Original Article

Modeling the correction system of special kick training in Mixed Martial Arts during selection fights

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Abstract:
Background: Using different models of strength training in MMA is one of the components of improving the training of athletes of different fighting styles. However, there was conducted no study of the impact of different training loads, structure of workouts on the level of training of striking style athletes during selection fights. The aim of the study was to improve the correction system of special kick training and to study its effectiveness during selection fights by modeling training loads. *Material and methods:* 60 athletes aged 16±0.9 years using a striking fighting style took part in the study. At the first stage, the results of selection fights for the 2021 Ukrainian Championship were analyzed in terms of using different kicks. At the second stage, the development of correction models for special kick training for each group took place. During next 3 months, the proposed training models for participation in selection competitions for the 2021Ukrainian MMA Cup were applied. At the third stage, there was a comparative analysis of the ratio of using 8 different kicks by the study participants during both selection competitions. *Results:* Using the developed training models had a different effect on the ratio of kicks performed by the participants of all groups. The 1st and 2nd group athletes demonstrated the unchanging priority of using "left/right kick" at all stages of the study. Despite the significant difference in the structure of models, a comparative analysis of two selection fights showed increased usage of this kick (18.2%). The ratio changes of other 7 kicks in athletes of groups 1 and 2 depended on the features of training load and energy supply modes. In the 3rd group athletes who used the training model developed on the principle of premature fatigue, the priority of kicks changed during the study. At the beginning, 15.2% of the total number of kicks during fights were "side kick to the head". However, at the end of the study, the priority of this kick decreased by 3.0%. The leader among athletes of the 3rd group (16.4%) was the "direct back leg kick from one-sided fighting stance". *Conclusions:* Improving the correction system of special kick training due to the development of new models of strength training allows to increase the athletes' level of training during the selection fights.
Keywords: striking style, training load regime, strength training model, MMA, priority, selection fights.

Introduction

The choice of effective ways to optimize the process of increasing the indicators of special kick training in Mixed Martial Arts is one of the priority issues for leading specialists (Chernozub et al., 2018; Plush et al., 2021; Folhes et al., 2023) in this sphere. There is an acute problem of determining the main constituent elements of training activity, taking into account the style of conducting fights. The determination of the optimal variability of the training structural parameters requires complex interaction of coaches and scientists (Bello et al., 2019; Ghoul et al., 2019; Antoniettô et al., 2023). The main factor that affects improving of the training system in MMA is the correspondence of the external stimulus (loads) parameters to the functional capabilities of the athletes (Kostikiadis et al., 2018; Lane et al., 2020; Beránek et al., 2023). However, there is no clear mechanism for practical implementation of this pattern and technical arsenal of kick training for athletes with different fighting styles.

Modeling the system of training athletes, especially the sequence of actions and the periodicity of evaluating their effectiveness, is paid attention to by specialists throughout the entire period of MMA development (McGill et al., 2010; Fernandes et al., 2018; Manolachi et al., 2023). The model structure of the training process and the validity of using training loads, means, principles and methods of training remain the most controversial issues. In most cases, while modeling training sessions, experts pay attention to the frequency of using combinations of loads with technical elements generally recognized in martial arts. The validity of such

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a ratio is caused by the need to apply the development of strength capabilities during the execution of kicks, throws, painful chokes and chokehold (Slimani et al., 2017; Tota et al., 2019; Wang et al., 2023). The structure of the training process is modeled in most cases taking into account the athlete's technical skill and the ability to implement these elements in fights. The available literature (Miarka et al., 2018; Bueno et al., 2022) presents an unlimited number of strength training programs for MMA athletes, but most of them are monotonous. There was also no research on determining the necessary parameters of volume and intensity of training loads, depending on the priority of using different types of kicks or throws. The issue of correcting strength training models for athletes who use a combined type of attacking actions (kicks, throws, painful chokes) during fights is insufficiently researched. Most studies are devoted to the peculiarities of the impact of training loads of different intensity on the body of athletes of a striking or wrestling style of fighting (Stephen et al., 2020; Plush et al., 2021; Albuquerque et al., 2022).

The modern training system in MMA serves the need to optimize the correction of special kick training (Wąsik et al., 2021; Chernozub et al., 2022; Manolachi et al., 2022). One of the problematic issues related to the search for effective ways to correct kick training is the lack of correlation between loads and the level of technical skill. In addition, there are no studies defining the mechanism of correction of striking training indicators depending on the priority of using certain kicks. The vast majority of works are devoted to the study of the influence of a set of tools on the power of a kick or a series of kicks (Miarka et al., 2018; Alzhanov et al., 2021; Folhes et al., 2023). In most cases, researchers studied the correlation between the growth of agonist muscles and the speed of kicks in fights. However, the problem of increasing the number of kicks while maintaining the parameters of the explosive power in each kick during the attack remains unsolved (Ghoul et al., 2019). A number of researchers use a wide range of mechanisms for correcting load indicators aimed at increasing strength endurance in the process of kick training (Tota et al., 2019; Bueno et al., 2022). At the same time, a number of scientists studied the influence of different modes of energy supply of muscle activity on the level of adaptive body reserves in athletes. The obtained results clearly reflected the course of the body adaptation to loads in conditions of anaerobic-alactate and anaerobic-glycolytic energy supply modes (Chernozub et al., 2018). However, the purpose of the research was a comparative analysis of the influence of different training models on adaptive body changes in athletes of striking and wrestling styles.

The study of mechanisms for kick training optimization based on the analysis of the results of the selection fights by means of load correction requires an integral approach to this process (Antoniettô et al., 2023; Manolachi et al., 2023). Comprehensive evaluation of selection fights allows to create a symbiosis between the magnitude of the external stimulus and adaptive body reserves of the athletes during the pre-competition period. Despite good skills in technical training, competitive activity requires a priority selection of a complex of kicks, throws or painful chokes (Stephen et al., 2020; Wang et al., 2023). The optimal choice of a complex of elements of striking or wrestling training depends on the morphofunctional characteristics and the level of athletes training (Spanias et al., 2019; Chernozub et al., 2022). However, there are no effective mechanisms for correcting special kick training by modeling training loads taking into account the physiological patterns of adaptation in MMA.

The aim of the work was to improve the correction system of special kick training and to study its effectiveness during the selection fights by modeling training loads.

Material & methods
Participants
60 athletes aged 16±0.9 years who use a striking style of fighting took part in the study. Experience in mixed martial arts is 3±0.52 years. 3 research groups with 20 people each were formed. The study took place in the sports club "Saigon" in Chernivtsi (Ukraine). A series of studies was conducted in 2021 during the selection fights for the Ukrainian Championship of Ukraine and the Ukrainian MMA Cup among juniors. In the period between the selection fights, the study participants used the proposed models for special kick training. The duration of this period was 3 months. The total number of trainings for this period was 36.

In accordance with the ethical standards of the Helsinki Declaration, the research algorithm and methods were approved by the ethical committee for biomedical research at Lesya Ukrainka Volyn National University. According to the recommendations of biomedical research ethics committees, the study participants provided written consent (WHO Regional, 2000).
Analysis of competitive activity
The priority ratio of using 8 most common kicks for MMA athletes was determined while analyzing the selection fights in each competition. In the course of research, the following indicators were monitored: direct back leg kick from one-sided fighting stance, side kick to the head, roundhouse kick, high kick with external leg lift, back leg knee kick from one-sided fighting stance, reverse kick, short back kick, left/right kick.

A quantitative analysis of using each kick was carried out in each fight, regardless of its effectiveness.
Analysis of pre-competition training in MMA
Pre-competition training was analyzed according to the following criteria: the level of technical training in mastering the most common kicks for MMA athletes; the ratio of applying these kicks in attacking and counter-attacking actions; the correlation between the level of athlete's functional capabilities, his training, and

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the priority of kicks used during fights; a mechanism for correcting the training process based on previous competitions and features of the training activity model (structure and loads); correspondence of the load volume and intensity parameters to the body energy reserves of striking style athletes.

Experimental design

At the first stage of the study, the results of the selection fights for the 2021 Ukrainian Championship were analyzed as to the ratio of using different kicks. At the second stage, the development of correction models for special kick training for each of the three groups took place. During the next 3 months, the proposed training models for participation in selection competitions for the 2021 Ukrainian Cup were implemented. At the third stage, there was a comparative analysis of the ratio of using 8 different kicks by the study participants during both selection competitions.

Statistical analysis

Statistical analysis of the research results was performed using the IBM *SPSS*Statistics 26 program package (StatSoftInc., USA). Median, interquartile range (IQR) were determined. Kruskal-Wallis H test was used for testing whether samples originate from the same distribution. The G-Power 3.1.96 program was used to calculate statistical power (determining the smallest sample size for the study). The sample size was evaluated using statistical tests: Wilcoxon signet-rank test (one sample case); ANOVA: repeated measures, between factors.

Results

Table 1 presents experimental models of correction special kick training in MMA. The presented models were developed on the basis of pre-competition training analysis before selection fights. In the modeling process, the kicks ratio during selection fights for the 2021 Ukrainian MMA Championship were taken into account.

In the pre-competition training analysis, the following indicators were evaluated: intensity mode of the training session; the value of the projectile working mass; a type of anaerobic mode of energy supply that ensures the performance of training loads in the given conditions of volume and intensity; the value of the projectile working mass in ratio to 1 RM; the advantage of using free weight or machine exercises; the ratio of basic and isolating exercises; frequency of using general principles of strength training in MMA; the variability of using the premature fatigue principle. The indicators listed above are the main components on which the peculiarity of the structure, mode of loads of correction models of special kick training depends.

The preliminary analysis of the selection fights allowed to develop a model taking into account the priority of using the most common kicks in MMA by the athletes of the examined groups. The correction of loads depends on the biomechanical characteristics of kicks, their priority of applying in fights, the number of involved muscle groups during execution.

Table 1

Experimental models of training correction during special kick training in MMA

Models	Peculiarities of the structure and training load regime
1	Training takes place in conditions of medium intensity load regime. The indicator of the projectile working mass is 70% of 1RM. The duration of a set is 50-60 seconds until the working muscles are completely tired during the exercise. Loads are performed in the anaerobic-glycolytic mode of energy supply for muscle activity. A complex of machine exercises is used. 2-3 muscle groups are loaded in each workout. During training, the muscle group is loaded first by performing 1 basic and then 2 isolated exercises. The duration of the eccentric phase of movement is 4 s, and the concentric phase is 2 s. The number of repetitions in a set is 8-10. Rest between sets is 45 seconds.
2	The training is performed in high-intensity load regime. The indicator of projectile working mass is 85% of 1RM. The duration of a set is 25-30 seconds until the working muscles are completely tired during the exercise. Loads are performed in the anaerobic-alactate mode of energy supply for muscle activity. A complex of free weight exercises (barbells and dumbbells) is used. 2-3 muscle groups are loaded in each workout. The muscle group is loaded first while executing 1 basic and then 2 isolated exercises. The duration of the eccentric phase of movement is 2 s, and the concentric phase is 1 s. 10 repetitions are performed in a set. Rest between sets is 60-70 seconds.
3	The principle of premature fatigue is used (a muscle group is first loaded by performing 2 isolated exercises, and then 1 basic). While doing isolated exercises, the medium intensity load regime is used in conditions of anaerobic-glycolytic type of energy supply. The eccentric phase duration is 4 s, and the eccentric phase is 2 s. There are 8-10 repetitions in a set. While performing basic exercises, a high-intensity regime is used in conditions of anaerobic-alactate type of energy supply. The duration of the eccentric phase of movement is 6 s, and the concentric phase is 3 s. The number of repetitions in a set is 4-5. The projectile working mass is 75% of 1PM, regardless of doing basic or isolation exercises. 2-3 muscle groups are loaded in each set. The total duration of the training is 30 minutes, and rest between sets is 45 seconds. Mainly machine exercises are used in these conditions.

Each experimental model presented in Table 1 differs significantly from others in terms of structure, indicators of training loads, means, principles and energy supply. However, the proposed models were developed

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with the aim of improving the effective interaction of using the adaptive body potential for athletes with striking style of fighting. This especially applies to the strength capabilities development of those synergistic muscles that provide the maximum power and speed of the most frequently used kicks.

The first model of training correction is directed at increasing the activity of intermuscular coordination to increase the strength endurance of athletes in the process of a series of kicks. This especially applies to multi-joint kicks involving more than 4-5 muscle groups and significant energy expenditure.

The second model of kick training correction focuses on intensifying the activity of fast-twitch muscle units (intra-muscular coordination). These actions increase the level of explosive force development during the execution of kicks.

The third model of training correction is an optimal combination of load regimes and energy supply modes of muscle activity from the first two developed models. Its peculiarity is the simultaneous effect of loads on increasing the level of intra-muscular and inter-muscular coordination. Using the principle of premature fatigue allows to significantly reduce the weight parameters (barbells or machine weights). At the same time, the indicator of the projectile working mass maintains optimal parameters.

The ratio of using 8 kicks during fights by athletes of the 1st group are shown in Figure 1. The comparative analysis of controlled indicators took place during selection fights for the 2021 Ukrainian MMA Championship and the Ukrainian MMA Cup.
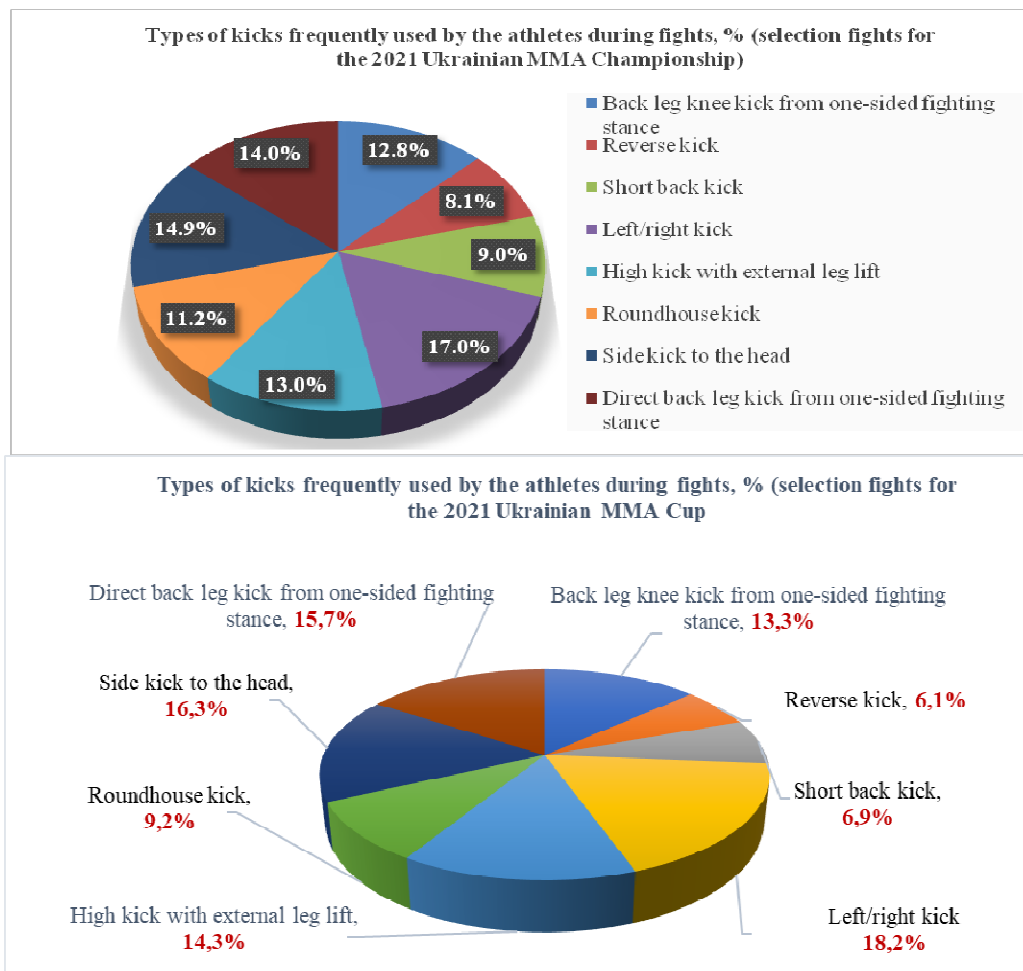

Fig. 1. The results of the kicks ratio during selection fights for the 2021 Ukrainian MMA Championship (at the beginning of the study) and the 2021 Ukrainian MMA Cup (after three months of research) performed by the first group athletes.

The results of the selection fights for the 2021 Ukrainian Championship revealed that the priority of using the "left/right kick" was 17.0%. among the 1st group athletes. At the same time, the smallest number (8.1%) was assigned to the "reverse kick".

The results analysis demonstrated that there were multidirectional changes in the studied indicators after 3 months of using the proposed model for the kick training correction. Thus, the quantitative indicator of using

left/right kick" recorded during selection fights for the Ukrainian MMA Cup increased to 18.2%. The percentage of using "reverse kick" during fights decreased by 2.0% in athletes of this group.

Figure 2 presents a comparative analysis of using different kicks by athletes of the 2nd group during two MMA selection competitions. The time gap between holding selection fights for the 2021 Ukrainian MMA Championship and the 2021 Ukrainian MMA Cup is 3 months. During this period, the sportsmen used the proposed models for kick training correction.
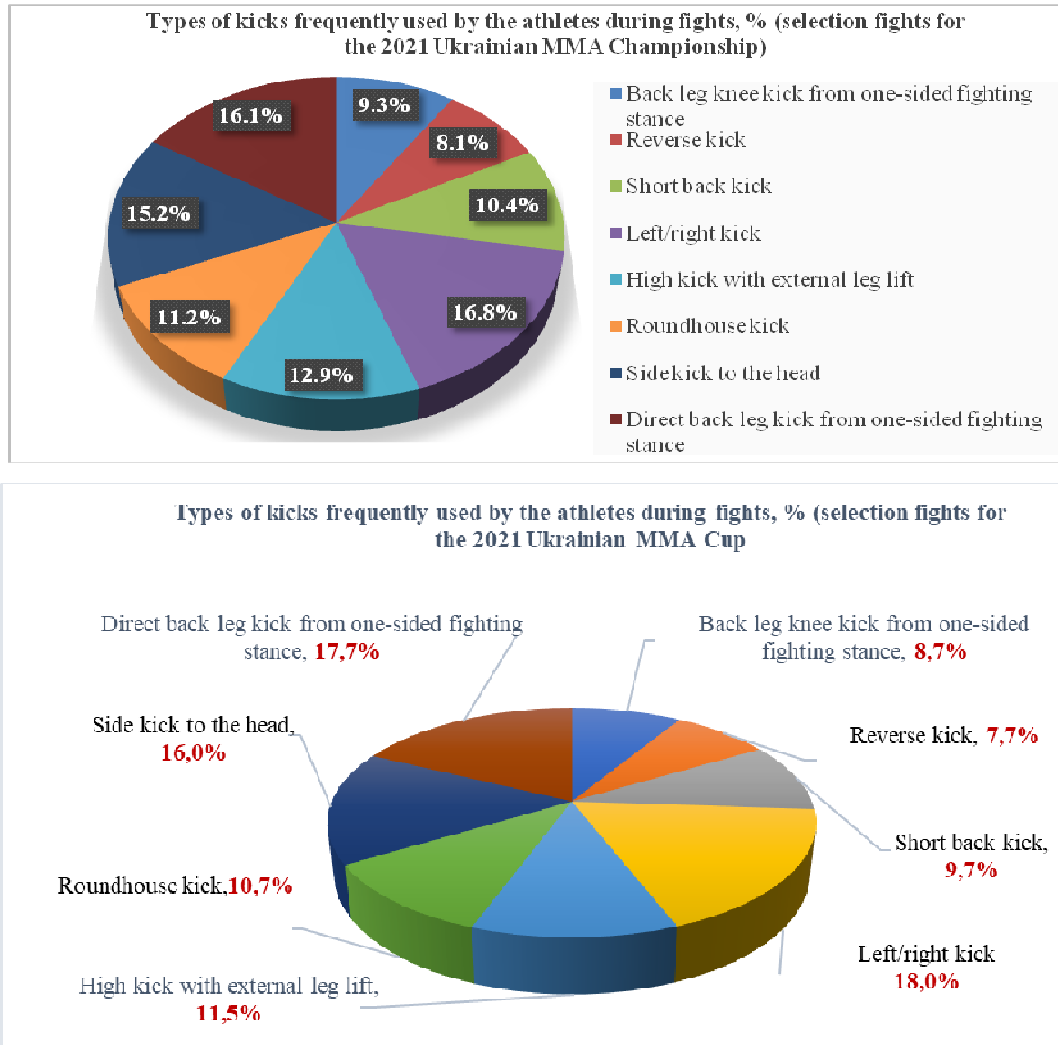

Fig. 2. The results of the kicks ratio during selection fights for the 2021 Ukrainian MMA Championship (at the beginning of the study) and the 2021 Ukrainian MMA Cup (after three months of research) performed by the second group athletes.

The obtained results showed that at the beginning of the study the priority of using the "left/right kick" was 16.8% in the 2nd group athletes. The smallest number (8.1%) was assigned to the "reverse kick". These results almost coincide with the data recorded in athletes of the 1st group before applying the developed model of kick training correction.

A comparative analysis of the initial and final study results demonstrated that the quantitative parameters of the controlled indicators had different changes. The largest increase of 1.6% was found in frequency of using the "direct back leg kick from one-sided fighting stance" in the selection fights for both competitions. The biggest decrease of 1.4% was noted in using the "high kick with external leg lift". However, the frequency of using the "left/right kick" in selection fights continued increasing by 1.2% after 3 months of practicing the proposed training model.

The results of 8 kicks ratio performed by the 3rd group athletes during selection are shown in Figure 3. The comparative analysis of controlled indicators took place during selection fights for the 2021 Ukrainian MMA Championship and the 2021 Ukrainian MMA Cup.
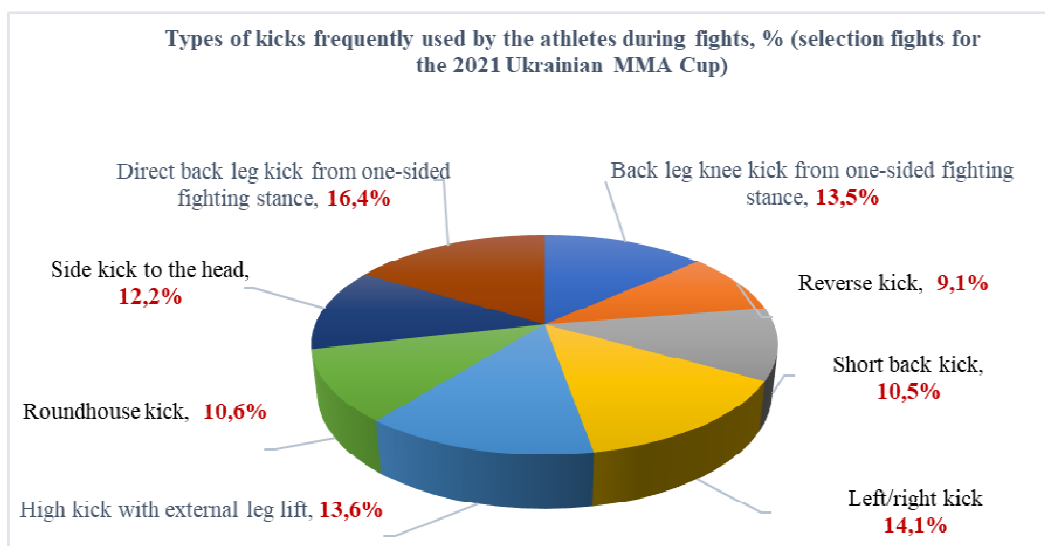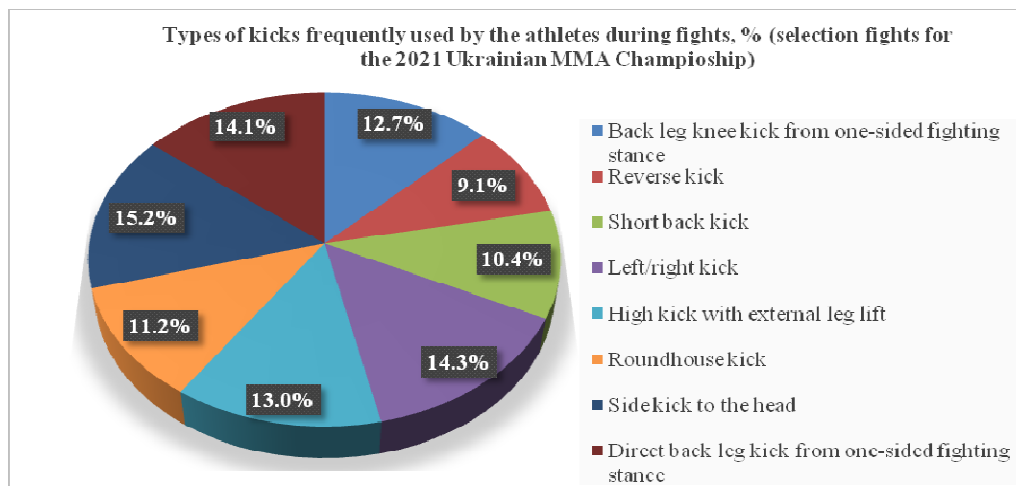
Fig. 3. The results of the kicks ratio during selection fights for the 2021 Ukrainian MMA Championship (at the beginning of the study) and the 2021 Ukrainian MMA Cup (after three months of research) performed by the third group athletes.

The results of the selection fights for the 2021 Ukrainian MMA Championship indicated the priority (15.2%) of using the "side kick to the head" among athletes of the 3rd group. At the same time, the smallest number of kicks (9.1%) during the selection fights was assigned to the "reverse kick".

After 3 months of using the proposed model of kick training correction, the priority of kicks performance changed in group 3 athletes. The use of "direct back leg kick from one-sided fighting stance" showed the highest rate (16.4%) during selection fights for the 2021 Ukrainian MMA Cup. Thus, the positive dynamics of using this kick is 2.5% compared to the initial study results. The frequency of using "side kick to the head" simultaneously decreased by 3.0%.

Discussion

This study is focused on the peculiarities of influence of the developed training models for the correction of kick training in MMA on the training level of striking style athletes. The change in the quantitative indicators of priority using of some kicks during selection fights due to the increase in adaptation body reserves is the result of the training process optimization. A comparative analysis of the kick ratio was conducted in selection fights for the 2021 Ukrainian MMA Championship and the 2021 Ukrainian MMA Cup. The presented work continues a series of studies aimed at finding effective mechanisms for improving the training process of striking style athletes (Slimani et al., 2017; Chernozub et al., 2022). The obtained results indicate that the correction mechanism of special kick training is not only the improvement of technical skill. Increasing the level of energy supply of muscle activity to ensure the performance of a series of kicks with certain power is an

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adaptive effect of the correction of kick training (Fernandes et al., 2018; Gottschall & Hastings, 2023). The development of the strength capabilities of the relevant muscle groups, depending on the proposed models, helped athletes to increase the level of implementation of the most optimal attacking kicks (Wąsik et al., 2021; Manolachi et al., 2023). The results of the study will contribute to the detailed disclosure of the mechanism of kick training correction due to the optimization of the main components of power loads to improve the training level of athletes. Coaches and athletes will better understand the expediency of using the principles of training inherent in power sports to improve striking training in MMA.

One of the most underestimated problems of modern MMA training is the use of an identical approach to increasing the functional capabilities of athletes, taking into account only the level of training. The search for effective mechanisms for training correction has provoked coaches and scientists to use exclusively boxing or wrestling models of strength training (Chernozub et al., 2018; Bello et al., 2019). The implementation of these long-term regularities has solid theoretical basis, but does not always demonstrate its effectiveness in competitive activities (Smajla et al., 2022; Folhes et al, 2023). There is a constant discrepancy between the level of adaptation body reserves and the energy supply necessary to ensure the maximum application of the athlete's power capabilities when performing a series of kicks. The search for optimal balance between effective kicks for each athlete and models of power loads is a constant concern of coaches. However, correction and improvement of the mechanism increasing the athlete's level in fights is one of the most controversial scientific problems in MMA (Plush et al., 2021; Chernozub et al., 2022; Beránek et al., 2023).

The study showed that athletes of striking style of fighting preferably used the following kicks: left/right kick, side kick to the head and direct back leg kick from one-sided fighting stance. However, almost all participants of the study, regardless of its stage, used the "reverse kick" least of all. Using experimental models of the kick training correction only partially affected the priority of using certain kicks in selection fights. The obtained results fractionally coincide with the data of leading researchers in mixed martial arts (Tota et al., 2019; Bueno et al., 2022). Most scientists studied not the priority of using certain kicks among athletes in fights, but primarily determined the most powerful kicks. Moreover, participants were graded according to the level of technical or physical training without taking into account the priority style of fighting (Slimani et al., 2017; Bello et al., 2019). The researchers mainly analyzed the technical side of the process of improving kicks and the effectiveness of their implementation in competitive activities. In most cases, these were kicks that required the involvement of 2-3 groups of synergistic muscles and belonged to the basic group (Wąsik et al., 2021; Albuquerque et al., 2022).

The proposed mechanism of the kick training correction in MMA using experimental models of strength power load affected the adaptive body potential of MMA athletes. The nature of adaptive body changes not only increased functional capabilities of athletes, but also affected the structure of their attacking and counter-attacking actions. That is, not only the percentage of effective kicks from athlete's point of view changes during the match, but even their priority.

These changes were noted in the 3rd group athletes who used the principle of premature fatigue in conditions of different intensity loads and different types of anaerobic energy supply. The obtained results complement the work of scientists who studied the impact of using different regimes of strength loads on the level of training of MMA athletes (Chernozub et al., 2022; Folhes et al., 2023). They reveal the peculiarities of improving kick training during selection fights which allow assessing the athlete's ability to combine technical and physical levels.

The priority of using certain kicks during fights is justified by the increase in their efficiency, which primarily depends on the change in the level of power capabilities ((Kostikiadis et al., 2018; Manolachi et al., 2022; Loturco et al, 2023). These scientists claim that power loads in the range of 80-85 of 1 RM in conditions of the anaerobic-alactate mode of energy supply contribute to the improvement of kick training. In conditions of training load of 70% of 1RM and anaerobic-glycolytic mode of energy supply, the level of intermuscular coordination and strength endurance parameters increased in study participants. The same adaptive changes in athletes' bodies were recorded by investigating the mechanisms of improving pre-competition activities and the effectiveness of performances at the main competitions of the year.

These scientists investigated the relationship between the features of the strength-oriented training and the way the victory was achieved (knockout, pain choke, etc.) (Antoniettô et al., 2023; Manolachi et al., 2023). The data presented in the study complement the research results of the above-mentioned scientists. The obtained results allow changing views on solving the long-standing problem of finding effective mechanisms for the kick training correction in MMA by modeling training loads.

Conclusions

Using the developed models for kick training correction, taking into account the physiological features of adaptation processes, contributed to the training level increase in striking style athletes who participated in the research. The proposed option for improving the functional body capabilities increased the percentage of effective types of kicks during selection fights. At the same time, using the model which combined load intensity, energy supply, and premature fatigue principle provoked a change in the kick priority. This change in

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kick priority is caused by increasing of motor muscle units' activity and the level of intermuscular coordination of these muscle groups. The obtained results reflect the characteristic signs of increasing the adaptation body reserves, the development of strength capabilities, and affect the results of kick training during competitions.

The research results implementation will allow coaches to develop optimal combinations of effective kicks (for each athlete according to his technical skill) and models of power loads. Using the proposed system of correction of special kick training will also increase the degree of technical mastery which will afterwards improve the level of attacking and counter-attacking actions. Modeling the correction system of special kick training during selection fights will allow athletes to change the percentage of using priority kicks.

The obtained results reveal one of the important problems for striking style athletes related to the search for effective ways to improve special kick training. The mechanism of accelerated growth in adaptation reserves of those muscle groups that are maximally involved in the most effective series of kicks is revealed. The results of the study justify using the developed training models, which will contribute to increasing of energy reserves necessary for the growth of attacking kicks power.

Conflicts of interest - There is no conflict of interest.

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