Effect of different stretching strategies on the kinetics of vertical jumping in female volleyball athletes

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Abstract

Purpose: The present study aimed to examine the effect of static stretching (SS) and a sport-specific dynamic stretching (DS) session at two specific post-stretch time intervals in highly trained female athletes (age 19.9 ± 1.60 years; height 1.80 ± 0.06 m; mass 76.87 ± 9.95 kg) on kinetic parameters of peak force, time-to-takeoff, and rate of force development.

Methods: The data were collected over 3 days (randomized within subject design with control session). Following each stretch session (SS vs. DS vs. control) of equal duration (7 min total: 30 s per targeted muscle group) participants performed countermovement jumping on a force platform at 1 and 15 min after stretching.

Results: The DS session significantly improved upon kinetic variables of rate of force development, peak force, and time-to-takeoff relative to SS at 1 min after stretching. No significant effect was found at 15 min.

Conclusion: Together these findings suggest that when training and competing to jump quickly and maximally the female athlete should incorporate DS instead of SS as part of their pre-competition warm-up, but conduct performance within 15 min of their warm-up to elicit maximal gains.

Keywords: Dynamic stretching; Female athletes; Rate of force development; Static stretching; Time-to-takeoff

1. Introduction

The ability to generate muscular strength quickly is defined as the rate of force development (RFD), and is an integral factor in activities involving stretch-shortening cycles (SSC), such as jumping, sprinting, and throwing.1 In this regard, coaches and athletes have sought to develop a pre-competition warm-up with stretching strategy that elicits the highest RFD relative to that given sport. Generally, athletes incorporate dynamic stretching (DS) and not static stretching (SS) as part of their general warm-up, because DS allows individuals to move through sport-specific movements in rehearsal that SS would otherwise not accomplish.2 In this sense, DS has been shown to improve upon selected measures of power output,2 jumping ability,3 and reaction time,4 whereas SS has been reported to create decrements in these same performance measures.5–7 Despite compelling evidence in favor of DS and against SS, a recent review of literature8 reports that approximately half of the stretching studies assessing the acute effect of SS and DS show no notable effect on SSC activities. Hence, to date, no clear consensus in the stretching literature has been accepted.

The ambiguity within stretching literature has been suggested to be the result of several notable factors, however, the timing of a specific stretch, the training status and/or the gender status of a sample population each has been shown to...
play a substantial role in performance outcomes.8–11 With regard to timing, the time elapsed between completion of the stretch-to-performance measures has been shown to cause significant reductions in peak torque immediately after various stretching durations of 2, 4, 6, and 8 min, but return to baseline by 10 min after stretching in young healthy males.11 Furthermore, Mizuno et al.12,13 reported that muscle-tendon unit (MTU) stiffness, a physiological index for rapid force generation, was significantly altered immediately after SS but returned to baseline by 10 and 15 min after stretching in healthy males. Although several articles provide a general consensus for when males should conduct stretching prior to activities, the magnitude of this effect is largely undefined in female athletes.

Investigating potential SSC performance outcomes after the application of stretching in female athletes would be particularly important because gender differences have been shown to exist with regard to how the MTU operates.14 The MTU has been hypothesized to be a primary candidate that is mechanistically linked to the effect of stretching by altering the length-tension and force-velocity relationship of skeletal muscle SSCs.15 For example, a single bout of SS has been shown to alter the length-tension relationship (a leftward shift)16 and this has led to a concomitant reduction in RFD.15 In this regard, a stiffer MTU is capable of generating a higher RFD, because there is less “slack” for the tendon to “pick-up” during skeletal muscle SSCs, thereby reducing the time lag from onset of muscular force generation to externally applied ground reaction forces (GRFs).15 Notwithstanding, females have been shown to exhibit a more compliant (less stiff) MTU than male counterparts and authors reason that the difference may alter the force-time curve during SSC activities.17 Even more, strength trained and/or plyometric trained individuals (i.e., high jumpers, volleyball players, basketball players) are well documented to decrease their MTU compliance (i.e., increased stiffness) parallel to improvements in RFD.17,18 Therefore, although resistance- and plyometric-trained individuals have a positive response during maximal force exerting tasks, female athletes may differentially alter how their MTU operates under different stretching conditions at different times, thus altering their kinetic profile during SSC activities. This paradox warrants further examination.

The force generating capacity that the MTU exhibits during SSC activities can be quantitatively assessed from ground reaction force-time (GRF-time) data using a force platform, and provides the most accurate way to assess strength qualities during vertical jumping.19 By measuring selected kinetic variables related to how quickly one jumps, such as time-to-takeoff (TTT),20 how maximally one produces force, such as peak force21 and variables linking both components, such as the rate at which force can be generated (e.g., RFD),22 it is possible to distinguish any notable effect that stretching of the lower extremity may have in female athletes.

Therefore, the current investigation aimed to evaluate: 1) the kinetic profile that female volleyball athletes exhibit during vertical jumping after SS and DS, and 2) to quantitatively describe changes in these kinetic parameters at two specific timing intervals (1 and 15 min) after stretching. On the basis of abovementioned evidence it was hypothesized that a sport-specific DS protocol compared with an equal duration of SS, would improve kinetic parameters 1 min after stretching but, by 15 min kinetic parameters would return to baseline (control).

2. Materials and methods

2.1. Participants

Ten female, collegiate varsity volleyball players (mean ± SD: age 19.9 ± 1.60 years; height 1.80 ± 0.06 m; mass 76.87 ± 9.95 kg) were recruited for this investigation. Participants were considered highly trained on the basis of a brief athletic training questionnaire, meaning that each participant was currently participating in regular off-season strength training and plyometric training, volleyball drills, and weekend competitions under the supervision of strength and conditioning coaches at the time of experimental testing. Frequency and duration of participation ranged from 2 to 5 days per week and 50–60 min per session. To prevent any potential diurnal variations in performance measures participants were asked to report to the laboratory at approximately the same time for every session (~1300–1500 h). Participants were verbally informed of the protocol and then read and signed the informed consent form. This investigation and all procedures utilized was approved by Ohio University’s Institutional Review Board.

2.2. Experimental design

This investigation used a randomized within subject design to evaluate the effectiveness of a traditional bout of SS, a DS routine (as prescribed by the coaches) and a control (no stretching) session of equal duration on kinetic variables describing the shape of the GRF-time curve during countermovement vertical jumping (CMJ) on a force plate. Kinetic parameters that were assessed from the raw vertical GRF trace (Fz) of the force platform were TTT, peak force (Fpk), and RFDavg. Because some athletes do not begin competing immediately after their warm-up with stretching routine, we examined the effects of DS and SS post-stretch timeline testing beginning at 1 min and ending at 15 min (Fig. 1). Each participant volunteered to participate in four sessions which consisted of one familiarization session and three randomized experimental testing days (Fig. 1). In the first session participants became familiarized to the procedures of each experimental session. This included correct CMJ technique as well as familiarization to the SS procedures. It was assumed that all participants understood the DS procedures, as this was their typical pre-match warm-up routine that was extrapolated from the coaching staff. After the familiarization session the following three randomized experimental testing sessions were conducted: 1) an SS...
session followed by three CMJs each at 1 and 15 min after SS, 2) a control session using only a general aerobic warm-up followed by three CMJs each at 1 and 15 min after warm-up, and 3) a DS session followed by three CMJs each at 1 and 15 min after DS.

Prior to each stretching session a brief aerobic warm-up was conducted on a cycle ergometer (Monark, Ergomedic 874E, Vansbro, Sweden) using 1 kg of resistance and cycling at a cadence of 60 RPMs for 5 min. Participants then performed one of three randomly assigned experimental stretching protocols, which lasted for a total duration of 7 min. After stretching, a stop-watch was started in order to monitor testing at 1 and 15 min after the stretch intervention. At each specific timing interval, the participant would position herself on the force platform and begin performing a sequence of three CMJs interspersed with a 1 min standing rest.

2.3. Stretching sessions

The DS protocol was the coaching-staff prescribed DS warm-up and consisted of 14 movements each with a duration of 30 s (total duration = 7 min). Movements progressed from light- and slowly-controlled stretches pulled through a full range of motion, to moderate- and high-intensity skipping and bounding on each leg (Table 1). All participants were visibly sweating after completion of the DS session.

Testing for SS consisted of a single bout of stretching which involved seven major muscle groups of the lower extremity. Each muscle group was stretched using one repetition on each side of the body for 30 s (total duration = 7 min) (Table 2). The emphasis was placed on holding each stretch to a point of “mild discomfort.” This duration of stretching fell within the recommendations set forth by the American College of Sports Medicine Guidelines to Testing and Prescriptions 9th ed. of 15–60 s.

The control session (Con) involved 5 min of general aerobic warm-up, then no stretching (rest) for 7 min. Thus, the period of time post general aerobic warm-up that would otherwise be spent stretching (i.e., SS and DS), was spent sitting in a chair for 7 min.

Table 1
Description of dynamic stretching procedures.

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light jog</td>
<td>Jog down half basketball court and back</td>
</tr>
<tr>
<td>Leg cross-overs</td>
<td>Supine-to-prone activity where legs are swung medio-laterally per leg on both sides</td>
</tr>
<tr>
<td>High knee-pull</td>
<td>A walk pulling every other leg up towards the chest with the hands and simultaneously plantar-flexing</td>
</tr>
<tr>
<td>High lunge-pull</td>
<td>Same procedures as the high knees pull, includes lunges</td>
</tr>
<tr>
<td>High knees-to-chest</td>
<td>Exaggerated running motion actively pulling</td>
</tr>
<tr>
<td>Quad pull</td>
<td>Every other leg is continuously pulled with the aid of the hands</td>
</tr>
<tr>
<td>Hip cradle</td>
<td>Every other leg is actively stretched by pulling the ankle medially towards the groin</td>
</tr>
<tr>
<td>Lunge with twist</td>
<td>Lunge on both legs concludes with a twist opposite to the side leg in front of the body</td>
</tr>
<tr>
<td>Reverse kick</td>
<td>A skip with a simultaneous kick forward-then-backward for every other leg</td>
</tr>
<tr>
<td>High kicks/reach</td>
<td>Walk with flexion of hips and full extension of the leg and thigh with the opposite hand reaching to touch toe</td>
</tr>
<tr>
<td>Spiderman</td>
<td>A floor crawl where athlete mimics climbing up a wall using exaggerated hip flexion and extension</td>
</tr>
<tr>
<td>Skip-hop</td>
<td>Skips with each leg being flexed as high as it can go</td>
</tr>
<tr>
<td>Back pedal</td>
<td>Exaggerated backward running with full leg extension</td>
</tr>
<tr>
<td>High kicks</td>
<td>Same as the high kicks with reach but with an exaggerated skipping while full extension of knees and hips</td>
</tr>
</tbody>
</table>

Note: Total duration is 7 min, or 14 stretches × 30 s each.
Table 2

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretzel</td>
<td>Sit with legs straight and upper body nearly vertical. Bend right leg and cross right foot over to the left side of the left knee. Push right leg knee toward left leg</td>
</tr>
<tr>
<td>Supine knee flex</td>
<td>Lie on back with legs straight flex right knee and hip; bring the thigh toward the chest. Position hand behind the knee and pull towards chest</td>
</tr>
<tr>
<td>Hip flexor lunge</td>
<td>Kneel on both knees. Bring left thigh forward and settle in front of the torso at 90° hip and knee flexion. Pull hips from underneath</td>
</tr>
<tr>
<td>Hurdler’s stretch</td>
<td>Sit with upper body nearly vertical and legs straight. Place the sole of the foot on the inner side of the right knee with the outer side of the leg resting on the floor. Lean forward using hip flexion keeping torso straight and reaching with right hand toward the tip of the shoes</td>
</tr>
<tr>
<td>Quadriiceps pull</td>
<td>Lie on the side with both legs straight. Place the left forearm flat on the floor and the upper arm perpendicular to the floor. Place the left forearm at a 45° angle to the torso. Flex the right leg (knee), with heel of the right foot moving toward the buttocks. Grasp the front of the ankle with the right hand and pull toward the buttocks</td>
</tr>
<tr>
<td>Calf stretch</td>
<td>Stand facing the wall with feet shoulder width apart and approximately two feet from the wall. Bring right leg directly back while leaning with hands placed against the wall. Keep back leg straight and lower heel to the floor</td>
</tr>
<tr>
<td>Soleus stretch</td>
<td>Same procedures as the calf stretch except a slight bend to the extended leg is applied at the knees to isolate the soleus muscle</td>
</tr>
</tbody>
</table>

Note: Total duration is 7 min, or 7 stretches × 30 s × 2 (right and left side).

2.4. Performance testing

Vertical jumping was performed on a 0.6 m × 0.4 m force platform (Kistler, Type 9290AD, Winterthur, Switzerland). The GRF-trace was sampled at a frequency of 1000 Hz, and filtered using a fourth-order Butterworth low pass filter with a 17 Hz cutoff frequency. A Vertec device (Vertec Sports Imports, Hilliard, OH, USA) was placed directly above the center of the force platform as a means for practical motivation and to maximize the trajectory of the Fz trace. Participants performed a CMJ by rapidly moving downward (knee and hip flexion combined with dorsiflexion at the ankle), immediately followed by a fast upward movement of the hip, knee, and ankle extensors (e.g., “triple extension”) while simultaneously reaching with her favored arm to displace the vanes on the Vertec, much in the same way as she would jump at the net to spike/tip a volleyball during competition. The two highest of three CMJ jump trials were averaged and used for statistical analysis.

2.5. Assessment of GRF-time variables

The resulting vertical force and displacement data from the GRF-time curve were extracted and used to measure the dependent variables, and is in accordance with previous methods.20,24 The Fz was defined as the point where the positive acceleration curve from the GRF-trace exceeded body weight by 7.5 N. Change in TTT was determined as the time at which the force in the propulsive phase began (point where Fz increased 7.5 N above athlete’s body weight) minus the time at the point of toe-off (point where no Fz trace is detected). Fpk was defined as the highest attainable value of the positive acceleration curve over a 20 ms period. RFDavg was determined as the difference (Δforce/Δtime) in the slope of the GRF-time record.

2.6. Statistical analysis

A Shapiro–Wilk test was first used to evaluate all data normality. Since all data presented normal distribution (p > 0.05), parametric statistics were used and descriptive statistics were calculated as means and standard deviations. The GRF-time assessments were analyzed using a 3 × 2 (session × timing) repeated measures (RM) ANOVA using SPSS version 19.0 (Windows 2007, Chicago, IL, USA) to determine any treatment effect for the independent variables (SS, Con, DS). If significant effects were detected, Bonferroni post-hoc procedures were applied to identify the significant main effects. If a significant interaction was found, one-way RM ANOVAs were run across each session (SS, Con, DS) or timing intervals (1 and 15 min). When sphericity was violated, Greenhouse-Geisser corrections were made. Effect size for any significant main effects were calculated by determining the differences between means, divided by the pooled standard deviation. Effect sizes were classified as trivial (<0.01), small (0.1–0.3), medium (0.3–0.5), and large (>0.5). The within session reliability of the three times jumping for each kinetic variable under each specific stretching treatment was determined using intraclass correlation coefficients (ICCs), and ICC > 0.80 was deemed as a minimal acceptable reliability. In all cases ICC values were acceptable and ranged 0.963 – 0.976. The α level was set at p < 0.05. Data are reported as mean ± SD.

3. Results

3.1. Peak force

For Fpk a significant interaction was found (p < 0.05). Follow-up analyses for DS revealed a significant decrease (p = 0.017, d = 0.41) across time (Fig. 2). No significant (p > 0.05) differences across time were found for Con and SS respectively. Analyses at 1 min post-stretch revealed that DS was significantly greater than SS. No significant (p > 0.05) difference was found at 15 min post-stretch for any intervention.

3.2. Average rate of force development

For RFDavg there was a significant interaction (p < 0.05). Follow-up analysis for DS revealed a significant decrease (p = 0.008, d = 0.30) across time (Fig. 3). No significant differences (p > 0.05) were observed for Con and SS across time. At 1 min post-stretch DS was significantly greater than
Stretching, female athletes, and vertical jumping

4. Discussion

The objective of the current investigation was to determine whether two specific stretching strategies (SS vs. DS) alter the kinetic profile ($RFD_{avg}$, $F_{pk}$, TTT) in female volleyball athletes during vertical jumping at two specific timing interval (1 min vs. 15 min) assessments. Consistent with our hypotheses, the current investigation found that DS caused an acute ergogenic improvement in all kinetic parameters 1 min after stretching when compared to an equal duration of SS. Additional findings were that a prior bout of SS caused an acute deleterious effect in all kinetic parameters 1 min after stretching. No significant effect was detected for any variables at 15 min. Together these findings suggest that short durations of SS and DS can substantially alter several important kinetic parameters involved in maximizing vertical jumping performance, but only for a brief period of time after stretching.

There is very little research that has investigated the acute effects of different stretching strategies in the female athlete, but conflicting results have emerged. For example, some authors\cite{25,26} have reported that a prior bout of SS and DS displays no notable effect on vertical jumping values in collegiate women. However, other authors found that a prior bout of SS and DS caused significant effects in collegiate women when performing SSC activities of vertical jumping\cite{27} and reactive muscle strength.\textsuperscript{8} These unclear observations parallel findings from a very recent review of the literature, where the authors report that approximately half the studies involving SS and DS showed no notable effect on SSC performance.\textsuperscript{8} Thus, it was the intent of this investigation to provide a biomechanical understanding during a commonly utilized SSC movement (vertical jumping) after two specific stretching strategies in a sport-specific and gender-specific population as a means to add clarity to the present conflicting research findings.

Quantifying the dynamic RFD after stretching was one priority in this investigation because when examining explosive muscular strength in athletes and how it is mechanistically linked to sport performance, RFD has been deemed to be the most important predictor variable affecting performance in sports requiring a high level of acceleration.\textsuperscript{28} Previous work has demonstrated that SS for a total duration of 10 min elicited acute decrements in RFD and $F_{pk}$ in recreationally active males.\textsuperscript{22} The present investigation is in agreement with previous evidence in that SS for 7 min total duration impaired RFD and $F_{pk}$ scores 1 min after SS. Other investigators\textsuperscript{2,21} however, have found no notable effects of $F_{pk}$ and RFD after SS. This may have been attributed to the likely positive effect of the dynamic warm-up performed with SS prior to performance testing. In this context, the current

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**Fig. 2.** Peak force ($F_{pk}$) values for no stretching (Con), dynamic stretching (DS), or static stretching (SS) at 1 and 15 min after stretching (mean ± SD, $n = 10$). *$p < 0.05$, compared with SS at 1 min; †$p < 0.05$, compared with DS at 1 min.

**Fig. 3.** Average rate of force development ($RFD_{avg}$) values for no stretching (Con), dynamic stretching (DS), or static stretching (SS) at 1 and 15 min after stretching (mean ± SD, $n = 10$). *$p < 0.05$, compared with SS and Con at 1 min; †$p < 0.05$, compared with DS at 1 min.

**Fig. 4.** Time-to-take-off (TTT) values for no stretching (Con), dynamic stretching (DS), or static stretching (SS) at 1 and 15 min after stretching (mean ± SD, $n = 10$). *$p < 0.05$, compared with SS at 1 min; †$p < 0.05$, compared with SS at 1 min.
investigation utilized a sport-specific DS session and it was found to have a clear notable improvement in RFD_{avg} and F_{pk} values at 1 min after stretching when compared to the same duration of SS. Therefore, it is within reason to assume that the coach’s prescribed, sport specific DS session in the present investigation may be a better representation as compared to a “generalized” DS warm-up that other investigations have utilized,2,25 because from a psychological perspective, athletes can be highly sensitive to changes in their specific warm-up routine.22

A variable rarely explored in literature, TTT was also determined because it quantitatively assesses the capacity of the athlete when jumping quickly as opposed to maximally.20 TTT has been found to be a practical descriptive performance measure, as it has previously been found to be significantly correlated to vertical jumping height performance in highly trained athletes.20 Indeed, jumping quickly as compared to maximally are mutually exclusive tasks that may be of priority, because in sports where athletes generate quick bursts of movement the culminating outcome to success typically goes to that athlete who responds to a given situation in as little time as possible. In this regard, TTT was found to be significantly decreased 1 min after DS and increased 1 min after SS. Hence, the sport specific DS session in the present investigation was the preferable mode of stretching to female volleyball athletes, because it improved upon how quickly they jumped, as opposed to as maximally and forcefully as possible, but only for a short time (i.e., 1 min post-stretch). Therefore, the current findings suggest that when training to jump quickly the female athlete should incorporate DS instead of SS as part of their warm-up, but conduct performance within 15 min of their warm-up to elicit maximal gains.

A timing signature was another priority in the present investigation which, as previously mentioned, needs further attention in female athletic populations. In the present investigation, it was found that SS for 7 min of all the major muscle groups of the lower extremity elicited acute decrements in kinetic parameters 1 min after stretching, but returned to baseline by 15 min. These findings are comparable with previous findings in male subjects, where the deleterious effects of SS are evident up to 10 min and 15 min after stretching. However, females are well known to differentially alter how their MTU operates in response maximal force producing tasks as compared to male counterparts.14 This is further obscured as athletes are known to exhibit a stiffer MTU complex compared to that of non-trained individuals.17,18 Although these differences have obvious performance implications to the female athlete, based on the abovementioned evidence as well as current research findings, it might otherwise be interpreted that female athletes exhibit similar MTU features as males, and that the stretch-induced force deficit appears to be evident within a similar time frame (10–15 min after stretching).

Despite the apparent lack of current knowledge regarding stretching strategies in the female athlete, from a practical standpoint the present investigation also may offer novel mechanistic insights towards proper placement strategies in a sport-specific DS regimen among other sports. For example, the English Premier League Pitch Protection Policy (2011/2012) states that pre-match warming up “shall end no later than 10 min before the kick-off” (The Football Association Premier League Limited, 2011, p. 138). Based on current findings where non-significant results were evident 15 min after DS, this can be substantially vital to teams and league players where guidelines may restrict that athlete from performing their warm-up with stretching routine in the appropriate time frame prior to performance, thereby potentially obscuring that athlete from sub-optimal performance during match play. Further research in other gender specific sporting populations is needed to clarify this concept.

The present study is not without a few limitations. Firstly, this study used a sample composed exclusively of highly trained female volleyball players. Therefore, findings of the present study may make it difficult to extrapolate these results to other populations, which may appear to respond differently to the effects of various stretching modalities. Secondly, we used a force plate to measure specific kinetic determinants during vertical jumping in the female volleyball athlete. Indeed, the force plate has previously been observed to be the most accurate way to assess strength qualities during vertical jumping19 and therefore is a sensitive method to describe any notable changes that may incur on the MTU properties during subsequent jumping tasks. However, a direct cause and effect relationship between ground reaction force variables and vertical jumping ability as measured by maximal jump height achieved, cannot be explicitly concluded in this investigation. Lastly, a small population sample was included by this investigation, which may be slightly underpowered (0.76). Nevertheless, the primary intent of this investigation was to utilize a specific population, exclusive to one particular sport, for direct assessment on the effect of stretching and vertical jumping kinetic characteristics. In this regard, while the limited sample population was a concern, we believe that this population represents a well-defined, tightly controlled sample for the intended purposes of the present investigation.

5. Conclusion

In conclusion, the present findings indicate that a sport-specific DS session is capable of generating superior kinetic scores relative to SS, but only for a short while (1 min after stretching). Furthermore, these findings indicate that if the female volleyball athlete waits 15 min to conduct vertical jumping, the positive effect of their sport-specific DS diminishes and returns to baseline. Although current literature concerning the effect of antecedent stretching and performance in the female athlete has yet to be convincingly demonstrated, the findings of the present study add further insight toward building a better understanding regarding the mechanisms underpinning SS and DS on subsequent maximal muscular force production with extended implications towards developing specific stretching strategies in female athletes prior to performance.
We would like to thank the volleyball players for volunteering to participate in this investigation. Extended appreciation goes out to the coaches who were willing to help us development the necessary experimental protocol for this investigation. Lastly, the authors are gratified for the technical assistance, skillful expertise, and enthusiastic involvement of Mr. Clevidence, Mr. Kelly, and Mr. Knutson.

References


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