Isokinetic Strength of the Trunk and Hip in Female Runners

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Abstract:

A plethora of research has examined bilateral and reciprocal concentric strength relationships of the thigh musculature in a variety of athletic populations. However, little research has reported strength values of the trunk and hip musculature. Thus, the purpose of this investigation was to examine concentric and eccentric strength of the trunk and hip flexor and extensor muscle groups in female runners. Twenty-one habitual female runners were assessed for trunk and hip strength via isokinetic dynamometry (KinCom, Chattecx Corp.). Strength was reported in newtons (N) and calculated as the average force over the range of motion in which the joint was tested. Eccentric strength at the trunk was greater than concentric strength. Similar results were found at the hip. Reciprocal muscle group ratios revealed that concentric trunk flexion was 52% of extension. Eccentric trunk flexion was 39% of extension. Concentric hip flexion was 98% of extension. Eccentric hip flexion was 103% of extension. The ratios were not significantly different. These findings establish previously unreported isokinetic strength values for the trunk and hip in female runners.

Article:

A plethora of research has examined bilateral and reciprocal concentric strength relationships of the thigh musculature in a variety of athletic populations. However, minimal research has reported isokinetic strength of the trunk and hip in any athletic population. Several studies have examined concentric trunk extensor and flexor strength via isokinetic dynamometry in sedentary males and females.[2-4,7,12] However, no data have been reported on hip strength or eccentric trunk strength. Langrana *et al*.[4] established male and female concentric strength values, and compared isometric versus isokinetic strength values of the trunk musculature. Hasue *et al*.[2] examined trunk flexor and extensor strength in sedentary males and females and in patients with low back pain. Langrana and Lee[3] examined trunk musculature testing protocols and concluded that a sitting position was the most effective method of isolating the trunk flexors and extensors and stabilizing the hip flexors and extensors.

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The purpose of this study was to examine the maximal concentric and eccentric force produced by the trunk and hip musculature in runners. In addition, reciprocal muscle group relationships were established from strength values obtained during both concentric and eccentric contractions.

METHODS

Subjects

Twenty-one habitual female runners (age 29.9 ± 6.3 yr, height 163.9 ± 5.3 cm, and wt 57.62 ± 1.32 kg) participated in the study after giving their informed consent in accordance with procedures established by a University Human Investigation Committee. All runners were nonsmokers and had normal menstrual status. For inclusion in the study, subjects necessarily ran at least 20 miles per week and had been running for at least 6 months.

Strength Assessment

Subjects were assessed for maximal isokinetic strength at the trunk and hip joints. An isokinetic strength dynamometer (KinCom, Chattecx Inc., Chattanooga, TN) was used to assess concentric and eccentric force during both flexion and extension.

All subjects performed a warmup prior to the test, which consisted of three to five submaximal concentric and eccentric contractions. Subjects then performed several maximal contractions, from which three reproducible concentric and eccentric force curves were selected and subsequently used for data analysis. A preload of 50 newtons (N) was established for all test conditions. The hip strength values were gravity corrected, while the trunk values were not corrected. Strength scores were reported as the average force (newtons) generated throughout the range of motion.

Trunk flexion and extension strength were assessed at a constant velocity of 15 deg/sec, through 35 deg total range of motion (-20 to +15 deg). Each subject was tested in an upright, seated position with the axis of the dynamometer aligned with the L4-L5 inter- space.

Hip flexion and extension strength were assessed at a velocity of 20 deg/sec. Hip flexion was assessed through 60 deg total range of motion (in a range of motion of -100 to -20 deg as defined via KinCom protocol). Hip extension was assessed through 30 deg total range of motion (in a range of motion of - 100 to -60 deg as per KinCom protocol). Subject comfort level and limitation determined the range in which each subject was tested within the previously defined range of motion. Each subject was tested from a standing position, and the axis of the dynamometer was aligned with the greater trochanter of the femur.

Statistical Analysis

Descriptive data were generated for all variables. Independent two-tailed t tests were used to determine if there were significant differences between concentric and eccentric strength values for all muscle groups assessed.

Table 1 Data summary (mean ± SD).

	Trunk	Hip

Extension				
Concentric	391.4	±	297.8	±
Eccentric	553.0	± 107.7	337.7	±
Flexion				
Concentric	196.7	±	273.0	±
Eccentric	212.2	±	325.7	±

Values reported as average force in newtons.

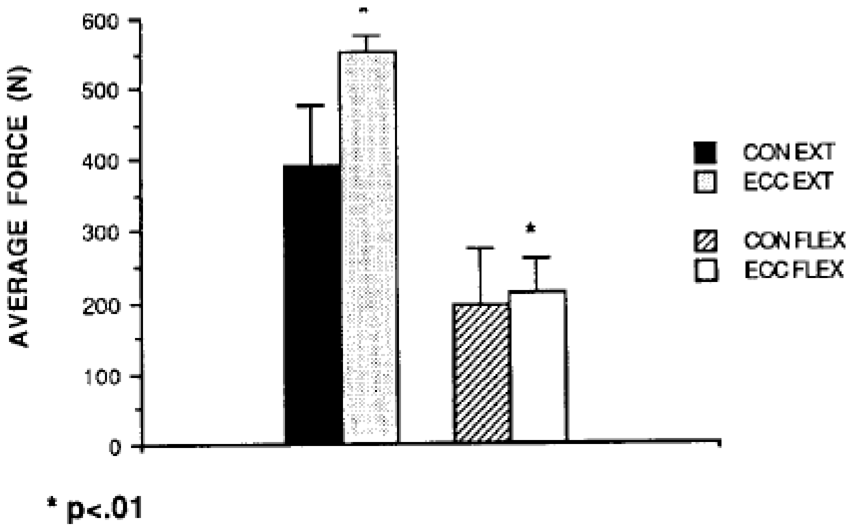

Figure 1: Trunk extension (EXT) and flexion (FLEX) concentric (CON) and eccentric (ECC) average force. Asterisks indicate eccentric force significantly greater than concentric force.

Ratios for the trunk and hip were calculated for the following reciprocal muscle groups: (1) trunk concentric flexion/extension, (2) trunk eccentric flexion/extension, (3) hip concentric flexion/extension, and (4) hip eccentric flexion/extension. Independent two- tailed t tests were computed to determine if the concentric and eccentric trunk reciprocal muscle group ratios, at both the trunk and the hip, were significantly different.

RESULTS

Descriptive data for all strength values may be found in Table 1. The independent t tests revealed that the force generated from eccentric contractions was greater ($p < 0.01$) than that from concentric contractions during flexion and extension at both the trunk and hip (Figures 1 and 2). The reciprocal muscle group ratios for the trunk revealed that during the concentric mode of contraction, flexion strength was 0.52 of extension strength. The ratios determined from the eccentric values revealed that flexion strength was 0.39 of extension strength. The concentric reciprocal muscle group ratios were found to be significantly greater than the eccentric muscle group ratios ($p < 0.01$). In contrast, no significant differences were found between concentric and eccentric ratios at the hip, where concentric hip flexion was 0.98 of concentric hip extension and eccentric hip flexion was 1.03 of eccentric hip extension (Figure 3).

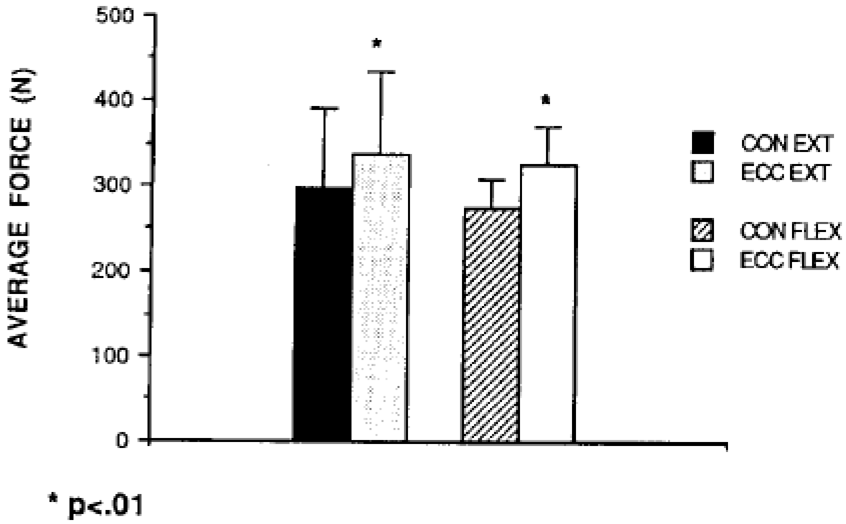

Figure 2: Hip extension (EXT) and flexion (FLEX) concentric (CON) and eccentric (ECC) average force. Asterisks indicate eccentric force significantly greater than concentric force.

DISCUSSION

At present, very few studies have examined strength of the trunk and hip musculature in an athletic population. Several studies have reported concentric trunk strength values in males and females in healthy populations as well as in groups presenting with chronic low back pain.[1-5,7-9,11,12] It is difficult to compare the results of this study to other studies, because those studies reported all strength data in peak torque and utilized a variety of isokinetic devices, test velocities, and patient positioning. However, reciprocal muscle group relationships may lend themselves to comparison with other investigations.

We observed a trunk flexion/extension reciprocal muscle group ratio of 0.52, which is slightly lower than would normally be expected. Several researchers have reported trunk flexion/extension ratios ranging from 0.70 to 0.97 for healthy sedentary females. These investigations utilized a Cybex II trunk stabilization unit at a test velocity of 30 deg/sec.[1,2,4,5,9] The lower value we observed may be due to the slower test velocity, since there is a trend of decreasing reciprocal muscle group ratios as the test velocity is decreased.[1,9,10]

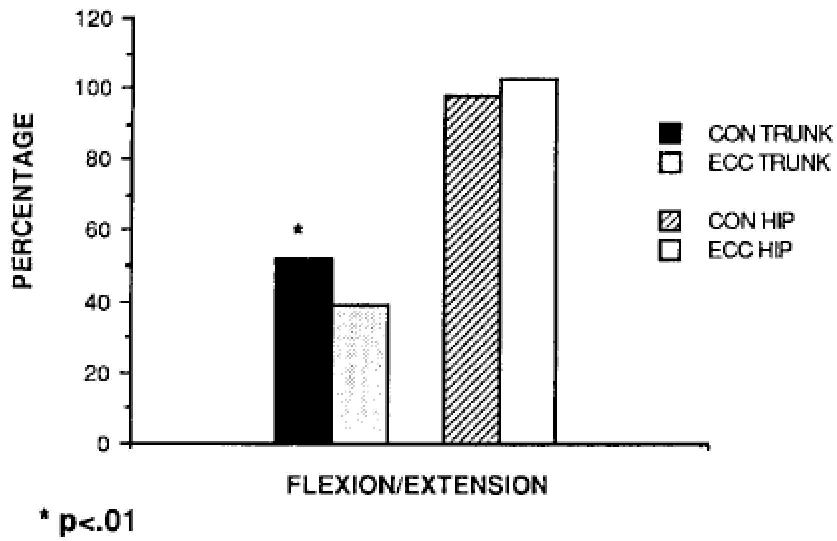

Figure 3: Trunk and hip flexion/extension concentric (CON) and eccentric (ECC) reciprocal muscle group ratios. Asterisks indicate concentric ratio significantly greater than eccentric ratio.

Another explanation for our observed decreased reciprocal muscle group relationship may be that subjects were assessed from a seated position,[3,4,8] whereas several other studies assessed subjects from a standing position.[1,3,5,9,10] Langrana and Lee[3] reported lower reciprocal muscle group ratios in subjects assessed from a seated position rather than from a standing position. Their results indicated a 100% increase in the peak torque values obtained from the trunk flexors, and a much smaller increase in trunk extension peak torque (20%) when the subjects were assessed in a standing position. They concluded that the trunk reciprocal muscle group ratios will decrease when the assessment is performed from the seated position because the iliopsoas is stabilized and thus will not cause an artificially increased trunk flexor strength value.[3]

It is also possible that the activity of running causes increased mechanical spinal loading, which serves to increase trunk extensor strength but not trunk flexor strength. This may result in lower reciprocal muscle group ratios, and ultimately may create potential muscle imbalances. These imbalances of the trunk musculature may predispose the female runner to lower back injury.

Eccentric trunk extensor and flexor strength was greater than concentric extensor and flexor strength. This was not an unexpected finding, since it is well documented that the force produced during an eccentric contraction is greater than the force produced during a concentric contraction.[6] Smidt *et al.*[7] also reported that eccentric trunk extensor and flexor strength was greater than concentric strength, although they failed to report the strength values. Our findings indicated that eccentric trunk extensor strength was 40% greater than concentric trunk extensor strength, whereas eccentric trunk flexor strength was only 8% greater than concentric trunk flexor strength. This resulted in an eccentric trunk flexion/ extension reciprocal muscle group ratio of 0.39. This suggests that the trunk extensor musculature may be subject to more eccentric loading than the flexor musculature. The absence of documented eccentric trunk strength in the literature makes it difficult to ascertain whether this finding is limited to female runners, or if this observation may be generalized to a sedentary population.

At present, we have been unable to locate research documenting isokinetic strength of the hip musculature in an adult population. Reciprocal muscle group muscle group ratios at the hip approximated 1.0 during both the eccentric and concentric modes of contraction. The value is deceiving, since eight of 21 subjects demonstrated greater concentric and eccentric hip flexor strength than extensor strength. The cause of this finding is unknown, but it may be due to postural deviations, running form, or running surface. Moreover, these variations in hip strength may not be an unusual finding in this particular population of female runners.

In conclusion, these findings establish previously unreported isokinetic strength values for the trunk and hip in female runners. Further research should examine the relationship between deficits in hip and trunk strength and injury to the musculoskeletal system. Moreover, additional research should examine concentric and eccentric strength of the hip and trunk in a variety of athletic and sedentary populations.

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