The Effectiveness of a Dynamic Warm-Up in Improving Performance in College Athletes

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Clinical Scenario

Warming up before performing rigorous physical activity is typically done to increase range of motion and improve athletic performance. Common warm-up techniques in college athletics include static stretching, proprioceptive neuromuscular facilitation (PNF) stretching, dynamic warm-ups, and sport-specific activities. However, the type of warm-up routine used in the college setting varies based on a variety of factors including coaching or therapist experience, education, and preference. Recent studies have investigated the effectiveness of different types of warm-up on college athlete performance measures such as vertical jump, agility, and sport-specific activities (eg, sprint performance). Although a dynamic warm-up is generally thought to be superior to other common warm-up techniques, there remains uncertainty regarding the best method to prepare for intercollegiate athletic participation.

Focused Clinical Question

Does a dynamic warm-up improve performance, such as vertical jump, more than static or PNF stretching in college athletes?

Summary of Search, “Best Evidence” Appraised, and Key Findings

• The literature was searched for studies of level 3 evidence or higher that investigated the effects of dynamic warm-up programs on performance.
• Two randomized crossover designs and 2 randomized controlled trials were located.
• Three studies demonstrated an increase in performance measures after a dynamic warm-up protocol compared with a static-stretching warm-up protocol.
• One study demonstrated sustained performance gains using a dynamic warm-up program over a 4-week period and decreased or no improvement in performance after a static-stretching warm-up protocol over the same 4-week period.

• One study demonstrated no significant differences in vertical-jump performance after 3 different warm-up protocols, including static- versus dynamic-stretching warm-ups.

**Clinical Bottom Line**

There is moderate evidence to support the use of dynamic warm-up programs to improve performance measures in college athletes.

**Strength of Recommendation:** There is level B evidence that the use of dynamic warm-up programs is effective in improving performance in college athletes.

**Search Strategy**

**Terms Used to Guide Search Strategy**

- Patient/Clinical group: collegiate and athlete
- Intervention (or assessment): dynamic or active and warm-up
- Comparison: static stretch or PNF
- Outcome(s): performance or agility or vertical jump

**Sources of Evidence Searched**

- PubMed
- CINAHL
- Ovid
- SPORTDiscus
- Cochrane Library
- Additional resources obtained through review of reference lists (hand searching)

**Inclusion and Exclusion Criteria**

**Inclusion Criteria**

- Studies investigating dynamic warm-up, static-stretching, and PNF programs for which a primary or secondary outcome measure was performance
- Limited to English language
- Limited to humans
- Limited to last 11 years (1999–2009)
Exclusion Criteria

- Studies that only investigated multicomponent programs (eg, static stretching plus dynamic warm-up)
- Noncollege athletes (eg, secondary school, recreational)
- Warm-up activities that were not dynamic warm-ups, static stretching, or PNF methods (eg, heat treatments, ultrasound)

Results of Search

Four relevant studies were located and categorized as shown in Table 1 (based on Levels of Evidence, Centre for Evidence Based Medicine, 1998).

Best Evidence

The studies in Table 2 were identified as the “best” evidence and selected for inclusion in this Critically Appraised Topic (CAT). These studies were chosen because they were graded with a level of evidence of 3 or higher, investigated dynamic warm-up protocols compared with other common warm-up techniques in college athletes, and described the effect of the intervention on the outcome of athletic-performance measures.

Implications for Practice, Education, and Future Research

Three of the 4 studies demonstrated a significant improvement in performance measures (eg, vertical jump, long jump, 300-yd shuttle run, medicine-ball underhand throw for distance) after a dynamic warm-up.1–3 Of significance between the 3 studies that demonstrated a positive effect on performance was the notion that dynamic warm-up protocols had beneficial effects on performance in both acute and long-term time frames. The 4-week dynamic stretching warm-up intervention was administered during preseason training and, in general, demonstrated long-term or sustained performance enhancements compared with a 4-week static-stretching warm-up protocol.1 In addition, the static-stretching program negatively affected some measures of performance, including the 600-m run and the number of push-

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Study design</th>
<th>Number located</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2b</td>
<td>Randomized crossover design, crossover design</td>
<td>2</td>
<td>Christensen et al⁴ and Thompsen et al³</td>
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<tr>
<td>2b</td>
<td>Randomized controlled trial</td>
<td>2</td>
<td>Herman et al¹ and Holt et al²</td>
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<tr>
<td>Characteristic</td>
<td>Holt et al(^2)</td>
<td>Herman et al(^1)</td>
<td>Christensen et al(^4)</td>
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<tr>
<td><strong>Participants</strong></td>
<td>64 college football players (18–25 y, mean ± SD 20.7 ± 1.8). Between-subjects control-group design. Random assignment. Exclusion of 1 outlier.</td>
<td>24 male college wrestlers (19.5 y, SEM ± .3; 20.3, SEM ± .3). Subjects were assigned randomly by using a random-digit algorithm to either the treatment condition or active control condition. Conditions were weight-class matched.</td>
<td>68 male and female college athletes (19.8–20.5 y). 36 men and 32 women. Randomized within-subject experimental repeated-measures design.</td>
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<td><strong>Intervention investigated</strong></td>
<td>Effect of 4 different warm-ups on vertical-jump performance. Groups: warm-up only, warm-up plus static stretching, warm-up plus dynamic stretching, warm-up plus dynamic flexibility. No blinding of subjects or therapists.</td>
<td>Effect of 2 different 15-min warm-ups performed daily for 4 wk on various performance measures. Groups: dynamic stretching warm-up (DWU), static stretching warm-up (SWU). Baseline anthropometric and performance measures were taken. Completion of 4-wk DWU intervention or the SWU active control condition. Anthropometric- and performance-measure testing was repeated at least 24 h after most recent DWU or SWU.</td>
<td>Effect of 3 different warm-ups on vertical jump. Groups: 600-m jog, 600-m jog followed by PNF stretching routine, 600-m jog followed by a dynamic-stretching routine. Subjects were placed into 1 of 6 groups. 6 groups were used to limit time between vertical-jump testing. Three sessions were used on 3 separate days in which each group performed 1 of the 3 different warm-ups. Each session concluded with vertical-jump testing consisting of 3 maximum efforts. The average of these jumps was used for the statistical analysis.</td>
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(continued)
Main findings Significant difference in vertical-jump performance between pre- and post-warm-up conditions, $P < .05$. Main finding was significant improvement in vertical-jump performance after general warm-up, general warm-up plus dynamic stretching, and general warm-up plus dynamic flexibility. No significant improvement was found with general warm-up plus static stretching. Measures of effect size for each group revealed that the dynamic-stretching warm-up and dynamic-flexibility warm-up led to better performance than general warm-up alone.

The 4-wk DWU intervention positively modulated peak torque of quadriceps, broad jump, medicine-ball toss, sit-ups, and push-ups and decreased 300-yd- and 600-m-run times. No observed improvements in the SWU group for peak torque of the quadriceps, broad jump, medicine-ball toss, sit-ups, or 300-yd shuttle run. Decreased performance in 600-m and push-up tests in the SWU group. Neither warm-up influenced peak torque of the hamstrings, flexibility of the hamstrings or trunk, or muscle endurance required to perform the pull up-test.

No significant differences in vertical-jump performance as a result of 3 different warm-ups. Long-jump and vertical-jump performance were significantly better after the dynamic warm-up protocols, with and without a weighted vest. Long-jump performance was best when the dynamic warm-up with a weighted vest was used.

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<td>No significant differences in vertical-jump performance between the 3 different warm-up conditions, but there were no negative effects on vertical-jump performance after a dynamic-stretching condition.</td>
<td>Long-jump and vertical-jump performance were significantly better after the dynamic warm-up protocols, with and without a weighted vest. Long-jump performance was best when the dynamic warm-up with a weighted vest was used.</td>
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| Level of evidence    | 2b               | 2b                  | 2b                       | 2b                    |
| Validity             | 5/11             | 5/11                | NA                       | NA                    |
| Conclusion           | Warm-up has a beneficial effect on vertical-jump performance, but static stretching negates the benefits of a warm-up when performed immediately before vertical jump. It appears that a dynamic warm-up and dynamic flexibility are beneficial for vertical-jump performance. | Incorporation of a 4-wk dynamic warm-up program daily in pre-season training produced longer-term or sustained improvements in various performance measures relating to power, strength, muscle endurance, anaerobic capacity, and agility. | No significant differences between the 3 different warm-up conditions, but there were no negative effects on vertical-jump performance after a dynamic-stretching condition. | These data indicate improvement in performance of vertical jump and long jump after a dynamic warm-up, in particular with the use of a weighted vest, compared with static stretching. |

PNF, proprioceptive neuromuscular facilitation.
ups performed in 2 minutes. Dynamic warm-ups resulted in benefits in quadriceps peak torque output, broad jump, underhand medicine-ball throw, sit-ups, push-ups, and both 300-yd shuttle-run time and 600-m-run time. Furthermore, acute performance improvements were observed when a dynamic warm-up was incorporated into vertical-jump and long-jump testing of college football players and female college athletes.\(^2,3\) Although the fourth study demonstrated no positive or negative effects on vertical-jump performance,\(^4\) a dynamic warm-up appears to be beneficial for performance compared with other common warm-up techniques such as static stretching and certain PNF techniques.

Athletic performance is often measured by an athlete’s ability to perform the activities investigated in these studies (eg, 300-yd shuttle, vertical jump, broad jump, and various sport-specific agilities). Considering that college athletic coaches, strength-and-conditioning coaches, and certified athletic trainers often use these performance measures to gauge conditioning level, they should feel confident in using a dynamic warm-up in preparation for athletic activity. Although the dynamic warm-up routines evaluated in our CAT appear to be beneficial to a variety of performance measures, other literature suggests that dynamic warm-ups may be detrimental if structured incorrectly.\(^5\)

Based on the articles in this review, beneficial dynamic warm-up programs incorporate a progressive process beginning with a general cardiovascular warm-up, followed by the dynamic warm-up and ending with sport-specific activities. According to Bishop et al,\(^5\) a dynamic warm-up should last no longer than 10 to 20 minutes and be performed at an intensity level that does not negatively affect performance. Bishop et al define this intensity level as approximately 60% of VO\(_{2\text{max}}\). In addition, the dynamic warm-up should incorporate the major body joints (ie, shoulder, trunk, hips, knees, and ankles).\(^1,6,7\) The investigations included in our CAT align with the recommendations of Bishop et al, except that VO\(_{2\text{max}}\) was not recorded or reported in any of the studies. Therefore, these guidelines should be used with caution because the exact parameters were not explicitly investigated for the purposes of this CAT.

The findings of this CAT may be limited based on the performance measures used in these studies to determine the effects of a dynamic warm-up. Gauging improvement in performance through isolated activities such as vertical-jump and hop tests may not translate to increases in sport-specific performance. For example, it remains unknown whether improvements in activities such as the vertical jump positively affect shot-blocking ability in basketball. These performance measures give us an idea of whether an athlete is conditioned to perform well in sporting activities, but it remains unknown whether these isolated activities result in better sport performance on the field.

Another consideration is that measures of performance should be aligned with the physical demands of the sport in question. Less physically demanding athletic activities may require a warm-up less demanding than those currently investigated. In addition, future studies aimed at identifying specific dynamic warm-up movements with sport-specific activities may help clinicians properly administer the correct dynamic warm-up routines for improving the types of performance that are critical and clinically relevant to particular sports.
Acknowledgments

We thank Dr Tamara Valovich McLeod for her guidance with the CAT process.

References