The purpose of the study was to obtain regression models of immediate and delayed training effect of strength loads in boys aged 8 years, based on a full factorial experiment. The study participants were 48 boys aged 8 years. The experiment was performed using a 2\(^2\) factorial design. The study materials were processed by the IBM SPSS 22 statistical analysis program. The study examined the impact of four variants of strength load on the immediate (ITE) and the delayed (DTE) training effect of orthogonal strength exercises modes and rest intervals in boys aged 8 years.

The study results show that in the proposed matrix of the 2\(^2\) full factorial design, the chosen step of variation of factors is sufficient to study the influence of different modes of strength exercises on the dynamics of ITE in boys aged 8 years. Based on the data analysis, the study obtained regression models of load for calculating the ITE\(_1\), ITE\(_2\), and DTE. The obtained regression models make it possible to calculate the number of repetitions and rest interval to achieve the most rational load variant.

The analysis of regression equations shows the interrelation between training effects: ITE\(_1\) —> ITE\(_2\) —> DTE. The value of ITE\(_1\), ITE\(_2\), and DTE at station I (exercises to strengthen arms and shoulders) and station II (exercises to strengthen abdominal muscles) depends on the increase in the number of repetitions in a set and the duration of the rest interval. The value of ITE\(_1\), ITE\(_2\), at station III (exercises to strengthen back muscles) depends on the increase in the number of repetitions in a set and the duration of the rest interval. The value of DTE – on the increase in the number of repetitions in a set and the reduction of the rest interval duration. The value of ITE, at station IV (exercises to strengthen leg muscles) depends on the increase in the number of repetitions in a set and the duration of the rest interval. To strengthen the DTE, it is necessary to reduce the number of repetitions in a set and the duration of the rest interval.

Keywords: boys aged 8 years, training effects, strength exercises, combined method of strength development, factorial design.
Khudolii, and Chernenko (2020). One of the technological approaches is the use of pattern recognition methodology in research (Neimark & Teklina, 2007, 2012; Ivashchenko et al., 2018). Ivashchenko, Khudolii, Iermakov, Chernenko, and Honcharenko (2018) indicate the effectiveness of using factorial designs and discriminant analysis in physical education research.

The importance of developing methodological approaches to normalization and management of training loads in physical education classes in order to improve the effectiveness of teaching is pointed out in the studies by Khudolii, Iermakov, and Bartik (2020), Ivashchenko, Berezhna, and Cieślicka (2020), Ivashchenko and Sirichenko (2020).

Thus, the problem of normalization of strength loads in primary schoolchildren’s physical education classes is relevant and requires additional research.

The purpose of the study was to obtain regression models of immediate and delayed training effect of strength loads in boys aged 8 years, based on a full factorial experiment.

Materials and methods

Study participants

The study participants were boys aged 8 years (\(n = 48\)). 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

To solve the tasks set, theoretical and empirical methods were used: analysis and generalization of scientific and methodological literature; modeling, pedagogical observation and experiment, regression analysis.

Table 1. Factorial design in studying the influence of different modes of the combined method of strength development (variant I) in primary schoolchildren (\(x_1\) – number of repetitions in a set; \(x_2\) – rest interval, s)

| No. of strength load variant | Method                  | \(x_1\) | \(x_2\) |
|-----------------------------|-------------------------|--------|--------|
| I                           | Dynamic effort method   | 3-     | 30-    |
|                             | Maximal effort method   | 1-     | 30-    |
|                             | Isometric effort method | 3-     | 30-    |
|                             | Repeated effort method  | 6-     | 30-    |
| II                          | Dynamic effort method   | 5+     | 30-    |
|                             | Maximal effort method   | 3+     | 30-    |
|                             | Isometric effort method | 5+     | 30-    |
|                             | Repeated effort method  | 12+    | 30-    |
| III                         | Dynamic effort method   | 3-     | 60+    |
|                             | Maximal effort method   | 1-     | 60+    |
|                             | Isometric effort method | 3-     | 60+    |
|                             | Repeated effort method  | 6-     | 60+    |
| IV                          | Dynamic effort method   | 5+     | 60+    |
|                             | Maximal effort method   | 3+     | 60+    |
|                             | Isometric effort method | 5+     | 60+    |
|                             | Repeated effort method  | 12+    | 60+    |

To determine the dynamics of strength training effects in boys aged 8 years, the study carried out an experiment according to the plan given in Table 1. Variant I of the combined method was used to strengthen arm and shoulder muscles (station I), abdominal muscles (station II), back muscles (station III), and leg muscles (station IV). At each station, the following methods were used: dynamic effort method, maximal effort method, isometric effort method, repeated effort method. The modes of performance for each group, for the indicated stations are given in Table 1. The study examined the impact of four variants of strength load on the immediate training effect (ITE) after performing exercises at four stations, the immediate training effect (ITE) after training, and the delayed training effect (DTE) 24 hours after training.

At each station, the following exercises were performed: Station I. Exercises for arm and shoulder muscles.

1. Dynamic effort method. Knee push-ups. The exercise is performed as quickly as possible.
2. Maximal effort method. Weighted push-ups (stuffed ball).
3. Isometric effort method. Weighted push-ups (stuffed ball).
4. Repeated effort method. Knee push-ups.

Station II. Exercises to strengthen abdominal muscles.

1. Dynamic effort method. Sit-ups. The exercise is performed as quickly as possible.
2. Maximal effort method. Hanging 90-degree leg raises on wall bars.
3. Isometric effort method. Decline bench 90-degree leg raises. The exercise is performed with two stops and fixation of joint angles (5 s).
4. Repeated effort method. Decline bench leg raises to plow.

Station III. Exercises to strengthen back muscles.

1. Dynamic effort method. Trunk lift. The exercise is performed as quickly as possible.
2. Maximal effort method. Trunk lift on a pommel horse with feet supported under wall bars.
3. Isometric effort method. Trunk lift with two stops and holding each static position for 5 s. The exercise is performed with two stops and fixation of joint angles (5 s) (hold positions in the upper point and horizontally).
4. Repeated effort method. The same starting position. Trunk lift.

Station IV. Exercises to strengthen leg muscles.

1. Dynamic effort method. Squats. The exercise is performed as quickly as possible.
2. Maximal effort method. Weighted squats (stuffed ball, dumbbells).
3. Isometric effort method. Weighted squats with stops. The exercise is performed with two stops and fixation of joint angles (5 s) (90°, 135°).
4. Repeated effort method. Squats.

During the experiment, the study recorded the results of the following tests: 1. Push-ups. 2. Speed push-ups, 3 times. 3. Sit-ups in 30 seconds. 4. Trunk lift in 10 seconds. 5. Standing long jump.

On the first day before the experiment, the study recorded the results of Test 2 “Speed push-ups, 3 times”, Test 1 “Push-ups”, Test 3 “Sit-ups in 30 seconds”, Test 4 “Trunk lift
in 10 seconds", Test 5 “Standing long jump”. After performing the exercises at station I – Tests 2, 1; at station II – Test 3; at station III – Test 4; at station IV – Test 5. After training – Tests 2, 1, 3, 4, 5. Twenty-four hours after training – Tests 2, 1, 3, 4, 5. The dynamics of test results was determined as a percentage relative to the initial level.

**Statistical analysis**

The study materials were processed using the IBM SPSS 22 statistical analysis program. The Yates’ algorithm was used to calculate the regression coefficients.

The study protocol was approved by the Ethical Committee of H. S. Skovoroda Kharkiv National Pedagogical University.

**Results**

Tables 2-7 show the results of the 2^2 full factorial design. The study examined the impact of four variants of strength load on the ITE, after performing exercises at four stations, the ITE after training, and the DTE 24 hours after training.

The results of the analysis of the immediate training effect (ITE), after performing exercises at four stations: station I “Exercises to strengthen arms and shoulders”; station II “Exercises to strengthen abdominal muscles”; station III “Exercises to strengthen back muscles”; station IV “Exercises to strengthen leg muscles” are given below (see Tables 2-3).

The analysis of the regression equations given in Table 2 made it possible to determine the influence of strength loads on the immediate training effect (ITE) of different modes of exercises in boys aged 8 years. After training at stations I-IV, the following data were obtained:

- after training at station I – exercises to strengthen arms and shoulders – the ITE, is most influenced by the number of repetitions in a set \( (x) \) (exercise No. 1) and the rest interval \( (x) \) (exercise No. 2). To strengthen the ITE, it is necessary to increase the number of repetitions in a set and the duration of the rest interval;
- after training at station II – exercises to strengthen abdominal muscles – the ITE, is most influenced by the rest interval \( (x) \), the number of repetitions in a set \( (x) \), and the interaction between the number of repetitions in a set and the rest interval \( (x,x) \). To strengthen the ITE, it is necessary to increase the number of repetitions in a set and the duration of the rest interval;
- after training at station III – exercises to strengthen back muscles – the ITE, is most influenced by the rest interval \( (x) \), the interaction between the number of repetitions in a set and the rest interval \( (x,x) \), and the number of repetitions in a set \( (x) \). To strengthen the ITE, it is necessary to increase the number of repetitions in a set and the duration of the rest interval;
- after training at station IV – exercises to strengthen leg muscles – the ITE, is most influenced by the rest interval \( (x) \), the interaction between the number of repetitions in a set and the rest interval \( (x,x) \), and the number of repetitions in a set \( (x) \). To strengthen the ITE, it is necessary to increase the number of repetitions in a set and reduce the duration of the rest interval.

The analysis of the variance given in Table 3 made it possible to determine the percentage influence of the factors on the immediate training effect (ITE) of different modes of exercise.

---

**Table 2.** Models of influence of different strength training modes on the change in the immediate training effect (ITE) in boys aged 8 years (\( n = 40 \)) (\( x_1 \) – amount of training, \( x_2 \) – rest interval). The first variant of the combined method of strength development.

| Place of training | Test | Conditions of recording | Regression equations |
|-------------------|------|------------------------|---------------------|
| Station I         | No. 1 “Push-ups” | after performing the exercises | \( Y = 90.113 – 2.998 x_1 – 1.168 x_2 + 0.967 x_1 x_2 \) |
| Station II        | No. 2 “Speed push-ups, 3 times” | after performing the exercises | \( Y = 104.660 + 2.655 x_1 + 3.315 x_2 – 1.240 x_1 x_2 \) |
| Station III       | No. 3 “Sit-ups in 30 seconds” | after performing the exercises | \( Y = 92.753 – 1.553 x_1 – 2.708 x_2 + 1.138 x_1 x_2 \) |
| Station IV        | No. 4 “Trunk lift in 10 seconds” | after performing the exercises | \( Y = 93.943 – 0.918 x_1 – 1.958 x_2 + 0.963 x_1 x_2 \) |
|                   | No. 5 “Standing long jump” | after performing the exercises | \( Y = 98.768 – 0.078 x_1 + 1.238 x_2 + 0.392 x_1 x_2 \) |

**Table 3.** Results of the analysis of variance for the 2^2 FFE in studying the influence of different strength training modes on the change in the immediate training effect (ITE) in boys aged 8 years (\( n = 40 \)) (\( x_1 \) – amount of training, \( x_2 \) – rest interval). The first variant of the combined method of strength development.

| Place of training | Test | Conditions of recording | Ratio of mean squares |
|-------------------|------|------------------------|----------------------|
| Station I         | No. 1 “Push-ups” | after performing the exercises | \( x_1 \) | \( x_2 \) | \( x_1 x_2 \) |
|                   | No. 2 “Speed push-ups, 3 times” | after performing the exercises | 79.6 | 12.0 | 8.4 |
| Station II        | No. 3 “Sit-ups in 30 seconds” | after performing the exercises | 36.0 | 56.1 | 7.9 |
| Station III       | No. 4 “Trunk lift in 10 seconds” | after performing the exercises | 21.8 | 66.4 | 11.8 |
| Station IV        | No. 5 “Standing long jump” | after performing the exercises | 15 | 68.4 | 16.6 |
|                   |      |                        | 0.35 | 90.5 | 9.15 |
Table 4. Models of influence of different strength training modes on the change in the immediate training effect (ITE) in boys aged 8 years (n = 40) (\(x_1\) – amount of training, \(x_2\) – rest interval). The first variant of the combined method of strength development. Comprehensive strength development of arm, abdominal, back, and leg muscles.

| Test                               | Regression equations                     |
|------------------------------------|------------------------------------------|
| No. 1 “Push-ups”                   | \(Y = 87.790 - 0.740x_1 - 0.1x_2 - 2.1x_1x_2\) |
| No. 2 “Speed push-ups, 3 times”    | \(Y = 106.108 + 0.877x_1 + 1.258x_2 + 0.068x_1^2\) |
| No. 3 “Sit-ups in 30 seconds”      | \(Y = 91.698 + 0.968x_1 - 2.258x_2 - 0.627x_1x_2\) |
| No. 4 “Trunk lift in 10 seconds”   | \(Y = 92.875 - 0.395x_1 - 1.465x_2 + 0.265x_1^2\) |
| No. 5 “Standing long jump”         | \(Y = 98.985 + 0.095x_1 - 0.19x_2 + 0.1x_1x_2\) |

The analysis of variance given in Table 5 made it possible to determine the percentage influence of the factors on the immediate training effect (ITE) of different modes of exercises in boys aged 8 years. After training, the following data were obtained:

- exercises to strengthen arms and shoulders – the ITE is most influenced by the number of repetitions in a set (\(x_1\)) and rest interval (\(x_2\));
- exercises to strengthen abdominal muscles – the ITE is most influenced by the rest interval (\(x_2\));
- exercises to strengthen back muscles – the ITE is most influenced by the interaction between the number of repetitions in a set and the rest interval (\(x_1x_2\));
- exercises to strengthen leg muscles – the ITE is most influenced by the interaction between the number of repetitions in a set and the rest interval (\(x_1x_2\)).

The results of analysis of the delayed training effect (DTE) 24 hours after training are given in Tables 6-7.

Table 5. Results of the analysis of variance for the 2\(^2\) FFE in studying the influence of different strength training modes on the change in the immediate training effect (ITE) in boys aged 8 years (n = 40) (\(x_1\) – amount of training, \(x_2\) – rest interval). The first variant of the combined method of strength development. Comprehensive strength development of arm, abdominal, back, and leg muscles.

| Test                               | Ratio of mean squares |
|------------------------------------|-----------------------|
|                                   | \(x_1\) | \(x_2\) | \(x_1x_2\) |
| No. 1 “Push-ups”                   | 11      | 0.2    | 88.8      |
| No. 2 “Speed push-ups, 3 times”    | 32.7    | 67.1   | 0.2       |
| No. 3 “Sit-ups in 30 seconds”      | 14.6    | 79.3   | 6.1       |
| No. 4 “Trunk lift in 10 seconds”   | 6.6     | 90.5   | 2.9       |
| No. 5 “Standing long jump”         | 16.4    | 65.5   | 18.1      |

The analysis of the regression equations given in Table 6 made it possible to determine the influence of strength loads on the delayed training effect (DTE) of different modes of exercises in boys aged 8 years. 24 hours after training, the following data were obtained:

- exercises to strengthen arms and shoulders – the DTE is most influenced by the number of repetitions in a set (\(x_1\)), the rest interval (\(x_2\)), the interaction between the number of repetitions in a set and the rest interval (\(x_1x_2\)) (exercise No. 1), and the interaction between the number of repetitions in a set and the rest interval (\(x_1x_2\)) (exercise No. 1).
Table 6. Models of influence of different strength training modes on the change in the delayed training effect (DTE) in boys aged 8 years (n = 40) (x₁ – amount of training, x₂ – rest interval). The first variant of the combined method of strength development. Comprehensive strength development of arm, abdominal, back, and leg muscles.

| Test                          | Regression equations                                      |
|-------------------------------|----------------------------------------------------------|
| No. 1 “Push-ups”              | Y = 96.785 + 2.195x₁ – 1.315x₂ – 1.095x₁x₂              |
| No. 2 “Speed push-ups, 3 times”| Y = 103.99 – 0.59x₁ + 0.475x₂ – 1.275x₁x₂              |
| No. 3 “Sit-ups in 30 seconds” | Y = 95.413 + 0.092x₁ – 0.232x₂ – 0.278x₁x₂            |
| No. 4 “Trunk lift in 10 seconds” | Y = 96.23 – 0.07x₁ + 1.505x₂ + 0.015x₁x₂             |
| No. 5 “Standing long jump”    | Y = 99.115 + 1.765x₁ + 0.81x₂ – 1.73x₁x₂          |

Table 7. Results of the analysis of variance for the 2² FFE in studying the influence of different strength training modes on the change in the delayed training effect (DTE) in boys aged 8 years (n = 40) (x₁ – amount of training, x₂ – rest interval). The first variant of the combined method of strength development. Comprehensive strength development of arm, abdominal, back, and leg muscles.

| Test                          | Ratio of mean squares |
|-------------------------------|-----------------------|
| No. 1 “Push-ups”              | 62.2 22.3 15.5        |
| No. 2 “Speed push-ups, 3 times”| 15.8 10.3 73.9       |
| No. 3 “Sit-ups in 30 seconds” | 6.1 38.7 55.2        |
| No. 4 “Trunk lift in 10 seconds” | 0.2 99.8 0           |
| No. 5 “Standing long jump”    | 46.1 9.7 44.2        |

Discussion

The study assumed that a full factorial experiment would allow to determine the influence of strength loads on the immediate training effect (ITE) and the delayed training effect (DTE) of different modes of exercises in boys aged 8 years. The study results show that in the proposed matrix of the 2² full factorial design, the chosen step of variation of factors is sufficient to study the influence of different modes of strength exercises on the dynamics of ITE in boys aged 8 years (Table 1). Based on the data analysis, the study obtained regression models of load for calculating the ITE, ITE, (Table 2), DTE (Table 4), and DTE (Table 6).

The studies by Iermakov, Ivashchenko, Khudolii, and Chernenko (2020), Ivashchenko, Khudolii, Prusik, and Giovanis (2020), Ivashchenko, Nosko, and Ferents (2019) substantiated the influence of different load variants on the dynamics of the immediate and delayed training effect on the basis of discriminant analysis. Iermakov, Ivashchenko, Khudolii, and Chernenko (2020) found the interrelation of training effects. The obtained data indicate that each of the variants of strength load can be effectively used depending on the educational tasks of both one and a series of physical education classes, and also show that the ITE and DTE of strength exercises depend on the initial level of fitness and the total amount of strength exercises in a physical education class. Ivashchenko, Khudolii, Prusik, and Giovanis (2020) point out that in the first variant of strength load, the greatest contribution to the dynamics of training effects is made by training at the first station “exercises to strengthen arms and shoulders”; in the second variant, the greatest contribution to the dynamics of training effects is made by training at the third station “exercises to strengthen back muscles”;
in the third variant, the greatest contribution to the dynamics of training effects is made by training at the first station “exercises to strengthen arms and shoulders” and the third station “exercises to strengthen back muscles”; in the fourth variant, the greatest contribution to the dynamics of the ITE is made by training at the first “exercises to strengthen arms and shoulders” and the third “exercises to strengthen back muscles” stations; the most significant changes in the DTE are connected with training at the fourth station “exercises to strengthen leg muscles”.

The obtained regression models make it possible to calculate the number of repetitions and rest interval to achieve the most rational load variant. These data supplement the results presented in the studies by Iermakov, Ivashchenko, Khudolii, and Chernenko (2020), Ivashchenko, Khudolii, Prusik, and Giovanis (2020) and form a methodology for studying training loads, which differs from the methods used in the studies by Arazzi et al. (2012), Ratames et al. (2012), Miranda et al. (2010) in that research is conducted using an active 2^k FFE and materials are processed with the help of regression and discriminant analysis.

The authors declare no conflict of interest.

References

Ivashchenko, O., Khudolii, O., Iermakov, S., Veremeenko, V., & Lopatiev, A. (2018). Power abilities: recognition of the level of development in girls aged 12-14 years. Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports, 22(3), 142-148. https://doi.org/10.15561/18189172.2018.0305

Veremeenko, V., Khudolii, O., & Ivashchenko, O. (2019). Motor abilities: methods of strength and strength endurance development in middle-school-aged boys in a 4-week physical training cycle. Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports, 23(2), 102-111. https://doi.org/10.15561/18189172.2019.0208

Washabaugh, E. P., Augenstein, T. E., & Krishnan, C. (2020). Functional resistance training during walking: Mode of application differentially affects gait biomechanics and muscle activation patterns. Gait & Posture, 75, 129-136. https://doi.org/10.1016/j.gaitpost.2019.10.024

Benzing, V., & Schmidt, M. (2019). The effect of exergaming on executive functions in children with ADHD: A randomized clinical trial. Scandinavian Journal of Medicine & Science in Sports, 29(8), 1243-1253. https://doi.org/10.1111/sms.13446

Bogdanis, G. C., Dounti, O., Papia, A., Dounti, A., Apostolidis, N., & Sands, W. A. (2019). Effect of Plyometric Training on Jumping, Sprinting and Change of Direction Speed in Child Female Athletes. Sports, 7(5), 116. https://doi.org/10.3390/sports7050116

Wertheimer, V., Antekolovic, L., & Matkovic, B. R. (2018). Muscle damage indicators after land and aquatic plyometric training programmes. Montenegrin Journal of

Conflict of interest

The authors declare no conflict of interest.
Sports Science and Medicine, 7(1), 13-19. https://doi.org/10.26777/issn.180302

Lovric, F., Mandic Jelaska, P., & Bilic, Z. (2018). Physical activity cannot be treated as a predictor of anthropological status among six-year-old children. Montenegro Journal of Sports Science and Medicine, 7(1), 53-57. https://doi.org/10.26777/issn.180307

Marttinen, R., N. Fredrick, R., III, & Silverman, S. S. (2018). Middle school students’ free-living physical activity on physical education days, non-physical education days, and weekends. Montenegro Journal of Sports Science and Medicine, 7(1), 5-12. https://doi.org/10.26777/issn.180301

Ivashchenko, O. (2020). Research Program: Modeling of Motor Abilities Development and Teaching of Schoolchildren. Тeорiя тa Методика Фiзiчного Виховання, 20(1), 32-41. https://doi.org/10.17309/tmfv.2020.1.05

Iermakov, S., Ivashchenko, O., Khudolii, O., & Chernenko, S. (2020). Strength Abilities: Assessment of Training Effects of Strength Loads in Boys Aged 8 Years. Тeорiя тa Методика Фiзiчного Виховання, 20(3), 174-181. https://doi.org/10.17309/tmfv.2020.3.07

Ivashchenko, O., Khudolii, O., Prusik, K., & Giovanis, V. (2020). Strength Abilities: Immediate and Delayed Training Effects of Orthogonal Modes of Strength Training in Boys Aged 8 Years. Тeорiя тa Методика Фiзiчного Виховання, 20(2), 109-116. https://doi.org/10.17309/tmfv.2020.2.07

Neimark, Y.L., & Teklina, L.G. (2007). Планіровання експерименту при ісследованні конкретних динаміческих систем методами розпознавання образів. Matematicheskie metody raspoznavaniia obrazov, 13(1), 194-196

Neimark, Y. I., & Teklina, L. G. (2012). On possibilities of using pattern recognition methods to study mathematical models. Pattern Recognition and Image Analysis, 22(1), 144-149. https://doi.org/10.1134/S010546612010282

Ivashchenko, O., Khudolii, O., Iermakov, S., Chernenko, S., & Honcharenko, O. (2018). Full factorial experiment and discriminant analysis in determining peculiarities of motor skills development in boys aged 9. Journal of Physical Education and Sport, 18(4s), 1958-1965. https://doi.org/10.7752/jpes.2018.s4289

Khudolii, O., Iermakov, S., & Bartik, P. (2020). Didactics: Methodological Basis of Motor Learning in Children and Adolescents. Journal of Learning Theory and Methodology, 1(1), 5-13. https://doi.org/10.17309/jltm.2020.1.01

Ivashchenko, O., Berezhnha, H., & Cieslicka, M. (2020). Motor Skills in the Structure of Physical Fitness of 7-Year-Old Boys. Journal of Learning Theory and Methodology, 1(1), 14-19. https://doi.org/10.17309/jltm.2020.1.02

Ivashchenko, O., & Sirichenko, D. (2020). Structure of Motor Fitness of 7-Year-Old Girls. Journal of Learning Theory and Methodology, 1(1), 20-25. https://doi.org/10.17309/jltm.2020.1.03

Arazi, H., Mirzaei, B., Sanghaiavini, M., & Abadi, M. (2012). An interaction between Exercise Order and Rest Interval during Lower-Body Resistance Exercise. Baltic Journal of Health and Physical Activity, 4(2). https://doi.org/10.2478/v10131-012-0008-x

Ratames, N. A., Chiarello, C. M., Sacco, A. J., Hoffman, J. R., Faigenbaum, A. D., Ross, R. E., & Kang, J. (2012). The effects of rest interval length manipulation of the first upper-body resistance exercise in sequence on acute performance of subsequent exercises in men and women. Journal of Strength and Conditioning Research, 26(11), 2929-2938. https://doi.org/10.1519/JSC.0b013e318270fc0f

Miranda, H., Simão, R., Dos Santos Vigário, P., De Salles, B. F., Pacheco, M. T. T., & Willardson, J. M. (2010). Exercise order interacts with rest interval during upper-body resistance exercise. Journal of Strength and Conditioning Research, 24(6), 1573-1577. https://doi.org/10.1519/JSC.0b013e3181d8e61

Ivashchenko, O., & Cieslicka, M. (2017). Features of evaluations of power loads in boys 7 years old. Journal of Education, Health and Sport, 7(1), 175-183. http://dx.doi.org/10.5281/zenodo.249184

Cieslicka, M., & Ivashchenko, O. (2017). Features of formation of the cumulative effect of power loads in boys 7 years old. Journal of Education, Health and Sport, 7(1), 198-208. https://doi.org/10.5281/zenodo.250599

Marchenko, S., & Kovalenko, K. (2020). Optimization of Teaching Boys Aged 10 Mae-Geri (Front Kick) Technique in Kyokushin Karate. Journal of Learning Theory and Methodology, 1(1), 33-39. https://doi.org/10.17309/jltm.2020.1.05

Correa, A. A., Grima, P., & Tort-Martorell, X. (2009). Experimentation order with good properties for 2k factorial designs. Journal of Applied Statistics, 36(7), 743-754. https://doi.org/10.1080/02664760802499337

Correa, A. A., Grima, P., & Tort-Martorell, X. (2012). Experimentation order in factorial designs: new findings. Journal of Applied Statistics, 39(7), 1577-1591. https://doi.org/10.1080/02664760.2012.661706

Khudolii, O. (2019). Research Program: Modeling of Young Gymnasts’ Training Process. Тeорiя тa Методика Фiзiчного Виховання, 19(4), 168-178. https://doi.org/10.17309/tmfv.2019.4.02

Ivashchenko, O., Nosko, Y., & Ferents, V. (2019). Strength Abilities: Dynamics of Training Effect of Strength Exercises in Girls Aged 9. Тeорiя тa Методика Фiзiчного Виховання, 19(4), 200-208. https://doi.org/10.17309/tmfv.2019.4.06

Khudolii, O., Ivashchenko, O., Iermakov, S., Nosko, Y., & Marchenko, S. (2019). Strength Abilities: Estimation of Immediate Training Effect of Strength Loads in Girls Aged 7 Years. Тeорiя тa Методика Фiзiчного Виховання, 19(2), 98-104. https://doi.org/10.17309/tmfv.2019.2.06

Kapkan, O., Khudolii, O., & Bartik, P. (2019a). Pattern Recognition: Motor Skills Development in Girls Aged 15. Тeорiя тa Методика Фiзiчного Виховання, 19(1), 44-52. https://doi.org/10.17309/tmfv.2019.1.06

Kapkan, O., Khudolii, O., & Bartik, P. (2019b). Motor Skills Development: Optimization of Teaching Boys Aged 14. Тeорiя тa Методика Фiзiчного Виховання, 19(3), 148-155. https://doi.org/10.17309/tmfv.2019.3.06
Мета дослідження – на основі повного факторного експерименту отримати регресійні моделі термінового і відставленого тренувального ефекту силових навантажень у хлопців 8 років.

Матеріали і методи. У дослідженні прийняли участь 48 хлопців 8 років. Експеримент був проведений за планом факторного експерименту 22. Матеріали дослідження опрацьовані в програмі статистичного аналізу IBM SPSS 22. Вивчався вплив чотирьох варіантів силового навантаження на терміновий (TTE) і відставленний (VTE) тренувальний ефект ортогональних режимів виконання силових вправ та інтервалів відпочинку у хлопчиків 8 років.

Результати. Результати дослідження свідчать, що у запропонованій матриці плану повного факторного експерименту типа 22 вибраний крок варіювання факторів є достатнім для вивчення впливу різних режимів виконання силових вправ на динаміку TTE у хлопчиків 8 років. На основі аналізу даних отримані регресійні моделі навантаження для розрахунку TTE1, TTE2, та VTE. Отримані регресійні моделі дають змогу розрахувати кількість повторень та інтервал відпочинку для досягнення найбільш раціонального варіанта навантаження.

Висновки. Аналіз рівнянь регресії вказує на взаємозв’язок тренувальних ефектів: TTE1 –> TTE2 –> VTE. Величина TTE1, TTE2, VTE на I станції (вправи для розвитку сили рук і плечового поясу) та II станції (вправи для розвитку сили передніх плечових м'язів) залежить від збільшення кількості повторень у підході й тривалості інтервалу відпочинку. Величина TTE3, TTE4, на III станції (вправи для розвитку сили спини) – від збільшення кількості повторень у підході й тривалості інтервалу відпочинку. Величина VTE – від збільшення кількості повторень у підході й зменшення тривалості інтервалу відпочинку. Величина TTE, на IV станції (вправи для розвитку сили спини) залежить від збільшення кількості повторень у підході й зменшення тривалості інтервалу відпочинку. Для підсилення VTE необхідно зменшити кількість повторень у підході й зменшити тривалість інтервалу відпочинку.

Ключові слова: хлопців 8 років, тренувальні ефекти, силові вправи, комбінований метод розвитку сили, план факторного експерименту.