STUDING THE INFLUENCE OF STRETCHING ON THE EFFECTIVENESS OF «FULL BODY» STRENGTH TRAINING AND ON THE RECOVERY PROCESS IN MIDDLE-AGED WOMEN

Olga Samoliuc[1]
https://orcid.org/0000-0001-7011-4853

Tatiana Cheban[2]
https://orcid.org/0000-0002-0845-044X

[1-2] **Pridnestrovian State University named after T.G. Shevchenko Tiraspol (the Republic of Moldova)**

correspondent-author – O. Samoliuc: ms.samolyuk2@gmail.com

doi: 10.32626/2309-8082.2024-29(2).69-75

In this research, the effect of stretching on the effectiveness of full body strength training and on the recovery process after it in women aged 45-50 years was studied. It was assumed that the use of stretching exercises on a rest day between major strength loads can have a noticeable effect on physical fitness indicators (ability to perform control tests for speed, strength, flexibility) and on the degree of recovery (sensory perception in the form of a desire to exercise and the degree of muscle pain) in middle-aged women engaged in fitness. *The purpose of the study* is to improve the methods of recreational physical exercises of a power orientation with middle–aged women. *Research objectives*: analysis of current research in the field of methods of strength training and flexibility training with middle-aged women; development of a stretching training program for women 45-50 years old; assessment of the impact of additional stretching classes on strength, speed, flexibility and sensory perception after strength training in women 45-50 years old. *Conclusions*: Regular 40-minute stretching sessions containing dynamic active exercises and used on rest days between strength training according to the "full body" program by women 45-50 years old for 8 months have a positive effect on strength, flexibility, and speed of movement. Also, this approach to alternating strength training and stretching can be effective for recovery after intense strength training. In the experimental group, significant positive changes were recorded in the following tests: squatting with a barbell ($p<0.01$), pulling up on a crossbar ($p<0.01$), leaning forward ($p<0.01$), chest press ($p<0.05$), understanding straight legs in the temple ($p<0.05$), muscular pain and limited movement ($p<0.01$), the desire to perform strength exercises ($p<0.01$).

Keywords: women, fitness, strength, flexibility, stretching, «full body».

Ольга Самолюк. Тетяна Чебан. **Вивчення впливу стретчинга на ефективність силового тренування «full body» і відновлення у жінок середнього віку.**

Анотація. В даному дослідженні було вивчено вплив стретчинга на ефективність силового тренування «full body» і на процес відновлення після неї у жінок 45-50 років. Передбачалося, що застосування занять стретчингом в день відпочинку між основними силовими навантаженнями може чинити помітний вплив на показники фізичної підготовленості (здатності до виконання контрольних тестів на швидкість, силу, гнучкість) і на ступінь відновлення (чуттєве сприйняття у вигляді бажання займатися і ступінь м'язового болю) у жінок середнього віку, що займаються фітнесом. *Мета дослідження* – вдосконалення методики оздоровчих занять фізичними вправами силової спрямованості з жінками середнього віку. *Завдання дослідження*: аналіз актуальних досліджень в області методики проведення силових тренувань і тренувань на гнучкість з жінками середнього віку; розробка програми занять стретчингом для жінок 45-50 років; оцінка впливу додаткових занять стретчингом на показники сили, швидкості, гнучкості і на чуттєве сприйняття після силового тренування у жінок 45-50 років. *Висновки:* регулярні 40-хвилинні заняття стретчингом, що містять динамічні активні вправи і використовуються в дні відпочинку між силовими тренуваннями за програмою «full body» жінками 45-50 років протягом 8 місяців роблять позитивний вплив на показники сили, гнучкості, швидкості рухів. Також даний підхід до чергування силового навантаження і стретчинга може бути ефективним для відновлення після інтенсивних силових тренувань. В експериментальній групі були зафіксовані достовірні позитивні зміни в наступних тестах: присідання зі штангою ($p<0.01$), підтягування на перекладині ($p<0.01$), нахил вперед ($p<0,01$), жим штанги від грудей ($p<0.05$), розуміння прямих ніг у висі ($p<0.05$), м'язовий біль і обмеженість рухів ($p<0.01$), бажання виконувати силові вправи ($p<0.01$).

Ключові слова: жінки, фітнес, сила, гнучкість, стретчинг, тренування «full body».

Introduction

Middle-aged women are active users of various fitness services. In order to improve their appearance by gaining muscle mass, a significant part of those involved prefer to use strength training [1; 3; 4]. Recently, the «full body» approach has become very popular in strength training, which means working out a significant number of muscle groups in each of the classes. It is such training that is considered the most acceptable for this age group of women, whose main goal is to improve the body [11]. At the same time, the effectiveness of each training session largely depends on the body's readiness for a new load. Basically, women who visit gyms three times a week use passive rest in between classes, in other words, they do not use supportive loads. It should be noted that the average age of 45-50 years is a period when the percentage of muscle mass decreases, and its increase is a difficult task for specialists. The onset of aging of the body, a decrease in the production of a number of hormones also leaves its mark on the productivity of strength training [13; 14; 15; 16]. Nevertheless, strength training leaves certain trace effects in the body of women in the form of muscle pain, fatigue, and a decrease in the desire to perform a new load [8]. Flexibility exercises are often used in the final part of strength training to reduce the negative effect. These exercises are aimed at relieving excess tension in the muscles, calming the nervous system, providing muscle relaxation and, accordingly, a faster outflow of lactic acid. The negative effect of stretching may be due to the fact that the use of stretching exercises contributes

to the predominance of braking processes and reduces strength and speed-strength indicators [10]. Thus, there is a contradiction that the use of additional stretching exercises on rest days can change the performance indicators of women in the following strength training, as for better and for worse.

This empirical experience is important for those who carry out long-term planning and make training programs for middle-aged women who use strength training and count on a systematic increase in strength indicators.

Materials and methods of research

The purpose of this study is to improve the methods of recreational physical exercises with middle-aged women. Research objectives: to analyze the literature in the field of methods of strength training and flexibility training with middle-aged women; to develop a stretching training program for women 45-50 years old; to assess the effect of additional stretching classes on physiological reactions and on the sensory perception of strength training in the participants of the experiment. The hypothesis of the study: the use of stretching classes can positively affect the effectiveness of strength training according to the «full body» program and the recovery process after strength exercises if stretching classes are conducted regularly on a rest day and contain dynamic active exercises.

Theoretical research methods: critical analysis and synthesis of data from relevant literary sources, comparison, deduction, induction. Empirical research methods: fixing strength indicators (squat with a barbell with a weight of 50 % of the maximum (number of times), bench press with a weight of 50 % of the maximum (number of times), lifting straight legs in a hang on a crossbar to an angle of 900 (number of times), pulling up on a low crossbar (number), speed (running 30 m (sec), flexibility (leaning forward from a sitting position (cm). The sensory perception of the subjects was also studied. In particular, a survey was conducted to understand the degree of recovery after strength training: the desire to perform strength training after stretching, as well as a survey to determine the degree of muscle pain and movement restriction (scale from 1 to 5 points). A pedagogical experiment was conducted (randomized controlled trial), mathematical methods of statistical data processing (Student's T coefficient) were used.

The pedagogical experiment was conducted on the basis of Pridnestrovian State University by name of T. G. Shevchenko (Republic of Moldova). The experiment was attended by university teachers – women 45-50 years old, who regularly exercise for a year or more. All participants in the study are overweight (body mass index – 26-28), admitted to classes on the basis of a medical examination and have no contraindications. Prior to the experiment, all participants visited the laboratory to measure strength, speed and flexibility. Based on the data obtained, the women were divided into two equal groups in terms of physical fitness (experimental and control). In the experimental (main) group, women (n=13) were engaged in "full body" strength training three times a week for 90 minutes. The experimental group also conducted stretching classes three times a week for 40 minutes the day after strength training. The control group also included women aged 45-50 (n=12) who use only three strength training sessions per week for 90 minutes. After completing the experimental sessions, the participants of both groups were again tested in the laboratory to assess the indicators of strength, speed and flexibility. Also, at the beginning and at the end of the experiment, the sensory perception of the load was evaluated. The participants shared their feelings immediately before the strength training: the desire to do strength exercises, the degree of muscle pain, limited movement. The experiment lasted from September 2023 to May 2024 (8 months). The participants of the experiment were familiarized with the conditions of the study. The organization and conduct of the study took into account the provisions of bioethics (Helsinki Declaration on "Ethical Principles of Medical Research Involving Humans", 2003) and the "General Declaration on Bioethics and Human Rights" (UNESCO). The personal data of the participants in the experiment were not disclosed.

The results of the research

Full body workouts are considered an ideal option for beginners. With this approach to training, each muscle group receives a sufficient load at each session. Classes in this format are also considered more energy-intensive than split workouts. These workouts are better suited to gain an understanding of the technique of exercises, as well as familiarize the human body with the processes of adaptation to physical exertion. As a rule, the «full body» workout includes basic strength exercises: squats with a barbell, bench press, push-ups and pull-ups, deadlift, overhead barbell press and other popular exercises. When performing these exercises, not one muscle is activated, but several muscle groups at once. It has also been proven that the activation of a large number of muscle groups involved in performing the movement stimulates the production of the hormone testosterone, which, in turn, leads to rapid growth of muscle tissue [11; 21].

The effect of «full body» strength training is observed immediately after the lesson. As a rule, most people report general fatigue, lethargy, minor muscle pain without pronounced location. During the first 12-24 hours, there is more pronounced muscle pain and stiffness of movements. Muscle pain is most often localized in fairly extensive areas of the body. This effect is due to the fact that performing basic exercises involves the function of muscles, ligaments, tendons, fascia not in isolation, but in a complex way. The next workout is practiced after 48 hours and is performed with incomplete recovery (foci of muscle pain remain, stiffness in some movements) [27]. This approach

to strength training is rational and uses the cumulative training effect and the effect of supercompensation. Nevertheless, the constantly present effect of stiffness in movements can have a negative impact on the overall result in terms of strength and quality of human movements as a whole [28]. It is advisable in this case to use various practices aimed at relaxing and stretching the muscles. However, studies show that the use of stretching immediately before strength training leads to a significant decrease in muscle speed and strength [23; 25; 29; 31]. This is largely due to the inhibitory effect of such exercises on the human central nervous system. The transmission of nerve impulses slows down and strength training loses its intensity and quality. Stretching exercises immediately after strength training are carried out in most cases, but, as practice shows, flexibility exercises in this case are effective for a short time and stiffness of movements and muscle pain remain after strength training [26].

Traditionally, stretching classes are also "full body" in nature. At each training session, exercises are performed to develop the mobility of most joints. The main purpose of stretching is to improve joint mobility, however, these workouts also help improve posture. This is important in terms of benefits for strength training. In particular, in such basic exercises as the barbell squat, it is impossible to make progress without having the correct position of the thoracic spine, sufficient flexion in the hip and ankle joints [12].

In addition, the presence of tissue fibrosis, specks in the fascia, and scars, manifested in the form of low flexibility, is actually also a significant limitation for performing strength exercises (insufficient amplitude, early onset of fatigue, difficulty maintaining balance) [5]. Movement restrictions due to the presence of tissue fibrosis, specks in the fascia, and scars occur in most people both in the course of everyday life (forced postures at the workplace or at school) and as a result of unevenly distributed power load in training sessions in the fitness room. A passion for strength training can also have a number of other negative effects if stretching is not used. This is an increase in muscle volume not in those muscle groups that were emphasized in training (an increase in the volume of the muscles of the front of the thigh instead of the muscles of the buttocks). There may also be tension or acute pain in the lower back muscles when performing abdominal strength exercises, as well as pain in the knee joints when performing squats [23; 24]. All this points to the need to reconsider the attitude towards strength training and stretching, as well as their correct combination and alternation in training programs.

The experimental stretching program includes dynamic active exercises that increase the mobility of the spinal column, hip joint, and ankle joint. These are a variety of flexion and extension, rotation, retraction and reduction of legs and arms. Exercises that increase the plasticity of movements were also used. The exercises were performed to calm music after a preliminary warm-up. Emphasis was also placed on breathing when performing training tasks [2].

It is important to note that it is the active and dynamic form of exercise that is considered the most rational today. Dynamic active flexibility exercises allow you to perform movements without pain with the maximum functional amplitude [7]. These forms of performing flexibility exercises are able to best return the actual amplitude to the muscles in everyday and sports movements [6].

Modern research demonstrates the advantage of dynamic stretching to improve performance in adults [22]. Dynamic stretching also has a positive effect on leg strength indicators and reduces stiffness of movements in gymnasts who regularly use both strength exercises and stretching [19]. Dynamic stretching helps to reduce the stiffness of muscles and tendons [22]. In particular, dynamic stretching has a positive effect on the indicators of dexterity of movements [20]. Dynamic stretching is considered more effective for injury prevention if used before intensive training [30].

Before the start of the experiment, the women demonstrated average indicators in the level of development of physical qualities according to the norms of this age. It should be noted that women have been practicing for more than a year under the «full body» program, however, the desired progress in terms of movement strength was not observed (Table 1).

Table 1 – Indicators of strength, flexibility and speed of movement in women before the start of the experiment

Indicators	Experimental group (n=13)			Control group (n=12)			*t*	*p*
	$\bar{x}$	*S*	*m*	$\bar{x}$	*S*	*m*		
Barbell Squat (one time)	8.5	2.1	0.7	9.0	2.0	0.6	0.7	>0.05
Bench press from the chest (once)	13.5	2.5	0.8	13.9	2.7	0.9	0.9	>0.05
Lifting straight legs in the temple (once)	3.7	0.9	0.27	3.5	0.7	0.2	0.6	>0.05
Pull-up on a low crossbar (one time)	5.5	0.7	0.2	5.8	0.7	0.2	0.6	>0.05
Forward tilt (cm)	6.4	1.0	0.3	6.9	1.3	0.4	0.8	>0.05
Running 30 m (sec)	7.5	1.2	0.4	7.9	1.4	0.45	0.6	>0.05

N o t e. *The differences are significant at t=2.05 (α=0.05); t=2.78 (α=0.01); df=23

A survey before the start of the experiment determined that women return to training after two days of rest with the presence of muscle pain, and also experience limited movement in selected muscle groups. They assessed the degree of muscle pain and limited movement on a scale from 1 to 5. Also, on a scale from 1 to 5, women assessed the degree of desire to engage in strength exercises. Based on their experience of training for a year or more, women could most objectively assess their feelings from strength training and the degree of recovery after classes. In general, women noted significant muscle pain 48 hours after strength training and a decrease in the desire to perform strength exercises (Table 2).

Table 2 – Indicators of women's recovery after strength training before the start of the experiment

Indicators	Experimental group (n=13)		Control group (n=12)		*U*	*p*
	$\bar{x}$	The sum of the anks	$\bar{x}$	The sum of the anks		
Muscle pain and limited movement	4.0	178.5	4.3	146.5	68.5	>0.05
The desire to do strength exercises	3.5	173.0	3.7	152.0	74.0	>0.05

N o t e . *The differences are significant at U=35(α=0.05); U=47(α=0.01)

After the completion of the pedagogical experiment. the indicators of strength, flexibility and speed of movement in both groups of subjects were again determined. After 8 months of regular training in strength exercises according to the "full body" program, as well as stretching. the experimental group showed significant progress in test exercises, unlike the control group. Significant differences between the average indicators were recorded in squatting with a barbell (p<0.01), pulling up on the crossbar (p<0.01), leaning forward (p<0.01). chest press (p<0.05), understanding straight legs in the hang (p<0.05). Improvements in performance were also recorded in the 30 m run, although there was no significant difference between the groups (Table 3).

Table 3 – Indicators of strength, flexibility and speed of movement in women after the experiment

Indicators	Experimental group (n=13)			Control group (n=12)			*t*	*p*
	$\bar{x}$	*S*	*m*	$\bar{x}$	*S*	*m*		
Barbell Squat, one time	10.2	2.4	0.8	9.5	2.5	0.8	2.8	<0.01
Bench press from the chest, once	15.5	2.7	0.9	14.2	2.7	0.9	2.7	<0.05
Lifting straight legs in the temple, once	4.6	0.8	0.25	3.9	0.7	0.2	2.5	<0.05
Pull-ups on a low crossbar, times	8.5	0.6	0.2	6.7	0.6	0.2	3.5	<0.01
Forward tilt, cm	11.5	4.1	1.2	7.0	1.5	0.5	5.2	<0.01
Running 30 m, sec	7.2	1.1	0.3	8.0	1.5	0.45	1.7	>0.05

N o t e. *The differences are significant at t=2.05 (α=0.05); t=2.78 (α=0.01); df=23

Indicators of the degree of recovery after a power load (when using stretching, and without these classes) were also studied. It can definitely be said that the data obtained indicate the advantage of the introduction of stretching for middle-aged women engaged in strength exercises according to the «full body» program. So, the women in the experimental group noted that when using stretching, they stopped experiencing muscle pain 48 hours after the power load. In the control group, a significant proportion of women still noted muscle pain and limited movement before the next power load. Significant differences in average values were recorded between the groups (p<0.01). There were also significant differences between the groups of subjects in the indicators of the desire to perform power loads again (p<0.01). Women using stretching as a supportive load noted a desire to perform strength training at 5 points on a 5-point scale, unlike the control group, where the average score was 3.5 (Table 4).

Table 4 – Indicators of women's recovery after a power load after the experiment

Indicators	Experimental group (n=13)		Control group (n=12)		*U*	*p*
	$\bar{x}$	The sum of the anks	$\bar{x}$	The sum of the anks		
Muscle pain and limited movement	2.0	94.0	4.5	231.0	3.0	<0.01
The desire to do strength exercises	5.0	237.0	3.5	88.0	10.0	<0.01

N o t e. *The differences are significant at U=35(α=0.05); U=47(α=0.01)

Discussion

The modern view of the strength training of middle-aged women is directed towards greater functionality and diversity. In this regard, the training program «full body» is the best way to implement this idea. However, as studies have shown, these training sessions are still not universal. In particular, when doing strength exercises three times a day, the desired increase in strength, speed and flexibility is not observed. The recovery process after strength training also requires improvement, since middle-aged women in most cases noted muscle pain and limited movement, as well as a decrease in the desire to perform strength exercises again [17].

Significant changes in the level of strength exercises can be explained by the beneficial effect of stretching exercises, which normalizes blood circulation, reduces muscle tension, while reducing the risk of injury, improving the activity of the central nervous system [18]. It can also be assumed that the improvement in performance in exercise tests is associated with those subjective feelings that women recorded after stretching. In particular, women who regularly use stretching, note a decrease in pain and stiffness of movements from strength exercises, as well as a high desire to train again. All this makes it possible to perform a wide variety of exercises in training for strength development according to the «full body» program, as well as progress in the amount of weights and in the intensity of strength exercises in training sessions.

Despite the fact that some researchers note that stretching in general has a negative effect on strength and speed of movement, if it is used as a warm-up, a different role was defined in this study for stretching. The proposed exercises were used as an active means of muscle recovery after strength training, contained only dynamic active exercises and were carried out according to the «full body» program.

The hypothesis put forward at the beginning of the study was confirmed. Regular stretching classes conducted on a day off from strength training, containing dynamic active exercises and used for 8 months, can have a positive effect on progress in the development of physical qualities (strength, flexibility, speed of movement), as well as on the processes of recovery from strength training.

Conclusions

1. Regular 40-minute stretching sessions containing dynamic active exercises and used on rest days between strength training according to the «full body» program by women 45-50 years old for 8 months have a positive effect on strength, flexibility, and speed of movement. Also, this approach to alternating strength training and stretching can be effective for recovery after intense strength training. Stretching classes should contain dynamic active exercises and be conducted according to the «full body» program.

2. As a result of the study, progress was noted in the experimental group and, in comparison with the control group, significant positive changes were recorded in squatting with a barbell ($p<0.01$), pulling up on the crossbar ($p<0.01$), leaning forward ($p<0.01$), chest press ($p<0.05$), understanding straight lines 3. In the experimental group, significant positive changes were noted in the assessment of recovery processes: muscle pain and limited movement ($p<0.01$), the desire to perform strength exercises ($p<0.01$).

Conflict of interest. The authors state that there is no conflict of interest.

References

1. Khurtenko, O. V., Patsan, V. M. (2021), «Struktura i zmist grupovih zanyat' silovim fitnesom z zhinkami 35-40 rokiv» [Structure and content of strength fitness group classes with women 35-40 years old]. *Prospects, problems and existing achievements of the development of physical culture and sports in Ukraine*. IV All-Ukrainian internet conference «Color of science», pp. 167-171. [in Ukraine].
2. Ruban, L. Putyatyna, R., Tsikhanovska, N. Cihanovs'ka, N. (2021), «Vpliv ozdorovchoї ruhovoї aktivnosti na vegetativnij balans zhinok pohilogo viku» [The effect of recreational motor activity on the vegetative balance of elderly women]. *Slobozhansky Bulletin of Science and Sports*, 5(85), pp. 34-39. [in Ukraine].
3. Sologubova, S. V. (2015), «Vpliv individual'nih program na fizichnij stan zhinok pershogo zrilogo viku» [The influence of individual programs on the physical condition of women of the first mature age]. *Physical education and sports in the context of the state program for the development of physical culture in Ukraine: experience, problems, prospects*, pp. 100-104. [in Ukraine].
4. Chernozub, A. A. (2016), «Bezpechni ta kritichni rivni fizichnih navantazhen' dlya trenovanih ta netrenovanih osib v umovah m'yazovoї diyal'nosti silovoї spryamovanosti» [Safe and critical levels of physical exertion for trained and untrained individuals in conditions of strength-oriented muscle activity]. *Physiological journal,* 62, № 2, pp. 110-117. [in Ukraine].

Література та джерела

1. Хуртенко О. В., Пацан, В. М. Структура і зміст групових занять силовим фітнесом з жінками 35-40 років. *Перспективи, проблеми та наявні здобутки розвитку фізичної культури і спорту в Україні: IV Всеукраїнська інтернет-конференція «Color of science,* 29 січня 2021 року. С. 167-171.
2. Рубан Л., Путятина Р., Ціхановська Н., Вплив оздоровчої рухової активності на вегетативний баланс жінок похилого віку. *Слобожанський Вісник науки і спорту*. 2021 5(85), 34-39. URL: https://doi.org/10.15391/snsv.2021-5.005
3. Сологубова С. В. Вплив індивідуальних програм на фізичний стан жінок першого зрілого віку. *Фізичне виховання та спорт у контексті державної програми розвитку фізичної культури в Україні: досвід, проблеми, перспективи*. 2015. С. 100-104.
4. Чернозуб А. А. Безпечні та критичні рівні фізичних навантажень для тренованих та нетренованих осіб в умовах м'язової діяльності силової спрямованості. *Фізіологічний журнал*. 2016. Т. 62. № 2. С. 110-117.
5. Amann, M., Proctor, L. T., Sebranek, J. J., Pegelow, D. F., & Dempsey, J. A. (2009). Opioid-mediated muscle afferents inhibit central motor drive and limit peripheral muscle fatigue development in humans. *The Journal of Physiology*, 587(1), 271–283. doi:10.1113/jphysiol.2008.163303

5. Amann, M., Proctor, L. T., Sebranek, J. J., Pegelow, D. F., & Dempsey, J. A. (2009). Opioid-mediated muscle afferents inhibit central motor drive and limit peripheral muscle fatigue development in humans. *The Journal of Physiology*, 587(1), 271–283. doi:10.1113/jphysiol.2008.163303
6. Behm, D. G., Chaouachi, A. (2011). A review of the acute effects of static and dynamic stretching on performance. *European Journal of Applied Physiology*, 111, 2633-2651.
7. Behm, D. G., Kay, A. D., Trajano, G. S. et al. (2011). Mechanisms underlying performance impairments following prolonged static stretching without a comprehensive warm-up. *Eur J Appl Physiol,* 121, 67–94 (2021). https://doi.org/10.1007/s00421-020-04538-89
8. Berchicci, M., Menotti, F., Macaluso, A., & Di Russo, F. (2013). The neurophysiology of central and peripheral fatigue during sub-maximal lower limb isometric contractions. *Frontiers in Human Neuroscience,* 7, 135. doi:10.3389/fnhum.2013.00135
9. Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Med Sci Sports Exerc,* 14, 377-381.
10. Chaabene, H., Behm, D. G., Negra, Y., Granacher U. (2019). Acute Effects of Static Stretching on Muscle Strength and Power: An Attempt to Clarify Previous Caveats. *Frontiers in Physiology*. https://doi.org/10.3389/fphys.2019.01468
11. Da Silva-Grigoletto Marzo, E., Marceli, M. A. Mesquita, Aragão-Santos, José C., Marta S. Santos, Resende-Neto, Antônio G., De Santana, Josimari M., Behm, D. G. (2019). Functional Training Induces Greater Variety and Magnitude of Training Improvements than Traditional Resistance Training in Elderly Women. *Journal of Sports Science and Medicine,* 18, 789-797.
12. Dallas, G., Pappas, P., Dallas, C. f, & Paradisis, G. (2021). Acute effects of dynamic and pnf stretching on leg and vertical stiffness on female gymnasts. *Science of Gymnastics Journal*, 13(2), 263-273. https://doi.org/10.52165/sgj.13.2.263-273
13. Figueiredo, V. C., de Salles, B. F., Trajano, G. S. (2018). Volume for Muscle Hypertrophy and Health Outcomes: The Most Effective Variable in Resistance Training. *Sports Medicine,* 48, 499-505.
14. Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W.J., Burke, G., McBurnie, M. A. (2001). Frailty in older adults: evidence for a phenotype. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences,* 56, 146-156.
15. Garcia-Hermoso, A., Cavero-Redondo, I., Ramirez-Velez, R., Ruiz, J. R., Ortega, F. B., Lee, D. C., Martinez-Vizcaino, V. (2018). Muscular Strength as a Predictor of All-Cause Mortality in an Apparently Healthy Population: A Systematic Review and Meta-Analysis of Data From Approximately 2 Million Men and Women. *Archives of Physical Medicine and Rehabilitation*, 99, 2100-2113.
16. Hicks, G. E., Shardell, M., Alley, D. E., Miller, R. R., Bandinelli, S., Guralnik, J., Lauretani, F., Simonsick, E. M., Ferrucci, L. (2012). Absolute strength and loss of strength as predictors of mobility decline in older adults: the In CHIANTI study. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences,* 67, 66-73.
17. Kadlec, D., Sainani, K. L., Nimphius, S. (2023). With Great Power Comes Great Responsibility: Common Errors in Meta-Analyses and Meta-Regressions in Strength & Conditioning Research. *Sports Medicine,* 53, 313-325.
18. Kataura, S., Suzuki S., Matsuo, S., Hatano, G., Iwata, M., Yokoi, K., Tsuchida, W., Banno, Y., Asai, Y. (2017). Acute Effects of the Different Intensity of Static Stretching on Flexibility and Isometric Muscle Force. *Journal of Strength and Conditioning Research,* 31, 3403-3410. DOI: 10.1519/JSC.0000000000001752
19. Kay, A. D., Husbands-Beasley, J. and Blazevich, A. J. (2015). Effects of Contract-Relax, Static Stretching, and Isometric Contractions on Muscle-Tendon Mechanics. *Medicine and Science in Sport and Exercis*e, 47(10), 2181-2190. doi: https://doi.org/10.1249/MSS.0000000000000632
20. Konrad, A., Stafilidis, S. Tilp, M. (2017). Effects of acute static, ballistic, and PNF stretching exercise on the muscle and tendon tissue properties. *Scandinavian Journal of Medicine and Science in Sport*, 27 (10), 1070-1080. doi: https://doi.org/10.1111/sms.12725
21. Lohne-Seiler, H., Torstveit, M. K., Anderssen, S. A. (2013). Traditional

20. Konrad, A., Stafilidis, S. Tilp, M. (2017). Effects of acute static, ballistic, and PNF stretching exercise on the muscle and tendon tissue properties. *Scandinavian Journal of Medicine and Science in Sport*, 27 (10), 1070-1080. doi: https://doi.org/10.1111/sms.12725
21. Lohne-Seiler, H., Torstveit, M. K., Anderssen, S. A. (2013). Traditional versus functional strength training: effects on muscle strength and power in the elderly. *Journal of Aging and Physical Activity,* 21, 51-70.
22. Lucas, S., Koslow, R. (1984). Comparative study of static, dynamic, and proprioceptive neuromuscular facilitation stretching techniques on flexibility. *Perceptual and Motor Skills*, 58 (2), 615-618. doi: https://doi.org/10.2466/pms.1984.58.2.615
23. McMillian, D. J., Moore, J. H., Hatler, B. S. Taylor, D. C. (2006). Dynamic vs. static-stretching warm up: The effect on power and agility performance. *Journal of Strength and Conditioning Research,* 20 (3), 492–499. doi: https://doi.org/10.1519/00124278-200608000-00006
24. Rees, S. S., Murphy, A. J., Watsford, M. L., McLachlan, K. A. and Coutts, A. J. (2007). Effects of Proprioceptive Neuromuscular Facilitation stretching on stiffness and force-producing characteristics of the ankle in active women. *Journal of Strength and Conditioning Research*, 21(2), 572-577. doi: https://doi.org/10.1519/00124278-200705000-00049
25. Sa, M. A., Matta, T. T., Carneiro, S. P., Araujo, C. O., Novaes, J. S. and Oliveira, L. F. (2016). Acute effects of different methods of stretching and specific warm-ups on muscle architecture and strength performance. *Journal of Strength and Conditioning Research*, 30(8), 2324-2329. doi: https://doi.org/10.1519/JSC.0000000000001317
26. Sharman, M. J., Cresswell, A. G. and Riek, S. (2006). Proprioceptive neuromuscular facilitation stretching: mechanisms and clinical implications. *Sports Medicine*, 36(11), 929-939. doi: https://doi.org/10.2165/00007256-200636110-00002
27. Tschakert, G., Handl, T., Weiner, L., Birnbaumer, P., Mueller, A., Groeschl, W., Hofmann, P. (2022). Exercise duration: Independent effects on acute physiologic responses and the need for an individualized prescription. *Physiological Reports*, 10, e15168. https://doi.org/10.14814/phy2.15168
28. de Queiros, Victor S., Rolnick, N., Sabag, A., Wilde, P., Peçanha, T., Aniceto, Rodrigo R., Rocha, Roberto Felipe C., Delgado, Douglas Z. (2024). Effect of High-Intensity Interval Exercise versus Continuous Low-Intensity Aerobic Exercise with Blood Flow Restriction on Psychophysiological Responses: A Randomized Crossover Study. *Journal of Sports Science and Medicine,* 23, 114-125. https://doi.org/10.52082/jssm.2024.114
29. Wenlu, Yu, DeSen, Feng, Ya, Zhong, Xiaohong, Luo, Qi, Xu, Jiaxiang, Yu. (2024). Examining the Influence of Warm-Up Static and Dynamic Stretching, as well as Post-Activation Potentiation Effects, on the Acute Enhancement of Gymnastic Performance: A Systematic Review with Meta-Analysis. *Journal of Sports Science and Medicine,* 23, 156-176. https://doi.org/10.52082/jssm. 2024.156
30. Woods, K., Bishop, P., Jones, E. (2007). Warm-up and stretching in the prevention of muscular injury. *Sports Medicine*, 37(12), 1089-1099. https://doi.org/10.2165/00007256-200737120-00006
31. Young, W., Elias, G., Power, J. (2006). Effects of static stretching volume and intensity on plantar flexor explosive force production and range of motion. *Journal of sports medicine and physical fitness,* 46(3), 403.

versus functional strength training: effects on muscle strength and power in the elderly. *Journal of Aging and Physical Activity,* 21, 51-70.
22. Lucas, S., Koslow, R. (1984). Comparative study of static, dynamic, and proprioceptive neuromuscular facilitation stretching techniques on flexibility. *Perceptual and Motor Skills*, 58 (2), 615-618. doi: https://doi.org/10.2466/pms.1984.58.2.615
23. McMillian, D. J., Moore, J. H., Hatler, B. S. Taylor, D. C. (2006). Dynamic vs. static-stretching warm up: The effect on power and agility performance. *Journal of Strength and Conditioning Research,* 20 (3), 492–499. doi: https://doi.org/10.1519/00124278-200608000-00006
24. Rees, S. S., Murphy, A. J., Watsford, M. L., McLachlan, K. A. and Coutts, A. J. (2007). Effects of Proprioceptive Neuromuscular Facilitation stretching on stiffness and force-producing characteristics of the ankle in active women. *Journal of Strength and Conditioning Research*, 21(2), 572-577. doi: https://doi.org/10.1519/00124278-200705000-00049
25. Sa, M. A., Matta, T. T., Carneiro, S. P., Araujo, C. O., Novaes, J. S. and Oliveira, L. F. (2016). Acute effects of different methods of stretching and specific warm-ups on muscle architecture and strength performance. *Journal of Strength and Conditioning Research*, 30(8), 2324-2329. doi: https://doi.org/10.1519/JSC.0000000000001317
26. Sharman, M. J., Cresswell, A. G. and Riek, S. (2006). Proprioceptive neuromuscular facilitation stretching: mechanisms and clinical implications. *Sports Medicine*, 36(11), 929-939. doi: https://doi.org/10.2165/00007256-200636110-00002
27. Tschakert, G., Handl, T., Weiner, L., Birnbaumer, P., Mueller, A., Groeschl, W., Hofmann, P. (2022). Exercise duration: Independent effects on acute physiologic responses and the need for an individualized prescription. *Physiological Reports*, 10, e15168. https://doi.org/10.14814/phy2.15168
28. de Queiros, Victor S., Rolnick, N., Sabag, A., Wilde, P., Peçanha, T., Aniceto, Rodrigo R., Rocha, Roberto Felipe C., Delgado, Douglas Z. (2024). Effect of High-Intensity Interval Exercise versus Continuous Low-Intensity Aerobic Exercise with Blood Flow Restriction on Psychophysiological Responses: A Randomized Crossover Study. *Journal of Sports Science and Medicine,* 23, 114-125. https://doi.org/10.52082/jssm.2024.114
29. Wenlu, Yu, DeSen, Feng, Ya, Zhong, Xiaohong, Luo, Qi, Xu, Jiaxiang, Yu. (2024). Examining the Influence of Warm-Up Static and Dynamic Stretching, as well as Post-Activation Potentiation Effects, on the Acute Enhancement of Gymnastic Performance: A Systematic Review with Meta-Analysis. *Journal of Sports Science and Medicine,* 23, 156-176. https://doi.org/10.52082/jssm. 2024.156
30. Woods, K., Bishop, P., Jones, E. (2007). Warm-up and stretching in the prevention of muscular injury. *Sports Medicine*, 37(12), 1089-1099. https://doi.org/10.2165/00007256-200737120-00006
31. Young, W., Elias, G., Power, J. (2006). Effects of static stretching volume and intensity on plantar flexor explosive force production and range of motion. *Journal of sports medicine and physical fitness,* 46(3), 403.

Надійшла до друку 21.05.2024