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EFFECTIVENESS OF MOTOR SKILLS DEVELOPMENT IN 5TH-7TH GRADE GIRLS AT DIFFERENT MODES OF PHYSICAL EXERCISES

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Abstract
The objective is to determine the influence of the physical exercises modes on effectiveness of motor skills development in 5th-7th grade girls.
Materials and methods. The study involved 5th grade girls (n = 28), 6th grade girls (n = 28) and 7th grade girls (n = 24). To solve the tasks set, the study relied on general scientific and special research methods, methods of mathematical experiment-planning.
Studying the influence of different variants of the educational process structure, namely: the number of repetitions (x_1) and the rest intervals (x_2) on acquisition of the technique of physical exercises performance, provided for achieving the objective. A full 2^2 type factorial experiment was conducted. The 5th-7th graders were divided into training groups according to the experiment plan. In total, there were twelve experimental groups organized, four in each class.
Results. The analysis of the regression equations shows that the rest interval between repetitions (x_2) has the greatest influence on teaching 5th-7th grade girls physical exercises, with the number of repetitions (x_1) being of somewhat less significant influence. The relation between these factors (x_1x_2) has a considerable weight in teaching to "rope climb in two or three sets" and to do a "pullover mount with a swing of one and a push-off with the other leg".
Conclusions. To increase the effectiveness of teaching 5th-7th grade girls physical exercises, the number of repetitions in throwing exercises should be increased to twelve times, and the rest interval reduced to 60 seconds. In the 7th grade, the number of repetitions should be reduced to six times, and the rest interval – to 60 seconds. The rest intervals in the exercises: "pullover mount with a swing of one and a push-off with the other leg" and "rope climbing in two or three sets", should be reduced to 60 seconds and the number of repetitions – to six.
Keywords: factorial experiment; physical exercises modes; motor skills development; 5th-7th grade girls.

Introduction

The process of teaching physical culture in a comprehensive secondary school requires seeking out rational forms of training organization and planning (Krutsevych, 2006; Krutsevych, Napadii, Imas, & Trachuk, 2016; Krutsevych, T., & Trachuk, 2017). In physical education, the study of physical exercises is the core of teaching, as the motor activity here is an object, a means and a goal of perfection (Chedzoy, 2000; Kapkan, 2013; Ivashchenko, 2017; Lopes, Stodden, & Rodrigues, 2017).

One of the most effective methods of learning the regularities in teaching physical exercises is mathematical modeling, which is a combined link between control and improvement of the effectiveness and quality of the teaching and learning activities, reflects the most important features of the object, and allows to describe the specific processes and narrower aggregate phenomena (Khudolii, & Ivashchenko, 2013; Ivashchenko, 2016; Khudolii, Ivashchenko, Iermakov, & Rumba, 2016; Lopatiev, Ivashchenko, Khudolii, Pjanylo, Chernenko, & Yermakova, 2017). The process of learning to perform motor actions is known to be subject to certain regularities in adaptive reactions development (Drid, Vujkov, Jaksic, Trivic, Marinkovic, & Bala, 2013; Iadreev, Cherkashin, Vujkov, & Drid, 2015; Hadžić, Bjelica, Vujović, & Popović, 2015). Mechanisms and regularities of different types of the body adaptation to muscle loads, depending on their intensity, duration, rest intervals, number of repetitions and influence of the performance capability level on the process of learning to perform physical exercises were the subject of scientific research conducted by Ivashchenko (2016); Raiola Gaetano, Altavilla Gaetano, Tafuri Domenico, and Lipoma Mario (2016); Maria Cuellar-Moreno (2016); Kaivo Thomson, Anthony Watt, and Jarmo

Liukkonen (2015). The obtained scientific data allowed to single out the peculiarities in teaching and learning activities planning and to effectively control the process of learning.

The studies by Chernenko (2015), Khudolii, Ivashchenko, and Chernenko (2015), Khudolii, Ivashchenko, Iermakov, S.S., and Rumba (2016) prove that the training lessons mode significantly influences the process of teaching motor actions. In Ivashchenko's opinion (2016), successful teaching of movements requires ensuring the rationally proportioned motor stimuli. Khudolii, Ivashchenko, and Chernenko, (2015), and Kapkan (2013) emphasize that the motor skills acquisition largely depends on the number of repetitions of the motor action being mastered. Khudolii and Ivashchenko (2013), Khudolii, Ivashchenko, and Iermakov and Rumba (2016) point out that determining the optimal rest period ensures effective implementation of the learning objectives. Ivashchenko (2016) considers it necessary to properly proportion both the rest intervals and the number of repetitions of the exercise in order to achieve quality changes in the children's and adolescents' bodies.

Thus, the possibility to determine and vary the pedagogical actions and to change the pedagogical conditions of training largely conditions the effectiveness of physical education. This implies the necessity to develop scientifically substantiated recommendations for modes regulation in teaching 5th-7th graders physical exercises.

The objective is to determine the influence of the physical exercises modes on the effectiveness of motor skills development in 5th-7th grade girls.

Materials and Methods

Study participants. The experiment participants were 5th (n=28), 6th (n=28) and 7th (n=24) grade girls. Children were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

Study organization. The following research methods were used to solve the tasks set: studies and analysis of scientific and methodological literature; pedagogical testing, pedagogical observation, timekeeping of educational tasks; pedagogical experiment, methods of mathematical statistics, and methods of mathematical experiment planning.

In teaching, the algorithmic method was used. The educational programs were developed for physical exercises being learned by 5th-7th graders at physical education lessons from the "Gymnastics" and "Track and Field" Sections. From the "Gymnastics" Section, the 5th grade girls learned to perform an "across squat mount onto the vaulting buck – arched dismount", "rope climbing in three sets"; the 6th grade girls learned to perform an "across straddle vault *over the buck*"; "rope climbing in two sets"; the 7th grade girls learned to perform an "across squat vault *over the buck*", "back rise on forearms from support" (boys). From the "Track and Field" Section, 5th-7th grade girls learned to perform a "running throw of a small ball to a range" and a running long "squat" jump.

The level of proficiency in the physical exercises performance was determined by the alternative method: "performed" or "failed". The schoolchildren had five attempts, their performance recorded in the protocol. A technically correct performance of the exercise gave them "1" point; a failure to perform the exercise gave them "0" entered in the protocol.

Studying the influence of different variants of the educational process structure, namely: the number of repetitions (x_1) and the rest intervals (x_2) on acquisition of the technique of physical exercises performance, provided for achieving the objective. The 5th-7th graders were divided into training groups according to the experiment plan. In total, there were four experimental groups organized in each class.

The conditions for conducting the factorial experiment are presented in Table 1. The bottom and top levels of the factors were chosen based on the data provided by Khudolii and Ivashchenko (2014), Ivashchenko (2016), Chernenko (2015), and were limited to the lesson framework.

Statistical analysis. This paper used the methods of analysis of the results of a full 2^k type factorial experiment (Khudolii & Ivashchenko, 2014; Ivashchenko, 2016).

The study protocol was approved by the Ethical Committee of H.S. Skovoroda Kharkiv National Pedagogical University. In addition, children and their parents or legal guardians were fully informed about all

Table 1. 2^2 Type Factorial Experiment Plan

Study No.	Mode of Training	
	Repetition Number	Rest Interval
1	6-	60-
2	12+	60-
3	6-	120+
4	12+	120+

Table 2. Dispersion analysis results for a full 2^2 type factorial experiment. Studying the influence of the number of repetitions (x_1) and rest interval (x_2) on the level of proficiency in physical exercises performance by 5th-7th grade girls

Grade	Physical Exercise	Duplicate Ratio in %		
		x_1	x_2	x_1x_2
5	A running throw of a small ball (weighing 150 g)	49.64	49.03	1.323
	A running long "squat" jump	19.71	77.09	3.08
	Rope climbing in three sets	3.33	72.82	23.59
	An across "squat" mount onto the vaulting buck – arched dismount (h = 80-100 cm)	9.3	87.61	3.18
6	A running throw of a small ball (weighing 150 g)	23.82	75.66	0.57
	A running long "squat" jump	19.53	75.8	4.6
	Rope climbing in two sets	6.28	66.99	26.78
	An across "straddle" vault over the buck (h = 100-110 cm)	12.7	85.64	1.6
	A pullover mount with a swing of one and a push-off with the other leg	1.23	56.49	42.2
7	A running throw of a small ball (weighing 150 g)	31.57	67.98	0.56
	A running long "squat" jump	12.94	83.35	3.755
	An across "squat" vault over the buck (h = 110-115 cm)	17.52	79.1	3.36

the features of the study, and a signed informed-consent document was obtained from all the parents.

Study Results

The dispersion analysis results indicate that the rest interval between the approaches (x_2) affects the effectiveness of the process of teaching 5th-7th grade girls physical exercises by 49-87%. The effectiveness of teaching to perform a "running throw of a small ball (weighing 150 g)" depends on the number of repetitions (x_1) by 23-49%. The effectiveness of teaching to rope climb (5th and 6th grades) and to do a "pullover mount with a swing of one and a push-off with the other leg" (6th grade) depends on the relation (x_1x_2) between the number of repetitions (x_1) and the rest interval (x_2). The effectiveness of teaching 7th grade girls physical exercises depends on the rest interval (x_1) by 67.98%, 83.35% and 79.1% respectively, and on the number of repetitions (x_2) – by 31.57%, 12.94% and 17.52 % respectively (see Table 2).

Table 3 presents the results of the full 2^2 type factorial experiment in the form of mathematical models – regression equations for coded variables, where Y is the level of motor skills development (level of proficiency).

The analysis showed that when teaching the 5th-6th grade girls to perform a "running throw of a small ball", the number of repetitions (x_1) should be increased to twelve times, and the rest intervals (x_2) – reduced to 60 seconds; in the 7th grade, the number of repetitions (x_1) should be brought down to six times and the rest interval (x_2) – to 60 seconds. The rest interval (x_2) and the relation between the factors x_1x_2 (the number of repetitions and the rest interval) affect the training of "rope climbing in two sets", "rope climbing in three sets" and a "pullover mount with a swing of one and a push-off with the other leg". The level of proficiency will be the highest when the exercise is repeated six times with the rest interval of 60 seconds.

Discussion

The shaping of the technique of physical exercises performance is an active pedagogical process where certain pedagogical actions and conditions under which the educational process takes place are of substantial significance (Ivashchenko, 2017; Ivashchenko, Iermakov, Khudolii, Cretu, Marian, & Potop, Vladimir, 2017). The data obtained in the pedagogical experiment show that the number of the exercise repetitions, the rest intervals between the repetitions and the relation between these factors significantly affect the process of motor skills development and supplement the study results obtained by Khudolii & Ivashchenko (2014), Ivashchenko (2016), Maria Cuellar-Moreno (2016). The acquisition of the educational material largely depends on the methodology that provides for the optimal correlation between the rest intervals and the number of repetitions, which also finds confirmation

Table 3. Regression dependence of physical exercises teaching on influence of the number of repetitions (x_1) and rest interval (x_2) in 5th-7th grade girls.

Grade	Physical Exercise	Regression Equations for Coded Variables
5	A running throw of a small ball (weighing 150 g)	$Y = 0.49 + 0.135x_1 - 0.13425\ x_2$
	A running long "squat" jump	$Y = 0.4985 - 0.0715x_1 - 0.1415x_2$
	Rope climbing in three sets	$Y = 0.6825 - 0.1275x_2 + 0.0725x_1x_2$
	An across "squat" mount onto the vaulting buck – arched dismount (h = 80-100 cm)	$Y = 0.55 - 0.07225x_1 - 0.2215x_2$
6	A running throw of a small ball (weighing 150 g)	$Y = 0.6125 + 0.136x_1 - 0.2425x_2$
	A running long "squat" jump	$Y = 0.5275 - 0.0875x_1 - 0.1725x_2$
	Rope climbing in two sets	$Y = 0.7 - 0.1225x_2 + 0.0775x_1x_2$
	An across "straddle" vault over the buck (h = 100-110 cm)	$Y = 0.632 - 0.063x_1 - 0.163x_2$
	A pullover mount with a swing of one and a push-off with the other leg	$Y = 0.42875 - 0.09975x_2 + 0.08625x_1x_2$
7	A running throw of a small ball (weighing 150 g)	$Y = 0.575 - 0.075x_1 - 0.11x_2$
	A running long "squat" jump	$Y = 0.665 - 0.065x_1 - 0.165x_2$
	An across "squat" vault *over the buck* (h = 110-115 cm)	$Y = 0.645 - 0.08x_1 - 0.17x_2$

in the studies conducted by Khudolii, Ivashchenko, & Chernenko (2015), Chernenko (2015).

The regression equations analysis shows that the rest interval between the repetitions (x_2) has the greatest impact on the process of teaching 5th-7th grade girls physical exercises, while the number of repetitions (x_1) is somewhat less influential. The relation between these factors (x_1x_2) has a significant weight in the process of teaching "rope climbing in two or three sets" and a "pullover mount with a swing of one and a push-off with the other leg". The obtained data confirm the effectiveness of the full 2^2 type factorial experiment in the study of the effects of the working modes on the efficiency of schoolchildren's training (Khudolii, & Ivashchenko, 2014; Ivashchenko, 2016; Kapkan, 2013; Marchenko 2008; 2009; Chernenko, 2015; Vlasov, Demichkovskyi, Ivashchenko, Lopatiev, Pitin, Pyanylo, & Khudolii, 2016).

A full factorial experiment method gives an opportunity to obtain a mathematical description of the process in some local area of the factor space around the point with the coordinates of the n-dimensional space and to verify the regression model. The regression equations provide a visual representation of the quantitative effect of each factor and their relations on the effectiveness of motor skills development in 5th-7th grade girls. The conducted studies allowed to determine the effectiveness and reliability of the 2^2 type factorial experiment plans in the study of the effect of the physical exercises performance modes on the effectiveness of the motor skills development in 5th-7th grade girls.

The study results indicate that the chosen step of variation in the factors in the proposed matrix of the factorial experiment plans is sufficient to study the effect of different modes of physical exercises performance on the effectiveness of teaching children and adolescents. These data supplement the information on formation of plans of factorial experiments in the study of the training loads (Cieślicka, & Ivashchenko, 2017) and the effectiveness of teaching children and adolescents (Chernenko, 2015; Ivashchenko, 2016; Abdulkhalikova, 2017).

Conclusions

To increase the effectiveness of teaching 5th-6th grade girls physical exercises, the number of repetitions in the throwing exercises should be increased to twelve times, and the rest interval should be reduced to 60 seconds. In the 7th grade, the number of repetitions should be decreased to six times, and the rest interval – to 60 seconds. In the exercises: a "pullover mount with a swing of one and a push-off with the other leg", "rope climbing in two or three sets", the rest intervals should be reduced to 60 seconds and the number of repetitions – to six.

The study results showed that regulation of the number of repetitions and the rest intervals allows to increase the effectiveness of teaching 5th-7th grade girls physical exercises.

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Conflict of Interest

The author declares no conflict of interest.

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ЕФЕКТИВНІСТЬ ФОРМУВАННЯ РУХОВИХ НАВИЧОК У ДІВЧАТ 5-7 КЛАСІВ ПРИ РІЗНИХ РЕЖИМАХ ВИКОНАННЯ ФІЗИЧНИХ ВПРАВ

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Мета – визначити вплив режимів виконання фізичних вправ на ефективність формування рухових навичок у дівчат 5–7 класів.

Матеріали і методи. У дослідженні прийняли участь дівчата 5 класу (n=28), 6 класу (n=28), 7 класу (n=24). Для вирішення поставлених завдань були використані як загальнонаукові так і спеціальні методи дослідження, методи математичного планування експерименту.

Для вирішення поставленої мети вивчався вплив різних варіантів побудови навчального процесу, а саме: кількості повторень (x_1) та інтервалів відпочинку (x_2) на засвоєння техніки виконання фізичних вправ. Був проведений повний факторний експеримент типу 2^2. Учні 5–7 класів були поділені на навчальні групи, згідно плану експерименту. Усього було організовано 12 експериментальних груп, по чотири в кожному класі.

Результати. Аналіз рівнянь регресії показує, що на процес навчання фізичних вправ дівчат 5–7 класів найбільший вплив має інтервал відпочинку між повтореннями (x_2), дещо менший вплив має кількість повторень (x_1). Взаємодія цих факторів (x_1x_2) має значну вагу в процесі навчання «лазінню по канату в два і три прийоми» та «підйому переворотом в упор махом однією та поштовхом іншою».

Висновки. Для підвищення ефективності процесу навчання фізичних вправ дівчат 5-6 класів кількість повторень у вправах з метання слід збільшити до 12 раз, інтервал відпочинку зменшити до 60 с. У 7 класі - зменшити кількість повторів до 6 раз, інтервал відпочинку – до 60 с. У вправах «підйом переворотом в упор махом однією та поштовхом іншою», "лазіння по канату у два і три прийоми" слід зменшити інтервали відпочинку до 60 с та кількість повторень до 6.

Ключові слова: факторний експеримент; режими виконання фізичних вправ; формування рухових навичок; дівчата 5–7 класів.

ЭФФЕКТИВНОСТЬ ФОРМИРОВАНИЯ ДВИГАТЕЛЬНЫХ НАВЫКОВ У ДЕВОЧЕК 5-7 КЛАССОВ ПРИ РАЗЛИЧНЫХ РЕЖИМАХ ВЫПОЛНЕНИЯ ФИЗИЧЕСКИХ УПРАЖНЕНИЙ

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Реферат. Стаття: 7 с., 3 табл., 30 джерел.

Цель - определить влияние режимов выполнения физических упражнений на эффективность формирования двигательных навыков у девочек 5-7 классов.

Материалы и методы. В исследовании приняли участие девочки 5 класса (n=28), 6 класса (n=28), 7 класса (n=24). Для решения поставленных задач были использованы как общенаучные так и специальные методы исследования, методы математического планирования эксперимента.

Для решения поставленной цели изучалось влияние различных вариантов построения учебного процесса, а именно: количества повторений (x_1) и интервалов отдыха (x_2) на усвоение техники выполнения физических упражнений. Был проведен полный факторный эксперимент типа 2^2. Ученики 5-7 классов были разделены на учебные группы, согласно плану эксперимента. Всего было организовано 12 экспериментальных групп, по четыре в каждом классе.

Результаты. Анализ уравнений регрессии показывает, что на процесс обучения физических упражнений девочек 5-7 классов наибольшее влияние имеет интервал отдыха между повторениями (x_2), несколько меньшее влияние имеет количество повторений (x_1). Взаимодействие этих факторов (x_1x_2) имеет значительный вес в процессе обучения «лазанию по канату в два и три приема» и «подъема переворотом в упор махом одной и толчком другой».

Выводы. Для повышения эффективности процесса обучения физических упражнений девочек 5-6 классов количество повторений в упражнениях в метании следует увеличить до 12 раз, интервал отдыха уменьшить до 60 с. В 7 классе - уменьшить количество повторов до 6 раз, интервал отдыха - до 60 с. В упражнениях «подъем переворотом в упор махом одной и толчком другой», «лазание по канату в два и три приема» следует уменьшить интервалы отдыха до 60 с и количество повторений до 6.

Ключевые слова: факторный эксперимент; режимы выполнения физических упражнений; формирование двигательных навыков; девочки 5-7 классов.

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