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Comparison of Acute Effects of Foam Roller Combined with Static-Dynamic Stretching on Combat Athletes' Performances: Experimental Research

Statik-Dinamik Isınma ile Kombine Edilmiş Foam Roller Uygulamasının Dövüş Sporcularının Performansı Üzerine Akut Etkilerinin Karşılaştırılması: Deneysel Araştırma

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ABSTRACT Objective: The purpose of this study is to examine the acute effects of combine foam roller (FR) and routine warm-up protocols on some performance parameters in combat athletes. **Material and Methods:** A total of 16 fighters (boxing, kickboxing, muaythai) athletes, 7 female and 9 male, were included in the study. The study was carried out with 2 measurements with an interval of 1 week. On the first day, the athletes were tested for flexibility, sprint, agility, and jumping, respectively, after performing static-dynamic stretching after 10 minutes of low-paced jogging. On the second day, the athletes were tested for flexibility, sprint, agility, and jumping, respec- tively, after performing static-dynamic stretching and foam roller exercises, respectively, after 10 minutes of low-paced jogging. Statistical analysis of the data obtained in the study was made using the IBM SPSS 23 analysis program. Wilcoxon Signed-Rank test was used to evaluate the difference between different warm-up protocols. Significance level was accepted as $p<0.05$. **Results:** Significant difference was observed 20 m sprint performance between the static stretching (SS)+dynamic stretching (DS) and FR warm-up protocols combined static stretching and dynamic stretching in favor of SS+DS ($p<0,05$). When the vertical jump height between the 2 different warm-up protocols of the athletes were examined, while a significant difference was found in jump height (cm) in favor of SS+DS. it was seen that there is a significant difference in favor of SS+DS+FR in the jump numbers of the athletes ($p<0.05$). **Conclusion:** FR combine static and dynamic stretching protocols do not have a positive effect on performance parameters in combat athletes, but SS+DS can improve athletes' vertical jump height and anaerobic performances.

Keywords: Vertical jump; flexibility; foam roller; warm-up

ÖZET Amaç: Bu çalışmanın amacı, dövüş sporcularında rutin ısınma protokollerine ek olarak foam roller (FR) uygulamasının bazı performans parametreleri üzerine akut etkisini incelenmektir. **Gereç ve Yöntemler:** Çalışmaya 7 kadın, 9 erkek olmak üzere toplam 16 dövüş (boks, kickboks, muaythai) sporcusu dâhil edildi. Çalışma, 1 hafta arayla 2 ölçümle gerçekleştirilmiştir. Birinci gün sporcular 10 dk'lık düşük tempolu koşu sonrasında statik-dinamik esneme yaptıktan sonra sırasıyla esneklik, sprint, çeviklik ve zıplama testlerine tabi tutuldu. İkinci gün sporcular 10 dk'lık düşük tempolu koşu sonrasında sırasıyla statik-dinamik germe ve FR egzersizlerini yaptıktan sonra sırasıyla esneklik, sprint, çeviklik ve sıçrama testlerine tabi tutuldu. Araştırmada elde edilen verilerin istatistiksel analizi IBM SPSS 23 analiz programı kullanılarak yapılmıştır. Farklı ısınma protokolleri arasındaki farkı değerlendirmek için Wilcoxon Signed-Rank testi kullanıldı. Anlamlılık düzeyi $p<0,05$ olarak kabul edildi. **Bulgular:** Statik ısınma (SI)+dinamik ısınma (DI) protokolü ve SI ve DI ile kombine FR ısınma protokolleri arasındaki 20 m sürat parametresinde FR uygulanmayan SI+DI lehine istatistiksel olarak anlamlı bir fark gözlenmiştir. ($p<0,05$).Sporcuların farklı 2 ısınma protokolleri arasındaki dikey sıçrama değerleri incelendiğinde; sıçrama yüksekliğinde (cm) SI+DI lehine anlamlı bir fark olduğu görülmektedir ($p<0,05$). Sporcuların sıçrama sayılarında SI+DI+FR lehine anlamlı bir fark olduğu görülmektedir ($p<0,05$). **Sonuç:** Dövüş sporcularında SI ve DI protokollerine ek olarak, FR uygulamalarının performans parametreleri üzerinde olumlu yönde bir etki oluşturmadığı, ancak SI ve DI'nın sporcuların dikey sıçrama ve anaerobik performanslarını geliştirebileceği söylenebilir.

Anahtar Kelimeler: Dikey sırçama; esneklik; foam roller; ısınma

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In order to increase efficiency, warm-up is performed before competition and training today. Warm-up generally include low-intensity aerobic exercises followed by static stretching (SS), dynamic stretching (DS) methods and branch-specific exercises and these are carried out in order to reach maximum performance.[1,2] Stretching exercises are performed to increase the length of the muscle and joint, to prevent injuries and to increase the range of motion.[3,4] SS exercises are carried out between 10-30 seconds, the pain spot is approached slowly and waited for a while, thus relaxation is achieved easily, and it is a simple method in terms of application.[5] Another method, DS, is performed passively (with support or with a partner) and actively (without assistance) and for each muscle group 8-12 repetitions and 3-4 sets are recommended.[6]

In particular, studies are carried out to achieve maximum efficiency in long-term training plans to improve athletic performance, but the number of studies conducted specifically for the warm-up section, which significantly affects athletic performance, is limited.[7] Apart from warm-up and stretching exercises, administrations such as heater pomade, passive warming methods, hot shower and massage are performed.[8] It was emphasized that massage, one of these methods, can have a positive effect on performance thanks to pressure on the tissue and myofascial stimulation with different techniques. Moreover, foam roller (FR), which is made of FR, with which the individual can create pressure on the fascia with his own body weight without outside help, is popularly used by trainers, conditioners, and clinicians as an alternative to many methods applied for myofascial stimulation. The effects of this method, which is said to contribute to range of motion and muscle length, on performance are also being investigated.[9,10] FR, which can be briefly explained as self-massage, is used to optimize warm-up design, increase performance, treat tension in connective tissues, and for post-exercise recovery.[11,12] Generally, 18 and 36 inch sizes are preferred.[13] FR, which has a cylindrical shape, is applied on the muscle tissue with the pressure created by the individual's own body weight with forward and backward movement in certain sets and times.[14]

It is suggested that adding FR exercise to warm-up protocols has the potential to have a positive effect on sprint, agility, and power performance.[15] FR, about which there are also controversial results, is widely used to increase joint range of motion (JRM) without reducing performance.[16,17] The studies carried out indicate that FR increase JRM more than SS and DS, and FR has positive effects on muscle peak power production capacity compared to SS. Moreover, it was observed that FR gives similar results with the DS on strength and jump performance.[9,18] Furthermore, in another study, it was stated that additional FR exercise to DS had positive results in squat jump and countermovement jump values compared to DS alone.[19]

Based on all this information, there is little evidence about the acute effects of FR warm-up protocols, which have recently been widely used in sports sciences, on athletes' sprint, agility, power, flexibility, and jumping abilities. In this context, the aim of this study is to examine the acute effects of FR on these performance parameters in addition to routine warm-up protocols in combat athletes.

MATERIAL AND METHODS

The research protocol was approved by the Ethics Committee of Karabük University Hasan Doğan School of Physical Education and Sports dated 20.12.2022 and numbered 2022/1198. Our study was carried out in accordance with the Non-Invasive Clinical Research Ethics Committee guidelines. This study was conducted in accordance with the principles of the Declaration of Helsinki. All participans in the study signed an informed consent form.

STUDY GROUP

A total of 16 fighters (boxing, kickboxing, muaythai) athletes, 7 female and 9 male, were included in the study. The mean age of the man athletes is 16.2±0.89, and the average height is 172.1±2.19. The mean weight was found to be 67.6±2.73. The mean age of the female athletes is 15.1±0.55, and the average height is 160.7±1.47. The mean weight was found to be 58.7±1.11. The athletes did not have any injuries or health problems. The athletes were informed about the purpose and content of the study and the best and healthiest measurements were taken.

STUDY DESIGN

The study was carried out in 2 days with an interval of 1 week. On the first day, the athletes were tested for flexibility, sprint, agility, and jumping, respectively, after performing static-DS after 10 minutes of jogging. Athletes continued their technical training for 1.5 hours 3 days a week for a week. On the second day, the athletes were tested for flexibility, sprint, agility, and jumping, respectively, after performing static-DS and foam roller exercises, respectively, after 10 minutes of low-paced jogging.

SS and DS Protocol: After 10 minutes of low-paced jogging at 5 km/h, standing wall calf stretches, standing quadriceps stretches, standing hamstring stretches, and seated gluteus maximus SS were performed for 2x30 seconds, with 10 seconds of passive rest between the sets (Table 1).[20]

In the dynamic stretching after the SS, DS such as high knees, walking pigeon, butt kickers, skips, leg swings, and open hips were performed for 1x20 seconds for each leg (Table 2).[19]

SS, DS and FR Warm-up Protocol: FR exercises were performed after SS and DS. A 36 inch FR was applied to both sides of the hamstrings, quadriceps, gluteus, and gastrocnemius muscles for 2x30 seconds with 10 seconds of passive rest. The athletes were given a 30-second rest period between the exercise sets (Figure 1).[21]

TABLE 1: Static warm up exercises.[20]

Exercise	Setxseconds (for each leg)
Standing wall calf stretches	2x30 sec
Standing quadriceps stretches	2x30 sec
Standing hamstring stretches	2x30 sec
Seated gluteus maximus stretches	2x30 sec

TABLE 2: Dynamic warm up exercises.[19]

Exercise	Setxseconds (for each leg)
High knees	1x20 sec
Walking pigeon	1x20 sec
Butt kickers	1x20 sec
Skips	1x20 sec
Leg swings	1x20 sec
Open ips	1x20 sec

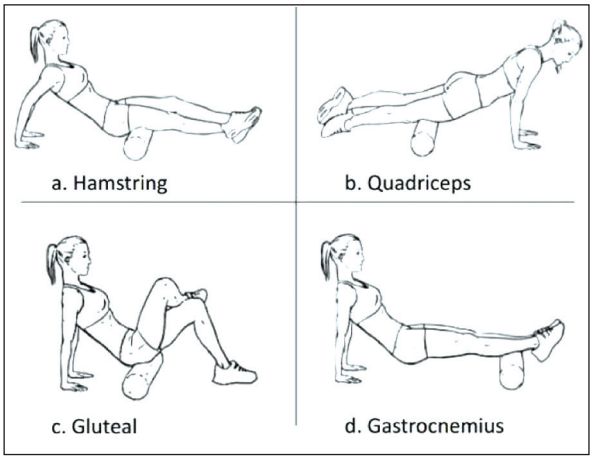

FIGURE 1: Foam roller warm up exercises.[21]

HEIGHT AND BODY ANALYSIS MEASUREMENT

Height measurements were conducted with a height meter with an accuracy of 0.01 m. Body analysis of the athletes, namely body weight (kg) and body fat percentage (%), was determined with the Inbody 270 (Seul, South Korea) brand professional body analyzer device.[22]

SPRINT TEST

The sprint performances of the athletes were measured with the Smart Speed Pro (Fusionsport, Australia) brand photocell installed between 10-20-30 m in the gym. The beginning was 1 meter behind the photocell. Two measurements were made with an interval of 3 minutes and the best score was recorded.[23]

PRO AGILITY TEST

The 5-10-5 agility test is a test consisting of running fast in a round-trip form of a 5-m field where the distance is 10 m. Fusion Sport brand Smart Speed Pro reactive wireless photocell to be installed in the area where the test was going to be applied was placed on the 5 m line. The door in the same direction with the start was positioned as the stopping door and the other door as the starting door. The time of the round-trip distance of 5 m was recorded in seconds. During the implementation period of the test, a 5-minute break was taken and the test was administered twice, and the best score was recorded.[24]

SIT AND REACH FLEXIBILITY TEST

A sit-reach flexibility bench was used to measure flexibility. The sit-reach flexibility test measures

hamstring flexibility first and lower back, hip, and calf flexibility second.[25] The test was carried out with a bench with a length of 35 cm, a width of 45 cm and a height of 32 cm, an upper surface length of 55 cm, an upper surface width of 45 cm, and whose top surface is 15 cm outside the surface on which the legs rest and which has a measuring ruler of 0-50 cm on the upper surface. The subjects sat on the floor, stretched their legs, put the soles of their feet on the front of the bench, extended their arms as far as possible on the meter on the upper surface of the table, and waited for a few seconds at the last point where their fingertips touched. The last point of contact on the meter was determined and recorded in cm. In cases when the participants' legs were bent before or during the waiting period and the contact with the ground was lost, the measurements were deemed invalid and repeated.[26]

VERTICAL JUMP HEIGHT TEST

Jumping performance measurements of the athletes were made with the Smart Speed Jump (Fusionsport, Australia) device mat. For the active jump measurements, the athletes quickly got down at the knees and jumped vertically, with their hands on their waists, their knees fully extended and in an upright position.[27] The best of 2 attempts was recorded.

MULTIPLE JUMP TEST

To conduct multiple jump measurements, the athletes tried to reach the maximal height for 30 seconds with their hands on their waists and knees at 90 degrees during squatting with Smart Speed Jump device mat. Two measurements were taken at 3-minute intervals and the best value was recorded.[28]

STATISTICAL ANALYSIS

This was a multiple cross-over trial. The statistical analysis of the values obtained from the study was performed using the IBM SPSS 23 (Chiago, IL) analysis program. The arithmetic mean and standard deviation values of the data were calculated. Wilcoxon Signed-Rank test was used to evaluate the difference between different warm-up protocols. The significance level was interpreted as $p<0.05$.

RESULTS

When Table 3 is examined, the mean age of the man athletes is 16.2±0.89, and the average height is 172.1±2.19. The mean weight was found to be 67.6±2.73. Body mass index was determined as 22.8±0.72 and body fat percentage as 17.4±2.32. Body muscle mass was determined as 31.2±1.34 (Table 3). When Table 3 is examined, the mean age of the female athletes is 15.1±0.55, and the average height is 160.7±1.47. The mean weight was found to be 58.7±1.11. Body mass index was determined as 21.9±0.56 and body fat percentage as 25.4±1.82. Body muscle mass was determined as 23.7±0.9 (Table 3).

While a statistically significant difference was observed in the 20 m sprint parameter (z=-2.17, p=0.03) between the SS+DS and SS+DS+FR warm-up protocols, no statistical significance was observed in the 10 m sprint, 30 m sprint, agility, and flexibility parameters between the 2 groups (Table 4).

While a statistically significant difference was observed in the jump height parameter (z=-2.99, p<0.00) between the SS+DS and SS+DS+FR warm-up protocols, no statistical difference was observed in the flight time maximum power and maximum power/kg parameters between the 2 groups (Table 5).

While a statistically significant difference was observed in the mean elevation (z=-3.05, p=0.00),

TABLE 3: The mean and standard deviation values of the descriptive characteristics of the participants (n=16).

Parameters	Sex	Mean±SD
Age (year)	Female	15.1±0.55
	Male	16.2±0.89
Height (cm)	Female	160.7±1.47
	Male	172.1±2.19
Body weight (kg)	Female	58.7±1.11
	Male	67.6±2.73
BMI (kg/m^2)	Female	21.9±0.56
	Male	22.8±0.72
Body fat percentage (%)	Female	25.4±1.82
	Male	17.4±2.32
Body muscle mass (kg)	Female	23.7±0.9
	Male	31.2±1.34

TABLE 4: Comparison of the sprint, agility, and flexibility means of the participants' after different warm-up protocols (n=16).

Parameters	SS+DS Mean±SD	SS+DS+FR
10 m sprint (sec)	2.11±0.05	2.12±0.04
20 m sprint (sec)	3.58±0.08*	3.62±0.08
30 m sprint (sec)	5.09±0.12	5.10±0.12
Agility (sec)	5.93±0.09	5.99±0.11
Flexibility (cm)	31.4±1.67	32.1±1.59

*p<0.05; SS: Static stretching; DS: Dynamic stretching; FR: Foam roller.

TABLE 5: Comparison of the vertical jump height means of the participants after different warm-up protocols (n=16).

Parameters	SS+DS Mean±SD	SS+DS+FR
Height (cm)	31.9±1.79*	31.7±1.55
Flight time (msec)	507.1±13.8	506.4±12.2
Maximum power (kg)	2898.3±155.6	3041.8±94
Maximum power/mass	46.4±2.17	48.5±1.57

*p<0.05; SS: Static stretching; DS: Dynamic stretching; FR: Foam roller.

mean flight time (z=-3.05, p<0.00), mean max power (z=-3.05, p<0.00)), maximum power (z=-2.99, p<0.00), mean power (watt/kg) (z=-3.05, p<0.00), maximum power (watt/kg) (z=-3.1, p=0.00), number of jumps (z=-2.55, p<0.01) parameters, no statistical difference was observed in the maximum elevation and mean contact time parameters between the 2 groups (Table 6).

TABLE 6: Comparison of the multiple jumps means of the participants after different warm-up protocols (n=16).

Parameters	SS+DS Mean±SD	SS+DS+FR
Maximum elevation (cm)	26.5±1.35	23.5±1.45
Mean altitude (cm)	21.8±1.25*	19.8±1.35
Flight time (msec)	418.1±11.8*	398.3±13.5
Mean contact time (msec)	201.6±12.9	187.4±5.04
Mean max power (watts)	2440.9±75.2*	2320.5±81.8
Maximum power (watts)	2716.9±80.7*	2544.3±87.8
Mean power (watts/kg)	39.2±1.13*	37.2±1.21
Maximum power (watts/kg)	43.7±1.4*	40.8±1.36
Number of jumps (n)	24.2±0.46	25.4±0.64*

*p<0.05; SS: Static stretching; DS: Dynamic stretching; FR: Foam roller.

DISCUSSION

Recently, self-myofascial release with a FR became an increasingly popular method and is being used both before and after training. In this context, this study was carried out to examine the acute effects of FR on some performance parameters in addition to warm-up protocols in combat athletes. As a result of the study, when the performance tests after both warm-up protocols were evaluated, a statistically significant difference was observed in favor of SS+DS without foam roller in the 20 m sprint parameter (p<0.05; Table 4) while no statistical significance was found in the 10 m sprint, 30 m sprint, agility, and flexibility parameters (p>0.05; Table 4). When the jump values of the athletes were examined, although a statistically significant difference was determined in favor of SS+DS without FR exercise in the values of jump elevation, mean elevation, mean flight time, mean maximum power, mean power, and number of jumps between the 2 different warm-up protocols, no significant difference was found in the flight time, maximum power and maximum power/kg, maximum elevation, and mean contact time values (p>0.05; Table 6).

When the literature is examined, it is seen that there are limited studies on FR and there is no clear information about the effects of FR. Yıldız et al. examined the acute effects of pre-exercise FR exercise in addition to DS on anaerobic power. In this study, the participants were given an anaerobic power test with an interval of 2 days after FR exercise with DS in addition to DS. When the data obtained were examined, it was seen that FR exercise in addition to DS was more effective on anaerobic power than DS alone in the male group.[29] However, no significant difference was detected in the female group. The results of this study differ from our study. It is thought that this may be due to the FR protocols they applied.

Yıldız et al. examined the acute effects of pre-exercise vibrating FR exercise in addition to DS on sprint, vertical jump height, agility, and flexibility. As a result of the study, no significant difference was found between the groups in the agility, active and squat jump values in sprint values while a statistically significant increase was found in the flexibility value

after vibrating FR exercise. Vibrating FR exercise before a workout is stated to acutely increase flexibility.[30] The flexibility parameter results of this study are similar to the results of our study. In the study by Lim and Park examining whether vibrating FR exercise improve hamstring flexibility and jump performance in young adults, the hamstring flexibility and vertical jump height test values of the participants were measured. As a result of the study, it was stated that there was a positive difference in the hamstring flexibility parameter between the vibrating FR protocol and the non-vibrating FR protocol. However, it was stated that there was no difference in the vertical jump height performance values of the participants.[14] Although different FR protocols were applied, the findings of this study are similar to our study in terms of vertical jump height performance values.

In the study by Behara and Jacobson, in which they examined the acute effects of FR and DS on muscle strength, power, and flexibility, the subjects' range of motion, muscle strength, vertical jump height pre-test and post-test values were measured. As a result of the study, it was stated that flexibility increased after FR exercise. However, no change was observed in the strength and vertical jump height parameters, and the vertical jump height results of this study show parallelism with the vertical jump height results of our study.[18] Saç et al. investigated the effects of FR on hip range of motion, flexibility, and vertical jump height performance in female basketball players. As a result of the study, while there was no significant difference when the pre-test and post-test performance values between the groups were compared, it was determined that FR exercise caused a significant difference in the JRM and flexibility parameters when the intra-group pre-test and post-test performance values were compared ($p<0.05$).[11]

Healey et al. examined the effects of myofascial release with FR on performance, and in this study the participants' fatigue, pain, effort, vertical jump height and power, isometric strength and agility performance values were measured. As a result of the study, when the pre-test and post-test values for pain and effort were compared, it was seen that there was a significant difference. In the comparison of the fatigue parameter, it was stated that there was a positive decrease. While a significant difference was found between the vertical jump height and power, isometric strength, and agility performance values between the sexes, it was stated that there was no significant difference when the pre-test and post-test values were compared.[10] Again, Yanaoka et al. examined the effect of variable FR on the recovery of range of motion. As a result of the study, it was stated that FR exercise of 2 different intensities had similar effects and that FR had a positive effect on the improvement of hip range of motion.[31] The flexibility parameter of this study is not similar to the flexibility results of our study.

Our study shows that FR practice does not increase acute performance of combat athletes. This study was limited to the flexibility, sprint, agility, and jump performance test measurements applied to 16 competitive combat athletes (boxing, kickboxing, muaythai) and athletes. It should be noted that these results were observed in male combat athletes. Therefore, our study results may not be generalized to participants of different performance levels, sex, and age groups.

CONCLUSION

This study shows that FR exercise in addition to SS and DS protocols in combat athletes do not have a positive effect on the selected performance parameters, but static and dynamic stretching can improve athletes' vertical jump height and anaerobic acute performances. Moreover, it is thought that future studies on different sexes, branches, and wider participants, as well as studies on fatigue, pain, and recovery time of participants, may contribute to the literature.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mustafa Şakir Akgül, Neslihan Akçay;* ***Design:*** *Mustafa Şakir Akgül, Neslihan Akçay;* ***Control/Supervision:*** *Mustafa Şakir Akgül;* ***Data Collection and/or Processing:*** *Alirıza Han Civan, Kerem Can Yildiz, Şeyma Baltaci, Melike Nur Akgül, Samet Kaplan;* ***Analysis and/or Interpretation:*** *Neslihan Akçay;* ***Literature Review:*** *Alirıza Han Civan;* ***Writing the Article:*** *Alirıza Han Civan, Neslihan Akçay, Mustafa Şakir Akgül;* ***Critical Review:*** *Alirıza Han Civan, Neslihan Akçay, Mustafa Şakir Akgül.*

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