Test-Retest Reliability and Validity of the Plank Exercise

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Abstract

PURPOSE: The plank exercise is a popular and widely used exercise to increase core strength. We previously established normative values for the plank exercise that may be used for fitness classification to identify gaps in core muscular strength and endurance. Whether the plank exercise can be confidently added to current fitness appraisal protocols will depend on its reliability and validity in the fitness testing environment. This study sought to examine test-retest reliability of the plank exercise and to compare plank performance with established normative values for the curl up test. The role of verbal encouragement cues during plank performance testing was also assessed. **METHODS:** Collegiate male (n=14) and female participants (n=19) performed the plank exercise in two separate sessions separated by a minimum of 72 hr. Participants maintained the plank position until complete fatigue was reached. Verbal cues were given to half of the participants in one of the two sessions. Performance on the curl up exercise was measured in a third, separate session. **RESULTS:** Intraclass correlation showed that mean time held in the plank position was not significantly different between the two plank testing sessions (108.15 $\pm$ 49.38 versus 111.39 $\pm$ 56.87 seconds, R = 0.996). Verbal encouragement cues did not improve performance time (between group effect, p = 0.940). The curl up test was not significantly correlated with either plank session (r = 0.410 and 0.276 for plank session one and two, respectively). Surprisingly, the curl up test was positively correlated with participant height (r = 0.578). **CONCLUSION:** This study suggests that the plank exercise is a reliable test; plank performance was comparable across testing sessions and not influenced by verbal encouragement. Further testing is needed to confirm validity of the plank exercise as a measure of core muscular endurance. We show here that plank performance was not correlated with the standard curl up test. However, the curl up test may not adequately measure core strength, given that increased body height was associated with higher curl up completion scores.

Introduction

The core musculature enables a wide variety of motions within human movement. It can be described as the lumbopelvic-hip complex that includes all of the lateral, medial, anterior and posterior muscles of that area (Oliver, Stone & Plummer, 2010). Others have defined the core as all muscles between the sternum and knees, specifically muscles of the abdomen, hips, thigh and lower back region. Core muscular strength is essential for adequate force generation in most athletic movements. Specifically, core activation allows for stabilization, optimum control, production and transfer of force to distal limbs in athletic movements (Kibler, Press & Sciascia, 2006). In addition, core strength ensures adequate body balance and alignment (Zattara & Bouisset, 1988).

In recent years, the plank exercise has become a popular and widely used exercise to increase core strength. We, and others (Strand, Hjelm, Shoepe & Fajardo, 2014) have sought to establish normative values for the plank exercise. Such values allow for fitness category classification, which could subsequently be used to identify gaps in core muscular strength and endurance. Whether the plank exercise can be confidently added to current fitness appraisal protocols as a means to assess muscular strength and endurance will depend on its reliability and validity in the fitness-testing environment. This study examined test-retest reliability of the plank exercise and compared performance of the plank with established normative values for the Canadian curl-up test. Also, the role of encouragement during plank performance was assessed. Currently, protocols vary in the verbal cues given by trainers during the plank exercise. If encouragement is consistently shown to improve plank performance, this component will need to be considered when establishing the specific protocol for administering the plank exercise during fitness testing.

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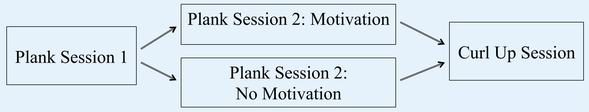
Methods

Participants. Thirty-three male (n=14) and female (n=19) undergraduate students at Linfield College participated in this study. Participants were recruited from the general student population using email and word of mouth. All procedures were reviewed and approved by the Linfield College Institutional Review Board.

Experimental Design. Participants were asked to participate in 3 testing sessions.



Session One: Height and weight were measured using a standard scale, followed by a 5 min warm up on a treadmill (3.5 mph). Participants had the proper plank position demonstrated by a technician. For the plank position, feet were placed hip width apart, with the ankles at 90°, knees straight, and pelvis tilted into a neutral position to engage the core. The elbows were bent to 90° and placed directly below the shoulders with the back flat. The forearms could be angled in, but the hands could not be clasped together. A white board was placed behind the participant's body with markings that indicate the range in which their posterior and anterior hip must stay between. If they were not able to maintain the hip within the area, a verbal cue was given to correct the form. If participants were unable to correct form, time was stopped. A technician recorded the time that proper plank form was maintained.
Session Two: $\geq$ 72 hours later, participants returned to the lab and were randomized to either a control group or motivation group. Participants in the motivation group received scripted verbal motivational/encouraging cues at 20-second intervals during plank performance. The control group performed the plank without verbal cues. As before, the plank exercise was performed and the amount of time in proper plank form was recorded.
Session Three: $\geq$ 72 hours later, participants returned to the lab and were instructed on the curl-up test. Following a 5 min warm up, participants were asked to perform consecutive curl-ups with correct technique. Verbal instruction was given to correct improper form. If participants were unable to correct form, the test was stopped and the number of correct curl-ups was recorded.

Results

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Standard Deviation
Height (cm)	33	142.8	197.4	171.9	13.3
Weight (lbs)	33	96.1	229	161.6	30.3
Age (years)	33	18	22	20.5	1.3
Curl-up (#)	33	0	250	34.4	46.2

The results indicated strong test-retest reliability for the plank exercise (R = 0.966). The means for sessions one and two of the plank were 108.2 seconds and 110.6 seconds, respectively. In regards to validity, there was no correlation between the plank sessions and the curl-up exercise (r = 0.102 and r = 0.284). The number of curl-ups performed was positively correlated to the height of the participant (r = 0.589, p = 0.013). Participants that were in the motivation group did not show improved times in the plank exercise compared to those not given motivational cues (p = 0.94).

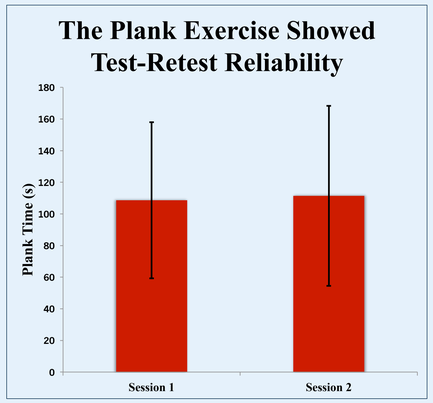


Figure 1: Plank Reliability, R = 0.966

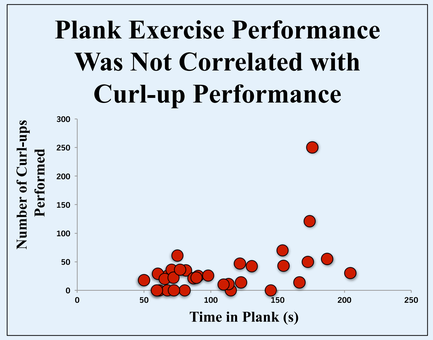


Figure 2: Validity Comparison between Plank Session 1 and Curl-up, r = 0.102

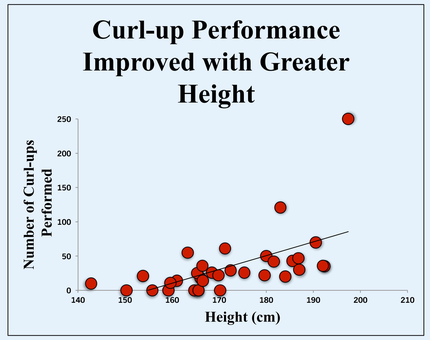


Figure 3: Correlation Between Height and Curl-up, r = 0.589

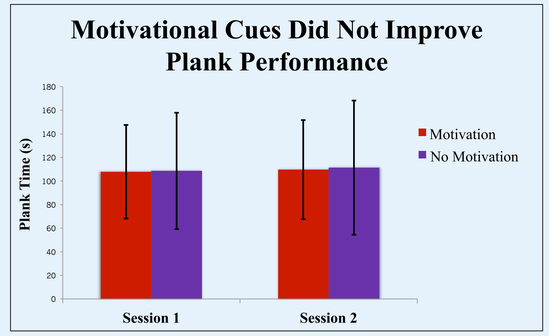


Figure 4: Plank Exercise Performance With or Without Motivational Cues (n = 16-17 per group)

Discussion

Our results showed that there was strong test-retest reliability of the plank exercise. This provides confidence that the plank exercise can be used as a fitness test to measure core muscular strength. The mean performance scores for both the curl-up and plank ranked in the category of "good" according to established normative values, which indicates some validity between the two exercise tests. However, we found no correlation between the first plank session and the curl up (p = 0.102). Thus, it is uncertain whether the plank exercise shows consistent validity as a measure of core strength. However, this may be confounded in part by our finding that participant height was positively correlated with performance in the curl-up test (p = 0.013). Taller individuals had higher performance scores than shorter individuals. This suggests that other measures of core strength need to be examined in relation to the plank exercise to determine the validity of this test.

In addition, we found that motivational cues during the plank exercise did not improve performance. The plank times were similar between groups. This may be explained by the contextual specificity of motivation. For example, the athletes in the motivation group may have been more motivated by a coach rather than a student research technician. In addition, a participant may not have responded to the motivational cues because of feelings of embarrassment given that their peers were observing and evaluating their performance. Thus, the utilization of a coach may be more effective than peer motivation. Future research is needed to explore the effect of motivation on performance because it is important for strength assessment tests to utilize methods that facilitate optimal performance.

It should be noted that most participants were either Division III NCAA athletes or exercised regularly. Further research should be done to test plank performance in a less fit population. A larger and more diverse participant pool in terms of the general fitness level would be beneficial to further support the reliability of this study. Furthermore, other core strength evaluation tools should be examined alongside the plank. For example, the bench trunk curl test or other forms of the curl-up test could be used to fully examine the validity of the plank exercise. Overall, the results of the study suggest that the plank is a reliable core strength evaluative test.

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