ORIGINAL SCIENTIFIC ARTICLE

PATTERN RECOGNITION: EFFECTIVENESS OF TEACHING BOYS AGED 14 THE PRESS HEADSTAND AND HANDSTAND

Inna Mugurdinova[1ABCD] and Sergii Iermakov[2,3ABCD]

[1]H. S. Skovoroda Kharkiv National Pedagogical University
[2]Gdansk University of Physical Education and Sport
[3]Kharkiv State Academy of Design and Arts

Abstract

Purpose. To determine the impact of exercise modes on the effectiveness of teaching boys aged 14 the press headstand and handstand.

Materials and methods. The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

Results. The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 14 the press headstand and handstand. The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6.

Conclusions. The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 14 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly.

Keywords: discriminant analysis, boys, acrobatic exercises, exercise mode, teaching.

Introduction

Motor skills development at school is a priority task of physical education of schoolchildren (Ivashchenko, Iermakov, Khudolii, Cretu, & Potop, 2017; Krutsevich, Pengelova, & Trachuk, 2019; Ivashchenko, Berezhna, & Cieślicka, 2020). The regularities of basic motor skills development are the object of research of a number of scientists (Adamo, Wilson, Harvey, Grattan, Naylor, Temple, & Goldfield, 2016; Abate, Pallonetto, & Palumbo, 2020; Barnett, & Makin, 2018). Researchers have studied the structure of basic motor skills (Basman, 2019; Pfeiffer, Saunders, Brown, Dowda, Addy, & Pate, 2013), age-related peculiarities of development (Bardid, Lenoir, Huyben, De Martelaer, Seghers, Goodway, & Deconinck, 2017; Barnett, Telford, Strugnell, Rudd, Olive, & Telford, 2019), pedagogical control of the level of development (Bryant, James, Birch, & Duncan, 2014; Ivashchenko, Kapkan, Khudolii, & Yermakova, 2017; Ivashchenko, 2017).

Acrobatic exercises can be considered as part of the structure of basic motor skills (Kapkan, Khudolii, & Bartik, 2019; Khudolii, Kapkan, Harkusha, Marchenko, & Veremeenko, 2020; Ivashchenko, Abdulkhalikova, & Cieślicka, 2017).

During motor skills development, the selection of physical exercises and the modes of their performance are of importance (Marchenko, & Kovalenko, 2020; Marchenko, Jagiello, Iermakov, Ivashchenko, & Khudolii, 2021; Ivashchenko, Nosko, & Ferents, 2019).

The analysis of motor skills development uses multivariate statistical methods, including discriminant analysis (Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018; Silverman, Woods, & Subramaniam, 1998; Ivashchenko, 2020).

Therefore, the study of the effectiveness of teaching is relevant.

The purpose of the study was to determine the impact of exercise modes on the effectiveness of teaching boys aged 14 the press headstand and handstand.

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Corresponding Author: Inna Mugurdinova,
E-mail: innamugurdinova@gmail.com

Materials and methods

Study participants

The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

The pedagogical experiment examined the influence of 6 and 12 repetitions with a 60-second rest interval during a physical education class on the number of repetitions of training tasks to the 100% level of proficiency. In the first group (n = 10), the boys repeated the tasks 6 sets 1 time each with a rest interval of 60 s, in the second group (n = 10) – 6 sets 2 times each with a rest interval of 60 s.

During teaching, the method of algorithmic instructions was used (Shlemin, 1973). The program of teaching the press headstand and handstand was developed based on the data of Shlemin (1973), Khudolii (2008) and included the following training tasks:

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (transition to training the next exercise)
First series of training tasks – exercises to develop motor abilities		
From standing position, with the back against stall bars, proceed to arch hang	Performed by jumping off both feet, hold the position for 3-4 seconds	Repeat 3–5 times
A push-up position. Bend arms and knees (5 times in 5-6 seconds)	Performed with maximum amplitude	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Second series of training tasks – exercises to master starting and ending positions		
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Hold the position for 3-4 seconds	Repeat 3 times
The same, lifting the legs off the floor and keeping them bent, straighten the back	Perform the exercise with assistance	Repeat 3 times
Third series of training tasks – actions without which it is impossible to perform the target exercise		
Lifting the legs off the floor and keeping them bent, straighten the back	Arriving to headstand and handstand should be done without any effort, by simply straightening the legs	Repeat 3 times
Lifting the legs off the floor and keeping them bent, straighten the back	Push off with the feet and, helping with hands, arrive to headstand. Straighten the legs	Repeat 3 times
Fourth series of training tasks – teaching the ability to assess movements in space, by time and muscular effort		
In kneeling position, bending and straightening of the arms (5 times)	Bend the arms simultaneously with straightening the legs as quickly as possible	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Bending and straightening of the arms in stoop standing position (5 times)	Plant the hands on the floor a step's length away from the toes	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
From normal standing position, lean forward, touch the floor with the hands and, moving the hands forward on the floor, adopt a push-up position, return to starting position in the same way	Do not bend knees when performing the exercise	Perform the exercise for 6 seconds
Fifth series of training tasks – preliminary exercises		
From squat, lean forward, put the head down on mat and evenly shift the body weight to the head and arms for 3–4 seconds	Straightening the back, hold balance with bent legs	If the student performs the exercise 3 times, proceed to the next exercise
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Straighten the legs, hold balance without bending the legs for 3-4 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Focus on the exercise technique	Correct performance of the series on 3 attempts
Sixth series of training tasks – the entire exercise		
A headstand with the back and legs against the stall bars, with assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts
A headstand without assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts

Table 1. Group Statistics. Boys Aged 14

| Series of tasks | 6 repetitions, rest interval of 60 s | | 12 repetitions, rest interval of 60 s | | Δx | Wilks' Lambda | F | df1 | df2 | Sig. |
	Mean	Std. Deviation	Mean	Std. Deviation						
1	5.3	2.11	4.8	2.39	0.5	.987	.245	1	18	.626
2	6.9	2.02	12.1	3.63	-5.2	.535	15.620	1	18	.001
3	14.6	2.87	15.5	2.17	-0.9	.967	.624	1	18	.440
4	9.4	2.06	13.4	1.71	-4	.448	22.222	1	18	.000
5	5.6	2.98	12.0	3.16	-6.4	.454	21.634	1	18	.000
6	6.6	1.83	10.0	2.05	-3.4	.542	15.211	1	18	.001

The next exercise started on condition of correct performance of the previous exercise on three consecutive attempts. The number of repetitions required for correct performance on three consecutive attempts was recorded. The level of proficiency in the exercises was determined by the alternative method: "performed" or "failed". A technically correct performance of the exercise gave the students "1" point; a failure to perform the exercise gave them "0" entered in the protocol.

Statistical analysis

The study materials were processed using the IBM SPSS 20 statistical analysis program. Discriminant analysis was conducted. For each canonical discriminant function, the study calculated the following: eigenvalue, variance percentage, canonical correlation, Wilks' lambda, Chi-square. For each step: prior probabilities, Fisher's function coefficients, unstandardized function coefficients, Wilks' lambda for each canonical function.

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

The analysis of averages shows that statistically significant differences in the number of repetitions are observed in performing series of training tasks 2, 4, 5, and 6. The boys aged 14 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the movements (Table 1).

To determine the impact of different modes of exercises on the level of proficiency, discriminant analysis was conducted (Tables 2-6). A necessary condition for discriminant analysis is the homogeneity of variances and covariances of data. The Box's M test confirms the assumption about the homogeneity of variances and covariances (Table 2).

Table 2. Box's M Test For Testing Equal Population Covariance Matrices (DA)

	Box's M	32.952
F	Approx.	1.521
	df1	15
	df2	1304.526
	Sig.	.090

The first canonical function explains 100% of the results variation, which indicates its high informativity (r = 0.891) (see Table 3). The analysis of the canonical function shows its statistical significance ($\lambda_1 = 0.207$; $p_1 = 0.001$). The first function has a high discriminative ability and value in interpretation of the general population (Table 4).

Table 3. Eigenvalues for Developing Discriminant Model (Canonical Correlation). Boys Aged 14

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.832	100.0	100.0	.891

Table 4. Outcomes of Calculated Wilks' Lambda of Discriminant Function. Boys Aged 14

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.207	24.417	5	.000

The standardized canonical discriminant function coefficients make it possible to determine the ratio of the contribution of variables to the function result. The results of the second and fifth series of training tasks make the largest contribution to the first canonical function. The above indicates that the exercises of the second (exercises to master starting and ending positions) and the fifth (preliminary exercises) series of training tasks are the most sensitive to exercise modes in boys aged 14 (Table 5).

Table 5. Standardized Canonical Discriminant Function Coefficients. Boys Aged 14

| Series of tasks | Function |
	1
Series 1	-.494
Series 2	.814
Series 3	-.478
Series 4	.139
Series 5	.982

The structure canonical discriminant function coefficients are the coefficients of correlation between the variables and the function. Thus, the function is most closely connected with the number of repetitions of exercises of the fourth (the ability to assess movements in space, by time and muscular effort), the fifth (preliminary exercises), and the second (exercises to master starting and ending positions) series of training tasks ($r_4 = 0.568$; $r_5 = 0.560$; $r_2 = 0.476$) (Table 6).

Table 6. Structure Matrix. Boys Aged 14

Series of tasks	Function
	1
Series 4	.568
Series 5	.560
Series 2	.476
Series 6[a]	.462
Series 3	.095
Series 1	-.060

[a] This variable is not used in the analysis.

Table 7. Canonical Discriminant Function Coefficients (Unstandardized coefficients)

Series of tasks	Function
	1
Series 1	-.219
Series 2	.277
Series 3	-.188
Series 4	.073
Series 5	.319
(Constant)	-2.345

Table 8. Functions at Group Centroids. Boys Aged 14

Exercise Mode	Function
	1
1 – 6 repetitions, rest interval of 60 s	-1.857
2 – 12 repetitions, rest interval of 60 s	1.857

Fig. 1. Graphic representation of classification results: 6 repetitions, rest interval of 60 s

Fig. 2. Graphic representation of classification results: 12 repetitions, rest interval of 60 s

The coordinates of centroids for two groups make it possible to interpret the canonical function in relation to the role in classification. At the positive pole is a centroid for the exercise mode of 12 repetitions ($M_{12} = 1.857$), at the negative – a centroid for the exercise mode of 6 repetitions ($M_6 = -1.857$) (see Table 8, Fig. 1, 2). This indicates a significant difference in the impact of exercise repetition modes on the number of repetitions required for motor skills development in boys aged 14 during physical education classes. The results of classification of the groups show that 100.0 % of the original grouped cases were classified correctly (Table 9). Based on the discriminant function coefficients and centroids, it is possible to calculate the number of repetitions for mastering the motor skill (Table 7). The value of the centroid for the exercise mode of 6 repetitions is approximate for calculation ($M_6 = -1.857$).
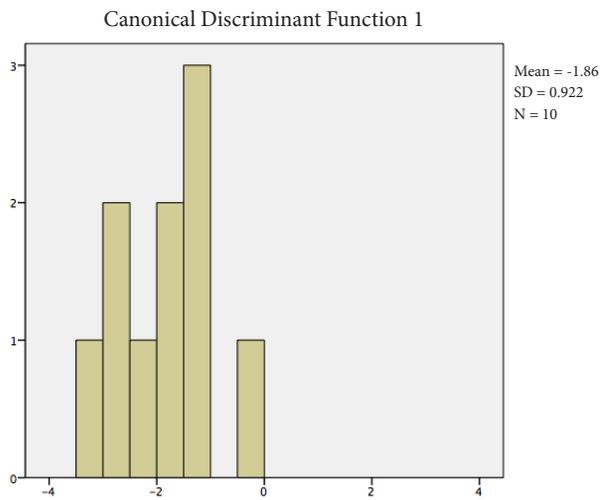
Table 9. Classification Results[a,c]

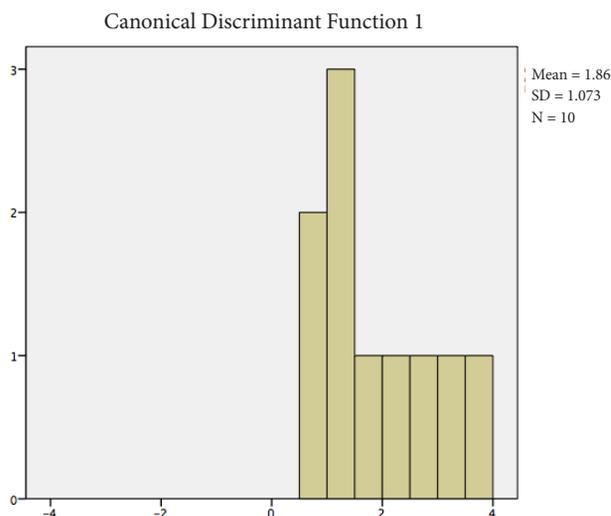|		Exercise Mode	Predicted Group Membership		Total
			1	2	
Original	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	0	10	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	.0	100.0	100.0
Cross-validated[b]	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	1	9	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	10.0	90.0	100.0

a. 100.0% 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.

c. 90.0% of cross-validated grouped cases correctly classified.

Discussion

The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 14 the press headstand and handstand. The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6 (p < 0.05).

These data complement the knowledge about the development of motor skills (Adamo, Wilson, Harvey, Grattan, Naylor, Temple, & Goldfield, 2016; Abate, Pallonetto, & Palumbo, 2020; Barnett, & Makin, 2018) and the importance of teaching in schoolchildren's physical education (Ivashchenko, Iermakov, Khudolii, Cretu, & Potop, 2017; Krutsevich, Pengelova, & Trachuk, 2019; Ivashchenko, Berezhna, & Cieślicka, 2020).

Structure canonical discriminant function coefficients indicate that the process of motor skills development is influenced by the selection of motor tasks and the modes of their performance. The obtained data complement the knowledge about the effectiveness of using discriminant analysis to assess the teaching process (Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018; Silverman, Woods, & Subramaniam, 1998; Ivashchenko, 2020), the level of schoolchildren's motor fitness (Teunissen, ter Welle, Platvoet, Faber, Pion, & Lenoir, 2021; Tkachenko, 2020; Zhang, Chen, Chen, S., Hong, Loflin, & Ennis, 2014) and on the impact of exercise regimes on learning effectiveness (Ivashchenko, & Karpunets, 2001; Ivashchenko, & Kapkan, 2015; Cieślicka, & Ivashchenko, 2017).

To plan the teaching process on the basis of unstandardized discriminant function coefficients and centroids, it is possible to calculate the number of repetitions for mastering the motor skill:

$Y = -2.345 - 0.219X_1 + 0.277X_2 - 0.188X_3 + 0.073X_4 + 0.319X_5$, where Y is the function value, X_1-X_5 are the number of repetitions to master the motor task.

The value of the centroid for the exercise mode of 6 repetitions is approximate for calculation ($M_6 = -1.857$).

Conclusions

The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 14 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly.

The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6.

Acknowledgment

Conflict of interest

The authors declare that there is no conflict of interest.

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РОЗПІЗНАННЯ ОБРАЗІВ: ЕФЕКТИВНІСТЬ ПРОЦЕСУ НАВЧАННЯ СТІЙКИ СИЛОЮ НА ГОЛОВІ І РУКАХ ХЛОПЦІВ 14 РОКІВ

Інна Мугурудінова[1ABCD], Сергій Єрмаков[2, 3ABCD]

[1]Харківський національний педагогічний університет імені Г.С. Сковороди
[2]Гданський університет фізичного виховання і спорту
[3]Харківська державна академія дизайну і мистецтв

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Мета дослідження – визначити вплив режимів виконання вправ на ефективність процесу навчання стійки силою на голові і руках хлопців 14 років.

Матеріали і методи. У дослідженні прийняли участь 20 хлопців 14 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь

в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження, хронометраж навчальних завдань; педагогічний експеримент, методи математичної статистики, дискримінантний аналіз.

Результати. Приймається припущення про суттєвий вплив режимів чергування повторень вправ та інтервалу відпочинку на ефективність навчання стійки силою на голові і руках хлопців 14 років. Встановлено що режим 6 підходів по 1 разу з інтервалом відпочинку 60 с має більшу ефективність ніж режим 6 підходів по 2 рази з інтервалом відпочинку 60 с у процесі навчання 2, 4, 5 та 6 серій навчальних завдань

Висновки. На основі аналізу нормованих, структурних коефіцієнтів та центроїдів груп визначено, що режими виконання вправ мають суттєвий вплив на процес навчання стійки силою на голові і руках хлопців 14 років на уроках фізичної культури. Результати класифікації груп показують, що 100 % вихідних згрупованих спостережень класифіковано правильно.

Ключові слова: дискримінантний аналіз, хлопці, акробатичні вправи, режим виконання вправ, навчання.

Information about the authors:

Muhurdinova Inna: innamugurdinova@gmail.com; https://orcid.org/0000-0002-8495-8640; H. S. Skovoroda Kharkiv National Pedagogical University, Department of Theory and Methodology of Physical Education, Alchevskikh St, 29, Kharkiv, 61002, Ukraine.

Iermakov Sergii: sportart@gmail.com; http://orcid.org/0000-0002-5039-4517; Gdansk University of Physical Education and Sport, Department of Sports, Kasimir Gorskogo St, 1, 80-336 Gdansk, Poland. Kharkiv State Academy of Design and Arts; Mystetstv St, 8, Kharkiv, 61002, Ukraine.