THE RELATIONSHIP BETWEEN CORE STABILITY AND PERFORMANCE IN DIVISION I FOOTBALL PLAYERS

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ABSTRACT
Nesser, TW, Huxel, KC, Tincher, JL, and Okada, T. The relationship between core stability and performance in Division I football players. J Strength Cond Res 22(6):1750–1754, 2008—The purpose of this study was to identify relationships between core stability and various strength and power variables in strength and power athletes. National Collegiate Athletic Association Division I football players (height 184.0 ± 7.1 cm, weight 100.5 ± 22.4 kg) completed strength and performance testing before off-season conditioning. Subjects were tested on three strength variables (one-repetition maximum [1RM] bench press, 1RM squat, and 1RM power clean), four performance variables (countermovement vertical jump [CMJ], 20- and 40-yd sprints, and a 10-yd shuttle run), and core stability (back extension, trunk flexion, and left and right bridge). Significant correlations were identified between total core strength and 20-yd sprint ($r = -0.594$), 40-yd sprint ($r = -0.604$), shuttle run ($r = -0.551$), CMJ ($r = 0.591$), power clean/body weight (BW) ($r = 0.622$), 1RM squat ($r = -0.470$), bench press/BW ($r = 0.369$), and combined 1RM/BW ($r = 0.447$); trunk flexion and 20-yd sprint ($r = -0.485$), 40-yd sprint ($r = -0.479$), shuttle run ($r = -0.443$), CMJ ($r = 0.436$), power clean/BW ($r = 0.396$), and 1RM squat ($r = -0.416$); back extension and CMJ ($r = 0.536$), and power clean/BW ($r = 0.449$); right bridge and 20-yd sprint ($r = -0.410$) and 40-yd sprint ($r = -0.435$), CMJ ($r = 0.403$), power clean/BW ($r = 0.519$) and bench press/BW ($r = 0.372$) and combined 1RM/BW ($r = 0.408$); and left bridge and 20-yd sprint ($r = -0.376$) and 40-yd sprint ($r = -0.397$), shuttle run ($r = -0.374$), and power clean/BW ($r = 0.460$). The results of this study suggest that core stability is moderately related to strength and performance. Thus, increases in core strength are not going to contribute significantly to strength and power and should not be the focus of strength and conditioning.

KEY WORDS core strength, agility, weight lifting, sprint

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performance variables in a group of collegiate strength and power athletes.

**Methods**

**Experimental Approach to the Problem**

Previous research failed to identify the effects of increases in core strength with improvements in sport performance (13,14,16). The current study attempted to determine whether core strength is related to more specific measurements of strength and power in strength and power athletes. To do so, a multivariate correlation design was used for this study. The independent variables were measurements of the core musculature: back extension, trunk flexion, right side-bridge and left side-bridge. The dependent variables were one-repetition maximum (1RM) bench press, 1RM squat, 1RM power clean, 20-yrd sprint, 40-yrd sprint, shuttle run, and countermovement vertical jump (CMJ). Each of the 1RM lifts is also used relative to body weight. Height and weight are used for descriptive purposes.

**Subjects**

Twenty-nine National Collegiate Athletic Association Division I male strength and power athletes (height 184.0 ± 7.1 cm, weight 100.5 ± 22.4 kg) were tested. All testing was completed as part of the team’s off-season strength and performance testing. An individual that was injured or missed a day of testing was not included in this study. All participants signed an informed consent. This study was approved by the university institutional review board. Physical characteristics are given in Table 1.

**Procedures**

A Vertec vertical height-measuring device (MF Athletic Corp, Cranston, Rhode Island) was used to measure the CMJ, a Speedtrap II wireless timing system (Brower Timing Systems, Draper, Utah) was used to measure the 40-yrd sprint times, and a handheld stopwatch was used to measure the 20-yrd sprint times, shuttle run times, and core muscle endurance times. All strength tests were completed on Samson strength equipment (Las Cruces, NM). Height was measured on a Seca 214 portable stadiometer (Hanover, Md). Weight was measured on a Transcell TI 500E digital scale (Wheeling, Ill).

Subjects reported for four test sessions during a 5-day period, with a minimum of 24 hours between each session. The first test session included study familiarization followed by data collection for the 20- and 40-yrd sprint tests. Tests in the second session were the CMJ followed by the power clean. Core tests followed by the back squat were completed during the third session, and the last session included pro agility shuttle run followed by bench press test. Before testing on each day, subjects warmed up as a team by completing a series of dynamic exercises.

**Measurements**

**Countermovement Vertical Jump.** Reach height was measured on all participants before vertical jump testing. Subjects stood flat-footed and reached as high as possible with one arm. The highest point reached on the Vertec was considered reach height. Individuals were allowed one arm swing down and up while jumping off both feet and reaching as high as possible with one arm to displace the highest possible vane on the Vertec. Height for CMJ was calculated as the distance from the highest point reached during the reach height and the highest point reached during the jump. Individuals were only allowed one attempt unless the previous attempt was not performed properly. In that case, 3–5 minutes of rest was allowed between attempts.

**Pro Agility Shuttle Run.** The pro agility shuttle run was used to determine agility performance. A distance of 10 yd was measured with a line in the middle at the 5-yrd point. Participants straddled the middle line and ran to their left to the end of the 10-yrd marker, then to their right to the opposite 10-yrd marks, and back to the middle 5-yrd point. Time began with initial movement and ended when the individual crossed the 5-yrd point a second time, covering a total distance of 20 yd. Two timers were used, and the average of the two was recorded to the 0.01 second. Individuals were only allowed one attempt unless the previous attempt was not performed properly. In that case, 3–5 minutes of rest was allowed between attempts.

**20- and 40-Yd Sprints.** Sprints of 20 and 40 yd were used to determine quickness. A distance of 40 yd was measured with a marker at the halfway point (20 yd). Individuals started in a 3-point stance with their fingers on a touch-and-release starter for the electronic timer. As soon as the athlete released pressure from the touch pad, the timer began. At the 20-yrd distance, a stopwatch was used to measure time. The stopwatch was started on movement of the athlete and stopped when he passed the 20-yrd marker. Two timers were used to measure 20-yrd sprint time, with the average of the two recorded to the nearest 0.01 second. A speed trap II electronic timer was used to measure time for the 40-yrd sprint. Individuals were only allowed one attempt unless the previous attempt was not performed properly. In that case, 3–5 minutes of rest was allowed between attempts.

**One-Repetition Maximum Bench Press, Squat, and Power Clean.** Individuals started each lift with 50% of their previous 1RM and increased weight by 10–20 kg until their 1RM was determined. All participants attempted to achieve their 1RM within five sets. All lifts were observed by the head strength

<table>
<thead>
<tr>
<th>TABLE 1. Physical characteristics (mean ± SD).</th>
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<tbody>
<tr>
<td>Height (cm)</td>
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<tr>
<td>Weight (kg)</td>
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</table>
Core Stability in DI Football Players

couch to determine whether it was an acceptable lift (i.e., proper depth, technique, etc.).

Core Testing

The protocol established by McGill (7) was used to determine muscle endurance of the torso stabilizer muscles. The protocol consists of four tests that measure all aspects of the torso via isometric muscle endurance: trunk flexor test, trunk extensor test, and left and right lateral musculature test. A handheld stopwatch was used to measure the length of time participants were able to hold each isometric position. Individuals were given a minimum of 5 minutes of rest between each test.

Trunk Flexor Test. The flexor endurance test begins with the person in a sit-up position with the back resting against a jig angled at 60° from the floor. Both knees and hips are flexed 90°; the arms are folded across the chest with the hands placed on the opposite shoulder, and the feet are secured. To begin, the jig is pulled back 10 cm, and the person holds the isometric posture as long as possible. Failure is determined when any part of the person’s back touches the jig.

Trunk Extensor Test. The back extensors are tested with the upper body cantilevered out over the end of the test bench and with the pelvis, knees, and hips secured. The upper limbs are held across the chest with the hands resting on the opposite shoulder. Failure occurs when the upper body drops below the horizontal position.

Lateral Musculature Test. The lateral musculature is tested with the person lying in the full side-bridge position (left and right side individually). Legs are extended, and the top foot is placed in front of the lower foot for support. Subjects support themselves on one elbow and on their feet while lifting their hips off the floor to create a straight line from head to toe. The uninvolved arm is held across the chest with the hand placed on the opposite shoulder. Failure occurs when the person loses the straight-back posture and/or the hip returns to the ground.

Statistical Analyses

Descriptive statistics were performed on all data. Relationships between test variables were determined using multiple bivariate correlations, represented by the Pearson correlation coefficient. Statistical significance was set at $p \leq 0.05$. SPSS 13.0 software (SPSS Inc., Chicago, Ill) was used for all analyses.

RESULTS

A number of significant correlations were identified between core strength/stability and the strength and performance measures. However, these significant correlations ranged between weak and moderate, and they are not consistent. Core and performance variables are listed in Table 2. Core strength correlations and core strength and performance correlations are given in Tables 3 and 4, respectively.

### Table 2. Core and performance variables (mean ± SD).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
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<tbody>
<tr>
<td>Trunk flexion (s)</td>
<td>113.8 ± 51.9</td>
</tr>
<tr>
<td>Back extension (s)</td>
<td>99.6 ± 22.3</td>
</tr>
<tr>
<td>Right flexion (s)</td>
<td>100.8 ± 24.4</td>
</tr>
<tr>
<td>Left flexion (s)</td>
<td>95.9 ± 31.9</td>
</tr>
<tr>
<td>20-m sprint (s)</td>
<td>2.8 ± 0.3</td>
</tr>
<tr>
<td>40-m sprint (s)</td>
<td>4.9 ± 0.5</td>
</tr>
<tr>
<td>Pro-agility (s)</td>
<td>4.5 ± 0.3</td>
</tr>
<tr>
<td>Vertical jump (in)</td>
<td>28.8 ± 4.5</td>
</tr>
<tr>
<td>Clean (kg)</td>
<td>120.9 ± 13.3</td>
</tr>
<tr>
<td>Clean/BW (kg)</td>
<td>1.3 ± 0.25</td>
</tr>
<tr>
<td>Squat (kg)</td>
<td>192.1 ± 28.7</td>
</tr>
<tr>
<td>Squat/BW (kg)</td>
<td>2.0 ± 0.37</td>
</tr>
<tr>
<td>Bench press (kg)</td>
<td>128.5 ± 18.9</td>
</tr>
<tr>
<td>Bench press per kilogram (kg)</td>
<td>1.3 ± 0.28</td>
</tr>
<tr>
<td>Total lift (kg)</td>
<td>444.7 ± 52.7</td>
</tr>
<tr>
<td>Total lift per kilogram (kg)</td>
<td>4.6 ± 0.84</td>
</tr>
</tbody>
</table>

**BW** = body weight.

DISCUSSION

An underlying belief exists to suggest that optimal core stability is imperative for peak strength and performance in sport. However, relationships between these variables have not been established through research. This study examined whether core stability is related to strength and performance in athletes who train specifically for strength and power. Overall, our results found significant but not strong relationships between core strength and strength and power performance variables. There are two possible reasons for these results: 1) the tests used to measure core strength are not specific to strength and power, and 2) core strength only plays a minor role in strength and power performance.

Our study incorporated McGill’s core stability tests. These tests were designed to measure muscle endurance of the core musculature. Muscles that can sustain prolonged contractions (i.e., muscle endurance) are less likely to fatigue and can thus

### Table 3. Core strength correlations.

<table>
<thead>
<tr>
<th></th>
<th>Trunk flexion</th>
<th>Back extension</th>
<th>Right flexion</th>
<th>Left flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk flexion</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back extension</td>
<td>0.080 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right flexion</td>
<td>0.357 0.201 1</td>
<td>0.617**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left flexion</td>
<td>0.468* 0.033</td>
<td>0.617**</td>
<td></td>
<td></td>
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</tbody>
</table>

*$p \leq 0.05$.

**$p \leq 0.01$.**
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core may be incorporated when sport-specific improvements (i.e., throwing velocity, club or bat velocity, tennis serve velocity, etc.) in sport performance are found. A good example of this is the study by Thompson et al. (15) who tested older golfers after they had completed 8 weeks of functional training. The effectiveness of the training was gauged by changes in club head speed. The testing of the effectiveness of the functional training program was specific to the sport and was much more meaningful to the participants.

PRACTICAL APPLICATIONS

It is the authors’ opinion that core training is necessary for optimal sport performance and should not be dismissed. Determination of the role of core strength/stability requires additional research and sport-specific means of determining its effectiveness. One general test may be sufficient to determine an individual’s base core stability/strength values, but a true understanding of core training’s role regarding whole-body movements for sport performance requires sport-specific testing.

REFERENCES