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Acute effects of dynamic stretching exercises supplemented with foam roller exercises on active jump, squat jump, and swimming performance

Dinamik germe egzersizlerine ek olarak yapılan foam roller egzersizlerinin aktif sıçrama squat sıçrama ve yüzme performansına akut etkisi

Emine Yabanabat Barış Gürol*

Eskisehir Technical University, Department of Movement and Training Sciences, Eskisehir, Turkey

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Abstract

The present study aimed to investigate the acute effects of dynamic stretching (DS) and dynamic stretching supplemented with vibrating foam roller exercises on active jump, squat jump, and 50-meter freestyle swimming performance (including 15-meter and 25-meter splits) in swimmers aged 15 to 18 years. Twenty male swimmers with a minimum of two years of swimming experience participated in the study. The participants were evaluated as a single group. During the first session, swimmers were familiarized with the testing procedures involving dynamic stretching and foam roller exercises to minimize learning effects. In the second session, a 5-minute low-intensity warm-up was followed by 10 minutes of dynamic stretching exercises, after which active jump, squat jump, and 50-meter freestyle swimming tests were performed. The third session involved performing vibrating foam roller exercises in addition to the protocol of the second session. All sessions were conducted with 48-hour intervals. All sessions were conducted at 48-hour intervals. The findings showed that 50-meter swimming performance increased with dynamic stretching and dynamic stretching + vibrating foam roller exercises ($t_{(19)}$= 3.854, p=0.001; p<0.05). The findings are in line with the literature; indicating that although myofascial stretching techniques do not affect jump performance, they positively affect swimming performance.

Keywords: Swimming, dynamic stretching, foam roller

Özet

Bu araştırmanın amacı, 15-18 yaş arası yüzücülerde antrenman öncesinde uygulanan dinamik germe (DG) ve dinamik germeye ek olarak titreşimli foam roller egzersizlerinin aktif sıçrama, squat sıçrama ve 50 metre serbest yüzme (15 metre ve 25 metre geçiş dereceleri) performansı üzerindeki akut etkilerini incelemektir. Araştırmaya en az iki yıl yüzme antrenmanı yapmış 20 erkek yüzücü katılmıştır. Katılımcılar tek grup olarak değerlendirilmiştir. Birinci oturumda, yüzücüler dinamik germe ve foam roller egzersizleri ile test parametrelerine alıştırılmış ve öğrenme etkilerini azaltmak amaçlanmıştır. İkinci oturumda, 5 dakikalık düşük yoğunluklu ısınma ve 10 dakikalık dinamik germe egzersizleri uygulanmış; aktif sıçrama, squat sıçrama ve 50 metre serbest yüzme testleri gerçekleştirilmiştir. Üçüncü oturumda, ikinci oturuma ek olarak titreşimli foam roller egzersizleri uygulanmıştır. Tüm oturumlar 48 saat aralıklarla yapılmıştır. Araştırma bulguları, 50 metre yüzme performansının dinamik germe ve dinamik germe+ titreşimli foam roller egzersizleri ile arttığını göstermiştir ($t_{(19)}$= 3,854, p=0,001; p<0,05). Sonuçlar, literatürle paralellik göstermektedir; miyofasyal germe teknikleri sıçrama performansına etki göstermese de yüzme performansını olumlu yönde etkilemektedir.

Anahtar Kelimeler: Yüzme, dinamik esnetme, köpük silindir

Sorumlu Yazar: Barış GÜROL, e-posta: bgurol@eskisehir.edu.tr

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1. INTRODUCTION

Swimming can be defined as a series of deliberate movements performed in a systematic manner in an aquatic environment. These movements are executed in accordance with specific techniques that have been developed and refined over time. The historical development of swimming as a sport can be traced back to the fundamental human need to traverse water and facilitate transportation through it (Keleş & Karacan, 2016). The practice of swimming emerged as a means of both livelihood and transportation for humans. Swimming can be conceptualized as the act of a person traversing a distance through the medium of water. Sportive swimming is a sport that incorporates a wide array of performance and technical skills, including aerobic and anaerobic endurance, strength, speed, agility, flexibility, and coordination (Yapıcı & Cengiz, 2015). Swimming, which engages all body muscles, entails completing a specific distance in the shortest possible time while utilizing synchronized arm and leg movements (Geyik, 2019). Engaging in swimming has been shown to enhance strength, muscle coordination, cardiovascular endurance, flexibility, and stress management (Bozdoğan & Özüak, 2003). Beyond the competitive arena, it also serves a significant role in leisure activities, strength enhancement, rehabilitation, and the return to sport (Bozdoğan & Özüak, 2003, Agopyan et al., 2012). Key parameters that have been identified as critical to enhancing swimming performance include aerobic and anaerobic capacity, swimming technique, flexibility, strength, power output, turn and exit techniques, anthropometric characteristics such as stroke length, body mass index, height and weight, psychological endurance, stress management, and swimming biomechanics (kinetic and kinematic) (Mengütay, 2019). Jump performance is a critical component for elite swimmers, especially at short distances. Previous studies indicate that individuals with high vertical jump values tend to be sprinters, those with low vertical jump values are likely to be long-distance swimmers, and those with moderate vertical jump values are likely to be middle-distance swimmers, among other distinctions (Yıldız, 2012). The power parameter is a crucial factor in training and competition, and its enhancement can be achieved through active warm-up routines. Incorporating stretching exercises into the warm-up regimen has also been shown to improve performance (Carvalho et al., 2012). The success of athletes in elite competitions can be influenced by minute performance values; therefore, athletes should consider the benefits of warm-up routines before training and competition. While milliseconds are critical in swimming, studies examining the effects of warm-up routines on performance on land are limited. Traditional warm-up routines utilize the following types of stretching: static (SS), dynamic (DS), ballistic (BS), and proprioceptive neuromuscular facilitation (PNF) (Behm & Chaouachi, 2011). However, static stretching has been observed to exert detrimental effects on muscle strength, sprinting, balance, and reaction time (Behm & Chaouachi, 2011, McMillan et al., 2006), and it has been documented to diminish 20-meter running performance in rugby players. Consequently, the implementation of dynamic stretching protocols is strongly recommended, as they have been shown to enhance performance by simulating the movements of the sport (McMillan et al., 2006, Gelen, 2010, Aguilar et al., 2012, Pagaduan et al., 2012), One of the most commonly used dynamic warm-up methods is the myofascial release technique, which aims to reduce barriers and adhesions in fascial tissue (Barnes, 1997). Self-myofascial release, a technique that utilizes one's own body weight on a foam roller to alleviate soft tissue restrictions, is a prevalent application (Paolini, 2009). Jumping, a ballistic movement that demands coordination between upper and lower body segments, serves as an indicator of explosive strength (Markovic et al., 2004) Active jumping (AJ) involves jumping from a stationary position with rapid collapse and maximum propulsion, while squat jumping (SJ) is performed by standing with knees at 90° flexion and then jumping (Van Hooren & Zolotarjova, 2017). In swimming, explosive power is also important in starts and turns. Both sports require efficient use of muscle groups and optimization of energy storage mechanisms, which offers a complementary relationship in training and performance assessments. Foam rollers, a type of foam rolling device, are utilized in Self-Myofascial Release exercises, a form of self-myofascial release technique. Individuals exercise specific muscle areas with repetitions and sets using their body weight (Macdonald et al., 2013). Studies show that Foam Roller provides similar effects to dynamic stretching and more positive effects than static stretching in increasing the range of motion (Behera & Jacobson, 2017, Su et al., 2017). Vibrating foam roller devices aim to increase ROM and muscle activation by combining foam rolling with local vibration (Macdonald et al., 2013). Vibration can increase motor unit activation by providing additional mechanical stimulation to the muscles (Cochrane, 2011). While 20-50 Hz vibrations provide a therapeutic effect, the 30-50 Hz range has been reported as the most efficient frequency for muscle activation. Below 20 Hz may cause excessive relaxation and above 50 Hz may cause muscle soreness (Lim & Park, 2019). However, there are limited studies on its effect on athletic performance. There are numerous studies in the literature comparing static stretching and dynamic stretching methods. However, studies comparing the effects of dynamic stretching exercises and foam roller exercises on different vertical jumping methods are scarce, and further studies are necessary. In this context, the present study aims to examine the acute effects of dynamic stretching and vibrating foam roller exercises on active jump, squat jump, and 50-meter freestyle swimming (15 m and 25 m transitions) performance in swimmers aged 15–18 years.

2. METHOD

2.1. Participants

The study was conducted on a group of 20 male athletes between the ages of 15 and 18 who regularly engaged in swimming training at various clubs in the Eskişehir Yenikent Olympic Swimming Pool. The selection of the athletes was made from individuals who had been engaged in regular training for a minimum of two years. Prior to the initiation of the study, approval was obtained from the Ethics Committee of Eskişehir Technical University. Additionally, consent was obtained from the families of athletes under the age of 18, and voluntary consent forms were obtained from the participants.

2.2.Study Design

The present study comprised a single group of 20 male swimmers, and its protocol was derived from Aslan and Kahraman (2023). However, for the present study, vibrating foam rollers and 50-meter swim time (15m, 25m transition degrees) were utilized, while the flexibility parameters from the aforementioned study were excluded. The dynamic warm-up protocol incorporated dynamic stretching exercises (2x20, totaling eight exercises) in both directions for major lower extremity muscle groups (Kurt et al., 2023). In the initial session, participants underwent a familiarization session with dynamic stretching and (vibrating) foam roller exercises prior to data collection. This session was designed to mitigate learning effects. In the subsequent session, the participants engaged in a 5-minute low-intensity warm-up run, followed by 9 minutes of dynamic stretching exercises targeting their active lower extremity muscle groups. Jump and squat jump measurements were obtained from the participants following the warm-up. Subsequently, the in-water warm-up protocol, as determined by their respective coaches, was implemented, and the swimmers swam 500 meters in freestyle at a moderate pace. Following this, the athletes proceeded to the sprint stone to obtain their 50-meter freestyle performance grades. After the exit command, the athletes were instructed to complete the 50 meters in the shortest possible time (15 meters). Additionally, transition times of 25 meters were recorded. In the third session, the athletes adhered to the same protocol as in the second session and performed the additional vibrating foam roller exercises. The parameters measured in the second and third sessions were consistent, and the procedures were repeated at 48-hour intervals.

2.2.1. 50 m Freestyle Swimming Test

The 50-meter swimming test (15-meter, 25-meter transition degrees) was administered to the athletes at the Eskişehir Yenikent Olympic Swimming Pool. The participants were instructed to complete the 50-meter distance expeditiously following the verbal command, "Take your marks!". The 50-meter anaerobic swimming speed tests were measured with a CASIO HS-80TW-1DF stopwatch. The values obtained at the conclusion of the measurement were transferred to the table.

2.2.2. Dynamic Warm-up Protocol

During the dynamic warm-up, participants were instructed to perform eight different exercises (straight leg kick, back kick, butt kick, high knee skipping, walking knee-to-chest, leg cradles, karaoke right and left, and walking lunge). Each exercise will be performed for a duration of 20 seconds, with two sets being completed in succession, separated by a 15-second interval. There will be a 30-second interval between each exercise. The execution of each dynamic warm-up exercise is to be performed with optimal expediency (Kurt et al., 2023).

2.2.3. Foam Roller Exercises

The foam roller (vibrating) exercise protocol was applied to the hamstring, quadriceps, gluteus, and gastrocnemius muscles on both sides of the body. The protocol consisted of 30-second foam roller exercises with 10-second passive rest breaks. The application speed was set to 38 Hz (Ateş & Yitik, 2018).

2.2.4. Jump Height Measurement

Two distinct jump tests were utilized to evaluate jump performance: the Active Jump (AJ) and the Squat Jump (SJ). Each test was executed with the hands fixed at the waist. The Active and Squat jump tests were performed twice, and recorded by taking the highest score into consideration (Atabek et al., 2010).

2.3. Statistical Analysis

The SPSS 22.0 package program was utilized for the statistical analysis of the data. Following the entry of the data into the SPSS program, a normality analysis was conducted initially. This analysis entailed the implementation of the Shapiro-Wilk test and the coefficient of variation to determine the normality of the data. Given the observation that the data exhibited a normal distribution, the employment of parametric tests was deemed appropriate. For the analysis of normally distributed data, the Paired Sample T Test was employed to evaluate in-group changes before and after the application, with a significance level of 0.05. The data were evaluated at a 95% confidence interval.

3. FINDINGS

The present study included a total of 20 male swimmers between the ages of 15 and 18. Mean and standard deviation values were calculated for the demographic variables of the participants. According to the data obtained, the mean age of the participants was 15.80 years, and the standard deviation value was calculated as 1.10. The mean height of the swimmers was 173.82 cm, and the standard deviation was 6.27 cm. The mean weight of the athletes was 62.54 kg, with a standard deviation of 8.18 kg. The mean body mass index (BMI) of the participants was calculated as 20.67, with a standard deviation of 1.66. The data obtained in the study were evaluated for normality analysis after calculating the demographic values. The Shapiro-Wilk test and coefficient of variation calculations indicated that the data exhibited normal distribution ($p > 0.05$). Subsequently, a paired groups T-test was applied to the data set that had been found to be normally distributed. The significance value for the test was set at $p < 0.05$, and the results are presented in Table 1.

The results of the paired groups T-test indicated that the active jumping scores of the participants with DS were 33.36 ± 6.75, t (19) = -0.042, p = 0.967, while the active jumping scores of the DS + VFR group were 33.28 ± 6.77, t (19) = -0.042, p = 0.967. These results indicate that there is no significant difference between DS and DS + VFR practices ($p > 0.05$). The mean squat jump score of the participants was 30.64 ± 6.72 in the DS condition, t (19) = -1.752, p = 0.917. The mean squat jump score for the DS + VFR condition was 31.42 ± 6.78, as indicated by the t (19) = 1.752, p = 0.096 result. In both instances, no statistically significant difference was observed between the squat jump DS and DS + VFR practices ($p > 0.05$) (Table 2).

The mean 15-meter transition score of the participants in the DS condition was 7.20 ± 0.91, t (19) = -0.106, p = 0.917 ($p > 0.05$). The mean squat jump DS + VFR score was 7.22 ± 0.84, t (19) = -0.106, p = 0.917. No significant difference was observed between DS and DS + VFR practices in terms of 15 m transition scores ($p > 0.05$). The mean 25-meter transition score of the participants in the DS condition was 14.42 ± 2.47, t (19) = 1.085, p = 0.291. The mean 25 m transition scores of the participants in the DS + VFR condition were 13.79 ± 1.58, t (19) = 1.085, p = 0.291. A subsequent analysis revealed no significant difference between DS and DS + VFR practices in 25 m transition scores ($p > 0.05$). The mean 50-meter swim score in the DS condition was 31.02 ± 2.83, t (19) = 3.854 ($p > 0.05$). Conversely, the mean 50-meter transition score in the DS + VFR condition was 30.28 ± 2.65, t (19) = 3.854, p = 0.001 ($p < 0.05$). This finding indicates a significant difference between DS and DS + VFR practices with respect to 50-meter transition scores ($p < 0.05$).

Table 1. Mean and standard deviation values of demographic variables in the male swimmers

Variables	N	$\bar{x}$± Sd.
Age	20	15.80±1.10
Height (cm)	20	173.82 ±6.27
Weight (kg)	20	62.54±8.18
BMI (kg/m^2)	20	20.67 ±1.66

Note. BMI = Body Mass Index; N= Number of Participants; $\bar{x}$=Mean; Sd = Standard deviation

According to the Shapiro-Wilk test and coefficient of variation calculations, the data were normally distributed ($p > 0.05$). The paired groups T-test was applied to the normally distributed data set. The significance value for the test was accepted as $p<0.05$.

Table 2. Paired groups T-test results of active jump and squat jump parameters of DS and DS+ FTR in the male swimmers

Variables	Sessions	x̄± Sd.	t	p
Active Jump	DS	33.36±6.75	-0.042	0.967
	DS+VFR	33.28±6.77		
Squat Jump	DS	30.64±6.72	-1.752	0.096
	DS+VFR	31.42±6.78		

Note. N= 20; DS = Dynamic Stretching; VFR= Vibrating Foam Roller; N= Number of Participants; x̄= Mean; Sd = Standard deviation

No significant difference was observed between Active Jump DS and DS + VFR practices (p >0,05). No significant difference was observed between Squat Jump DS and DS + VFR practices ($p >0.05$).

Table 3. Paired groups T-test results of DS and DS+ VFR application for 15m transition, 25m transition and 50m swim score parameters in the male swimmers

Variables	Sessions	x̄± Sd.	t	p
15m. Transition Score	DS DS+VFR	7.20±0.91 7.22±0.84	-0.106	0.917
25m. Transition Score	DS DS+VFR	14.42±2.47 13.79±1.58	1.085	0.291
50m. Swim Score	DS DS+VFR	31.02±2.83 30.28±2.65	3.854	0.001

Note. N= 20; M=Meter; DS = Dynamic Stretching; VFR= Vibrating Foam Roller; x̄= Mean; Sd = Standard deviation

No significant difference was observed between DS and DS + VFR applications in terms of 15 m transition scores ($p > 0.05$).

No significant difference was observed between DS and DS + VFR practices in terms of 25 m transition scores ($p > 0.05$).

There was a significant difference between DS and DS + VFR applications in terms of 50 m transition scores ($p < 0.05$).

4. DISCUSSION

The study findings indicate an absence of a statistically significant difference between dynamic stretching and dynamic stretching plus foam roller applications with respect to active jump performance. This finding is corroborated by similar results reported in the related literature. Jones et al. (Jones et al.,2015) examined the acute effects of foam roller exercises on vertical jump and found no difference between dynamic warm-up and foam rollers. Sağıroğlu (2017) reported that foam roller exercises on male football players were effective in enhancing lower extremity strength and flexibility performance. However, these exercises did not result in a significant change in active jump performance. In contrast, Bailey (Bailey, 2014) observed no increase in vertical jump height in training with foam rollers and vibrating foam rollers.

Conversely, Lin et al. (Lin et al., 2020) reported significant improvements in active jump performance in badminton athletes following the implementation of a dynamic warm-up and vibrating foam roller protocol. This finding suggests that foam roller applications may positively affect jump performance in certain sports. Previous studies indicate that the low jump performance may be attributed to the absence of plyometric exercises in training regimens. It is acknowledged that jumping power is associated with the explosive power of muscles, strength, and flexibility of leg muscles (Arvas et al., 2006). In this context, Civan et al. (Civan et al,. 2022) reported that plyometric training was effective in improving jump performance in skateboard athletes. These findings suggest that micro-level plyometric training may be useful in improving jump performance in swimmers.

The findings of the study demonstrated that dynamic stretching and foam roller applications did not result in a significant difference in squat jump performance. However, Aslan and Kahraman (Ekmekçi, 2020) reported that the utilization of foam rollers enhanced squat jump performance and 15-meter short-distance swimming in swimmers. These findings underscore the impact of foam roller applications on diverse performance parameters.

Ekmekçi (2020) further corroborated the efficacy of myofascial release methods, demonstrating their capacity to enhance performance across various swimming strokes. These observations highlight the potential of foam rollers and similar techniques in optimizing athletic performance.

5. CONCLUSIONS

In conclusion, further comprehensive and longitudinal studies are required to enhance our comprehension of the effects of dynamic warm-up routines and foam roller applications on performance. Additionally, the findings indicated that land-based training for jump performance, aimed at enhancing vertical jump parameters, can play a significant role in improving the jump performance of swimmers. Swimmers are advised to consider incorporating diverse land-based training exercises to enhance their explosiveness performance. Such training has the potential to enhance not only short-distance swimming performance but also general athletic abilities.

Suggestions

1. Coaches and athletes are encouraged to include dynamic stretching and vibrating foam roller exercises as part of their pre-training and pre-competition warm-up routines, as these methods may enhance short-distance swimming performance.
2. Since no significant improvement was observed in jump performance, future studies should integrate plyometric or resistance-based land training programs alongside warm-up exercises to determine their combined effects.
3. Further research with larger sample sizes and different age and gender groups is recommended to generalize the effects of dynamic and myofascial stretching techniques.

Conflict of Interest

There are no conflicts of interest between the author(s) and any individual, institution, or organization that could have influenced the research process or its outcomes.

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Author Biographies and Contributions

Corresponding Author: *Barış Gürol* – Doç. Dr.; Eskisehir Technical University, Department of Movement and Training Sciences, Eskisehir, Turkey, ORCID: 0000-0002-3372-617X, E-mail: bgurol@eskisehir.edu.tr

Contributions: Literature review, data collection and processing, manuscript writing, preparation of figures and tables, and organization of references and sources.

Author: *Emine Yabanabat* – Eskisehir Technical University, Department of Movement and Training Seciences, Eskisehir, Turkey, ORCID: 0000-0002-3372-617X, E-mail: bgurol@eskisehir.edu.tr

Contributions: Supervision, conceptualization, data analysis and interpretation, critical review and editing of the manuscript, and final approval of the version to be published.

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