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Investigating The Acute Effects of Different Warm-Up Protocols on Sprint Performance in Female Volleyball Players

Kadın Voleybolcularda Farklı Isınma Protokollerinin Sprint Performansına Akut Etkisinin İncelenmesi

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Abstract: The number of studies on warm-up protocols has increased in recent years. However, there are very few studies that are specific to the population of female athletes and consist of a large number of participants. This study was designed to investigate the effects of 3 different warm-up protocols on sprinting performance in young female volleyball players. A total of 62 licensed female volleyball players aged 13-17 years participated voluntarily. There were 3 sessions in the study. The participants were randomly divided into a general warm-up group (GWG), a dynamic stretch group (DSG) and a static stretch group (SSG). After completing the warm-up protocols, the groups underwent a 5-minute transition period. The 20-metre sprint performance test was then performed. Data analysis was performed with the Python programming language and IBM SPSS 26 software. Shapiro-Wilk and Kolmogorov-Smirnov tests and kurtosis and skewness checks were performed. The data were indicated to be normally distributed ($p > 0,05$). Repeated Measures Anova test was used to detect the differences and the significance level was chosen as $\alpha=0,05$. When the results were examined, it was found that there was no statistically significant difference between the GWG and SSG 20-meter sprint time values ($p>0,05$), whereas when the DSG and GWG and SSG 20 metre sprint time values were compared, it was found that the DSG group's sprint time improved statistically significantly ($p<0,05$). In conclusion, DG had a positive effect on acute sprint performance in female volleyball players whereas SG had no effect on performance. This study provides evidence that a well-designed DS warm-up routine that focuses on the lower limbs can optimize the sprint performance of competitive female volleyball players. This information may be of value to sport professionals who are working with female athletes.

Keywords: Dynamic stretching, general warm-up, sprint performance, volleyball, female athletes.

Özet: *Isınma protokolleri üzerine son yıllarda yapılan araştırma sayısı gittikçe artmaktadır. Ancak geniş katılımcı sayısından oluşan kadın atlet popülasyonuna özgü araştırma oldukça azdır. Bu çalışmanın amacı genç kadın voleybolcularda 3 farklı ısınma protokolünün sprint performansa etkisinin incelenmesidir. Çalışmaya yaş ortalamaları 13-17 arasında, 62 lisanslı kadın voleybol oyuncusu gönüllü olarak katılmıştır. Çalışma 3 oturumda gerçekleştirilmiştir. Katılımcılar randomize bir şekilde Genel Isınma grubu (GWG), Dinamik Germe grubu (DSG) ve Statik germe grubu (SSG) olarak ayrılmıştır. Gruplar ısınma protokollerini tamamladıktan sonra 5 dakikalık geçiş fazına tabi tutulduktan sonra 20 metre sprint performans testini gerçekleştirmişlerdir. Elde edilen veriler Python programlama dili ve IBM SPSS 26 ile analiz edilmiştir. Shapiro Wilk ve Kolmogorov-Smirnov testleri ile basıklık ve çarpıklık kontrolü sonucunda, verilerin normal dağılım gösterdiği tespit edilmiştir ($p> 0,05$). Farkların tespit edilebilmesi için Repeated Measures Anova testi kullanılmış ve anlamlılık seviyesi $\alpha =0,05$ seçilmiştir. Bulgular incelendiğinde GWG ile SSG grubunun 20 metre sprint zamanı değerleri arasında istatistiksel olarak anlamlı farklılık görülmezken($p>0,05$), DSG ile GWG ve SSG gruplarının 20 metre sprint zamanı değerleri karşılaştırıldığında DSG grubunda sprint zamanının istatistiksel olarak anlamlı seviyede geliştiği görülmüştür($p<0,05$). Çalışmanın bulguları ışığında DG' nin kadın voleybolcuların akut sprint performans çıktısı üzerin olumlu bir etkisinin olduğu, SG' nin ise performansı etkilemediği görüldü. Bu çalışma, iyi tasarlanmış bir alt ekstremite yönelimli DS ısınma rutininin, müsabık kadın voleybolcularda sprint koşu performansını optimize edebileceğine dair kanıt sağlar. Bu bilginin kadın atletlerle çalışan spor çalışanları için yol gösterici olacağı düşünülmektedir.*

Anahtar Kelimeler: *Dinamik germe, genel ısınma, sprint performans, voleybol, kadın atlet.*

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INTRODUCTION

Athletic performance refers to an individual's ability to excel in various physical activities and disciplines. Pre-exercise warm-up routines are a common practice in almost all sports, both before training sessions and competitions. For decades, professionals have recommended warm-up routines for their athletes with the dual goals of injury prevention and performance enhancement (De Bruyn-Prevost, 1980; Ekstrand et al.,1983). Pre-exercise warm-up routines have been extensively studied in the literature and are widely accepted to optimise performance. Such routines increase intramuscular temperature, nerve conduction velocity and metabolic responses (Abade et al., 2017). The induction of post-activation strengthening can acutely improve muscle performance following a preloaded maximal or near-maximal stimulus (Sale, 2002). Outcomes such as physiological preparation and injury prevention can be considered common denominators of warm-up. However, the structure and use of warm-up protocols are still controversial. Warming up before training and competing is common practice in almost every sport. In addition, the state of hyperthermia caused by an increase in body temperature usually results in vasodilation and an increase in intramuscular blood flow. This is likely to help optimise aerobic function by increasing oxygen consumption during subsequent activities (Gray, S. and Nimmo, 2001; Neiva et al., 2014). For decades, practitioners have been recommending warm-up exercises to prevent injury and improve performance, however there is still a gap between evidence-based approaches and practice. To date, acute preparation prior to maximal performance, which is an important component of training, can have variable outcomes (Yıldız et al., 2013). Such practices often trigger several physiological responses in the body. These include increased cardiac output and increased intramuscular and core body temperatures. The increased muscle temperature leads to decreased muscle viscosity as these physiological responses occur. This can result in an increased range of movement. Simultaneously, muscle coordination is rapidly improved through specific movement pattern exercises. These patterns can increase reflex activation in working muscles with better motor unit triggering and synchronization. This process also takes place through the use of specific movement patterns for the rapid improvement of muscle coordination. These movement patterns can improve more efficient firing and synchronization of motor units by increasing muscle reflex activation in working muscles. This combination can contribute to a more fluid and smoother movement of the body by increasing the cooperation between the muscles (Günay et al., 2019; Günay et al., 2023). The aim of a warm-up before exercise is to reduce the risk of injury and optimize subsequent exercise performance. Some studies show that warming up for activities like running improves performance (Tsurubami et al., 2020). Stretching may have benefits in terms of flexibility and range of motion. However, the literature is inconsistent. A review of the literature identified several stretching exercise protocols. These protocols include static, dynamic, combined, ballistic stretching, proprioceptive neuromuscular facilitation (PNF) and sport-specific stretching methods (Aydın et al., 2019; Zakas, 2005). In addition to studies suggesting that static stretching improves performance, there are studies suggesting that static stretching decreases maximal strength and therefore performance (Chatzopoulos et al., 2007; Çilli et al., 2014; Gelen, 2010; Ribeiro and Vecchio,2011). There are studies which suggest that static stretching does not appear to affect performance. Some researchers have suggested dynamic stretching as an alternative (Amiri- Khorasani and Kellis, 2013; Yamaguchi et al., 2007). Studies show that dynamic stretching has a positive effect on performance (Baştürk et al.,2019; LaRoche et al., 2008; Zaruta, 2009). However, more research is needed to better understand the effects of different warm-up protocols on performance in different sports. Based on these data, the aim of our study was to investigate the acute effects of different stretching exercises on the 20-metre sprint performance of young female volleyball players.

METHODS

Research Model: In order to compare the acute effects of 3 warm-up protocols on sprint performance in volleyball players, all test sessions were randomly allocated (Needham et al., 2009). All athletes underwent three warm-up protocols: general warm-up, dynamic stretching protocol and static stretching protocol on non-consecutive days. All test sessions were performed at the same time of the day and in an indoor sports hall. Volleyball players maintained the same training and dietary routine, avoiding caffeine intake for 12 h before each test. Testing the thermic effect of food consumption two hours before the test was not allowed (Türkmen et al., 2022). To minimise the effects of fatigue, test procedures were performed 48 h after a match or high-intensity training session. The individual strength and conditioning programme of the participants was controlled to avoid confounding effects of training. All participants were informed of the procedures and each gave informed consent in writing. The ethics committee of Trakya University approved all procedures and experimental design (2023/11-15). The study protocol complied with the ethical principles of the Declaration of Helsinki and the aims and risks of the study were understood by all participants and their parents who signed informed consent before the start of the study.

<u>Warm-up Protocols</u>

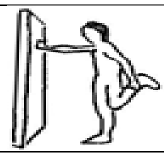
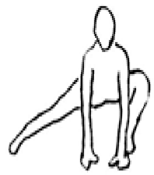
General Warm-up Protocol: In the running-based warm-up session, participants performed a 10-minute running exercise that progressed from **mild to moderate**.

Static Stretching Protocol: The static stretching session consisted of a 10-minute general warm-up protocol followed by 5 minutes of SG (Türkmen et al., 2022; Unick et al., 2005; Watson, 1997; Yamaguchi and Ishii,2005). The SG exercises focused on the following 5 lower limb muscle groups; hip flexors, quadriceps, hamstrings, gluteal muscles and hip adductors (Table 1). All static stretches were performed by holding at the "point of discomfort" for 30 seconds with 1 repetition in each limb (Faelli et al., 2021).

Dynamic Stretching Protocol: This protocol consists of 5 different movements designed for the quadriceps, hamstrings, hip flexors, hip adductors and gluteal muscles used during sprinting (Table 2). For each dynamic stretching exercise, 14 repetitions (~10 m) were performed. Light stretching was performed at a 2:2 pace during the repetitions. The stretching was performed at a moderate level and 3-step walking intervals were performed during the relaxation. The movements were designed with 10 s rest in between and the total duration was limited to 5 min (Faigenbaum et al., 2022; Günay et al., 2023; Holt and Lambourne, 2008; Manoel et al., 2008; Unick et al., 2005; Zmijewski et al., 2020).

Contents of Static Stretching Protocol

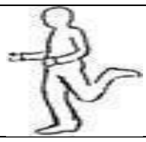
Table1: Static Warm-up Movements (Zakas,2005)

Buttock Stretch	In the supine position, with the knees to the chest, the right leg was pulled to the pain threshold. The right leg was placed on the left thigh and waited for 30 seconds	
Quadriceps Wall Stretch	With one hand on the wall, one leg was lifted. The pain threshold was waited for 30 seconds. The same was then done with the other leg.	
Calf Stretch	With one foot in front and the other foot behind, the hind leg was held at the pain threshold for 30 seconds. On the other side, the same movement was performed.	
Adductors	At the extreme point where the feet could be opened, the other leg was placed on the floor. The other leg was held straight, supported by the hand, and waited for 30 seconds at the pain threshold. On the other side, the same movement was performed.	
Modified Hurdlers Stretch	In the sitting position, one leg was kept in front for 30 seconds at the pain threshold and the same movement was applied to the other side.	

Contents of Dynamic Stretching Protocol

Table2: Dynamic Warm-up Movements (Zakas,2005)

Side-Front Arm Crossover	Both arms are crossed at the level of the chest and are swung back and forth. Perform at 2:2 speed with 1o seconds rest.	
Walking Lunge with Rotation	A large step forward and a knee bend with simultaneous horizontal arm rotation was performed at a 2:2 ratio.	

Lateral Shuffle	Lateral movements were performed at a 2:2 speed. The feet went right and left.	
Frankenstain Walks	As each leg is lifted, both hands should be stretched out in front of the body. Step forward at a 2:2 pace.	
Heel-Ups	When moving forward, the heels are placed on the buttocks. Performed at a speed of 2:2.	

20m. Sprint Running Test: Protocols for the assessment of sprint performance in team sports are constantly evolving and may be subject to change (Chatzopoulos et al., 2007). The 20 m sprint is considered a performance parameter. It is important for success in all sports that involve sprinting (Devore and Hagerman, 2006; Fletcher, 2010). All participants performed from a standing start (high power). The dominant foot was forward (Needham et al., 2009). The experimental design was as follows: The athletes performed the maximum 20 m sprint test after a 1 min rest period following completion of the warm-up protocols. It was performed with the use of photocell beams set at 0 m and 20 m from the starting point. All participants performed the test on the same surface. They wore sports shoes (Turki et al., 2012).

Purpose of the research: It is known that warm-up is very important to prevent injuries during training and competition as well as to maximize athletic performance. More research is needed to better understand the effects of different warm-up protocols on performance in different sports. Based on these data, the aim of our study was to investigate the acute effects of different stretching exercises on 20 m sprint performance of young female volleyball players.

Research Group: The minimum sample size of 52 people with 80% power, 5% type 1 error and d=0.80 effect size was determined according to the power analysis using the Python stats models library. Sixty-two healthy female volleyball players participated voluntarily in the study. They played in regional volleyball matches and had been licensed for at least two years. The anthropometric data of the participants showed that the mean age was 14.68 ± 1.50 years, the mean weight was 55.25 ± 7,86 kg and the mean height was 1.68 ± 0.07 m.

Data Collection: All measurements of the study were carried out in an indoor volleyball court. Anthropometric measurements : Height was measured to the nearest 0.5 cm using a mobile stadiometer (Seca, model 217, Hamburg, Germany) in mid-inspiration without shoes. Body mass was measured using a calibrated portable electronic weighing scale (Seca, model 875, Hamburg, Germany). Time for the 20-m sprint test was measured with a Vald Performance - Smart Speed wireless photocell pro device. All measurements were performed on independent days.

Analysis of Data: Statistical analysis first began with the identification of outliers. Data rows of 3 participants were identified as outliers based on normal Q-Q plots and were excluded from the analysis. The analysis continued with 59 participants. First, the normal distribution control was performed. Repeated measures analysis of variance (ANOVA) was used due to the assumption of normal distribution and sufficient number of data. Since the normal distribution was provided and the data size was sufficient, repeated measures of variance analysis (ANOVA) and effect size (cohen d) were used.

RESULTS

The descriptive statistics in Table 3 show that the kurtosis and skewness of the data for all three groups ranged from -1.5 to +1.5, this situation is considered as an indicator of normal distribution (Ozdamar, 1999). In addition, according to the results of Shapiro-Wilk and Kolmogorov-Smirnov normality tests shown in Table 4 (p>0.05), the data were considered to be normally distributed.

Table 3: Descriptive statistics for variables

(n=59)	**Mean (ms*)**	**Std. Deviation**	**Min.**	**Max.**	**Skewness**	**SD of Skewwness**	**Kurtosis**	**SD of Kurtosis**
GWG (ms)	3627	194	3272	4025	-0,00	0,31	-0,92	0,61
SSG (ms)	3599	202	3236	4022	-0,00	0,31	-1,04	0,61
DSG (ms)	3533	197	3147	4011	0,23	0,31	-0,53	0,61

**ms= millisecond*

Table 4: Testing the Normality of Variables

	Kolmogorov Smirnov			**Shapiro Wilk**		
	Statistic	df	Sig.	Statistic	df	Sig.
GWG (ms)	0,08	59	0,20	0,97	59	0,19
SSG (ms)	0,10	59	0,20	0,97	59	0,12
DSG (ms)	0,08	59	0,20	0,99	59	0,74

**ms= millisecond*

According to Mauchly's sphericity test (p<0,05), since the condition of sphericity was not met (p<0,05), according to the Greenhouse Geisser test in the table of tests for within-subjects effects, it was seen that there was a difference between the sprint running times after three different warm-up methods (p<0,05, F=31,4). When the pairwise comparisons table in Table 5 and the marginal means plot in Figure 1 were examined to determine how much difference there was between which groups, it was seen that the difference between the group that used the GWG general warm-up method and the group that used the SSG warm-up method was not statistically significant (p>0,05). There was a statistically significant difference in terms of sprint running times between the group in which the DSG method was used and the groups in which the GWG and SSG methods of warming up were used (p<0,05).

Table 5: Pairwise Comparisons

Measure:	Effect on 20 m sprint performance according to warm-up types						
(I)warm-up groups	Warm-up groups (J)	Mean Difference (I-J)	Standart Error	Sig.(p)	95% Confidence Interval for Difference		Cohen d
					Lower Bound	Upper Bound	
1(GWG)	2	27,78	13,47	0,13	-5,44	60,99	0,27
	3	94,25	13,45	0,00	61,07	127,43	0,91
2(SSG)	1	-27,78	13,47	0,13	-60,99	5,44	0,27
	3	66,47	9,18	0,00	43,83	89,11	0,94
3(DSG)	1	-94,25	13,45	0,00	-127,43	-61,07	0,94
	2	-66,47	9,18	0,00	-89,11	-43,83	0,91

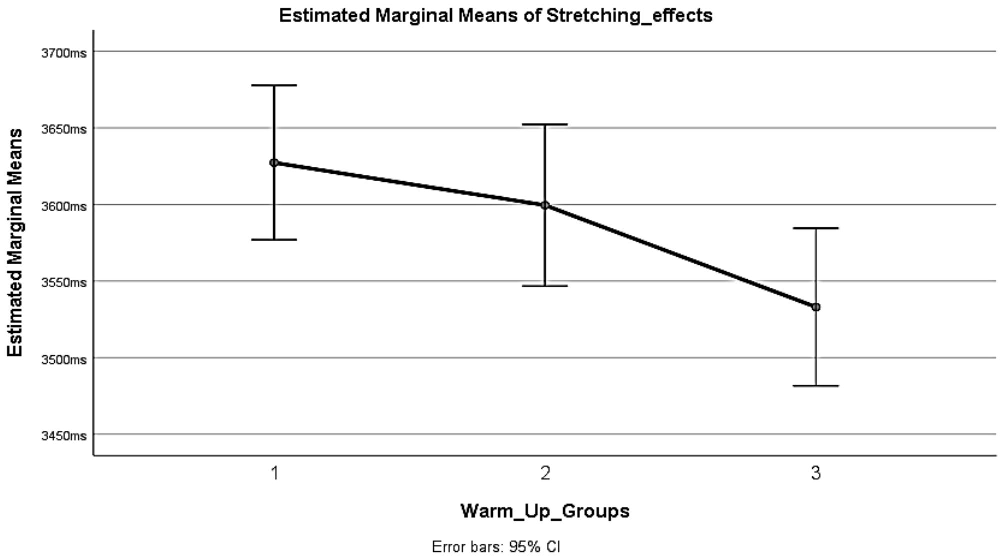


Figure 1: Marginal means plot

When analyzing the difference between the means, it was found that the highest difference was between the 20 m sprint running time of the group using the GWG warm-up method and the 20 m sprint running time of the group using the DSG warm-up method (94.25 ms). It was also observed that the 20 m sprint running time of the group using the DSG warm-up method was lower than the 20 m sprint running time of the group using the GWG warm-up method (66.47 ms). When the effect size of the difference between the group averages was examined, it was seen that the difference between the DSG heating method and the GWG and SSG heating methods had a greater effect (d=0.94 and d=0.91>0.80) (Cohen, 1988). From the marginal means plot in Figure 1, it was seen that the group using the DSG warm-up method, which is the third warm-up method, had the best sprint running performance.

DISCUSSION

The aim of this study was to investigate the effects of three different warm-up protocols on the 20-meter sprint performance of female volleyball players between 13 and 17 years of age. The main finding of the study was that dynamic stretching significantly improved sprint performance in female athletes compared to both static and general warm-up protocols. Static stretching did not improve sprint performance compared to the general warm-up protocol. When reviewing the literature, there are some research findings specific to female volleyball players. In one study of female athletes, it was reported that 30 seconds of SG applied to the knee extensor muscles had a 1.3% decrease in vertical jump performance and a 1.3% decrease in repetition jump performance (Cornwell et al., 2002). In recent years (Günay et al.,2023; Behm et al., 2001; Behm et al., 2006; Fowles et al., 2000; Nelson et al., 2005), there have been many studies suggesting that SG has no effect on injury prevention, that flexible individuals are more likely to be injured than less flexible individuals, and that it has a negative effect on performance. Recent studies have emphasised that passive stretching may be detrimental to performance by reducing power production rather than supporting the athlete (Watson, 1997; Cornwell et al., 2002; Fowles et al., 2000; Rosenbaum and Hennig,1995; Young and Elliott, 2001). These findings are in contrast to studies that have examined the relationship between SG and vertical jump performance in men. These studies have generally reported a decrease in performance (Church et al., 2001; Young et al., 2006). Kubo et al investigated gender differences in the viscoelastic properties of tendon structures and found that tendon stiffness was reduced in the medial gastrocnemius (calf muscle) of females compared to males (Kubo et al., 2003). This suggests that impaired muscle performance following static stretching is associated with structural as opposed to neurological mechanisms (Fowles et al., 2000; Nelson et al., 2005).

In three separate studies using the DG protocol in female volleyball players, the way in which the DG protocol was applied may have caused a greater increase in muscle temperature. This may have improved performance and resulted in an increase in leg extension power (Manoel et al., 2008; Fletcher, 2010; Fernández-Agulló, 2022). This could mean that the muscle-tendon units in the targeted muscles of women are already softer. It has been speculated that this strength deficit is due to either an inhibitory neural mechanism or an increase in musculotendinous compliance (Unick et al., 2005). In their study, Granata et al. found that men had higher levels of leg muscle stiffness than women at different jump frequencies. They also found a similar situation at different torque levels. In a recent study, controlled measurements of knee kinematics after mechanical perturbation during active flexion and extension efforts found that women had less than 57% of the active muscle stiffness compared to men. This finding suggests that gender differences play a role in the musculoskeletal stability of the knee (Granata et al.,2002). Another reason for these differences may be the natural differences in active muscle stiffness between the sexes. Other explanations, such as reflex factors and energy conservation, may also be involved.

Compared to other stretching methods, DSG performance may increase core body temperature more (Günay et al.,2023). There are also studies that suggest that DG stretching exercises increase flexibility, vertical jump height and sprint performance (Faigenbaum et al., 2022; Fletcher and Anness, 2007 ; Little and Williams, 2006; McMillian et al., 2006; Yamaguchi and Ishii, 2005). In addition, it has also been observed that DG exercises increase the performance of a 20 m sprint (Fletcher and Jones, 2004). These increases in core temperature may have promoted faster and stronger muscle contractions by making nerve receptors more sensitive and increasing nerve conduction velocity (Fletcher and Jones, 2004). In this context, in the results of our study, in female volleyball players aged between 13 and 17 years, the mean sprint performance of the group using the GWG warm-up method was 3627±193 in milliseconds, the mean sprint performance of the group using the SSG warm-up method was 3599±202 in seconds, and the mean sprint performance of the group using the DSG warm-up method was 3533±197 in seconds. The ANOVA results showed a significant difference between the 20 m running times of the three warm-up protocols (p<0,05). The sprint time was lower for the DSG stretching group. Volleyball players were found to significantly reduce sprint times and improve performance when DSG stretching was incorporated into their warm-up routine. The effect size (Cohen's d=0.94) of the difference between the DSG warm-up and other warm-up methods was found to be high. Looking at the physiological basis of sprint performance, some basic themes emerge. Increased nerve conduction velocity, synchronization and motor unit firing (participation) form the neuromotor basis of sprinting performance.

Mechanically, the lengthening and shortening cycle processes affect the power produced by the muscle during sprinting. From a metabolic point of view, the increase in intramuscular temperature and enzymatic activities that accelerate energy pathways such as ATP-PC, which are required in the alactacid zone, are effective. In terms of running mechanics, the involvement of elastic elements and joint range of motion influence sprint performance. It is predicted that a dynamic stretching model may have more positive contributions to the physiological mechanisms mentioned above than static stretching and a general warm-up protocol. There is research to support this information. In this study, these results allowed the effects of dynamic stretching on female athletes to be verified with a large group of participants. Similar results to the literature on male athletes also show that the effects of dynamic stretching on sprint performance are similar between the sexes (Yamaguchi et al., 2007; McMillian et al., 2006; Alipasali et al., 2019). The fact that the use of static passive stretching leads to a decrease in performance is also supported by a number of studies (Cornwell et al., 2002; Fletcher and Jones, 2004; McArdle et al., 2010; Rosenbaum and Hennig, 1995; Silva et al., 2014; Young and Elliott, 2001). In the SG method, the reason for the decrease in the SS protocol may be related to the results, which may indicate the effect of acute neural inhibition resulting from passive stretching, which has the effect of reducing neural stimulation of the muscle. However, it has been suggested that passive stretching actually changes the tendon structure, making the tendon more flexible, which may result in a lower force production rate (McArdle et al., 2010).

Conclusion: These results show that warming-up with DG improves sprinting performance, whereas warming-up with SG has no effect on performance. The increase in stretching time may have had a negative effect on sprint performance, which is a high-power activity in female athletes, through muscle mechanics. Further basic research on this topic is needed in future studies. This study provides evidence that a well-designed lower extremity focused DS warm-up routine can optimize sprint performance in competitive female volleyball players. The researchers recommend that a dynamic stretching model should be used, especially before training loads that require high power output.

Ethical Considerations: *Institutional permission was obtained for the study with the information of Trakya University, Non-invasive clinical research ethics committee Number: 2023/269, Date: 03.07.2023.*

Conflict of Interest: *There is no conflict of interest between the authors.*

Contribution of authors: *All authors contributed equally to the literature and analysis of the study.*

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GENİŞLETİLMİŞ ÖZET

Isınma protokolleri üzerine yapılan çalışmaların sayısı son yıllarda hızla artmaya devam etmektedir. Ancak, geniş katılımcı sayısından oluşan kadın atlet popülasyonuna özgü araştırma sayısı oldukça azdır.

Çalışmanın Amacı: Isınmanın, antrenman ve müsabaka sırasında yaralanmaları önlemenin yanı sıra atletik performansı en üst düzeye çıkarmak için de çok önemli olduğu bilinmektedir. Farklı spor dallarında farklı ısınma protokollerinin performans üzerindeki etkilerini daha iyi anlamak için daha fazla araştırmaya ihtiyaç vardır. Bu verilere dayanarak, çalışmamızın amacı farklı germe egzersizlerinin genç kadın voleybolcuların 20 m sprint performansı üzerindeki akut etkilerini araştırmaktır.

Araştırma Problemi

Bu çalışma, genç kadın voleybolcularda genel ısınma (GI), statik germe (SG) ve dinamik germe (DG) protokollerinin 20 m sprint performansı üzerinde akut etkisini belirlemek amacıyla gerçekleştirilmiştir.

Literatür Araştırması: Egzersiz öncesi ısınma rutinleri hem antrenman seansları hem de müsabakalar öncesinde neredeyse tüm spor dallarında yaygın bir uygulamadır. Onlarca yıldır profesyoneller, sakatlıkların önlenmesi ve performansın artırılması gibi ikili hedeflerle sporcularına ısınma rutinleri önermektedir (De Bruyn-Prevost, 1980; Ekstrand et al.,1983). Egzersiz öncesi ısınma rutinleri literatürde kapsamlı olarak incelenmiştir ve performansı optimize ettiği yaygın olarak kabul edilmektedir. Bu rutinler kas içi sıcaklığı, sinir iletim hızını ve metabolik tepkileri artırır (Abade et al., 2017). Aktivasyon sonrası güçlenmenin indüksiyonu, önceden yüklenmiş maksimal veya maksimale yakın bir uyaranın ardından kas performansını akut olarak iyileştirebilir (Sale, 2002). Fizyolojik hazırlık ve yaralanmaların önlenmesi gibi sonuçlar ısınmanın ortak paydaları olarak kabul edilebilir. Bununla birlikte, ısınma protokollerinin yapısı ve kullanımı hala tartışmalıdır. Antrenman ve müsabakadan önce ısınmak hemen hemen her spor dalında yaygın bir uygulamadır. Buna ek olarak, vücut sıcaklığındaki artışın neden olduğu hipertermi durumu genellikle vazodilatasyona ve kas içi kan akışında artışa neden olur. Bunun, sonraki aktiviteler sırasında oksijen tüketimini artırarak aerobik işlevi optimize etmeye yardımcı olması muhtemeldir (Gray, S. and Nimmo, 2001; Neiva et al., 2014). On yıllardır uygulayıcılar sakatlanmayı önlemek ve performansı artırmak için ısınma egzersizleri önermektedir, ancak kanıta dayalı yaklaşımlar ile uygulama arasında hala bir boşluk vardır. Bugüne kadar, antrenmanın önemli bir bileşeni olan maksimal performans öncesi akut hazırlığın değişken sonuçları olabilmektedir (Yıldız et al., 2013). Egzersiz öncesi ısınmanın amacı yaralanma riskini azaltmak ve sonraki egzersiz performansını optimize etmektir. Bazı çalışmalar, koşu gibi aktiviteler için ısınmanın performansı artırdığını göstermektedir (Tsurubami et al., 2020). Esneme hareketlerinin esneklik ve hareket açıklığı açısından faydaları olabilir. Bununla birlikte, literatür tutarsızdır. Literatür taramasında çeşitli germe egzersiz protokolleri tespit edilmiştir. Bu protokoller arasında statik, dinamik, kombine, balistik germe, proprioseptif nöromüsküler fasilitasyon (PNF) ve spora özgü germe yöntemleri yer almaktadır (Aydın et al., 2019; Zakas, 2005). Statik germenin performansı artırdığını öne süren çalışmaların yanı sıra, statik germenin maksimal gücü ve dolayısıyla performansı azalttığını öne süren çalışmalar da vardır (Chatzopoulos et al., 2007; Çilli et al., 2014; Gelen,2010; Ribeiro and Vecchio,2011). Statik germenin performansı etkilemediğini öne süren çalışmalar da vardır. Bazı araştırmacılar alternatif olarak dinamik germeyi önermişlerdir (Amiri- Khorasani and Kellis, 2013; Yamaguchi et al., 2007).

Yöntem: Bu çalışma, genç kadın voleybolcularda 3 farklı ısınma protokolünün sprint performansı üzerindeki etkilerini araştırmak üzere tasarlanmıştır. Çalışmaya 13-17 yaş arası toplam 62 lisanslı kadın voleybolcu gönüllü olarak katılmıştır. Çalışmada 3 oturum gerçekleştirilmiştir. Katılımcılar genel ısınma grubu (GIG), dinamik germe grubu (DGG) ve statik germe grubu (SGG) olarak ayrıldı. Isınma protokollerini tamamladıktan sonra gruplar 5 dakikalık bir geçiş sürecinden geçmiştir. Ardından 20 metre sprint performans testi gerçekleştirilmiştir. Voleybolcularda 3 ısınma protokolünün sprint performansı üzerindeki akut etkilerini karşılaştırmak için tüm test seansları rastgele dağıtılmıştır (Needham et al., 2009). Tüm sporculara üç ısınma protokolü uygulanmıştır: ardışık olmayan günlerde genel ısınma, dinamik germe protokolü ve statik germe protokolü. Tüm test seansları günün aynı saatinde ve kapalı bir spor salonunda gerçekleştirilmiştir. Voleybolcular her testten önce 12 saat boyunca kafein alımından kaçınarak aynı antrenman ve beslenme rutinini sürdürmüştür. Testten iki saat önce gıda tüketiminin termik etkisinin test edilmesine izin verilmemiştir (Türkmen et al., 2022). Yorgunluğun etkilerini en aza indirmek için, test prosedürleri bir maçtan veya yüksek yoğunluklu antrenman seansından 48 saat sonra gerçekleştirilmiştir. Antrenmanın karıştırıcı etkilerinden kaçınmak için katılımcıların bireysel güç ve kondisyon programı kontrol edilmiştir. Trakya Üniversitesi etik kurulu tüm prosedürleri ve deneysel tasarımı onaylamıştır (2023/11-15).

Sonuç ve Değerlendirme: Bu çalışmanın sonucunda, 13-17 yaş arası bayan voleybolcularda GIG ortalama sprint performansı milisaniye cinsinden 3627±193, SGG ortalama sprint performansının milisaniye cinsinden 3599±202 ve DGG ortalama sprint performansı ise milisaniye cinsinden 3533±197 olduğu tespit edilmiştir. ANOVA sonuçları üç ısınma protokolünün 20 m koşu süreleri arasında anlamlı bir fark olduğunu göstermiştir($p<0,05$). Özellikle DGG ısınma yöntemi ile diğer ısınma yöntemleri arasındaki farkın etki büyüklüğü (Cohen d=0,94) yüksek bulunmuştur. DGG sprint süresinin daha düşük olduğu dolayısı ile voleybol oyuncularının ısınma rutinlerine DGG esnemesini dahil ettiklerinde sprint sürelerini önemli ölçüde düşürdüğü ve performanslarını artırdıkları görülmüştür.