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The Acute Effects of Different Stretching Exercises on the Power and Agility of Adolescent Football Player

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Abstract

The aim of this study was to compare the acute effects of static and dynamic stretching exercises on the power and agility of adolescent male football players. Ten male football players (age 15.8 ± 1.47 years, height 1.66 ± 0.05 m, body weight 59.6 ± 10.7 kg, training age 3 ± 1.94 years) from a team competing in the Bitlis 1st Amateur Group B of the 2019/20 season voluntarily participated in the study. All subjects participated in control (warm-up only), static stretching (warm-up + static stretching) and dynamic stretching (warm-up + dynamic stretching) exercise groups, respectively, on non-consecutive days. All groups were given 10-minute warm-up exercises. After warming up, the control group was given 10 minutes of passive rest. For the main muscle groups, 10 minutes of static stretching was applied to one of the other two groups, and 10 minutes of dynamic stretching exercises were applied to the other. After 1-2 minutes of rest, T-drill, medicine ball throwing and vertical jump test measurements were taken from the athletes, respectively. The obtained data were analyzed statistically and the level of significance was determined as $p<0.05$. As a result of the research, while there was no significant difference between acute static stretching and dynamic stretching in terms of power performance, a significant difference was found in favor of dynamic stretching in agility performance.

Keywords: Static Stretching, Dynamic Stretching, Warm-Up, Power, Agility.

Introduction

Football, one of the most popular sports branches in the world and in our country; Since it is a simple, interesting and enjoyable game that is played by every segment of society and watched fondly at the same time, it has cost a large audience and won the love of millions of people (Şenel, 1999). Football is a high-intensity sport in which both aerobic and anaerobic efforts are used alternately, and motor skills such as speed, strength, power, flexibility, agility, cardiovascular endurance, muscular endurance and coordinative abilities affect performance together (Brown et al., 2018:283-284). The fact that this sport gains momentum and spreads to wider masses is because science and sports science contribute to football interactively (Günay et al., 2008).

Physiological requirements of our body (respiration, circulation, nervous, muscular systems, etc.) before training/competition are at the lowest level. These physiological needs cannot be expected to increase suddenly or spontaneously. Athletes should do warm-up and stretching exercises before training/competition in order to prepare the body physically and psychologically for these needs (Günay et al., 2017: 473). The main purpose of warming up is to accelerate blood circulation by increasing body temperature, the main purpose of stretching exercises is to improve performance by increasing joint range of motion or flexibility (Alp, 2016).

Since the early 1980s, static stretching before doing physical activity has been widely promoted as a method to prevent injury and improve physical performance (Small et al., 2008). Of the pre-training/pre-competition warm-up and stretching exercises, static stretching has traditionally been the most widely used, but whether incorporating this type of warm-up into a warm-up routine has a detrimental effect on agility and power generation has been investigated (Samuel et al., 2008; Yamaguchi et al., 2005; Young et al., 2003).

The link between static stretching and performance has been the subject of many studies. Studies have focused on speed, strength, flexibility and power to determine short-term anaerobic power. When the recent studies are examined, it is seen that the findings that other performance elements other than flexibility are negatively affected by static stretching exercises are intense. Studies have shown that both acute and chronic static stretching exercises reduce the risk of injury (İşleğen, 2013; Small et al., 2008) by increasing flexibility (Akyüz, 2017; Demirel et al., 2004; Depino et al., 2000; Göksu et al., 2003; Nelson et al., 2004; Yaşlı et al., 2019), which is an important performance feature for athletes. Contrary to these studies, in some studies, acute static stretching exercises negatively affect performance items such as agility (Chatzopoulos et al., 2014; McMillian et al., 2006), explosive force (Young et al., 2001), maximal strength (Bacurau et al., 2009), power (Marek et al., 2005; Samuel et al., 2008; Yamaguchi et al., 2005), peak torque (Cramer et al., 2004), speed (Winchester et al., 2008; Yıldız et al., 2013), reaction and movement time (Behm et al., 2004), or they cannot be added at all.

Based on previous studies showing a decrease in vertical jump height after static stretching, it is assumed that there will be an acute decrease in vertical jump after static stretching, while performing dynamic stretching will increase vertical jump (Fattahi-Bafghi et al., 2012). Recently, dynamic stretching exercises have come to the fore. In a study, it was suggested that voluntary contractions to be performed from a moderate level such as dynamic stretching before training/competition to high intensity will activate the muscle-nervous system and increase power production (Bishop, 2003). In some studies, it has been reported that acute dynamic stretching exercises increase performance elements such as power (Manoel et al., 2008; Yamaguchi et al., 2005), strength (Young et al., 2003), agility (McMillian et al., 2006; Polat et al., 2019), flexibility (Atan, 2019; Perrier et al., 2011) and speed (Akyüz, 2017).

Contrary to these studies, some studies have suggested that acute dynamic stretching exercises negatively affect or do not affect performance items such as power (Behara et al., 2017; Fattahi-Bafghi et al., 2012), agility (Shaji et al., 2009), flexibility (O'Sullivan et al., 2009). Many explosive performance elements are required in football, including jumping, kicking, picking up the ball from the feet, sudden changes of direction, running, changing speeds, and sustaining strong contractions (Stolen et al., 2005). In addition to these, the individual is in a state of mobility throughout his life from the beginning of life. This mobility is not the same at all stages of life and may differ. Mobility is extremely high because school-aged and pre-school children have more internal impulses. Although there is a decrease in the movements of the individual during the period of puberty, it has been determined that there are improvements in the older ages (15-19) (Gündüz, 2017). There are not enough studies in the literature on the effects of stretching on the performance of amateur football players in this transitional age.

The aim of this study is to determine the development of adolescent male football players in terms of power and agility performance after acute static stretching and dynamic stretching exercises and to compare and evaluate the effects of stretching exercises.

Material and Method

Experimental Approach to the Problem

The research was carried out after obtaining the necessary approval from the Gazi University Ethics Commission (dated 30/12/2019 and decision no E/134861). This study, which examines the effects of acute stretching exercises on the power and agility of adolescent boys, was applied based on the "experimental research model".

The schematic view of the method used in the research is as follows;

1.Day	S	G1	I	X	T
3.Day	S	G2	I	Y	T
5.Day	S	G3	I	Z	T

Figure 1. Schematic View of the Method Used in the Research. S: Group of the same people (n=10), G1: Warm-up, G2: Warm-up + static stretching, G3: Warm-up + dynamic stretching, I: Warm-up protocol, X: Rest (10min), Y: Static stretching protocol (10min), Z: Dynamic stretching protocol (10min), T: Performance tests (T-drill, medicine ball throw, vertical jump).

The current research protocol was taken from a highly cited article (McMillian et al., 2006) and adapted to the circumstances at hand. All subjects participated in warm-up, warm-up + static stretching, and warm-up + dynamic stretching groups, respectively, on non-consecutive days. During the warm-up phase, all participants were given a total of 10 minutes of exercise as 8 minutes of warm-up run and 2 minutes of jog. After warming up, the control group was given 10 minutes of passive rest. For the main muscle groups, 10 minutes of static stretching was applied to one of the other two groups, while 10 minutes of dynamic stretching protocols were applied to the other. After resting for 1-2 minutes, all participants participated in T-drill, medicine ball throwing and vertical jump performance tests twice and their best results were recorded. Full rest was applied between tests. The study was carried out in the open area (Tatvan City Stadium) and the air temperature was taken from meteorology on 17, 19, 21 May 2020 as 1st Day 20°, 3rd Day 20° and 5th Day 21° (Accuweather, 2020). During the experiment, subjects were given feedback to improve the proper conduct of both warm-up techniques and performance measures.

All subjects received orientation training for both stretching exercises and performance tests one week beforehand. During the research process, it was recommended that the athletes not do any sports activities other than their warm-up routines and continue their daily eating habits without applying any special nutrition program. Care has been taken to avoid tasks that cause fatigue, as fatigue has been found that inhibit local muscle performance, particularly for tasks involving a stress-shortening cycle (Horita et al., 1996; Wilson et al., 2004).

Subjects

Ten adolescent male football players (age 15.8 ± 1.47 years, height 1.66 ± 0.05 m, body weight 59.6 ± 10.7 kg, training age 3 ± 1.94 years, body mass index 21.37 ± 3.44 kg/m2) in a team competing in the Bitlis 1st Amateur Group B in the 2019/20 season volunteered for the research. The subjects declared that they would participate in the research by signing the "Informed Voluntary Consent Form for Participants". The subjects were informed about the purpose of the research and the warm-up routines applied. During the research process, it was recommended that the athletes not do any sports activities other than their warm-up routines and continue their daily eating habits without applying any special nutrition program. At the beginning of the study, the physical characteristics of all athletes were measured and recorded. The physical properties of the subjects are given in Table 1.

Table 1. Descriptive Characteristics of the Participants (mean ± standard deviation).

Variables	**n**	**mean ±SD**
Age (years)	10	15,8 ± 1,47
Height (m)	10	1,66 ± 0,05
Body weight (kg)	10	59,6 ± 10,70
Training age (years)	10	3 ± 1,94
Body mass index (kg/m^2)	10	21,37 ± 3,44

Procedures

Height and body weight measurement protocols: The heights of the subjects participating in the study were determined with the help of a meter fixed to the wall and a wooden rod. The height of the athletes was recorded in cm by measuring them barefoot, with the heels of their feet adjacent, while holding their breath with a rod placed on the head while in anatomical posture. The body weights of the subjects were measured with an electronic scale (Arçelik Slimo) with an accuracy of ±0.1 kg, only wearing shorts and a T-shirt, and recorded in kg.

Performance Tests

In anaerobic power measurements; Vertical jump test was used for lower body power and medicine ball throw test was used for upper body power measurement. The agility of the athletes was also examined with the "T-drill test". All tests are described in

Table 2.

Table 2. Performance Tests and Their Description.

Tests	Description
Vertical jump	In this measurement, the distance between the height that the person can reach while standing and the point they can touch by jumping was measured in term of meters (Cicioğlu et al., 1996). Then, using the power calculation of the subjects and their body weights, anaerobic power calculation in kg.m/s was made with the following formula†. The vertical jump was chosen as a measure of functional leg power. Harman et al. (1991) showed that this test is a valid and reliable test for assessing muscle power and explosive power.
Medicine ball throwing	The subject receives strength by bringing the medicine ball (3 kg) back at a fixed distance, with the feet in line, and the arms back. Then, he throws the ball forward with both hands with maximal power. Each subject makes two shots and the best result is recorded in term of meters (Cicioğlu et al., 1996). Throwing the medicine ball was chosen as a measure of total body power. Stockbrugger and Haennel (2001) showed that this test is a valid and reliable test for assessing total body movement pattern and general athletic ability and explosive power.
T-drill	Three cones are spaced 5 m apart in a straight line, while the fourth cone is placed 5 m from the middle cone to form a "T" (McMillian et al., 2006). The stopwatch was started as soon as the subject left point A. Subjects touch the cones at all points, running straight from point A to B, from B to C with lateral steps, from there to D with lateral steps, from D to point B with lateral steps, and finally to point A with stepping backwards from B the work has been terminated. A total of 30 m was run and the measurements were recorded down to 0.01 of a second. Pauole et al. (2000) showed that this test is a valid and reliable measure in evaluating agility. To emphasize the lateral movement, the T-drill forward and backward runs are 10 m at the distance described by Pauole et al. (2000) placed more than 5 m distance.

† Metric Unit Formula: P (kg.m/s) = $\sqrt{4.9}$ x W x $\sqrt{D}$; P = Anaerobic Power; W =Body Weight (kg); D = Jump Distance (m); $\sqrt{4.9}$ = Standard (sec) (Fox et al., 1993: 658).

Protocols

Warm-up protocol

Active warm-up was used as a warm-up method. The warm-up protocol is adjusted to increase body temperature by 1-1.5 degrees without consuming energy substrates. The subjects were given a total of 10 minutes of aerobic exercise as 8 minutes of aerobic jogging and 2 minutes of jog.

Dynamic stretching protocol

The dynamic stretching protocol consists of 15 exercises, including 10 calisthenic exercises and 5 movement drills performed in a 20-meter area (Table 3). In calisthenic exercises, 10 repetitions of each movement were performed and 5-10 seconds of rest was given between movements. In moving exercises, 1 repetition of each movement (round trip) was performed. 5-10 seconds rest between departure and return, 10-15 seconds between movements. Each stretch is done in a slow to moderate rhythm. The total duration of the dynamic stretching protocol was set to 10 minutes.

Table 3. Dynamic Stretching Exercises.

Exercises	Execution
	Calisthenic exercises
Bend and reach	Open legs shoulder-width apart and raise hands straight into the air. Then bend the knees slightly and extend the hands towards the heels. Return to the starting position in a slow rhythm (trapezius, rectus abdominis, latissimus dorsi).
Rear lunge and reach	Start with hands on hips. Take a step back. Return to the starting position in one motion. Repeat with the opposite leg. Keep most of the weight on the forefoot. Dive progressively further and deeper with each repetition. Keep the abdominal muscles tight to keep them in a stable trunk. Perform in a slow rhythm (hamstrings, calf muscles).
Turn and reach	Stand with legs spread out to the sides at shoulder level. Turn back to the furthest point with the arms as if swinging the golf club backwards. Pause with the pelvis facing forward. The arms should be directed forwards and backwards. Keep the abdominal muscles tight to keep them in a stable trunk. Return to the starting position, then repeat on the other side. Perform in a slow rhythm (latissimus dorsi, oblique muscles).
Squat	Start with hands on hips. Squat down until thighs are parallel to the floor (or pain threshold). Keep the heels on the ground. For balancing, the arms should be raised to shoulder level (quadriceps, hamstrings, gluteus maximus, calf muscles).
Rower	Start in the supine position, lift a few inches off the floor with the chin slightly tucked close to the chest. In one move, get into a sitting position, bend the knees to stabilize the feet, and bring the arms parallel to the floor (trapezius, rectus abdominis, latissimus dorsi).
Power jump	Begin with arms on hips and feet, knees and hips aligned vertically. Squat down with arms down and reach toward floor, keeping back straight, raise arms into air as you jump vertically upwards from squat position. Return to the starting position (hamstrings, quadriceps, calf muscles).
Prone row	Begin in the prone position with the arms up and a few inches off the floor, slightly lifting the chest and bringing the hands back to shoulder level as if rowing. Maintain abdominal muscle tension throughout the exercise. Hands and elbows remain parallel to the ground at all times. Keep the neck in a neutral position (trapezius, latissimus dorsi, rectus abdominis, external obliques, musculus iliopsoas).
Push-up	In the starting position, prone on the floor with hands directly at shoulder level or slightly wider. Elbows are straight but not locked. The abdomen and body are kept in line with the thighs. Do not exceed the body where the upper arms are parallel to the floor. Do it at a moderate to fast rhythm (pectorals, deltoids, triceps, serratus anterior).
Windmill	In a relatively wide stance with arms outstretched and feet slightly open at shoulder level, bend forward with the right hand to reach the left foot and rotate the body to the left. Return to the starting position, then repeat on the opposite side. Keep arms in opposite directions. Avoid excessive bending of the spine (rectus abdominis, obliques).
Diagonal lunge and reach	Push arms to the sides. Move forward diagonally to the left while simultaneously lowering the hands on the lower leg. Return to the starting position in one motion. Repeat to the right. Keep the foot of the forward leg forward, not in the direction of the lunge. Keep your body straight and your head upright. Do not let the knee of the forward leg go beyond the toes or be lateral to the foot (quadriceps, gluteus, hamstrings.).

Table 4. (continued).

Exercises	Execution
	Movement drills
Verticals	Run forward on feet, raise knees to waist level and lie down straightly. Use strong arm motion to support the movement. Hands should go over waist to chin level with a bend of approximately 90 degrees at all elbows. With these drills, the legs should not swing backwards (quadriceps, hamstrings, gluteus muscles, calf muscles).
Laterals	Step sideways, slightly rising and bringing hind leg to front leg. Quickly jump to the side and squat with feet shoulder-width apart. Always place it facing the same direction, with the first 25 meters moving to the left and the second 25 meters to the right (gracilis, adductors).
Crossovers	Put the trailer leg in front of the guide leg first and move in the direction of travel to return to the starting position. Then get the track foot behind the guide foot and move in the driving direction to return to the starting position. Repeat with the same row until the 25-yard stop. Always look in the same direction so that the movement of the first 25 meters moves to the left and the movement of the second 25 meters to the right (gluteus, gracilis, adductors).
Skip	Press and then jump, landing on the same leg, then repeat the same movement with the opposite leg. Use strong arm motion to support the movement. Hands should go over waist to chin level with a bend of approximately 90 degrees at all elbows. When the right leg moves forward, the left arm swings forward and the right arm is at the back. When the left leg is forward, the right arm swings forward and the left arm is at the back (quadriceps, hamstrings, gluteus muscles, calf muscles).
Shuttle sprint	25 m run to the line at a moderate pace. As you approach the line, slow down the movement, making a quarter turn clockwise, place the left foot parallel to the line, and crouch or bend to touch the ground on the line. Return to the starting line by turning counterclockwise to touch the floor with the right hand. 25 meters line and gradually increase (quadriceps, hamstrings, gluteus muscles, calf muscles).

Static stretching protocol

The static stretching protocol consists of 8 movements (Table 5). Each stretching movement was performed at a slow to moderate rhythm, stretching for 15 seconds. 5-10 seconds rest between movements. The total duration of the static stretching protocol was set to 10 minutes.

Table 5. Static stretching exercises.

Exercises	Execution
Overhead arm pull	Raise right arm and place right hand behind head. Grasp under the right elbow with your left hand and pull the trunk to the left, leaning to the left. Repeat the same movement on the opposite side (triceps brachii, obliques, latissimus dorsi, quadratus lumborum).
Turn and reach	Stand with arms extended to the sides at shoulder level. Twist the trunk to the left while keeping the hips forward to bring the arms forward and back. Keep the hips and abdominal muscles tight to prevent pelvic rotation. The head and eyes remain facing forward. Just hold for 10-15 seconds to avoid shoulder fatigue. Repeat in the opposite direction (pectoralis major, trapezius, latismus dorsi, biceps brachii).
Rear lunge and reach	Start with hands on hips. Take a step back as hands reach into the air at the same time. Stretch your arms in the opposite direction of your back step (ex: we stretch our right leg to the left when we step back). Return to the starting position in one motion. Repeat with opposite leg. Keep most of the weight on the forefoot. Keep the abdominal muscles tight to keep them in a stable trunk (quadriceps, abdominals, gluteus, hamstrings, hip flexors).
Hamstring stretch	Take a step forward with the left leg and bend at the waist to reach towards the left foot. Both knees are slightly bent and arms are straight on either side of the forward leg. The trunk remains in a neutral position with a flat head. Repeat on the opposite side (hamstring erector spinae, calf).
Calf stretch	Extend the left foot half a step forward and place the heel on the floor with the toes pointing up. Bend forward and grasp the sides of the left foot with both hands. Gradually straighten the knee of the left foot and pull the heel of the foot back towards the point of resistance and hold. Repeat the same movement on the opposite side (calf muscles).
Quadriceps stretch	Catch your right ankle or foot. Pull the right heel toward the buttocks and behind the buttocks. The right hip can be extended further with the pressure of the left foot. Repeat on the opposite side. Do not pull the heel strongly against the hip, especially if there is discomfort in the knee joint. In this case, get a useful stretch by allowing the knee to straighten slightly and pull towards the back of the thigh (Quadriceps).
Posterior hip stretch	In supine position, cross right ankle over left thigh. Grasp the right knee with both hands and pull it towards the left shoulder while pulling the left knee towards the chest. Repeat on the opposite side (Gluteus maximus, hamstrings, latissimus dorsi, erector spinae).
Trunk flexion/extension stretch	Part 1: In supine position, reach forward with arms at sides, chin close to chest. The head remains passively bent. Part 2: In a prone position, reach back with chin in air, arms at sides. The thighs and pelvis are flat on the floor. Relax the back and abdominal muscles as you shift body weight through straight arms. Feet point back (Rectus abdominis, pectoralis major, obliques).

Statistical Analysis

The statistic of this study was performed using One-Way Analysis of Variance (ANOVA) to determine whether the three-group variable differed between the groups in terms of performance test results. On the other hand, Tukey HSD test, which is one of the Post Hoc multiple comparison methods, was used to determine whether there was a significant difference between which groups in terms of performance test results.

All statistical operations were analyzed using the SPSS 22.0 package program and the significance level was taken as 0.05.

Findings

Test results in terms of stretching type variable of the subjects participating in the study, T-drill test 8.59 ± 0.26 sec, medicine ball throwing test 4.45 ± 1.01 m, anaerobic power test 86.4 ± 20.3 kgm/ sec; T-drill test 8.86 ± 0.32 sec, medicine ball throw test 4.57 ± 0.92 m, anaerobic power test 85.9 ± 20.8 kgm/sec in static stretching group; In the dynamic stretching group, the T-drill test was 8.30 ± 0.44 sec, the medicine ball throwing test was 4.86 ± 1.21 m, and the anaerobic power test was 91.1 ± 21.1 kgm/sec. The analysis results of the test results of the groups are shown in Table 6.

Table 6. Data on T-drill, anaerobic power test scores, ANOVA and Tukey HSD multiple comparison results in terms of stretching type variable of the subjects participating in the study (mean ± standard deviation).

		T-drill test (sec)	Medicine ball throwing test (cm)	Vertical jump test (kgm/sec)
Group	**n**	**mean ± SD**	**mean ± SD**	**mean ± SD**
Warm-up	10	8,59 ± 0,26	4,45 ± 1,01	86,4 ± 20,3
Warm-up + Static	10	8,86 ± 0,32	4,57 ± 0,92	85,9 ± 20,8
Warm-up + Dynamic	10	8,30 ± 0,44*	4,86 ± 1,21	91,1 ± 21,1
p		**,005***	**,685**	**,828**

*p<,05 Different according to the warm-up+static stretching group.

According to the variance analysis results of the subjects participating in the study, the medicine ball throwing scores of the adolescent male football players did not show a significant difference according to the stretching type variable. In other words, the effects of different stretching types on medicine ball throwing test scores were found to be similar. As a result of the analysis of the anaerobic power test, no significant difference was found between the groups. This finding can be interpreted as the effect of different stretching types on anaerobic power test scores is similar.

Contrary to other performance tests, a significant difference was found in the analysis results of the T-drill test according to the stretching type variable of male soccer players in adolescence (p<.05). According to the results of the Tukey HSD multiple comparison test performed to determine between which groups there were significant differences, there was a significant difference between dynamic stretching (8.30 ± 0.44 sec) and static stretching (8.86 ± 0.32 sec) in favor of dynamic stretching scores (p<.05) was found. This finding shows that the effect of dynamic stretching on T-drill test scores is more positive.

Discussion

In this study, we compared the acute effects of static and dynamic stretching on the power and agility of adolescent football players from their sportive performance. In the study, a p<.05 significant difference was found in agility performance in favor of dynamic warm-up type scores between dynamic warm-up type (8.30 ± 0.44 sec) and static warm-up type (8.86 ± 0.32 sec). Dynamic stretching has been found to positively affect agility. Similar studies on the effect of static and dynamic stretching exercises on agility were examined in the literature.

Unlike our study, Little et al. (2006) conducted their research on professional football players. Despite the difference in physical age and training age, agility performance results show parallelism with our study. In the study of Van Gelder et al. (2011), which is similar to our study but with different age groups, it has been observed that university students have a positive increase in 505 agility test results after dynamic stretching exercise compared to static stretching. In the study conducted by Amiri-Khorasani et al. (2010) on professional football players, an additional group of experiments in which static and dynamic stretching exercises were performed in combination, in addition to the same stretching groups, participated in the experiment. It was found that static warm-up did not have a detrimental effect on illinois agility test performance when combined with dynamic warm-up for professional football players, but when compared with the dynamic stretching group, the most effective exercise in preparation for agility performance during warm-up was dynamic stretching exercises. Chatzopoulos et al. (2014), in their study on female high school athletes, concluded that dynamic stretching is more suitable than static stretching for activities that require balance, agility and movement time of the upper extremities. In another study (McMillian et al., 2006), the effect of dynamic stretching exercises on agility performance on students aged 18-24 from the United States Military Academy club sports was in similar with our study, while different results were obtained in its positive effect on power performance. Dynamic stretching is an active contraction process and its benefits to the achieved performance; The rehearsal of movements that can increase the sensitivity of nerve receptors and increase nerve conduction velocity is facilitated motor control through increased blood flow, elevated core or peripheral temperature. It is suggested that it can increase performance as nerve impulses encourage potential muscle contractions to be faster and stronger (Shellock et al., 1985). In the related study, the reason why the effect of dynamic stretching on power differs from this study is thought to be due to the fact that the developmental stages of adolescents are still continuing. Amiri-Khorasani et al. (2013) investigated the acute effects of static, fixed dynamic and dynamic dynamic stretching exercises on power and agility on 19 university football players. According to the results of the study, the vertical jump and illinois agility test results were found to be higher in the warm-up + fixed dynamic stretching group than in the other groups. On the other hand, it was found that it caused a negative effect on the vertical jump performance in the warm-up + static stretching group.

Jordan et al. (2012) compared static and PNF stretching on U14 young football players in terms of Balsom agility test performance applied with a soccer ball. As a result of the research, it was found that static stretching did not affect agility performance and a common conclusion was reached with this study. Avloniti et al. (2016), on the other hand, concluded that static stretching applied at different times (10, 15, 20, 30, 40 and 60 seconds) does not affect agility performance. Herman et al. (2008) investigated the chronic effects of static and dynamic stretching exercises applied for four weeks on 20 active wrestling athletes on performance. As a result of the research, it was found that static stretching did not affect strength, power, endurance, speed and agility performances. Dynamic stretching was found to improve strength by 11%, power by 4%, speed, endurance by 2.4% and agility by 2%. Dynamic stretching has improved endurance and agility performance both in comparison to static stretching and in itself.

In this study, medicine ball throwing and vertical jump scores did not show a significant difference according to the warm-up type variable. Vertical jump score averages (warm-up group 86.4 ± 20.3 kgm/sec, static warm-up group 85.9 ± 20.8 kgm/sec, dynamic warm-up group 91.1 ± 21.1 kgm/sec) in dynamic warm-up group Although it is higher, the level of significance is greater than 0.05. In the literature, studies related to the effect of static and dynamic stretching exercises on power and which have parallel results with our study are mentioned below. For example, Unick et al. (2005) examined the acute effects of static and ballistic stretching on vertical jump on 16 trained women (age 19.2 ± 1.0 years) playing in the NCAA (National Collegiate Athletic Association) Division III women's basketball team. They investigated whether the power changed 15, 30 minutes after stretching. As a result of the research, it was revealed that stretching exercises and duration had no effect on power performance. In another similar study (Power et al., 2004), the effect of acute static stretching on strength and power performances was investigated on 12 university students. As a result of the research, static stretching provided a significant increase in flexibility by 6%, while it significantly decreased isometric strength by 9.5%. Explosive power, on the other hand, showed insignificant decreases between 2% and 5.4%. Little et al. (2006) concluded that static and dynamic stretching did not affect vertical jump performance on 18 professional male football players. In their study, Behara et al. (2017) looked at the acute effects of deep tissue roller rolling and dynamic stretching on muscle strength, power and flexibility in 14 attacking football players aged 18-24 playing in the NCAA Division I league. As a result of the study, hip ROM values of both exercise groups increased significantly, while power and strength performances were not affected. Faigenbaum et al. (2006) in their study investigating the effect of static stretching, dynamic stretching and combined static + dynamic stretching exercises on 30 athletes (26 men, 4 women) on power, concluded that static stretching affects power negatively, while dynamic stretching and combined static + dynamic stretching do not. The reason for the decrease in strength and power production in relation to static stretching has been attributed to the alteration of visco-elastic properties, which has been suggested to cause a decrease in the stiffness of the muscle tendon unit (Avela et al., 1999; Kokkonen et al., 1998). In contrast (Knudson et al., 2001) argue that these changes are due to acute neural inhibition, resulting in an increase in autogenic inhibition that reduces the neural excitation of the muscle and leads to a decrease in muscle activation.

In the literature review, there are studies suggesting that this study has an effect contrary to the results. For example, Jaggers et al. (2008) investigated the effects of acute dynamic and ballistic stretching exercises on vertical jump performance on 20 university students (10 males, 10 females) aged 21-34 years. As a result of the research, it was determined that there was no difference between the control group and the ballistic stretching group, but it was found that dynamic stretching increased the power compared to the control group. In another study, the acute effect of static and dynamic stretching of the lower extremities on power and EMG (electromyographic) activity in 11 healthy men, mean age 21, who regularly compete in competitive university sports (football, hockey, athletics, squash and cricket). As a result of the comparisons, it was found that static stretching negatively affected vertical jump height (4.2%), while dynamic stretching increased vertical jump height (4.25%) compared to static stretching (Hough et al., 2009). Unlike this study, in some studies, when the muscle or muscle groups included in the measurement in terms of measurement method and technique are examined from different joint angles, it has been found that dynamic stretching increases the power significantly compared to static stretching (Manoel et al. 2008; Yamaguchi et al., 2007).

Conclusion

As a result, there was no significant difference between the groups in the vertical jump and medicine ball throwing test results. According to T-drill agility test results, a significant difference $p<.05$ was found between dynamic warm-up and static warm-up in favor of dynamic warm-up scores. In the agility test results of our study, similar results were obtained with the relevant literature for adolescent athletes. When the literature is examined, there are studies on the effect of stretching on power performance, as well as studies that reached similar results with this study, as well as studies that reached a contrary conclusion. It is thought that this is due to differences such as the physical condition, physical age and training age of the experimental groups.

In sports branches where agility is at the forefront, dynamic stretching exercises may be preferred by adolescent athletes before training/competition instead of acutely static stretching.

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