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Static balance ability as an indication of static stability among healthy physical therapy students at Taibah University

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Abstract

Background: Balance is an essential component for the overall physical performance among individuals.

Objectives: The purpose of this study was to investigate and to compare the static balance ability, in terms of endurance time, during trunk stability push-up and during deep squat.

Method and Materials: Twenty three healthy physical therapy students, aged between 20 and 23 years, were recruited from college of medical rehabilitation to participate in the study. The physical therapy testers demonstrated the activity to the participants. Every participant had to maintain his balance as long as tolerated during deep squat and during doing push-up while maintaining the trunk stable. The order of measurement was counterbalanced.

Results: The mean score, in seconds, for trunk stability push-up was 49.57 (SD=22.07), and the mean score for deep squat was 52.83 (SD=24.60). No significant difference between trunk stability push-up and deep squat mean value, was found \( t(22)=-0.639, p >0.05 \). Also, a moderate positive correlation was found \( r(21) = 0.454, p <.05 \] indicating a significant linear relationship between the two variables.

Conclusions: There is diminished static balance endurance ability among healthy college students for both lower and upper body but there was no significant difference between them. Clinicians should recommend static balance training; like deep squat and push-up for promoting balance and stability of lower and upper body in healthy individuals.

Keywords: Balance, posture, physical endurance, healthy participants, correlation.
INTRODUCTION

Balance skills play a vital role in enjoying good physical health\(^1\). Maintaining good static and dynamic balance is essential for individuals’ well-being across different ages\(^2\). Static balance is strongly associated with the ability to process visual information; however, dynamic balance is associated with the speed of motor response\(^3, 4\). The ability to adopt proper balance strategies to maintain equilibrium and having good postural control is depending on the level of task demand and on balance performance\(^5, 7\). Static balance skills, like assuming and holding on the deep squat or the push-up on arms positions, are necessary for functional performance and activity of daily living\(^8, 9\). For example, during walking up and down stairs or picking up objects from the floor individuals need to bend knees and maintain static balance and stability. Also, pushing oneself up or pushing large objects around needs good upper extremity strength, static balance and trunk stability.

Balance is crucial for injury prevention. McGuine et al.\(^10\) studied balance abilities in a group of high school basketball players. Results showed that diminished stability and poor static balance performance are considered as a predictor of injury. Moreover, pre-season functional movement screen can predict injury but in professional athlete\(^11\). Static balance measures are good indicators of effect of fatigue on postural control\(^12\). Deep squat and trunk stability push-up test are considered simple, noninvasive, inexpensive tests for assessment of static balance of different body parts across different ages\(^8, 9, 13, 14\). Balance stability can be administered at any clinic or even the patient’s house by any clinician and at any time. Any individual who is able to bend his knees to assume the deep squat and balance can be tested for deep squat static balance. Deep squat and push-up can be used for testing of static balance skills as well as for static balance training\(^8, 9\). However, within the same healthy individual, is there any difference or relation between the static balance ability of lower and upper body as tested through deep squat and trunk stability push-up. Knowing the relationship will help clinicians to guide individuals during testing and to provide clinical progression during training.

METHOD AND MATERIAL

Subjects

Twenty-three consecutive healthy males, aged between 20 and 23 years, were recruited to participate in the study. Participants’ demographic information was collected. All participants are students at college of medical rehabilitation, physical therapy division, Taibah University in Al-Madina Al-Munawara city. Research design is a prospective, single-group, repeated-measures design. Inclusion criteria: subjects were included if they were between the ages of 20 and 23 years old, healthy, and free from any physical disability or significant pain. Exclusion criteria: subjects were excluded if they have had previous orthopedic surgery, discogenic back pain, or suffering from major health problems or physical disability.

Procedure

The physical therapy tester explained the study protocol to every participant and a written informed consent was obtained. The study was approved by institutional review board of college of medical rehabilitation. In the following paragraphs and throughout
the rest of the paper, the physical therapy tester will be referred to as the investigator. The investigator demonstrated every single activity to the participants before actual recording. The investigator examined shoulders’ composite mobility, sagittal spinal mobility, balance skills using single leg standing, and static balance ability. Borg scale was used to determine the rate of perceived exertion right after the static balance skills. First, shoulder joints functional mobility was measured. The investigator instructed every participant to demonstrate superior Apley’s of right shoulder and inferior Apley’s of left shoulder followed by superior Apley’s of left shoulder and inferior Apley’s of right shoulder as reported in literature\(^{15}\). The investigator measured the distance between finger tips of right and left middle fingers using tape measure. Second, flexion axial mobility was measured by having every participant to stand up upright with knees straight and bend forward as far as possible. The investigator measured the distance from finger- tip of middle finger to the floor\(^{16}\). Regarding trunk extension mobility, every participant had to lie down on the floor and push himself up on his arms while maintaining the pelvis on the floor. The investigator measured the perpendicular distance from the sternal notch to the floor using tape measure.\(^{17}\) Third, regarding static balance skills every participant was instructed to lift off one leg and balance on the other leg with arms dangled and hold on that position as long as tolerated with a ceiling time of 30 seconds as reported in Jonsson et al. study\(^{18}\). Matsuda et al.\(^{1}\) recommended one-legged stance as a useful tool to test static balance ability in young people. Fourth, static balance time was recorded, during deep squat and during push-up while keeping the trunk stable. The order of measurement was randomized. Every participant was instructed to push himself up on straight arms with keeping the trunk stable (Figure 1) and to bend his knees to less than 90° and maintains his static balance as long as tolerated (Figure 2). Every participant was instructed to keep eyes open, breathe normally and balance adequately. If the participant started to shiver his muscles, the tester used to give him verbal feedback to balance and if the participant could not immediately restore his balance, the test was terminated and the balance timing was recorded using stop watch. If any participant managed to balance up to three minutes, the time was recorded and considered as ceiling time in our study. The investigator used the template attached as Appendix A. Fifth, every participant was instructed to rate the perceived exertion based on the Borg scale. Borg CR 10 is reliable and easy to use to compare the rate of perceived exertion during physical activity. The rate ranges from zero that indicates no effort at all to 10 that indicates maximum effort\(^{19}\). A hard copy of Borg CR10 scale was provided as a guide for the participants. The investigator instructed every participant to rate the perceived exertion directly after finishing the static stability test of deep squat and trunk stability push-up.

**STATISTICAL ANALYSIS**

Descriptive statistics were conducted for all variables included in the study. A paired sample t-test was conducted to determine whether a significance difference existed, in endurance timing, between deep squat and trunk stability push-up static stability. Pearson correlation was conducted to determine the relationship between the two measurements\(^{20}\). Statistical significance was set at alpha ≤0.05. SPSS 20.0 was the software used for all data analysis.
Figure 1. Trunk stability push-up static balance test.

Figure 2. Deep squat static balance test.
RESULTS
The main focus of this study was to determine the static balance functional ability of the healthy individuals when holding on the deep squat and the push-up positions while maintaining static stability. Participants were all physical therapy students at college of medical rehabilitation, Taibah University in Al-Madina Al-Munawara city. Participants’ descriptive statistics and demographics can be seen in Table 1. The participants’ static balance time mean, standard deviation (SD) during trunk stability push-up and during deep squat can be seen in Table 1.

Table 1. Participants descriptive statistics (N=23)

|                          | Minimum | Maximum | Mean   | ± SD  |
|--------------------------|---------|---------|--------|-------|
| Age                      | 20.00   | 23.00   | 22.15  | 2.06  |
| Height                   | 160.00  | 185.00  | 171.21 | 8.77  |
| Weight                   | 56.00   | 90.00   | 69.50  | 12.03 |
| LtSupRtInfApley’sScratch (cm) | 00.00   | 23.00   | 4.20   | 1.99  |
| RtSupLtInfApley’sScratch (cm) | 00.00   | 20.00   | 3.90   | 1.86  |
| Flexion Mobility (cm)    | 0.00    | 15.00   | 2.15   | 4.34  |
| Extension Mobility (cm)  | 19.00   | 60.00   | 30.45  | 7.91  |
| Trunk Stability Push UP   | 18.00   | 120.00  | 49.57  | 22.07 |
| Deep Squat               | 24.00   | 120.00  | 52.83  | 24.60 |
| Borg @ Trunk Stability Push-Up | 2.00    | 6.00    | 5.13   | 1.17  |
| Borg @ Deep Squat        | 1.00    | 4.00    | 3.15   | 1.05  |
| Rt Single Leg Standing    | 26.00   | 30.00   | 29.03  | 1.21  |
| Lt Single Leg Standing    | 24.00   | 30.00   | 28.53  | 2.32  |

Lt Sup Rt Inf Apley’s Scratch (cm); Left superior right inferior Apley’s scratch test.
Rt Sup Lt Inf Apley’s Scratch (cm); Right superior left inferior Apley’s scratch test.
A paired sample $t$ test was run to establish baseline equivalency within subjects. No significant difference was found between single leg standing of right and left side. Also, no significant difference was found between left superior-right inferior Apley’s scratch test and right superior-left inferior Apley’s scratch test $p > 0.05$.

A paired sample $t$ test was calculated to compare the mean score of static balance during trunk stability push-up and the deep squat positions. The mean score, in seconds, for trunk stability push-up was 49.57 (SD=22.07), and the mean score for deep squat was 52.83 (SD=24.60). No significant difference between trunk stability push-up mean value and deep squat mean value, was found $[t (22)= - 0.639, p >0.05]$.

A Pearson correlation was calculated examining the relationship between participants’ static balance time values for trunk stability push-up and deep squat. A moderate positive correlation was found $[r (21) = 0.454, p <.05]$, indicating a significant linear relationship between the two variables. Participants who scored high time during trunk stability push-up were able to score high during deep squat.

A paired sample $t$ test was computed to compare the mean score of Borg scale perceived with holding on the deep squat and trunk stability push-up positions. No significant difference between the mean values of Borg scale was found $[t (22) = 1.42, p >0.05]$.

Two participants out of the 23 participants indicated that they are physically active. The investigator found no value for conducting statistical analysis between subjects based on being physically active or inactive due to unequal participants’ number.
DISCUSSION
Balance skills are essential for individuals’ wellness and welfare\(^1\),\(^2\). Static balance is mainly concerned with maintaining stability and having good control over body posture at different positions\(^2\). The finding of the present study revealed poor static balance ability among physical therapy college students but without any significant difference between deep squat and trunk stability push-up. Poor performance in static balance corresponds with the findings of Perry and Koehle\(^1\) who found association between the level of exercise participation and the score of functional movement screen. Balance deficiencies might increase the physical demand on the musculoskeletal system which exhaust the muscles and eventually lead to chronic fatigue and physical disorders. Sjolie and Ljunggren\(^2\) evaluated muscle performance using static endurance test. Results showed that low baseline lumbar extension strength predicts low back pain. The authors concluded that inadequate strength and stability in the low back play a major role in current and future back pain in adolescents. Given that only two out of 23 participants indicated that they are physically active, it seems to be logic to have 92\% of participants in the present study who indicated that muscle fatigue and soreness were the reasons behind discontinuing the hold on the static balance test. The findings concur with Gribble and Hertel\(^1\) who found that muscle fatigue decreases postural control which in turn decreases balance ability. Since the majority of participants in the present study indicated that they are physically inactive, inconsistently active and tend to engage in low intensity exercises, the participants’ performance tends to converge with several studies findings. Hottenrott et al.\(^2\) pointed out the importance of high intensity training and endurance training on aerobic capacity in recreationally active participants. Haskell et al.\(^3\) mentioned that the American college of sports medicine recommends practicing moderate-intensity aerobic exercise on five days each week with a minimum of 30 minute/session especially to all healthy adults above 18 years old. Participants indicated that muscle fatigue and soreness but without knee joints pain was the reason behind discontinuing to hold on the deep squat position. The findings are in agreement with what was reported by Sriwarno et al\(^4\), who studied the effect of postural changes on muscle activities in healthy individuals. Individuals were tested in three squatting conditions: full squatting, tiptoe squatting, and tiptoe squatting on a 15° slop. Outcomes measures showed that full squat is the most physically demanding position and is considered as the main cause for musculoskeletal pain even among healthy individuals. In the present study investigators used the deep squat not the full squat position for testing the lower extremity static balance ability. Static balance and stability tests are fundamental component of the functional movement screen. Minick et al.\(^5\) performed a reliability study to determine the interrater reliability of the functional movement screen. Results showed excellent agreement which indicates that functional movement screen can be easily applied by trained individual to identify athletes who are at risk for injury. In essence, poor static balance performance among the healthy students participated in this study could put their physical health in jeopardy. Therefore, having individuals to practice simple static balance training; like deep squat and trunk stability push-up exercises with eyes open, is a simple way for balance training to healthy individual among the healthy students participated in this study could put their physical health in jeopardy.

CONCLUSION
In essence, poor static balance performance
Therefore, having individuals to practice simple static balance training; like deep squat and trunk stability push-up exercises with eyes open, is a simple way for balance training to healthy individuals.

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(Appendix A)

Name:                                                                  Age:                       Gender:                Handedness: 
Occupation:                                         Smoking: yes/no                  Ht:                        Wt: 
Cell phone #:                                      Diagnosis:                                               Nationality: 
Recreationally active: 30min x 5x/ week ( Yes- No) 
Previous upper limbs, lower limbs, spine injury or surgery? (yes- no) 

Static balance ability as an indication of static stability among healthy PT students. 
Instructions: (Measurements will be number of seconds the participant can achieve while maintaining 
his balance while assuming the testing position) 
1. Start with familiarization session 
1. Participants should be bare feet. Subjects should be free of significant pain, surgery or severe 
deformity. If you experience some pain please mark it on the body diagram below and indicate pain 
severity out of /10. 
2. Counterbalance the order of measurements 
3. Participant should maintain his/her balance adequately. If the participant shows difficulties or 
started to shiver then you record the timing using stop watch. 
4. If the participant managed to maintain the position more than three minutes then you record it and 
tell him….. Finished. 

| Static balance in seconds | Trunk stability push-up | Deep Squat |
|---------------------------|-------------------------|------------|
|                           |                         |            |
|                           |                         |            |

- Static balance in seconds
- Trunk stability push-up
- Deep Squat