value 9.329%) is most highly correlated with the results of the following tests: test 8 "Catching of falling Dietrich's stick" (.842) and characterizes the development of dexterity.

Table 5. Factor analysis matrix for girls aged 10 (n = 46). Invocation method: Varimax with Kaiser's Normalization

Test №	Description of test	Components						Common features (h^2)
		1	2	3	4	5	6	
1	Static stance on one foot (sec.)				.690	.486		.801
2	Walking along segments of hexagon (steps)	.800					.427	.941
3	Combined movements of arms, torso and legs (errors)	.904						.887
4	Walking along straight line after 5 rotations, deviations (cm)					-.803		.743
5	Shuttle run 4×9 m (sec.)	-.529		.302			.393	.626
6	30 m run (sec.)		.871					.812
7	Frequency of arms' movements (times)					.732		.650
8	Catching of falling Dietrich's stick (cm)						.842	.809
9	Long jump from the spot (cm)		.569	-.425				.673
10	300 meters' run (sec.)			.317	-.474		-.482	.630
11	Arms' bending and unbending in mixed hanging on rope (times)				.897			.894
12	Torso rising in sitting position during 1 minute (times)	.623		-.381				.620
13	Torso bending from sitting position (cm)		.530	-.673				.795
14	Index assessment of backbone mobility		-.864					.801
15	Index assessment of shoulder joints' mobility			.928				.892

Consequently, the factor model of motor readiness of the girls aged 10 includes the integrated development of coordination abilities (factor 1), dexterity, speed strength and flexibility (factor 2), flexibility (factor 3), strength and coordination of movements (factor 4), coordination and dexterity (factor 5), dexterity (factor 6). The analysis of common features (h2) showed that the most informative tests to assess motor readiness of the girls aged 10 are: test 2 "Walking along segments of hexagon" (.941), test 11 "Arms' bending and unbending in mixed hanging on rope" (.894), test 15 "Index assessment of shoulder joints' mobility" (.892), test 3 "Combined movements of arms, torso and legs" (.887).

The most informative tests to assess motor readiness of the girls aged 6-10 are the following:

- test 2 "Walking along segments of hexagon" (.961), test 4 "Walking along straight line after 5 rotations, deviations" (-0.946), test 15 "Index assessment of shoulder joints' mobility" (-.931) (girls aged 6);
- test 8 "Catching of falling Dietrich's stick" (.816), test 3 "Combined movements of arms, torso and legs" (.792), test 15 "Index assessment of shoulder joints' mobility" (.775), test 13 "Torso bending from sitting position" (.761) (girls aged 7);
- test 11 "Arms' bending and unbending in mixed hanging on rope" (.858), test 8 "Catching of falling Dietrich's stick" (.818), test 1 "Static stance on one foot" (.754) (girls aged 8);
- test 1 "Static stance on one foot" (.868), test 2 "Walking along segments of hexagon" (.822), test 13 "Torso bending from sitting position" (.840) (girls aged 9);
- test 2 "Walking along segments of hexagon" (.941), test 11 "Arms' bending and unbending in mixed hanging on rope" (.894), test 15 "Index assessment of shoulder joints' mobility" (.892), test 3 "Combined movements of arms, torso and legs" (.887) (girls aged 10).

To determine the informative indicators of comprehensive pedagogical control of motor readiness, the research conducted a discriminant analysis (Table 6).

According to the results of the discriminant analysis, the first canonical function explains the results variation by 85.3%, the second one — by 8.1%, which indicates their high informative value. The correlation coefficient between the calculated values of the discriminant function and the indicators of group belonging equals to r = 0.831 and shows a high predictive value of the first canonical function. The actual value of the first canonical function indicates that its coefficients are well-chosen.

The analysis of the canonical functions shows that the first and second functions have a high discriminant ability and value in the interpretation with regard to the general totality (λ=0.216 and the statistical significance p = 0.001 for the whole set of canonical functions).

The standardized coefficients of the canonical discriminant function make it possible to determine the ratio of the contribution of variables to the function result.

1. The variables with the greatest contribution to the first canonical function are the following:

- Shuttle run 4×9 m — .552
- Catching of falling Dietrich's stick — .343
- Walking along segments of hexagon (steps) — -.344
- 300 meters' run — .329

2. The variables with the greatest contribution to the second canonical function are the following:

- Combined movements of arms, torso and legs — -.577
- Long jump from the spot — .553
- Static stance on one foot — .522
- Frequency of arms' movements — -.424

3. The variables with the greatest contribution to the third canonical function are the following:

- Shuttle run 4×9 m — .717
- Index assessment of backbone mobility (bridge) — .604
- Frequency of arms' movements — .488

4. The variables with the greatest contribution to the fourth canonical function are the following:

- Index assessment of shoulder joints' mobility —.627
- Long jump from the spot — -.615
- Torso rising in sitting position during 1 minute — .507

Using the results of the variables on the first list, it is possible to classify the girls aged 6-10, using those on the second list — the girls aged 7-10; on the third list — the girls aged 8-10; on the fourth list — the girls aged 9-10.

Given that the first and second functions have the highest discriminant ability, the variables included in the first and second lists play the leading role in the classification.

The structural coefficients of the canonical discriminant function, which are correlation coefficients of the variables and the function, determine the effect of the independent variables on the dependent one.

1. In the first function, the greatest effect of the independent variables on the dependent one is observed in the following tests:

- Shuttle run 4×9 m — .715
- 300 meters' run — .531
- 30 m run — .477
- Long jump from the spot — -.462
- Catching of falling Dietrich's stick — -.385
- Walking along segments of hexagon (steps) — .228

2. In the second function, the greatest effect of the independent variables on the dependent one is observed in the following tests:

- Static stance on one foot — .363
- Combined movements of arms, torso and legs — -.351

3. In the third function, the greatest effect of the independent variables on the dependent one is observed in the following tests:

- Frequency of arms' movements — .384
- Index assessment of backbone mobility (bridge) — .377
- Arms' bending and unbending in mixed hanging on rope — -.202
- Torso bending from sitting position — .135

Table 6. Non-standardized canonical discriminant function coefficients. Girls aged 6-10

Description of test	Age (years)				
	6	7	8	9	10
Static stance on one foot (sec.)	-.003	.081	-.007	.022	-.003
Walking along segments of hexagon (steps)	-.154	-.019	.008	.002	-.154
Combined movements of arms, torso and legs (errors)	.057	-.189	-.029	.059	.057
Walking along straight line after 5 rotations, deviations (cm)	.000	.001	-.004	-.005	.000
Shuttle run 4×9 m (sec.)	.500	.364	.649	-.071	.500
30 m run (sec.)	.366	.202	-.342	.007	.366
Frequency of arms' movements (times)	-.017	-.040	.046	-.002	-.017
Catching of falling Dietrich's stick (cm)	.047	-.016	.017	.015	.047
Long jump from the spot (cm)	.002	.030	.013	-.033	.002
300 meters' run (sec.)	.019	-.015	-.023	-.006	.019
Arms' bending and unbending in mixed hanging on rope (times)	-.005	-.013	-.047	.018	-.005
Torso rising in sitting position during 1 minute (times)	-.013	.019	.005	.055	-.013
Torso bending from sitting position (cm)	.010	-.019	.058	.040	.010
Index assessment of backbone mobility	.015	-.036	.080	-.004	.015
Index assessment of shoulder joints' mobility	.392	.705	-.190	1.760	.392
(Constant)	-13.463	-6.996	-9.522	-.255	-13.463

Table 7. Functions at group centroids. Girls aged 6-10

Age (years)	Function			
	1	2	3	4
6	2.843	.501	.173	.054
7	.632	-.575	-.481	.083
8	-.239	-.132	.139	-.277
9	-1.085	-.293	.610	.191
10	-1.697	.611	-.306	.050

Table 8. Results of group classification. Girls aged 6-10

	Age (years)	Predicted group belonging					Total
		6	7	8	9	10	
Frequency	6	30	6	0	0	0	36
	7	4	27	15	1	1	48
	8	4	9	28	7	8	56
	9	0	1	13	15	9	38
	10	0	0	4	8	34	46
%	6	83.3	16.7	.0	.0	.0	100.0
	7	8.3	56.3	31.3	2.1	2.1	100.0
	8	7.1	16.1	50.0	12.5	14.3	100.0
	9	.0	2.6	34.2	39.5	23.7	100.0
	10	.0	.0	8.7	17.4	73.9	100.0

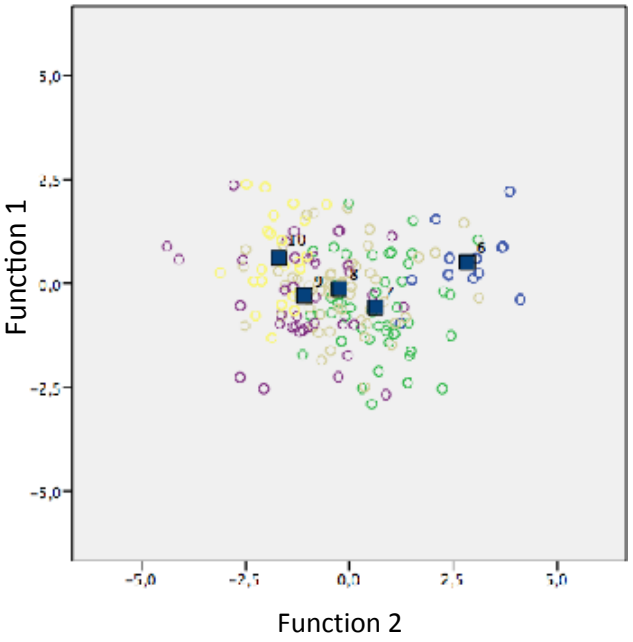

Fig. 1. Canonical discriminant functions. Graphic representation of the classification results of the girls aged 6-10 by the level of motor readiness: ▪ — centroids for the data groups (age 7, 8, 9, 10)

4. In the fourth function, the greatest effect of the independent variables on the dependent one is observed in the following tests:

- Index assessment of shoulder joints' mobility — .596
- Walking along straight line after 5 rotations, deviations — -.342
- Torso rising in sitting position during 1 minute — .331

The analysis of the correlation coefficients shows that the integrated development of motor abilities is typical for the girls aged 6-10; with the girls aged 7-10, attention is focused on the development of coordination abilities; with the girls aged 8-10 — on dexterity, strength and flexibility; with the girls aged 9-10 — on flexibility, coordination of movements and strength endurance.

Table 6 demonstrates the canonical discriminant function coefficients (non-standardized), which act as the factors of specified variable values included in the discriminant functions. By comparing the data obtained with the centroids of the functions (see Table 7), the research has classified each individual case. The classification results are given in Table 8. 59.8% of the initial group observations have been classified correctly (Fig. 1). This makes it possible to state that the girls aged 6-10 can be classified according to the battery of tests provided below.

Discussion

The results obtained supplement the data on methodological approaches to pedagogical control of motor abilities development [Ivashchenko, 2016, 2017], increase the potential of modeling in obtaining new information on the dynamics of motor abilities development in children [Lopatiev, Ivashchenko, Khudolii, Pjanylo, Chernenko, & Yermakova, 2017; Ivashchenko, 2016; Khudolii, 2011].The research has proved the effectiveness of factor and discriminant analyses in determining the structure of children and adolescents' motor readiness [Krucevich, et al., 2016; Cieślicka, & Ivashchenko, 2017; Ivashchenko, & Cieślicka, 2017]. The data obtained are important for assessing junior schoolers' readiness for motor actions training and supplement the data on the impact of motor abilities level on teaching effectiveness [Repko, Kozin, & Kostyrko, 2016; Ivashchenko, 2016]. They also indicate the need to develop strength abilities [Cieślicka, & Ivashchenko, 2017; Ivashchenko, & Cieślicka, 2017].

Therefore, on the basis of the factor and discriminant analyses, the research has defined the dynamics peculiarities of motor readiness of girls aged 6-10. The research has obtained new data on the dynamics of girls' motor readiness.

There are two vectors in the pedagogical control of motor abilities development. The first vector is the

assessment of a current state, the second one is the assessment of a state dynamics. It is essential to choose an appropriate informative indicator and assessment scale. The first vector requires a factor analysis, which determines informative indicators of current control. The second one requires a discriminant analysis, which makes it possible to determine informative indicators for comprehensive control, and, on the basis of discriminant functions, to define a school student's readiness class (Fig. 1). For a comprehensive control, it is appropriate to use the tests that are most highly correlated with the first canonical discriminant function.

With the girls aged 6-10, the greatest effect of the independent variables on the dependent one in the first function is observed in the following tests:

- Shuttle run 4×9 m (sec.) — .715
- 300 meters' run (sec.) — .531
- 30 m run (sec.) — .477
- Long jump from the spot (cm) — -.462
- Catching of falling Dietrich's stick (cm) — .385
- Walking along segments of hexagon (steps) — -.228.

Conclusions

The girls aged 6-10 show a multifactorial structure of motor readiness. By analyzing the common features, the research has defined informative tests of motor readiness control for each age group. During the analysis, the research has calculated the canonical discriminant function coefficients (non-standardized), which act as the factors of specified variable values included in the discriminant functions. On their basis, it is possible to classify the girls by their level of motor readiness according to the age, which is of practical value.

To assess a current state, it is possible to use a factor analysis, which determines informative indicators of schoolchildren's motor readiness.

To assess the dynamics of motor and functional readiness, it is effective to use a discriminant analysis which makes it possible to determine informative indicators for comprehensive control and, on the basis of discriminant functions, to define a school student's readiness class. For a comprehensive control, it is appropriate to use the tests that are most highly correlated with the first canonical discriminant function.

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Conflict of interests

The author declares that there is no conflict of interests.

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МЕТОДОЛОГІЧНІ ПІДХОДИ ДО ПЕДАГОГІЧНОГО КОНТРОЛЮ РУХОВОЇ ПІДГОТОВЛЕНОСТІ ДІВЧАТОК 6-10 РОКІВ

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Реферат. Стаття: 13 с., 8 табл., рис. 1, 41 джерел.

Мета – визначити методологічні підходи до педагогічного контролю рухової підготовленості дівчаток 6—10 років.

Матеріали і методи. У дослідженні прийняли участь дівчатка 6 років (n=36), 7 років (n=48), 8 років (n=57), 9 років (n=38), 10 років (n=46). Для вирішення поставлених завдань були застосовані такі методи дослідження: аналіз науково-методичної літератури, педагогічне тестування та методи математичної статистики. У програму тестування увійшли загальновідомі тести. Як метод моделювання використаний факторний і дискримінантний аналіз.

Результати. На основі аналізу факторної і дискримінантної моделі рухової підготовленості отримана інформація, яка необхідна для прийняття рішення в процесі управління фізичним вихованням, а також для розробки ефективних програм фізичної підготовки дівчаток 6—10 років.

Висновки. У дівчаток 6—10 років спостерігається багатофакторна структура рухової підготовленості, на основі аналізу спільностей для кожного віку визначені інформативні тести контролю рухової підготовленості. В процесі аналізу розраховані канонічні коефіцієнти дискримінантної функції (нестандартизовані), які виступають як

множники заданих значень змінних, що входять в дискримінантні функції. На основі них можлива класифікація дівчаток за рівнем рухової підготовленості відповідно до віку дівчаток, що має практичне значення.

Ключові слова: педагогічний контроль, рухові здібності, факторний, дискримнантний аналіз, дівчатка 6-10 років.

МЕТОДОЛОГИЧЕСКИЕ ПОДХОДЫ К ПЕДАГОГИЧЕСКОМУ КОНТРОЛЮ ДВИГАТЕЛЬНОЙ ПОДГОТОВЛЕННОСТИ ДЕВОЧЕК 6-10 ЛЕТ

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Реферат. Статья: 13 с., 8 табл., рис. 1, 41 источник.

Цель – определить методологические подходы к педагогическому контролю двигательной подготовленности девочек 6-10 лет.

Материалы и методы. В исследовании приняли участие девочки 6 лет (n = 36), 7 лет (n = 48), 8 лет (n = 57), 9 лет (n = 38), 10 лет (n = 46). Для решения поставленных задач были применены следующие методы исследования: анализ научно-методической литературы, педагогическое тестирование и методы математической статистики. В программу тестирования вошли общеизвестные тесты. Как метод моделирования использован факторный и дискриминантный анализ.

Результаты. На основе анализа факторной и дискриминантной модели двигательной подготовленности получена информация, необходимая для принятия решения в процессе управления физическим воспитанием, а также для разработки эффективных программ физической подготовки девочек 6-10 лет.

Выводы. У девочек 6-10 лет наблюдается многофакторная структура двигательной подготовленности, на основе анализа общностей для каждого возраста определены информативные тесты контроля двигательной подготовленности. В процессе анализа рассчитаны канонические коэффициенты дискриминантной функции (нестандартизированные), которые выступают как множители заданных значений переменных, входящих в дискриминантные функции. На основе них возможна классификация девочек по уровню двигательной подготовленности в соответствии возрасту девочек, что имеет практическое значение.

Ключевые слова: педагогический контроль, двигательные способности, факторный, дискримнантний анализ, девочки 6-10 лет.

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