

PATTERN RECOGNITION: IMPACT OF EXERCISES MODES ON DEVELOPING A SMALL BALL THROWING SKILL IN BOYS AGED 8

Sergii Iermakov^{1ABCD}, Olha Ivashchenko^{2ABCD}, Oleg Khudolii^{2ABCD},
Sergii Chernenko^{3ABCD}, Viktoriia Veremeenko^{2ABCD}, Bohdan Zelenskyi^{2ABCD}

¹Gdansk University of Physical Education and Sport

²H. S. Skovoroda Kharkiv National Pedagogical University

³Donbas State Engineering Academy

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Corresponding Author: Olha Ivashchenko, E-mail: ivashchenko@hnpu.edu.ua

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Abstract

The purpose of the study was to determine the impact of exercises modes on developing a small ball throwing skill in boys aged 8.

Materials and methods. The study participants were 21 boys aged 8, who were randomly divided into three groups of 7 people. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

The study examined the influence of the number of repetitions on the effectiveness of teaching boys aged 8 throwing a small ball at a target. A pedagogical experiment examined the influence of 6, 12, and 18 repetitions with a 60-second rest interval on the increase in the level of proficiency in exercises of boys aged 8. In the first group, the boys repeated the task 6 times with a rest interval of 60 s, in the second group – 12 times with a rest interval of 60 s, in the third group 18 times with a rest interval of 60 s. When teaching throwing exercises during the class, the study evaluated the level of proficiency by the alternative method (“performed”, “failed”) and calculated the probability of exercise performance ($p = n/m$, where n is the number of successful attempts, m is the total number of attempts).

In teaching boys aged 8, the method of algorithmic instructions was used. The next exercise started after three successful attempts. Throwing a ball at a vertical target was taught.

The study materials were processed by the IBM SPSS 20 statistical analysis software. During discriminant analysis, a prognostic model for group membership was created.

Results. Discriminant analysis made it possible to determine the impact of the number of repetitions on the effectiveness of developing the skills of throwing a small ball at a target; answer the question as to how significantly the modes of repetitions differ by the effectiveness of motor skills development, what class the object belongs to based on the values of discriminant variables.

Conclusions. Based on the analysis of group centroids, it was found that in boys aged 8, six repetitions of the exercise (6 sets one time with a rest interval of 60 s) significantly influence the increase in the level of proficiency in exercises during physical education lessons.

The results of group classification show that 85.7% of the original grouped observations were classified correctly.

Keywords: boys aged 8, ball throwing, discriminant function.

Introduction

In the modern school, physical education is considered as a single process of motor skills formation, motor abilities development, and an increase in schoolchildren's motor activity (Chan, Ha, Ng, & Lubans, 2019; Chang, Ward, &

Goodway, 2020; Barnett, Telford, Strugnell, Rudd, Olive, & Telford, 2019). Motor skills development is associated with the impact on children's and adolescents' health improvement (Bolger, L. A., Bolger, L. E., O'Neill, Coughlan, Lacey, O'Brien, & Burns, 2019; Bolger, L. E., Bolger, L. A., O'Neill, Coughlan, O'Brien, Lacey, Burns, & Bardid, 2020).

The learning process in physical education was studied in the following areas:

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- motor skills in the structure of schoolchildren's physical fitness (Petrov, Khudolii, & Cieślicka, 2020; Shevchenko, Khudolii, & Potop, 2020; Ivashchenko, Berezhna, & Cieślicka, 2020);
- gender-related peculiarities of motor skills development (Iermakov, Ivashchenko, & Khomiakov, 2020; Khudolii, Golovnin, & Bartik, 2020; Kelly, O'Connor, Harrison, & Ní Chéilleachair, 2019);
- regularities of motor skills development (Afrouzeh, Musa, Suppiah, & Abdullah, 2020; Khudolii, 2019; Hastie, Rudisill, Boyd, & Johnson, 2019);
- methods of assessing motor skills in children (Klingberg, Hoeboer, Schranz, Barnett, De Vries, & Ferrar, 2019; Lovric, Jelaska, Clark, Duncan, & Miletic, 2019; Nobre, Valentini, & Rusidill, 2020).

It was found that the conditions for motor skills development are one of the factors that determine the effectiveness of schoolchildren's learning (Ivashchenko, 2020; Ivashchenko, Nosko, M., Nosko, Y., & Chernenko, 2019; Kapkan, Khudolii, & Bartik, 2019a). The conditions for motor skills development are understood as the alternation of exercises and rest intervals (Marchenko & Taranenko, 2020; Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018). The importance of studying the process of teaching physical exercises is pointed out by Ivashchenko, Iermakov, Khudolii, Cretu, and Potop (2017), Marchenko, and Kovalenko (2020), Abhaydev, Bhukar, and Thapa (2020); the modes of physical exercises were also considered in the process of motor abilities development (Khudolii, Iermakov, Ivashchenko, & Nosko (2020); Iermakov, Ivashchenko, Khudolii, & Chernenko, 2020).

Studies on motor skills development used a probabilistic approach for motor skills assessment (Kapkan, Khudolii, & Bartik, 2019b; Ivashchenko, Khudolii, Iermakov, & Harkusha, 2017), factorial designs (Khudolii, 2019; Ivashchenko, 2020), and discriminant analysis to study the regularities of motor skills development (Gert-Jan de Bruijn & Benjamin Gardner, 2011; Lulzim, I., (2013), which make it possible to obtain new knowledge about the regularities of motor skills development in schoolchildren. Thus, the study of the effectiveness of teaching primary schoolchildren with the use of modern multivariate statistical methods is relevant.

The purpose of the study was to determine the impact of exercises modes on developing a small ball throwing skill in boys aged 8.

Materials and methods

Study participants

The study participants were 21 boys aged 8, who were randomly divided into three groups of 7 people. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Study organization

The study examined the influence of the number of repetitions on the effectiveness of teaching boys aged 8 throwing a small ball at a target.

A pedagogical experiment examined the influence of 6, 12, and 18 repetitions with a 60-second rest interval on the

increase in the level of proficiency in exercises of boys aged 8. In the first group, the boys repeated the task 6 times with a rest interval of 60 s, in the second group – 12 times with a rest interval of 60 s, in the third group 18 times with a rest interval of 60 s.

When teaching throwing exercises during the class, the study evaluated the level of proficiency by the alternative method (“performed”, “failed”) and calculated the probability of exercise performance ($p = n/m$, where n is the number of successful attempts, m is the total number of attempts).

In teaching boys aged 8, the method of algorithmic instructions was used. The next exercise started after three successful attempts. Throwing a ball at a vertical target was taught.

The study analyzed the impact of the number of sets on the level of proficiency in the following movements: 1. Throwing a ball against the floor; 2. Throwing a ball forward and up, feet shoulder width apart; 3. Throwing a ball forward and up, left leg forward; 4. Throwing a ball forward and up, left side to the throwing direction; 5. Throwing a ball at a 3 m distant target.

Statistical analysis

To determine the impact of the suggested modes of physical exercises for boys aged 8, discriminant analysis was conducted.

The study materials were processed by the IBM SPSS 20 statistical analysis software. During discriminant analysis, a prognostic model for group membership was created. This model builds a discriminant function (or, when there are more than two groups – a set of discriminant functions) in the form of a linear combination of predictor variables, which ensures the best division of groups. These functions are built according to a set of observations, for which their group membership is known. These functions can further be used for new observations with known values of predictor variables and unknown group membership.

For each canonical discriminant function, the study calculated: eigenvalue, dispersion percentage, canonical correlation, Wilks' Lambda, Chi-square.

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

Tables 1-3 show the results of a comparative analysis of the level of proficiency in a series of learning tasks of boys aged 8 depending on the number of repetitions.

The exercise mode of 6 repetitions with a 60-second rest interval has a statistically significantly better dynamics of the level of proficiency than the exercise mode of 12 repetitions with a 60-second rest interval for exercise 2 “Throwing a ball forward and up, feet shoulder width apart” ($p = 0.001$), the difference in proficiency in other exercises is not statistically significant ($p > 0.05$).

The exercise mode of 12 repetitions with a 60-second rest interval has a statistically significantly better dynamics of the level of proficiency than the exercise mode of 18 repetitions

Table 1. The results of a comparative analysis of the level of proficiency in a series of learning tasks of boys aged 8

No	Exercise	6 repetitions (n = 7)		12 repetitions (n = 7)		Δx	t	p	95% confidence interval of the difference of means	
		X	s	X	s				Lower limit	Upper limit
1	Throwing a ball against the floor	0.434	0.161	0.528	0.176	-0.094	-1.044	.317	-.291	.102
2	Throwing a ball forward and up, feet shoulder width apart	1	0	0.529	0.176	0.471	7.071	.000	.326	.617
3	Throwing a ball forward and up, left leg forward	0.433	0.162	0.529	0.176	-0.096	-1.057	.311	-.293	.102
4	Throwing a ball forward and up, left side to the throwing direction	0.48	0.263	0.67	0	-0.19	-1.914	.080	-.406	.026
5	Throwing a ball at a 3 m distant target	0.573	0.159	0.623	0.125	-0.05	.02632	.525	-.217	.117

Table 2. The results of a comparative analysis of the level of proficiency in a series of learning tasks of boys aged 8

No	Exercise	6 repetitions (n = 7)		18 repetitions (n = 7)		Δx	t	p	95% confidence interval of the difference of means	
		X	s	X	s				Lower limit	Upper limit
1	Throwing a ball against the floor	0.434	0.161	0.481	0.176	-0.047	-.522	.611	-.244	.149
2	Throwing a ball forward and up, feet shoulder width apart	1	0	0.811	0.176	0.189	2.828	.015	.043	.334
3	Throwing a ball forward and up, left leg forward	0.433	0.162	0.717	0.228	-0.284	-2.691	.020	-.514	-.054
4	Throwing a ball forward and up, left side to the throwing direction	0.48	0.263	0.67	0	-0.19	-1.914	.080	-.406	.026
5	Throwing a ball at a 3 m distant target	0.573	0.159	0.811	0.176	-0.238	-2.657	.021	-.434	-.043

Table 3. The results of a comparative analysis of the level of proficiency in a series of learning tasks of boys aged 8

No	Exercise	12 repetitions (n = 7)		18 repetitions (n = 7)		Δx	t	p	95% confidence interval of the difference of means	
		X	s	X	s				Lower limit	Upper limit
1	Throwing a ball against the floor	0.528	0.176	0.481	0.176	0.047	.500	.626	-.158	.253
2	Throwing a ball forward and up, feet shoulder width apart	0.529	0.176	0.811	0.176	-0.282	-3.000	.011	-.488	-.077
3	Throwing a ball forward and up, left leg forward	0.529	0.176	0.717	0.228	-0.188	-1.732	.109	-.426	.049
4	Throwing a ball forward and up, left side to the throwing direction	0.67	0	0.67	0	0	-	-		
5	Throwing a ball at a 3 m distant target	0.623	0.125	0.811	0.176	-0.188	-2.309	.040	-.366	-.011

with a 60-second rest interval for the first exercise ($p = 0.049$). For other exercises, the dynamics of the level of proficiency is not statistically significant ($p > 0.05$).

The exercise mode of 18 repetitions with a 60-second rest interval has a statistically significantly better dynamics of the level of proficiency than the exercise mode of 6 repetitions with a 60-second rest interval for the third and fifth exercises, and a worse dynamics for exercise 2 “Throwing a ball forward and up, feet shoulder width apart” ($p = 0.015$).

Thus, when developing a small ball throwing skill, the modes of physical exercises significantly influence the effectiveness of teaching.

To determine the impact of different modes of physical exercises on the level of proficiency, discriminant analysis was conducted (see Tables 4–6).

The first canonical function explains 75.3% ($r = 0.856$) of the results variation, the second canonical function explains 24.7% ($r = 0.688$) of the results variation, which indicates

their high informativeness (see Table 4). The materials of analysis of the canonical functions show a statistical significance of the first and second canonical functions ($\lambda_1 = 0.141$; $p_1 = 0.001$; $\lambda_2 = 0.526$; $p_2 = 0.036$). The first and second functions have a high discriminative ability and value in interpretation with respect to the general population (Table 5).

Table 6 shows the standardized canonical discriminant function coefficients, which make it possible to determine the ratio of the contribution of variables to the result of the function. The greatest contribution to the first canonical function is made by variable 2 "Throwing a ball forward and up, feet shoulder width apart", variable 3 "Throwing a ball forward and up, left leg forward"; to the second canonical function – exercise 5 "Throwing a ball at a 3 m distant target", exercise 3 "Throwing a ball forward and up, left leg forward": the greater the increase in proficiency in these exercises, the larger the value of the functions. The above indicates that exercises 2, 3, 5 are most sensitive to the number of repetitions in boys aged 8.

Table 6 shows the structure canonical discriminant function coefficients, which are the coefficients of correlation between the variables and the function. Thus, the first function is most closely connected with the results of the increase in proficiency in exercise 2 "Throwing a ball forward and up, feet shoulder width apart", exercise 4 "Throwing a ball forward and up, left side to the throwing direction": hence, a significant difference between the teaching modes is observed in exercises 2 and 4.

The second function is most closely connected with the results of the increase in proficiency in exercise 5 "Throwing a ball at a 3 m distant target", exercise 3 "Throwing a ball

forward and up, left leg forward": hence, a significant difference between the teaching modes is observed in exercises 5 and 3. The first function makes it possible to differentiate three exercise repetition modes, the second function enables determining which exercises are most influenced by 12 and 18 repetitions.

Table 7 shows the coordinates of centroids for two groups. They 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 with a 60-second rest interval, at the negative – a centroid for the exercise mode of 12 repetitions with a 60-second rest interval (see Fig. 1). This indicates a significant difference of the impact of the number of repetitions on the increase in the level of proficiency in exercises during physical education lessons. The exercise mode of 6 repetitions with a 60-second rest interval is most effective in terms of the total impact. The results of group classification show that 85.7% of the original grouped observations were classified correctly.

Discussion

The study assumed the possibility of using a discriminant function to assess the effectiveness of different modes of physical exercises when teaching a series of throwing exercises, as the verification of canonical functions indicates their statistical significance.

The analysis determined the total impact of each teaching mode on the level of proficiency in five exercises, as well

Table 4. Canonical discriminant function. Eigenvalues. Boys aged 8

Function	Eigenvalues	% Dispersion Explained	Cumulative %	Canonical Correlation
1	2.744 ^a	75.3	75.3	.856
2	.900 ^a	24.7	100.0	.688

Table 5. Canonical discriminant function. Wilks' Lambda. Boys aged 8

Verification of Functions	Wilks' Lambda	Chi-Square	Degrees of Freedom	p
from 1 to 2	.141	31.394	10	.001
2	.526	10.270	4	.036

Table 6. Canonical discriminant function coefficients. Wilks' Lambda. Boys aged 8

N	Exercise	Standardized Coefficients		Structure Coefficients	
		1	2	1	2
1	Throwing a ball against the floor	.024	.253	-.146 [*]	-.008
2	Throwing a ball forward and up, feet shoulder width apart	1.014	.298	.868 [*]	.221
3	Throwing a ball forward and up, left leg forward	-.398	.404	-.145	.658 [*]
4	Throwing a ball forward and up, left side to the throwing direction	-.239	.247	-.339 [*]	.319
5	Throwing a ball at a 3 m distant target	.156	.805	-.098	.735 [*]

Table 7. Functions at group centroids. Boys aged 8

Variants of Modes	Function	
	1	2
6 repetitions, rest interval of 60 s	1.910	-.589
12 repetitions, rest interval of 60 s	-1.846	-.653
18 repetitions, rest interval of 60 s	-.064	1.242

85.7% of original grouped observations are classified correctly

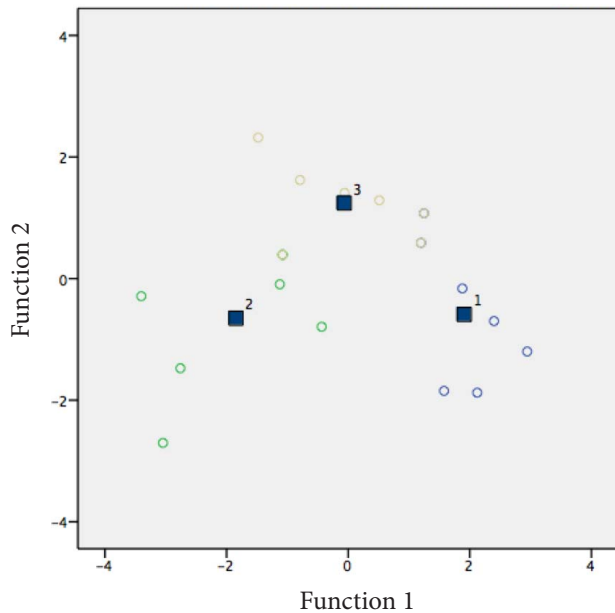


Fig. 1. Canonical discriminant functions. Graphic representation of classification results of the level of proficiency in exercises of boys aged 8: ■ – centroids for data groups after 1 – 6 repetitions, 2 – 12 repetitions, 3 – 18 repetitions

as a detailed impact of the teaching modes on the level of proficiency in each exercise.

The data obtained supplement the information on the factors that influence the effectiveness of motor skills development (Afrouzeh et al., 2020; Khudolii, 2019; Hastie et al., 2019); confirm the information that the conditions for motor skills development are one of the factors that determine the effectiveness of schoolchildren’s learning (Ivashchenko, 2020; Ivashchenko et al., 2019; Kapkan et al., 2019a). In addition, the study supplemented the data on the use of a discriminant function in the classification of schoolchildren by motor activity (Milić et al., 2011; Gert-Jan de Bruijn, & Benjamin Gardner, 2011; Lulzim, 2013). As in the papers by Geoffrey D. Broadhead and Gabie E. Church (1982), Kapkan et al. (2019a), Ivashchenko (2020), Ivashchenko et al. (2019), the study observed a high discriminative and prognostic ability of the obtained functions in assessing motor skills development in children and adolescents.

Discriminant analysis makes it possible to obtain new data to monitor the process of motor skills development in primary schoolchildren and supplements the information on the methods of assessing motor skills in children (Klingberg et al., 2019; Lovric et al., 2019; Nobre et al., 2020).

Based on discriminant analysis, it can be argued that to teach the five exercises, the mode of 6 repetitions (3 sets two times) with a 60-second rest interval may be recommended; for more difficult exercises — the mode of 18 repetitions

(9 sets two times) with a 60-second rest interval. Based on the analysis of structure coefficients and centroids of functions, the mode of 18 repetitions (9 sets two times) with a 60-second rest interval may be recommended for the exercise “Throwing a ball at a 3 m distant target”.

Conclusions

Discriminant analysis made it possible to determine the impact of the number of repetitions on the effectiveness of developing the skills of throwing a small ball at a target; answer the question as to how significantly the modes of repetitions differ by the effectiveness of motor skills development, what class the object belongs to based on the values of discriminant variables.

Based on the analysis of group centroids, it was found that in boys aged 8, six repetitions of the exercise (6 sets one time with a rest interval of 60 s) have the greatest total impact on the increase in the level of proficiency in exercises during physical education lessons. The results of group classification show that 85.7% of the original grouped observations were classified correctly.

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Conflict of interests

The authors state that there is no conflict of interest.

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РОЗПІЗНАННЯ ОБРАЗІВ: ВПЛИВ РЕЖИМІВ ВИКОНАННЯ ВПРАВ НА ФОРМУВАННЯ НАВИЧКИ МЕТАННЯ МАЛОГО М'ЯЧА ХЛОПЧИКІВ 8 РОКІВ

Сергій Єрмаков^{1ABCD}, Ольга Іващенко^{2ABCD}, Олег Худолій^{2ABCD}, Сергій Черненко^{3ABCD}, Вікторія Веремеєнко^{2ABCD}, Богдан Зеленський^{2ABCD}

¹Гданський університет фізичного виховання і спорту

²Харківський національний педагогічний університет імені Г. С. Сковороди

³Донбаська державна машинобудівна академія

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

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Мета дослідження – визначити вплив режимів виконання вправ на формування навички метання малого м'яча хлопчиків 8 років.

Матеріали і методи. У дослідженні прийняли участь 21 хлопчик 8 років, які були розділені на три групи по 7 осіб у випадковому порядку. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті.

Досліджувався вплив кількості повторень на ефективність процесу навчання метанню малого м'яча в ціль у хлопчиків 8 років. У педагогічному експерименті вивчався вплив 6, 12 і 18 повторень з інтервалом відпочинку 60 с на приріст рівня навченості вправ хлопчиків 8 років. У першій групі хлопчики повторювали завдання 6 разів з інтервалом відпочинку 60 с, у другій групі – 12 разів з інтервалом відпочинку 60 с, у третій групі 18 раз з інтервалом відпочинку 60 с. У процесі навчання кидкових вправ у занятті оцінювався альтернативним методом рівень навченості («виконав», «не виконав»), розраховувалася вірогідність виконання вправи ($p = n/m$, де n – кількість успішно виконаних спроб, m – загальна кількість спроб). У навчанні хлопчиків 8 років використовувався метод алгоритмічних

розпоряджень. Перехід до наступної вправи здійснювався після трьох успішних спроб. Вивчалися метання м'яча у вертикальну ціль.

Матеріали дослідження опрацьовані в програмі статистичного аналізу – IBM SPSS 20. У процесі дискримінантного аналізу була створена прогностична модель для належності до групи.

Результати. Дискримінантний аналіз дозволив визначити вплив кількості повторень на ефективність формування навичок метання малого м'яча в ціль; дати відповідь на питання наскільки достовірно різняться режими повторення за результативністю формування рухових навичок, до якого класу належить об'єкт на основі значень дискримінантних змінних.

Висновки. На основі аналізу центроїдів груп визначено, що у хлопчиків 8 років 6 повторень вправи (6 підходів по 1 разу з інтервалом відпочинку 60 с) мають суттєвий вплив на приріст рівня навченості на уроках фізичної культури. Результати класифікації груп показують, що 85,7% вихідних згрупованих спостережень класифіковано вірно.

Ключові слова: хлопчики 8 років, метання м'яча, дискримінантна функція.

Information about the authors:

Iermakov Sergii: sportart@gmail.com; <https://orcid.org/0000-0002-5039-4517>; Gdansk University of Physical Education and Sport, Department of Sports, Kasimir Gorskiego St, 1, 80-336 Gdansk, Poland.

Ivashchenko Olha: ivashchenko@hnpu.edu.ua; <https://orcid.org/0000-0002-2708-5636>; H. S. Skovoroda Kharkiv National Pedagogical University, Department of Theory and Methodology of Physical Education, Alchevskykh St, 29, Kharkiv, 61002, Ukraine.

Khudolii Oleg: khudoli@hnpu.edu.ua; <https://orcid.org/0000-0002-5605-9939>; H. S. Skovoroda Kharkiv National Pedagogical University, Department of Theory and Methodology of Physical Education, Alchevskykh St, 29, Kharkiv, 61002, Ukraine.

Chernenko Sergii: chernenko.sergey65@ukr.net; <https://orcid.org/0000-0001-9375-4220>; Donbas State Engineering Academy, Department of Physical Education, Akademichna St, 72, Kramatorsk, 84313, Ukraine.

Veremeenko Viktoriia: viktoriaveremeenko91@gmail.com; <https://orcid.org/0000-0002-9826-9678>; H. S. Skovoroda Kharkiv National Pedagogical University, Department of Theory and Methodology of Physical Education, Alchevskykh St, 29, Kharkiv, 61002, Ukraine.

Zelenskyi Bohdan: bod9.borec@gmail.com; <https://orcid.org/0000-0002-2862-6131>; H. S. Skovoroda Kharkiv National Pedagogical University, Department of Theory and Methodology of Physical Education, Alchevskykh St, 29, Kharkiv, 61002, Ukraine.

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