OPTIMAL CORE TRAINING FOR FUNCTIONAL GAINS AND PEAK PERFORMANCE: CXWORX

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Abstract

The American College of Sports Medicine and the United States Department of Health and Human Services recommend that healthy adults, under 65 years of age, complete a strength training routine that includes core exercises twice a week. They specifically advocate core training as a means to improve stability, reduce injury, and maintain mobility. There are countless exercises that target the primary core trunk muscles (abdominal and lumbar) with the aim of providing these benefits. However, it is unknown which exercises elicit the greatest activation thereby maximizing functional gains as well as peak performance.

PURPOSE: To determine whether integrated core exercises that require activation of the distal trunk muscles (deltoid and gluteal) elicit greater activation of primary trunk muscles in comparison to isolated core exercises that only require activation of the primary trunk muscles. RATIONALE: We wanted to develop a core program that would optimize functional gains as well as peak performance. METHODS: Twenty participants, 10 men and 10 women, completed 16 randomly assigned exercises (for example, crunch, upper body extension, standing balance, and hover variations). Each exercise was performed for 10 repetitions at a cadence of 15 repetitions per minute with the exception of the hover and balance tasks, which were performed statically for 20 seconds. Therefore, all the exercises were analyzed during a 20 second period of activation. We measured muscle activity with surface electromyography of the anterior deltoid, rectus abdominus, external abdominal oblique, lumbar erector spinae, thoracic erector spinae, and gluteus maximus.

In order to determine if the muscle activation differed between exercises, we normalized the active muscle periods, performed a repeated-measures ANOVA and defined the statistical significance at p < 0.05. RESULTS: Activation of the abdominal and lumbar muscles was greatest during the exercises that required activation of deltoid and gluteal muscles. For instance, the hover activity was 20% greater for the rectus abdominus, external abdominal oblique, and lumbar erector spinae compared to a traditional crunch and upper body extension exercise (p = 0.02). CONCLUSION: When completing the core strength guidelines, a routine that incorporates the activation of distal trunk musculature would be optimal in terms of maximizing strength, improving endurance, enhancing stability, reducing injury, and maintaining mobility. CXWORX™ by Les Mills provides this unique combination of core exercises for functional gains as well as peak performance.
Introduction

The American College of Sports Medicine\(^1\) and the United States Department of Health and Human Services\(^2\) recommend that healthy adults, under 65 years of age, complete a strength training routine that includes core exercises twice a week. In order to meet these guidelines, numerous exercise products, including the Les Mills™ programs, include a core-strengthening component within their conditioning plans. Core exercises are also commonly implemented within both sport and rehabilitation objectives in order to maximize strength, improve endurance, enhance stability, reduce injury, and maintain mobility. Therefore, multiple past studies have focused on how to optimize trunk muscle activation\(^3\).

Despite the extensive previous research, it is unknown if isolation or integration exercises elicit the greatest activation thereby optimizing functional and performance gains\(^4\). We define integration core exercises as movements that require activation of the proximal limb muscles (deltoid and gluteal) as well as activation of the primary trunk muscles (abdominal and lumbar) in comparison to isolation core exercises that only require activation of the primary trunk muscles. Thus, our purpose was to evaluate the muscle activity of distal and proximal muscles during a series of both isolation and integration exercises.

Methods

Twenty, healthy college students, 10 men and 10 women, completed the protocol. All the participants gave written informed consent that followed the guidelines of The Pennsylvania State University Human Research Committee.

We instrumented each participant with 8 pairs of surface electromyography (EMG) electrodes on the trunk (Figure 1). We are reporting 6 pairs in the current report for simplicity. Prior to electrode placement, we prepared the skin and performed a series of measurements to locate the muscle centers of the anterior deltoïd (AD), rectus abdominus (RA), external abdominal oblique (EO), lumbar erector spinae (LE), thoracic erector spinae (TE), and gluteus maximus (GM) according to the recommendations of Cram and Kasman\(^5\).
Each participant completed a standing trial, a walking trial, and the sequence of core exercises. A complete data set was comprised of the successful completion of 16 randomly assigned isolation and integration exercises. We are reporting 7 exercises in the current report for simplicity.

Each participant performed each exercise dynamically at a cadence of 15 flexion and extension cycles per minute with the exception of the hover and balance tasks, which were performed statically. In total for each exercise, we analyzed 20 seconds of activity data.

In order to compare exercises between participants, we normalized the activity of each muscle during a core exercise to the activity during level walking at a self-selected speed. Finally, we completed a repeated-measures ANOVA and post-hoc tests to investigate the differences between exercises and muscles. Significance was defined as \( p < 0.05 \).
Results

Overall, our results demonstrated a novel finding that the activation of the abdominal and lumbar muscles was greatest during the integrated exercises that required activation of deltoid and gluteal muscles. One straightforward example of this is the comparison between a traditional isolation exercise of a crunch and an integrated exercise of the hover with hand reach.

**ISOLATION: crunch**

**INTEGRATION: hover with hand reach**

During the isolation and integration exercises, the rectus abdominus is the primary active muscle. However, during the integrated hover exercise the abdominal activity was 20% greater. To add, anterior deltoid, erector spinae, and gluteus maximus activities were 2 times greater. Therefore while both the exercises are appropriate for strengthening the central core, there are potential benefits to training the agonist and antagonist muscles concurrently.
Moreover, we incorporated a balance component to the integration exercises. The participants completed a plank with alternating hip and knee flexion to the contralateral elbow. This addition of a higher center of mass as well as the tripod stance resulted in a significantly greater activity for all of the muscles. In detail, rectus abdominus and anterior deltoid activity were over 10% greater than the forearm hover while the external oblique, erector spinae, and gluteus maximus activity were over 20% greater. This example illustrates the beneficial consequences of adding various levels of difficulty to continually provide unique challenges for each individual. This is also an illustration about how core exercises can be completed with numerous options to provide an optimal core training session for all ability levels.
For the oblique crunch and side hover exercises, the rectus abdominus and external obliques were the primary active muscles. Although, the average normalized value of the rectus abdominus was less than the forearm hover exercises from above, the external oblique activity was 25% greater. When comparing the isolation and integration exercises, the largest difference in muscle activity was for the lumbar erector spinae, which was almost 5 times greater during the side hover. This extreme difference is an illustration of how the integration exercises may be a superior choice for a training regimen as they target a wider range of muscles for a more comprehensive strengthening effect.
For the upper body extension exercises, we compared an isolated double arm extension and an integrated horse stance pointer with Les Mills™ tubes. The primary muscles for both exercises were the erector spinae and the overall average of this group was 38% greater during the integrated task. Due to the contralateral limb movements of the integrated exercise, the external abdominal obliques were three times greater than the isolated exercise. This result provides additional evidence that complex movements stimulate the targeted muscles groups as well as other primary groups.

Discussion

Integrated exercises that require activation of the distal trunk musculature would potentially be optimal in terms of maximizing strength, improving endurance, enhancing stability, reducing injury, and maintaining mobility when completing the core strengthening guidelines. During the current project, these integration exercises elicited the overall greatest muscles activity while challenging coordination and balance.

During hover and horse stance exercises, the muscles of the shoulder and hip provided body weight support as well as position steadiness. To add, abdominal and lumbar muscle activity was greatest.
when balance was challenged, by adding complex movements to these traditional core exercises. For example, rectus abdominus and lumbar erector spinae activity increased from a forearm hover position with both hips extended, to a cross over mountain climber with alternating hip and knee flexion to the opposite limb. Also, both thoracic and lumbar activities were greatest during the horse stance pointer compared to a double arm extension.

In summary, a comprehensive, core-strengthening program would incorporate a unique combination of both isolation and integration exercises. Isolation exercises are simple, single joint movements, which target primary trunk muscles and are easy to complete. Integration exercises are complex, multi-joint movements that elicit greater proximal trunk muscles activity as well as distal trunk muscles activity. Due to the nature of the exercises, integration exercises illicit activity from a broader range of muscle groups while challenging the sensory systems simultaneously. Thus, when completing the core strength guidelines, a routine that incorporates the activation of distal trunk musculature would be optimal in terms of maximizing strength, improving endurance, enhancing stability, reducing injury, and maintaining mobility. CXWORX™ by Les Mills provides this unique combination of core exercises for functional gains as well as peak performance.

References


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