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THE INFLUENCE OF COMPLEXES OF MACHINE AND FREE WEIGHTS EXERCISES ON THE LEVEL OF POWER TRAINING OF ATHLETES IN STRIKE FIGHTING IN HORTING

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Abstracts

Purpose. To study the peculiarities of influence of power training loads including machine and free weights exercises on the development of maximum muscle strength of athletes in horting and on their level of training in strike fighting. ***Methods.*** We examined 40 sportsmen aged 20±1,2 engaged in horting. The study took place at the stage of specialized basic training and lasted 3 months. All participants were divided into 2 groups, 20 athletes in each group. Group 1 used machine exercises and group 2 used free weights exercises (barbells, dumbbells). The effectiveness of the proposed exercises in the specified modes of muscle activity was evaluated by the indicators of maximum strength development and level of training in strike fighting in horting. Biochemical analysis of cortisol concentration was used to assess their adaptive and compensatory reactions to a physical stimulus**.** ***Results.*** The research results showed that using machine exercises in conditions of anaerobic-glycolytic mode of energy supply contributed to the growth of average group indicators of maximum strength development by 44,8 % ($p<0,05$) in group 1 athletes. The same indicators increased by 45,1 % ($p <0,05$) in group 2 athletes who used free weights exercises on the background of anaerobic-alactate mode of energy supply. The special strike training results in horting showed that the most pronounced increase in the number of kicks with maximum force for 15 s was by 30,4 % ($p<0,05$) in group 2 athletes (according to the results of 3 control exercises). Group 1 athletes also showed positive dynamics, but with almost 4,5 times lower progression. At the beginning of the study group 2 athletes demonstrated decrease in cortisol concentration by 18,8 % ($p<0,05$), and group 1 athletes increased this indicator by 10.3% compared to the state of rest. The results revealed at the end of the study indicated that this hormone did not change its parameters in response to a physical stimulus. ***Conclusion.*** Using free weights exercises contributed to positive changes in control indicators of strike training in horting, despite almost identical increase in maximum strength parameters in both group athletes. Despite the compensatory reaction manifestations in response to power loads in the conditions of anaerobic-alactate mode of energy supply at the beginning of the study, we observed the process of long-term adaptation at the end of the study.

Key words: horting, athletes, machine exercises, free weights exercises, level of training in strike fighting, cortisol.

Станіслав Федоров, Іван Штефюк, Олександр Завізіон, Андрій Чернозуб. Вплив комплексів вправ та вільної ваги на рівень силової підготовки спортсменів із бойового хортингу. ***Мета*** статті – вивчити особливості впливу силових тренувальних навантажень, у тому числі вправ із тренажерами та вільними вагами, на розвиток максимальної м'язової сили спортсменів і на рівень їх підготовки в бойовому хортингу. ***Методи***. Обстежено 40 спортсменів віком 20±1,2 року, які займаються хортингом. Навчання відбувалося на етапі спеціалізованої базової підготовки й тривало три місяці. Усі учасники були поділені на дві групи по 20 спортсменів у кожній. Перша група використовувала вправи на тренажері, а друга – вправи з вільною вагою (штанга, гантелі). Ефективність запропонованих вправ у зазначених режимах м'язової діяльності оцінювали за показниками максимального розвитку сили й рівнем підготовленості в бойовому хортингу. За допомогою біохімічного аналізу концентрації кортизолу оцінювали їхні адаптаційно-компенсаторні реакції на фізичний подразник. ***Результати.*** Результати дослідження засвідчили, що застосування тренажерних вправ в умовах анаеробно-гліколітичного режиму енергозабезпечення сприяло зростанню середньогрупових показників максимального розвитку сили на 44,8 % ($p<0,05$) у спортсменів 1-ї групи. Ці ж показники зросли на 45,1 % ($p<0,05$) у спортсменів 2-ї групи, які використовували вправи з власною вагою на фоні анаеробно-алактатного режиму енергозабезпечення. Результати спеціальної ударної підготовки з хортингу засвідчили, що найбільш виражене збільшення кількості ударів ногами максимальної сили за 15 с – на 30,4 % ($p<0,05$) у спортсменів 2-ї групи (за результатами трьох контрольних вправ). Спортсмени 1-ї групи також показали позитивну динаміку, але майже в 4,5 раза меншу прогресію. У спортсменів другої групи на початку дослідження спостерігали зниження концентрації кортизолу на 18,8 % ($p<0,05$), а в спортсменів 1-ї цей показник збільшився на 10,3 %, у порівнянні зі станом спокою. Результати, отримані в кінці дослідження, засвідчили, що цей гормон не змінював своїх параметрів у відповідь на фізичний подразник. ***Висновок.*** Застосування вправ із вільними вагами сприяло позитивним змінам контрольних показників ударної підготовки в хортингу, незважаючи на майже однаковий

приріст максимально-силових параметрів у спортсменів обох груп. Незважаючи на прояви компенсаторних реакцій у відповідь на силові навантаження в умовах анаеробно-алактатного режиму енергозабезпечення на початку дослідження, наприкінці дослідження спостерігали процес тривалої адаптації.

Ключові слова: хортинг, спортсмени, тренажерні вправи, вправи з вільними вагами, рівень підготовленості зі страйк-бою, кортизол.

Introduction. The problem of constant search for effective and simultaneously safe mechanisms for increasing the functional capabilities of athletes' bodies for their implementation in order to increase the power and speed of blows during attacking and counter-attacking actions in horting, hand-to-hand combat, and MMA has been one of the acute and controversial issues in studies of leading experts [2, 4, 6] in recent years. This issue is especially acute at the stage of specialized basic training during the selection of optimal means, methods and load parameters, which in the shortest possible time will allow to maximize the level of special strike training in horting and other similar types of martial arts. In Mixed Martial Arts and hand-to-hand combat, a number of scientists made attempts to improve the strength training system of athletes using load regimes that differ in volume and intensity parameters [1, 3, 8]. At the same time, the problem of determining informative markers for evaluating adaptive and compensatory reactions of the body in different kinds of martial arts and for improving technical and tactical training, pre-competitive and competitive activities, has not been investigated. Most of the works presented in the scientific literature concern the study of the processes of short-term and long-term adaptation based on the biochemical analysis of blood indicators, which are most often used in Mixed Martial Arts, boxing, wrestling [5, 7, 12, 14].

The effectiveness of using complexes of machine exercises and free weights exercises during training is one of the long-standing controversial issues for coaches and scientists in bodybuilding, powerlifting, and fitness [6, 11, 15]. However, despite the various prevalence of using such combinations and the discussion of this problem among power sports specialists, no fundamental studies have been conducted to determine the nature of the adaptive and compensatory reactions of athletes in the given conditions of muscular activity using physiological and biochemical research methods. There is no research concerning these issues in horting. At the same time, the determination of the most effective complexes of strength exercises, which will allow not only to increase the functional capabilities of the athlete's body on the whole, but also to positively influence the dynamics of indicators of special strike training in horting, remains a debatable issue.

The Purpose of the Study. To study the peculiarities of influence of power training loads including machine and free weights exercises on the development of maximum muscle strength of athletes in horting and on their level of training in strike fighting.

Materials & Methods. Participants. In the course of research, we examined 40 athletes aged 20±1,2 at the stage of specialized basic training in horting. Research was conducted during 2021 in the following horting sports clubs in Kyiv (Ukraine): Alfa, Horting, Sylna natsia. The duration of the experimental studies was 3 months. The study participants were divided into 2 groups, 20 athletes in each group. Athletes of the 1st group used a complex of strength training machine exercises in conditions of anaerobic-glycolytic mode of energy supply (the 1st training mode). The participants of the 2nd group used a complex of free weights exercises (barbells, dumbbells) in conditions of anaerobic-alactate mode of energy supply (the 2nd training mode 2) (table 1).

The research was approved by the Ethical Committee for Biomedical Research in accordance with the ethical standards of the Helsinki Declaration. The research participants gave written consent to the study in accordance with the recommendations of the Biomedical Research Ethics Committees (WHO Regional, 2000).

Measurements. Maximal Muscle Strength. Measurement of indicators of the development of maximum muscle strength (1 RM) in athletes of both groups took place at the beginning and during the next 3 months of the study with a control interval every 30 days. Control basic and isolation strength exercises were used to determine the nature of the studied indicator. Basic strength exercises included: bench press on the Smith simulator, behind-the-neck lat pulldowns, narrow-stance leg press. The group of isolation exercises consisted of the following: pec deck in butterfly machine raising hands, rope lat pull-over, hip abduction machine exercise. Measurement of the 1 RM indicator was carried out precisely on machine exercises to reduce the level of injury of the study participants. In the process of control testing and during the entire training period, strength exercises were performed in accordance with generally accepted techniques and methods [6, 7].

Special Training. The level of special strike training of both group of athletes was determined using the method of control testing of the number of accurate kicks performed for 15 seconds with maximum force.

Control of the studied indicators took place at the beginning and during next 3 months of the study with a control interval every 30 days. We used the following basic attacking and counter-attacking kicks in horting: roundhouse side kick, side kick to the head, reverse side kick. The result was recorded if an athlete fulfilled an accurate kick with the maximum force at the possible speed with observance of the general technique.

Biochemical Parameters. The cortisol concentration in blood serum was determined by enzyme immunoassay using the SteroidIFA-testosterone reagent kit on Alcor Bio equipment. The blood sampling procedure was carried out in accordance with the general requirements for medical and biological research. Blood was taken from the veins of the subjects by a medical worker before and after the training session. The periodicity of biochemical blood control of the athletes took place at the beginning and at the end of the third month of research, in compliance with all norms. Physiologically acceptable norms of cortisol concentration in blood serum of healthy people are within 150–660 nmol/l.

Statistical Analysis. Statistical analysis of the research results was performed using the IBM *SPSS*Statistics 26 program package (StatSoftInc., USA). Descriptive statistics methods were used to calculate the arithmetic mean and error of the mean. The non-parametric Wilcoxon test was used to assess the reliability of pairwise differences, and Friedman's ANOVA was used to analyze repeated measurements (Nasledov, 2013).

Results. Table 1 presents the training modes used by the participants of the examined groups during 3 months of the study. According to the results of leading experts in power fitness and bodybuilding, these training modes are the most effective for the accelerated growth of maximum strength and muscle mass of athletes (Schoenfeld et al., 2016; Chernozub et al., 2018; Titova et al., 2018). The proposed modes differ in the structure of the complexes of strength exercises, parameters of volume and intensity of loads, energy supply systems in conditions of muscular activity, duration of motor activity in a separate set until complete exhaustion, and recovery periods.

Table 1

Peculiarities of Strength Training Modes Used by Athletes During the Study, n=40

Training Modes	
Training Mode 1	**Training Mode 2**
Training loads are performed in the anaerobic-glycolytic mode of energy supply. A complex of machine exercises is used. 2–3 muscle groups are loaded in a training session. During a session the muscle group first performs 1 basic exercise, and then 2 isolation exercises. The duration of the eccentric phase of movement is 6 s, and the concentric phase is 3 s. Each set consists of 8–10 repetitions. The projectile working mass is 70 % of the 1RM. The total duration of the session is 30 minutes, and the rest between sets is 45 seconds.	Training loads are performed in the anaerobic-alactate mode of energy supply. A complex of exercises with a barbell and dumbbells is used. 2–3 muscle groups are loaded in a training session. During a session the muscle group first performs 1 basic exercise, and then 2 isolation exercises. The duration of the eccentric phase of movement is 2 s, and the concentric phase is 1 s. Each set consists of 10–12 repetitions. The projectile working mass is 85 % of 1RM. The total duration of the session is 30–32 minutes, and the rest between sets is 60–70 seconds.

Table 2 presents the dynamics of the maximum muscle strength (1RM) indicators in athletes of both groups while performing the control exercises (basic and isolation) during 3 months of the study.

The analysis of the obtained results showed that athletes of both groups had identical positive dynamics of the maximum muscle strength parameters growth while performing both basic and isolation control exercises. Thus, using a complex of machine exercises in the conditions of anaerobic-glycolytic mode of energy supply by group 1 athletes contributed to an increase in the 1RM indicator by 49,3 % ($p<0,05$) on average while performing basic exercises, and by 40,4 % ($p<0,05$) doing isolation exercises. At the same time, group 2 athletes who used free weights exercises (barbells, dumbbells) during training in the conditions of the anaerobic-alactate energy supply regime, showed an increase in the maximum strength indicator by 49,6 % ($p<0,05$) in basic exercises and by 40,7 % ($p<0,05$) in isolation exercises.

The results of changes in indicators of special strike training in horting (number of accurate kicks on the mannequin for 15 s with maximum force) of athletes of both groups during 3 months of research are presented in table 3.

Table 2

Changes in the Maximum Strength (1RM) Indicators of Both Group Participants Performing Control Exercises During 3 Months of the Study, n=40

Strength Exercises	Groups	Period of Observation, Months				χ^2, p df=3
		Initial Data	1	2	3	
Exercises for Chest Muscles						
Bench press on the Smith simulator (basic exercise)	1	66,60 ± 1,11	79,22 ±0,91[1] Z=-3,9; p<0,000	92,05±1,53[1] Z=-3,9; p<0,000	99,80±1,64[1,2] Z=-3,7; p<0,000 Z=-3,9; p<0,000	χ^2=59,4 p<0,000
	2	62,45 ± 1,63	72,77±1,59[1] Z=-4,0; p<0,000	84,57±1,47[1] Z=-3,9; p<0,000	94,57±1,35[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=60,0 p<0,000
Pec deck in butterfly machine (isolation exercise)	1	63,50± 1,14	72,80±0,98[1] Z=-3,9; p<0,000	79,42±1,25[1] Z=-3,9; p<0,000	84,12±1,38[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=60,0 p<0,000
	2	61,90± 1,62	70,50±1,24[1] Z=-3,9; p<0,000	78,60±1,11[1] Z=-3,9; p<0,000	82,72±1,13[1,2] Z=-3,8; p<0,000 Z=-3,9; p<0,000	χ^2=59,7 p<0,000
Exercise for Back Muscles						
Behind-the-neck lat pulldowns (basic exercise)	1	56,95 ± 0,62	64,85±0,47[1] Z=-3,9; p<0,000	71,00 ±0,54[1] Z=-3,9; p<0,000	75,35±0,46[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=58.0 p<0.000
	2	56,85 ± 0,49	66,45±0,50[1] Z=-3,9; p<0,000	73,00±0,42[1] Z=-3,9; p<0,000	78,57±0,68[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=59.0 p<0.000
Rope lat pull-over (isolation exercise)	1	37,10± 0,69	42,05±0,67[1] Z=-3,9; p<0,000	50,85±0,54[1] Z=-3,9; p<0,000	54,85±0,47[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=60.0 p<0.000
	2	37,82± 0,38	45,77±0,58[1] Z=-3,9; p<0,000	54,00±0,39[1] Z=-3,9; p<0,000	57,70±0,33[1,2] Z=-3,8; p<0,000 Z=-3,9; p<0,000	χ^2=59,6 p<0,000
Exercises for Leg Muscles						
Narrow-stance leg press (basic exercise)	1	102,50± 2,25	132,82±2,26[1] Z=-3,9; p<0,000	157,17 ±2,21[1] Z=-3,9; p<0,000	169,97±2,22[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=60,0 p<0,000
	2	106,75± 2,06	133,02±2,11[1] Z=-3,9; p<0,000	156,62±2,43[1] Z=-3,9; p<0,000	169,95±2,82[1,2] Z=-3,9; p<0,000 Z=-3,9; p<0,000	χ^2=60,0 p<0,000
Hip abduction machine exercise (isolation exercise)	1	40,67± 0,62	47,22±0,66[1] Z=-3,9; p<0,000	54,50±0,72[1] Z=-3,9; p<0,000	57,35±0,50[1,2] Z=-3,5; p<0,000 Z=-3,9; p<0,000	χ^2=58,2 p<0,000
	2	44,05± 0,73	50.20±0,82[1] Z=-3,9; p<0,000	56,30±0,67[1] Z=-3,8; p<0,000	59,95±0,72[1,2] Z=-3,5; p<0,000 Z=-3,9; p<0,000	χ^2=57,1 p<0,000

Note. [1] - *The difference compared to the previous results is significant according to the Wilcoxon test (p<0,05);* [2] *- the difference compared to the initial values is significant according to the Wilcoxon test (p<0,05); df is the number of degrees of freedom; p is the level of significance.*

The analysis of results showed that the initial data of the studied indicators had no significant intergroup difference, which allowed determining the effectiveness of the influence of the proposed training regimes on their dynamics.

In the process of research, we established that the parameters of the dynamics of special strike training in horting during control exercises increased on average by 7,2 % (p<0,05) in the athletes of group 1 during 3 months of research. At the same time, in the athletes of group 2, the studied indicators increased more than 4 times (by 30,4 % (p<0,05) compared to the results of group 1.

Table 3

Changes in the Number of Accurate Control Kicks on the Mannequin with the Maximum Force for 15 s by Both Group Participants During the Study, n=40

Groups	Observation Period,				χ^2, p df=3
	Initial Data	1	2	3	
Roundhouse Side Kick					
1	6,20± 0,17	6,55±0,23[1] Z=-2,6; p<0,008	6,65 ±0,24 Z=-1,4; p>0,157	6,75±0,26[2] Z=-1,4; p>0,157 Z=-3,3; p<0,001	χ^2=23,5 p<0,00
2	6,40± 0,16	7,55±0,22[1] Z=-3,9; p<0,000	8,55±0,15[1] Z=-3,7; p<0,000	8,40±0,23[2] Z=-0,6; p>0,527 Z=-4,1; p<0,000	χ^2=52,5 p<0,000
Side Kick to the Head					
1	7,25± 0,21	7,55±0,26[1] Z=-2,4; p<0,014	7,80 ±0,29 Z=-1,8; p>0,059	7,80 ±0,29[2] Z=-0,0; p>1,00 Z=-2,8; p<0,005	χ^2=18,2 p<0,000
2	7,55± 0,16	8,60±0,16[1] Z=-4,1; p<0,000	9,85±0,21[1] Z=-3,8; p<0,000	9,70±0,24[2] Z=-0,8; p>0,405 Z=-4,0; p<0,000	χ^2=52,7 p<0,000
Reverse Side Kick					
1	5,90± 0,17	6,15±0,24[1] Z=-2,2; p<0,025	6,30 ±0,27 Z=-1,7; p>0,083	6,20±0,25[2] Z=-0,8; p>0,414 Z=-2,1; p<0,034	χ^2=12,1 p<0,007
2	5,90± 0,16	7,10±0,17[1] Z=-4,1; p<0,000	7,85±0,22[1] Z=-3,6; p<0,000	7,75±0,20[2] Z=-0,6; p>0,527 Z=-4,0; p<0,000	χ^2=50,5 p<0,000

Note. *[1] - the difference compared to the previous results is significant according to the Wilcoxon test (p<0,05); [2] - the difference compared to the initial values is significant according to the Wilcoxon test (p<0,05); df is the number of degrees of freedom; p is the level of significance.*

Table 4 presents the results of changes in the concentration of the steroid hormone cortisol in the blood serum of the athletes of the examined groups in conditions of different levels of variability in load components, energy supply of muscle activity, and the structure of strength-training exercise complexes during all stages of the examination.

We observed an increase of the cortisol concentration in the blood serum of group 1 athletes by 10,3 % from the beginning and a decrease by 2,1 % at the end of the study in response to power training loads comprising a complex of machine exercises in conditions of the anaerobic-glycolytic mode of energy supply. In group 2 athletes, we observed a significant decrease in cortisol concentration by 18,8 % (p<0,05) at the beginning and no changes after 3 months of the study in response to power training loads while using a set of free weights exercises in conditions of anaerobic-alactate mode of energy supply.

Table 4

The Results of Biochemical Blood Indicators of Both Group Participants During the Study, n=40

Indicator	Group	At the Beginning of the Study		After 3 Months of Training	
		Before Exercise	After Exercise	Before Exercise	After Exercise
Cortisol, nmol/l	1	376,35±15,11	415,11±21,70 Z=-1,7; p>0,079	384,25±7,43 Z=-0,1; p>0,960	376,09±22,58 Z=-6,4; p>0,627
	2	413,33±17,13	335,67±13,38* Z=-3,6; p<0,000	337,13±8,61** Z=-1,9; p<0,048	342,34±11,82 Z=-1,8; p>0,067

Note. **- Difference compared to previous results is significant by the Wilcoxon test (p<0,05); ** - difference between basal parameters (before exercise) compared to previous results is significant by the Wilcoxon test (p<0,05) %.*

Discussion. The problem of the lack of clear management mechanisms for improving the training activities in horting and similar types of martial arts raises a number of controversial questions among

scientists regarding the effectiveness of using complex approaches to optimizing the training process. Research activities in this direction may allow to ensure the optimal level of functional reserve of the athletes' body and its implementation in competitive activities [13, 15, 18]. In horting, there is no clear understanding of which set of tools will contribute to maximal increase of the level of special strike training of athletes in the shortest possible time at the stage of specialized basic training. At the same time, one of the important aspects of optimizing training activities in martial arts remains the problem of controlling the processes of adaptation of athletes' bodies to loads using biochemical blood markers [9, 14, 19].

The conducted research showed that regardless using different in structure, load and energy supply systems of muscle activity of strength training modes, the indicators of maximum muscle strength (1 RM) had identical growth dynamics. The obtained results only complicated the long-standing controversial discussion of power sports specialists regarding the effectiveness of using complexes of machine exercises or free weights exercises in the process of strength training of athletes [7, 9, 11]. The obtained data contradict the results of scientists who claim that in conditions of the anaerobic-alactate mode of energy supply of muscle activity, the level of strength capabilities shows a more pronounced rate of growth compared to other modes [8, 16].

The significant decrease in the cortisol concentration in the blood serum of study participants, which occurred in response to power loads of an anaerobic-alactate nature during a series of free weights exercises, indicates compensatory reactions on the background of high energy expenditure during training [10, 14, 17]. At the same time, change in the cortisol concentration in the blood serum of athletes in response to a stressful stimulus revealed after 3 months of the study indicates the processes of long-term adaptation of athletes [4, 15].

Based on the analysis of the data of testing the level of special strike training of the study participants, we found out that the average number of accurate kicks with maximum force for 15 s increased more than 4 times in athletes who used free weights exercises, compared to the results of group 1. However, it becomes unclear why we recorded a significant difference in the increase of special strike training indicators on the background of the identical dynamics of growth of the maximum muscle strength in both group athletes, regardless of the difference in their training regimes. It is possible that these changes are associated with an increase in adaptive reserves due to a simultaneous increase in maximum strength and strength endurance on the background of hypertrophy of fast-twitch muscle fibers and an increase in the body's resistance to a similar mode of energy supply of muscle activity [2, 14, 19]. A several-fold increase in the quantitative indicators of special strike training of athletes who used free weights exercises compared to group 1 athletes indicates an increase in adaptation potential due to indicators of intermuscular coordination [5, 8, 11]. Performing exercises with free weights requires the involvement of additional muscle groups necessary to hold the barbell and dumbbells in a certain position. That is why additional losses of energy resources caused a significant decrease in the concentration of cortisol in the blood serum while performing these exercises [7, 16].

Conclusion

1. Using free weights exercises in conditions of anaerobic-alactate regime of energy supply contributes to a more pronounced increase in the control indicators of strike training in horting, than during the long-term using of machine exercises. It should be noted that similar changes occur despite an almost identical increase in maximum strength parameters, regardless of the structure of exercise complexes, load parameters, and modes of energy supply of training activities.

2. Using biochemical indicator of the cortisol concentration in the blood serum of athletes in the process of horting training as an informative marker for assessing the adaptive and compensatory reactions of the athletes to a physical stimulus, allows clearly determining the adequacy of loads to the body's functional capabilities. This biochemical marker of blood lets us clearly determine the accelerated reduction of energy resources in conditions of power loads of the anaerobic-alactate mode of energy supply and contributes to the prompt correction of the training process to increase the effectiveness of attacking and counter-attacking kicks in horting.

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