RELATIONSHIP BETWEEN CORE POWER AND MEASURES OF SPORT PERFORMANCE

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Abstract:

Development of core muscle strength and power to improve sport performance has been a controversial issue yielding mixed results. The purpose of this study was to investigate the relationship between two core field tests emphasizing power and measures of sport performance. Participants were twenty healthy, recreationally active males (age 23.40±1.88 yrs, height 174.63±5.81 cm, mass 76.08±7.67 kg). Participants were tested on four performance variables (40-yd sprint, shuttle run [5-10-5], vertical jump, and 1RM back squat) and two core field tests (front abdominal power throw [FAPT] and side abdominal power throw [SAPT]). Results demonstrated significant moderate correlations between the FAPT and 1RM back squat (r=.652) and relative back squat (r=.509). No other significant correlations were found. Results indicate that although the FAPT and SAPT tests are easy to perform in the field, most, but not all, performance measures were unrelated to core power. In order to properly assess the core and its role in human performance, it is necessary to evaluate sport-specific muscle actions and movements.

Key words: *field tests, abdominal power, power throw*

Introduction

Development of core stability to improve sport performance has been a controversial issue. Core refers to the muscles surrounding the hips, pelvis, and lower back. Therefore, core stability functionally maintains a pelvic neutral position while protecting the lumbar spine (Stanton, Reaburn, & Humphries, 2004). This may be important from the aspect of preventing injury, but research has found mixed results regarding the relationships between core stability (Abt, et al., 2007; Nesser, Huxel, Tincher, & Okada, 2008; Nesser & Lee, 2009) and core exercise programs (Meyer, Ford, Brent, & Hewitt, 2006; Scibek, 1999; Stanton, et al., 2004; Thompson, Cobb, & Blackwell, 2007; Tse, McManus, & Masters, 2005). The core musculature is believed to play an integral role in the process of transferring energy from the trunk to the extremities (Abt, et al., 2007; Scibek, 1999; Tse, et al., 2005). Weak core musculature paired with strong extremity musculature could lead to fatigue and insufficient force generation that may be detrimental to many aspects of sport performance or exercise (Nesser, et al., 2008; Nesser & Lee, 2009; Tse, et al., 2005).

To evaluate the role of the core musculature in sport performance, studies have examined correlations between various measures of the core and performance by athletes in cycling, American football, and soccer (Abt, et al., 2007; Nesser, et al., 2008; Nesser & Lee, 2009). Additional studies have looked at running economy/performance (Stanton, et al., 2004), club head speed in golfers (Thompson, et al., 2007), swimming (Scibek, 1999), rowing (Tse, et al. 2005), and balance (Meyer, et al., 2006). However, current research lacks significant and consistent results and has focused primarily on the stabilization and endurance aspects of the core musculature when looking to determine its effects on sport performance (Abt, et al., 2007; Meyer, et al., 2006; Nesser, et al., 2008; Nesser & Lee, 2009; Sato & Mokha, 2009; Scibek, 1999; Stanton, et al., 2004; Tse, et al., 2005). Measures used to evaluate the core musculature might not assess its role in the transfer of energy during sport performance (Cowley, Fitzgerald, Sottung, & Swensen, 2009; Cowley & Swensen, 2008; Nesser, et al., 2008; Nesser & Lee, 2009; Tse, et al., 2005) due to a lack of test specificity.

At this time, there is limited research on the relationship between core power and sport performance (Myer, et al., 2006; McGill, Karpowicz, & Fenwicket.al. 2009) utilizing tests that are specifically targeted at the core. In addition, the core musculature may not play as large a role in sport performance as is popularly thought. Therefore, the purpose of this study was to investigate the relationship between two dynamic core power tests and measures of sport performance.

Methods

Participants

Participants in this study were twenty recreationally active males (23.40±1.88 yrs, 76.08±7.67 kg, 1.75±0.06m) all of whom volunteered to participate. Prior to the participation, they were asked to sign an informed consent document approved by the University Institutional Review Board. All the participants had a minimum of six-month-experience in resistance training and were required to be free of any orthopedic injuries that could negatively influence their performance or ability to produce maximal efforts.

Instruments and measurements

To investigate the relationship between core power and sport performance, we utilized a within-subjects design consisting of familiarization and two experimental testing sessions (3 visits). The first session consisted of informed consent, familiarization, and the collection of anthropometric measures. The second session consisted of performance testing. The third session consisted of the core power tests in random order.

Participants reported for three total visits, with the two testing sessions being separated by at least 24 hours. Each session lasted approximately 60-75 minutes. Participants were directed to refrain from any upper body, lower body, or core/trunk exercises as well as to maintain a normal diet for the duration of the study.

On the first session, a brief orientation took place in which the participants completed an informed consent as well as an orientation to get accustomed to the study. Measurement scores of height and body mass were also collected for descriptive data.

The second session consisted of (in this order): the 40-yard sprint, shuttle run, vertical jump, and 1RM back squat. Participants underwent a 5-minute warm-up on a stationary cycle at a self-selected speed with ½ kp resistance. Participants wore athletic attire and were given a 5-minute rest between attempts for both the 40-yard and shuttle-run tests. All performance tests were separated by 10-minute rests.

The third session consisted of the core power tests. These were performed in randomized order, with a 2-minute rest between the tests.

1 RM back squat

One repetition maximum testing for the back squat followed the procedures used by the NSCA (Baechle & Earle, 2008). Participants began by performing the lift at 50% of their previous 1RM and the weight was increased by 10-20 kg until their 1RM was achieved. All 1RM scores were measured within five sets and assessed by a certified strength and conditioning specialist (CSCS). A successful lift for the back squat required participants to start in the standing position with their feet parallel and shoulder-width apart, then to descend by flexing the knees and hips until the thighs were parallel to the floor and to ascend back to the starting position by extending the knees, hips, and torso without assistance.

Vertical jump

A Vertec device (Sports Imports, Columbus, OH) was used to determine jump height. Each vertical jump was performed with the participant standing flat-footed, using a countermovement with arm swing, followed by explosively jumping off the ground with both feet while reaching as high as possible. Each participant performed a total of three maximum vertical jumps with 30-second rests between them (Meyer, et al., 2006). The greatest vertical jump score of the three attempts was kept (Nesser, et al., 2008; Nesser & Lee, 2009).

40-yard sprint (36.57m)

The 40-yd sprint was conducted using the procedures used by Nesser et al. (2008) and Nesser and Lee (2009). Participants started in a 3-point stance with their fingers on the starting line. An electronic timer (Brower Timing Systems, Draper, Utah) and touch pad were used to collect the sprint times. Time began once the participant's thumb came off the touch pad and ended when the participant crossed the 40-yd mark. Each participant performed three sprints with a 5-minute rest between the trials. The best time was used for analysis.

5-10-5 yard shuttle run (4.57 - 9.14 - 4.57m)

Procedures for performing the shuttle run followed those of Nesser et al. (2008) and Nesser and Lee (2009). A distance of 10 yards was measured and participants started at a line at the 5-yd point between the two marks. Participants straddled the line and started by running to the left towards the first 5-yd marker. Once the 5-yd marker was reached, participants then ran to their right towards the other 5-yd marker, then back to their starting point. Participants were given a total of three attempts with a 5-minute rest between each attempt. Of the three attempts, the best (fastest) time was used for data analysis. Time began with the initial movement of the participant and ended when the 5-yd starting point was crossed. Two handheld timers were used with the average of the two being rounded to the nearest 0.01 second.

Core power testing

Core power was tested and evaluated by the Front Abdominal Power Throw (FAPT) and Side

Abdominal Power Throw (SAPT). Both the FAPT and SAPT tests utilized a 4-lb medicine ball (1.81kg), (Cowley & Swensen, 2008; Cowley, et al.2009). Each participant progressed from a volleyball, to a 2-lb medicine ball (0.9kg), and finally to the 4-lb medicine ball after performing 3 correct throws with both the volleyball and the 2-lb medicine ball. Participants then performed three more trials with the 4-lb medicine ball, repeating the throw if performed incorrectly. Each attempt with the 4-lb medicine ball was separated by a 2-minute rest. The FAPT and SAPT tests were performed in randomized order, with the tests being separated by a 2-minute rest. The maximum distance the medicine ball traveled of the three trials (three correct throws) was used for analysis.

The FAPT test (Figure 1) required participants to lay supine with their knees bent to 90 degrees and feet shoulder-width apart (feet were unsecured). The participants started with the medicine ball in their hands and arms extended over their head, with the ball resting on the ground. While maintaining the arms extended, the medicine ball was then thrown and released once over the knees, by explosively contracting and activating the abdominal and hip musculature. Distance was measured from the tip of the participant's feet to where the ball had landed. The test was discounted if the arms were used in any way to propel the medicine ball.

The SAPT test (Figure 2) required participants to be seated on the ground with their knees bent to 90 degrees and feet shoulder-width apart (feet were unsecured). Next, the participants extended their arms out in front of them, lowered their trunk until their hips were at 45 degrees, then rotated the trunk 90 degrees to the right and held the medicine ball against a wall as the start position. While grasping the medicine ball participants were required to have their hands supinated with the 5th digit of each hand touching. Next, an explosive trunk rotation to the left was performed, with the participants maintaining extended arms and releasing the ball once over the left knee. Distance was measured from the edge of the participants' left foot to where the medicine ball had landed.

Statistical analyses

Pearson's r correlations were calculated between the core tests (FAPT and SAPT) and each of the dependent variables (vertical jump, 1RM back squat, shuttle run, and 40-yard sprint). The Statistical Package for the Social Sciences (SPSS 18.0 for Windows, SPSS, Inc., Chicago, IL) was utilized to conduct all statistical procedures. *A-priori* alpha was set at .05.

Results

Descriptive values for all tests are shown in Table 1. Correlations between the core power tests and the performance tests are shown in Table 2. There was a moderate positive significant ($p<.05$) correlation between the FAPT and 1RM back squat and a moderate positive significant ($p<.05$) correlation between the FAPT and relative back squat. No other correlations were significant.

a) b) c)

Figure 1. Starting position (a), point of release (b), and end position (c) for the front abdominal power throw (FAPT).

a) b)

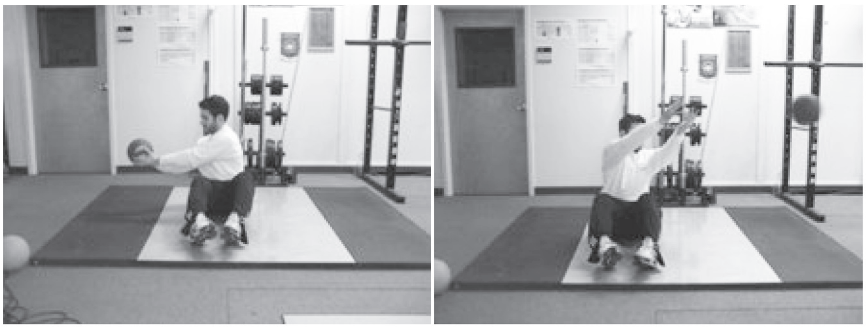

Figure 2. Starting position (a) and ending position (b) for the side abdominal power throw (SAPT).

Table 1. Descriptive statistics for the 40-yd sprint, shuttle run (5-10-5), vertical jump (VJ), back squat (BS), relative back squat (BS/BW), front abdominal power throw (FAPT) and side abdominal power throw (SAPT)

	Mean	SD
40yd (s)	5.43	0.23
5-10-5 (s)	5.04	0.30
VJ (cm)	66.14	7.09
BS 1RM (kg)	127.46	24.51
BS/BW (kg/kg)	1.68	0.31
FAPT (m)	1.88	0.64
SAPT (m)	4.58	1.02

*Table 2. Pearson's r correlations between front abdominal power throw (FAPT), side abdominal power throw (SAPT) and performance tests (40-yd sprint [40yd], shuttle run [5-10-5], vertical jump [VJ], 1 RM back squat [BS 1RM] and relative back squat [BS/BW]). * significant (p<.05)*

	FAPT	SAPT
40yd	-.350	-.220
5-10-5	-.316	-.307
VJ	.256	.198
BS 1RM	.652*	.322
BS/BW	.509*	.215

Discussion and conclusions

The purpose of this study was to determine the relationship between two dynamic core power tests and measures of sport performance. There were moderate correlations between the 1RM back squat, relative back squat, and the front abdominal power throw. No other significant correlations were found. This could mean that the core, as measured with these specific power tests, lacks specificity or does not significantly contribute to sport performance as measured in this study.

While the majority of the performance variables in this study were found not to be significantly correlated with either the FAPT or SAPT tests, the 1 RM back squat and relative back squat were found to have moderate correlations with the FAPT test. This could be because the FAPT test targets the trunk flexors, including the *m. rectus abdominus* and hip flexors such as the *m. psoas major* and *m. rectus femoris*, which may also be stressed/activated during the back squat. So, in this case, a greater 1RM back squat and FAPT score may be attributable to greater hip flexor strength. This does not mean that these muscles of the trunk were not being used or activated during the other performance tests, but perhaps that the muscle actions or movements used in the FAPT and SAPT tests were not specific to the different roles the core musculature plays in the various performance tests.

Although our study focused on the power component of the core musculature, the results are similar to those of Nesser and Lee (2009), who determined the relationships between core stability and endurance, and various performance variables. They found no significant correlations between the core stability tests and any of the performance variables. These results may be attributed to the specificity of training and testing to determine the role and involvement of the core musculature in sport performance. The findings of our study, demonstrating a lack of significant contribution of the core to sport performance, are also similar to those of Tse et al. (2005) and Scibek (1999). These studies investigated the effectiveness of a core training program on core endurance and various measures of performance. Both studies found no significant between-group or within-group differences from pre- to post-core training for any of the performance variables. This could be because either the core training protocols were not long enough or they did not properly train the core musculature.

Another study by Nesser et al. (2008) found significant, but not strong relationships between core strength and various strength and power performance variables. Similar to the results of our study, Nesser et al. (2008) found a significant, but moderate correlation between the 1RM back squat and the total core stability score. However, results also indicated significant, but weak correlations between the core stability tests and the 20-m sprint, 40-m sprint, pro-agility run, and vertical jump. The results of our study agree with previous work in that these weak correlations may be because the core does not play a major role in sport performance (Nesser, et al., 2008).

To properly measure the core and its role in performance, sport and skill-specific tasks (throwing velocity, club or bat velocity, tennis serve velocity, etc.) may need to be evaluated (Tse, et al., 2005). Although some previous studies have focused on some sport-related tasks, such as the 100-yard swim (Scibek, 1999) and 2000-m rowing (Tse, et al., 2005), significant results were not found, either because the core training protocols were not specific to performance or the performance tests focused more on cardiovascular fitness and muscle endurance. One study that looked at a specific task and how it was affected by an 8-week training program was that of Thompson et al. (2007), who looked at club head speed in golfers. They found that the experimental group had an increase in club head speed of 4.9%, while the control group slightly decreased.

This need to focus on sport specificity when trying to evaluate the core musculature and determine its role in performance was also examined by Kubo, Ohta, Takahashi, Kukidome and Funato (2007). MRIs were taken of wrestlers' trunk musculature, with results indicating that the higher the level of performance, the larger the muscle cross-sectional area (CSA) of the trunk flexor muscles. Although the study by Kubo and colleagues indicates there is a relationship between the CSA of the trunk muscles and performance, it does not state how the core is contributing to performance. The two core field tests utilized in our study (FAPT and SAPT) emphasized the power component of the core. The lack of significant relationships between these tests and the various performance tests we used could mean the core field tests were not movement-specific, or the core plays little role in the performance tests utilized.

It appears the FAPT and SAPT tests are not specific to the performance measures used in our study. For athletic or strength and conditioning coaches, this means that in order to properly evaluate the core musculature or its role in performance, sport-specific core tests need to be utilized. Sport specificity as well as the mastery of the skills involved may be more important to teach and learn so the core musculature is activated and utilized in the same way as during competition.

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POVEZANOST IZMEĐU SNAGE TRUPA I POKAZATELJA SPORTSKE USPJEŠNOSTI

Razvijanje mišićne jakosti i snage trupa kako bi se unaprijedila sportska izvedba i uspješnost jest kontroverzan znanstveni i stručni problem istraživanje kojega daje miješane rezultate. Cilj je ovoga istraživanja bilo utvrđivanje povezanosti između dva terenska testa za procjenu snage trupa i pokazatelja sportske uspješnosti. Uzorak ispitanika činilo je 20 zdravih, rekreativno aktivnih muškaraca (dob 23,40±1,88 godina, tjelesna visina 174,63±5,81 cm, tjelesna masa 76,08±7,67 kg). Sportska uspješnost ispitanika procijenjena je četirima testovima (sprint na 40 jarda, *shuttle run*: 5-10-5 jarda, vertikalni skok i maksimalni stražnji čučanj), a snaga njihova trupa (*core*) procijenjena je dvama terenskim testovima (eksplozivno bacanje medicinke prema naprijed – FAPT, i eksplozivno bacanje medicinke strance – SAPT). Rezultati analiza su pokazali značajne umjerene korelacije između FAPT i maksimalnoga stražnjega čučnja (r=,652) i relativnoga stražnjega čučnja (r=,509). Nisu utvrđene značajne korelacije između ostalih testova. Rezultati pokazuju da, iako je terenske testove FAPT i SAPT vrlo lako provoditi, većina, ali ne i sve varijable koje procjenjuju sportsku uspješnost nisu u korelaciji sa snagom trupa procijenjenom navedenim testovima. Da bi se adekvatno procijenila snaga trupa i njena uloga u sportskoj izvedbi i uspješnosti, potrebno je vrednovati sportu svojstvene mišićne akcije i kretnje.

Ključne riječi: *terenski test, snaga trbušnih mišića, bacanje medicinke*

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