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EXERCISE PHYSIOLOGY

Effect of core strength and endurance training on performance in college students: Randomized pilot study

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Summary Core training continues to be emphasized with the proposed intent of improving athletic performance. The purpose of this investigation was to discover if core isometric endurance exercises were superior to core isotonic strengthening exercises and if either influenced specific endurance, strength, and performance measures. Ten untrained students were randomly assigned to core isometric endurance ($n = 5$) and core isotonic strength training ($n = 5$). Each performed three exercises, two times per week for six weeks. A repeated measures ANOVA was used to compare the measurements for the dependent variables and significance by bonferroni post-hoc testing. The training protocols were compared using a 2×3 mixed model ANOVA. Improvement in trunk flexor and extensor endurance ($p < 0.05$) along with squat and bench press strength ($p < 0.05$) occurred with the strength group. Improvement in trunk flexor and right lateral endurance ($p < 0.05$) along with strength in the squat ($p < 0.05$) were found with the endurance group. Neither training protocol claimed superiority and both were ineffective in improving performance.
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Introduction

Training the muscles that constitute the anatomical core has been suggested in the prevention (Akuthota et al., 2008; McGill, 2010) and treatment (Kumar et al., 2009; Hides et al., 2001; McGill, 2007) of low back pain. In conjunction with its use for injuries, a surge of excitement has taken place in the sports environment where training

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Table 1 Demographic information.

Subject	Gender	Age (y)	Height (cm)	Weight (Kg)
Common strength training group				
1	M	20	177.8	70.3
2	F	21	165.1	62.6
3	M	20	175.3	66.2
4	F	19	154.9	44.0
5	F	20	170.2	66.7
Mean		20	168.7	62.0
Specific endurance training group				
1	M	28	180.3	72.1
2	F	19	165.1	71.7
3	F	21	165.1	59.0
4	F	22	162.6	71.7
5	M	20	172.7	62.6
Mean		22	169.2	67.4

has focused on the potential connection between core musculature conditioning and improved athletic performance (McGill, 2010; Hedrick, 2000).

Definitions regarding the anatomical components of the core have suffered in consistency. The core was described as an anatomical box consisting of 29 pairs of muscles forming a front (abdominals), back (paraspinals and gluteals), top (diaphragm), and bottom (pelvic floor and hip girdle) (Richardson et al., 1999).

The purpose of the core musculature has been described as both producing and preventing motion (Behm et al., 2010) or only preventing motion (McGill, 2010; Bergmark, 1989; Fredericson and Moore, 2005). Power is never generated by the core but rather in the hips and then transmitted through a stable or stiffened core (McGill, 2010). Optimal core stability is the ability to control the trunk to allow the greatest transfer of torque to the terminal segments (Kibler et al., 2006). Consequently, the ability to stabilize the anatomical core or preventing motion could have a significant influence on athletic performance by not bending and loosing propulsion, thus encouraging the transfer of torque to the extremities.

It has been argued that core stability is best accomplished through a "stiffening" of the core (McGill, 2010). To accomplish this goal, muscle endurance and neuromuscular control training is required (McGill, 2010). There is evidence to support the positive influence incorporating core exercises has on performance measures (Sato and Mokha, 2009; Cosio-Lima et al., 2003). There is also evidence reported to the contrary (Stanton et al., 2004; Tse et al., 2005; Parkhouse and Ball, 2011). The populations used in these studies were athletes of various sports and untrained females. No studies have incorporated McGill's bracing technique and "big 3" exercise protocol (McGill, 2007) for core stability training and its influence on performance measures. Therefore, one purpose of this investigation was to discover if core stability exercises (endurance or strength) influence specific endurance, strength, and performance measures with an untrained population. Another purpose was to find if a specific core muscle isometric endurance protocol would be superior to a traditional core muscle isotonic strength protocol (Konrad et al., 2001) regarding specific endurance, strength, and performance measures with an untrained population.

Methods

Participants

Ten untrained college students participated in this study. Their physical characteristics were obtained using standard procedures (Table 1). Exclusion criteria consisted of any low back injury or pathology diagnosed within the previous six months and resistance training or any type of core muscle training within the last six months. Participants were randomly assigned to either the core muscle isotonic strengthening exercise group or the core muscle isometric endurance exercise group. The content of the consent form was explained to the volunteers prior to them reading and signing it before participating. The proposed study was approved by the Institutional Review Board.

Experimental approach

This study consisted of two randomly assigned groups performing three exercises, two times per week for six weeks. One group used a training protocol consisting of multiple set isotonic exercises that were performed in the 10—15

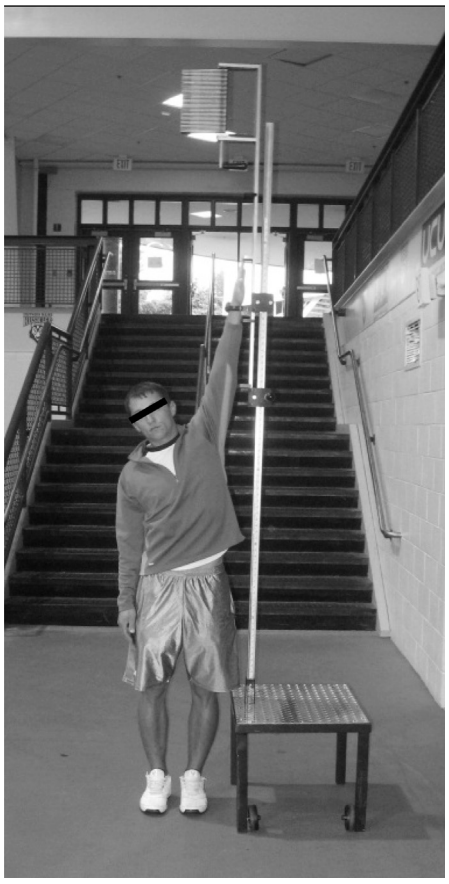

Figure 1 Zeroing vertical jump station.