

Effect of Static and Dynamic Stretching on Knee Muscle Strength in Trained Players

Antrenmanlı Sporcularda Statik ve Dinamik Germe Egzersizlerinin Diz Kas Gücü Üzerine Etkisi

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Abstract

Objective: The study examined the effects of two different stretching exercises on knee muscle strength in basketball players in order to determine the most appropriate pre-competition protocols for basketball conditioning.

Method: Thirty-two basketball players (mean age 22.75±2.73 years, weight 87.47±10.99 kg, height 188.85±7.35 cm, body mass index 24.46±1.89) participated in this study. They performed two different stretching protocols according to basketball training experience in randomly assigned order: randomized in consecutive manner according to admission order, well-trained basketball players (training frequency = 5 days/week, groups I and II), less-trained basketball players (1 day/week, groups III and IV). Basketball players in groups I and III were exposed to isokinetic tests-one each after dynamic stretching and, 1 week later, after static stretching. In groups II and IV, similar evaluations were made after static stretching and, 1 week later, after dynamic stretching. Five days/week were included in the well-trained group. The less-trained group consisted of basketball players who trained 1 day/week.

Results: In less-trained basketball players, static stretching resulted in higher extensor muscular strength and endurance values, whereas dynamic stretching increased knee flexor strength and endurance.

Conclusion: Our results suggest that before competitions, stretching exercises should be chosen depending on the conditioning of the basketball player (well-trained, less-trained). Including both static and dynamic stretching into the "stretching" concept seems effective.

Keywords: Dynamic stretching, isokinetic test, static stretching

Öz

Amaç: Bu çalışmanın amacı, basketbol oyuncularında fiziksel dayanıklılığı artırmak için müsabaka öncesi en uygun protokolün belirlenmesinde iki farklı germe egzersizinin etkilerini incelemektir.

Yöntem: Bu çalışmada, 32 basketbol oyuncusu (ortalama yaş 22,75±2,73, kilo 87,47±10,99 kg, boy 188,85±7,35 cm, vücut kitle indeksi 24,46±1,89) yer almıştır. Basketbol oyuncuları antrenman deneyimlerine göre iki farklı germe egzersizi yapmak üzere randomize olarak gruplara ayrılmıştır: ardışık rastgele seçim yapılarak iyi antrenmanlı basketbol oyuncuları (antrenman sayısı =5 gün/hafta, grup I ve II), kötü antrenmanlı basketbol oyuncuları (1 gün/hafta, grup III ve IV). Grup I ve III için dinamik germe, ardından bir hafta sonra statik germe, grup II ve IV için statik germe, ardından bir hafta sonra dinamik germe egzersizleri sonrası izokinetik test uygulanmıştır.

Bulgular: Düşük-ıdmanlı basketbol oyuncularında, statik germe egzersizleri, daha yüksek ekstansör kas gücü ve dayanıklılık verileri gösterirken, dinamik germe, diz fleksör gücü ve dayanıklılığını artırmıştır.

Sonuç: Bulgularımız, basketbol oyuncularında antrenman durumuna göre (iyi antrenmanlı, kötü antrenmanlı) germe egzersizlerinin seçilmesini önermektedir. Hem statik hem de dinamik germe egzersizleri etkili bulunmuştur.

Anahtar kelimeler: Dinamik germe, izokinetik test, statik germe



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Introduction

Physical training is an important part of basketball performances (1). Stretching applied during the warm-up period increases the energy absorbent capacity of muscles, thus decreasing injury risk. In addition, it prepares the body for upcoming physical activity. Thus, stretching exercises are a part of athletes' pre-competition warm-up protocols (2,3).

Flexibility is a component of physical fitness that athletes desire to develop. Static and dynamic-stretching exercises are among the methods that bring flexibility. Static stretching (SS) is defined as stretching where the athletes stay in a stretching position for a certain period (4). Dynamic stretching (DS), on the other hand, consists of slow-paced dynamic movements that are similar to upcoming actual physical activity (5).

Muscle strength is one of very important sports components for preventing injury and enhancing performance. Isokinetic dynamometers are very useful to evaluate muscle strength. These dynamometers determine the muscle balance and forces between the dominant and non-dominant extremities as well as the agonist and antagonist muscles. Today, isokinetic devices are used for muscle rehabilitation and muscle training (6).

Isokinetic testing provides an objective quantitative measure for muscle functions. It also provides results on such parameters as muscle work, power, and endurance. With these objective parameters, it is possible to follow the progress of athletes or patients during rehabilitation periods and competitive performances (7).

Pre-competition warm-up, which has become a traditional practice, has limited scientific evidence to support its importance. Warm-up protocols usually reflect personal experiences of coaches, instructors and athletes. Previous studies have supported the positive effects of stretching exercises using static, dynamic or proprioceptive neuromuscular facilitation stretching techniques on increasing the joint mobility. Moreover, previous studies have also suggested that these positive effects include reduction in muscle injuries and improvement of sports performance (8). In this study, isokinetic tests were performed by basketball players after following SS and DS exercises, with a view of establishing their advantages and weaknesses. The aim of the study was to determine the most appropriate pre-competition exercise protocols for basketball players.

Materials and Methods

A quantitative, cross-sectional, and prospective study was conducted between 11.12.2013 and 11.06.2014 with the approval of the Ethics Committee of Trakya University Faculty of Medicine (protocol number: TÜTF-GOKAEK 2013/185) and the written informed consent was obtained from all participants.

Thirty-two male basketball players who met the eligibility criteria and committed to participate were included in this study. The eligibility criteria of the study were as following: having been involved in basketball for ≥ 5 years, male gender, age of 18-30 years, absence of inflammatory or infectious joint pathology, commitment to participate in the study, absence of previous knee surgery, and absence of neurological disease affecting knee joint innervation.

Exclusion criteria of the study were as following: a history of cardiovascular or pulmonary disease that might hamper exercise, an inflammatory or infectious pathology of the knee joint, uncontrolled endocrine pathology, significant system or organ failure, neurological disease affecting the knee joint innervation, and previous knee surgery. Basketball players who met the eligibility criteria and committed to participate in the study were examined according to their ages, height, weight, and dominant extremities.

Thirty-two basketball players included in the study were classified in two groups according to their training frequencies (Figure 1). Basketball players who trained 5 days/week were included in the well-trained group. The less-trained group consisted of basketball players who trained 1 day/week. Well-trained basketball players were randomized into groups I and II, and less-trained basketball players were randomized into groups III and IV. Basketball players in groups I and III were applied two isokinetic tests, one after DS and, 1 week later, the other after SS. Basketball players in group II and IV were subjected to the same evaluation following SS and, 1 week later, after DS, respectively.

All basketball players performed stretching exercises after cycling for 7 min, which was at a speed of 80-90 revolution per minute (rpm) in the bicycle ergometer.

Dynamic Exercise Group: First, basketball players performed DS exercises after warming up in the bicycle ergometer at 80-90 rpm for 7 min. In dynamic exercises, movements lasted for 15 s each, to be repeated after resting for 20-s (Table 1). DS exercises practiced by basketball players were as follows (Figure 2):

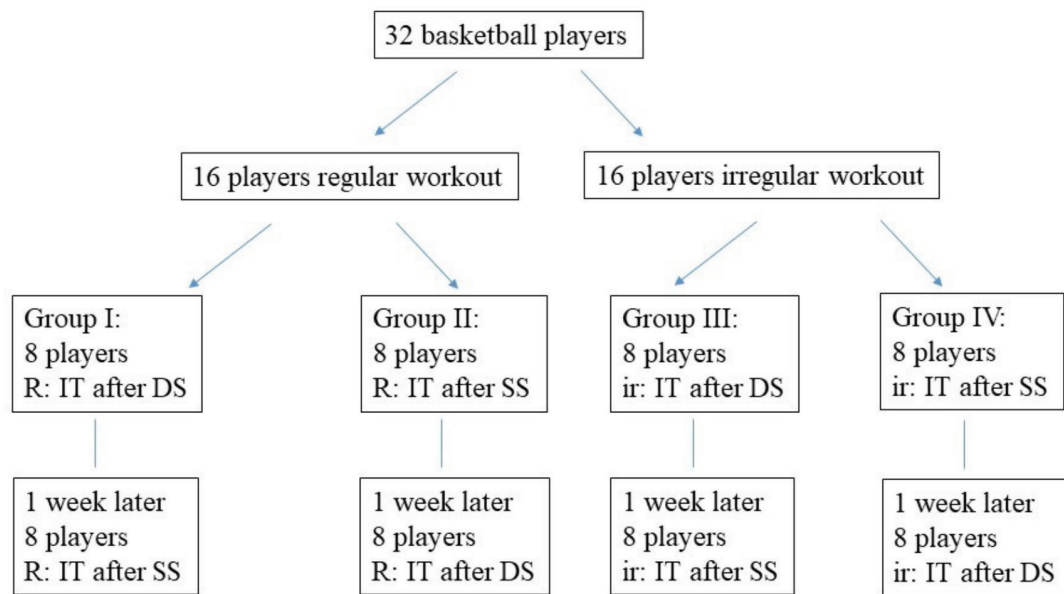


Figure 1. Experimental design

IT: Isokinetic test, SS: Static stretching, DS: Dynamic stretching, R: Regular, ir: Irregular

Table 1. Duration of stretching exercises applied to right and left extremity muscles

Muscles	Dynamic-stretching exercises	Static-stretching exercises
Hamstring	75 s	80 s
Quadriceps	45 s	40 s
Adductors	60 s	40 s
Hip extensors	45 s	20 s
Hip flexors	15 s	20 s
Gastrocnemius	75 s	80 s

s: Second

DS exercise 1- Basketball players assumed a supine position with their upper limbs by the side of the body and their forearms supinated. When they performed cycling exercises, they flexed their hips and knees such that the knees touched their hands in a rhythmical pattern. This exercise stretches the hip extensors and hamstring muscles (Figure 2-1).

DS exercise 2- Basketball players' lower limbs were semi-flexed, their shoulders were abducted to 70°, and their forearms were externally rotated with the palms facing up. Movements were repeated rhythmically along the line (right and left, then to the left). This exercise stretches adductor, quadriceps and gastrocnemius muscles (Figure 2-2).

DS exercise 3- From a standing position, basketball players raised one lower limb forward to flex the hip and knee to 90° flexion, and then brought the limb back to the floor

by hyperextending the hips and knees. Then, they moved the same lower limb forward by stepping rhythmically and flex the other lower limb such that the knee touched the floor while the hip was in hyperextension. This exercise stretches hip flexors, quadriceps, hip extensors, hamstring and gastrocnemius muscles (Figure 2-3).

DS exercise 4- While standing, basketball players abducted their hips to at least 50° abduction. One lower limb was flexed to 90° flexion at the knee and hip; the BW was transferred to that side and the adductor muscles of that side were stretched; during this, the other lower limb was in full extension. The trunk was then rotated 180° while the same position was maintained. Then, the lower limb in full extension was flexed to at 90° hip and knee flexion. This exercise stretches adductor muscles, while the other lower limb is in full extension (Figure 2-4).

DS exercise 5- While the basketball players were standing, one upper limb was flexed at the shoulder to 180° flexion while the knee of the opposite side was flexed to 90° flexion (right upper limb and left lower limb; then the left upper limb and the right lower limb). These movements were repeated rhythmically. This exercise stretches hip extensors and hamstring muscles (Figure 2-5).

DS exercise 6- Basketball players attempted to rhythmically touch the toes with the contralateral hands while they were walking. During this movement, the elbow was extended and shoulder was abducted, whereas the lower limb was

in maximum flexion. This exercise stretches hamstring and gastrocnemius muscles (Figure 2-6).

DS exercise 7- Basketball players were standing with their shoulders at 90° flexion and the elbow and wrist in full extension; then, they placed their palms on the wall. Basketball players transferred their weights to one of their lower limbs and they put the other lower limb forward. This lower limb was placed in maximum adduction and maximum abduction positions for 15 s each. The same movements were repeated for the other lower limb. This exercise stretches adductor muscles (Figure 2-7).

DS exercise 8- Basketball players were standing with their knees at full extension while hips were at full flexion; then hip extension repeated rhythmically in 15 seconds. The same exercise was repeated for the other side. This exercise stretches hamstring and gastrocnemius muscles (Figure 2-8).

Static Exercise Group: Basketball players warmed up on the bicycle ergometer for 7 min at 80-90 rpm speed. Then, they performed static-stretching exercises consisting of

six movements. Five of the static exercises were repeated for 20 s for one extremity, and the same movement was repeated for the other extremities. They rested for 15 s and moved to the other movement. One of the static exercises was directed to both limbs and the exercise lasted 20 s. The exercise was repeated after resting for 15 s (Table 1).

Static-stretching exercises (Figure 3) were as follows:

SS exercise 1- While the basketball players were standing, they positioned both their lower limbs at a minimum 50° abduction at the hip. On one side, they positioned the knee and the hip to 90° flexion. Then, the body weight (BW) was transferred to that side, and the abductor muscles were stretched while the other lower limb was in full extension. The same exercise was repeated for the other side (Figure 3-1).

SS exercise 2- Basketball players moved one of their lower limbs forward, with the knee and the hip at 90° flexion, and then, placed the other lower with the hip in hyperextension. The same exercise was repeated for the other side. This

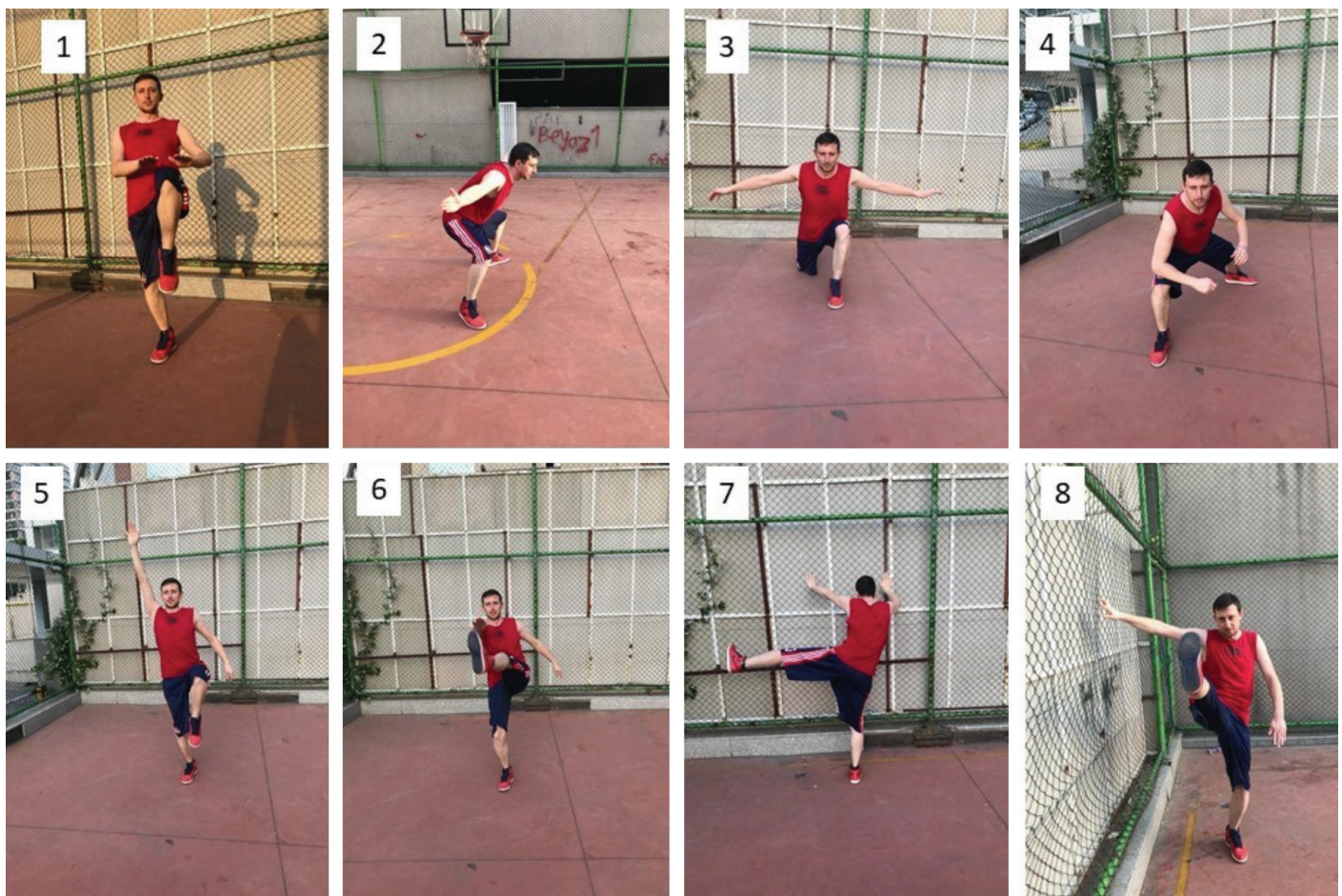


Figure 2. Dynamic stretching exercises applied to basketball players

exercise stretches hip flexors, quadriceps, hip extensors and hamstring muscles (Figure 3-2).

SS exercise 3- While basketball players were sitting with their backs straight, both lower limbs were stretched out with the hips at maximum abduction. While the lower-limb tension was maintained, the trunk was laterally flexed to make contact with one of the thighs, and the basketball players tried to touch their toes. The exercise was repeated on the other side. This exercise stretches adductor, hamstring and gastrocnemius muscles (Figure 3).

SS exercise 4- Both the lower limbs were stretched and positioned perpendicular to the other. The trunk was brought to touch the thighs while the tension of lower limbs was maintained. This exercise stretches hamstring and gastrocnemius muscles (Figure 3-4).

SS exercise 5- Basketball players stood standing while using support with one hand for balance. With the help of the other hand, the contralateral lower limb was flexed backward to the hip level. The same process was repeated for the other side. This exercise stretches the quadriceps muscle (Figure 3-5).

SS exercise 6- Basketball players stood two feet away from the wall. While one lower limb was stretched, the opposite lower limb was twisted one step forward and both hands were placed on wall for balance. During this stretching exercise, attention was on the heels' not being raised from the floor. The same process was repeated for the other side. The gastrocnemius muscles in both the extremities were stretched (Figure 3-6).

Isokinetic Evaluation

CSMI Cybex HUMAC NORM (model number 502.140 with isokinetic tests and exercise systems) was used for isokinetic evaluation. The device was calibrated before each test. The protocol for knee flexion and extension isokinetic muscle strength and endurance measurements were as following: Submaximal four trials at 60°/s angular velocity, and 6-s rest, four tests at maximum force and 20-s rest. Submaximal four trials at 240°/s angular velocity, and 6-s rest, 20 tests at maximum force and termination of test. Before the test, the basketball players were informed regarding the purpose of this study, devices and the application; they also received motivational instructions during the test. Values of peak torque (PT), % BW, total work (TW) and TW % BW were



Figure 3. Static stretching exercises applied to basketball players

recorded (9). PT value: It is the highest torque value among all test parameters obtained in the full range of motion in each full-joint movement at angular velocity. Among all test parameters, it is accepted as the gold standard in terms of accuracy, precision and reliability. Its measure is Newton meter.

PT% BW: It is important to compare the test results among individuals and to evaluate the functional strength of the muscles that hold the weight. TW: It is the distance a force moves a certain resistance. Power: The amount of work done in time unit. Its unit is Watt. The endurance is the measurement of the fatigue developed in the muscle (10,11). The low PT % BW emphasizes the need for more strength training, a low TW value reflects lack of endurance and need of high repetition training. Moreover, low average power values highlight that power-based exercises should be applied (12).

Statistical Analysis

The data obtained from the study were saved in computer files. IBM Statistical Package for Social Sciences (SPSS) Statistics version 22 was used for statistical analyses (license number: 10240642). All parameters were normally distributed (Kolmogorov-Smirnov test). For group comparisons, One-Way ANOVA test and the paired sample t-test were used. The level of significance was set at p values of <0.05.

Results

Mean age, weight, and body mass index values of the groups are provided in Table 2. The mean age of all basketball players was 22.75±2.73 (18-28) years. The mean age was lower in group II than in group III (p=0.017). The mean height was higher in group I than in group IV (p=0.049). There were no other differences among the groups. The groups with no difference between the weight and body mass index averages were suitable for comparison (p>0.05) (Table 2).

Results of the First Evaluation

The mean values of right knee extensor PT (EPT), flexor peak torque (FPT), extensor TW (ETW), flexor total work

(FTW); left knee FPT, ETW, ETW % BW and FTW % in group I (R: IT after DS) were significantly higher than those in group IV. The mean values of right knee EPT was higher in group I than in group III. The mean values for EPT % BW in group II (R: IT after SS) were higher than those in group III and group IV (Ir: IT after SS). In the first measurements in the right knees, group III had lower mean FTW% BW than group I and group II. These differences were statistically significant (p≤0.05). There were no other statistically significant differences among the groups (Tables 3 and 4).

Results of the Evaluation Made 1 Week after

The mean values for right knee EPT and left knee ETW % BW in group IV were lower than those in groups I and II. The mean values for right knee EPT, FPT and ETW as well as left knee FPT, ETW and FTW were higher in group I than in group IV. The average values for both right and left knee ETW and FTW were higher than those in group III. The mean values of right and left knee flexor, PT % BW in group II were higher than those in group IV. These differences were statistically significant (p≤0.05). There were no other statistically significant differences among other groups (p>0.05, Tables 3 and 4).

Difference between the Two Evaluations

Within- Groups:

A significant difference was observed in the amount of change in the mean values for left and right knee FPT and left knee flexor PT % BW. The differences in the values were found to be higher in group II than in group I. In group II (R: IT after SS), the difference observed between the left knee FPT and flexor PT % BW was higher than that in group III (Ir: IT after DS). These differences were statistically significant (p≤0.05). No other statistically significant differences were found within the groups for other parameters (p>0.05, Tables 3 and 4).

Discussion

Most athletes are recommended to perform pre-activity DS and post-activity SS. SS may lead to performance degradation when it is performed before activity. To

Table 2. Evaluation of groups according to mean age, height, weight and body mass index

	Group I	Group II	Group III	Group IV	p
Age	22.25±1.49	20.63±2.50	24.5±2.93	23.63±2.50	0.018*
Height	194±6.95	191.38±8.31	186.25±5.18	183.75±8.94	0.042*
Weight	94.88±13.83	84.75±8.66	83.88±10.15	86.38±11.34	0.204
BMI	25.11±2.23	23.12±1.56	24.14±2.38	25.48±1.40	0.091

Data presented are mean values ± standard deviation, BMI: Body mass index, One-Way ANOVA test, *: p<0.05

decrease this risk, the following stretching exercises are recommended: resting period following SS, a general warm-up period or DS (13).

There are many studies showing that performance level can vary according to the type of stretching employed. DS improves physical performance, whereas SS improves

flexibility. Therefore, when choosing stretching exercises, all the following are considered: i.e., improving flexibility, preventing injuries and improving strength (14).

However, there are also studies that suggest both types of stretching should be performed, in addition to aerobic running, for improving flexibility (15). Some studies have

Table 3. Evaluation of groups according to right and left knee (60°/sec) extensor and flexor peak torque (Newton meters) means

		Group I	Group II	Group III	Group IV	1p
R-EPT	Before	311±43.87	286±51.40	243.38±31.39	247±25.82	0.005**
	After	300.5±51.64	295.63±52.86	246.88±33.32	231±29.20	0.005**
	Difference	-10.5±21.47	9.63±19.63	3.5±21.27	-16±18.60	0.060
	2p	0.209	0.208	0.656	0.045*	-
R-FPT	Before	218.25±29.70	188.25±39.43	180.88±29.81	171.25±25.28	0.034*
	After	217.75±22.74	210.13±26.04	187.13±24.99	178.38±23.49	0.009**
	Difference	-0.5±15.11	21.88±19.22	6.25±11.08	7.13±13.21	0.039*
	2p	0.928	0.015*	0.155	0.171	-
L-EPT	Before	305.5±50.53	278.13±59.90	249.25±50.64	250.5±29.95	0.092
	After	282.25±42.13	285.75±60.27	249±52.09	245.13±33.27	0.213
	Difference	-23.25±31.43	7.63±26.72	-0.25±16.08	-5.38±7.76	0.064
	2p	0.075	0.446	0.966	0.091	-
L-FPT	Before	206.38±34.76	174.88±33.29	174.88±29.67	155.75±32.31	0.034*
	After	204±29.84	197±31.04	173.25±23.04	165.13±28.38	0.029*
	Difference	-2.38±11.81	22.13±11.95	-1.63±31.30	9.38±10.64	0.044*
	2p	0.587	0.001**	0.887	0.041*	-

Data presented are mean values ± standard deviation, R: Right knee, L: Left knee, EPT: Extensors peak torque, FPT: Flexors peak torque, ¹One-Way ANOVA test, ²Paired sample t-test, *: p<0.05, **: p<0.01

Table 4. Evaluation of groups according to right and left knee (240°/s) extensor and flexor total work means

		Group I	Group II	Group III	Group IV	1p
R-ETW	Before	2.257±363.62	1822.38±367.40	1511.75±450.97	1628.5±278.33	0.002**
	After	2302.25±371.13	2008.5±455.45	1679.38±525.97	1658.88±267.61	0.013*
	Difference	45.25±184.87	186.13±214.96	167.63±168.35	30.38±117	0.188
	2p	0.511	0.044*	0.026*	0.487	-
R-FTW	Before	2041.25±327.67	1853.38±305	1472.5±307.72	1592.88±156.65	0.002**
	After	2140.25±340.32	1936.13±456.22	1620.63±295.7	1706.25±161.97	0.017*
	Difference	99±192.81	82.75±244.09	148.13±358.94	113.38±103.29	0.956
	2p	0.190	0.370	0.281	0.017*	-
L-ETW	Before	2245.5±329.22	1843.75±310.63	1670.5±322.37	1542.13±235.97	0.001**
	After	2238.5±339.87	2006±345.43	1743.13±256.8	1549.75±299.63	0.001**
	Difference	-7±149.59	162.25±250.17	72.63±154.60	7.63±198.11	0.299
	2p	0.898	0.109	0.226	0.916	-
L-FTW	Before	1987.88±305.23	1740.38±335.99	1428.88±233.59	1494.63±239.33	0.002**
	After	1966±417.11	1864.63±270.45	1548.38±282.44	1586.88±290.40	0.035*
	Difference	-21.88±234.67	124.25±338.32	119.5±290.91	92.25±155.75	0.660
	2p	0.800	0.333	0.283	0.138	-

Data presented are mean values ± standard deviation, R: Right knee, L: Left knee, ETW: Extensors total work, FTW: Flexors total work, ¹One-Way ANOVA test, ²Paired sample t-test, *: p<0.05, **: p<0.01

reported that DS increases agility, speed and strength (8,15), whereas some other studies report that SS negatively affects the performance (2,8,14,16,17). Kurt and Firtin (15) suggest that professional athletes may avoid SS before training or competitions to prevent a decrease in anaerobic performance.

Few studies have investigated performance variables, such as endurance (18) and power (19,20), which we examined in our study. The results of this study suggested that DS exercises in well-trained basketball players improved knee extensor and flexor strength and endurance; on the other hand, SS was found to increase extensor strength and knee muscle endurance in less-trained basketball players. These results are consistent with previous studies that did not find any decrease in performance caused by the DS (21). Yamaguchi and Ishii (20) examined 30-s static and DS effect on limb strength. As a result of this study, it was suggested that the 30-s SS did not affect muscular performance, whereas DS led an increase in lower-limb strength (20). Although the results of group II in our study are consistent with the values from the previous study, different results were obtained in group IV. In group IV (I: IT after SS) EPT values were found to be statistically significantly lower after SS than after DS. In the same group, PT and PT % BW values were measured after DS, and they were significantly higher than those measured after SS. Values of the left and right knee flexor strengths (PT and PT% BW) were measured after DS and they were significantly higher in group II (R: IT after SS) than those measured after SS (right PT, PT % BW and left PT, PT % BW).

In our study, differences in the TW (endurance, maintenance of maximal muscle power) were similar among the four groups. Measurements taken after the DS in group II showed a statistically significant increase. In group IV, measurements taken after DS in right flexor (TW and BW values) suggested a significant increase than those after SS. DS is recommended as the primary stretching method before high-speed and force-requiring activities (22). In this type of stretching, athletes perform similar movements that they perform in competitions; thus, they also focus on competitions at the same time (23).

The less-trained group III showed a statistically significant increase in measurements of the right extensor (TW and TW % BW values) after SS than after DS. Unlike results of the present study, knee flexion and extension maximal performance (1- RM =1- Max repetition) measured 10 min after SS decreased by 7.3% and 8.1%, respectively (24).

This decrease in performance may be because of the type of activity following the stretching type and the stretching routine. In recent years, conventions regarding warm-up routines have been changed because some types of stretching have been reported to cause performance loss (25). Many athletic teams and individuals have also added DS to their warm-up routines. DS is expected to be superior to SS because DS includes movements similar to those in future competitions (26); however, this has not yet been fully substantiated using scientific research. Many research studies suggest that combining static and DS may have decreased the negative aspects of SS (25).

O'Sullivan et al. (27) examined the short-term effects of warming up with static and DS on hamstring flexibility. Their research included participants with hamstring injuries and a control group. This study suggested that SS increased hamstring flexibility whereas DS had no effect. Therefore, the lack of evaluation on hamstring flexibility is a limitation of our study. Similar research has been conducted with fewer participants, but the sample size (32 people) was another limitation (20,21,28). Further studies should investigate not only the optimal warm-up parameters according to time, intensity and resting intervals but also include dynamic and static-stretching combinations, sports-specificity, environmental conditions and psychological factors.

Thus, we found that SS increases knee extensor strength and endurance in less-trained basketball players; however, DS increases knee flexor strength and endurance.

Conclusion

Our study results suggest that before competitions, static and DS exercises might affect performance positively in less-trained basketball players. In addition, we found that DS exercises following a warm-up contribute to knee extensor and flexor strength and endurance in well-trained basketball players. Therefore, we suggest that SS should be included in stretching exercise protocols, although with less frequency compared to DS.

Ethics

Ethics Committee Approval: A quantitative, cross-sectional, and prospective study was conducted between 11.12.2013 and 11.06.2014 with the approval of the Ethics Committee of Trakya University Faculty of Medicine (protocol number: TÜTF-GOKAEK 2013/185).

Informed Consent: The written informed consent was obtained from all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: C.M.A., F.T., H.K.A., D.D.K., H.T., Design: C.M.A., F.T., H.K.A., D.D.K., H.T., Data Collection or Processing: C.M.A., F.T., Analysis or Interpretation: C.M.A., F.T., H.K.A., D.D.K., H.T., Writing: C.M.A., F.T., H.K.A., D.D.K., H.T.

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