Original Scientific Article

Gender-Related Peculiarities of 7-Year-Old Schoolchildren’s Motor Fitness

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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 identify gender-related peculiarities of 7-year-old schoolchildren’s motor fitness.

Materials and methods. The study participants were 59 7-year-old schoolchildren (girls – 27, boys – 32). 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. The study recorded the primary schoolchildren’s level of proficiency in gymnastic exercises. The coefficient was determined by the formula: \( p = \frac{m}{n} \times 100 \), 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 exercise. In the experiment, the study controlled the level of proficiency in the following exercises: forward roll; backward roll; shoulderstand with bent legs.

Results. The differences in the development level of movement coordination of individual parts of the body and vestibular stability are not statistically significant; in the 7-year-old girls and boys, there is a statistically significant difference in the development level of strength, speed strength, speed, endurance, and the level of proficiency in acrobatic exercises.

Conclusions. A canonical discriminant function can be used to classify and identify the indicators that have the greatest weight in assessing gender-related peculiarities of 7-year-old schoolchildren’s motor fitness. In assessing gender-related peculiarities of 7-year-old schoolchildren’s motor fitness, these indicators include the level of proficiency in acrobatic exercises, the level of relative strength of shoulder flexors, endurance, and speed strength.

Keywords: discriminant analysis, girls, boys, motor skills, motor fitness.

Introduction

The analysis of scientific literature revealed the following gender-related peculiarities of motor function development in children: at 3-5 years, there are no gender-related differences in motor fitness (Hnatiuk, Lamb, Ridgers, Salmon, & Hesketh, 2019); at the age of 6-8 years, gender-related differences are observed in movement control, motor activity (Herrmann, Heim, & Seelig, 2019; Kashuba, Futornyi, Andrieieva, Goncharova, Carp, Bondar, & Nosova, 2018; Kondakov, Voloshina, Kopeikina, & Kadutskaya, 2020); at 7-10 years, there are statistically insignificant differences in the indicators of dynamic and static balance (Moseichuk, Zoriy, Kostashchuk, Kanivets, Nakonechnyi, Koshura, Potop, Yarmak, & Galan, 2020).

To identify the patterns of motor function development, modern research uses methods of multivariate statistics such as factor and discriminant analysis (Brusseau & Burns, 2018; Hohmann, Siener, & He, 2018; Ivashchenko, 2020). Discriminant analysis allows to obtain both a regression equation to classify schoolchildren by their motor fitness level, and to
identify the indicators that are key in the classification, which is important in assessing schoolchildren’s gender-related peculiarities (Ivashchenko, 2020).

However, in the studied scientific sources, there are no results aimed at studying the priority of motor skills development in schoolchildren. Therefore, the problem of identifying key indicators in assessing primary schoolchildren’s gender-related peculiarities requires additional research.

The purpose of the study was to identify gender-related peculiarities of 7-year-old schoolchildren’s motor fitness.

Materials and methods

Study participants

The study participants were 59 7-year-old schoolchildren (girls – 27, boys – 32). The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

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), as well as 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 “Maintenance of stable posture – standing on one leg with closed eyes (s)”, No. 11 “Walking along 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)×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; shoulderstand with bent legs.

Statistical analysis

The study materials were processed using IBM SPSS 20 statistical analysis software. The study calculated: arithmetic mean, standard deviation. 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 7-year-old schoolchildren’s motor fitness.

A comparison of testing results revealed that the 7-year-old schoolchildren differ statistically insignificantly by the anthropometric indicators. In test No. 9 “Combined movements of arms, torso and legs, points”, the girls and boys show high results, the difference in fitness is statistically insignificant. In the results of tests that characterize vestibular stability (No. 10 “Maintenance of stable posture – standing on one leg with closed eyes, s”, No. 11 “Walking along straight line after 5 rotations, deviations in cm”), the difference is statistically insignificant, the girls and boys show low results.

In the results of tests No. 3, 4, 5, 7, 8, 12, 13, 14, the difference between the girls and boys is statistically significant, the

<p>| Table 1. The results of testing the 7-year-old schoolchildren’s motor fitness |
| --- | --- | --- | --- | --- | --- |</p>
<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>girls (n = 27)</th>
<th>boys (n = 32)</th>
<th>Δ</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height, cm</td>
<td>123.85</td>
<td>3.62</td>
<td>123.34</td>
<td>4.43</td>
<td>0.51</td>
</tr>
<tr>
<td>2</td>
<td>Body weight, kg</td>
<td>24.22</td>
<td>4.54</td>
<td>23.28</td>
<td>4.58</td>
<td>0.94</td>
</tr>
<tr>
<td>3</td>
<td>Standing long jump, cm</td>
<td>108.7</td>
<td>12.37</td>
<td>130.91</td>
<td>16.06</td>
<td>-22.21</td>
</tr>
<tr>
<td>4</td>
<td>300 m running, s</td>
<td>136.44</td>
<td>18.18</td>
<td>109.47</td>
<td>14.3</td>
<td>26.97</td>
</tr>
<tr>
<td>5</td>
<td>30 m running from a standing start, s</td>
<td>6.79</td>
<td>0.48</td>
<td>6.22</td>
<td>0.29</td>
<td>0.57</td>
</tr>
<tr>
<td>6</td>
<td>Seated forward bend, cm</td>
<td>7.11</td>
<td>3.68</td>
<td>3.47</td>
<td>3.37</td>
<td>3.64</td>
</tr>
<tr>
<td>7</td>
<td>Mixed hang rope pull-ups, times</td>
<td>2.63</td>
<td>1.8</td>
<td>4.56</td>
<td>1.95</td>
<td>-1.93</td>
</tr>
<tr>
<td>8</td>
<td>Shuttle run 4×9 m, s</td>
<td>13.4</td>
<td>0.77</td>
<td>12.63</td>
<td>0.73</td>
<td>0.77</td>
</tr>
<tr>
<td>9</td>
<td>Combined movements of arms, torso and legs, points</td>
<td>9.17</td>
<td>0.76</td>
<td>9.38</td>
<td>0.71</td>
<td>-0.21</td>
</tr>
<tr>
<td>10</td>
<td>Maintenance of stable posture – standing on one leg with closed eyes, s</td>
<td>17.54</td>
<td>14.05</td>
<td>18.59</td>
<td>13.14</td>
<td>-1.05</td>
</tr>
<tr>
<td>11</td>
<td>Walking along straight line after 5 rotations, deviations in cm</td>
<td>90.07</td>
<td>66.24</td>
<td>80.84</td>
<td>63.85</td>
<td>9.23</td>
</tr>
<tr>
<td>12</td>
<td>Forward roll, level of proficiency</td>
<td>46.67</td>
<td>19.22</td>
<td>76.88</td>
<td>15.33</td>
<td>-30.21</td>
</tr>
<tr>
<td>13</td>
<td>Backward roll, level of proficiency</td>
<td>46.67</td>
<td>19.22</td>
<td>75.63</td>
<td>15.85</td>
<td>-28.96</td>
</tr>
<tr>
<td>14</td>
<td>Shoulderstand with bent legs, level of proficiency</td>
<td>46.67</td>
<td>19.22</td>
<td>80.63</td>
<td>14.8</td>
<td>-33.96</td>
</tr>
</tbody>
</table>
boys show better results. In test No. 6 “Seated forward bend, cm”, statistically significantly better results are shown by the 7-year-old girls (see Table 1).

Thus, the differences in the development level of movement coordination of individual parts of the body and vestibular stability are not statistically significant; in the 7-year-old girls and boys, there is a statistically significant difference in the development level of strength, speed strength, speed, endurance, and the level of proficiency in acrobatic exercises.

Tables 2-5 show the results of discriminant analysis, which make it possible to classify the 7-year-old girls and boys by the level of motor fitness.

The obtained canonical function explains the variation of results by 100% and is informative for classifying the 7-year-old schoolchildren's motor fitness (see Table 2).

The analysis of the canonical function shows its statistical significance (λ = 0.178; р < 0.001) (see Table 3).

Table 4 shows the standardized canonical discriminant function coefficients which allow to measure the ratio of contribution of variables to the function result. Variables No. 14 “Shoulderstand with bent legs, level of proficiency”, No. 13 “Backward roll, level of proficiency”, No. 7 “Mixed hang rope pull-ups, times” make the greatest contribution to the canonical function: the larger the values of these variables, the greater the value of the function. The above indicates that the classification is based on the level of motor abilities and motor skills development (see Table 4, column 3).

Table 4 shows the structure coefficients of the canonical discriminant function, which are the coefficients of correlation between the variables and the function. Thus, the function is most closely connected with the level of proficiency in acrobatic exercises and general endurance: therefore, a significant difference between the girls and boys aged 7 is observed in the level of proficiency in acrobatic exercises.

Table 5 shows the centroid coordinates for the two groups. They make it possible to interpret the canonical function in terms of the role in classification. At the positive pole, there is a centroid for the 7-year-old boys, at the negative – a centroid for the 7-year-old girls (see Fig. 1, 2). This indicates a significant difference in the fitness of the 7-year-old girls and boys. The results of classification of the groups show that 98.3 % of the original grouped observations were classified correctly.

Thus, a canonical discriminant function can be used to classify gender-related peculiarities of 7-year-old schoolchildren's motor fitness.

**Discussion**

The study assumed that the identification of gender-related peculiarities of 7-year-old schoolchildren's motor fitness would reveal the cause-and-effect relationships that influence motor skills development in 7-year-old girls and boys.

It is well known that the level of coordination abilities development determines the success in developing motor skills (Khudolii, 2019; Marchenko & Dykhanova, 2019; Ivashchenko, 2020), but the results of testing coordination abilities showed that the girls and boys did not statistically significantly differ by these indicators (Table 1) and had a statistically significant difference in the level of proficiency in acrobatic exercises. For the girls, the proposed acrobatic exercises are difficult to perform.

**Table 2. Canonical discriminant function. Eigenvalues**

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigenvalue</th>
<th>% of Variance</th>
<th>Cumulative %</th>
<th>Canonical Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.617</td>
<td>100</td>
<td>100</td>
<td>0.907</td>
</tr>
</tbody>
</table>

**Table 3. Canonical discriminant function. Wilks' Lambda**

<table>
<thead>
<tr>
<th>Test of Function(s)</th>
<th>Wilks' Lambda</th>
<th>Chi-square</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.178</td>
<td>87.156</td>
<td>13</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Table 4. Canonical discriminant function coefficients**

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Canonical discriminant function coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standardized</td>
<td>Structure matrix</td>
</tr>
<tr>
<td></td>
<td>Function</td>
<td>Function</td>
</tr>
<tr>
<td>1</td>
<td>Height, cm</td>
<td>0.154</td>
</tr>
<tr>
<td>2</td>
<td>Body weight, kg</td>
<td>-0.415</td>
</tr>
<tr>
<td>3</td>
<td>Standing long jump, cm</td>
<td>0.165</td>
</tr>
<tr>
<td>4</td>
<td>300 m running, s</td>
<td>-0.123</td>
</tr>
<tr>
<td>5</td>
<td>30 m running from a standing start, s</td>
<td>-0.285</td>
</tr>
<tr>
<td>6</td>
<td>Seated forward bend, cm</td>
<td>-0.304</td>
</tr>
<tr>
<td>7</td>
<td>Mixed hang rope pull-ups, times</td>
<td>0.517</td>
</tr>
<tr>
<td>8</td>
<td>Shuttle run 4×9 m, s</td>
<td>-0.304</td>
</tr>
<tr>
<td>9</td>
<td>Combined movements of arms, torso and legs, points</td>
<td>-0.187</td>
</tr>
<tr>
<td>10</td>
<td>Maintenance of stable posture – standing on one leg with closed eyes, s</td>
<td>-0.048</td>
</tr>
<tr>
<td>11</td>
<td>Walking along straight line after 5 rotations, deviations in cm</td>
<td>0.770</td>
</tr>
<tr>
<td>12</td>
<td>Forward roll, level of proficiency</td>
<td>-0.533</td>
</tr>
<tr>
<td>13</td>
<td>Backward roll, level of proficiency</td>
<td>0.962</td>
</tr>
<tr>
<td>14</td>
<td>Shoulderstand with bent legs, level of proficiency</td>
<td>1.041</td>
</tr>
<tr>
<td>(Constant)</td>
<td></td>
<td>-2.311</td>
</tr>
</tbody>
</table>

The results obtained complement the data of Ivashchenko, Berezhna, and Cieślicka (2020) who found that the level of proficiency in exercises determines the variation of testing results in 7-year-old boys by 28.437%, the development of “agility” and “movement coordination” ensures the formation of motor skills, and the development of arm strength and vestibular stability is the reserve in training 7-year-old boys that will increase the effectiveness of the educational process; and also the data of Ivashchenko and Sirichenko (2020), according to which the level of proficiency in exercises determines the variation of testing results in 7-year-old girls by 29.772%.

A discriminant analysis revealed the indicators that have the greatest weight in assessing gender-related peculiarities of motor fitness of 7-year-old schoolchildren. They include the level of proficiency in acrobatic exercises, the level of relative strength of shoulder flexors, endurance, and speed strength.

The results obtained complement the data of Kapkan, Khudolii, and Bartik (2019a), Khudolii, Ivashchenko, and Chernenko (2015), Khudolii, Kapkan, Harkusha, Marchenko, and Veremeenko (2020) about the factors that influence the effectiveness of motor skills development in schoolchildren.

The study used a discriminant model to identify the cause-and-effect relationships that influence motor skills development in 7-year-old schoolchildren. The study confirmed the effectiveness of using a discriminant function to determine the indicators that have the greatest weight in assessing gender-related peculiarities of 7-year-old schoolchildren’s motor fitness; supplemented the data on using discriminant analysis in physical education and sports (de Bruijn & Gardner, 2011; Arede, Esteves, Ferreira, Sampaio, & Leite, 2019; Brusseau & Burns, 2018). As in the study by Lovell, Fransen, Bocking, and Coutts (2019), discriminant analysis revealed the importance of motor skills development in school-age children for further improvement of motor fitness.

The data obtained highlight the need to develop separate educational programs for girls and boys, as well as conduct separate physical education classes for them.

### Conclusions

A canonical discriminant function can be used to classify and identify the indicators that have the greatest weight in assessing gender-related peculiarities of 7-year-old schoolchildren’s motor fitness.

In assessing gender-related peculiarities of 7-year-old schoolchildren’s motor fitness, these indicators include the level of proficiency in acrobatic exercises, the level of relative strength of shoulder flexors, endurance, and speed strength.

### Acknowledgements

The study was carried out in accordance with the plan of research work of the Department of Theory and Methodology of Physical Education of H. S. Skovoroda Kharkiv National Pedagogical University.

### Conflict of Interest

The authors declare that there is no conflict of interest.
References


Мета дослідження – визначити гендерні особливості рухової підготовленості школярів 7 років.

Матеріали і методи. У дослідженні прийняли участь 59 школярів 7 років (дівчаток – 27 чол., хлопчиків – 32 чол.). 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, ямовірнісний підхід до оцінки процесу навчання, методи математичної статистики. У школярів молодших класів реєструвався рівень навченності гімнастичних вправ. Коефіцієнт визначався за формулою: \( p = \frac{m}{n} \times 100 \), де \( p \) – рівень навченості, \( m \) – кількість успішно виконаних вправ, \( n \) – загальна кількість спроб на виконання вправ. В експерименті контролювався рівень навченності таким вправам: перекид уперед; перекид назад; стійка на лопатках зігнувши ноги.

Результати. У рівні розвитку координації рухів окремими частинами тіла та вестбулярний стійкість розбіжності статистично не достовірні, у рівні розвитку сили, швидкісної сили, бистроти, витривалості та рівня навченності акробатичних вправ у дівчаток і хлопчиків 7 років спостерігається статистично достовірна різниця.

Висновки. Канонічна дискримінантна функція може бути використана для класифікації і визначення показників які мають найбільшу вагу в оцінці гендерних особливостей рухової підготовленості школярів 7 років. В оцінці гендерних особливостей рухової підготовленості школярів 7 років найбільшу вагу мають рівень навченності акробатичних вправ, рівень відносної сили згиначів плеча, витривалості і швидкісної сили.

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

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