



EVALUATION OF THE CORRELATION BETWEEN STRENGTH AND SPECIAL TRAINING INDICATORS IN MIXED MARTIAL ARTS

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Abstract

Study purpose. To study the peculiarities of correlation between the maximum strength development and quantity of kicks in MMA using load regimes of different intensity and energy supply.

Materials and methods. 75 athletes aged 19 ± 0.7 practicing MMA for 4 ± 0.8 years were examined and divided into 3 groups. During 12 weeks, group 1 athletes used low-intensity ($Ra=0.53$) load regime, group 2 – medium-intensity ($Ra=0.65$) and group 3 – high-intensity ($Ra=0.72$). The control of attacking kicks (front kick, reverse side kick, roundhouse kick) quantity with maximum force until full muscle fatigue for 20 s allowed to check special training. The level of strength training was evaluated by estimating the maximum strength development (1 RM) indicators. Non-parametric methods of mathematical statistics were used for data processing.

Results. The indicators of special training showed the greatest increase by an average of 13.2% in group 3 athletes during 12 weeks. In the other two groups, the dynamics of the controlled indicator was 3.2 times smaller for a similar period of time. The maximum muscle strength indicator increased by 41.9% in group 3 athletes compared to the initial data. These changes are on average 1.5 times higher than the results recorded in athletes of groups 1 and 2. Despite the revealed growth of strength and special training indicators in MMA athletes, there was no strong correlation between them in any research group.

Conclusions. Using high-intensity load regime in conditions of anaerobic-alactate mode of energy supply allowed achieving the greatest results in strength and special training indicators. However, the study did not show correlation between the increase in maximum strength development and quantitative indicators of attacking kicks. Further research will be focused on searching for more informative markers for assessing the training of athletes in MMA and adaptation processes using biochemical control methods.

Keywords: MMA, load regimes, intensity, muscle strength, special training.

Introduction

Mixed Martial Arts is one of the spectacular professional types of martial arts in the world, which has been developing rapidly in recent years. Being related to "gladiator matches" and creating a bright "show" requires great skill from athletes. The need to master the perfect technique of kicks, punches, and pain techniques together with a powerful level

of functional capabilities and physical development requires constant improvement of training (Chernozub et al., 2018; Antonietto et al., 2023; Bueno et al., 2022). The study of effective mechanisms for optimizing the training system in MMA is one of the debated issues among scientists in spheres of sports, biology and medicine. At the same time, the question of the effectiveness and expediency of using certain ways of solving this problem is quite controversial (James et al., 2020; Kirk et al., 2020; Olkhovyi O. et al., 2020; Chernozub et al., 2022).

Strength training is one of the key factors increasing the adaptive reserves of athletes and enlarging their explosive

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power (Chernozub et al., 2019; Kirk et al., 2021; Liu et al., 2022). An important aspect of optimizing the training process is the effective combination of energy supply modes of muscle activity and the magnitude of load indicators. Using loads of different volume and intensity allows precisely influencing on the level of functional training of athletes of the striking or wrestling style of fighting in MMA (Chernozub et al., 2018; Pavelka et al., 2022). Power load regimes optimization is impossible without employing a wide range of physiological and biochemical methods for controlling adaptive and compensatory reactions to a stressful stimulus, which is an integral part of improving the training system (Giboin & Gruber, 2022; Tota & Wiecha, 2022).

Scientists have been recently paying close attention to studying the impact of various load regimes on the growth of strength capabilities and indicators of special training (Seniuk et al., 2020; Camarco et al., 2022; Folhes et al., 2022). These studies concern the need to improve the quantity and power of attacking and counter-attacking kicks in MMA due to the growth of maximum muscle strength (1 RM). However, the results of research identifying correlation between these indicators have not been found in the available scientific literature.

Thus, the purpose of this research is to study the peculiarities of correlation between the maximum strength development and quantity of kicks in MMA using load regimes of different intensity and energy supply.

Materials and methods

Study participants

75 athletes aged 19 ± 0.7 who had been practicing MMA for the last 4 ± 0.8 years were examined and divided into 3 groups. The duration of the study was 12 weeks. Athletes of the 1st group used low-intensity load regime ($R_a=0.53$), which had the following characteristics: anaerobic-glycolytic mode of energy supply of muscle activity; full amplitude of movement with fixation at the peak point; the duration of a repetition is 4 seconds; 12 repetitions in a set; the maximum duration of work in a set is 48-55 seconds; rest between sets lasts 60 seconds; the projectile working mass is 53-55% of 1RM. Group 2 representatives used a medium-intensity ($R_a=0.65$) load regime characterized by the following features: anaerobic-glycolytic mode of energy supply of muscle activity; full amplitude of movement without fixation at the peak point; the duration of each repetition is 5-6 seconds; 8 repetitions in a set; the maximum duration of work in a set is 40-43 seconds; rest between sets lasts 60 seconds; the projectile working mass is 65-67% of 1RM. The third group athletes used a high-intensity ($R_a=0.72$) load regime based on anaerobic-alactate mode of energy supply of muscle activity and including partial (90%) range of motion; the duration of each repetition is 8-9 seconds; 4 repetitions in a set; the maximum duration of work in a set is 32-35 seconds; rest between sets lasts 45 seconds; the projectile working mass is 72-75% of 1RM.

Study organization

The level of strength training in study participants was assessed with the help of the maximum strength indicators (1 RM) using the control testing method. Control over 1 RM

development of certain muscle groups was carried out using training exercises: bench press on the Smith simulator, block thrust behind the head, and lying leg press.

The level of special training in MMA was determined using the method of control testing of the training level of athletes. The proposed method is based on monitoring the dynamics of quantitative indicators of attacking kicks (reverse side kick, roundhouse kick) performed with maximum force until full muscle fatigue for 20 seconds. Measurements were taken at the beginning of the study and every 4 weeks.

The research algorithm consisted of three stages. At the first stage, load regimes were developed using the integral method of quantitative estimation of load capacity in power fitness depending on the conditions of muscular activity and level of training (Chernozub et al., 2018). At the second stage, the dynamics of strength and special training indicators were studied. At the third stage, we studied the peculiarities of correlation between the maximum strength development and the quantity of kicks in MMA using load regimes of different intensity and energy supply.

Statistical analysis

Statistical analysis of the research results was performed using the IBM *SPSS*Statistics 26 program package (StatSoftInc., USA). Median, lower and upper quartiles, interquartile range (IQR) were determined. Kruskal-Wallis H test was used for testing whether samples originate from the same distribution. Friedman's two-way analysis of variance by ranks was used to compare indicators of the same sample of subjects during the control period. Kendall's W (the Kendall's coefficient of concordance) is an effect size index for Friedman test. The G-Power 3.1.96 program was used to calculate statistical power (determining the smallest sample size for the study). The relationship between certain variables and individual-typological characteristics of the subjects was established using Spearman's rank correlation coefficients.

Results

Table 1 presents the results of changes in the maximum muscle strength (1 RM) in athletes of all groups using the proposed load regimes during 12 weeks of the study.

The obtained results showed that initial indicators of the maximum muscle strength development did not differ in the athletes of all three groups. During 12 weeks of research, the maximum muscle strength indicators increased by 41.9% on average ($p<0.05$) in group 3 athletes. In the representatives of the other two groups, the studied strength indicators also grew, but with a smaller progression (on average by 3.2 times) over a similar period of time.

Thus, it is the high-intensity load in conditions of anaerobic-alactate mode of energy supply that contributes to the accelerated growth of the maximum muscle strength development in MMA athletes.

The results presented in Figure 1 demonstrate the peculiarities of changes in the quantitative indicators of kicks (front kick, reverse side kick, roundhouse kick) performed with maximum force until complete fatigue for 20 seconds. Control of the studied indicators in athletes of all three groups took place during 12 weeks of using load regimes that differ in terms of energy supply and intensity.

Table 1. The results of the maximum muscle strength (1RM) development in study participants during 12 weeks, (median, interquartile range (IQR), n=75)

Exercises	Group	Term of observation, weeks				χ^2 , p df=3
		Initial data	4 weeks	8 weeks	12 weeks	
Bench press on the Smith simulator	1	65.00 (11.50) H=1.24 p=0.53	72.50 (8.75) 11.5%1*	80.00 (10.00) 10.3%1*	82.00 (10,00) 2.5%1* 26.1%2***	$\chi^2=74.19^{***}$ W=0.98***
	2	65.00 (10.00) H=1.24 p=0.53	75.00 (8.75) 15.4%1*	85.00 (9.00) 13.3%1*	87.00 (6.00) 2.4%1* 33.8%2***	$\chi^2=71.93^{***}$ W=0.96***
	3	60.00 (12.50) H=1.24 p=0.53	75.00 (17.75) 25.0%1*	85.00 (15.00) 13.3%1*	86.00 (13.50) 1.2%1* 43.3%2***	$\chi^2=73.20^{***}$ W=0.97***
Block thrust behind the head	1	65.00 (10.00) H=7.50 p=0.07	70.00 (10.00) 7.7%1*	75.00 (8.50) 7.1%1*	77.00 (7.00) 2.7%1* 18.4%2***	$\chi^2=73.62^{***}$ W=0.98***
	2	65.00 (10.00) H=7.50 p=0.07	75.00 (5.00) 15.4%1*	80.00 (7.00) 6.7%1*	80.00 (5.00) 0.0%1 23.0%2***	$\chi^2=72.61^{***}$ W=0.96***
	3	60.00 (50.0) H=7.50 p=0.07	72.00 (10.00) 20.0%1*	77.50 (11.50) 7.6%1*	82.00 (6.50) 5.8%1* 36.6%2***	$\chi^2=73.40^{***}$ W=0.97***
Lying leg press	1	120.00 (22.50) H=3.22 p=0.20	138.00 (13.50) 15.0%1*	152.00 (16.00) 10.1%1*	155.00 (16.50) 2.0%1* 29.1%2***	$\chi^2=69.58^{***}$ W=0.92***
	2	125.00 (25.50) H=3.22 p=0.20	135.50 (25.50) 8.4%1*	155.00 (30.00) 14.4%1*	165.00 (26.50) 6.4%1* 32.0%2***	$\chi^2=73.20^{***}$ W=0.97***
	3	120.00 (20.00) H=3.22 p=0.20	148.00 (21.00) 23.3%1*	170.00 (20.00) 14.9%1*	175.00 (18.50) 2.9%1* 45.8%2***	$\chi^2=73.97^{***}$ W=0.98***

Notes: 1 - difference (%) compared to previous results; 2 - difference (%) in comparison with the initial data; df is the number of degrees of freedom; H - Kruskal Wallis criterion; χ^2 - Friedman test; W is the Kendall coefficient; * - p<0.05; *** - p<0.001

At the beginning of the study the controlled indicators had no significant differences among the athletes of the examined groups. This fact allowed determining the level of influence of the proposed load regimes on the quantitative indicators of the studied types of kicks in the given conditions.

The quantitative indicators of kicks controlled during the study increased on average by 13.2% (p<0.05) in group 3 athletes compared to the initial data. The studied indicators showed a positive tendency in group 1 athletes, but 3.7 times lower compared to the 3rd group results. In group 2 athletes,

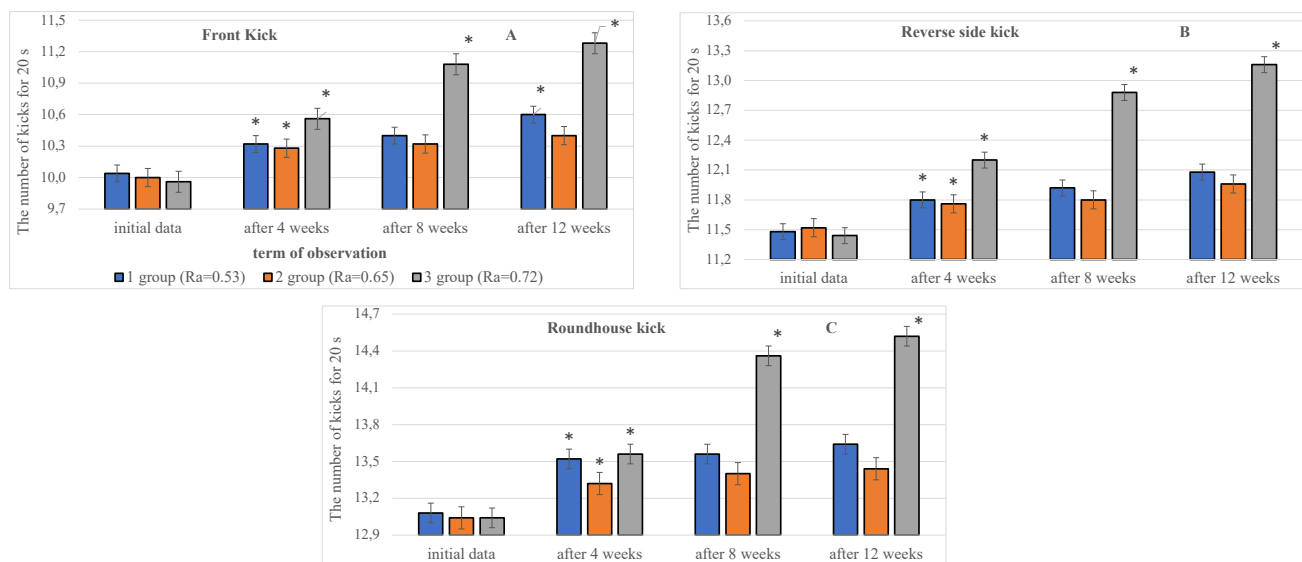


Fig. 1. Results of changes in quantitative indicators of “Front kick” (A), “Reverse side kick” (B), “Roundhouse kick” (C) for 20 s in athletes of the examined groups during the study, n=75. Note: * (p<0.05) – compared with the previous results

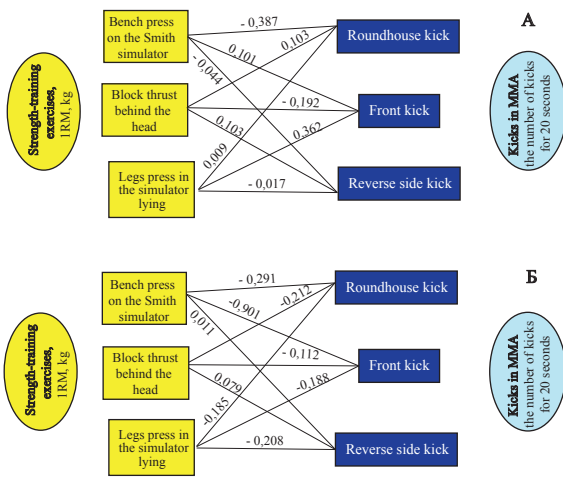


Fig. 2. The results of the correlation analysis between the maximum strength development (1PM) and the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in group 1athletes

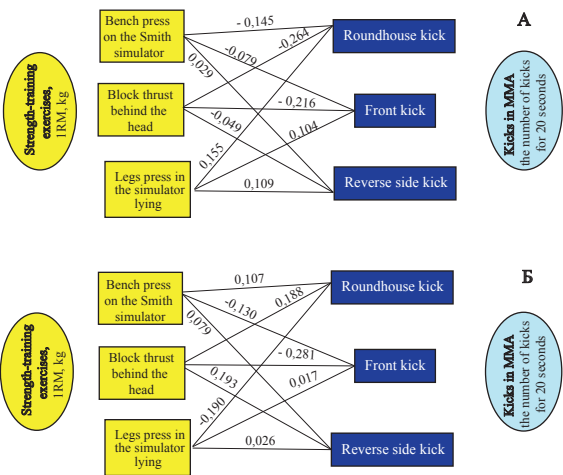


Fig. 3. The results of the correlation analysis between the maximum strength development (1PM) and the change in the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in athletes of the 2nd group

who used medium intensity (Ra=0.65) load regime, the studied indicators increased by 5.0%. during the study.

Thus, the changes in the quantitative indicators of kicks (front kick, reverse side kick, roundhouse kick) indicated the advantage of using high-intensity load regime in the anaerobic-alactate mode of energy supply in MMA athletes. This statement is confirmed by the results of monitoring the dynamics of the maximum muscle strength development in the study participants. These changes mainly occur due to the activation of a significant number of moving units in muscles and the additional involvement of synergist muscles while performing control exercises.

Figures 2-4 graphically present the results of correlation between the maximum strength development (1PM) and the number of kicks performed by the athletes of the examined groups for 20 seconds during the study.

The results of group 1 athletes showed no strong correlation between the maximum strength indicators and

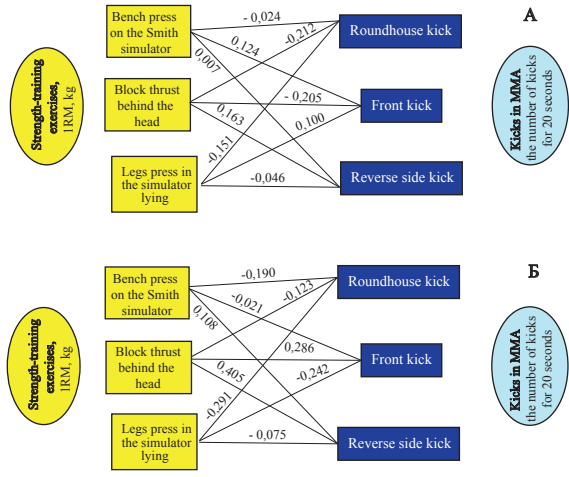


Fig. 4. The results of the correlation analysis between the development of the maximum strength indicators (1PM) and the change in the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in the 3rd group athletes

the level of special training (the number of kicks performed for 20 seconds). The lack of correlation between the controlled indicators is observed both at the beginning and at the end of the study, despite the significant growth of their parameters in all exercises.

Analysis of the results presented in figure 3 shows that there is no correlation between the controlled indicators at all stages of the study in group 2 athletes.

The study analysis demonstrated that there was no correlation between the level of the 1 RM indicator and the number of kicks during the control exercises (Fig. 4) in group 3 athletes at all stages of the study.

Thus, the results of the correlation analysis between the level of the maximum strength development and the number of kicks performed for 20 s during control exercises indicated the need for additional research. It is possible that the use of physiological and biochemical methods of studying the processes of adaptation in the given conditions of muscle activity will allow to substantiate the obtained results of the correlation analysis.

Discussion

This study describes the peculiarities of the influence produced by load regimes different in intensity and energy supply on the level of changes in strength and special training indicators in MMA athletes. We studied the correlation between the level of the maximum muscle strength (1RM) development and the change in the number of kicks during control exercises, depending on the features of the applied load regimes. The study results showed that using high-intensity load (Ra=0.72) regime gave the greatest increase in strength and special training indicators. Despite the significant growth of strength capabilities and quantitative indicators of kicks during control exercises, the correlation analysis demonstrated no strong correlation between the compared indicators at all stages of the study. The results of this study will allow developing a mechanism for correcting loads for athletes taking into account the individual duration of attacking or counter-attacking actions of MMA athletes.

The lack of clear understanding which mechanisms for training optimization allow to maximize the power of attacking punches is one of the unresolved problems of modern training in MMA. Using a great variety of power load regimes from various types of martial arts, powerlifting, bodybuilding is not always a scientifically based mechanism for improving the training of athletes (Chernozub et al., 2018; Antonietto et al., 2023; Olkhovyi O. et al., 2020). Determining the effective parameters of load indicators, taking into account the individual capabilities of athletes, the style of conducting matches, the adaptive body reserves formation will open one of the ways to solve this scientific problem. In the process of strength training, most researchers suggested using principles, methods and load correction mechanisms that are most often used in boxing and wrestling (Camarco et al., 2022; Folhes et al., 2022).

Leading experts in MMA paid little attention to the problem of compliance of the training regime to certain conditions of energy supply, and period of duration and power of counter-attacking actions in a fight. The problem of researching adaptation and compensatory reactions in similar conditions of training and competitive activity was solved in the same way (Chernozub et al., 2019; Kirk et al., 2021; Liu et al., 2022). The highest level of strength and special training indicators while using high-intensity ($Ra=0.72$) load regime indicated pronounced body adaptation processes in MMA athletes. These adaptive changes are associated with increasing the recruitment of mobile units of fast-twitch muscle fibers, growing creatine phosphate reserves in muscles, and strengthening of the creatine phosphokinase ATP resynthesis mechanism (Tota & Wiecha, 2022).

The results of correlation analysis between the level of maximum strength development and the number of kicks performed for 20 seconds during control exercises demonstrated no strong correlation. At the same time, the results of studied indicators do not depend on the load regimes used by the athletes or the type of energy supply of muscle activity. It can be assumed that such changes occur due to the use of different sources of energy supply of muscle activity during strength and special training control exercises. The duration of performing the control exercise to determine the 1 RM indicator lasts 1-2 s and requires significant activation of intra-muscular and inter-muscular coordination. Energy supply occurs at the expense of ATP reserves. While performing a series of kicks with maximum force for 20 seconds before complete muscle fatigue, energy supply occurs mainly due to the reserves of creatine phosphate and muscle glycogen. The level of strength abilities in these conditions will mainly depend on the activation of intermuscular coordination.

Conclusions

Using high-intensity load regime in conditions of anaerobic-alactate mode of energy supply allowed to achieve the most pronounced results in indicators of strength and special training in MMA athletes. However, no strong correlation between the increase in maximal strength and quantitative indicators of attacking kicks with maximal strength to full muscle fatigue for 20 s was found. It is possible that such changes can occur while using different sources of energy supply of muscle activity during control

exercises of strength and special training. It is necessary to conduct further search for more informative markers for evaluating the training of athletes and adaptation processes using biochemical control methods.

Conflicts of interest

The authors declare that they have no competing interests.

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ОЦІНКА ВЗАЄМОЗВ'ЯЗКУ МІЖ ЗМІНОЮ ПОКАЗНИКІВ СИЛОВОЇ ТА СПЕЦІАЛЬНОЇ ПІДГОТОВКИ СПОРТСМЕНІВ ЗМІШАНИХ ЄДИНОБОРСТВ

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

Реферат. Стаття: 7 с., 1 табл., 4 рис., 18 джерел.

Мета дослідження. Вивчити особливості взаємозв'язку між динамікою максимальної сили та ударами ногами в ММА в процесі використання різних за енергозабезпеченням та інтенсивністю режимів навантаження.

Матеріали та методи. Обстежено 75 спортсменів віком 19±0,7 років, які займаються ММА протягом останніх 4±0,8 років. Учасники були рівномірно розділені на 3 групи. Протягом 12 тижнів спортсмени 1 групи використовували навантаження низької інтенсивності (Ra=0,53), а представники 2 групи – навантаження середньої інтенсивності (Ra=0,65). Режим навантажень високої інтенсивності (Ra=0,72) використовували спортсмени 3 групи. Контроль кількісних показників атакуючих ударів ногами (front kick, reverse side kick, roundhouse kick) з максимальною силою до повного м'язового стомлення за 20 с дозволяв оцінити спеціальну підготовку. Рівень зміни силової підготовки оцінювали за рахунок розвитку показників максимальної сили (1 RM). Для обробки даних використовували непараметричні методи математичної статистики.

Результати. Встановлено, що показники спеціальної підготовки демонструють найбільшу динаміку за 12 тижнів дослідження в середньому на 13,2 % у спортсменів 3 групи. В інших двох групах, динаміка контрольованого показника в 3,2 рази менша за аналогічний проміжок часу. Виявлено, що у спортсменів 3 групи показник максимальної м'язової сили за період дослідження зростає на 41,9% порівняно з вихідними даними. Відповідні зміни розвитку показника 1 RM в середньому в 1,5 рази перевищують результати фіксовані у спортсменів інших двох груп. Однак, незважаючи на виявлену позитивну динаміку зростання показників силової та спеціальної підготовки в ММА, кореляційного взаємозв'язку між ними не виявлено в жодній із дослідних груп.

Висновки. Використання режиму навантажень високої інтенсивності в умовах анаеробно-алактатного типу енергозабезпечення дозволяє досягти найбільшої результатів в динаміці показників силової та спеціальної підготовки. Однак, достовірний взаємозв'язок між зростанням максимальної сили та кількісними показниками атакуючих ударів ногами не виявлений. Для поглибленого дослідження, необхідний пошук більш інформативних маркерів оцінки тренуваності спортсменів в ММА та процесів адаптації з використання біохімічних методів контролю.

Ключові слова: ММА, режими навантаження, інтенсивність, м'язова сила, спеціальна підготовка.

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