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Dynamic vs. Static-stretching Warm-up Protocol: The Effect on Physical Performance

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Abstract
This study aimed to compare the effects of dynamic and static stretching warm-ups protocols on physical performance (PP). Twenty healthy recreationally active male participants between 18-22 years of age were recruited for the study. Participants were randomized to 1 of 2 groups: Dynamic stretching warm-up (DWU, n=10) and static stretching warm-up (SWU, n=10) groups. Before the intervention; agility, velocity, and vertical jump tests were conducted to measure participants' baseline PP. Afterward, the participants performed the dynamic or static warm-up protocol according to their groups after 10 minutes of jogging. Each warm-up exercise was done for 30 seconds. A 5-second rest was given after each movement. After completing 1 set of 5 movements, 3 sets in total, a 2-minute rest was given. Then 4-min resting were given and PP testing procedures were repeated. No significant difference was found between the DWU and SWU in the vertical jump (p=0.22), velocity (p=0.99), and agility (p=0.24) performances after the intervention. It was concluded that the study indicates no difference between SWU and DWU effects on PP.
Keywords: Agility, Dynamic stretching, Static stretching, Velocity, Vertical jump

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Introduction

Physical performance (PP) can be defined as simultaneously demonstrating both the physiological, psychological, and biomechanical efficiency required by physical activity during activity (Özdal et al., 2019; Pancar et al., 2020). Warming up before the competition or physical activity is a practice that is necessary to achieve optimum PP. Because it is well documented that warming-up increases muscle flexibility (O'Sullivan et al., 2009), balance (Erkut et al., 2016), sprint (Zmijewski et al., 2020), agility (Fradkin et al., 2010), endurance (Wei et al., 2020) and strength (Park et al., 2018). While the relationship between the warm-up protocol and physical performance is affected by many factors, the type of exercises chosen while creating the protocol is essential to achieve optimum performance.

The traditional warm-up commonly includes a short, low-intensity aerobic exercise followed by stretching and sport-specific practices. Warming up before exercise generally aims to increase muscle-tendon flexibility, stimulate peripheral blood flow, increase muscle temperature, and develop free, coordinated movement (Özer et al., 2017; Pancar et al., 2017; Smith, 2004; Vural et al., 2019).

According to Keskin et al., (2021) the literature on warm-up practices focuses is mainly on comparing static stretching (SS) and dynamic stretching (DS) warm-up protocols. SS mainly described moving a limb to the end of its range of motion and holding the stretched position between 15–60 s (Behm & Chaouachi, 2011). Although the SS warm-up protocol has the potential to reduce the risk of muscle-related injury (Amako et al., 2003), many studies have reported that it can impair acute muscle performance and reduce maximal strength, muscle strength, or balance, resulting in decreases in athletic performance (Behm & Chaouachi, 2011; Lin et al., 2020). Neural (reduced voluntary activation, persistent inward current effects on motor neuron excitability), morphological (i.e., changes in the force-length relationship, decreased Ca2+ sensitivity, alterations in parallel elastic component), or psychological (a mental energy deficit and nocebo effects) factors can cause putative mechanisms underlying stretch-derived deficits which impairment in performance outcomes (Behm et al., 2021). While SS predominantly leads to performance deficits, several studies showed that SS has no significant adverse effect or can even improve performance.

As cumulating evidence reported that SS could trigger various performance deficits, practitioners mostly preferred DS rather than SS as the primary flexibility component of the warm-up protocols (Judge et al., 2020). Because DS includes similar movement patterns with subsequent exercises (Torres et al., 2008). DS is more recommended to achieve optimum sporting performance (Turki et al., 2019). Studies reported that DS warm-up improves in shuttle run time, medicine ball throw distance, five-step jump distance, and vertical jump height (Curry et al., 2009; Hough et al., 2009; McMillian et al., 2006). However, Topçu and Arabacı (2017) indicated that SS might also positively contribute to an activity performance where flexibility is at the forefront.

A large body of studies examined the physiological and neural underlying mechanisms of different warming strategies to understand the contribution to performance clearly. Experts continue to research the most effective warm-up strategies for how best to increase PP in competition or recreationally. In this regard, this study aimed to compare the effects of dynamic and static stretching warm-up protocols on PP. We hypothesized that DWU would provide a greater beneficial effect on physical performance parameters.

Material and Method

Participants

Twenty healthy recreationally active male participants studying at Aksaray University, Faculty of Sport Sciences, between 18 and 22 years of age were voluntarily recruited in this study, and demographic data is given in Table 1. All eligible participants are informed about this study. The study was conducted according to the guidelines of the Declaration of Helsinki and informed consent was obtained from all subjects involved in the study. Participants were randomized to 1 of 2 groups: dynamic warm-up (DWU, n=10) and static warm-up (SWU, n=10) groups.

Study Design

This study used a randomized and pre-post test design without control conditions to compare the effects of two different warm-up interventions on PP (Figure 1.). After the familiarization session, all participants took part in the intervention session simultaneously in the same order. We first conducted Illinois agility, velocity (photocell, and vertical jump (My jump 2 application) tests to measure participants' baseline PP. Afterward, the participants performed the dynamic or static warm-up protocol according to their groups after 10 minutes of jogging. While the dynamic warm-up protocol included high knees, lunge walk, straight leg kick, butt kick, and air squat movements, the static warm-up protocol included quadriceps stretch, toe reach, calf stretch, lunge stretch, and knee hugs (Fakazlı & Kolayiş, 2018; Keskin et al., 2021).

Each warm-up exercise was done for 30 seconds. A 5-second rest was given after each movement. After completing 1 set of 5 movements, 3 sets in total, a 2-minute rest was given. Then 4-min resting were given and performance testing procedures were repeated.

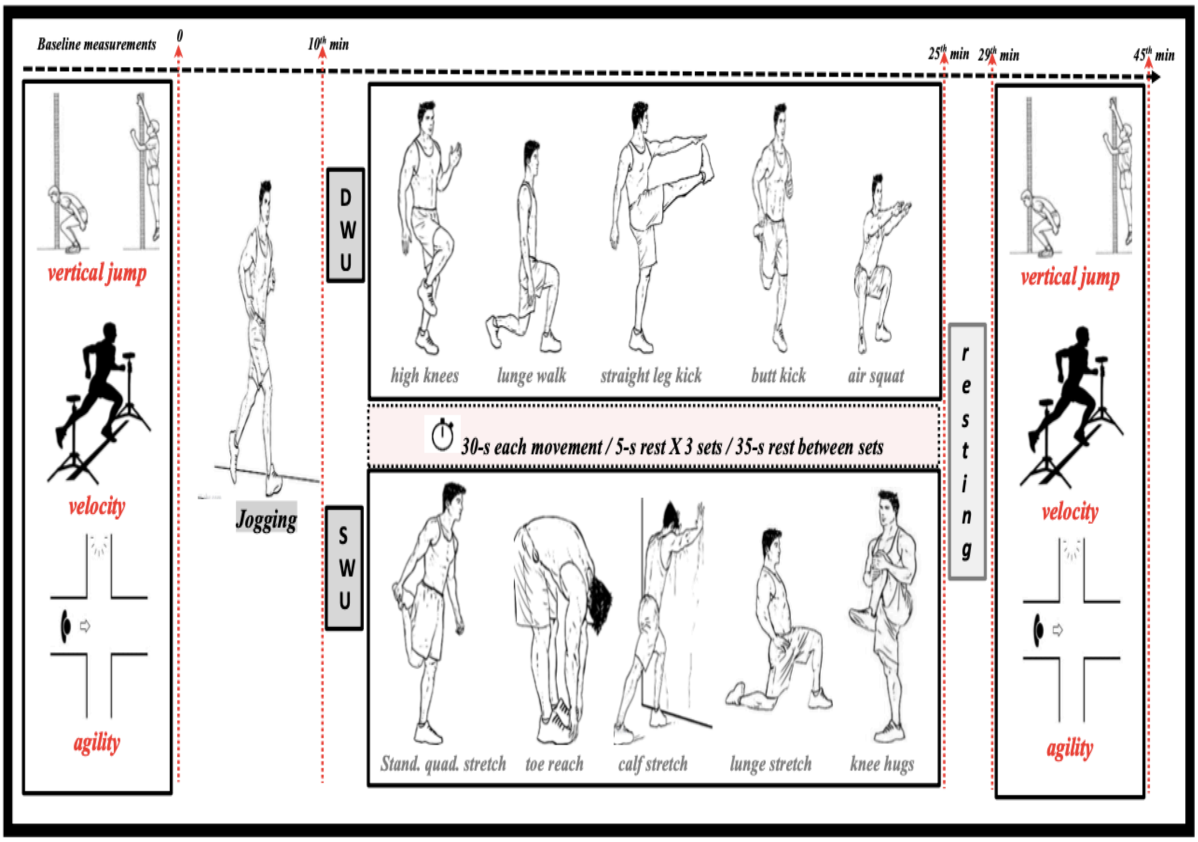

Figure 1. Timeline of the experimental protocol. DWU: Dynamic warm-up, SWU: Static warm-up, min: minute

Physical performance measurements

Vertical jumps. My Jump 2 application for iPhone 12 was used to calculate the jump height by manually selecting the take-off part and landing part of the video (Pancar, 2020). Participants completed two trials with 30-second intervals, and the best grade was recorded. The same person and phone made all trials and data collections. Participants were always recorded from the same position and with the same distance (from the participants 1.5 m) as standard calibration according to the manufacturer's instructions.

Velocity. The test involves running a single maximum sprint over 30 meters recording the time automatically by photocell (Fusion Sport, USA). Participants performed two trials with 3-minutes intervals in a 30 m area pointed by photocell, and the best grade was recorded (Pancar, 2020).

Agility. The Illinois agility test was used to determine agility (Figure 2), (Homoud, 2015). The start and the finish gates were positioned at two consecutive angles of the rectangular area, and two markers were positioned on the opposite side to indicate the two turning points. Further, four hurdles were placed in the center equally apart. The participant had to run as quickly as possible, following a marked direction from the start gate, performing a slalom through the hurdles without knocking or cutting across them. On the signal, from a standing position, each participant sprinted 10 m and then returned to the starting position again; they then had to slalom of the markers; they then completed another 2 sprints of 10 m; and finally, they completed the test by passing through the finish line. The best time of two attempts was recorded as the time to complete the Illinois test.

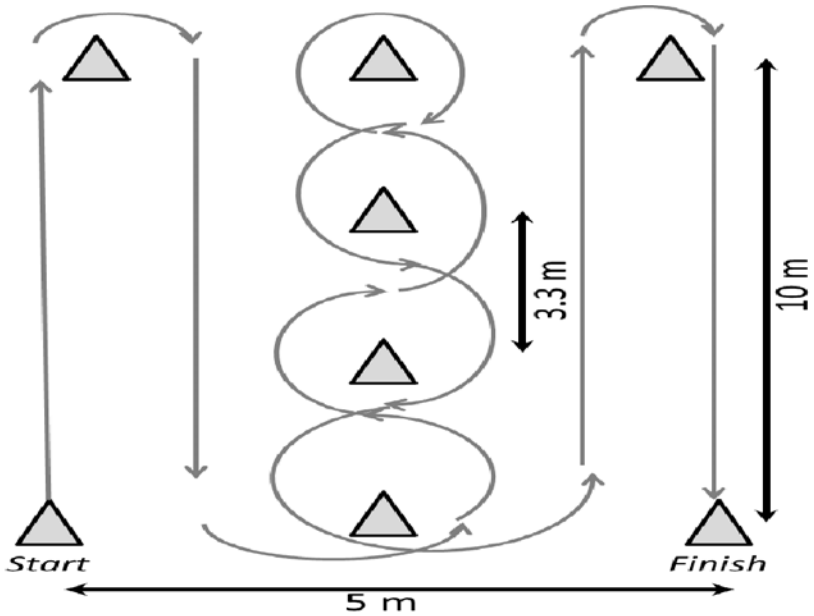

Figure 2. Illinois agility test protocol.

Statistical Analysis

SPSS 24 package program (Windows, Chicago, Illinois, USA) was used in all statistical analyzes. The normality distributions of the data were evaluated with the Shapiro-Wilk test. Comparisons were made with the independent sample t-Test in between groups. Significance levels were determined as $p<0.05$.

Results

Demographic characteristics of the participants were given in table 1. The mean age of the participants was 19.30±4.44 years, height 165.35±14.26 cm, bodyweight 71.93±7.77 kg, and BMI 23.80±1.65 kg/m^2.

Table 1. Demographic characteristics

N:20	Mean	SD
Age (years)	19.30	4.44
Height (cm)	165.35	14.26
Bodyweight (kg)	71.93	7.77
BMI (kg/m^2)	23.80	1.65

BMI: Body mass index, SD: Standart deviation, cm: centimeter, kg: kilogram, SD: standard deviation, kg/m^2: kilogram / square meter.

Comparison between the effect of DS and SS on vertical jump, velocity, and agility performances were given in table 2 and figure 3.

Table 2. Evaluation of physical performance

				t-Test		
Physical Performance	**Groups**	**Mean**	**SD**	**t**	**df**	**p**
Vertical Jump (cm)	DS SS	43.60 45.80	4.27 3.29	-1.28	16.90	0.22
Velocity (s)	DS SS	4.12 4.42	0.15 0.30	-1.77	13.54	0.99
Agility (s)	DS SS	12.32 12.99	0.81 0.98	-1.19	17.39	0.24

*p<0.05 indicates significant differences. cm: centimeter, s: second, DS: dynamic stretching, SS: static stretching, SD: standart deviation.

There was no significant difference between the groups in the vertical jump (p=0.22), velocity (p=0.99), and agility (p=0.24) performances.

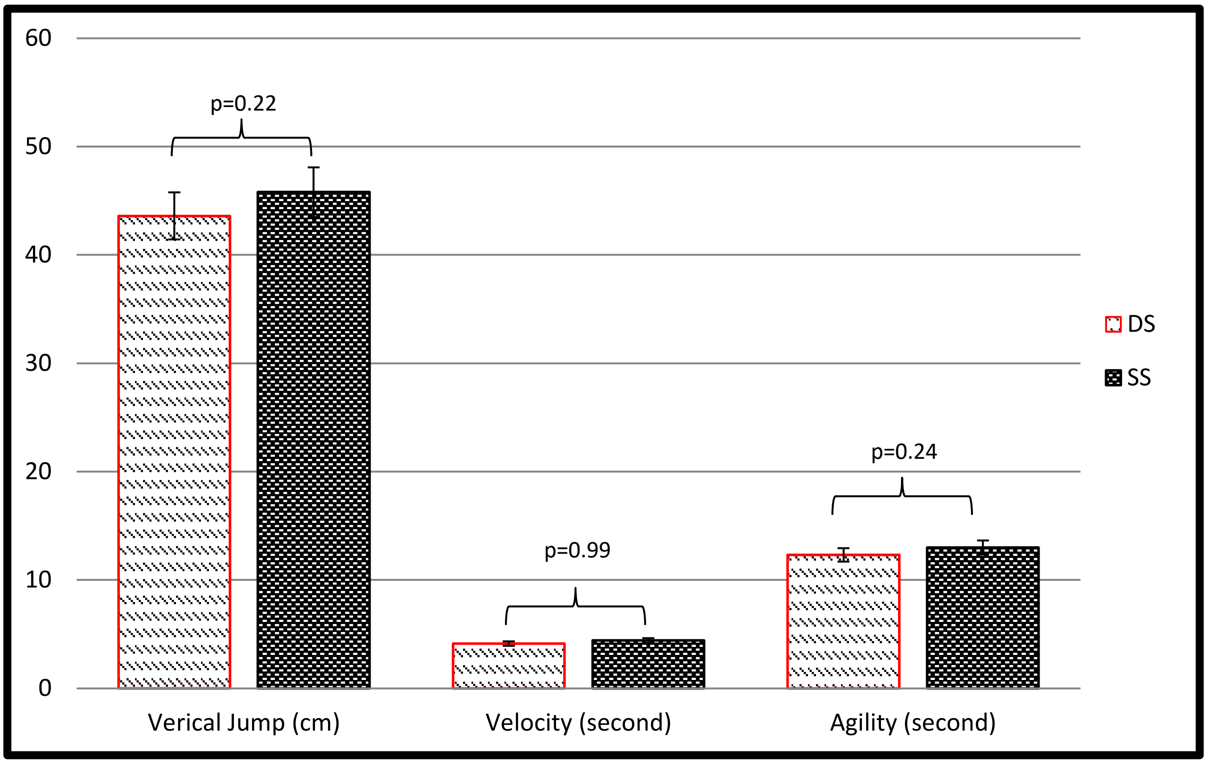

Figure 3. Evaluation of physical performance. *p<0.05 indicates significant differences. DS: dynamic stretching, SS: static stretching

Discussion

The present study aimed to compare the effects of dynamic and static stretching warm-ups protocols on physical performance. There was no significant difference between the DWU and SWU effects on the vertical jump, velocity, and agility performances. In line with our findings, Blazevich et al. (2018) showed that both SS and DS have no effect on sprint running, jumping or change of direction performance. Little & Williams (2006) showed no differences in 20-m sprint time or countermovement jump height after SS or DS. Similarly, Samson et al. (2012) reported no difference in rapid kicking, countermovement jump or 20-m sprint test performances between SS and DS in recreational and competitive athletes. Moreoever, Alipasali et al. (2019) concluded that both stretching techniques have a similar positive effect on the velocity of recreational male volleyball players.

In contrast to our findings, many studies showed that after the SWU reduced vertical jump performance and agility (Cornwell, 2001; McNeal & Sands, 2003; Young & Eliot, 2001). The acute negative effect of SS on performance can be explained by changes in the muscle's neuromuscular conduction and/or biomechanical properties. Kubo et al. (2001) suggested that SS changes the biomechanical structure of the muscle tendon, making it softer and indirectly reducing the rate of power production and causing delays in muscle activation.

Ceylan et al. (2014) showed that DS exercises activities are more effective than SS in terms of the slalom dribbling and 30 m sprint performance in women futsal players. Gelen et al. (2010) investigated the acute effects of different warm-ups protocols on sprint performance. According to the authors, soccer players should prefer to perform DS exercises before performing activities that require a high power output. Similarly, Gelen et al., 2008 investigated the acute effects of SWU and DWU on vertical jump performance (56 men, age 21.6±2.1 years). The authors showed that SWU was found to impair vertical jump performance, while DWU was found to have a positive effect. Zmijewski et al. (2020) revealed that DS improved repeated-sprint ability performance more than SS or no stretching.

This study also has many limitations. First of all, only five movements were determined in the dynamic and static warm-up protocols. These warm-up protocols may not be suitable for a particular performance output. In addition, it is challenging to disseminate the results of this study, which has a small sample group, to the general population. Future studies should examine different warm-up protocols, including various movement patterns that provide optimum performance in specific sports or physical activities.

The differences in the results may be that the movements in the applied stretching protocols are very different, the differences in the application and resting times, and the characteristics of the subject group. In conclusion, this study indicates no difference between static and dynamic-stretching warm-up effects on velocity, agility, and vertical jump performance.

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