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The Acute Effects of Static and Ballistic Stretching on Vertical Jump Performance in Trained Women

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Note: Author Jessica Unick graduated in January of 2004 and correspondence is yet to be determined thus we have included H. Scott Kieffer’s information as the corresponding address during this interim period. All correspondence can be made regarding the article to the Home site at the HHP Lab at Messiah College.
ABSTRACT

Traditionally stretching has been included as part of a warm-up that precedes athletic participation. However, there is mixed evidence as to whether stretching may actually enhance or hinder athletic performance. Therefore, the purpose of this study was to examine the acute effects of static (SS) and ballistic stretching (BS) on vertical jump (VJ) performance and to investigate if power was altered at 15 and 30 minutes following stretching. Sixteen actively trained women performed a series of vertical jumps (countermovement and drop jumps), after an initial non-stretching (NS) session and after participating in BS and SS sessions that were conducted in a balanced and randomized order. The results indicated that there was no significant difference (p ≤ 0.05) in VJ scores as a result of static or ballistic stretching, elapsed time, or initial flexibility scores. This suggests that stretching prior to competition may not negatively affect the performance of trained women.

Key Words: flexibility, muscle tendon unit, power
Introduction:

Flexibility is an important component to many athletic movements and it should not be overlooked. Adequate flexibility requires that muscles and joints perform through a functional range of motion, which may lead to a decreased risk of injury (1,13). As of recently, there has been much debate as to whether stretching should be included as part of a proper warm-up preceding practice and competition or whether it is more beneficial to perform during the cool-down phase of a workout (15,16,30). According to the *Essentials of Strength Training and Conditioning* (13) and the *ACSM Guidelines for Exercise Testing and Prescription* (1), stretching before or after competition are both acceptable practices. Moreover, the NSCA guidelines (13) state that stretching before competition will improve performance and functional abilities. Despite inconclusive evidence of recent studies, stretching prior to practice or competition is still commonly recommended (27).

Some of the factors that can influence flexibility are the frequency, duration, and intensity of stretching. Even within these areas of flexibility prescription, there is much debate as to how a stretching routine should be performed. The NSCA (13) believes that the ideal amount of time to hold a static stretch is 30 seconds and the American College of Sports Medicine (1) recommends stretching to a point of mild discomfort, and holding a stretch for a duration of 10 to 30 seconds and performing this stretch for a total of 3 to 4 repetitions.

For years, stretching has been integrated into many athletic and fitness programs due to numerous proposed benefits. Stretching is thought to reduce the risk of injury (15,28,33), decrease muscle stiffness of the muscle-tendon unit (MTO) leading to an
increase in range of motion (15,28,33), alleviate pain (28,30), and improve athletic performance (28,30,33). However, recent research on the acute effects of stretching has begun to challenge many of these preconceived theories. Recent studies have sought to examine whether stretching prior to competition is advantageous or detrimental to one’s athletic performance. Although studies have shown stretching to be beneficial for increasing strength as a result of a longitudinal stretching program (3-12 weeks) (17,32), acute stretching just prior to competition may actually decrease strength. Kokkonen, Nelson and Cornwell (19) and Nelson and Kokkonen (24) showed a significant decrease in maximal strength performance following a twenty-minute bout of static stretching and ballistic stretching, respectively.

Strength is not the only factor that may be hindered shortly after stretching. Some recent studies have shown there to be a decrease in power. However, previous studies indicate mixed results for the variable of power. In a study performed by Young and Elliott (34), a significant reduction in drop jump performance following a static stretching routine was found. However, there was no other significant reduction in the drop jump following PNF stretching or for either type of stretch during the squat jump. Nelson and Cornwell (23) also found a significant decrease in squat and countermovement jumps as a result of static stretching.

Since stretching has been shown to possibly produce a decrease in power and strength prior to the supercompensation phase of training (15), it is important to learn if indeed this power or strength deficit exists and if so for how long. This knowledge is essential for athletes, especially those involved in sports that require power and strength to be exhibited throughout the course of training and/or competition. Athletes desire to
perform at the best of their ability and therefore should be aware if pre-competition
stretching is actually helping or hindering specific performance variables. Therefore, the
purpose of this study was to examine the acute effects of both static and ballistic
stretching on vertical jump performance in trained women and to examine the resulting
effect of a stretching intervention immediately after stretching as well as at fifteen and
thirty minute intervals following the stretching routine. It is also important to compare the
results produced following the static stretching regimen with those of the ballistic
stretching program, to determine if one method could be a more favorable method for
athletes than the other. Thus it was hypothesized, through the null, that there would be
no significant decrease in vertical jump performance as a result of either SS or BS nor
would there be a difference in vertical jump as a result of stretching over a period of time.
Also, it was hypothesized that an individual’s flexibility would not alter the effect that
stretching had on vertical jump performance.

Methods:

Subjects

Sixteen trained women (mean ± SD age, 19.2 ± 1.0 years) participated in this
study. All subjects were recruited from a highly competitive Division III women’s
basketball team and were concurrently participating in a preseason workout program that
included a sport-specific weight training program, agility drills and open gym pickup
games. This population was chosen because each subject had previous jumping
experience as part of their prior and current training and sport-specific participation. The
Institutional Review Board of the institution approved the study and each participant was
required to provide informed written consent prior to participating in the study. Subjects were informed that the study was for research purposes and were encouraged to give maximal effort throughout the entire testing procedure.

**Experimental Procedure**

The purpose of this study was to examine the acute effects of static and ballistic stretching on vertical jump performance in trained women. Furthermore, all subjects were asked to perform three different testing procedures on three separate days. The non-stretching treatment was performed on the first testing day to establish baseline data for vertical jump and sit-and-reach scores. The ballistic and static stretching treatments were performed on separate days and were scheduled within one week of each other, at or about the same time each day. The order of these stretching treatments was randomized and balanced between treatments to eliminate a possibility of treatment bias. The testing procedure was similar to the protocol established by Young and Elliot (34), but modified to accommodate our stretching treatment (see Figure 1). Although the NSCA (13) recommends stretches to be held for a length of thirty seconds, this stretching protocol was chosen to mimic an athlete’s common stretching routine prior to athletic participation. Sport stretching, as defined by Halbertsma, van Bolhuis, and Goeken (11), is a program that demonstrates the type of stretching typically performed before participation in sporting events, which in their study consisted of 5 minutes of active stretching.

The subjects were first asked to perform an initial modified sit-and-reach test to measure hamstring flexibility. Participants removed their shoes and sat on the floor with their back against the wall and the soles of their feet flat up against the box (Novel
Products, Rockton, IL). The subjects were instructed to place one hand on top of the other, and to slowly push the lever on the box as far as possible making sure to bend at the waist. The subjects performed three trials and the mean scores were recorded.

Following the initial flexibility assessment, each subject performed a 5-minute warm-up jog (at a self-selected intensity) followed by a 30-second rest period. For the non-stretching treatment, subjects were instructed to rest for an additional six minutes (the approximate amount of time that was required to perform the stretching treatments). For the SS and BS treatments, the 30-second rest period was followed immediately by the respective stretching intervention. All three treatments (NS, BS, SS) were followed by a four-minute walking period prior to measuring the subject’s vertical jump. Subjects performed three countermovement jumps followed by three drop jumps from a 26.5 cm high box. The mean scores were recorded for both the countermovement and drop jumps. Following a 15-minute rest period, flexibility scores were measured and vertical jump tests were again performed. Measurements were recorded in the same manner and this procedure was repeated again at the 30-minute mark.

Static Stretching Protocol

The static stretching (SS) treatment followed the protocol used by Knudson, Bennett, Corn, Leick & Smith (16). Each participant performed 4 different lower body stretching exercises (the seated bilateral hamstring stretch, the standing unilateral calf stretch, both with and without a bent knee, and the standing unilateral quadriceps stretch) designed to stretch the major involved in executing a vertical jump. Each stretch was completed 3 times and each repetition was held for 15 seconds.
The researcher demonstrated the proper stretching technique prior to each testing routine and monitored the subject's movements throughout stretching to ensure that each stretch was performed correctly. Subjects were informed that the holding point of the stretch was established at the point “just before discomfort” (16). The SS exercises are as follows:

- The seated bilateral hamstring stretch - Subjects began this stretch by sitting on the floor with both legs extended and were instructed to lower their head towards their knees, bending at the hip.

- The standing unilateral calf stretch (leg straight) - This stretch was performed one leg at a time, placing two hands on the wall in front of them with both feet flat on the ground, having the toe of the hind foot about one foot behind the heel of the front foot. The subject was then instructed to lean forward, with a slight bend in the front knee, making sure to keep the heel of the hind foot flat on the ground. To isolate the gastrocnemius, it was important to ensure that the hind leg was straight at all times throughout the stretch.

- The standing unilateral calf stretch (bent knee) – This stretch was performed in the same manner as the previous stretch with one modification. Instead of keeping the hind leg straight, the subjects was instructed to slightly bend the back knee while keeping the heel of that foot flat on the ground. This modification was made to ensure that the muscle being stretched was the soleus.

- The standing unilateral quadriceps stretch – Subjects stood on one leg, holding onto the wall for balance, and passively pulled the other knee into flexion with
their hand. Subjects were instructed to remain erect, making sure not to pull the leg into abduction while performing this stretch.

**Ballistic Stretching Protocol**

The ballistic stretching (BS) program followed the identical stretching protocol as the SS group, again focusing on the quadriceps, hamstrings, and calves. However, once the subject had reached the initial stretched position, they were asked to bob up and down at a pace of one bob per second (24). The subjects were asked to keep the joint angle displacement for each bob at approximately 2-5 degrees (24). After performing the stretch for 15 seconds there was a 20 second rest interval before that leg was stretched again (34).

**Vertical Jump Tests**

Two different vertical jump tests were performed. The first test measured the subject jumping from a standing position using a countermovement (29), and the second test was a drop jump test from a 26.5 cm high box (33,34). Maximum vertical jump was measured using the Vertec vertical jump system (Sports Imports, Hilliard, OH). The participant’s standing reach was first recorded before the initial jumps took place. To measure vertical reach, the subjects stood beside the instrument and extended their dominant arm over their head without lifting their heels off the ground. This height was recorded and later subtracted from the maximum height jumped to calculate the subject’s vertical jump. Participants performed each jump three times and the average of the three trials was taken.
Standard Countermovement Jump

The standard countermovement jump employed in this study did not allow for a step and required both feet to be stationary on the floor until take off (14,29,31). Just prior to the jump, a countermovement consisting of bending at the knees and the hips while at the same time flexing the trunk was performed. Subjects were instructed to lower themselves to a point that felt most comfortable while at the same time moving their arms back into hyperextension. Immediately after reaching this point, making sure not to pause between the flexion and extension phase, they were told to jump as high as possible reaching with their dominant hand. The highest point that the subject reached on the Vertec was recorded as their maximal jump. This procedure was repeated two more times and the average of the three jumps was recorded.

Drop Jump Test

Subjects began by standing on a 26.5 cm high box with arms in neutral position. They were then instructed to step off of the box with one leg straight to make sure that the jump took place from a height of 26.5 cm (34). When stepping off of the box, subjects brought their arms back into extension, landed on two feet, and exploded up after landing, trying to reach the highest possible point on the Vertec with their dominant hand. The average of the three jumps was calculated and recorded.

Statistical Analyses:

To assess the effect of the independent variables on vertical jump, a 3 (treatment) by 3 (time) by 2 (flexibility) factorial ANOVA was conducted on the vertical jump scores for the countermovement and drop jumps. The flexibility score was introduced to
determine if the subject’s initial flexibility scores contributed to the results of the study. Subjects were classified as a low or high level of flexibility if they fell below or above the group median (34.5 cm), respectively. Statistical significance was set at the \( p \leq 0.05 \) level. In addition, an intraclass correlation was conducted for both the countermovement jump and drop jump after each of the three treatments (NS, BS, and SS) to indicate the vertical jump test’s reliability. This statistical analysis was performed to determine if there was consistency within the three jumping trials as a result of time.

Results:

Table 1 represents the descriptive statistics of the sample population tested in this study. A 3 (treatment) by 3 (time) by 2 (flexibility) factorial ANOVA was conducted on the vertical jump scores of trained women basketball players for a countermovement vertical jump and a 26.5 cm drop jump. The results of Levene’s Test of Equality supported the assumption of homogeneity of variance for each testing protocol.

The mean vertical jump scores for the countermovement jump are displayed in Table 2. The main effects of treatment and time were not significant (\( p=0.91 \) and \( p=0.77 \), respectively) (see Figure 2). In addition, the main effect of flexibility revealed no significant difference between subjects above and below the median sit and reach score (\( p=0.57 \)) (see Figure 4). The first order interaction effects of treatment by time (\( p=0.99 \)), treatment by flexibility (\( p=0.96 \)), and time by flexibility (\( p=0.96 \)) were not significant. Finally, the second order interaction effects of treatment by time by flexibility was not significant (\( p=0.99 \)).
Similar results were found in the mean vertical jump scores for the 26.5 cm drop jump as shown in Table 3. The main effects of treatment and time were not significant (p=0.47 and p=0.75, respectively) (see Figure 3). The main effect of flexibility resulted in no significant difference between subjects in the upper and lower 50 percentile of subject pool (p=0.35) (see Figure 4). The first order interaction effects for the 26.5 cm drop jump demonstrated no significant difference between treatment by time (p=0.99), treatment by flexibility (p=0.87), and time by flexibility (p=0.96). The second order effect of treatment by time by flexibility was not significant (p=0.99).

The results from the intraclass correlation revealed that there was little variance in vertical jump scores from trial to trial within each time and treatment parameter for the drop jump and countermovement jump. The intraclass correlation coefficient (R) values were all found to be above 0.980 and the R-values for the countermovement jump and drop jump are displayed in Tables 4 and 5, respectively.

Discussion:

The purpose of this study was to examine the acute effects of static and ballistic stretching on vertical jump performance and to investigate if power was altered for time intervals of 15 and 30 minutes following stretching. A 3 (treatment) by 3 (time) by 2 (flexibility) factorial ANOVA revealed no significant decrease in vertical jump scores as a result of either stretching treatment, nor was there any difference in VJ scores as a result of time. Initial flexibility scores also proved to be non-significant in determining if an individual’s flexibility altered the effect that stretching had on vertical jump scores.
The results of this current study add to the growing volume of conflicting research regarding pre-competition stretching on specific performance variables. Power is one performance variable in particular, that has been shown to be both unaltered and significantly decreased as a result of a stretching regimen. For example, one study revealed no significant difference in vertical velocities as a result of static stretching (16). Church, Wiggins, Moode and Crist (4) found mixed results depending on the type of stretching performed. Countermovement vertical jump scores following PNF stretching were significantly decreased from the general warm-up. However, they found no significant difference in vertical jump heights following a static stretching regimen. Young and Elliott (34) on the other hand, found a significant reduction in drop jump performance following a static stretching routine but found there to be no significant difference as a result of PNF stretching. Nelson and Cornwall (23) and Young and Behm (33) also found that static stretching negatively influenced vertical jump performance for squat and countermovement jumps and drop and concentric jumps respectively. From these studies, it can be observed that the evidence is inconclusive as it relates to the acute effects of stretching on vertical jump performance.

Some researchers argue that stretching may decrease musculotendinous stiffness, which could possibly cause an increase in slack on the tendon, therefore decreasing the speed of force from muscle to bone (4,33). It has also been suggested that decreases in strength can be attributed to an increase in the length of the muscle tendon unit (26). Another theory proposes the idea that this decrease in power is related to the myogenic reflex referring to the reduction of the natural contraction when muscles go through ranges of motion very quickly (4). Fowles and Sale (7) suggested that strength deficits
could be related to impaired contractile forces and impaired motor unit activation. It is still unknown as to whether this decrease in performance is due to mechanical properties of the muscle tendon unit, neuromuscular transmission, or other mechanisms (26).

As a result of this study, no significant decrease in vertical jump performance was found for either ballistic or static stretching. These results differed from several previous studies that found a decrease in vertical jump as a result of stretching (4,23,33,34). However, the cause for this difference is unknown but can be speculated. Although the design of this study did not examine the mechanisms involved with this type of stretching, a few reasons can be theorized as to why similar decreases in vertical jump performance were not found as were seen in other studies.

The recovery of motor neuron excitability is one explanation as to why vertical jump performance was unaltered as a result of either static or ballistic stretching. Many previous researchers have used Hoffman reflex (H-reflex) measures as an indicator of changes in motorneuron excitability (2,6,10). In a study by Avela, Kyrolainen, and Komi (2) the effect of prolonged and repeated stretching on reflex sensitivity was examined. The results of their study found a depression of the H-reflex following stretching, but showed that the strength of this reflex was almost completely recovered four minutes post stretching. Guissard, Duchateau, and Hainaut (10) also examined the H-reflex and found it to quickly recover immediately following brief static stretching, such as used in this study. The design of this study allowed for four minutes of walking following the termination of stretching and just prior to the first countermovement jump performed by each subject. Even more time had elapsed between the initial stretch (seated bilateral hamstring stretch) and the beginning of vertical jump testing. Therefore, the “resting
period” between the stretching phase and the jumping phase could have allowed a return in neuromotor excitability, causing any alterations that had occurred to return to pre-stretching or near pre-stretching status. Young and Behm (33) examined vertical jump performance following 4 stretches (each held for 2 sets of 30 seconds) that focused on stretching the quadriceps and ankle plantar flexors. Their study only required a two-minute rest period following stretching and found there to be a significant decrease in both drop jump and concentric jump performance as a result of static stretching. Due to the time decay effect of stretching, differences in recovery time between the two studies may possibly explain why such different results were found.

It is unknown as to how much stretching must be performed to see immediate changes in muscle length as related to musculotendinous stiffness. It is possible that the duration of stretching performed (although chosen to mimic that used by a typical athlete) may have been too minimal for the elastic properties of the musculotendinous unit to be altered. Halbertsma et al. (11) showed that following a 10-minute bout of stretching, ROM was increased but muscle stiffness was unchanged. Magnusson, Aagaard, and Nielson (22) also showed that 3 sets of 45 seconds of stretching had no acute effect on the viscoelastic properties of the hamstring muscle. Another study examined the changes in muscle length following two 15-second passive stretches on the ankle dorsiflexion ROM and found there to be no significant increase in the length of the muscle (35). Therefore, the quantity of stretching used in our study (3 sets of 15-seconds), may not have been enough to alter the viscoelastic properties of the muscles.

Another possible explanation for varying results may be attributed to gender. Due to the low number of women (specifically trained women) in the literature, this study
focused exclusively on this particular population. These trained women were highly experienced with jumping and were also currently involved in plyometric and sport-specific training programs. Moreover, the experimental design of this study was based on the design used by Young and Elliott (34) whose subject pool included only men. Their results indicated that there was a significant decrease in drop jump performance as a result of static stretching but no decrease was found in squat jump performance. It was speculated that this power deficit was caused by an inhibitory neural mechanism or increases in musculotendinous compliance, although this information was not within the scope of their study to examine. One possible reason why a decrease in vertical jump performance was not found in this study could be accredited to the fact that our study focused solely on women. Granata, Wilson and Padua found men to exhibit greater leg stiffness than women at different hopping frequencies (8) and they found the same to be true at different torques (9). Another difference found between genders is that males were found to have thicker muscles while females averaged a longer muscle fiber bundle length (3) as compared to their male counterpart. Kubo, Kanehisa, and Fukunaga (20) found the stiffness of the tendon structures to be significantly lower in women than in men, suggesting that there are indeed gender differences in the viscoelastic properties of the tendon structures between genders. Therefore, the different effects that stretching may have on different genders should be further investigated.

Another difference between the study by Elliott and Young (34) and this study is the training status of the subjects participating. Their study utilized fourteen men who at one point participated in track and field, football, or field hockey, having a minimum of one season experience in his respective sport. However, there was no mention as to
whether these subjects were currently performing jump/sport-specific training at the time of testing. The subjects in this study were currently involved in plyometric and sport-specific training and therefore were familiar with jumping. A training effect which enhances neuromuscular recovery or other mechanisms could have resulted in a reduced effect from static stretching on the performance of the subject’s used in this study.

Part of the ambiguity related to the acute effects of stretching on vertical jump performance can be attributed to the many different modes, intensities, frequencies, and durations of stretches used in various studies. Many of these studies implemented significantly different stretching regimens as part of their protocol and as a result, have found varying results. Static stretching seemed to be the most common stretching method examined by studies within the literature (4,16,18,19,25,33,34). Even among the studies in which stretches were held for 15-30 seconds for 2-3 repetitions results varied significantly and were inconclusive. However, Fowles and Sale (7) looked at the effects of a maximal stretching routine (14 passive stretches for a time period of 33 minutes) and found there to be a decrease in strength for up to an hour proceeding the stretching period. This type of stretching for this length of time is probably very unrealistic for the athletic population prior to competition and is rarely ever performed.

Ballistic stretching is another form of stretching that is often times used as part of the pre-exercise warm-up (13). However, in certain sports, it doesn’t seem to be used as frequently as static stretching possibly because it tends to stretch the muscle more than any other method, causing the potential for injury to be greater (5,12,13). However, due to the principle of specificity and the nature of ballistic stretching, it may be a more appropriate stretching method than static stretching, because even warm-up activities
should mimic movements performed in athletic events, and ballistic stretching does just that (5). To our knowledge there have been a limited number of studies that looked at the effects of ballistic stretching on strength, and none have investigated the effect of ballistic stretching on power. Therefore, since ballistic stretching might be the ideal stretching method for power athletes, it is important that more research be done looking at its effects on athletic performance.

The methods of ballistic and static stretching were selected for this study because these techniques don't require any assistance, unlike proprioceptive neuromuscular facilitation (PNF) stretching in which a partner is required. This is more practical for athletes who wish to stretch prior to competition. A realistic duration of stretch was also chosen due to time restrictions that athletes might have prior to competition. Studies have shown there to be similar flexibility gains between short durations of stretching (10-15 seconds) and longer bouts lasting for thirty or more seconds (15). A study performed by Madding et al. (21) also supported this research concluding that stretching for a duration of 15 seconds was just as effective as stretching for 45 seconds or even a minute. This evidence reinforces the fact that 15 seconds was a reasonable amount of time to hold a stretch for since holding a stretch for a longer period of time was shown to be just as beneficial. Therefore, the stretching protocol of this study was intended to portray a more accurate representation of the typical athlete's stretching routine. Overall, this study aimed to mimic a stretching routine that trained athletes were likely to perform and to see if this type of stretching would have any affect on their performance.
Practical Applications:

The results of this study suggest that the acute effects of stretching may not adversely affect power performance in trained women. Due to the uniqueness of this population and the fact that this group consisted of women who were trained in jumping, the possibility of an increase in vertical jump scores due to familiarization could be eliminated. However, because of this population’s uniqueness, it cannot be assumed that the results from this study could be duplicated if the exact experimental protocol were performed on a dissimilar population. Since stretching prior to competition is still recommended (1,13) despite contradicting evidence, it is necessary that future studies be performed to examine the acute effects of static and ballistic stretching on different populations, possibly having a larger subject pool or comparing both genders. It may also be necessary to look at various other stretching protocols to clarify the debate over whether stretching effects athletic performance and to determine the mechanism associated with decreases in power that are sometimes found.
References


34. YOUNG, W., AND ELLIOTT, S. Acute effects of static stretching, proprioceptive neuromuscular facilitation stretching, and maximum voluntary

Table 1: Physical characteristics of the subjects. Values are represented as means ± SD.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Height (cm)</td>
<td>173.2 ± 6.44</td>
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<td>Weight (kg)</td>
<td>67.6 ± 7.35</td>
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Table 2: Vertical jump scores for countermovement jump (mean ± SD).

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<th>Treatment</th>
<th>Initial</th>
<th>15-min</th>
<th>30-min</th>
</tr>
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<tbody>
<tr>
<td>No stretching (NS)</td>
<td>41.12 ± 5.89</td>
<td>40.46 ± 5.89</td>
<td>40.54 ± 5.46</td>
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<tr>
<td>Static stretching (SS)</td>
<td>41.71 ± 5.28</td>
<td>41.22 ± 5.44</td>
<td>40.69 ± 5.64</td>
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<tr>
<td>Ballistic stretching (BS)</td>
<td>41.50 ± 5.89</td>
<td>40.41 ± 5.92</td>
<td>40.79 ± 5.64</td>
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Table 3: Vertical jump scores for drop jump (mean ± SD).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Initial</th>
<th>15-min</th>
<th>30-min</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stretching (NS)</td>
<td>40.16 ± 5.69</td>
<td>39.17 ± 5.38</td>
<td>38.96 ± 5.61</td>
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<tr>
<td>Static stretching (SS)</td>
<td>41.10 ± 5.99</td>
<td>40.79 ± 5.33</td>
<td>40.39 ± 5.87</td>
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<tr>
<td>Ballistic stretching (BS)</td>
<td>41.01 ± 5.77</td>
<td>40.44 ± 5.64</td>
<td>40.36 ± 5.51</td>
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Table 4: Intraclass correlation coefficient (R) for the countermovement

<table>
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<th>Initial</th>
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<th>30-min</th>
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</thead>
<tbody>
<tr>
<td>No stretching (NS)</td>
<td>0.980</td>
<td>0.992</td>
<td>0.995</td>
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<tr>
<td>Static stretching (SS)</td>
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<tr>
<td>Ballistic stretching (BS)</td>
<td>0.996</td>
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Table 5: Intraclass correlation coefficient (R) for the drop jump

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<th>Treatment</th>
<th>Initial</th>
<th>15-min</th>
<th>30-min</th>
</tr>
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<tbody>
<tr>
<td>No stretching (NS)</td>
<td>0.990</td>
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<td>Static stretching (SS)</td>
<td>0.995</td>
<td>0.988</td>
<td>0.993</td>
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<tr>
<td>Ballistic stretching (BS)</td>
<td>0.995</td>
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</table>
Figure 1: A summary of the experimental protocol, adapted and modified to the protocol used by Young and Elliot (34).
**Figure 2:** Vertical jump performance for the three stretching treatments for the countermovement jump at the specified time intervals. Data represented as mean ± SD. No significant difference for treatment or time.

**Figure 3:** Vertical jump performance for the three stretching treatments for the drop jump at the specified time intervals. Data represented as mean ± SD. No significant difference for treatment or time.
Figure 4: Vertical jump performance for women basketball players, above and below the median flexibility score as measured by the initial sit & reach test.