



PATTERN RECOGNITION: EFFECTIVENESS OF TEACHING BOYS AGED 15 THE PRESS HEADSTAND AND HANDSTAND

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

DOI: 10.17309/jltm.2022.1.03

Abstract

Purpose. To determine the impact of exercise modes on the effectiveness of teaching boys aged 15 the press headstand and handstand.

Materials and methods. The study participants were 20 boys aged 15. 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 15 the press headstand and handstand. The study found that statistically significant differences in the number of repetitions are observed in performing all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of motor tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions).

Conclusions. The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 15 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 2 times each with a rest interval of 60 s is more effective than the mode of 6 sets 1 time with a rest interval of 60 s when teaching series of motor tasks 1, 3, 4, 5, and 6.

Keywords: discriminant analysis, boys aged 15, acrobatic exercises, exercise mode, teaching.

Introduction

The importance of increasing motor activity of school-children is highlighted by the findings of researchers (Prystynskyi, Babych, Zaytsev, Boychuk, & Taymasov, 2020; Samsudin, Setiawan, Taufik, & Solahuddin, 2021; Krutsevich, Marchenko, Trachuk, Panhelova, Napadij, & Dovgal, 2021). It was found that the increase in motor activity is associated with the level of development of fundamental movements (Ré, Logan, Cattuzzo, Henrique, Tudela, & Stodden, 2018; Peers, Issartel, Behan, O'Connor, & Belton, 2020; Newell, 2020), the priority of motor skills development (Ivashchenko, Berezna, & Cieśllicka, 2020; Ivashchenko & Sirichenko, 2020; Khudolii, Golovnin, & Bartik, 2020), as well as the development of teaching technologies (Khudolii, Iermakov, & Bartik, 2020; Kapkan, Khudolii, & Bartik, 2019; Shueva, Ivashchenko, &

Jagiello, 2021). In the process of developing the skills of fundamental movements, it is also important to test the level of their development (Valentini, Zanella, & Webster, 2017; Wagner, Kipling Webster, & Ulrich, 2017; Webster, & Ulrich, 2017).

One of the factors that influence the effectiveness of teaching is the mode of alternating repetitions and rest intervals (Marchenko & Kovalenko, 2020; Marchenko, & Taranenko, 2020; Marchenko, Jagiello, Iermakov, Ivashchenko, & Khudolii, 2021). Ivashchenko and Karpunets (2001), Ivashchenko and Kapkan (2015), Browne, Flynn, O'Neill, Howatson, Bell, and Haskell-Ramsay (2017) point out a more significant impact of exercise modes on the effectiveness of performing complex coordination exercises. Thus, the study of the effectiveness of motor skills development is relevant.

The purpose of the study was to determine the impact of exercise modes on the effectiveness of teaching boys aged 15 the press headstand and handstand.

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Materials and methods

Study participants

The study participants were 20 boys aged 15. 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) (Table 1).

Table 1. Program of teaching boys aged 15 the press headstand and handstand (Shlemin, 1973; Khudolii, 2008)

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	

Table 2. Group Statistics. Boys Aged 15

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	8.2	1.61	4.7	1.33	3.5	.393	27.771	1	18	.000
2	8.6	1.64	6.6	1.57	2	.701	7.692	1	18	.013
3	11.2	1.47	14.2	2.09	-3	.568	13.682	1	18	.002
4	16.0	1.49	12.3	1.25	3.7	.333	36.132	1	18	.000
5	8.9	1.52	6.7	1.33	2.2	.605	11.773	1	18	.003
6	7.9	1.28	6.4	1.34	1.5	.736	6.470	1	18	.020

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 all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of training tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions) (Table 2).

To determine the impact of different modes of exercises on the level of proficiency, discriminant analysis was conducted (Tables 3-10). 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 3).

The first canonical function explains 100% of the results variation, which indicates its high informativity ($r=0.935$) (see Table 4). The analysis of the canonical function shows its statistical significance ($\lambda_1 = 0.125$; $p_1 = 0.001$). The first function has a high discriminative ability and value in interpretation of the general population (Table 5).

Table 3. Box's M Test For Testing Equal Population Covariance Matrices (DA)

	Box's M	33.236
F	Approx.	.996
	df1	21
	df2	1191.671
	Sig.	.465

Table 4. Eigenvalues for Developing Discriminant Model (Canonical Correlation). Boys Aged 15

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	6.988*	100.0	100.0	.935

Table 5. Outcomes of Calculated Wilks' Lambda of Discriminant Function. Boys Aged 15

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.125	31.169	6	.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 first (exercises to develop motor abilities) and the fourth (teaching the ability to assess movements in space, by time and muscular effort) series of training tasks make the largest contribution to the first canonical function. The above indicates that in the classification of exercise modes for boys aged 15, the exercises of the first and fourth series of training tasks are a priority (Table 6).

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 and first series of training tasks ($r_4 = 0.536$; $r_1 = 0.470$) (Table 7).

Table 6. Standardized Canonical Discriminant Function Coefficients. Boys Aged 15

Series of tasks	Function
	1
Series 1	.695
Series 2	-.541
Series 3	-.536
Series 4	.858
Series 5	.472
Series 6	.116

Table 7. Structure Matrix. Boys Aged 15

Series of tasks	Function
	1
Series 4	.536
Series 1	.470
Series 3	-.330
Series 5	.306
Series 2	.247
Series 6	.227

Table 8. Canonical Discriminant Function Coefficients (Unstandardized coefficients)

Series of tasks	Function
	1
Series 1	.468
Series 2	-.336
Series 3	-.296
Series 4	.623
Series 5	.329
Series 6	.088
(Constant)	-8.725

Table 9. Functions at Group Centroids. Boys Aged 15

Exercise Mode	Function
	1
1 – 6 repetitions, rest interval of 60 s	2.508
2 – 12 repetitions, rest interval of 60 s	-2.508

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 6 repetitions ($M_6 = 2.508$), at the negative – a centroid for the exercise mode of 12 repetitions ($M_{12} = -2.508$) (see Table 9, 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 15 during physical education classes. The results of classification of the groups show that 100.0 % of the original grouped cases were classified correctly (Table 10). Based on the discriminant function coefficients and centroids, it is possible to calculate

Canonical Discriminant Function 1

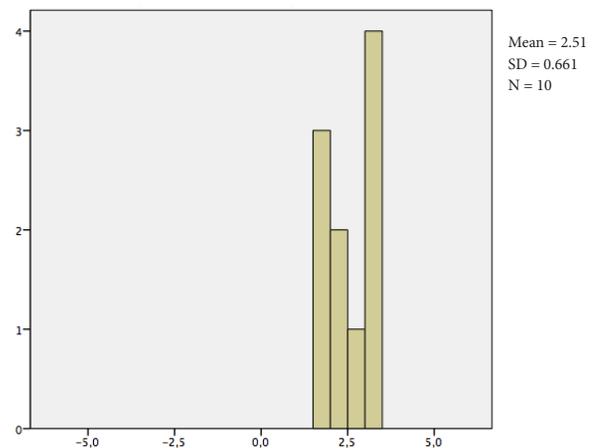


Fig. 1. Graphic representation of classification results: 6 repetitions, rest interval of 60 s

Canonical Discriminant Function 1

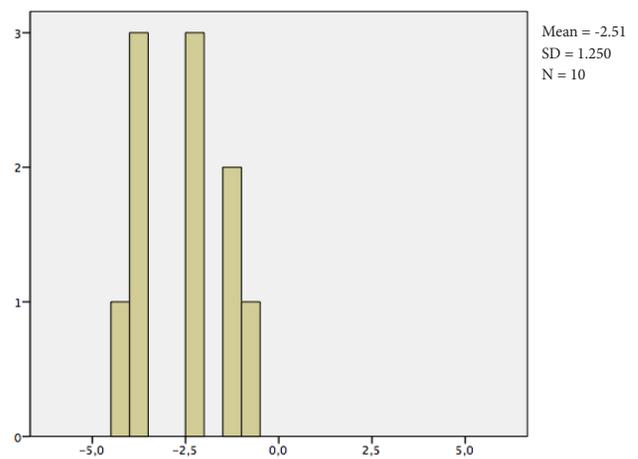


Fig. 2. Graphic representation of classification results: 12 repetitions, rest interval of 60 s

the number of repetitions for mastering the motor skill (Table 8). The value of the centroid for the exercise mode of 12 repetitions is approximate for calculation ($M_{12} = -2.508$).

Table 10. 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. 100.0% 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 15 the press headstand and handstand. The study found that statistically significant differences in the number of repetitions are observed in performing all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of motor tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions) (Table 2).

The obtained data complement the knowledge about the regularities of motor skills development in children and adolescents (Ré, Logan, Cattuzzo, Henrique, Tudela, & Stodden, 2018; Peers, Issartel, Behan, O'Connor, & Belton, 2020; Newell, 2020).

The analysis of standardized and structure discriminant function coefficients shows that in the process of teaching the press headstand and handstand, previous strength training (first series of tasks) and the ability to control movements (fourth series) are a priority. This confirms the information on the impact of exercise modes with a complex coordination structure (Browne et al., 2017).

The results of the analysis of the teaching process confirm the effectiveness of the discriminant function for determining the regularities of motor skills development and complement the knowledge about its use in physical education and sports (Broadhead & Church, 1982; Baudry, Sforza, Leroy, Lovecchio, Gautier, & Thouwarecq, 2009; Kermarrec, & Michot, 2007).

To plan the modes of exercises on the basis of discriminant function coefficients and centroids, it is possible to calculate the number of repetitions for mastering the motor skill. The calculation is performed using the following equation:

$$Y = -8.725 + 0.468X_1 - 0.336X_2 - 0.296X_3 + 0.623X_4 + 0.329X_5 + 0.088X_6,$$

where Y is the function result, X_1 - X_6 are the number of repetitions of series of training tasks 1-6.

The value of the centroid for the exercise mode of 12 repetitions is approximate for calculation ($M_{12} = -2.508$).

Conclusions

The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 15 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 2 times each with a rest interval of 60 s is more effective than the mode of 6 sets 1 time with a rest interval of 60 s when teaching series of motor tasks 1, 3, 4, 5, and 6.

Acknowledgment

The study was carried out according to the research plan of the Department of Theory and Methodology of Physical

Education of H. S. Skovoroda Kharkiv National Pedagogical University within the topic "Theoretical and methodological foundations of modeling the learning process and motor abilities development in children and adolescents" (2013–2022) (state registration number 0112U002008).

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 15 РОКІВ

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

Реферат. Стаття: 7 с., 9 табл., 2 рис., 26 джерел.

Мета дослідження – визначити вплив режимів виконання вправ на ефективність процесу навчання стійки силою на голові і руках хлопців 15 років.

Матеріали і методи. У дослідженні прийняли участь 20 хлопців 15 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 15 років. Встановлено, що статистично значущі розбіжності у кількості повторень спостерігаються у виконанні всіх навчальних завдань. Хлопці 15 років, які використовують другий режим (6 підходів по 2 рази з інтервалом відпочинку 60 с), витрачають менше повторень на оволодіння 1, 3, 4, 5 та 6 серії рухових завдань. Хлопці 15 років, які використовують перший режим (6 підходів по 1 разу з інтервалом відпочинку 60 с) витрачають менше повторень

на оволодіння другої серії навчальних завдань (вправи на оволодіння вихідних і кінцевих положень).

Висновки. На основі аналізу нормованих, структурних коефіцієнтів та центротидів груп визначено, що режими виконання вправ мають суттєвий вплив на процес навчання стійки силою на голові і руках хлопців 15 років на уроках фізичної культури. Результати класифікації груп показу-

ють, що 100 % вихідних згрупованих спостережень класифіковано вірно. Встановлено що режим 6 підходів по 2 рази з інтервалом відпочинку 60 с має більшу ефективність ніж режим 6 підходів по 1 разу з інтервалом відпочинку 60 с у процесі навчання 1, 3, 4, 5 та 6 серії рухових завдань.

Ключові слова: дискримінантний аналіз, хлопці 15 років, акробатичні вправи, режим виконання вправ, навчання.

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Cite this article as: Siedykh, K., Ivashchenko, O., Bartik, P., & Veremeenko, V. (2022). Pattern Recognition: Effectiveness of Teaching Boys Aged 15 the Press Headstand and Handstand. *Journal of Learning Theory and Methodology*, 3(1), 18-24. <https://doi.org/10.17309/jltm.2022.1.03>

Received: 25.10.2021. Accepted: 05.02.2022. Published: 28.02.2022

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