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Investigation of the Effects of Different Warm-Up Protocols on Some Performance Parameters*

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ABSTRACT

Purpose: In this study, it was aimed to examine the effects of different warm-up protocols on some performance parameters.

Method: In this study, 45 licensed male basketball players aged 12-15, who participated in school sports competitions held in Tuzluca district of Iğdır province in 2020, filled out the consent form with their families and were included in the study voluntarily. Different warm-up protocols including static warm-up, dynamic warm-up, and jogging warm-up were applied to the participants. After applying different warm-up protocols, the participants' agility, flexibility, vertical jump, and speed test measurements were taken. Mean and standard deviation values were calculated for all variables. One-way analysis of variance (ANOVA) was used in repeated measurements to determine the effect of different warm-up protocols on performance parameters. Bonferroni post-hoc analysis was applied to determine which warm-up protocol caused the difference. SPSS statistics program was used for all data and the confidence interval for statistical processes was accepted as $p<0.05$.

Results and Conclusion: According to the findings of the study, it was determined that the flexibility and vertical jump values obtained after dynamic warm-up were statistically higher than the values obtained after static warm-up and jogging warm-up ($p<0.05$). It was determined that the values obtained after dynamic warm-up in the speed parameter were statistically lower than the values obtained after static warm-up and jogging warm-up ($p<0.05$). No statistically significant difference was reported in the agility values obtained after applying different warm-up protocols ($p>0.05$). As a result of the application of different warm-up protocols, it was determined that the highest flexibility and vertical jump values were obtained in the dynamic warm-up group among the groups. Looking at the speed values, it was determined that the dynamic warm-up group performed better than the other warm-up groups. However, there was no difference between the groups in terms of performance in agility values.

Keywords: Dynamic, Warm-Up, Jogging, Performance, Static

ÖZET

Farklı Isınma Protokollerinin Bazı Performans Parametreleri Üzerine Etkisinin İncelenmesi

Amaç: Bu çalışmada, farklı ısınma protokollerinin bazı performans parametreleri üzerine etkisinin incelenmesi amaçlanmıştır.

Yöntem: Bu çalışmaya 2020 yılında Iğdır ili Tuzluca ilçesinde gerçekleştirilen okul sporları müsabakalarına katılan 12-15 yaş aralığındaki 45 lisanslı erkek basketbol sporcusu gönüllü olarak dahil edilmiştir. Katılımcılara statik ısınma, dinamik ısınma ve jogging ısınma olmak üzere farklı ısınma protokolleri uygulanmıştır. Farklı ısınma protokolleri uygulandıktan sonra katılımcıların çeviklik, esneklik, dikey sıçrama ve sürat test ölçümleri alınmıştır. Tüm

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değişkenler için ortalama ve standart sapma değerleri hesaplanmıştır. Farklı ısınma protokollerinin performans parametreleri üzerine etkisinin belirlenmesi için tekrarlı ölçümlerde tek yönlü varyans analizi (ANOVA) kullanılmıştır. Farkın hangi ısınma protokolünden kaynaklandığını belirlemek amacıyla Bonferroni post-hoc analizi uygulanmıştır. Tüm işlemler için SPSS programı kullanılmış ve istatistiki işlemler için güven aralığı $p<0.05$ olarak kabul edilmiştir.
Bulgular ve Sonuç: Analiz sonuçlarına göre, dinamik ısınma sonrası elde edilen esneklik ve dikey sıçrama değerlerinin, statik ısınma ve jogging ısınma sonrası elde edilen değerlerden istatistiksel olarak daha yüksek olduğu tespit edilmiştir ($p<0.05$). Sürat parametresinde dinamik ısınma sonrası elde edilen değerlerin statik ısınma ve jogging ısınma sonrası elde edilen değerlerden istatistiksel olarak daha düşük olduğu tespit edilmiştir ($p<0.05$). Farklı ısınma protokollerinin uygulanması sonrasında elde edilen çeviklik değerlerinde ise istatistiksel olarak anlamlı bir farklılık bulunamamıştır ($p>0.05$). Farklı ısınma protokollerinin uygulanması sonucunda gruplar arasında en yüksek esneklik ve dikey sıçrama değerlerinin dinamik ısınma grubunda elde edildiği tespit edilmiştir. Sürat değerlerine bakıldığında dinamik ısınma grubunun diğer ısınma gruplarına göre daha iyi performans gösterdiği tespit edilmiştir. Çeviklik değerlerinde ise gruplar arasında performans bakımından herhangi bir farka rastlanmamıştır.
Anahtar Kelimeler: Dinamik, Isınma, Jogging, Performans, Statik

INTRODUCTION

People generally want to be physically, mentally and spiritually healthy, and the most effective way to achieve this goal is stated as physical education, sports and physical activity (Yıkılmaz, 2019). Physical education, sports and physical activity have a place in the lives of many people for both health and sportive performance. Accordingly, nowadays it is necessary to start with a warm-up to work both in a sports activity for health purposes and in a performance sport or a training specific to that sports branch, during a competition or a training period (Kuter and Öztürk, 1997). Warm-up is considered as a set of general exercises or branch-specific studies that ensure the mental and physical adaptation of the athlete to the pre-competition loadings to prevent injuries that may occur and increase the performance of the athlete (Stamford, 1985; Muratlı and Sevim, 1993). It is mentioned that warm-up activities should be included as a priority in the competitions or sports activities that people will perform for either competitive or recreational purposes in their daily life (Köse, 2014). When we consider the human body as a whole, it resembles a system working in coordination with each other. It is considered that while muscle temperature can rise up to 43°C in high-intensity exercises, the fact that body temperature can rise up to 41°C is considered to prove this (Bangsbo, 1996).

The primary purpose of warming up before exercise is to exercise the muscles sufficiently to increase the intramuscular warmth together with the body temperature. Failure

to perform efficient warm-up indicates that the width of the vessels is not at the desired level as a result of the body temperature falling below 37°C, the blood circulation slows down, the oxygen-carrying capacity of the blood decreases, the risk of deformation in the fibers increases and it is considered that this may be the cause of major injuries. To prevent these, it is stated that the injuries that may occur may be minimized by exercising or warming up before the competition at a sufficient level (Günay and Yüce, 2008). What type of warm-up method will be applied in sportive activities is a very important issue. When the scientific researches are examined, it is stated that warming up before sports activities is very important; however, it is not concluded which warm-up method will increase the sportive efficiency more (Fletcher and Jones, 2004). In sportive activities, training and competitions, it is important to do warm-up exercises in order for the athletes to show an adequate performance or to prevent injuries, and it is necessary to do warm-up activities appropriate for the branch. It is believed that with an efficient warm-up exercise to be performed before sports activities, both maximal muscle strength is developed and there is an improvement in sportive performance (Young and Behm, 2002). Light pace aerobic jogging and stretching exercises, which are among the most used warm-up exercises from the past to the present, are among the most popular warm-up exercises (Yamaguchi et al., 2006).

The positive effects of warming up, stretching, and massage techniques, which increase performance through neurological and physiological mechanisms and reduce the risk of muscle damage, have been reported in many scientific studies (Callaghan, 1993). In all sportive activities, warm-up movements, static or dynamic stretching exercises are generally done before training and competitions, and then the main phase or work is started after. In other words, it is considered that after warming up, static stretching and dynamic stretching movements have done before training and competitions, it is necessary to move on to the other phase of the training or competition or the competition should be started (Ünlü, 2008).

Because of the examination of the studies, it is stated that performing static stretching movements before the activity contributes positively to the performance of the athlete, prevent the risk of injury, and affects the development of the posture position of our body (Duncan and Woodfield, 2006). Within the framework of these effects, static stretching movements are considered to be a suitable warm-up method for both children and adults (Young and Behm, 2002). According to several scientific studies dealing with adults, successful performance has been reported to be directly proportional to maximal power development, and it is stated that

acute static stretching movements have a negative tendency towards performance types (Cornwell et al., 2001; Nelson et al., 2005).

Moreover, certain researchers have doubts about the effect of dynamic exercises on flexibility development (Shrier and Gossal, 2000). It is considered that dynamic warm-up exercises performed during the transition from low intensity to moderate intensity can be another option that helps static stretching movements in children and adults (Herbert and Gabriel, 2002; Faigenbaum et al., 2005). Based on their experiences, trainers and athletes from the sport believe that warming up, stretching and massage movements done before the exercises are beneficial for the person or the athlete. In fact, it is believed that warm-up exercises, massage techniques, and stretching movements can affect performance in pre-exercise studies and decrease the risk of muscle damage that may occur in eccentric exercises as a result of neural, mental, and physiological mechanisms (Weerapong, 2005).

This study aims to investigate the effects of different warm-up protocols on flexibility, jump, agility, and speed performance. For this purpose, positive and negative effects of static warm-up, dynamic warm-up, and 5-min jogging run on flexibility, vertical jump, agility and 30-m speed performance after general warm-up will be determined, and various suggestions will be made based on the information obtained. The desired result of the research; to reveal the effects of the application of static and dynamic stretching exercises performed after a warm-up on flexibility, vertical jump, agility, and speed performance. The expected contribution from the research is to help individuals and trainers doing sports in our country and in the world in line with scientific data.

METHOD

Participants

In this study, 45 licensed male basketball players aged 12-15, who participated in school sports competitions held in Tuzluca district of Iğdır province in 2020, filled out the consent form with their families and were included in the study voluntarily. Candidates participating in the study were required to be volunteers and not have been injured or had surgery in the last six months. First of all, all the details of the content of the study were explained to each candidate who accepted to participate in the study. Before the measurements were taken, all participants were warned not to do heavy exercise on the day before the measurement.

Randomization was applied to determine the three different warm-up method sequences applied. The measurements of each different warm-up method were carried out at 24-h

intervals. This study was carried out with the permission of Iğdır University Scientific Research and Publication Ethics Committee No. 2021/07.

Research Design

This study was conducted to evaluate the effects of three different warm-up applications (static stretching, dynamic stretching, and only jogging run) with 3 different groups of 15 people designed in random order on agility, flexibility, vertical jump, and speed performance. After each warm-up method, speed, flexibility, agility, and vertical jump performance measurements were taken (Köse, 2014).

The Applied Warm-Up Protocols

Static Stretching (SS): After a warm-up run (5-min of jogging) and 1-min of walking, five stretching movements starting at medium intensity and going towards high intensity were performed on the lower extremities within 10-min. Each stretch was applied 2 times for each leg, 15-s stretching 5-s relaxation for 45-s for each leg and a total of 90-s for both legs. Measurements were made after 4-min of rest. The applied stretching movements are as follows:

1. Modified Obstacle Stretching: It is performed in the sitting position with one leg in the extended (straight) position, and the other leg is placed on top of the extended leg and reached in a forward position.

2. Stretching the Hip Rotators: In the supine position, one leg is placed on the other leg to form the Figure 4 and the hip is double-sided and straight forward or it is done in a 90-degree rotation movement in the direction of the lower straight leg.

3. Touching the Toe in a Twisted Position: While the heel of one foot is in a standing position very slightly in front of the toe of the other foot, the upper part of the body (chest) is tilted downwards, while dorsal flexion is made towards the calf of the front foot.

4. Stretching the Quadriceps: The back (spine) is held in an upright standing position by bending the knee with one hand and the quadriceps is stretched by pulling the heel towards the hip.

5. Calf Stretching: In a standing position at a distance of 2-3 feet from the wall, both hands approach the wall, one leg is straight back and the front leg is slightly bent and the wall is pushed.

Dynamic Stretching (DS): After a warm-up run (5-min jogging) and 1-min of walking, 7 dynamic type warm-up exercises were performed. Participants applied each dynamic type of warm-up exercise for 15-m with increasing intensity; after resting for 10-s, they repeated the same exercise again to the starting point. Measurements were taken after 4-min of rest. The dynamic warm-up movements applied are as follows:

1. High Knee Walk: While walking with normal walking steps, the knees were pulled up, and the arms were adjusted to the movement.

2. High Knee Pull: While walking with normal walking steps, the knees are pulled up and the movement is completed by pulling the hands and knees more upwards.

3. High Knees: While moving with running steps, the movement is applied by pulling the knees to the chest.

4. Butt Kicks (Heels to Hips): Heels touch the hips and proceeds with running steps.

5. Lunge Walks (Lunge Forward): Hands are brought together at the neck, and forward walking is done with lunge steps. Moreover, the knee of back foot is touched to the ground. This way the march continues.

6. Backward Lunge (Back Commando): Hands are brought together at the neck and backward walking is performed with lunge steps. Furthermore, the knee of back foot is touched to the ground. This way the march continues.

7. Straight Leg Kick: With the walking steps, the hands are kept parallel in the front and the tip of the toes is brought into contact with the hands. This exercise is performed without bending the knees.

Warm-up Run (Jogging): It comprises only 5-min of aerobic jogging and 1-min of walking. After this run, measurements were taken after 4-min of rest without any stretching or dynamic warm-up exercises.

Data Collection Tools

Sit and Reach Flexibility Test: The flexibility test measurement of the athletes participating in the study was carried out with a sit and reach test box with a length of 35 cm, a width of 45 cm, and a height of 32 cm. The participants sat on the ground and put their bare feet flat against the test box. The participants then stretched their hands in front of their body as far as they could by bending their torso forward, without bending their knees. The

participants waited in this state for 1-2 s at the farthest point. The test was repeated twice, and the best value was determined in “cm”.

30-Meter Speed Test: A 30-m sprint test was applied to determine the speed performance of the participants. Photocells were placed at distances of 0 and 30-m. Before starting the test, the participants performed a warm-up protocol with 7-min of dynamic stretching and short sprinting after a 10-min warm-up run. The participants performed the test twice, after a 5-min rest interval. The best time of the two attempts was recorded. When the participant was ready, he started from 1-m behind the starting photocell; after reaching the end photocell at a 30-m distance with the highest speed that he could reach, the running time was recorded automatically. The test was carried out twice; the highest value was recorded in “s”.

Vertical Jump Test: A digital jump meter with a 0.1 cm accuracy was used for vertical jump measurements in the performance tests. After the digital indicator of the jump meter was connected to the waist area and the rope was adjusted, the participant made the jump upward by stretching on his knees. After the jump, the participant tried to fall into the circular plastic area that was connected to the jump meter and placed on the ground. In the event of the participant taking a step forward or backward after landing, the jump was deemed invalid and repeated. The test was carried out twice, and the highest value was recorded in “cm”.

Agility T-Test: Three cones on a straight line are vertically arranged 10-m and horizontally 5-m apart, forming the letter "T". The athlete started to run from point A with the command to start, first went to point B, then to the left side with side steps to point C, then to point D, then touched point B again and then came back to point A and completed the test. Athletes ran with their bodies straight to the opposite side during the side-to-side running. The test was repeated twice with a full rest; the best result was recorded in “s”.

Statistical Analysis

Statistical analysis of the data obtained in the study was made using the SPSS 22 statistics program. The normality distribution of the data was analyzed with the Shapiro-Wilk test, and the data showed a normal distribution. Analysis of variance (ANOVA) and Bonferroni corrected paired comparison test were used in repeated measurements to determine whether different warm-up methods had an effect on the measured parameters by calculating the arithmetic mean and standard deviations of the data obtained in the study. Statistical significance level was accepted as $p<0.05$.

RESULTS

Table 1. Descriptive Statistics Chart Showing Age, Height, Body Weight, Body Mass Index and Training Ages of the Jogging Group Participants

Variables	N	Mean	SD
Age (years)	15	13.40	1.12
Height (cm)	15	158.50	12.83
Body Weight (kg)	15	50.31	10.93
Body Mass Index (kg/m²)	15	19.76	1.57
Training Age (years)	15	2.53	1.06

Table 2. Descriptive Statistics Chart Showing Age, Height, Body Weight, Body Mass Index and Training Ages of Participants in Static Stretching Group

Variables	N	Mean	SD
Age (years)	15	13.53	1.18
Height (cm)	15	159.56	10.99
Body Weight (kg)	15	51.19	12.58
Body Mass Index (kg/m²)	15	19.91	3.44
Training Age (years)	15	2.73	1.16

Table 3. Descriptive Statistics Chart Showing Age, Height, Body Weight, Body Mass Index and Training Ages of Participants in Dynamic Stretching Group

Variables	N	Mean	SD
Age (years)	15	13.33	1.17
Height (cm)	15	159.86	11.63
Body Weight (kg)	15	48.88	7.87
Body Mass Index (kg/m²)	15	19.63	2.50
Training Age (years)	15	2.80	1.32

Participants of the jogging warm-up group have an average age of 13.40±1.12 years, an average height of 158.50±12.83 cm, an average body weight of 50.31±10.93 kg, average body mass index of 19.76±1.57 kg/m^2, and the average training age was determined as 2.53±1.06 years (Table 1). Participants of the static stretching group have an average age of 13.53±1.18 years, an average height of 159.56±10.99 cm, average body weight of 51.19±12.58 kg, mean body mass index of 19.91±3.44 kg/m^2 and the average training age was determined as 2.73±1.16 years (Table 2). Participants of the dynamic stretching group have an average age of 13.33±1.17, an average height of 159.86±11.63 cm, average body weight of

48.88±7.87 kg, average body mass index of 19.63±2.50 kg/m^2 and the average training age was determined as 2.80±1.32 years (Table 3).

Table 4. Flexibility (Sit and Reach) Test Values Applied with Different Warm-Up Protocols

Variable	Warm-Up Protocol	Mean	SD	F	P	Difference
Flexibility (cm)	Jogging (1)	24.36	3.93	93.41	**0.04***	3>2>1
	Static (2)	26.20	4.13			
	Dynamic (3)	27.26	4.62			

Note. *p<0.05

When the flexibility values of the participants after different warm-ups are examined in Table 4, it is seen that after dynamic warm-up it is 27.26±4.62 cm, after static warm-up it is 26.20±4.13 cm, and after jogging warm-up it is 24.36±3.93 cm. It was determined that the flexibility values obtained after the dynamic warm-up were statistically higher than those obtained after static warm-up and jogging warm-up (p<0.05).

Table 5. Vertical Jump Test Values Applied with Different Warm-Up Protocols

Variable	Warm-Up Protocol	Mean	SD	F	P	Difference
Vertical Jump (cm)	Jogging (1)	23.24	5.57	2.78	**0.03***	3>1>2
	Static (2)	21.56	5.01			
	Dynamic (3)	26.08	5.27			

Note. *p<0.05

When the vertical jump values of the participants after different warm-ups were examined in Table 5, it was seen that after dynamic warm-up it was 26.08±5.27 cm, after jogging warm-up 23.24±5.57 cm, and after static warm-up, it was 21.56±5.01 cm. It was determined that the vertical jump values obtained after dynamic warm-up were statistically higher than the vertical jump values obtained after jogging warm-up and static warm-up (p<0.05).

Table 6. 30-m Speed Test Values Applied with Different Warm-Up Protocols

Variable	Warm-Up Protocol	Mean	SD	F	P	Difference
30-m Speed (s)	Jogging (1)	5.17	0.47	0.87	**0.02***	2>1>3
	Static (2)	5.33	0.47			
	Dynamic (3)	5.12	0.36			

Note. *p<0.05

When the speed values of the participants after different warm-ups are examined in Table 6, it is seen that after the static warm-up it is 5.33±0.47 s, after jogging warm-up it is 5.17±0.47 s, and after dynamic warm-up it is 5.12±0.36 s. It was determined that the speed values obtained after dynamic warm-up were statistically lower than the speed values obtained after jogging warm-up and static warm-up (p<0.05).

Table 7. Agility T-Test Values Applied with Different Warm-Up Protocols

Variable	Warm-Up Protocol	Mean	SD	F	P	Difference
Agility (s)	Jogging (1)	13.22	1.46	93.41	0.87	-
	Static (2)	12.74	1.12			
	Dynamic (3)	12.56	1.04			

Note. *p<0.05

In Table 7, when the agility values of the participants after different warm-ups are examined, it is seen that after the dynamic warm-up it is 12.56±1.04 s, after the static warm-up 12.74±1.12 s, and after the jogging warm-up it is 13.22±1.46 s. There was no statistically significant difference in agility values after different warm-ups (p>0.05).

DISCUSSION and CONCLUSION

Considering the results of the study, it was determined that the flexibility and vertical jump values obtained after dynamic warm-up were statistically higher than the values obtained after static warm-up and jogging warm-up. It was determined that the values obtained after dynamic warm-up in the speed parameter were statistically lower than the values obtained after static warm-up and jogging warm-up. No statistically significant difference was reported in the agility values obtained after applying different warm-up protocols.

As one of the important results of the study, it was determined that the flexibility values obtained after dynamic warm-up were statistically higher than the values obtained after static warm-up and jogging warm-up. When the literature is reviewed, there are studies demonstrate that warm-up protocols increase flexibility performance. In the study conducted by Çoknaz et al. (2008), in which the effects of different stretching times on the performance of artistic gymnasts were examined, it was stated that the flexibility values had more effect on the 11 artistic gymnasts who performed 10 repetitions for 15-s compared to those who performed 5 repetitions of static stretching for 30-s and those who did not perform any stretching movements. In this study, the fact that the dynamic stretching times are 15-s may be the reason for the high flexibility values after dynamic warm-up. In the study conducted by Özkaptan (2006), in which the effect of different warm-up methods applied to 235 male football players with an average age of 10 on speed performance was examined, it was stated that there was a difference in the flexibility data between the groups in which different stretching methods were applied and the groups were statistically superior to each other.

Samson et al. (2012) investigated the effect of general warm-up and special warm-up on dynamic and static stretching models; consequently, they argued that the model with static stretching provides more increase than other models in terms of flexibility performance value. Coons et al. (2017) stated in their study on female volleyball players that both static and dynamic stretching increase the range of motion (ROM) and affect flexibility performance. Su et al. (2017) stated in the study that they examined the effects of static stretching, dynamic stretching, and roller rolling studies on flexibility and that all three stretching methods have a positive effect on flexibility. In the study by Sevinç (2008), in which the effect of coordination studies in football applied to children in the 10-14 age group on basic motor and anthropometric properties was examined, 37 athletes were subjected to a 16-week study and it was stated that a significant difference occurred between the flexibility values of the participants based on their pre-test and post-test values.

In the study by Çolak and Çetin (2010), in which the effect of four different warm-up methods applied to female students of physical education and sports high schools on flexibility was examined, it was reported that there was a significant difference in the pre-test and post-test data of the stretching exercise group compared to the massage group. In the study by O'Sullivan et al. (2009) examining the effect of dynamic and static stretching exercises on hamstring muscles after the warm-up studies performed by university students

who are 21 years old on average, it is stated that the static stretching method increases flexibility and the dynamic stretching method has a negative effect on flexibility.

There are studies in the literature showing that static warm-up methods produce better or similar results compared to dynamic warm-up methods. These results may be related to the stimulation of the muscle spindles and the increase in contractile activation as a result of the static stretching of the muscle. Thus, it may be ensured that the muscle produces more force in an acute force generation.

In the study by Ryan et al. (2014) examining the acute effect of dynamic stretching methods with different repetitions on flexibility, it is mentioned that both study groups affect flexibility. In a study conducted by Woolstenhulme et al. (2006) the acute effect of different warm-up methods on the flexibility and vertical jump performances of basketball players was investigated; consequently, it was reported that ballistic stretching applications improved the flexibility performance of the four stretching methods. In a study conducted by Daneshjoo et al. (2013) had FIFA 11+ and harmoknee applications performed in 24 parts and the quadriceps and hamstring force measurements of the participants at non-uniform angular velocities were taken with an isokinetic dynamometer. Consequently, it was determined that FIFA 11+ and harmoknee warm-up methods positively affected some performance variables of the participants, and it was stated that the flexibility parameter improved as one of these variables and the participants' performance progressed.

It can be said that the findings obtained as a result of the present study are in line with the results of the aforementioned research. Considering the above researches, it is seen that dynamic warm-up methods are more effective on some motor properties such as strength and flexibility compared to static warm-up methods. One of the important physiological changes that occur in the person with flexibility applications is the increased muscle tendon compliance (Nelson et al., 2007). Golgi tendon organs in tendons and muscle spindles positioned parallel to muscle fibers send information to the central nervous system regarding the length and tension on the muscle. Thus, tearing is prevented by adjusting the contraction tension of the muscle (Kenney et al., 2015). It has been stated that increased muscle-tendon compliance during dynamic warm-up exercises may also cause an increase in muscle strength (Shrier, 1999). The physiological mechanism of the positive effect of dynamic warm-up exercises on flexibility can be explained by the fact that the tension produced along with the muscle during movement stimulates the golgi tendon organ, resulting in short-term inhibition of the muscle spindles and thus achieving a wider range of motion.

According to another result of the research, it was determined that the vertical jump values obtained after dynamic warm-up were statistically higher than the values obtained after static warm-up and jogging warm-up. When the literature is reviewed, there are studies show that warm-up protocols increase vertical jump performance. In the study by Faigenbaum et al. (2006), in which the acute effects of different warm-up methods on anaerobic performance in young athletes were examined, groups with dynamic stretching and a combination of static and dynamic stretching had significant differences in vertical jumping, sitting medicine ball throwing and 10 yards sprint performances compared to static stretching groups and it was stated that there was a significant difference.

In the study by Köse (2014) examining the effect of different warm-up types applied to 28 male participants from Ondokuz Mayıs University Faculty of Sport Sciences on the jump and balance performances of athletes, it is stated that static stretching applications have more effect on jumping compared to the jogging application group. In the study conducted by Haghshenas et al. (2014) the acute effect of different warm-up models on the vertical jump performance of volleyball players was investigated, and groups were formed as a dynamic stretching group, static stretching group, combined stretching group, and non-stretching group by randomization method. According to the results obtained after the research, it was stated that the dynamic stretching group had a greater effect on the vertical jump performance than the other groups. Morrin et al. (2013) examined the acute effects of different stretching methods on vertical jump performance in a study involving dancers as a participant and stated that dynamic stretching and combined stretching applications had a greater effect on vertical jump performance than static stretching applications. Yazıcı (2018) stated that in the study investigating the effects of different warm-up protocols applied to young football players on physical parameters, dynamic warm-up methods have a positive effect on the vertical jump performance of athletes.

It can be said that the findings obtained as a result of the present study are in line with the results of the aforementioned research. When the studies in the literature were examined, it was seen that there were results indicate that the static warm-up performed decreased the vertical jump performance, as well as the results reporting that it had no effect on performance. Based on these results, it is seen that there is no consensus on this issue. The results found in this study support the results of some studies in the literature. It is thought that the differences in both the number of stretching and the stretching time in static and dynamic warm-up movements, the use of different warm-up methods, the difference in the

jump patterns used to determine the jump performance, the lack of full heating of the muscles for high performance and climatic reasons are thought to be the reasons for these differences. In the light of these results, it is thought that dynamic warm-up exercises are more suitable than other stretching methods before jumping exercises, just like strength training.

In another of the results obtained in the study, it was determined that the values obtained after dynamic warm-up in the speed parameter were statistically lower than the values obtained after static warm-up and jogging warm-up. When the literature is reviewed, there are studies showing that warm-up protocols increase speed performance. Ayala et al. (2017) stated that FIFA 11+ and harmoknee warm-up methods were applied to football players contribute positively to 30-m speed performances. Eken (2015) examined the acute effect of different warm-up protocols on some performance parameters in judokas in his study with 11-14 age group participants and stated that the combined static and dynamic group's 30-m speed measurement values were higher than the other groups. Alikhajeh et al. (2012) investigated the effect of different warm-up methods on the determined motor performance variables of 20 players between the ages of 14 and 16 at the elite level, as a result, in this method applied to 20 elite players between the ages of 14 and 16, dynamic warm-up applications were used for other warm-up applications and it has been stated that it gives more positive results. Fletcher and Jones (2004) examined the effect of different warm-up methods applied to the participants on 20-m speed performance in their study on 97 rugby players and stated that dynamic warm-up practices improved speed performance.

Kilding et al. (2008) stated that in a study where the average age range was 41, and 40 athletes were involved, FIFA 11+ warm-up methods showed an absolute increase in 20-m sprint performance compared to the control group. Oliveira et al. (2017) participated in the study of 12 football players who trained in a programmed manner; he examined the effects of static, dynamic, ballistic, and PNF stretching applications on 10, 20, and 30-m speed performance; consequently, he reported that dynamic and ballistic stretching applications positively contributed to the speed performance. Durukan et al. (2019) investigated the effects of FIFA 11+ applications on the 5, 10, and 30-m speed performances of football players in a study in which the participants were made up of football players; it was stated that FIFA 11+ exercises had a positive effect on the speed performance of football players.

When the studies on the effect of dynamic warm-up methods on speed performance are examined, the results of this study support the previous findings. Considering these results, it is seen that speed performance is negatively affected by static and PNF stretching just like

other features requiring sudden force, but this effect is less after ballistic stretching. The reason for this is that elastic force is required in speed performance, elastic force property is a force formed by converting the potential energy accumulated in the eccentric phase to kinetic energy in the concentric phase, the static and PNF stretching methods performed specially for a long time (15-s and above), the myotatic reflex, which reduces the sensitivity and this negatively affects the strength (Bompa, 2001). It is thought that this effect does not occur due to the relaxation and stretching movements involved in ballistic and dynamic stretching, on the contrary, it prepares the muscle for movement.

As one of the important results of the study, no statistically significant difference was reported in the agility values obtained after applying different warm-up protocols. When the literature is reviewed, there are studies showing that warm-up protocols do not affect agility performance. McMillan et al. (2006) in a study examining the effect of static and dynamic stretching protocols on strength and agility performance with 16 male and 14 female participants with a mean age of 20, stated that static warm-up practices did not show any change in agility performance. Mohammadtaghi et al. (2010) in a study conducted on football players, stated that there was a decrease in agility performance following the application of static stretching movements as a result of examining the acute effects of different stretching methods on agility performance testing. Chatzinikolaou et al. (2013) examined the effect of static stretching application times on agility values; consequently, they stated that static stretching applications did not have a positive or negative effect on agility performance. Gürses and Akgül (2019) in a study examining the effects of different warm-up protocols applied by adult amateur male football players on speed, agility, and vertical jump performance stated that the stretching exercises applied did not have an acute effect on the short-term, high-intensity performances of the football players.

When the studies on the effects of different warm-up methods on agility performance are examined, the results of this study support the previous findings. There are a limited number of studies investigating the effects of different warm-up methods applied before exercise on agility. This situation is getting narrower especially for basketball players. As a result of the study, it was determined that the applied warm-up protocols did not statistically cause any difference in agility performance. It is quite common in the literature that dynamic stretching will have a positive effect on agility performance. It is thought that the fatigue level that may occur in the participants due to the age range of the participants, the inadequacy of their energy systems to meet the sufficient level of anaerobic performance, the climatic

conditions, the training status of the participants and the agility test measurement being placed after the other tests.

According to the results, different warm-up protocols had an effect on flexibility, vertical jump, and speed performance, but had no effect on agility performance. As a result of the study, the flexibility measurement values obtained after the dynamic warm-up protocol in different warm-up protocols were statistically higher than the flexibility measurement values obtained after the static warm-up and jogging warm-up protocols. In the 30-m speed test and vertical jump test, the dynamic warm-up protocol afforded better results than the static warm-up and jogging warm-up protocols.

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