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DISCRIMINANT ANALYSIS: AGE-SPECIFIC FEATURES OF MOTOR FITNESS OF GIRLS AGED 7 TO 9

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

The purpose of the study was to determine the age-specific features of the motor fitness of girls aged 7 to 9.

Materials and methods. The study participants were 27 girls aged 7, 40 girls aged 8, and 35 girls aged 9. The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment. The study used such research methods as analysis of scientific and methodical literature, pedagogical observations, motor fitness testing, a probabilistic approach to the assessment of the learning process, and methods of mathematical statistics.

Results. The level of proficiency in gymnastic exercises, the level of development of coordination abilities, endurance and speed strength are those indicators that can be used to assess the motor fitness of girls aged 7 to 9. Attention is drawn to the fact that the level of proficiency in exercises is a key element in the motor fitness of girls. The obtained discriminant functions have statistical significance both in the classification of data and in the determination of the structural features of the motor fitness of girls aged 7 to 9.

Conclusions. The standardized and structure coefficients of the discriminant function indicate that the most important indicators in the motor fitness of girls aged 7 to 9 are the level of general endurance, coordination of movements, relative arm strength and the level of proficiency in gymnastic exercises.

Keywords: girls aged 7 to 9, motor fitness, discriminant analysis.

Introduction

The problem of the motor fitness of school students was considered in terms of organizing the physical education process in physical education classes (Ivashchenko, Iermakov, & Khudolii, 2021; Nesen, 2022; Ivashchenko, 2020), conducting sports classes at school (Marchenko & Satdyiev, 2021; Driukov & Marchenko, 2021; Zymohliad & Marchenko, 2021), and in investigating the relationship between motivation, motor activity and motor fitness (Capio et al., 2015; Cohen et al., 2014; Cools et al., 2011).

Studies have confirmed the effectiveness of physical education classes in developing motor abilities (Iermakov et al., 2020; Ivashchenko, Khudolii, & Jagiello, 2021; Tkachenko, 2020) and forming motor skills (Kharkovshchenko, 2022; Mugurdinova & Iermakov, 2022; Siedykh, Ivashchenko, Bartik & Veremeenko, 2022). It was established that conducting sports classes at school on selected sports is effective in motor training of school students (Chang et al., 2020; Lindsey, 2020; Piñeiro-Cossio et al., 2021), and the results indicate a positive effect of the motor fitness level on the amount of motor activity and motivation for physical exercises (Connolly et al., 2020; O'Donnell et al., 2020; Strotmeyer et al., 2020).

In order to determine the specific features of the motor fitness of school students, studies solve the tasks of their fitness classification (Iermakov et al., 2020; Ivashchenko et al., 2020; Marchenko et al., 2021) and structural analysis (Khudolii et al., 2019; Janjic et al., 2018). Multivariate methods of mathematical statistics are used for this purpose. The effectiveness of discriminant analysis in solving such research tasks has been confirmed (Brusseau & Burns, 2018; Courel-Ibáñez et al., 2019; Fridolfsson et al., 2021). The study assumed that the use of multivariate statistics would make it possible to obtain new information about the specific features of the motor fitness of girls aged 7 to 9.

The purpose of this study was to determine the age-specific features of the motor fitness of girls aged 7 to 9.

Materials and methods

Study participants

The study participants were 27 girls aged 7, 40 girls aged 8, and 35 girls aged 9. The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment.

Study organization

The study used such research methods as analysis of scientific and methodical literature, pedagogical observations, motor fitness testing, a probabilistic approach to the assessment of the learning process, and methods of mathematical statistics.

The testing program included common tests that were used to assess the motor fitness of younger grade students (Shevchenko, Khudolii, & Potop, 2020; Khudolii, Golovnin, & Bartík, 2020; Ivashchenko, & Sirichenko, 2020). The study recorded the indicators of height (cm) and body weight (kg) and the results of tests No 3 'Standing long jump (cm)', No 4 '300 m running (s)', No 5 '30 m running from a standing start (s)', No 6 'Seated forward bend (cm)', No 7 'Mixed hang rope pull-ups (times)', No 8 'Shuttle run 4×9 m (s)', No 9 'Combined movements of arms, torso and legs (points)', No 10 'Postural balance test – single leg stance, eyes closed (s)', No 11 'Walking along a straight line after 5 rotations (deviations in cm)'.

The study recorded the proficiency level of girls aged 7 to 9 in gymnastic exercises. The coefficient was determined by the formula: p = (m/n)*100, where p is the level of proficiency, m is the number of successfully performed exercises, n is the total number of attempts to perform the exercise. In the experiment, the study controlled the level of proficiency in the following exercises: forward roll; backward roll; shoulder stand with legs bent (girls aged 7); shoulder stand, bridge stand from the supine position, one leg swing upward circle (girls aged 8); rope climbing in 2 steps, rope climbing in 3 steps, one leg swing upward circle (girls aged 9).

Statistical analysis

The study materials were processed by IBM SPSS 20 statistical analysis software. Arithmetic mean and standard deviation were calculated. Discriminant analysis was performed because it enables interpreting differences between classes and classifying objects.

The study protocol was approved by the Ethics Committee of the University. In addition, the 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

The results of comparison of the mean values obtained from the tests showed that no statistically significant differences ($p>0.05$) were observed in indicators No 6 'Seated forward bend (cm)', No 7 'Mixed hang rope pull-ups (times)', No 10 'Postural balance test — single leg stance, eyes closed (s)', and No 11 'Walking along a straight line after 5 rotations (deviations in cm)'. The girls aged 7 to 9 show statistically significant differences ($p<0.001$) between them in the results of the following tests: No 1 'Height (cm)', No 2 'Body weight (kg)', No 3 'Standing long jump (cm)', No 4 '300 m running (s)', No 8 'Shuttle run 4×9 m (s)', No 9 'Combined movements of arms, torso and legs (points)', No 12 'Level of proficiency in exercise 1', No 13 'Level of proficiency in exercise 2', No 14 'Level of proficiency in exercise 3'. Thus, the given data show that the level of proficiency in exercises, the level of development of coordination abilities, endurance and speed strength are those indicators that can be used to assess the motor fitness of girls aged 7 to 9 (Fig. 1).

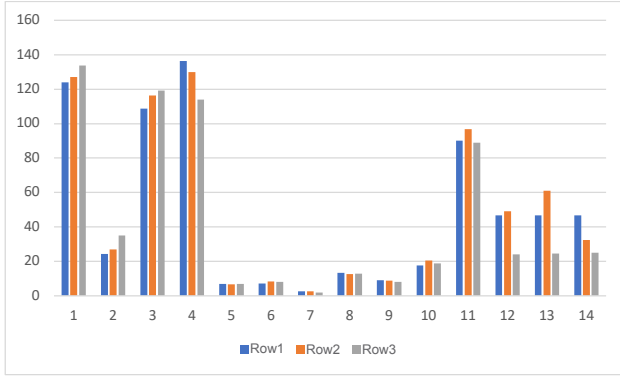

Fig. 1. Indicators of the level of motor fitness of girls aged 7 to 9: aged 7 – row 1; aged 8 – row 2; aged 9 – row 3; 1 to 14 – tests

The results of the statistical analysis of the discriminant functions are shown in Tables 1 and 2. The first function covers 79.1% of variance (r_1=0.887), and the second function covers 20.9% of variance (r_2=0.702) (Table 1). Wilks' Lambda criterion (λ_1=0.109, λ_2=0.508) indicates a high discriminative ability of the first and second discriminant functions ($p<0.001$) (Table 2). Therefore, the analysis of the coefficients of the first and second discriminant functions will make it possible to objectively assess the specific features of the motor fitness of girls aged 7 to 9.

As a result of the analysis, standardized (1) and structure (2) coefficients of the discriminant function were obtained, which, on the one hand, characterize the ratio of the contribution of the variables (1) to each of the canonical functions, and on the other hand, indicate correlations between the variables and the functions (2) (Tables 3 and 4).

It was established that the value of the first function most significantly depends on the results of tests No 1 'Height (cm)', No 4 '300 m running (s)', No 5 '30 m running from

Table 1. Eigenvalues. Girls aged 7 to 9

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.673	79.1	79.1	0.887
2	0.969	20.9	100.0	0.702

Table 2. Wilks' Lambda. Girls aged 7 to 9

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	0.109	205.298	28	0.000
2	0.508	62.679	13	0.000

Table 3. Standardized Canonical Discriminant Function Coefficients

No	Content	Function	
		1	2
1	Height, cm	-0.710	-0.361
2	Body weight, kg	-0.038	0.133
3	Standing long jump, cm	-0.294	-0.243
4	300 m running, s	0.624	0.107
5	30 m running from a standing start, s	-0.482	-0.028
6	Seated forward bend, cm	-0.223	0.341
7	Mixed hang rope pull-ups, times	0.317	-0.421
8	Shuttle run 4×9 m, s	0.306	0.540
9	Combined movements of arms, torso and legs, points	0.212	0.163
10	Postural balance test – single leg stance, eyes closed, s	0.258	-0.008
11	Walking along a straight line after 5 rotations, deviations in cm	0.029	0.197
12	Exercise 1, proficiency level	0.375	0.029
13	Exercise 2, proficiency level	0.650	-1.067
14	Exercise 3, proficiency level	-0.403	1.220

Table 4. Structure Matrix

No	Content	Function	
		1	2
1	Height, cm	-0.437*	-0.217
13	Exercise 2, proficiency level	0.390*	-0.370
9	Combined movements of arms, torso and legs, points	0.311*	0.085
4	300 m running, s	0.299*	0.118
12	Exercise 1, proficiency level	0.296*	-0.094
2	Body weight, kg	-0.199*	-0.064
7	Mixed hang rope pull-ups, times	0.103*	-0.001
8	Shuttle run 4×9 m, s	0.052	0.443*
3	Standing long jump, cm	-0.122	-0.224*
14	Exercise 3, proficiency level	0.149	0.223*
5	30 m running from a standing start, s	-0.072	0.182*
6	Seated forward bend, cm	-0.021	-0.126*
10	Postural balance test – single leg stance, eyes closed, s	0.003	-0.089*
11	Walking along a straight line after 5 rotations, deviations in cm	0.016	-0.039*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function. *Largest absolute correlation between each variable and any discriminant function

a standing start (s)' and the level of proficiency in the gymnastic exercises. The value of the second function most significantly depends on the results of tests No 8 'Shuttle run 4×9 m (s)', No 7 'Mixed hang rope pull-ups (times)' and the level of proficiency in the gymnastic exercises (Table 3).

The analysis of the structure coefficients showed that the first function is most correlated with the results of tests No 1 'Height (cm)', No 9 'Combined movements of arms, torso and legs (points)', No 4 '300 m running (s)' and the level of proficiency in the gymnastic exercises. The second function is most correlated with the results of tests No 8 'Shuttle run 4×9 m (s)', No 3 'Standing long jump (cm)' and the level of proficiency in exercise 3 (Table 4).

Table 5. Functions at Group Centroids. Girls aged 7 to 9

Girls, age	Function	
	1	2
7	1.587	1.396
8	1.207	-1.036
9	-2.604	0.107

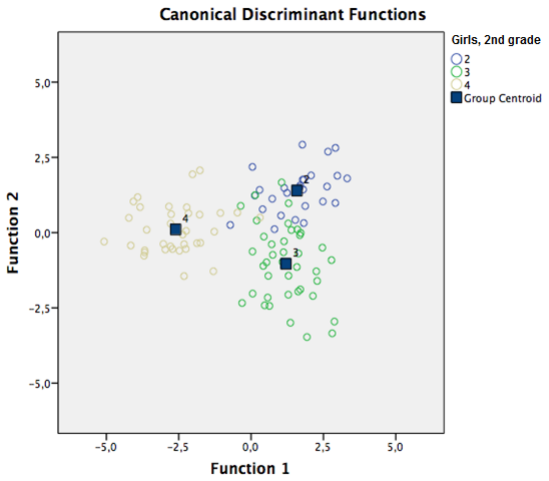

Fig. 2. Canonical discriminant functions. A graphical display of the results of the classification of the age-specific features of the motor fitness of girls aged 7 to 9: ▪ –centroids for groups aged 7, 8, and 9

Thus, the standardized and structure coefficients of the discriminant function indicate that the level of general endurance, coordination of movements, relative arm strength and the level of proficiency in gymnastic exercises are important indicators of the motor fitness of girls aged 7 to 9.

The analysis of the centroid values and the results of the classification of the level of motor fitness of girls aged 7 to 9 indicates that 93.1% of the data were classified correctly, and the graphic material confirms the objectivity of the classification (Tables 5 and 6, Fig. 2).

Discussion

The paper assumed that the motor fitness of girls aged 7 to 9 has age-specific features. It was established that the level of proficiency in exercises, the level of development of coordination abilities, endurance and speed strength are those indicators that can be used to assess their motor fitness. Attention is drawn to the fact that the level of proficiency in exercises is a key element in the motor fitness of girls, with age they master more complex gymnastic exercises, but with an increase in body weight and height, 9-year-old girls have a statistically significantly lower level of proficiency in more complex gymnastic exercises than girls aged 7 to 8.

The obtained data complement the results of the studies by Shevchenko, Khudolii, and Potop (2020), Khudolii, Golovnin, and Bartík (2020); Ivashchenko and Sirichenko (2020) on the markers of the motor fitness of elementary school students as well as the data of the studies by Ha et al.

Table 6. Classification Results[a,c]

		Girls, age	Predicted Group Membership			Total
			7	8	9	
Original	Count	7	25	1	1	27
		8	4	36	0	40
		9	0	1	34	35
	%	7	92.6	3.7	3.7	100.0
		8	10.0	90.0	0.0	100.0
		9	0.0	2.9	97.1	100.0

a. 93.1% of original grouped cases correctly classified. b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case

(2017), Da Silva Gasparotto et al. (2020), Ruiz et al., (2011) on the specific features of school students' physical fitness and motivation for physical activity.

The analysis of the discriminant functions indicates their statistical significance both in the classification of data and in the determination of the structural features of the motor fitness of girls aged 7 to 9. The values of the centroids and the results of the classification of the level of motor fitness of girls aged 7 to 9 indicate that 93.1% of the data were classified correctly. The obtained data confirm the conclusions by Iermakov et al. (2020), Ivashchenko et al. (2020), Marchenko et al. (2021) about the high informativity of discriminant functions in determining the specific features of the motor fitness of school students.

The standardized and structure coefficients of the discriminant function indicate that the level of general endurance, coordination of movements, relative arm strength and the level of proficiency in gymnastic exercises are important indicators of the motor fitness of girls aged 7 to 9. The obtained data supplement the results of existing studies on the effectiveness of using discriminant analysis both for the classification of school students by their level of motor fitness (Brusseau & Burns, 2018; Courel-Ibáñez et al., 2019; Fridolfsson et al., 2021) and for determining the structural features of their fitness (Khudolii et al., 2019; Janjic et al., 2018).

Thus, the discriminant analysis made it possible to determine the specific features of the motor fitness of girls aged 7 to 9. Motor fitness is affected by body height and weight, and with age, on the one hand, the level of endurance changes, and on the other hand, so does the level of proficiency in gymnastic exercises, which indicates the need for an integrated development of motor abilities in girls aged 7 to 9.

Conclusions

The level of proficiency in gymnastic exercises, the level of development of coordination abilities, endurance and speed strength are those indicators that can be used to assess the motor fitness of girls aged 7 to 9. Attention is drawn to the fact that the level of proficiency in exercises is a key element in the motor fitness of girls.

The obtained discriminant functions have statistical significance both in the classification of data and in the determination of the structural features of the motor fitness of girls aged 7 to 9.

The standardized and structure coefficients of the discriminant function indicate that the most important indicators of the motor fitness of girls aged 7 to 9 are the level of general endurance, coordination of movements, relative arm strength and the level of proficiency in gymnastic exercises.

Conflict of interest

The authors declare no conflict of interest for this study.

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ДИСКРИМІНАНТНИЙ АНАЛІЗ: ВІКОВІ ОСОБЛИВОСТІ РУХОВОЇ ПІДГОТОВЛЕНОСТІ ДІВЧАТ 7-9 РОКІВ

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Реферат. Стаття: 6 с., 6 табл., 2 рис., 34 джерела.

Мета дослідження – визначити вікові особливості рухової підготовленості дівчат 7-9 років.

Матеріали і методи. У дослідженні прийняли участь: 27 дівчат 7 років, 40 дівчат 8 років, 35 дівчат 9 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Були використані такі методи дослідження як аналіз наукової та методичної літератури, педагогічні спостереження, тестування рухової підготовленості, ймовірнісний підхід до оцінки процесу навчання, методи математичної статистики.

Результати. Рівень навченості гімнастичних вправ, рівень розвитку координаційних здібностей, витривалості та швидкісної сили є тими показниками які можуть бути використані для оцінки рухової підготовленості дівчат 7-9 років. Звертає увагу той факт, що рівень навченості вправ є ключовим елементом в руховій підготовленості дівчат. Отримані дискримінантні функції мають статистичну значущість як в класифікації даних, так і у визначенні структурних особливостей рухової підготовленості дівчат 7-9 років.

Висновки. Стандартизовані і структурні коефіцієнти дискримінантної функції вказують, що найважливими показниками у руховій підготовленості дівчат 7-9 років є рівень загальної витривалості, координації рухів, відносної сили рук та рівень навченості гімнастичних вправ.

Ключові слова: дівчата 7-9 років, рухова підготовленість, дискримінантний аналіз.

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