Merve KOCA KOSOVA[1]
Sercin KOSOVA[1]
Atalay ARKAN[2]

THE EFFECTS OF STATIC STRETCHING ON ANAEROBIC PERFORMANCE IN ATHLETES WITH DIFFERENT FLEXIBILITY LEVELS*

Geliş Tarihi: 03.07.2018

Kabul Tarihi: 13.04.2019

ABSTRACT

The purpose of this study was to measure the effects of static stretching on anaerobic performance in male participants with different flexibility levels. Thirty male participants who performed exercises at least three days a week, volunteered for this study. They were asked to warm up by riding a bicycle with an ergometer and set at resistant of 50 watts. On the first day hamstring and quadriceps muscle flexibility was measured. Vertical jump measurement and Wingate Test (WT) were conducted in two minutes intervals. On the second and third day of the study, participants applied stretching protocols which included waiting 15 and 60 s at their maximum level. Then, vertical jump measurement and WT were conducted. Anaerobic power responses were evaluated with one-way Anova with repeated measures in both the whole group and the divided flexibility groups. In addition, the responses of the groups were compared with each other using a t test. The results of both the vertical jumping test and the WT, performed after different static stretching protocols, showed no statistically significant difference in all groups. The results comparing the divided groups, also showed no statistically significant difference. Consequently one set of short-term or long-term static stretching performed at least 2 minutes before anaerobic performance will not affect performance.

Key Words: Muscle stretching exercises; athletic performance, flexibility

FARKLI ESNEKLİK SEVİYELERİNE SAHİP SPORCULARDA STATİK GERME EGZERSİZLERİNİN ANAEROBİK PERFORMANS ÜZERİNE ETKİLERİ*

ÖZ

Çalışmanın amacı, farklı esneklik seviyelerine sahip bireylerde statik germe egzersizlerinin anaerobik performans üzerine etkisini ölçmektir. Araştırmanın örneklemini haftada en az üç gün egzersiz yapan 30 erkek oluşturmuştur. Katılımcılardan standart ısınma olarak 50 Watt'lık (W) dirence karşı bisiklet ergometresinde pedal çevirmeleri istenmiştir. İlk gün katılımcıların quadriceps ve hamstring kas grupları esneklik seviyeleri ölçülmüştür. İki dakika içinde dikey sıçrama ölçümü yapılmış ve sonraki iki dakika içinde katılımcılara Wingate testi (WT) uygulanmıştır. Araştırmanın ikinci ve üçünü gününde katılımcılar ilk gün ölçülen kendi maksimum esneklik seviyelerinde 15 ve 60 saniye beklemelerini içeren germe protokolünü uygulamıştır. Ardından dikey sıçrama testi ve sonrasında WT uygulanmıştır. Anaerobik güç yanıtları hem tüm grupta hem esneklik seviyelerine göre ayrılan iki grupta değerlendirilmiştir. Bu değerlendirme için tekrarlı ölçümlerde tek yönlü varyans analizi kullanılmıştır. Ayrıca iki esneklik grubunun sonuçlarının birbiriyle karşılaştırılması bağımsız gruplarda t testi ile yapılmıştır. Farklı statik germe protokolleri sonrasında uygulanan dikey sıçrama testi ve WT sonuçlarında hiçbir grupta istatistiksel olarak anlamlı fark belirlenmemiştir. İki esneklik grubunun sonuçları birbiriyle karşılaştırıldığında da iki grup arasında anlamlı fark belirlenmemiştir. Sonuç olarak anaerobik güç performansının yaklaşık 2 dakika öncesine kadar kısa süreli veya uzun süreli bir set statik germe uygulamak performansı etkilememektedir.

Anahtar Sözcükler: Germe egzersizleri, sportif performans, esneklik

[1] Dokuz Eylül Üniversitesi Spor Bilimleri Fakültesi
[2] Dokuz Eylül Üniversitesi Tıp Fakültesi
* Yüksek Lisans tezinden hazırlanmıştır.

INTRODUCTION

Warm up routines may vary depending on the type of exercise[24] and play a key role in increasing muscular performance during exercise. Stretching has numerous physical effects on the body[15]. Stretching places related body parts into certain positions so as to strain the target muscle groups and the surrounding soft tissues[48]. Stretching exercises have been reported to prevent the risk of injury[40], rehabilitate a muscle after injury[28] and increase the range of motion of a joint[4]. Stretching as a part of a pre-exercise warm up routine has been advocated to reduce injury and enhance the athletic performance by most athletes[1,25]. A variety of stretching techniques exist, such as static, ballistic, Proprioceptive Neuromuscular Facilitation (PNF) and dynamic stretching[1].

Static stretching is applied by reaching and maintaining a maximum stretch[37] . In recent years, it has been suggested that performed static stretching before anaerobic performance may affect performance negatively. Kyranoudis et al. (2018) found decrease in sprint performance after static stretching protocol[30]. Harmancı and Karavelioğlu (2017) reported that static warm up method cause a decrease in Running-based Anaerobic Sprint Test (RAST) results on male athletes[23]. Nevertheless Oshita et al. (2016) found that 30 s of static stretching had no effect on peak power performance during Wingate test, but mean power performance increased after static stretching[36].

Some other studies have shown that stretching may actually acutely decrease athletic performance, muscular strength[6,16,29] muscular endurance[19,34] vertical jump performance[11,12,50] and sprint performance[33]; nevertheless, some studies that have failed to report significant reductions[5,51]. The effects of static stretching on muscles are closely associated with the stretching technique, duration of the exercise, frequency the gap between periods of intervention and measurement[32]. Contradictions in the literature can be explained by variations in the numbers of repetitions, durations of the stretching, muscle groups activated in stretching and types of stretching[19]. It is also known that there are differences in flexibility levels in different branches[22]. Otherwise there is a deficiency in the literature on levels of flexibility's effect. The lack of research on the effect of stretching on the performance of athletes with different flexibility levels has helped us determine our method.

The objective of this study is to measure and evaluate the effects of static stretching on anaerobic performance in male athletes with different levels of flexibility. The prior hypotheses in this study are as follows:

H1) The effects of short-term (15 s) and long-term (60 s) static stretching exercises on anaerobic performance differ depending on the level of flexibility of the participants.

H2) Short-term and long-term static stretching exercises affect vertical jump performance.

H3) Short-term and long-term static stretching exercises have acute effects on anaerobic performance as measured by the Wingate Test (WT).

MATERIALS AND METHODS

Study Population

Thirty male participants (mean age 21.6±1.8 years, weigth 71±6.8 kg, height 174.9±6.2 cm, BMI 23.2±1.8) completed this study. They were physically active and doing exercise at least three days per week. We used convenience sampling

method. The participants were divided into two groups according to their hamstring flexibility levels. The participants with a hamstring flexibility of less than or equal to 10.8 cm were placed in the low flexibility group, and those with flexibility greater than 10.8 cm were placed in the high flexibility group. Their quadriceps flexibility level is 27.2±5.1°, hamstring flexibility level is 10.6±8.1 cm. The study was approved by the Research Ethics Committee of institution. The volunteers read and signed an informed consent form.

Procedures

The participants came to the laboratory for three days. On the first day, without stretching beforehand, all of the participants performed a vertical jump and a WT. On the second day, one group of randomly chosen subjects completed a 15 s static stretching protocol, and the other group completed the 60 s static stretching protocol before the vertical jump and WT. On the third day of the testing session, the participants completed the stretching protocol that they had not performed on the second day and after that they performed a vertical jump and WT. The stretching exercises targeted the hamstring and quadriceps muscles. Hamstring flexibility was measured using a sit-and-reach flexibility testing platform. In the 15 and 60 s stretching protocols, the participants maintained their maximum stretch measured in the sit-and-reach test. Quadriceps muscles flexibility was also measured with a goniometer. In the 15 and 60 s stretching protocols, the subjects maintained their maximum reachable position attained with the goniometer. Thus, an individual maximum stretch was determined for each participant. This method ensured that the stretching exercises were performed objectively and eliminated the effect of daily variations in flexibility.

All of the measurements were completed between (3pm and 6pm with) two or four days off between the two measurements[46]. Four or five subjects were measured on one day. Acute explosive power responses after the stretching exercises were considered in both the whole group (all participants) and the two groups divided according to their hamstring flexibility levels. The results of the two flexibility groups were compared. On the first day, the participant's height, weight and body fat percentage were measured. As a general warm up, the participants were asked to cycle against 50 Watt (W) resistance[43] in a bicycle ergonometric for five minutes. After that, the flexibility of the participant's quadriceps and hamstrings were measured. The vertical jump measurement was completed within two minutes[26]. In the next two minutes, the participants performed a WT. On the second day of the study, after performing the usual warm up exercises, the participants were randomly assigned to performed a stretching protocol (either the 15 s or 60 s stretch). After completing the static stretching with a 10 s break between hamstring and quadriceps stretches, they performed a vertical jump and then completed a WT in two minutes intervals. On the last day of the study, after the pre-exercise warm up routines, the participants who performed the 15 s stretching on the second day completed the 60 s stretching protocol, and those who performed the 60 s stretching procedure the previous day completed the 15 s stretching protocol. After the stretching the vertical jump and WT were performed.

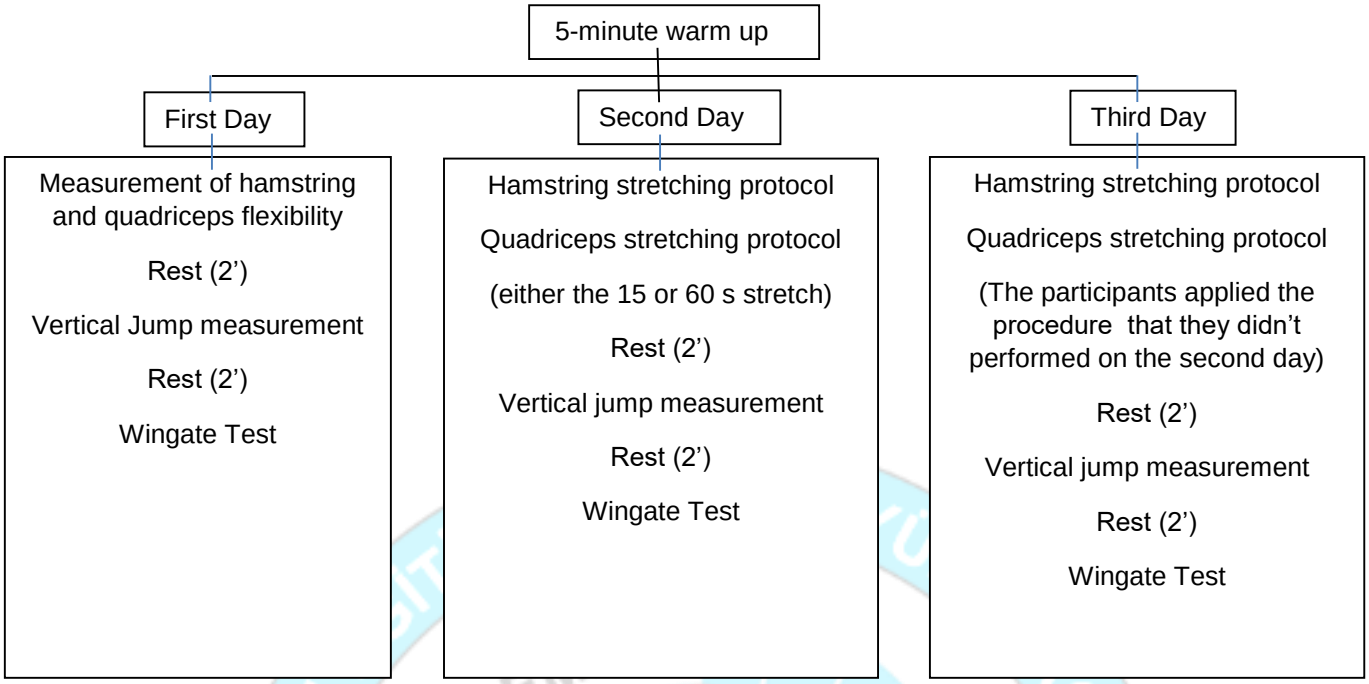

Figure 1. Schematic representation of study design.

Sit-and-Reach Test and Stretching Protocols

The sit-and-reach test was used as a measure of hamstring flexibility[10]. The participants sat with their soles and heels touched the board, legs extended, and hands placed over side by side. The participants were asked to reach as far as possible along the measuring board and hold that position. Two trials were performed, and the best result was considered the hamstring level of flexibility. On the second and third days of measurement, the participants were asked to hold the stretch for 15 or 60 s at the testing board at their personal best hamstring level of flexibility that first day recorded. This procedure was done with the support of the researcher.

Figure 2. Hamstring stretching protocol

Goniometric Measurement of Quadriceps Flexibility and Quadriceps Stretching Protocol

The goniometer was used as a measure of quadriceps flexibility[49]. The participants were asked to lie in the prone position on the stretcher. The dominant knee was maximally flexed by the researcher, while the other foot was placed on the stretcher. The lateral epicondyle of the femur is the place where the top of the goniometer was enchased. The fixed arm was enchased to the major trochanter of the femur. The active arm was enchased to the lateral malleolus of the tibia[49]. This measurement was always applied by the same researcher. Two trials were performed, and the best result was considered the quadriceps level of flexibility. On the second and third days of the testing, the participants were asked to hold the stretch for 15 or 60 s at their personal best quadriceps level of flexibility that first day measured. This protocol was applied on two legs at the same time. The stretch was performed in the same position as the first day and stretching protocol was completed with the support of the researcher.

Figure 3. Quadriceps stretching protocol

Vertical Jump Test

Jumping performance is a important criterion for power and vertical jump test was used at many studies in the literature[26,46,50]. In the vertical jump procedure, a Newtest Powertimer 300 contact mat system (Newtest OY., Oulu, Finland) was used. The participants were instructed to start in a standing position with their legs open shoulder width, their arms freely positioned at their side. The participants were then encouraged to do their best jump. Two trials were performed, and the best result was used for the statistical analysis.

The Wingate Test

The WT is a common test used to measure an anaerobic performance[38] and performed on a cycle ergometer designed for immediate-load resistance (Monark Ergomedic 839E, Monark, Sweden). The participants were asked to perform as fast as possible against a load corresponding to 7.5 % of their body mass[2]. The WT duration is 30 s and the computer automatically started the time when the participants reached predetermined cadence. The participants were encouraged until the test finished. The resulting peak power was used for the statistical analysis.

Statistical Analyses

All of the statistical analyses were performed using SPSS 15 software, (Chicago, IL, USA). The participants were divided according to their hamstring flexibility levels into two flexibility groups by the median split method**.** The homogeneity of the data was evaluated by an analysis of skewness and kurtosis. Skewness and kurtosis were well within the accepted limits. “A one-way Anova with repeated measures“ was used to determine whether there were any differences in the average vertical jump height or WT performance after different stretching periods; the statistical test was applied to all of the participants and to both of the flexibility groups separately. The differences in the mean vertical jump height and WT performances between the two flexibility groups were compared using a t test.

RESULTS

Vertical Jump Test

There were no statistically significant differences between the average vertical jumps heights performed after different periods of stretching for all of the participants (n: 30) the high flexibility group (n: 15) or the low flexibility group (n: 15) analyzed separately (Table 1). Also no statistically significant differences observed between the high and low flexibility groups with respect to the mean vertical jumps height after the same stretching protocols.

The Wingate Test

No significant differences were found between the in average peak powers recorded after different periods of stretching for all of the participants (n: 30); the high flexibility group (n: 15) or the low flexibility group (n: 15) analyzed separately (Table 2). Furthermore there were no statistically significant differences between the high and low flexibility groups with respect to the mean peak power recorded after the same stretching protocols.

Table 1. Vertical jump heigts performed after static stretching exercise of different durations.

High flexibility group	Mean (cm)	Sd	N	F	p
0 sec.	49.4	7.5			
15 sec.	50.5	5.4	15	.776	.480
60 sec.	48.6	6.1			
Low flexibility group					
0 sec.	45.5	7.0			
15 sec.	46.3	6.8	15	2.008	.174
60 sec.	43.6	7.2			
All group					
0 sec.	47.4	7.4			
15 sec.	48.4	6.4	30	2.590	.093
60 sec.	46.1	7.0			

Table 2. Wingate test results performed after static stretching exercise of different durations.

High flexibility group	Mean (watt)	Sd	N	F	p
0 sec.	879.91	96.02			
15 sec.	862.21	92.00	15	.988	.399
60 sec.	872.91	106.63			
Low flexibility group					
0 sec.	870.48	110.56			
15 sec.	878.23	109.50	15	1.772	.209
60 sec.	837.46	104.33			
All group					
0 sec.	875.20	101.86			
15 sec.	870.22	99.70	30	1.274	.296
60 sec.	855.18	105.22			

DISCUSSION

When one looks at the analyses of the whole group or the low flexibility group, performance in the vertical jump test and WT appear to be reduced when performed after 60 s of static stretching compared with no stretching or 15 s of static stretching; however, these differences were not statically significant. Dalrymple et al. (2010) and Young et al. (2006) found consistent results with us[13,51].

Some types, durations or intervals of stretching have been reported to cause a statistically significant change in strength and power performance. For example, Ogura et al. (2007) found that 30 s of static stretching had no impact on muscular performance, but 60 s of static stretching dramatically reduced the athlete's muscle power[35]. Fortier et al. (2013) found that 20 s of static stretching did not significantly reduce strength and speed, but vertical jump performance decreased after stretching[17]. Brusco et al. (2018) found that 30 s of static stretching after a five minutes dynamic warm up cause a decrease in lower limb power measured by countermovement jump height[8]. Iatriodu et al. (2018) reported that 40 (2x20) and 60 (3x20) s of static stretching reduced the sprint performance[27].

Some studies in the literature have shown that isokinetic measurements can be related to athletic performance[41,44]. Siatras et al. (2008) studied the effects of different periods (0, 10, 20, 30 or 60 s) of static stretching on isometric and isokinetic peak power in quadriceps muscles in 50 participants. Dramatic declines in isometric and isokinetic peak power were demonstrated after 30 or 60 s of static stretching[45].

These conflicting findings in the literature can be explained by a number of different factors, including, the break allowed between stretching exercises and test performance[39]. Some studies have found that when power is tested immediately after static stretching, stretching has a negative effect on performance[45]. Our study included a two minute break between stretching and performance testing. This may have resulted in a decrease in the effect of stretching on performance. The duration of stretching, the number of repetitions and the type of stretching may also contribute to the seemingly contradictory results. For example Franco et al. (2012) used three sets of 30 s static stretching exercises and found a negative effect of static stretching and PNF on WT performance compared with dynamic stretching or no stretching[20]. Tsolakis et al. (2012) studied the effects of three different types of stretching exercises[46]. In contrast our study included only static stretching, which was performed only once. This may explain for our inability to demonstrate impacts of stretching or find meaningful differences among our variable stretching protocols.

Some researchers have claimed that compared with untrained athletes, well trained athletes might be less sensitive to the effects of explosive power stretching[47]. This may be the result of too much flexibility or joint movement[31]. Behm and Chaouachi (2011) have also claimed that during trainings that includes less than a total of 90 s of static stretching, it is more difficult to detect a decrease in performance[7]. Our study's results are consistent with this viewpoint.

The physiological mechanism of the decline in the ability to produce power after stretching is not clear. One theory is that the decrease is related to mechanical properties in the muscle tendon unıt, or neuromuscular factors[42]. Initially, a change in performance can be associated with an increase in the length of the muscle- tendon system and a decrease in muscle stiffness[29]. A change in intramuscular length and speed might cause a decline in the amount of power produced in the units of straining muscles[45]. Like the decline in muscular activation and changing reflex sensitivity,

neuromuscular factors may interact with other mechanisms[3,18]. Guissard et al. (2001) strained wrist joints to 10° and 20° angles and recorded the decrease in reflex responses[21]. The Hoffman reflex (H reflex) decreases as an acute result of stretching, and this might lead to a drop in performance[18]. This reflex is acquired from the triad of triseps surae muscles and the soleus muscle in normal adults[14]. A limited H reflex after stretching might be due to the sensitivity in the decrease of muscle spindle[3]. The H Reflex activity improved in a very short time[9]. Apart from neuromuscular factors, high intensity stretching can disturb the blood flow in the muscle[34], and performance can be affected by the changes in blood flow in the muscle.

The study has some limitations. The number of athletes in this study can be considered as relatively small. Also they were doing different types and durations of exercise. But we evaluated them according to their level of flexibility that can eliminate this limitation.

CONCLUSION

In conclusion, performed 15 and 60 s of static stretching before anaerobic power performance had no effect on performance. Further studies are required to investigate the effect of different durations of static stretching and the effect of static stretching on female athletes. It would also be interesting to compare the acute effects of static stretching with other types of stretching. The use of larger test groups would also be beneficial. New studies will help to athletes and coaches for setting new stretching routines.

REFERENCES

1. Alter. M.J., Sport Stretch, Second Edition, Human Kinetics, Champaign IL, 1997.

2. Australian Sports Commission. Physiological Tests For Elite Athletes, First Edition, ABD: Human Kinetics, 2000.

3. Avela J., Kyrolainen H., Komi P.V., "Altered reflex sensitivity after repeated and prolonged passive muscle stretching" Journal of Applied Physiology. 86(4). 1283-1291, 1999.

4. Bandy W.D., Irion J.M., Briggler M., "The effect of time and frequency of static stretching on the flexibility of the hamstring muscles" Physical Therapy. 77(10). 1090-1096, 1997.

5. Beedle B., Rytter S.J., Healy R.C., Ward T.R., "Pretesting static and dynamic stretching does not affect maximal strength" The Journal of Strength & Conditioning Research. 22(6). 1838-1843, 2008.

6. Behm D.G., Bamburi A., Cahill F., Power K., "Effect of acute static stretching on force, balance, reaction time, and movement time" Medicine & Science in Sports & Exercise. 36(8). 1397-1402, 2004.

7. Behm D.G., Chaouachi A., "A review of the acute effects of static and dynamic stretching on performance" European Journal of Applied Physiology. 111(11). 2633-2651, 2011.

8. Brusco C.M., Pompermayer M.G., Esnaola B.W., Lima C.S., Pinto R.S., "Short duration static stretching preceded by cycling warm-up reduces vertical jump performance in healthy males" Sport Sciences for Health. 14. 77–82, 2018.

9. Budini F., Tilp M., "Changes in H-reflex amplitude to muscle stretch and lengthening in humans" Reviews in The Neurosciences. 27(5). 511–522, 2016.

10. Canadian Society for Exercise Physiology. The Canadian Physical Activity, Fitness and Lifestyle Approach, Third edition, Health Canada Publishers: Ottawa Ontario, 2003.

11. Church J.B., Wiggins M.S., Moode F.M., Crist R., "Effect of warm-up and flexibility treatments on vertical jump performance" Journal of Strength and Conditioning Research. 15(3). 332-336, 2001.

12. Cornwell A., Nelson A.G., Heise G.D., Sidaway B., "The acute effects of passive muscle stretching on vertical jump performance" Journal of Human Movement Studies. 40. 307-324, 2001.

13. Dalrymple K.J., Davis S.E., Dwyer G.B., Moir G.L., "Effect of static and dynamic stretching on vertical jump performance in collegiate women volleyball players" The Journal of Strength & Conditioning Research. 24(1). 149-155, 2010.

14. Ertekin. C., Klinik Elektromiyografi, Ege Üniversitesi Matbaası, İzmir, 1977. [In Turkish]

15. Estes T.M., "The effects of static and dynamic stretching protocols on a 30-second anaerobic bicycle test" Master's thesis, California University of Pennsylvania, 2008.

16. Evetovich T.K., Nauman N.J., Jonney D.S., Todd J.B., "Effect of static stretching of the biceps brachii on torque, electromyography, and mechanomyography

during concentric isokinetic muscle actions" The Journal of Strength & Conditioning Research. 17(3). 484-488, 2003.

17. Fortier J., Lattier G., Babault N., "Acute effects of short-duration isolated static stretching or combined with dynamic exercises on strength, jump and sprint performance" Science & Sports. 28(5). 111-117, 2013.

18. Fowles J.R., Sale D.G., Macdougall J.D., "Reduced strength after passive stretch of the human plantar flexors" Journal of Applied Physiology. 89(3). 1179-1188, 2000.

19. Franco B.L., Signorelli G.R., Trajano G.S., Oliveira C.G., "Acute effects of different stretching exercises on musculer endurance" The Journal of Strength & Conditioning Research. 22(6). 1832-1837, 2008.

20. Franco B.L., Signorelli G.R., Trajano G.S., Costa P.B., "Acute effects of three different stretching protocols on the Wingate test performance" Journal of Sports Science & Medicine. 11(1). 1-7, 2012.

21. Guissard N., Duchateau J., Hainaut K., "Mechanisms of decreased motoneurone excitation during passive muscle stretching" Experimental Brain Research. 137(2). 163-169, 2001.

22. Gürsoy R., Akarsu S., Hazar K., "Examination of correlation among reaction time, strength, and flexibility of sedentary and athletes in different branches" Journal of Human Sciences. 14(4). 3282-3291, 2017.

23. Harmancı H., Karavelioğlu M.B., "Effects of different warm-up methods on repeated sprint performance" Biomedical Research. 28(17). 7540-7545, 2017.

24. Hazar S., Polat M., Hazar K., Kaya Ç., Cansu G., "Effect of Active and Passive Warm-Up on Flexibility, Anaerobic Power and Strength" Ulusal Spor Bilimleri Dergisi. 2(1). 20-30. 2018.

25. Herbert R.D., Gabriel M., "Effects of stretching before and after exercising on muscle soreness and risk of injury: Systematic review" British Medical Journal. 325(7362). 468, 2002.

26. Hough P.A., Ross E.Z., Howatson G., "Effects of dynamic and static stretching on vertical jump performance and electromyographic activity" The Journal of Strength & Conditioning Research. 23(2). 507-512, 2009.

27. Iatridou G., Dionyssiotis Y., Papathanasiou J., Kapetanakis S., Galitsanos S., "Acute effects of stretching duration on sprint performance of adolescent football players" Muscles, Ligaments and Tendons Journal. 8(1). 37-42, 2018.

28. Jonhagen S., Nemeth G., Eriksson E., "Hamstring injuries in sprinters: the role of concentric and eccentric hamstring muscle strength and flexibility" The American Journal of Sports Medicine. 22(2). 262-266, 1994.

29. Kokkonen J., Nelson A.G., Cornvell A., "Acute muscle stretching inhibits maximal strength performance" Research Quarterly For Exercise and Sport. 69(4). 411-415, 1998.

30. Kyranoudis A., Nikolaidis V., Ispirlidis I., Galazoulas C., Alipasali F., Famisis K ., "Acute effect of specific warm-up exercises on sprint performance after static and dynamic stretching in amateur soccer players" Journal of Physical Education and Sport. 18(2). 825-830, 2018.

31. Magnusson S.P., Simonsen E.B., Aagard P., Dyhre-Poulsen P., Mchugh M.P., Kiaer M., "Mechanical and physical responses to stretching with and without preisometric contractions in human skeletal muscle" Archives of Physical Medicine and Rehabilitation. 77(4). 373-378, 1996.

32. McHugh M.P., Cosgrave C.H., "To stretch or not to stretch: the role of stretching in injury prevention and performance" Scandinavian Journal of Medicine & Science in Sports. 20(2). 169-181, 2010.

33. Nelson A.G., Driscoll N.M., Landin D.K., Young M.A., Schexnayder I.C., "Acute effects of passive muscle stretching on sprint performance" Journal of Sports Sciences. 23(5). 449-454, 2005.

34. Nelson A.G., Kokkonen J., Arnall D.A., "Acute muscle stretching inhibits muscle strength endurance performance" The Journal of Strength & Conditioning Research. 19(2). 338-343, 2005.

35. Ogura Y., Miyahara Y., Naito H., Katamoto S., Aoki J., "Duration of static stretching influences muscle force production in hamstring muscles" Journal of Strength and Conditioning Research. 21. 788-792, 2007.

36. Oshita K., Yamaguchi K. and Ariyoshi K., "Effect of 30 s of statıc actıve stretching on anaerobic power using the Wİngate test" Malaysian Journal of Movement, Health & Exercise. 5(2). 23-29, 2016.

37. Page P., "Current concepts in muscle stretching for exercise and rehabilitation" International Journal of Sports Physical Therapy. 7(1). 109-119, 2012.

38. Ramirez E.B., Williford H.N., Olson M.S., "Effects of a static stretching versus conventional warm-up on power output during Wingate cycle performance" In: Book of Abstracts of 54th Annual Meeting American College of Sports Medicine. New Orleans-USA. p.353, 2007.

39. Robbins J.W., Scheuermann B.W., "Varying amounts of acute static stretching and its effect on vertical jump performance" The Journal of Strength & Conditioning Research. 22(3). 781-786, 2008.

40. Safran M.R., Seaber A.V., Garrett W.E., "Warm-up and musculer injury prevention: an update" Sports Medicine. 8(4). 239-249, 1989.

41. Saliba L., Hrysomallis C., "Isokinetic strength related to jumping but not kicking performance of Australian footballers" Journal of Science and Medicine in Sport. 4(3). 336-347, 2001.

42. Schilling B.K., Stone M.H., "Stretching: Acute effects on strength and power performance" Strength & Conditioning Journal. 22(1). 44-47, 2000.

43. Sekir U., Arabacı R., Akova B., Kadagan S.M., "Acute effects of static and dynamic stretching on leg flexor and extensor isokinetic strength in elite women athletes" Scandinavian Journal of Medicine & Science in Sports. 20(2). 268-281, 2010.

44. Sharp R.L., Troup J.P., Costil D.L., "Relationship between power and sprint freestyle swimming" Medicine and Science in Sports and Exercise. 14(1). 53-56, 1982.

45. Siatras T.A., Mittas V.P., Mameletzi D.N., Vamvakoudis E.A., "The Duration of the inhibitory effects with static stretching on quadriceps peak torque production" The Journal of Strength & Conditioning Research. 22(1). 40-46, 2008.

46. Tsolakis C., Bogdanis G.C., "Acute effects of two different warm-up protocols on flexibility and lower limb explosive performance in male and female high level athletes" Journal of Sports Science & Medicine. 11(4). 669-675, 2012.

47. Unick J., Kİeffer H.S., Cheesman W., Feeney A., "The acute effects of static and ballistic stretching on vertical jump performance in trained women" Journal of Strength and Conditioning Research. 19(1). 206-212, 2005.

48. Walker. B., The Anatomy of Stretching, Second Edition, Lotus Publishing England, 2011.

49. Witvrouw E., Danneels L., Asselman P., D'Have T., Cambier D., "Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players" The American Journal of Sports Medicine. 31(1). 41-46, 2003.

50. Young W.B., Behm D.G., "Effects of running, static stretching and practice jumps on explosive force production and jumping performance" Journal of Sports Medicine and Physical Fitness. 43(1). 21-27, 2003.

51. Young W., Elias G., Power J., "Effects of static stretching volume and ıntensity on plantar flexor explosive force production and range of motion" Journal of Sports Medicine and Physical Fitness. 46(3). 403-411, 2006.