Power abilities: the structure of development in girls of 12-14 years old

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Abstract

Purpose: To determine the structure of the development of power abilities in girls aged 12-14 years

Material: Girls aged 12 years (n = 20) participated in the study; 13 years (n = 27), 14 years old (n = 30). Factorial analysis performed.

Results: It is determined that the most informative in girls of 12-14 years old are the following tests: which characterize the development of dynamic and static strength of muscles of the feet and hands (girls of 12 years old); which characterize the development of static, high-speed strength of leg muscles, static and dynamic strength of the muscles of the abdomen and hands (girls of 13 years old); which characterize the development of the static and dynamic strength of leg muscles, the dynamic strength of the muscle of the hands (girls of 14 years old).

Conclusions: Factor analysis allowed to determine informative indicators for controlling the development of power abilities in girls of 12-14 years old. The greatest weight in power preparedness has the relative and static strength of the leg muscles. In the second place, girls of 12-13 years old have the development of muscle strength shoulder girdle. 14 years old girls in second place, have the development of dynamic and static strength of the abdominal muscles and the dynamic strength of muscles of the shoulder girdle. Girls of 12 years old in third place have the development of coordination of movements, the static strength of the shoulder girdle and the dynamic strength of the back muscles. Girls of 13 years in the third place have development of the development of muscle strength of the abdomen. Girls of 14 years in third place have development of high-speed force and coordination of movements.

Keywords: girls, strength training, factor analysis, structure of force readiness.

Introduction

The problem of studying motor activity is one of the most important in the field of physical education [1, 2]. Physical education of schoolchildren is aimed at increasing the motor activity of children and adolescents [3, 4] and solves the following problem:

• optimizing the physical development, strengthening and health of the child [5, 6];
• improvement of the process of development of motor abilities [7, 8];
• improvement of the process of training physical exercises [9, 10].

In the structure of physical education, power abilities relate to the basic, their level of development affects the manifestation of motor abilities and the effectiveness of teaching physical exercises of schoolchildren [7, 11]. Based on numerous studies, conclusions are drawn:

• on the effectiveness of complex development of strength, vigor, coordination, endurance and flexibility in children [12, 13];
• on the influence of the level of development of force on the process of learning the physical exercises of schoolchildren [7, 14];
• on the effectiveness of the use of means and methods of training in the development of power capabilities [15, 16].

In previously published works, attention was focused on: studying the relationship of indicators of the level of motor abilities’ development [7, 17]; determining the structure of motor preparedness in children and adolescents [18, 19].

Multidimensional methods of mathematical statistics such as factor and discriminant analysis [7, 20] are effective for studying the structure of motor readiness of schoolchildren. Using factor analysis allowed to establish the structure of motor readiness of schoolchildren [21, 22]. However, in available literature there is not enough data on the peculiarities of the structure of power abilities development among middle class students.

Thus, the study of the peculiarities of the structure of power abilities development in girls of 12-14 years old is relevant.

The purpose of the research is to determine the structure of power abilities development among girls aged 12-14 years.

Materials and methods

Study participants. The study involved girls: 12 (n =20), 13 (n = 27), 14 (n = 30) years old.

The study protocol was approved by the Ethical Committee of H. S. Skovoroda Kharkiv National Pedagogical 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.
Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0,904;
Test 4 “Cadence Push-Up Test, quantity of times” – 0,834;
Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0,669.
The factor characterizes the development of the relative and static strength of the leg muscles.
The second factor is 15.264%. The factor with the greatest correlation is the following:

- Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0,904;
- Test 4 “Cadence Push-Up Test, quantity of times” – 0,834;
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0,669.
The factor characterizes the development of muscle strength of the shoulder girdle.
The third factor has a weight of 14.142%. The factor with the greatest correlation is the following:

- Test 18 “4x9 m shuttle test, sec.” – 0,902;
- Test 5 “The subject lies in prone position, arms bent at the elbow 90 degrees - hold position in seconds” – 0,755;
- Test 9 “Trunk Lift Test, quantity of times” – 0,606.
The factor characterizes the development of coordination of movements, the static strength of the shoulder girdle and the dynamic strength of the back muscles.
The fourth factor has a weight of 13.593%. The factor with the greatest correlation is the following:

- Test 19 “Hand tapping test, sec.” – 0,834;
- Test 17 “Eurofit Sit Up Test (for 30 sec.), quantity of times” – 0,729;
- Test 15 “Handgrip Strength Test, kg” – 0,723;
- Test 16 “Standing Long Jump Test (Broad Jump), cm” – 0,723.
The factor characterizes the complex development of motor abilities on the system of tests “Eurofit”.
The fifth factor has a weight of 13.224%. The factor with the greatest correlation is the following:

- Test 7 “Hanging Leg Raises, sec.” – 0,861;
- Test 6 “Pull Up Bar- Straight Leg Hanging Leg Raises, quantity of times” – 0,840;
- Test 21 “Flamingo Balance test - single leg balance test” – 0,703;
- Test 8 “Decline Reverse Crunch on Bench, quantity of times” – 0,625.
The factor characterizes the development of leg muscle strength.
The sixth factor has a weight of 7.757%. The factor with the greatest correlation is the following:

- Test 2 “Bent Arm Hang Test (two hands), sec.” – 0,810;
- Test 20 “Seated Forward Bend, cm” – 0,458;
- Test 9 “Trunk Lift Test, quantity of times” – 0,448.
The factor characterizes the development of static muscle strength of the shoulder girdle.
Analysis of communities shows that the most informative in the structure of motor fitness girls 12 years are the following:

- Test 16 “Standing Long Jump Test (Broad Jump), cm” – 0,959;
- Test 5 “The subject lies in prone position, arms bent at the elbow 90 degrees - hold position in seconds”
The above tests describe the development of the dynamic and static strength of the muscles of the feet and hands of girls aged 12 years.

Sixteen factors have been identified among girls aged 13 years, which explain the variation of dispersion by 75.876% (Table 2).

The first factor has a weight of 22.019%. The factor with the greatest correlation is the following:
- Test 13 “Single Leg Squat (Pistol) - right leg” – 0.894;
- Test 14 “Single Leg Squat (Pistol) - left leg” – 0.855;
- Test 10 “Squats Test (two legs), quantity of times” – 0.824;
- Test 12 “Single Leg Squat (SLS) Test - left leg, quantity of times” – 0.786;
- Test 11 “Single Leg Squat (SLS) Test - right leg, quantity of times” – 0.719.

The factor characterizes the development of the relative and static strength of the leg muscles.

The second factor has a weight of 16.518%. The factor with the greatest correlation is the following:
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0.838;
- Test 8 “Decline Reverse Crunch on Bench, quantity of times” – 0.824;
- Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0.817.

The factor characterizes the development of the relative and static strength of the leg muscles. The second factor has a weight of 16.518%. The factor with the greatest correlation is the following:
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0.838;
- Test 8 “Decline Reverse Crunch on Bench, quantity of times” – 0.824;
- Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0.817.

The factor characterizes the development of muscle strength.
The third factor has a weight of 14.428%. The factor with the greatest correlation is the following:

- Test 6 “Pull Up Bar Straight Leg Hanging Leg Raises, quantity of times” – 0.880;
- Test 7 “Hanging Leg Raises, sec.” – 0.865;
- Test 20 “Seated Forward Bend, cm” – 0.599.

The factor characterizes the development of the strength of the shoulder girdle.

The fourth factor has a weight of 8.760%. The factor with the greatest correlation is the following:

- Test 17 “Eurofit Sit Up Test (for 30 sec.), quantity of times” – 0.790;
- Test 4 “Cadence Push-Up Test, quantity of times” – 0.648;
- Test 21 “Flamingo Balance test - single leg balance test” – 0.703;
- Test 20 “Seated Forward Bend, cm” – 0.566.

The factor characterizes the complex development of motor abilities on the system of tests “Eurofit”.

The fifth factor has a weight of 7.688%. The factor with the greatest correlation is the following:

- Test 15 “Handgrip Strength Test, kg” – -0.676;
- Test 18 “4x9 m shuttle test, sec.” – 0.572;
- Test 21 “Flamingo Balance test - single leg balance test” – -0.703;
- Test 20 “Seated Forward Bend, cm” – -0.566.

The factor characterizes the complex development of motor abilities on the system of tests “Eurofit”.

The sixth factor has a weight of 6.464%. The factor with the greatest correlation is the following:

- Test 19 “Hand tapping test, sec.” – 0.857;
- Test 16 “Standing Long Jump Test (Broad Jump), cm” – 0.512.

The factor characterizes the development of velocity force.

The analysis of communities shows that the most
informative in the structure of motor preparedness girls aged 13 years are the following:

- Test 13 “Single Leg Squat (Pistol) - right leg” – 0.874;
- Test 6 “Pull Up Bar- Straight Leg Hanging Leg Raises, quantity of times” – 0.869;
- Test 7 “Hanging Leg Raises, sec.” – 0.841;
- Test 19 “Hand tapping test, sec.” – 0.812;
- Test 16 “Standing Long Jump Test (Broad Jump), cm” – 0.798.

The tests described characterize the development of static, high-speed strength of leg muscles, static and dynamic strength of muscles of the abdomen and hands in girls 13 years.

Seven factors have been identified in girls for 14 years, which explain the variance of variance by 79.544%.

Table 3. Factor structure of motor preparedness of the girls 14 years old. Method: principal component analysis. Rotation method: Varimax with Kaiser Normalization (n = 30)

<table>
<thead>
<tr>
<th>No</th>
<th>Test</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Component 5</th>
<th>Component 6</th>
<th>Component 7</th>
<th>h²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pull-Up / Chin Up Test (low crossbar), quantity of times</td>
<td>,794</td>
<td>,425</td>
<td>,862</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bent Arm Hang Test (two hands), sec.</td>
<td>,302</td>
<td>,863</td>
<td>,864</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Pull-Up / Chin Up Test (Rope Climbing), quantity of times</td>
<td>-500</td>
<td>-353</td>
<td>611</td>
<td>,860</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cadence Push-Up Test, quantity of times</td>
<td>,504</td>
<td>-420</td>
<td>,779</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>The subject lies in prone position, arms bent at the elbow 90 degrees - hold position in seconds</td>
<td></td>
<td></td>
<td></td>
<td>,870</td>
<td>,828</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pull Up Bar- Straight Leg Hanging Leg Raises, quantity of times</td>
<td>,753</td>
<td></td>
<td></td>
<td>,788</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Hanging Leg Raises, sec.</td>
<td>,826</td>
<td></td>
<td></td>
<td>,800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Decline Reverse Crunch on Bench, quantity of times</td>
<td>,821</td>
<td></td>
<td></td>
<td>,778</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Trunk Lift Test, quantity of times</td>
<td>,461</td>
<td>,335</td>
<td>,552</td>
<td>,668</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Squats Test (two legs), quantity of times</td>
<td>,731</td>
<td></td>
<td></td>
<td>,627</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Single Leg Squat (SLS) Test - right leg, quantity of times</td>
<td>,908</td>
<td></td>
<td></td>
<td>,887</td>
<td></td>
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<td></td>
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<td>12</td>
<td>Single Leg Squat (SLS) Test - left leg, quantity of times</td>
<td>,911</td>
<td></td>
<td></td>
<td>,866</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>13</td>
<td>Single Leg Squat (Pistol) - right leg</td>
<td>,896</td>
<td></td>
<td></td>
<td>,913</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Single Leg Squat (Pistol) - left leg</td>
<td>,889</td>
<td></td>
<td></td>
<td>,879</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Handgrip Strength Test, kg</td>
<td></td>
<td></td>
<td></td>
<td>,842</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Standing Long Jump Test (Broad Jump), cm</td>
<td>,878</td>
<td></td>
<td></td>
<td>,833</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>17</td>
<td>Eurofit Sit Up Test (for 30 sec.), quantity of times</td>
<td>,389</td>
<td>,360</td>
<td>-455</td>
<td>,331</td>
<td>,673</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>4x9 m shuttle test, sec.</td>
<td>,832</td>
<td></td>
<td></td>
<td>,774</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Hand tapping test, sec.</td>
<td>,631</td>
<td>,402</td>
<td>-343</td>
<td>,774</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Seated Forward Bend, cm</td>
<td>,829</td>
<td></td>
<td></td>
<td>,710</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Flamingo Balance test - single leg balance test</td>
<td>-485</td>
<td>,362</td>
<td>495</td>
<td>,700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% dispersion</td>
<td>19,467</td>
<td>17,126</td>
<td>9,829</td>
<td>8,772</td>
<td>8,497</td>
<td>8,364</td>
<td>7,490</td>
<td>79,544</td>
</tr>
</tbody>
</table>

The first factor has a weight of 19.467%. The factor with the greatest correlation is the following:

- Test 12 “Single Leg Squat (SLS) Test - left leg, quantity of times” - 0.911;
- Test 11 “Single Leg Squat (SLS) Test - right leg, quantity of times” - 0.908;
- Test 13 “Single Leg Squat (Pistol) - right leg” – 0.896;
- Test 14 “Single Leg Squat (Pistol) - left leg” – 0.889.

The factor characterizes the development of the relative and static strength of the leg muscles.

The second factor is 17.126%. The factor with the greatest correlation is the following:

- Test 7 “Hanging Leg Raises, sec.” – 0.826;
- Test 8 “Decline Reverse Crunch on Bench, quantity of times” – 0.821;
The analysis of communities shows that the most informative in the structure of motor readiness of girls aged 12-14 years are the following tests: which characterize the development of static, high-speed strength of leg muscles, the dynamic strength of the brush and the relative strength of the muscles of the shoulder girdle.

The third factor has a weight of 9.829%. The factor with the greatest correlation is the following:

- Test 16 “Standing Long Jump Test (Broad Jump), cm” – 0.878;
- Test 18 “4x9 m shuttle test, sec.” – 0.832.

The factor characterizes speed-power and coordination readiness.

The fourth factor is weighing 8,772%. The factor with the greatest correlation is the following:

- Test 15 “Handgrip Strength Test, kg” – 0.867;
- Test 4 “Cadence Push-Up Test, quantity of times” – 0.504;
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0.500.

The factor characterizes the development of the strength of the brush and the relative strength of the muscles of the shoulder girdle.

The fifth factor has a weight of 8,497%. The factor with the greatest correlation is the following:

- Test 5 “The subject lies in prone position, arms bent at the elbow 90 degrees – hold position in seconds” – 0.870;
- Test 9 “Trunk Lift Test, quantity of times” – 0.552.

The factor characterizes the development of the static muscle strength of the shoulder girdle and the dynamic strength of the back muscles.

The sixth factor has a weight of 8,364%. The factor with the greatest correlation is the following:

- Test 20 “Seated Forward Bend, cm” – 0.829;
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0.611;
- Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0.425.

The factor characterizes the development of flexibility and dynamic strength of muscles of the shoulder girdle.

The seventh factor has a weight of 7.490%. The factor with the greatest correlation is the following:

- Test 2 “Bent Arm Hang Test (two hands), sec.” – 0.863;
- Test 21 “Flamingo Balance test - single leg balance test” – 0.495;
- Test 4 “Cadence Push-Up Test, quantity of times” – 0.420.

The factor characterizes the development of static and dynamic muscle strength of the shoulder girdle and coordination abilities.

The analysis of communities shows that the most informative in the structure of motor readiness of girls aged 14 years are the following:

- Test 13 “Single Leg Squat (Pistol) - right leg” – 0.913;
- Test 14 “Single Leg Squat (Pistol) - left leg” – 0.879;
- Test 12 “Single Leg Squat (SLS) Test - left leg, quantity of times” – 0.866;
- Test 2 “Bent Arm Hang Test (two hands), sec.” – 0.864;
- Test 1 “Pull-Up / Chin Up Test (low crossbar), quantity of times” – 0.862;
- Test 3 “Pull-Up / Chin Up Test (Rope Climbing), quantity of times” – 0.860.

The above presented tests describe the development of static and dynamic strength of the leg muscles, the dynamic strength of the muscle of the hands of girls aged 14 years.

**Discussion**

The presented results indicate that the power abilities have structural features of development in girls of 12-14 years old. It was found that girls have the greatest weight in the development with relative and static strength of leg muscles (22,036%, 22,019%, 19,467% respectively). In girls of 12-13 years old in the second place the development of muscle strength shoulder girdle (15.264%, 16.518% respectively). In girls aged 14 years in second place, the development of dynamic and static strength of abdominal muscles and dynamic muscle strength of the shoulder girdle (17.126%). In girls aged 12 years in third place, the development of coordination of movements, the static strength of the shoulder girdle and the dynamic strength of the muscles of the back (14.142%). In girls aged 13 years in the third place the development of muscle strength of the abdomen (14,428%), girls aged 14 years – speed and coordination of movements (9,829%).

It is confirmed that multidimensional methods of mathematical statistics are effective for the study of the strength training structure of girls aged 12-14 years: factor and discriminant analysis [7, 20]. It is added that the use of factor analysis allows to determine the structure of the development of power abilities and their interrelation with endurance in girls aged 12-14 years [21, 22].

The obtained results characterize the peculiarities of the dynamics of force readiness of middle classes girls and complement the data of Veremeenko [24], Ivashchenko et al. [25] on the regularities of motor preparedness of children and adolescents. The authors recognize that with age, the weight of high-speed force and coordination of movements in the structure of motor-preparedness of girls increases. Our results complement the data on the development of coordination of movements in adolescents [14, 26].

On the basis of the analysis of communities it is determined that the most informative in girls aged 12-14 years are the following tests: which characterize the development of dynamic and static strength of muscles of the legs and hands (girls 12 years old); which characterize the development of static, high-speed strength of leg muscles, static and dynamic strength of the muscles of the abdomen and hands (girls 13 years old); which characterize the development of the static and dynamic strength of leg muscles, the dynamic strength of the muscle of the hands
Indicators for controlling the development of power endurance of muscles among boys of middle school age. The structure of force’s preparedness of girls points to the need for a comprehensive development of power abilities. Attention is paid to the development of the static and dynamic strength of the leg muscles. The most informative tests can be used to control girls’ preparedness.

Consequently, the problem of development of power abilities is considered from the point of view of age dynamics [22] and the planning of work force in training sessions [27, 28]. The discussion of data is carried out from the standpoint of the purpose of the analysis [29]. Disclaimers and methodological approaches to the purpose of the analysis are set out in the work of Fisher [30].

Further investigations require the study of patterns of development and the relationship between strength and endurance of muscles among boys of middle school age.

**Conclusions**

Factor analysis allowed to determine informative indicators for controlling the development of power abilities in girls of 12-14 years old. The greatest weight in power preparedness has the relative and static strength of the leg muscles. In the second place, girls of 12-13 years old have the development of muscle strength shoulder girdle. 14 years old girls in second place, have the development of dynamic and static strength of the abdominal muscles and the dynamic strength of muscles of the shoulder girdle. Girls of 12 years old in third place have the development of coordination of movements, the static strength of the shoulder girdle and the dynamic strength of the back muscles. Girls of 13 years in the third place have development of the development of muscle strength of the abdomen. Girls of 14 years in third place have development of high-speed force and coordination of movements.

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**Conflict of Interest**

The authors state that there is no conflict of interest.

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