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Abdominal Core Strength, Fatigue, and Incidence of Low Back Pain in Distance Runners

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ABSTRACT

This study investigated absolute and relative abdominal strength, fatigue, and low back pain differences among distance runners. Runners (45 female and 52 male) were evaluated by ABTEST for abdominal strength and fatigue. Age, gender, weight, and incidence of low back pain data were recorded for each participant. Runners were self-classified into groups based on their own perceived level of fitness as either beginner, intermediate, or advanced. Maximal abdominal force and the rate of fatigue over a 10 second time interval were recorded for every participant. Relative abdominal strength was determined by adjusting for body weight. Differences were noted for absolute abdominal strength between male and female groups with males having significantly greater force. Female advanced distance runners possessed greater absolute abdominal strength than female beginner distance runners. No differences were found to exist for abdominal fatigue, relative abdominal strength, or low back pain. Age comparisons of absolute abdominal strength revealed moderate negative correlations for males and females. Conversely, age comparisons of abdominal fatigue resulted in a moderate correlation for males. Findings indicate that a strong core does not result in less low back pain, males and females do not differ in abdominal fatigue or relative abdominal strength, and that age declines in strength may be moderate.

INTRODUCTION

Athletes participate in strength training exercises in hopes of improving performance. However, available research in regards to the effectiveness of core training, especially pertaining to distance running, is limited and inconclusive. Stanton, Reaburn, and Humphies (1) found positive improvements in core musculature strength and endurance following a six-week study involving Swiss ball training among young male athletes, but found no concomitant improvements in running economy. Cleveland (2) noted increases in core strength and stability among long distance runners, but found no significant changes in running performance. Conversely, Sato and Mokha (3) studied recreational and competitive runners following a six-week core stabilization intervention program and found improvements in both distance running and shuttle run times without finding similar gains in either kinetic efficiency or lower extremity stability.Additionally, strong correlations have been found between spinal flexion strength, distance run per week, and best time in a competitive race (4). In a related study involving swimming, 50-meter freestyle swim times, velocity, and stroke index were greatly improved following core training (5).Other studies involving either non-running sports or sports related activities have resulted in core strength/endurance improvements without showing gains in functional performance. Tse, McManus, and Masters (6) found that competitive rowers assigned to a core endurance intervention group demonstrated significant improvements in trunk endurance following an 8-week core training program without finding any improvements in functional performance testing. Similarly, Seibek, Guskiewicz, Prentice, Mays, and Davis (7) found increased core stability in swimmers following therapy ball training without finding functional improvements in their sport. Furthermore, weak to moderate correlations have been noted between abdominal exercises and performance among university football players (8).

Other research has focused on finding a link between a strong core and injury prevention. Abdelraouf and Abdel-aziem (9) studied college male athletes and found that the nonspecific low back pain group performed significantly worse

than the healthy group on core endurance tests and concluded that nonspecific low back pain may be associated with poor core endurance. Similarly, Gorman and Lirgg (4) found that both male and female runners who experienced severe low back pain had lower abdominal strength scores than those who either experienced little or no low back pain. Other research has shown that a weak core may play a role in either injury or predisposing an athlete to possible injury (10; 11; 12).

Although the present research study does not attempt to study the effectiveness of abdominal intervention programs as it relates to athletic performance, it attempts to quantify differences in abdominal strength and abdominal fatigue as it relates to specific running groups and low back pain. One purpose of this study was to investigate if gender, running experience, and age affect abdominal strength and abdominal fatigue. A second purpose was to determine if differences exist between absolute and relative abdominal strength. A third purpose was to investigate differences in abdominal strength and reported pain incidences.

METHOD

Participants

Forty-five female and 52 male adult distance runners were solicited from area running events. Participants' age, gender, weight, and incidence of low back pain was recorded. Low back pain was self-reported by participants as never, rarely, sometimes, often, or regularly. Participants were asked to self-classify their running experience as either beginner, intermediate, or advanced, based on years of experience.

Procedure

Runners were assessed on abdominal strength and abdominal fatigue using ABTEST (Abdominal Test and Evaluation Tool). The ABTEST evaluation tool has been validated and used in prior studies to measure abdominal strength and abdominal fatigue (13; 14; 15; 4; 16). During testing, participants were placed on a 30 degree inclined bench, with hips and knees aligned at a 90 degree angle. A cushioned rubber strap was place on the xiphoid process and thread through a strain gauge at the back of the unit. A force transducer was aligned directly over the xiphoid process and maximum force was recorded in units (lbs.) using a Sentran VB3 bending beam load cell (Ontario, CA).

Participants were instructed to place their hands on their opposite shoulders to prevent swaying that could result in increased force production. They were then asked to inhale normally and exhale slowly prior to exerting a constant isometric force against the transducer unit for 10 seconds. Maximal force along with the rate of abdominal muscle fatigue was recorded for one trial for each participant. If a participant experienced discomfort, testing was ended and the participant was not included in the study. If proper mechanics were not maintained throughout the procedure, the participant was asked to repeat the test after a rest period.

Treatment of the Data

Means, standard deviations, and percentages were calculated for gender and experience on absolute abdominal strength and abdominal fatigue with pounds being the unit of measurement.Abdominal fatigue was indicated by the percentage loss of force over the 10 second testing period. Absolute abdominal strength was defined as the maximal amount of force exerted during the testing. Relative abdominal strength was also calculated and adjusted for weight and expressed as maximum force divided by kg. ANOVAs were used to determine group differences.Correlations between age and both abdominal strength and abdominal fatigue were calculated.

RESULTS

Comparisons of absolute abdominal strength revealed a significant difference between male distance runners and female distance runners (*ES*=1.46). Male runners had 99.7% greater absolute abdominal strength than female runners. Furthermore, advanced female runners exhibited 161.9% greater absolute abdominal strength than beginning female runners (*ES*=1.84). No other abdominal strength differences were found when comparing beginner, intermediate, and advanced runners for both male and female groups. Comparisons of abdominal fatigue resulted in no differences between running experience groups. There was no significant difference in both male and female runners when comparing relative abdominal strength. Means and standard deviations for strength and fatigue for both genders as well as experience groups are reported in Table 1.

Table1.*Means & SD for Abdominal Strength and Fatigue by Performance Level and Gender*

	Male	Female
Absolute Abdominal Strength		
Beginner	88.67 (25.92)	26.20 (7.77) b
Intermediate	98.00 (40.53)	45.85 (23.77)
Advanced	85.82 (30.64)	68.63 (31.60) [b]
Total	93.19 (36.60) [a]	46.66 (26.34) [a]
Relative Abdominal Strength*		
Beginner	.836 (.156)	1.58 (1.51)
Intermediate	1.24 (.76)	1.96 (1.92)
Advanced	.939 (.41)	1.62 (1.41)
Total	1.13 (.61)	1.86 (1.78)
Fatigue		
Beginner	39.83 (13.96)	35.80 (18.95)
Intermediate	32.18 (12.90)	34.14 (16.23)
Advanced	33.18 (12.07)	27.38 (10.56)
Total	33.50 (12.72)	32.67 (15.16)

*Abdominal strength divided by weight (kg)

[a] sig. diff, $p < .0001$

[b]sig, diff, $p = .012$

Additionally, there was no significant difference when comparing absolute abdominal strength and reported incidence of back pain. Correlational analyses between age and absolute abdominal strength revealed a moderate negative relationship for both males (r = -.442) and females (r = -.306). Age and abdominal fatigue yielded a moderate positive correlation for males (r = .453) but a very low correlation for females (r = - .138).

DISCUSSION

The present study also found similar significant differences in absolute abdominal strength for advanced female runners compared to beginning female runners but did not find significant differences in absolute abdominal strength between male experience groups. In addition, no significant differences were noted for either male vs. female groups or between all experience groups for both relative abdominal strength or relative abdominal fatigue. Core muscular strength and endurance improvements following intervention programs have been reported in the literature (2; 7; 1; 6). However, there have been mixed results when examining actual functional performance. Some researchers (4; 5; 6) have found gains in athletic performance while others (8, 7, 6) found either no improvements in functional performance or weak to moderate correlations between core exercises and performance. The present study, instead of researching core intervention programs and how they relate to functional performance gains, looked at gender, experience, age, and self-reported pain differences in distance runners. This study's findings somewhat collaborate the research of Gorman and Lirgg (4) who found that males scored significantly higher than females on absolute core strength. However, they reported percentage increase differences for advanced, intermediate, and beginning runners and found that both advanced male and advanced female distance runners had higher absolute and relative strength scores and less abdominal fatigue than their beginning counterparts.

The differences between the two studies may be attributed to the statistical procedures used in the studies. The Gorman and Lirgg (4) study only examined percentage increases while the present study looked at significant differences in group means. In a related study, Glenn et al., (14) found that Korean subjects by gender demonstrated significantly lower absolute abdominal strength scores and lower percentage abdominal fatigue index scores than their American counterparts. However, significant differences were only observed between male populations for relative abdominal strength and not for the female population. The present findings combined with past findings suggest that even though absolute abdominal strength scores have been found to exist between certain populations, relative abdominal strength adjusted for body weight and abdominal fatigue may not differ by gender, experience level, or possibly ethnicity, although strength and fatigue differences between ethnic groups would require further study. The authors believe that relative

abdominal strength is a better indicator of abdominal core strength than absolute core strength because it takes into account a person's weight.

The present study found stronger correlations for age than the previous Gorman and Lirgg (4) study indicating that there may be declines in absolute abdominal strength associated with aging but possibly no measureable declines in abdominal fatigue. Based on this finding, it is recommended that as individuals age, they may need to engage in core strength training activities to offset the possible strength loses due to aging. Runners may also want to include more abdominal endurance exercises in their training since abdominal fatigue may be a limiting factor in distance events (17). The present study also differs from Gorman and Lirgg (4) in regards to how pain was evaluated and analyzed. Gorman and Lirgg (4) divided their subjects into two groups based on either experiencing severe low back pain sufficient to hamper daily living activities or no/less extreme pain and found that male and female runners with severe low back pain demonstrated 36% and 32% less absolute strength scores than the no/less extreme pain group. The present study researched the incidence of pain using group means and found no significant differences between five self-reported low back pain groups. Findings indicate that a strong abdominal core does not necessarily result in less back pain. It is possible that back pain experienced by distance runners may be due to overuse or prior injuries more than a weak abdominal core.

Overall, the data suggests that male distance runners have greater abdominal strength than females distance runners and that advanced female runners have greater abdominal strength than female beginning runners. The findings may be attributed to genetics, the amount of training, or differences in the types of training used to prepare for racing by the participants, e.g., the more advanced runners may train harder or devote more time to producing a strong abdominal core. However, differences between male and female groups and between experience levels were not found when considering abdominal fatigue and adjusting for body weight.

A limitations of this study was the use of self-reported categories of running experience and amount of perceived back pain. However, self-reporting is a common way of categorizing participants after giving them guidelines. It is possible but not likely that runners self-categorized incorrectly as most runners are very aware of their abilities and fitness levels based on the number of miles they run per week.

In summary, the findings of this study suggest that size may not have anything to do with abdominal fatigue and that females have an equivalent amount of abdominal strength for their body size. Findings also indicate that a strong core does not necessarily result in less back pain and that back pain experienced by distance runners may be due to overuse or prior injuries more than a weak core. Furthermore, as core strength and abdominal fatigue naturally tend to decrease over time, with proper and continued training throughout a runner's life span, these effects may be mitigated.

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