



Gender, Trunk Muscle Endurance and Static Balance in Young Adults

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Abstract

Balance and muscular endurance gender-related differences are very controversial.

Objective: *This study aimed at examining the difference between young adult males and females in trunk muscles' endurance and static balance.*

Method: *Thirty participants (15 males and 15 females) with mean (SD) age 20.2 ± 2.2 years and BMI 30.56 ± 2.12 kg/m² participated in the study. Single-limb Stance (SLS) test was used to assess the static balance. The Sorensen test of trunk extensor endurance, trunk flexor endurance test and side bridge endurance test were used to assess the endurance of trunk muscles.*

Results: *One way between-subject MANOVA revealed that there were non-significant ($p > 0.05$) between-subject effects for the endurance of trunk extensors, flexors and lateral flexors in addition to the single leg stance time between males and females.*

Conclusion: *The findings indicate that gender has no effect on the endurance of trunk muscles and static balance in young adults.*

Keywords: *Gender, Trunk Muscle, Endurance, Balance.*

Introduction

Balance is an important factor for prevention and treatment of injuries¹. It is a basic prerequisite for all types of sports and daily movements². Balance impairment is a main cause of fall and daily injuries¹. So, balance assessment is beneficial for improving health condition and daily movements³. Balance can be defined as one's ability to maintain a static position, and perform different movements without falling⁴. It has also been defined as the state of equilibrium or the ability to maintain the center of gravity (COG) over the

base of support (BOS)⁵.

Good balance requires the coordination of three systems; vestibular, proprioceptive and visual systems. The primary information is from the vestibular system. The second source is the proprioceptive system originating from somatosensory receptors in muscles, tendons, and joints for kinesthetic sense, body posture and spatial awareness. Finally, the visual system sends visual signals about body's position⁶.

Fatigue has a negative effect on static balance⁷. It can weaken the proprioceptive and kinesthetic

properties of joints, increases the threshold of muscle spindle discharge and disrupts afferent feedback and ultimately alters joint awareness⁸. But its effects on measures of dynamic balance are unknown^{1,2,9}.

Functional movements of the body are highly dependent on the core. Core muscles stabilize the spine, pelvis and shoulder and weakness of these muscles may result in injuries¹⁰. The core consists of many different muscles that stabilize and provide a base for movement in the extremities. These muscles help control movements, transfer energy, shift body weight and distribute the stresses of weight-bearing⁶.

The major muscles of the core are transversus abdominis in the anterior, multifidus in posterior, pelvic floor in lower and the diaphragm in upper part. Minor core muscles include the latissimus dorsi, gluteus maximus, and trapezius^{6,11}. Core exercises concentrate on the muscles of pelvis, lower back, hips and abdomen to coordinate in a manner that leads to better balance and stability^{12,13}.

The main aims of most core training programs are to optimize trunk muscle strength and endurance which is considered as basic requirements for athletic performance⁹. Although core muscle strength is suggested to be necessary for activity and sports, its endurance has a very important role in balance during prolonged physical activity and protects from injury¹³.

In literature, various studies conducted to assess and improve the core muscle strength¹⁴ in both males and females. However, there is limited knowledge about the effects of gender on core muscle endurance and balance. So, this study aimed at examining the difference between males and females in trunk muscles' endurance and balance. Understanding the effects of gender on muscle endurance and balance may help for early detection of individuals with balance disorders, prevent injury and improve the quality of life. Single-limb Stance (SLS) test was used to assess the static balance. The Sorensen test of trunk extensor endurance, trunk flexor endurance test

and side bridge endurance test were used to assess the endurance of trunk muscles. These tests proved to have great intra-rater reliability^{15,16}.

Methods

Participants

A total of 30 participants (15 males and 15 females) participated in this study. Their mean (SD) age, mass and height were 20.2 (5.2) years, 65.5(8.2) kg and 1.62(0.04) m, respectively. Participants were excluded from the study if they had history of low back pain, history of lower limb injury, neuromuscular disorders and any vestibular or balance problems. Participants were also excluded if they were participated in a professional sports activity. An informed consent was obtained from each participant. The institutional review board for research at the Faculty of Physical Therapy, Cairo University approved the procedures used in this study.

Instrumentation

The single-limb stance (SLS) test was used to assess the static balance of both dominant and non-dominant sides. It is a reliable test to assess static balance and it is suited for population based researchers¹⁷. The Sorensen test of trunk extensor endurance, trunk flexor endurance test and side bridge endurance test were used to assess the endurance of trunk muscles. All tests were performed by the author under supervision of another two physiotherapists, to improve the inter-rater reliability. All tests were performed three times and the average scores were used in the statistical analysis. All testing procedures were performed approximately at the same time of the day.

Procedures

Each participant was allowed to randomly select one from four folded papers located in a container. These papers represented the four tests. Then, each participant was asked to randomly select one from another two folded papers located in another container. These papers represented the dominant and non-dominant limbs' assessment for the SLS

and side bridge testing procedures. Each participant was tested according to these random selections.

In SLS Test, participants were asked to stand on the one foot with placing their hands on both iliac crests. The foot of the other lower extremity was put on the inner aspect of the supported knee. The examiner asked the participant to lift the heel of the supported foot and keep the position while time was recorded. The test was ended if the participant performed compensatory movements (such as relocation of ball of supported foot). The test was performed three times and the average scores were calculated to be used for statistical analysis. The same procedure was repeated for the other lower limb after resting for five minutes.

Sorensen test was used for the evaluation of trunk extensor endurance. Each participant was positioned in prone lying, with the upper edge of the iliac crests positioned on the edge of the testing table. The pelvis, knees, and ankles were fixed to the table by straps and arms were folded over the chest. The participant was asked to keep up the upper body in a horizontal position as long as he/she can. A chair was put in front of the subject to help him/her in case of inability to keep the position. The time during which the participant kept the upper body straight was recorded.

The trunk flexor endurance test was used to assess the endurance of trunk flexors. Each participant lied in a supine position on flat surface with both hips and knees were flexed at 90 degrees and the arms crossed over the chest. The subject was asked to raise the trunk in a smooth movement, keeping the position as much as possible. The time was recorded.

The side bridge exercise; described by McGill; was used for testing the endurance of lateral trunk musculature. It recruits quadratus lumborum and anterolateral trunk wall muscles. Participants were positioned in side lying position. The upper body supported off the ground by their elbows and forearms. Their legs were straight, with the foot of the upper lower limb positioned in front of the

other foot. The hip was lifted off the floor while the elbow and feet supported the body, making a straight line from head to toe. The upper hand was placed on the supporting shoulder. When the subject was in correct position, the time was started to be recorded. The test was ended, when the subject was not able to hold the back straight and the hip was lowered. After five-minute' rest, the other side was tested.

Statistical Analysis

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 20 for windows. Initially and prior to final analysis, data were screened for normality assumption as a prerequisite for parametric analysis. This was conducted through assessing for the presence of significant Kolmogorov-Smirnov and Shapiro-Wilks normality tests and significant skewness and kurtosis in addition to the presence of extreme scores. Once data were found not to violate the normality assumption, parametric analysis was used. One-way between-subject Multivariate Analysis of Variance (MANOVA) was used to differentiate between the two groups for the endurance of trunk flexors, extensors and lateral flexors in addition to single leg stance time. The level of significance was set at an alpha level of 0.05.

Results

One way between-subject MANOVA revealed that there were non-significant between-subject effects for the endurance of trunk extensors ($F=0.37$, $p= 0.54$), flexors ($F= 0.002$, $p= 0.96$), and lateral flexors on both dominant and non-dominant sides ($F= 0.238$, $p= 0.63$ & $F= 0.235$, $p= 0.632$) in addition to single leg stance time of both dominant and non-dominant sides ($F= 0.222$, $p= 0.64$ & $F=1.63$, $p= 0.213$), respectively. The subsequent multiple pair wise comparison tests showed that all the dependent (measured) variables increased non-significantly ($p>0.05$) in males compared with females. Tables (1 & 2) and figure (1) show the above findings.

Table 1 Descriptive statistics of the endurance of trunk flexors, extensors and lateral flexors and single leg stance time in young adults.

	Trunk extensors endurance (in seconds) Mean(SD)	Trunk Flexors endurance (in seconds) Mean(SD)	Lateral flexors endurance [dominant-side] (in seconds) Mean(SD)	Lateral flexors endurance [non-dominant side] (in seconds) Mean(SD)	Single leg stance [Dominant side] (in seconds) Mean(SD)	Single leg stance [non-dominant] (in seconds) Mean(SD)
Females	23.42 (10.54)	16.34 (12.26)	17.49(9.02)	18.16(10.46)	4.89(2.5)	3.99(0.72)
Males	26.04 (11.16)	16.53 (11.24)	19.27(9.53)	20.08(9.64)	5.40 (2.9)	4.84 (2.3)

Table 2. Post-hoc analysis for the multiple comparisons between the two tested groups

	Trunk extensors endurance	Trunk flexors endurance	lateral flexor endurance dominant side(RT)	lateral flexor endurance non-dominant side(LT)	single leg stance dominant-side (seconds)	single leg stance non-dominant (seconds)
Females vs. males	P=0.544	P=0.96	P=0.630	P=0.632	P=0.64	P= 0.21

(*) the mean difference is significant at $p < 0.05$

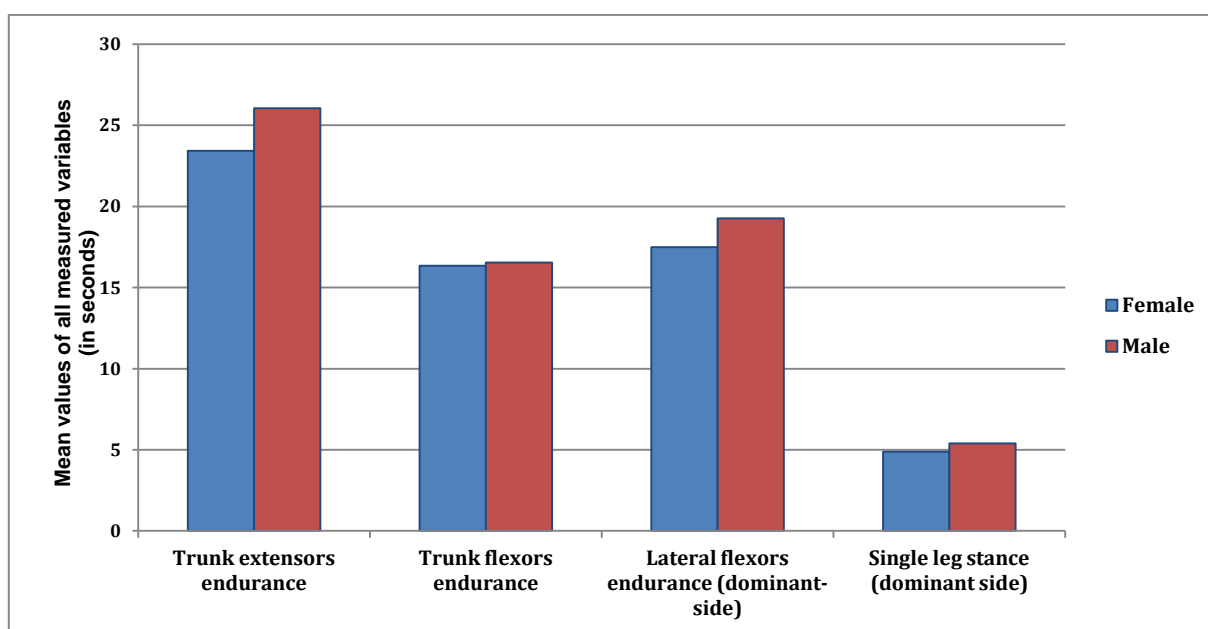


Figure (1) Trunk flexors, extensors and lateral flexors endurance and single limb stance time measured in seconds in young adult males and females.

Discussion

The findings of the current study revealed a non-significant main effect of gender on the endurance of all trunk muscles in addition to single leg stance time in young adult individuals. The results of descriptive statistics for the effect of the participants' gender on the measured variables demonstrated differences between males and females in all variables where males achieved higher total mean scores than females for all dependent variables in the study. However, the

results of MANOVA showed no significant differences between males and females. This means that gender does not affect participants' scores in their balance performance and trunk muscles' endurance.

The non-significant differences in the SLS testing found between the two tested groups are suggested to have resulted from the matched level of physical activity of both groups. As both groups are physically active students in the same grade at the same faculty (sedentary and athletic

students were excluded). Previous studies have shown that regular physical activities can contribute to improving muscle strength, minimizing existing balance disorders, besides reducing body sway due to its beneficial effect on the sensory and motor systems^{18,19}. Moreover, Torres et al.²⁰ stated that regular physical activities help equalize the response of the postural control system of men in semi-static situations.

The findings of the current study agree with those of a study conducted by Bryant et al.^[21] who tested balance performance in female and male at the time of retirement. Those researchers assessed the balance under different situations; feet together eyes closed feet together eye open, and one leg stance eyes open. Their results showed that males performed a statistically better center of pressure adjustment than females, but, after normalizing the data for participant's height, the outcomes changed and no gender differences were seen. Then the researchers concluded that there were no differences in static balance performance between men and women.

In the same context, Torres et al.²⁰, Martins et al.²², and Melan et al.²³ conducted studies on physically active young individuals. Their results also showed no significant differences in postural control system between men and women. Additionally, Wolfson et al.^[24] and Hageman et al.²⁵ reported that there is no gender difference in the elderly's balance ability. Also, Fujiwara et al.²⁶ reported that there was no gender difference in the elderly's dynamic balance ability in horizontal oscillation. In the study conducted by Demura et al.²⁷, there was no gender difference in the number of steps and the average connecting time in stepping right and left.

On the other hand, our results are contradicted with those reported by Nolan et al.^[14], Farenc et al.²⁸, Gribble et al.²⁹, Dorneless et al.³⁰. These researchers found significant differences between male and female balance scores. This controversy might be due to different balance testing procedures, different participants' level of activity

and different ages. In general, it was previously mentioned that most of the articles that have reported gender differences in balance performance did not normalize their data for differences in body size²¹.

Regarding the trunk muscle's endurance, the non-significant differences found in males compared with females might be due to the young age of participants. Previous work has suggested that there was a significant effect of gender on strength and endurance that may be resulted from age-related loss of muscle mass in elderly females more than males^{31,32}. These changes are known as sarcopenia^{33,34}.

The results of the current study agree with those reported by Clark et al.³⁵. The researchers reported that there was no difference in endurance performance during the isotonic exercise between male and female. These researchers also suggested that gender differences in muscle fatigue are influenced by muscle contraction type. Additionally, Silva et al.³⁶ reported that gender differences disappeared when accounting for hip extensor strength and endurance.

On the other hand, our results are contradicted with those reported by Salvador et al.³⁷ and Sugimoto et al.³⁸. These researchers found significant differences in the endurance between males and females. This controversy might be due to different definition of endurance, different testing procedures, different type of muscle contraction, and different ages of participants.

The current study is limited by the small number of participants which may affect the ability of the statistical test to find the significance. On the other hand, randomization of testing rendered it more controlled than much of the previously conducted research in this area.

Conclusion

Gender has no effect on the endurance of trunk muscles and static balance in young adult individuals.

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Submission Statement

I represent that this submission is original work and is not under consideration for publication with any other Journal.

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