



PATTERN RECOGNITION: FEATURES OF MOTOR FITNESS OF 9-YEAR-OLD SCHOOLCHILDREN

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Abstract

The purpose of the study was to identify the gender-related features of motor fitness of 9-year-old schoolchildren.

Materials and methods. The study involved 83 9-year-old schoolchildren (35 girls, 48 boys). 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 the following research methods: analysis of scientific and methodological literature, pedagogical observations, testing of motor fitness, probabilistic approach to assessing the learning process, methods of mathematical statistics. In the experiment, the study controlled the level of proficiency in the following exercises: Rope climbing in 2 steps, Rope climbing in 3 steps, One leg swing upward circle.

Results. In the girls and boys, the differences in the level of development of movement coordination between individual parts of the body and vestibular stability are not statistically significant. The 9-year-old boys have a statistically significantly higher level of development of strength, speed strength, speed, endurance, and a higher level of proficiency in gymnastic exercises and rope climbing than the girls. The obtained canonical function explains 100% of the variation of results and is informative for classifying 9-year-old schoolchildren's motor fitness ($r = 0.937$). The analysis of the canonical function indicates its statistical significance ($\lambda = 0.122$; $p = 0.001$).

Conclusions. The canonical discriminant function can be used to classify the gender-related features of motor fitness of 9-year-old schoolchildren. The discriminant analysis revealed the indicators that have the greatest weight in assessing the gender-related features of motor fitness of 9-year-old schoolchildren. They include the level of relative strength of the shoulder flexors, speed strength, agility, and the level of proficiency in the One leg swing upward circle on a low bar.

Keywords: girls, boys, level of proficiency, motor fitness, motor skills, discriminant analysis.

Introduction

The importance of increasing schoolchildren's motor activity is pointed out by Krutsevich, Pengelova, and Trachuk (2019), Krutsevich, and Marchenko (2018a,b). Motor activity is regarded as a condition for physical development and formation of cognitive functions (Junger et al., 2019; Haverkamp et al., 2020; Biddle et al., 2019).

Studies focus on substantiating the amount of motor activity (Bull et al., 2020; Guthold et al., 2020; Love et al., 2019); investigating the effect of physical exercises on human cognitive functions (Quaney et al., 2009; Rodriguez-Ayllon et al., 2019); developing a technique for teaching physical exercises (Khudolii et al., 2020); developing a technique for motor abilities development in schoolchildren (Ivashchenko et al., 2020).

The problem of physical education of schoolchildren was given consideration with reference to their motor fitness (Ivashchenko, 2017), the effect of training loads on the dynamics of strength development (Cieślicka & Ivashchenko, 2017; Ivashchenko & Cieślicka, 2017), the effect of physical training modes on the effectiveness of motor skills formation (Khudolii, Ivashchenko, & Chernenko, 2015; Mugurdinova & Iermakov, 2022; Siedykh et al., 2022) and gender-related features of motor fitness (Iermakov et al., 2020; Khudolii, Golovnin et al., 2020; Petrov et al., 2020). It was found that the positive effect of learning depends on the level of motor skills development, consistent solving of learning tasks, and rational application of methods (Khudolii, 2019; Ivashchenko, 2020; Kharkovshchenko, 2022).

The study of the problem of physical education of schoolchildren remains relevant in view of decrease in motor activity of children and adolescents. The need to improve the pro-

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cess of teaching physical exercises requires further research on gender-related features of motor fitness of schoolchildren.

The purpose of the study was to identify the gender-related features of motor fitness of 9-year-old schoolchildren.

Materials and Methods

Study Participants

The study participants were eighty-three 9-year-old schoolchildren (35 girls and 48 boys). 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 the following research methods: analysis of scientific and methodological literature, pedagogical observations, testing of motor fitness, probabilistic approach to assessing the learning process, methods of mathematical statistics.

The study recorded the indicators of height (cm), body weight (kg), and the results in tests No. 3 "Standing long jump, cm", No. 4 "Middle- and long-distance running. 300 m running, s", No. 5 "30 m sprint 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 primary schoolchildren's level of proficiency in gymnastic exercises. The coefficient was determined by the formula: $p = (m/n) \times 100$, 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 exercises. In the experiment, the study controlled the level of proficiency in the following exercises: "Rope climbing in 2 steps", "Rope climbing in 3 steps", "One leg swing upward circle".

Table 1. The results of testing the 9-year-old schoolchildren's motor fitness

No.	Indicator	Girls (n = 35)		Boys (n = 48)		d	t	p
		X	s	X	s			
1.	Height, cm	133.66	4.93	135.88	5.43	-2.22	1.908	0.060
2.	Body mass, kg	34.94	18.94	32.77	5.48	2.17	0.754	0.453
3.	Standing long jump, cm	119.09	13.02	135.42	10.21	-16.33	6.402	0.000
4.	300 m running, s	113.91	16.13	100.63	17.32	13.28	3.552	0.001
5.	30 m running from a standing start, s	6.82	0.32	6.35	0.44	0.47	5.421	0.000
6.	Seated forward bend, cm	8.09	3.02	4.56	3.18	3.53	5.087	0.000
7.	Mixed hang rope pull-ups, times	1.97	1.12	4.79	1.91	-2.82	7.790	0.000
8.	Shuttle run 4×9 m, s	12.84	0.74	12.24	0.67	0.6	3.875	0.000
9.	Combined movements of arms, torso and legs, points	8.11	0.72	8.28	0.9	-0.17	0.903	0.369
10.	Postural balance test — single leg stance, eyes closed, s	18.89	10.76	20.83	11.11	-1.94	0.792	0.431
11.	Walking along a straight line after 5 rotations, deviations in cm	88.8	65.26	81.56	66.06	7.24	0.495	0.622
12.	Rope climbing in 2 steps, proficiency level	24	21.03	32.29	16.4	-8.29	2.018	0.047
13.	Rope climbing in 3 steps, proficiency level	24.57	22.27	32.29	16.4	-7.72	1.820	0.073
14.	One leg swing upward circle, proficiency level	25.14	23.44	53.75	17.09	-28.61	6.435	0.000

Statistical Analysis

The study materials were processed using the IBM SPSS 20 statistical analysis software. Discriminant analysis was performed.

The study protocol was approved by the Ethical 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

Table 1 shows the results of testing the 9-year-old schoolchildren's motor fitness.

The results of testing were compared, which made it possible to find out that the difference in height and body mass between the 9-year-old girls and boys was not statistically significant ($p > 0.05$). In test No. 9 "Combined movements of arms, torso and legs, points", the girls and boys show results below average, the difference in fitness is not statistically significant ($p > 0.05$). The difference in the results of the tests for vestibular stability (No. 10 "Postural balance test — single leg stance, eyes closed, s", No. 11 "Walking along a straight line after 5 rotations, deviations in cm") is not statistically significant, the girls and boys show low results. The standard (mean-root-square) deviation value in both the girls and boys indicates that the level of fitness is not homogeneous in the groups.

Compared to the girls, the boys show a 16.33 cm better result in test No. 3 "Standing long jump, cm" ($p = 0.001$), a 13.28 s better result in test No. 4 "300 m running, s" ($p < 0.001$), a 3 time better result in test No. 7 "Mixed hang rope pull-ups, times" ($p < 0.001$), a 0.6 s better result in test No. 8 "Shuttle run 4×9 m, s" ($p = 0.001$). While the 9-year-old girls show statistically significantly better results in test No. 6 "Seated forward bend, cm" (see Table 1).

The 9-year-old boys have a 28.61% higher level of proficiency in the One leg swing upward circle ($p = 0.001$) and an 8.29% higher level of proficiency in the Rope climbing in 2 steps ($p = 0.047$).

The discriminant analysis results which allow to classify the 9-year-old girls and boys by their level of motor skills development, their level of proficiency in rope climbing and gymnastic exercises are set out in Tables 2–5.

The obtained canonical function explains 100% of the variation of results and is informative for classifying 9-year-old schoolchildren’s motor fitness ($r = 0.937$) (see Table 2).

Table 2. The canonical discriminant function. Eigenvalues

Function	Eigenvalues	% of variance explained	Cumulative %	Canonical correlation
1	7.191	100.0	100.0	0.937

Table 3. The canonical discriminant function. Wilks’ lambda

Function test	Wilks’ lambda	χ -square	degrees of freedom	p
1	0.122	155.622	14	0.000

The analysis of the canonical function indicates its statistical significance ($\lambda = 0.122$; $p = 0.001$) (see Table 3).

The standardized coefficients of the canonical discriminant function which make it possible to determine the percentage contributions of selected variables to the function result are set out in Table 4. The largest contribution to the canonical function is made by variables No. 12 “Rope climbing in 2 steps, proficiency level”, No. 13 “Rope climbing in 3 steps, proficiency level”, No. 14 “One leg swing upward circle, proficiency level”: the larger is the value of these variables, the larger is the value of the function.

The structure coefficients of the canonical discriminant function which are the coefficients of correlation between the variables and the function are set out in Table 4. For instance, the function is most substantially related to the results of test No. 14 “One leg swing upward circle, proficiency level” and

Table 4. The canonical discriminant function coefficients

No.	Indicator	Canonical discriminant function coefficients		
		standardized function	structure function	unstandardized function
		1	1	1
1	2	3	4	5
1.	Height, cm	0.355	0.037	0.068
2.	Body mass, kg	-0.261	-0.031	-0.020
3.	Standing long jump, cm	0.425	0.265	0.037
4.	300 m running, s	-0.094	-0.147	-0.006
5.	30 m running from a standing start, s	-0.145	-0.225	-0.370
6.	Seated forward bend, cm	-0.479	-0.211	-0.154
7.	Mixed hang rope pull-ups, times	0.486	0.323	0.298
8.	Shuttle run 4×9 m, s	0.037	-0.161	0.053
9.	Combined movements of arms, torso and legs, points	-0.041	0.037	-0.049
10.	Postural balance test – single leg stance, eyes closed, s	0.098	0.033	0.009
11.	Walking along a straight line after 5 rotations, deviations in cm	0.221	-0.021	0.003
12.	Rope climbing in 2 steps, proficiency level	0.926	0.084	0.050
13.	Rope climbing in 3 steps, proficiency level	-30.971	0.075	-0.208
14.	One leg swing upward circle, proficiency level	20.916	0.267	0.146
	(Constant)			-120.593

Table 5. The results of classification. The function values at the group centroids. 9-year-old schoolchildren

	1 – girls, 2 – boys	Predicted belonging to group		Total	Function values at group centroids
		1.00	2.00		1
Frequency	1.00	35	0	35	-3.102
	2.00	1	47	48	2.262
%	1.00	100.0	.0	100.0	
	2.00	2.1	97.9	100.0	

a. 98.8% of the original grouped data were classified correctly.

tests No. 7 “Mixed hang rope pull-ups, times”, No. 3 “Standing long jump, cm”, No. 4 “300 m running, s”: hence, a substantial difference between the 9-year-old girls and boys is observed in the level of relative strength of the arms, speed strength, agility, and the level of proficiency in gymnastic exercises.

The centroid coordinates for two groups are set out in Table 5. They allow to interpret the canonical function with respect to the role in the classification. The centroid for the 9-year-old boys is situated on the positive pole, and the centroid for the 9-year-old girls is situated on the negative pole (see Fig. 1, 2), which indicates a substantial difference in the fitness level of the 9-year-old girls and boys. The results of classification of the groups show that 98.8% of the original grouped observations were classified correctly.

Discussion

The paper assumed that the motor fitness of 9-year-old schoolchildren have gender-related features. It was established that the differences between the girls and boys in the level of development of motor coordination between individual parts of the body and in vestibular stability are not statistically significant. The 9-year-old boys have a statisti-

cally significantly higher level of development of strength, speed strength, speed, endurance, and a higher level of proficiency in gymnastic exercises and rope climbing than the girls (see Table 1). The data obtained supplement the data on the state of motor fitness of children and adolescents (Ivashchenko, Khudolii, Iermakov, Chernenko, & Holovko, 2015; Ivashchenko, Iermakov, Khudolii, Cretu, & Potop, 2017; Khudolii, Ivashchenko, & Beketov, 2015), and indicate that schoolchildren's motor fitness has gender-related features. As in the studies by Ivashchenko, Nosko, Bartik, & Makanin (2020), Iermakov, Ivashchenko, & Khomiakov (2020), non-significant differences in the level of development of motor coordination and statistically significant differences in the level of development of strength, speed strength, speed, endurance, and in the level of proficiency in gymnastic exercises between girls and boys were observed, which indicates a need for dedicated development of motor skills. Such development is possible in teaching physical exercises with the use of programmed materials, as indicated by literature data (Shueva, Ivashchenko, & Jagiello, 2021; Suprun, Ivashchenko, & Cieślicka, 2021; Kharkovshchenko, 2022).

The discriminant analysis made it possible to determine that, in identifying gender-related features of motor fitness of 9-year-old schoolchildren, the classifier is the level of proficiency in gymnastic exercises and rope climbing (see Table 4, column 3). The data set out supplement the data provided by Petrov, Khudolii, and Cieślicka (2020), Shevchenko, Khudolii, and Potop (2020), Ivashchenko, Berezhna, and Cieślicka, (2020) and stating that the formation of motor skills is a priority in the educational process at primary school, the development of "agility" and "motor coordination" ensures the formation of motor skills, and the development of arm strength and vestibular stability is that reserve which allows to improve the effectiveness of the educational process. Furthermore, focusing efforts on the learning process is associated with the formation of cognitive functions such as ability to acquire and recognize information, as indicated by literature data (Junger et al., 2019; Haverkamp et al., 2020; Biddle et al., 2019).

Based on the discriminant analysis, it was found that motor fitness can be controlled based on the regression equation set out in column 5 (Table 4) and the comparison between the result obtained and the function value at group centroids (2.262). The data set out supplement the data on the use of discriminant analysis in physical education of schoolchildren (Mandoli, Sharma, & Joshi, 2021; Siedykh, Ivashchenko, Bartik, & Veremeenko, 2022; Mugurdinova, & Iermakov, 2022).

Thus, the data obtained are of both theoretical and practical importance for organizing the educational process at primary school. They can be used in planning learning activity and controlling its quality in physical education.

Conclusions

The canonical discriminant function can be used to classify the gender-related features of motor fitness of 9-year-old schoolchildren. The discriminant analysis revealed the indicators that have the greatest weight in assessing the gender-related features of motor fitness of 9-year-old schoolchildren. They include the level of relative strength of the shoulder flexors, speed strength, agility, and the level of proficiency in the One leg swing upward circle on a low bar.

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Conflict of interest

The authors declare no conflict of interest.

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РОЗПИЗНАННЯ ОБРАЗІВ: ОСОБЛИВОСТІ РУХОВОЇ ПІДГОТОВЛЕНOSTI ШКОЛЯРІВ 9 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

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Мета дослідження – визначити гендерні особливості рухової підготовленості школярів 9 років.

Матеріали і методи. У дослідженні прийняли участь 83 школярі 9 років (дівчаток – 35 чол., хлопчиків – 48 чол.). Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. У дослідженні використані такі методи дослідження як аналіз наукової та методичної літератури, педагогічні спостереження, тестування рухової підготовленості, ймовірнісний підхід до оцінки процесу навчання, методи математичної статистики. В експерименті контролювався рівень навченості таким вправам: лазіння по канату у 2 прийоми, лазіння по канату у 3 прийоми, підйом переворотом в упор махом однією.

Результати. У дівчаток і хлопчиків у рівні розвитку координації рухів окремими частинами тіла та вестибулярній стійкості розбіжності статистично не достовірні. Хлопчики 9 років мають статистично достовірно вищий рівень розвитку сили, швидкісної сили, бистроти, витривалості та вищий рівень навченості гімнастичних вправ і лазінню по канату ніж дівчатка. Отримана канонічна функція пояснює на 100 % варіацію результатів і є інформативною для класифікації рухової підготовленості школярів 8 років ($r = 0,937$).

Аналіз канонічної функції свідчить про її статистичну значущість ($\lambda = 0,122$; $p = 0,001$).

Висновки. Канонічна дискримінантна функція може бути використана для класифікації гендерних особливостей рухової підготовленості школярів 9 років. У результаті дискримінантного аналізу виявлено показники які мають найбільшу вагу в оцінці гендерних особливостей рухової підготовленості школярів 9 років. До них відносяться рівень відносної сили згиначів плеча, швидкісної сили, прудкості та рівень навченості підйому переворотом в упор махом однією на низькій поперечині.

Ключові слова: дівчатка, хлопчики, рівень навченості, рухова підготовленість, рухові навички, дискримінантний аналіз.

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