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Functional Mobility and Balance of College-Age Adults Before and After TRX® Suspension Training

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Functional Mobility and Balance of College-Age Adults Before and After TRX® Suspension Training

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Abstract

The suggestion that functional mobility and balance can be improved with targeted physical activity interventions for individuals to maintain efficient movement patterns and independence throughout the life span is the cause for many current lines of research. Understanding how muscle activation contributes to efficient movement patterns is coupled with the need to use assessment tools that can measure functional mobility and balance in an individual over time; however, the need for effective exercise intervention programs designed to improve functional mobility and balance persists throughout current research literature. The purpose of this study was to investigate how TRX® Suspension Training impacted the functional mobility and balance of college-age adults. Undergraduate and graduate students (n = 12; 20.3 ± 1.5 years) participated in a six-week TRX® Suspension Training program. Functional mobility and balance were assessed pre- and post-intervention using the Functional Movement System (FMS) and the Y Balance Test (YBT). Eleven participants completed the study. A significant difference was found for the FMS composite scores as well as in the left YBT ($p = 0.02$) and right YBT ($p = 0.01$) composite scores pre- to post-intervention. Significant differences were found in the individual FMS test for left shoulder mobility ($p = 0.034$) and in the following directional YBTs: left posteromedial ($p = 0.036$), right posteromedial ($p = 0.050$), left posterolateral ($p = 0.014$), and right posterolateral ($p = 0.050$). While the benefits of TRX® Suspension Training intervention shows promise in improving functional mobility and balance in these college age adults, more research in other populations such as older adults and in various settings such as rehabilitation and sports performance could be useful in determining the degree of change that TRX® Suspension Training can provide for functional mobility and balance improvements.

Keywords: functional mobility, balance, TRX®, FMS, YBT

Functional Mobility and Balance of College-Age Adults Before and After TRX® Suspension Training

Basic exercise patterns, known as functional movements, are crucial to performing the daily tasks required to live a long and healthy life. Functional movement is defined as the production and maintenance of mobility and stability balance along the kinetic chain, which is utilized in performing fundamental muscle patterns with accuracy and efficiency (Okada et al., 2011). These functional movements are commonly categorized into five primary movement patterns: hinge, push and pull, rotation, lunging, and squatting; all of which are required to complete daily tasks such as walking, picking up groceries, taking the stairs, and even getting up and down from a chair. Without accurate and efficient functional movement patterns, individuals may experience a decreased quality of life and independence and may also be at an increased risk for injury (Cortell-Tormo et al., 2018). Efficiency with functional movement patterns and balance requires sensory, biomechanical, and motor-processing strategies that are adaptive to change and learned responses from previous experiences. From these strategies are core stability and trunk stabilization, which are essential components in facilitating efficient and safe limb movements in the action of transferring or generating forces throughout the kinetic chain (Cortell-Tormo et al., 2018). Core stability and trunk stabilization are crucial to movements that involve the kinetic chain, which the five primary functional movements all engage.

The engagement of the kinetic chain with appropriate muscle activation throughout functional movements is essential to producing safe and efficient muscle patterns. The theory that movement control and stability throughout the kinetic chain stem from proximal to distal (core-to-extremity) and head to toe (cephalo-caudal) progression supports the idea that factors such as muscular strength, endurance, flexibility, coordination and balance are necessary in order to achieve efficient functional movement patterns (Okada et al., 2011). As functional movement patterns are essential to performing tasks of daily life efficiently and accurately, identifying inefficient movement patterns, where abnormal patterns are present, that stem from those factors can be done. Identification of abnormal or inefficient movement patterns is essential; however, appropriate interventions that support improvements to the components of functional movement patterns (such as increases in strength, coordination, balance, flexibility and endurance) must also be determined. Because of this, investigating the relationship between assessments of strength, balance, and individual functional movement patterns as well as effective intervention strategies to determine how improvements in functional movement patterns and balance can be facilitated should continue to be researched.

Functional Resistance Training and TRX® Suspension Training

Functional resistance training, an exercise method that tends to focus more on multiplanar and multi-joint exercises through coordination, core engagement, and technique rather than training loads, is one exercise intervention that promotes dynamic stabilization training to encourage muscle activation level improvements (Cortell-Tormo et al., 2018). One method of functional resistance training growing in popularity is TRX® Suspension Training, which is also known as total resistance exercise training. TRX® Suspension Training was developed by former U.S. Navy SEAL Randy Hetrick in 2005 using only a jiu jitsu belt and parachute webbing (Fitness Anywhere LLC, 2020). The TRX® Suspension Training system is comprised of two straps that have a cradle on each end and are connected to each other by an anchor point. These training systems are meant to be used by one individual at a time by utilizing their own body weight as the method of resistance. Its intention is to provide a versatile training method that has the capability to challenge the entire kinetic chain throughout various movement patterns.

Suspension training, as a different variation of body weight exercise training, requires increased muscle activation in order to perform any given task; however, the training load and intensity is based on an individual's ability to alter three properties: size and location of base of support relative to the body, direction of vector forces, and the horizontal body position relative to the individual's center of mass (Bettendorf, 2010). By understanding how the body responds to varying degrees of an unstable base of support, balance and muscle movement pattern responses can be tailored to individualize the range and efficiency of an individual's kinematics. Individuals who reflect inefficient kinematics usually display a learned compensation method or a non-painful biomechanical dysfunction; however, insufficient kinematics may be subject to progressively heavier loads, which increase an individual's risk of musculoskeletal injury and may prohibit progressions in their training. By providing unstable training, such as suspension training, the body receives a greater sensory feedback in order to enhance appropriate responses of the motor system to increase levels of co-contraction and joint stability.

Benefits of TRX® Suspension Training

TRX® Suspension Training, which involves the progression of a wide range of motion over the body's base of support and an ability to increase the load and intensity of the exercise, has been shown to be effective in increasing muscle activation and awareness (Bettendorf, 2010). Harris et al. (2017) compared body weight exercises to those utilizing body weight suspension training and found significant increases in muscle activation in the following muscles per exercise: plank (obliques), pushup (pectoralis, rectus abdominus, obliques, rhomboids, erector spinae), row (deltoid, obliques), and bridge (rectus abdominus, erector spinae). Similarly, Morat et al. (2019) reported a significant difference in muscle activation during TRX® exercises in eight different trunk muscles (serratus anterior, obliquus externus abdominus, erector spinae, multifidus, rectus abdominus, and latissimus dorsi). Both studies utilized EMG electrodes on young adults of a mean age between 25 and 27 years and identified significant differences in muscle activation in single muscles (Harris et al., 2017; Morat et al., 2019). In addition to these studies, there were significant findings on increased trunk activation targeting four muscles (rectus abdominis, external oblique, rectus femoris and serratus anterior) that occurred in the TRX® suspended exercises versus plank exercises performed on the floor (Byrne et al., 2014). The results from these studies performed by Harris et al. (2017), Morat et al. (2019), and Byrne et al. (2014), support the prevalence of increased muscle activation in unstable conditions, such as those induced by suspension training, compared to stable training conditions of body weight and ground contact alone.

Increased muscle activation and improved proprioception are just two of the many benefits in utilizing suspension training exercises such as TRX®, over traditional body weight or floor exercises alone. By incorporating suspension exercises into a regular exercise routine, individuals elicit metabolic responses that meet guidelines for improving and maintaining cardiorespiratory and muscular fitness levels while positively impacting cardiovascular and metabolic disease risk factors (Smith et al., 2016). In a study of moderately active individuals between 21 and 71 years of age, suspension exercises led to a significant decrease in waist circumference, body fat percentage, resting systolic and diastolic blood pressure and reflected an 89.2% clinically beneficial rate to improving the 30-year cardiovascular risk. Additionally, it has been noted that though suspension exercise did not typically improve VO_{2max} values, it significantly increased 1-Repetition Max values in the leg and bench press, curl up, and push up tests (Smith et al., 2016). These results indicated TRX® Suspension Training significantly improved strength measures, which present the potential for TRX® exercise programs to be used in rehabilitation and specialized performance training fields.

Unstable training, as provided by TRX® Suspension Training, is a specific intervention method of exercise that can provide strength, range of motion, and balance improvements in functional movement patterns. When recommended as an intervention, suspension training may improve physical fitness measures enough to decrease the risk of injury. This method of training for improving functional movement patterns and balance is relatively new, as demonstrated by Smith et al. (2016). By incorporating an 8-week program of TRX® Suspension Training in moderately active individuals, significant differences in muscular endurance and strength as well as flexibility sit-and-reach tests were found. Though the benefits of TRX® training were discussed previously, these findings support the hypothesis that TRX® Suspension Training can be recommended as a form of exercise that not only improves health components, but also improves functional movement patterns and factors such as balance, strength, and efficiency. Recommending an exercise intervention such as TRX® Suspension Training to improve functional movement and balance deficits should be supported; however, identifying and assessing where those deficits occur and the extent to which they occur, should also be considered.

Assessing Functional Movement and Balance Deficits

The implementation of specific interventions, such as TRX® Suspension Training, that target functional movement patterns have reflected outcomes of improvement in movement analysis tests such as the Functional Movement Screen (FMS) and the Y Balance Test (YBT) (Bodden et al., 2015; Huebner et al., 2019; Kiesel et al., 2011; Stanek et al., 2017; Tejani et al., 2019). Interventions utilizing suspension training have been an effective intervention and exercise method to improve functional movement patterns and should be encouraged by exercise and fitness professionals as an appropriate exercise method (Bodden et al., 2015; Huebner et al., 2019; Kiesel et al., 2011; Tejani et al., 2019). An example of implementing such interventions was observed in professional football players who participated in a structured seven-week strength and conditioning program with corrective exercises to increase range of motion. This strength and conditioning program, which incorporated corrective exercises, allowed motor learning and a stimulation of natural core muscle activation. The program also resulted in an increase in the number of football players who scored above a 14 score on FMS from seven to 39 out of 62 players studied. Additionally, exercise programming improved the overall FMS composite score of players from pre-test (lineman: 11.8 ± 1.8; non-lineman: 13.3 ± 1.9) to post-test (lineman: 14.8 ± 2.4; non-lineman: 16.3 ± 2.4) (Kiesel et al., 2011).

Although the study by Kiesel et al. (2011) supports the use of this structured exercise intervention in athletes, Stanek et al. (2017) also found that active duty firefighters had significant improvements in FMS score by participating in an 8-week intervention program incorporating strength and conditioning training sessions. By encouraging firefighters to partake in a structured exercise plan, there was a significant improvement in FMS composite scores (pre-test mean ± SD: 12.09 ± 2.75; post-test mean ± SD: 13.66 ± 2.28), mobility, and advanced movements. These results reflected a 65% improvement in advanced movement scores, with 55% and 58% improvement on mobility and stability scores in participants. The reflected improvements in FMS scores from both Kiesel et al. (2011) and Stanek et al. (2017) indicate the effectiveness of interventions targeted to address limb asymmetries implemented into strength and conditioning programs having a significant effect on mobility, balance, and overall risk of injury. With these results, exercise professionals can advocate for more strength and conditioning programs to implement corrective exercises and interventions targeted to address limb asymmetries to improve mobility, stability, and overall risk of injury.

Assessing Effectiveness of Corrective Exercise Programs

The implementation of specific interventions that target functional movement patterns have reflected outcomes of improvement in movement analysis tests such as the FMS and the YBT (Bodden et al., 2015; Huebner et al., 2019; Kiesel et al., 2011; Stanek et al., 2017; Tejani et al., 2019). The FMS consists of seven tests, which are scored collectively as best out of 21 and each test is scored from zero to three; all of which challenge an individual's ability to perform the basic movement patterns necessary for combinations of flexibility, strength, range of motion, balance, coordination, and proprioception (Schneiders et al., 2011). A composite score less than or equal to 14 has been indicated to predict a greater risk of injury with values of specificity at 0.91 (out of 1.00) and a sensitivity of 0.54 (out of 1.00). In a study of professional football players by Kiesel et al. (2007), players who scored less than a 14 had more than a 1.87 times greater relative risk for time loss injuries over the course of their season, calculated by injury surveillance over all the participants over the course of their preseason (Kiesel et al., 2007). The seven tests of the FMS are as follows: deep squat, hurdle step, in-line lunge, shoulder mobility with clearing exam, active straight leg raise, trunk stability push-up with clearing exam, and rotary stability with clearing exam (Cook et al., 2014a; Cook et al., 2014b). The primary goal of the FMS test is to evaluate the kinetic chain system, which works in a proximal to distal direction to initiate movement (Cook et al., 2014; Schneiders et al., 2011).

The YBT utilizes clinical measures of dynamic balance that incorporate unilateral balance in a low-cost design that reflects postural control and balance within planes of movement commonly relied upon in sport (Greenberg et al., 2019). Biomechanically, the YBT requires dynamic movement and balance in a single leg stance to assess functional limb symmetry unilaterally in the lower extremities. Additionally, YBT promotes the use of neuromuscular factors such as strength, proprioception, coordination, flexibility, postural control, and core stability throughout single leg balance (Ruffe et al., 2019). The single leg stance in the lower extremity requires the utilization of these neuromuscular factors throughout three directions of the YBT: anterior (ANT), posteromedial (PM) and posterolateral (PL) (Greenberg et al., 2019; Ruffe et al., 2019). The YBT is scored by the greatest reach out of three trials for the left and right leg in each of the three directions (PL, ANT, PM). A trial is considered invalid if the following occurs: leg and foot did not return to start, placed reach foot on the ground, raised or moved the stance foot so stance foot did not maintain contact on the platform, and if individual placed whole weight on reach plate to push further without contact or kicked plate with reach out (Ruffe et al., 2019). Successful trials are measured and evaluated individually and against each other: ANT versus PM, ANT versus PL, and PM versus PL.

Assessing the scores observed from the YBT reflect the differences measured in each direction and between limbs to predict a greater risk of injury due to limb asymmetry or neuromuscular deficits (Greenberg et al., 2019; Ruffe et al., 2019). Current research hypotheses in YBT indicate there is a relative increase in risk of injury if an individual demonstrates a composite score or between limb difference of more than 4.0 centimeters (Ruffe et al., 2019; Wilson et al., 2018). In a study from Chimera et al. (2015), a greater variability in YBT reach asymmetry between limbs were more common in individuals with trunk or back injuries, which have been shown to contribute to a greater risk for lower extremity injuries as well. As a result, YBT and FMS are both field-expedient options to capture multiple risk factors of injury efficiently and provide a wide range of valuable information on movement patterns.

Effects of TRX® Suspension Training

The prevalence of injuries in college-age adults, regardless of physical activity level, is a call to action for health and fitness professionals. By understanding how assessment tools should be utilized to assess an individual's movement patterns, recommendations can be made to provide interventions that are effective in reducing the risk of injury (Huebner et al., 2019). TRX® Suspension Training, with its multidimensional training methods and ability to promote enhanced levels of neuromuscular activation and proprioception, could be an efficient exercise intervention to recommend. Additionally, reliable assessment tools such as the FMS and YBT should be used to help researchers quantify and evaluate improvements in factors such as functional movement and balance patterns. To our knowledge, no other research studies have investigated TRX® Suspension Training as an intervention method to improve functional mobility and balance in the collegiate population. Therefore, the purpose of this study was to examine the effects of TRX® Suspension Training on functional mobility and balance in college-age adults.

Methods

Participants

Undergraduate and graduate students (*N* = 12) from a mid-sized, public institution participated in this research study. All participants were 18-25 years of age and attested that they met the weekly physical activity guidelines as set by the U.S. Department of Health and Human Services (HHS) (HHS, 2018).

Equipment, Materials, & Measures

Pre-test and post-test assessments were completed using the FMS tool kit (FMS; Functional Movement Systems Inc., Chatham, Virginia) and YBT kit (Move2Perform, Evansville, Indiana).

Functional Movement Screen. The FMS test consists of seven tests, all of which challenge an individual's ability to perform the basic movement patterns necessary for combinations of flexibility, strength, range of motion, balance, coordination, and proprioception (Schneiders et al., 2011). Each test is scored on a range from zero to three, with three being the best possible score and zero representing the presence of pain during the movement and the need for further assessment by a health professional. A score of one indicates that the person cannot complete the movement or assume the pattern necessary for the movement while a score of two is given if the person can complete the movement, but a compensation is necessary to reach achievement. A score of three reflects a fundamental movement is done correctly, without visible compensations (Cook et al., 2014a; Cook et al., 2014b). For any score less than a three, additional comments should be noted by the evaluator in order to provide more information on the course of action needed for the appropriate corrective exercise or intervention that should follow post-assessment.

The seven tests of the FMS are as follows: deep squat, hurdle step, in-line lunge, shoulder mobility with clearing exam, active straight leg raise, trunk stability push-up with clearing exam, and rotary stability with clearing exam (Cook et al., 2014a; Cook et al., 2014b). A description of each test, as described by Gray Cook (Cook et al., 2014a; Cook et al., 2014b), details what each functional movement and clinical implication related to the findings of the test are described below.

Deep Squat. This movement challenges total body mechanics to assess functional mobility of the hips, knees, and ankles, bilaterally and symmetrically. The deep squat requires a dowel pressed overhead, which assesses bilateral, symmetrical mobility of the shoulders and thoracic spine as well as stability and motor control of the core musculature. Clinical implications reflect the maintenance of a closed kinetic chain by dorsiflexion of the ankles, flexion of the knees and hips, extension of the thoracic spine, and flexion and abduction of the shoulders (Cook et al., 2014a).

Hurdle Step. The hurdle step is an analysis of the mechanics during a stepping motion using a proper stride. Proper coordination and stability between the hips and torso during the stepping motion, as well as single leg stance ability is required with bilateral functional mobility and stability of the hips, knees, and ankles. Stance leg stability at the ankle, knee and hip while maintaining a closed kinetic chain extension of the hip and the step leg brings an open kinetic chain dorsiflexion of the ankle, and flexion of the knee and hip throughout dynamic balance (Cook et al., 2014a).

In-Line Lunge. This test stimulates stresses during rotational and lateral type movements by imposing a narrow base of support that challenges the trunk and extremities to resist rotation and maintain proper alignment while assessing hip and ankle mobility and stability with knee stability and quadriceps flexibility (Cook et al., 2014a).

Shoulder Mobility. The shoulder mobility test requires bilateral and reciprocal range of motion, combining internal rotation with adduction of one shoulder and external rotation and abduction of the other requires normal scapular mobility and thoracic spine extension. This test and its clearing exam are performed to observe a pain response and identify shoulder impingement (Cook et al., 2014b).

Active Straight Leg Raise. This test requires stability of the torso that is disassociated with the mobility of a lower limb from the trunk. Flexibility of the hamstring, gastrocnemius, and soleus while maintaining a stable pelvis, and core and active extension of the opposite leg is required to demonstrate adequate hip mobility of the opposite leg and pelvic and core stability (Cook et al., 2014b).

Trunk Stability Push-Up. This test requires stabilization of the core and spine in an anterior and posterior plane during a closed-chain upper body movement in the sagittal plane. A clearing exam is performed at the end of the trunk stability push-up test to observe a pain response to indicate the presence of back pain (Cook et al., 2014b).

Rotary Stability. The rotary stability test requires proper neuromuscular coordination and energy transfer from on segment of the body to another through the torso utilizing multi-planar trunk stability. The test is performed through the extension of the hip and knee while flexing the shoulder and is followed by bringing the elbow to knee in line over the board while maintaining bilateral core control throughout the exercise. If the exercise cannot be completed with bilateral balance and control with same side arm and leg, opposite limb movement is performed. A clearing exam is performed at the end of the rotary stability test by remaining over the board in a table top position and extending the arms forward as far as possible while hips rotate back over the ankles, which will indicate if there is a presence of back pain (Cook et al., 2014b).

The seven tests of the FMS are scored collectively as best out of 21; however, a larger part of the tests in the FMS, 5 out of 7 tests to be exact, are directed towards both left and right sides, with both sides being scored and the lower of the two scores being the final score that is counted toward the total (Schneiders et al., 2011). As a result, the composite score is evaluated for overall risk of injury while individual test scores can help identify specific insufficient movement patterns.

Y Balance Test. The YBT was developed as a modification of the Star Excursion Balance Test (SEBT) that measures reach in eight directions (Greenberg et al., 2019). The Lower Quarter Y Balance Test is scored by the greatest reach out of three trials for the left and right leg in each of the three directions (PL, ANT, PM). A trial is considered invalid if the following occurs: leg and foot did not return to start, placed reach foot on the ground, raised or moved the stance foot so stance foot did not maintain contact on the platform, and if individual placed whole weight on reach plate to push further without contact or kicked plate with reach out (Ruffe et al., 2019). Successful trials are measured and evaluated individually and against each other: ANT versus PM, ANT versus PL, and PM versus PL. The YBT composite scores are calculated using the sum reach value of each of the three directions (posterolateral, anterior, posteromedial) divided by three times the length of the right limb with this value multiplied by 100. The differences measured in each direction and between limbs, left and right side, are used to predict a greater risk of injury due to limb asymmetry or neuromuscular deficits (Greenberg et al., 2019; Ruffe et al., 2019).

Procedures

Orientation. The University Institutional Review Board approved this research study. Participants were recruited by word of mouth, announcements made through the University campus email system, and email advertisements sent by the researcher's graduate coordinator. Participants expressed interest in participating in the study to the primary investigator who invited them to sign up for an information session and pre-testing appointment. Information sessions and pre-testing appointments were held until the maximum number of participants (N = 12) was recruited. During the information session, all participants were given adequate time to read the consent form, which included the purpose, description of the FMS and YBT procedures, confidentiality protection, and risks of participation as well as the exercise session details. Time was allotted for questions, which were answered. The researcher then asked participants to sign the informed consent form if they wanted to participate in the study. The researcher then scheduled the pre-testing session with each participant. The researcher followed up with an email, reminding participants of their pre-testing session appointment time, directions to the laboratory, and recommendations to wear active clothing and shoes. The email concluded with a reminder to participants that all testing (pre- and post-testing) would be completed in the Exercise Physiology Laboratory to maintain privacy and confidentiality for each participant during testing sessions.

During the pre-testing session, the participant arrived at the Exercise Physiology Laboratory and was greeted at the entrance by the researcher. Each participant was provided an explanation of what the tests and measurements consisted of within the pre-testing session. The researcher recommended participants ask for clarification if any instructions for the movements of the tests were unclear and if the participants were to experience any pain during any of the movements, they immediately stop. If pain was experienced by the participant, the researcher made note of it and moved to the next test. After confirmation from the participant that they understood all that had been explained, the testing started.

Testing Sessions. The first test conducted was the FMS, which consisted of seven tests and three clearing tests. Participants self-reported their age, body weight, and height while measurements for dominant hand length and dominant leg length were collected by the researcher. Procedures for the FMS in pre- and post-testing were followed according to the set-up recommended by Cook (2014a; 2014b). The seven tests and three clearing tests were performed in order as follows: deep squat, hurdle step, inline lunge, shoulder mobility and shoulder impingement clearing test, active straight leg raise, trunk stability push-up and clearing test, rotary stability, and posterior clearing test. Five of the seven tests (hurdle step, inline lunge, shoulder mobility, active straight leg raise, and rotary stability) are scored on the left and right sides of the body. These tests are scored on an ordinal scale of 0-3 with the final score of each test being summed for a composite score. Each participant had a maximum of three trials for each of the tests before moving to the next test and the lowest score from the two sides was used for the final score of the individual test. After all the individual tests were scored, a composite score was calculated by adding the final scores of all seven tests together.

The YBT was then explained for participants by instructing participants to push the indicator box for a maximum of three trials in each of the three directions using first their left leg and then the right leg along the YBT test kit measurement scale. Balance reach distance measurements for right and left leg in each of the three directions (posterolateral, anterior, posteromedial) were measured using the YBT. After data collection for all directions for each leg was conducted, participants were enrolled into six weeks of a TRX® exercise program.

Participants were informed that the pre-test had been completed and the TRX® exercise sessions would start the following week at the student recreation center. A follow up email providing instructions to the location of the TRX® training room for the exercise sessions was sent and a recommendation to arrive on time to the session wearing active attire and shoes was suggested.

TRX® Training – the Treatment. The exercise program utilized TRX® Suspension Training, a total body resistance form of exercise, and was led by a certified personal trainer at the University Student Recreation Center. The goal of these exercise sessions was to stimulate natural core muscle activation and enhance the relationship between functional movements, strength, and balance in a conditioning program that utilized body weight as the only resistance throughout the exercises. The TRX® exercise program was offered twice per week for six weeks for a total of 12 exercise sessions. Attendance by sign-in sheet was taken at all 12 exercise sessions. Exercise sessions were 55 minutes in length and consisted of a proper warm up and cool down period. Participants were encouraged in person and via email to attend all 12 sessions immediately following the pre-test session and at the halfway point of the training program prior to exercise session number six.

One week prior to the last TRX® exercise session, participants were verbally encouraged to sign up for the post-testing FMS and YBT session, which was performed the week following the conclusion of the training program. A follow up email after the tenth exercise session encouraged participants to sign up for a post-testing time with the researcher during the week immediately following the twelfth exercise session. Post-testing was completed by each of the remaining participants. All post-testing sessions repeated the pre-testing session procedures; however, after the YBT test, all participants were informed that they had completed the study. The researcher verbally offered all participants a follow up email after the collected data was analyzed to provide an explanation of their results and provide appropriate corrective exercises, if desired. Participants verbally accepted or denied the offer for a follow up at the conclusion of the post-testing session.

Statistical Analysis

SPSS 26 statistical software (IBM Corp., Armonk, N.Y., USA) was used to analyze the demographics for the participants as shown in Table 1. Means and standard deviations for age, body height, body weight, body mass index (BMI), pre- and post-test FMS scores, and pre- and post-test YBT composite scores of the participants were calculated using descriptive statistics. Wilcoxon Signed Rank Tests were performed to compare the pre- and post-test individual FMS tests of the left and right sides, including the FMS tests: hurdle step, inline lunge, shoulder mobility, active straight leg raise, and rotary stability. Comparisons between pre- and post-test YBT directions (anterior, posteromedial, posterolateral) for the left and right sides were compared using Wilcoxon Signed Rank Tests in order to distinguish if significant differences may be found in certain directions as well as where those significances may be found. To compare pre- and post-test composite scores of the FMS and YBT, one-way repeated measures ANOVAs were calculated. The p value was set *a priori* at $p < 0.05$.

Results

Participants were 18-25 years of age (20.3 ± 1.5 years). Means and standard deviations for height, weight, and Body Mass Index are listed in Table 1. The sample consisted of 12 participants (*n* = 10 females; *n* = two males), 11 of which whom participated in all components of the study: pre-testing, TRX® training, and post-testing. One female participant withdrew from the study due to unrelated illness.

Table 1

Descriptive Statistics for Participants' (N=11) Demographics

Variable	Mean ± SD	Minimum	Maximum
Age (years)	20.3 ± 1.5	18	22
Height (inches)	65.0 ± 2.6	60.0	68.0
Weight (lbs)	149.0 ± 23.5	115	185
Body Mass Index (kg/m^2)	24.8 ± 3.7	19.1	29.2

Note. SD (Standard Deviation).

Interrater Reliability for the Functional Movement Screen Scores of Three Raters

For the present study, a certified FMS Level 1 examiner completed all of the FMS testing. The reliability of this rater was assessed by comparing the tester's ratings to two other FMS® Level 1 Certified examiners in order to establish interrater reliability. Participants (*N* =12) ages 18-25 years from the same university as the examiners were recruited by word of mouth and were evaluated by all three raters for each of the seven individual FMS tests and three clearing tests. An Intraclass Correlation Coefficient (ICC) was calculated for the FMS composite scores. Additionally, the intraclass correlation coefficient was calculated at a 95% CI (0.879-0.985) and equaled 0.952, which indicates a high reliability between the three raters. It was concluded that the FMS Certified Level 1 rater for the present study could provide accurate ratings for the FMS.

Krippendorff's alpha (Kα) was calculated to determine the interrater reliability between the three raters for each FMS test (Hayes & Krippendorff, 2007). On the scale of 0.0000 (absence of reliability) to 1.0000 (perfect reliability), a Kα score of 0.8 or above has been indicated as an acceptable rating of good to excellent reliability (Bonazza et al., 2016). All of these values are reported in Table 2. For the tests of right hurdle step, trunk stability push-up, right active straight leg raise, and right rotary stability Kα's were between 0.8-1.0 which indicates high reliability among the three testers. All FMS tests met this criterion except for the deep squat (Kα = 0.78), left hurdle step (Kα = 0.78), left inline lunge (Kα = 0.42), and right inline lunge (Kα = 0.55). A q value or the probability of failure to achieve an alpha level of 0.67 if 10,000 participants were tested was calculated for these four tests and are indicated as follows in Table 2: squat = 0.09, left hurdle step = 0.09, left inline lunge = 0.98, and right inline lunge = 0.82, respectively.

The probability that the Kα would not be acceptable (i.e., > 0.67 even if 10,000 participants were tested) is interpreted from the q values. As a result, the deep squat and left hurdle step have only a 9% chance of not being above 0.67 if 10,000 participants were tested. Therefore, the Kα's for deep squat and left hurdle step are moderately reliable. Comparatively, the left and right inline lunge tests had a 97% chance and an 82% chance of being below 0.67 if the entire population was tested. Thus, the agreement of the ratings for these two tests among the raters would not necessarily be reliable.

Table 2

Interrater Reliability of Participants (N=12) Between Three Examiners

Variable	K alpha	95% Confidence Intervals	q at 0.67	% chance of failing to reach 0.67
Deep Squat	0.78	(0.57, 0.95)	0.09	9%
Left Leg Hurdle Step	0.78	(0.57, 0.95)	0.09	9%
Right Leg Hurdle Step	0.85	(0.73, 0.95)		
Left Leg Inline Lunge	0.42	(0.16, 0.66)	0.98	98%
Right Leg Inline Lunge	0.55	(0.33, 0.78)	0.82	82%
Left Shoulder Mobility	1	(1, 1)		
Right Shoulder Mobility	1	(1, 1)		
Left Active Straight Leg Raise	1	(1, 1)		
Right Active Straight Leg Raise	0.91	(0.78, 1)		
Trunk Stability Push-Up	0.95	(0.87, 1)		
Left Rotary Stability	1	(1, 1)		
Right Rotary Stability	0.89	(0.74, 1)		

Note. (q) represents the probability (percent chance) that Kα would not achieve at least 0.67 if the entire population of 10,000 was tested (Hayes & Krippendorff, 2007).

Functional Movement Screen

Means and standard deviations for the total composite scores of the FMS are shown in Table 3. Descriptive statistics for individual FMS tests including those for single limb (left and right sides) are exhibited in Table 4. A one-way, repeated measures ANOVA was calculated to determine if there was a statistically significant difference for FMS composite scores pre- to post- TRX® training (see Table 5). Wilcoxon Signed Rank Tests were performed for comparisons between pre- and post-test scores of each individual FMS test (see Table 6). The FMS test scores significantly increased at the post-testing for left shoulder mobility, while right shoulder mobility approached significance as well. The main effects of Time for the remaining individual FMS tests were not statistically significant. Overall, the FMS composite score pre- to post-intervention was significantly different (p=.01) as the mean of the post-test composite score (15.5 ± 1.9) was 1.8 greater than the pre-test composite score (13.7 ± 2.2).

Y Balance Test

Mean and standard deviations for left and right YBT composite scores are shown in Table 3 and left YBT (Table 8) composite score compared to the right YBT (Table 9) composite score were not found to be statistically significantly different. A significant difference in left YBT composite score pre- to post-test (p=.02) was found as the means of the pre-test composite score (101.8 ± 8.7) improved by 4.8 to the post-test composite score (106.6 ± 8.9). In the right YBT, the composite score was statistically significantly different (p=.01) pre- to post-test as the mean composite scores improved by 3.7 (pre-test: 102.1 ± 8.4; post-test: 105.8 ± 9.5).

Directional scores on the left and right sides for the YBT including anterior, posteromedial, and posterolateral are shown with descriptive statistics in Table 7. Wilcoxon Signed Rank Tests were performed for comparisons between YBT directional scores (anterior, posteromedial, posterolateral) pre- and post-training (see Table 10). There was a significant increase in directional scores of the YBT in the left and right posteromedial and the left and right posterolateral directions. The anterior directional scores of the YBT were not statistically different after training.

Table 3

Descriptive Statistics for Participants (N=11) Total Composite Score of FMS and YBT (Left and Right) Pre-Test and Post-Test of TRX® Training

Variable	Pre-Test Mean ± SD	Post-test Mean ± SD
FMS[a]	13.7 ± 2.2	15.5 ± 1.9*
Left YBT[b]	101.8 ± 8.7	106.6 ± 8.9*
Right YBT[b]	102.1 ± 8.4	105.8 ± 9.5*

*$p < 0.05$; Post-test > Pre-test. *Note.* FMS (Functional Movement Screen), YBT (Y Balance Test), SD (Standard Deviation); [a]FMS composite score is calculated by taking the lowest raw score for each side (if applicable) to give a final score for each individual test and adding all final scores for the seven tests together; [b]YBT composite score is the sum of the greatest reach in each of the directions (anterior, posterolateral, posteromedial) divided by three times the limb length in centimeters, then multiplied by 100.

Table 4

Descriptive Statistics for Participants (N=11) Pre-Test and Post-Test of TRX® Training of Scores for Individual FMS Tests

Variable	Pre-Test Mean ± SD	Post-test Mean ± SD
Deep Squat	2.3 ± 0.7	2.6 ± 0.7
Left Leg Hurdle	1.8 ± 0.6	2.0 ± 0.0
Right Leg Hurdle	1.9 ± 0.7	2.3 ± 0.8
Left Leg Inline Lunge	2.3 ± 0.8	2.5 ± 0.5
Right Leg Inline Lunge	2.3 ± 0.8	2.3 ± 0.7
Left Shoulder Mobility	2.3 ± 0.8	2.8 ± 0.4*
Right Shoulder Mobility	2.2 ± 0.7	2.7 ± 0.4
Left Active Straight Leg Raise	2.6 ± 0.5	2.6 ± 0.5
Right Active Straight Leg Raise	2.5 ± 0.5	2.5 ± 0.5
Trunk Stability Push-Up	1.3 ± 0.7	1.5 ± 0.8
Left Rotary Stability	2.0 ± 0.0	2.0 ± 0.4
Right Rotary Stability	1.9 ± 0.3	2.0 ± 0.4

*$p < 0.05$; Post-test > Pre-test. *Note.* FMS (Functional Movement Screen), SD (Standard Deviation).

Table 5

Repeated Measures ANOVA (Tests of Within-Subjects Effects) for Participants' (N=11) FMS Total Composite Score

Source with Variable (Time)	Type III Sum of Squares	*df*	Mean Square	*F*	Significance $p \leq 0.05$ (2-tailed)	Partial Eta Squared	Observed Power
Sphericity Assumed	18.18	1	18.18	9.66	0.01*	0.49	0.80
Greenhouse-Geisser	18.18	1.00	18.18	9.66	0.01*	0.49	0.80
Huynh-Feldt	18.18	1.00	18.18	9.66	0.01*	0.49	0.80
Lower-bound	18.18	1.00	18.18	9.66	0.01*	0.49	0.80

*Significant at $p < 0.05$

Table 6

Wilcoxon Signed Rank Test for Participants (N=11) Pre- and Post-TRX® Training of Scores for Individual FMS Tests

Variable	*Z*	Significance $p \leq 0.05$ (2-tailed)
Deep Squat	-1.3[a]	0.180
Left Leg Hurdle Step	-0.8[a]	0.414
Right Leg Hurdle Step	-1.6[a]	0.102
Left Leg Inline Lunge	-1.1[a]	0.257
Right Leg Inline Lunge	0.0[b]	1.000
Left Shoulder Mobility	-2.1[a]	0.034*
Right Shoulder Mobility	-1.8[a]	0.063
Left Active Straight Leg Raise	0.0[b]	1.000
Right Active Straight Leg Raise	0.0[b]	1.000
Trunk Stability Push-Up	-1.4[a]	0.157
Left Rotary Stability	0.0[b]	1.000
Right Rotary Stability	-0.6[a]	0.564

*Significant at $p < 0.05$; [a] Wilcoxon Signed Rank Test based on negative ranks; [b] The sum of negative ranks equals the sum of positive ranks.

Table 7

Descriptive Statistics for Participants' (N=11) Pre-Test and Post-Test of TRX® Training for YBT Directional Test Scores

Variable	Pre-Test Mean ± SD	Post-test Mean ± SD
Left Anterior	75.1 ± 8.7	76.6 ± 10.4
Right Anterior	74.5 ± 9.9	74.4 ± 9.8
Left Posteromedial	101.0 ± 8.8	107.1 ± 10.2*
Right Posteromedial	101.2 ± 9.9	106.2 ± 12.2*
Left Posterolateral	103.5 ± 9.9	109.1 ± 8.4*
Right Posterolateral	104.7 ± 7.4	110.1 ± 11.3*

*$p < 0.05$; Post-test > Pre-test. *Note.* Left and Right refer to using either the left leg or right leg to push the reach plate in the corresponding direction.

Table 8

Repeated Measures ANOVA (Tests of Within-Subjects Effects) for Participants (N=11) Left YBT Composite Score

Source with Variable (Time)	Type III Sum of Squares	*df*	Mean Square	*F*	Significance $p \leq 0.05$ (2-tailed)	Partial Eta Squared	Observed Power
Sphericity Assumed	122.86	1	122.86	7.40	0.02*	0.43	0.69
Greenhouse-Geisser	122.86	1.00	122.86	7.40	0.02*	0.43	0.69
Huynh-Feldt	122.86	1.00	122.86	7.40	0.02*	0.43	0.69
Lower-bound	122.86	1.00	122.86	7.40	0.02*	0.43	0.69

*Significant at $p < 0.05$

Table 9

Repeated Measures ANOVA (Tests of Within-Subjects Effects) for Participants (N=11) Right YBT Composite Score

Source with Variable (Time)	Type III Sum of Squares	*df*	Mean Square	*F*	Significance $p \leq 0.05$ (2-tailed)	Partial Eta Squared	Observed Power
Sphericity Assumed	74.85	1	74.85	9.28	0.01*	0.48	0.78
Greenhouse-Geisser	74.85	1.00	74.85	9.28	0.01*	0.48	0.78
Huynh-Feldt	74.85	1.00	74.85	9.28	0.01*	0.48	0.78
Lower-bound	74.85	1.00	74.85	9.28	0.01*	0.48	0.78

*Significant at $p < 0.05$

Table 10

Wilcoxon Signed Rank Test for Participants (N=11) Pre- and Post-TRX® Training Scores of Directional YBT Tests

Variable	*Z*	Significance $p \leq 0.05$ (2-tailed)
Left Anterior	-0.3[b]	0.789
Right Anterior	-0.2[a]	0.859
Left Posteromedial	-2.0[b]	0.036*
Right Posteromedial	-1.9[b]	0.050*
Left Posterolateral	-2.4[b]	0.014*
Right Posterolateral	-1.9[b]	0.050*

Note. Left and Right refer to using either the left leg or right leg to push the reach plate in the corresponding direction.

*Significant at $p < 0.05$; [a] Wilcoxon Signed Rank Test based on positive ranks;

[b] Wilcoxon Signed Rank Test based on negative ranks.

Discussion

The purpose of this study was to investigate the effects of a six-week TRX® Suspension Training program on functional mobility and balance in college-age adults. The results from this study suggest that TRX® Suspension Training can be effective in improving overall functional movement and balance patterns in young, active populations. This program highlighted the benefits of adding TRX® Suspension Training to the regular physical activity levels of college-age adults, but more importantly, identified the body's response to TRX® Suspension Training in a way that could be individually evaluated by FMS and YBT. Using FMS and YBT as evaluation tools to assess intervention programs such as TRX® Suspension Training require a high reliability in evaluators. This study included that reliability component by performing an interrater reliability analysis between three FMS raters, which resulted in an Intraclass Correlation Coefficient (ICC) calculated at a 95% CI (0.879-0.985). This ICC equaled to 0.952, which indicates a high reliability between the three certified raters (Table 2). The completion of this interrater reliability indicates the high reliability that the pre- and post FMS scores may be replicated in future studies. This study, especially with its interrater reliability component, is the first to investigate the effectiveness of TRX® Suspension Training and encourage the use of transferrable and reliable assessment tools via the FMS and YBT to assess functional mobility and balance in regularly active college age adults.

Functional Movement Screen

Analysis of the results from this study show that the FMS composite scores significantly increased while individual FMS tests were statistically significant for left shoulder mobility as well. The remaining individual FMS tests were not statistically significantly different after the TRX® Suspension Training. Though only one individual FMS was statistically significant, the increases in pre-intervention to post-intervention scores shows promise that individuals may experience improvement in functional mobility and balance from TRX® Suspension Training. Past research indicates a greater risk of injury and greater occurrences of injury present for those who exhibited an FMS composite score of less than 14 (Kiesel et al., 2007; Lehr et al., 2013); however, the current study indicated the importance of implementing TRX® Suspension Training as a way to improve FMS composite scores and lower the risk of injury. With an improvement magnitude of 1.8 for mean composite scores pre-intervention (13.7 ± 2.2) to post-intervention (15.5 ± 1.9), TRX® Suspension Training can be used as an effective training tool to lower the risk of injury from individuals due to the improvement of overall functional mobility and balance in college age adults.

Similar studies with FMS performed by Kiesel et al. (2011) in football lineman and non-lineman, and Stanek et al. (2017) in professional firefighters, utilized structured strength and conditioning programs to improve overall functional mobility and balance. The athletes completed an eight-week structured strength and conditioning program, similar to the current study, which targeted to improve functional mobility with corrective exercises. The strength and conditioning program with targeted strength and conditioning exercises showed an overall 3.0 FMS mean composite score improvement in lineman and non-lineman of 3.0 from pre-test (lineman: 11.8 ± 1.8; non-lineman: 13.3 ± 1.9) to post-test (lineman: 14.8 ± 2.4; non-lineman: 16.3 ± 2.4) (Kiesel et al., 2011). Stanek et al. (2017) showed similar statistically significant improvements in FMS composite scores pre-test (mean 12.09 ± 2.75) to post-test (mean 13.66 ± 2.2) with active firefighters in an intervention that resulted in a 65% improvement in advanced movement scores, 55% improvement in mobility and a 58% improvement in stability within participants. The results of these studies are similar to improvements observed within this current study and indicate the effectiveness of implementing a structured exercise program that is targeted to address mobility, limb asymmetries, and balance; all of which are incorporated into standardized TRX® Suspension Training.

The results of the individual FMS tests were not indicative of statistically significant improvements, with the exception of the left shoulder mobility test. While improvements in pre-test to post-test scores were analyzed (Table 4), the inability of the scores to reflect a statistically significant difference may be due to this population and their current physical activity status. In a study by Triplett et al. (2018) of 100 college age adults that participated in regular activity, a mean FMS score of 14.4 was observed; however, half of the adults had composite scores less than 14, while the other half had scores above 15. The participants who tended to participate in more multi-dimensional training, as found in regular activity and recreational sports, than the average adult scored higher than the average FMS score of 14.4 (Triplett et al., 2018). The results found in the study by Triplett et al. (2018) corresponds to the findings of Perry et al. (2013), who noted in middle age adults that there were more significant increases in FMS scores in those with lower physical activity levels; however, those younger in age and more physically active tended to have smaller increases in individual test and composite scores post-intervention than other populations. As more active individuals tend to have greater levels of physical fitness, it can be suggested that overall improvements to the composite and individual scores of the FMS may not be as substantial as improvements pre- to post-test that could be found in populations who are inactive or older, specifically due to the inefficiency of their functional movement patterns and balance (Zou, 2016). Because of this, the activity level of this study's population may have been a limiting factor in the range of score improvement as the participants had attested to meeting physical activity guidelines and were relatively young.

Due to the magnitude required in individual FMS test scores to change the raw score and total composite score, physically active college age adults may have significant increases in individual FMS test scores when participating in a program for only six weeks in duration. The results of the current study reflect this theory and indicate that the intervention program was not sufficient enough to significantly change the raw scores of the individual tests. These studies by Kiesel et al. (2011), Stanek et al. (2017), and Perry et al. (2013) all support the hypothesis that FMS scores may be impacted by a participant's physical activity level pre-intervention, and the FMS scores may also change as a result of frequencies and type of physical activity in the intervention; as a result, the FMS data from the current study are similar to results displayed in the literature that focuses on this population.

Y Balance Test

The assessment of balance by analyzing YBT results in the current study showed the left YBT composite scores (Table 8) and right YBT composite scores (Table 9) were significantly different post-training intervention. When comparing the results of the current study to a study conducted by Bulow et al. (2019) with a similar sample of healthy, college-age adults, the left YBT (102.1 ± 8.7) and right YBT (103.6 ± 8.8) composite scores are strikingly similar to those found pre-intervention to the current study (left YBT: 101.8 ± 8.7; right YBT: 102.1 ± 8.4). However, by implementing TRX® Suspension Training in the current study, the effects of a structured exercise program are testimony to increasing YBT composite scores to above normal in the general college age adult population. With post-test composite scores increasing by more than 3.7 in the right YBT and 4.8 in the left YBT, TRX® Suspension Training should be recommended as a viable intervention to increase overall balance in college age individuals. The composite scores from these participants are encouraging as these improvements in balance were found in healthy, college age adults; therefore, populations who are older or suffering from injury or balance deficits may experience even greater benefits from a TRX® Suspension Training program.

The differences in directional scores pre- and post-intervention in the current study are predictive of the results that should be observed in healthy, college age adults. The Wilcoxon Signed Rank Test for comparisons between YBT directional scores (anterior, posteromedial, posterolateral) pre- and post-training (see Table 10) indicated a significant increase in directional scores of the YBT in the left and right posteromedial and posterolateral directions. However, the anterior directional scores of the YBT were not statistically different post-training. Though the current study is one of the first to be done with TRX® Suspension Training and college age adults, the study by Bulow et al. (2019) in teenagers 12-18 years of age showed smaller reach distances in all three directions than those performed in the current study. By comparing the reach distances produced in the current study with those shown by teenagers in the study by Bulow et al. (2019), the results of the current study's participants are predictive of how reach distance may change with normal increases in age, BMI, and height from puberty to early adulthood. This hypothesis is supported by another study that included high school athlete participants who were closer in age to the participants of this study and showed much closer directional scores in the posteromedial and posterolateral reach distances to the ones reflected in the current study (Gorman et al., 2012). As a result, the reliability of the data from this current study is very good and the changes observed pre- to post-intervention may be used in comparison for future studies that may have participants corresponding to this population of healthy, active college age adults.

Current Study Strengths and Weaknesses

There are many variables or reasons for the results shown in the current study; however, the overall results are promising as it is the first study to investigate TRX® Suspension Training in college age adults with assessments on functional mobility and balance. A strength of this study was the length of the intervention. The length of the TRX® Suspension Training program (6 weeks; 12 sessions) did indicate some improvements in YBT and FMS scores, although the length of the intervention may also be an explanation for why the results were shown to be not statistically significantly different for individual FMS and YBT tests. While neural adaptations can occur as early as four weeks into an exercise program, Balshaw et al. (2019) indicated that maximum agonist activation changes occur predominantly up to the first twelve weeks of resistance training. Interestingly, the results of the current study show that most individuals did improve FMS and YBT scores; however, not all the individual test scores were statistically significantly significant. Though six weeks of intervention was clear in this study to support an improvement in balance and functional mobility, longer interventions may aid in producing greater improvements in individual FMS tests and YBT reach directions. Long term (from 12 weeks up to four years) resistance exercises as studied by Balshaw et al. (2019), indicated increased inter-muscular coordination from muscle antagonist coactivation, which is a primary contributor in efficient functional mobility; therefore, future research studies may benefit from intervention programs lasting longer than six weeks to further increase the validity of results that indicate functional mobility and balance improvements (Balshaw et al., 2019).

An additional strength to this study was the inherent design of the TRX® Suspension Training program as its most common movements incorporate functional movements similar to those performed in the FMS. Though TRX® Suspension Training is a resistance exercise, the method of resistance is primarily body weight and gravity, which are both required to perform the FMS and YBT. With exercise sessions occurring twice a week, the repetitions and frequency of the movements within TRX® Suspension Training classes resemble other body weight training programs and free weight exercises that incorporate major muscle groups and flexibility. As a result, the participants in this study did reflect some improvements in FMS and YBT scores; however, future research should investigate which TRX® Suspension Training exercises as well as the frequency of exercises that should be recommended for the greatest improvement in functional mobility and balance. Another explanation for these results may include the fact that these participants were already physically active and met the weekly physical activity guidelines as outlined by U.S. Department of Health and Human Services (HHS) (HHS, 2018). Future studies are recommended to investigate the number of sessions or length of program required to see improvement in composite scores in the college age population; however, this study is limited by its non-generalizability, as future studies investigating these components may only be correlated with participants the same age and activity level as these participants.

With only eleven participants completing this study, the small sample size, power, effect size, and margin of error may have been decreased as compared to results that might have been seen in a similar study with a larger sample size. Increasing the sample size in future studies may contribute to a greater internal and external validity than this study could provide with its sample size ($n = 11$). The lack of control group does not contribute to the reliability of this study that improvement of functional mobility and balance scores are a result of participating in the TRX® Suspension Training program or from other variables unknown to the researcher. By having a control group, future studies may be able to enhance the effect of a TRX® Suspension Training program on this population of college age adults and increase the reliability of this research in scientific literature. Lastly, it is possible that the participants remembered their pre-test performance which may have affected their post-test performance; however, scores and results were not shared with participants until after the study concluded with post-testing. As a result, the practice effect of performing the FMS and YBT is possible, but the knowledge of their scores as a participant pre- to post-test was taken out of consideration.

Future Research Considerations

Though there were many individual improvements in composite scores for the FMS and YBT as well as improvements in individual FMS tests, not all were statistically significant; however, length of the intervention or demographics of the sample may result in different results. Because of this, future studies in college age adults may be tailored to those that are inactive or do not meet physical activity guidelines, as well as in the athlete population, to study the effects of TRX® Suspension Training program on existing functional mobility and balance in populations that either have no structured strength and conditioning program or to those that do. Additionally, future studies utilizing TRX® Suspension Training to investigate functional mobility and balance should be focused on different populations such as older and inactive adults, as their physiological response and muscle activation rates may show greater response levels pre- to post-training. Potential future research should also investigate how TRX® Suspension Training may improve the risk of injury in susceptible populations such as athletes, older adults, and those who are inexperienced with physical activity or may experience strength or balance deficits.

Conclusion

This study reflects improvements in functional mobility and balance in college-age adults after a six-week TRX® Suspension Training program. These improvements in functional mobility and balance were assessed utilizing the highly reliable Functional Movement Screen and Y Balance Test. Both FMS and left and right YBT composite scores were statistically significantly different pre- to post-test; however, only the individual tests of left shoulder mobility and left and right posteromedial and posterolateral YBT directional scores were significantly different after training. These findings may be applied to future research and practices performed by health and exercise professionals to not only increase the efficiency and patterns of functional movement and balances, but also to decrease the risk of injury and identify sources of inefficiency, low range of motion, and muscular or skeletal weakness. Though FMS and YBT have widely been used to assess injury risk, this study indicates that these assessment tools are highly reliable in assessing quality of movement, such as functional movement patterns and balance. By implementing exercise intervention programs that focus on body weight stability and muscle activation through functional movement patterns and balance, as found in TRX® Suspension Training, functional movement patterns and balance measures may be improved. In conclusion, the results of this study support that TRX® Suspension Training programming can have a positive effect on functional movement and balance.

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Appendices

Appendix A

Informed Consent Form

BGSU

BOWLING GREEN STATE UNIVERSITY
School of Human Movement, Sport, & Leisure Studies

Informed Consent Form

Project Title: TRX Suspension Training on Functional Mobility and Balance in College-Age Adults

Researcher: Lindsay Rausch, Graduate Student, Kinesiology

Advisor: Dr. Jessica Kiss, Instructor, Human Movement, Sport & Leisure Studies

Key Information: This research study is being conducted to fulfill a master's project requirement for Lindsay Rausch. Participants who are 18-25 years of age and a college student at Bowling Green State University and who are recreationally active (at least 150 minutes per week according to ACSM recommendations) with no limiting conditions may be eligible to participate. A participant can expect an eight-week long, twice weekly, time commitment with the first week pertaining to an orientation session and a pre-testing session, twelve exercise sessions over six weeks, and a post-testing session in the eighth and final week. In the orientation and testing sessions, the participants will complete the Functional Movement Screen (FMS) and Y Balance tests. The exercise sessions will be TRX Suspension Training, as led and completed by a certified personal trainer within the Fitness Department at the BGSU Student Recreation Center. Participation in this study provides no greater risk than those experienced in daily life and in daily exercise activities. All data collected and analyzed throughout this study will remain confidential and in a locked office throughout the study. All participants will have the option to receive their results at the conclusion of the study.

Introduction: My name is Lindsay Rausch and I am a Kinesiology graduate student working under the supervision of my advisor, Dr. Jessica Kiss, at Bowling Green State University. I am inviting you to participate in a research study.

Purpose: You are being asked to participate in a study I am conducting for my master's project. The purpose of this project is to determine how TRX Suspension Training may impact the functional mobility and balance in college age adults 18-25 years of age. The importance of this study will help researchers and exercise professionals to better understand how the nature of TRX Suspension Training, using bodyweight as the primary resistance in its movement patterns, may impact functional mobility and balance over a period of time.

Purpose & Procedure: You will: schedule a time for each of the orientation and testing sessions (pre- and post-test) that will take place in either the Exercise Physiology Laboratory (Eppler S124) or in the Eppler South Gymnasium at Bowling Green State University; wear appropriate attire and shoes for physical activity; complete the PAR-Q and verbally attest that you participate in at least 150 minutes of moderate physical activity per week according to ACSM recommendations; have your height and weight measured, and complete the Functional Movement Screen (FMS) and Y Balance tests. After you read through this consent form, you may decide to participate; and, if not, we will thank you for your time and efforts to assist us and you may leave.

If you participate in this eight week study, you will be asked to attend the orientation session which consists of collecting your height and weight, and signing the BGSU Department of Recreation and Wellness Fitness Waiver and completing a PAR-Q (Physical Activity Readiness Questionnaire) which indicates that you are fully aware and understand the risks and hazards associated with group exercise activities. The PAR-Q will collect data about your fitness and health history in order to assess your readiness to participate in exercise. Participants must be recreationally active (at least 150 minutes of moderate activity per week according to ACSM recommendations) to participate in this study and will confirm that upon completion of the PAR-Q. Upon completion, you will schedule an appointment to complete the Functional Movement Screen (FMS) and the Y Balance test in the Eppler Complex South Gymnasium or in the Eppler Physiology Lab on the BGSU campus prior to the start of small group TRX Suspension Training exercise classes, which take place at the BGSU Student Recreation Center (SRC). Lindsay will contact you via email, as provided upon signup, to schedule the appointment and, if no reply within 48 hours, will follow up with a phone call with the phone number as provided upon signup. All appointments to complete the FMS and Y Balance testing before training classes must be done before October 8, 2020. An initial orientation session will be scheduled for all participants before pre-testing FMS and Y Balance tests in order to provide all participants practice and familiarity with the testing components. The FMS and Y balance testing appointments, as well as the orientation session, will last no longer than 60 minutes.

The orientation and testing session will have the FMS Administered after height and weight are collected. The FMS screen is a seven-part functional movement test in addition to three clearing tests. You will have three trials for each of the seven movement tests and, if needed, one trial for the clearing test. The order of the tests and the descriptions are as follows:

1. The Deep Squat- with a light-weight bar overhead slowly squat as deep as possible and return to a standing position.

2. Hurdle Step (Left & right)- positioning dowel across shoulders, step over the elastic hurdle and touch heel to the floor and return the moving leg back to the starting position, slowly and controlled. Repeated with opposite leg.

3. Inline Lunge (Left & right)- the dowel is placed vertically behind the back, the hand opposite to the front foot will grasp dowel at the cervical spine. The other hand will be placed on dowel at the lumbar spine. Step forward with one foot, moving in a downward motion until your thigh is parallel with the floor. Bring forward foot back to return to a standing position. This will be repeated with the opposite leg

4. Shoulder Mobility (Left & right)- Make a fist with both hands and bring one arm behind your head as far as possible. Bring your opposite arm behind your back and bring your fists as close together as possible. This will be repeated with your arms performing the opposite movement.

5. Impingement Clearing Test (Left & right)- Place palm of your hand on the opposite shoulder. Raise your elbow as high as possible with your hand remaining in contact with your shoulder.

6. Active Straight-Leg Raise (Left & right)- While on the floor, lay on your back with your arms at your sides. Raise one leg as high as you can, keeping your knee straight. Your other leg should remain down and straight. This will be repeated with the opposite leg.

7. Trunk Stability Pushup- While on the floor, lay on your stomach with the balls of your feet touching the floor. Have your hands be palm down on the floor. You will have your thumbs lined up with your chin. Keeping your knees and hips straight, press up your body into a pushup position (up on the balls of your feet and hands). You starting hand position can be changed if needed.

8. Press-up Clearing Test- While on the floor, lay on your stomach with the balls of your feet touching the floor. Have your hands be palm down on the floor. You will have your thumbs lined up with your chin. Keep your hips in contact with the floor and press up with your hands.

9. Rotary Stability (Left & right)- Begin in a position where you are on your hands and knees. At the same time, extend one arm forward while straightening the same sided leg behind you. Keeping the arm and leg in the air, bring the extended leg and arm together, touching knee to elbow. This will be repeated with the opposite leg and arm.

10. Posterior Rocking Clearing Test- Begin in a position where you are on your hands and knees. Move into a position to where your buttock touches. Keep your hands out in front of you, with your arms straight and hands flat on the floor.

Y Balance Test: Immediately following the FMS, the Y Balance test will be done, which identifies deficiencies in functional movement as the lower extremity reaching tasks assess dynamic balance. There are three directions of balance in this test: anterior, posteromedial, and posterolateral. You will push an indicator box with your testing leg as far as possible (with your hands on your hips) and will test one leg three times followed by your other leg three times in the same direction. Both the anterior and posteromedial direction will be completed and then in the posterolateral direction. This pre-season testing session is projected to take approximately 45-60 minutes. The post-season session will follow the exact same protocol as the first session and take 45-60 minutes.

After orientation and pre-testing session, you will participate in the TRX Suspension small group training twice per week, for a period of six weeks in total. Each exercise session will last 45-60 minutes. All exercise sessions will include a proper warm-up and cool down and will be taught by a certified personal trainer or instructor, whom is also certified in CPR and First Aid. TRX Suspension training is total resistance training using bodyweight exercises to leverage gravity by moving the body with handles attached to anchored nylon suspensions from an anchor point. All exercise sessions for the TRX training group will take place at the BGSU Recreation and Wellness Center located at 1411 Ridge Road, Bowling Green, Ohio 43403. All exercise movements and positions will be planned and designed as desired by the certified personal trainer provided by the Fitness Department at the BGSU Student Recreation Center. All movements, positions, and exercises may be individually modified to adapt to the individual participant's fitness ability and will be directed by the certified personal trainer accordingly. No previous experience in TRX Suspension Training is required before participating in this study.

FMS and Y Balance test data will be collected one week prior to and one week following participation in the TRX exercise sessions. Within the last two weeks of the exercise sessions, you will be contacted by the email address provided upon signup to schedule an appointment with Lindsay. If a response to schedule an appointment is not received with 48 hours, you will be contacted by phone with the number you provided upon signup. All appointments will be to complete the FMS and Y Balance tests at the Eppler Center, either in the 2nd floor Eppler South gym or the Exercise Physiology Lab in Eppler S124, and will last no longer than 60 minutes. You must be at least 18 years of age in order to participate in this study.

Benefits: Your participation in this research study will benefit the general population as results and knowledge gained from this study will be contributed to the current body of knowledge about TRX Suspension Training and its effects on functional mobility and balance in college age adults. Your participation in this research study may benefit you as an individual as your participation will involve 45-60 minutes of physical activity, twice weekly, and may improve your functional mobility, balance, and overall fitness levels as well as providing you with a sense of enjoyment from participation. Additionally, the benefits of this study include identifying any functional movement weaknesses you might have and the opportunity to collect your data at the end of the study and corrective exercises that you may implement to strengthen those weaknesses.

Confidentiality: Confidentiality of all information you provide and data collected during the research study will be protected to the best ability of the researcher. The researcher, advisor, and research assistant will be the only individuals collecting data and will store it with password protected technology and in a locked file cabinet located in Lindsay's office within the BGSU Recreation and Wellness facility. An additional graduate student and research assistant, Adrienne Ansel, will be assisting with data collection and will be the only person besides the primary researcher and advisor with access to the locked file cabinet and collected data. Any identifiers, such as names of participants used to collect data and tabulate results, will be changed after data are analyzed to ensure the protection and confidentiality of all participants. As a result, any collected data from the signup lists will not contain any identifying information included in papers or presentations related to this study and will be encrypted to protect the identity of the participant. The researcher and advisor will be the only individuals with access to hard copy forms and results. The consent forms and test results will all be secured in the same locked office, located in the BGSU Recreation and Wellness facility, throughout the study. At the conclusion of the study, all participants will have the option to receive their results by personal email address from the primary researcher. All computer files and data related to this study will be stored with password protected devices for seven years.

<u>Additional Consent Information</u>

Your involvement in this study will help the researcher understand how TRX Suspension Training may impact functional mobility and balance in college age adults after six weeks of small group training.

Risk of participation is expected to align with risks associated with physical activity as outlined by the BGSU RecWell assumption of risk waiver provided by the Fitness Department. This assumption of risk details that participants understand that this study includes moderate intensity exercise classes, that may lead to potential mild muscle soreness or mild muscle strains; however, the risk of injury is no greater than that experienced in everyday life while exercising.

Additionally, all participants will have completed the PAR-Q (Physical Activity Readiness Questionnaire) which assesses the readiness and ability to engage in physical activity. Our procedures are designed to protect your confidentiality. Any information that could link you to this study will be removed or coded in all printed products. Should any exercise make you feel uncomfortable, you may choose not to participate or try the adapted or modified exercises as prescribed by the certified personal trainer or fitness instructor of the exercise classes. You may also withdraw your consent or end participation at any point during the study. If you choose to withdraw from the study, it will not affect your relationships with the researchers, your membership with the BGSU Recreation and Wellness Center, your enrollment within the BGSU Fitness Department or Bowling Green State University.

Contact Information: Additional questions or concerns about this study may be directed to me, Lindsay Rausch (419-563-5070, lrausch@bgsu.edu), or my advisor, Jessica Kiss (419-372-0227, jekiss@bgsu.edu). If you have questions about the conduct of this study or your rights as a research participant, you may contact, the Institutional Review Board, Bowling Green State University (419-372-7716, orc@bgsu.edu).

Your signature below indicates the following:

"I have been informed of the purposes, procedures, risks and benefits of this study. I have had the opportunity to have all of my questions answered and I have been informed that my participation is completely voluntary and may be withdrawn at any time without penalty. I agree to participation in this research."

______________________________ ______________________________

Signature Printed Name

______________________________ ______________________________

Phone Number Date

____

Email

Appendix B

Interrater Reliability Informed Consent Form

BGSU®

BOWLING GREEN STATE UNIVERSITY
School of Human Movement, Sport, & Leisure Studies

Informed Consent Form

Project Title: TRX Suspension Training on Functional Mobility and Balance in College-Age Adults – Interrater reliability testing data collection

Researcher: Lindsay Rausch, Graduate Student, Kinesiology with Kaycee Rowe, Graduate Student Kinesiology, and Nikole Keil, Graduate Student, Kinesiology

Advisors: Dr. Jessica Kiss, Assistant Teaching Professor, and Dr. Lynn Darby, Professor School of Human Movement, Sport & Leisure Studies

Key Information: This research testing is being conducted as a part of the master's project by Lindsay Rausch. Lindsay Rausch, Kaycee Rowe, and Nikole Keil are all certified to perform the Functional Movement Screen (www.functionalmovement.com). In order to document interrater reliability of their scoring of the FMS, 15 participants will be recruited who are 18-25 years of age, college students at Bowling Green State University, and who have no self-reported physical health limitations. After the FMS is explained to each volunteer, each participant will complete the Functional Movement Screen (FMS) one time. Participation in this study provides no greater risk than those experienced in daily life and in daily exercise activities. All data collected and analyzed throughout this study will remain confidential and in a locked office throughout the study. All participants will have the option to receive their results after testing has been completed and the results are compiled.

Introduction: Our names are Lindsay Rausch, Kaycee Rowe, and Nikole Keil. We are Kinesiology graduate students working under the supervision of our advisors, Dr. Jessica Kiss and Dr. Lynn Darby, at Bowling Green State University. We are inviting you to participate in one FMS testing session so that we can determine if we all rate your functional movement tests in the same way.

Purpose: You are being asked to participate in functional movement testing –one time.

Procedure: You will schedule a time to complete the Functional Movement Screen (FMS) in the Exercise Physiology Laboratory at BGSU. Your total participation time in the testing session should take approximately 45 minutes. After you read through this consent form, you may decide to participate; and, if not, we will thank you for your time and efforts and you may leave the laboratory.

If you agree to participate in this one time testing, you will be oriented to and taught the seven tests and three clearing tests of the FMS, and asked to complete the Functional Movement Screen (FMS) in the Exercise Physiology Laboratory in Eppler South at BGSU. Lindsay Rausch, Kaycee Rowe, or Nikole Keil will ask you to schedule a testing time when you are being recruited. Recruitment will take place by word-of-mouth by explanations to colleagues and acquaintances of Lindsay Rausch, Kaycee Rowe, and Nikole Keil.

The FMS screen is seven functional movement tests and three clearing tests. You will have three trials for each of the seven movement tests and one trial for the clearing tests. The order of the tests and the descriptions are as follows:

1. The Deep Squat- with a light-weight bar overhead slowly squat as deep as possible and return to a standing position.

2. Hurdle Step (Left & right)- positioning dowel across shoulders, step over the elastic hurdle and touch heel to the floor and return the moving leg back to the starting position, slowly and controlled. Repeated with opposite leg.

3. Inline Lunge (Left & right)- the dowel is placed vertically behind the back, the hand opposite to the front foot will grasp dowel at the cervical spine. The other hand will be placed on dowel at the lumbar spine. Step forward with one foot, moving in a downward motion until your thigh is parallel with the floor. Bring forward foot back to return to a standing position. This will be repeated with the opposite leg.

4. Shoulder Mobility (Left & right)- Make a fist with both hands and bring one arm behind your head as far as possible. Bring your opposite arm behind your back and bring your fists as close together as possible. This will be repeated with your arms performing the opposite movement.

5. Impingement Clearing Test (Left & right)- Place palm of your hand on the opposite shoulder. Raise your elbow as high as possible with your hand remaining in contact with your shoulder.

6. Active Straight-Leg Raise (Left & right)- While on the floor, lay on your back with your arms at your sides. Raise one leg as high as you can, keeping your knee straight. Your other leg should remain down and straight. This will be repeated with the opposite leg.

7. Trunk Stability Pushup- While on the floor, lay on your stomach with the balls of your feet touching the floor. Have your hands be palm down on the floor. You will have your thumbs lined up with your chin. Keeping your knees and hips straight, press up your body into a pushup position (up on the balls of your feet and hands). You starting hand position can be changed if needed.

8. Press-up Clearing Test- While on the floor, lay on your stomach with the balls of your feet touching the floor. Have your hands be palm down on the floor. You will have your thumbs lined up with your chin. Keep your hips in contact with the floor and press up with your hands.

9. Rotary Stability (Left & right)- Begin in a position where you are on your hands and knees. At the same time, extend one arm forward while straightening the same sided leg behind you. Keeping the arm and leg in the air, bring the extended leg and arm together, touching knee to elbow. This will be repeated with the opposite leg and arm.

10. Posterior Rocking Clearing Test- Begin in a position where you are on your hands and knees. Move into a position to where your buttock touches. Keep your hands out in front of you, with your arms straight and hands flat on the floor.

Benefits: Your participation in this testing will benefit the general population as results and knowledge gained from this testing will contribute to the current body of knowledge about functional movement testing in college age adults. Your participation in this research study may benefit you as an individual as your participation will involve 45 minutes of testing and your results will be provided to you and explained after testing is completed.

Confidentiality: Confidentiality of all information you provide and data collected during the testing will be protected to the best ability by the researchers. The researchers will be the only individuals collecting data and will store it with password protected technology and in a locked file cabinet located in Lindsay's office within the BGSU Recreation and Wellness facility. Only the primary researchers for this testing and their advisors may have access to the deidentified data (i.e., data will only be identified by subject ID #'s without names attached) to ensure the protection and confidentiality of all participants. As a result, any collected data will not contain any identifying information in papers or presentations related to this study and will be encrypted to protect the identity of the participant. The researchers and advisors will be the only individuals with access to hard copy forms and results. The consent forms and test results will all be secured in the same locked office, located in the BGSU Recreation and Wellness facility, throughout the study. All computer files and data related to this study will be stored with password protected devices for seven years.

Additional Consent Information

Your involvement in this study will help the researchers understand how accurate they are in rating the functional movements of the same participants. You must be at least 18 years of age in order to participate in this study.

Risk of participation is expected to be no greater than the risks associated with the participation in daily physical activity. This means that participants understand that this testing may include mild stretching or supporting the body weight in various body positions during testing and the possibility of a mild muscle strains; however, the risk of injury is no greater than that experienced in everyday life while exercising.

You may also withdraw your consent or end participation at any point during the testing. If you choose to withdraw from the testing, it will not affect your relationships with the researchers, advisors, or Bowling Green State University.

Contact Information: Additional questions or concerns about this study may be directed to, Lindsay Rausch (419-563-5070, lrausch@bgsu.edu), or my advisor, Jessica Kiss (419-372-0227, jekiss@bgsu.edu). If you have questions about the conduct of this study or your rights as a research participant, you may contact, the Institutional Review Board, Bowling Green State University (419-372-7716, orc@bgsu.edu).

Your signature below indicates the following:

"I have been informed of the purposes, procedures, risks and benefits of this testing. I have had the opportunity to have all of my questions answered and I have been informed that my participation is completely voluntary and may be withdrawn at any time without penalty. I agree to participation in this testing to determine the interrater reliability among the three FMS test administrators."

Signature______________________Printed Name________________________

Phone Number________________________ Date______________

Email ________________________

Appendix C

Recruitment Email to HMSLS Graduate Coordinator

Dear Dr. Krane,

As a graduate student in the Kinesiology program within the School of HMSLS, I am currently recruiting participants for my Masters research project. I am reaching out to you in hopes that you will send this information (as attached below) out to all current graduate and undergraduate students on your HMSLS Listserv to see if any students are interested in participating in my study.

Thank you for the consideration and please contact me if you have any questions.

Sincerely,
Lindsay Rausch

Recruitment Email:

Good day, my name is Lindsay Rausch and I am a Master's student studying Kinesiology within the School of Human Movement, Sport & Leisure Studies (HMSLS). I am reaching out to you in regards to my upcoming research study in hopes that you will consider participating.

I am researching the effects of TRX Suspension Training in Small Group Training in Young Adults ages 18-25 years old. The study will be approximately eight weeks in length and will investigate the effects of TRX Suspension Training on functional mobility and balance. The small group training will be conducted in the format of six weeks of free TRX Suspension Training exercise classes twice per week. Functional mobility and balance testing will occur one week prior to and one week following the six week TRX Suspension Training exercise classes.

If interested and would like to sign up, or for any additional information or questions, please contact me as the primary investigator through my email: lrausch@bgsu.edu

Thank you for your time and consideration.

Sincerely,
Lindsay Rausch

Appendix D

Email to Fitness Coordinator for Research Study & Personal Trainer Permissions

Ms. Karyn,

Good afternoon!

Wanted to touch base with you in regards to my research project. In talking with Dr. Kiss, we have changed my project scope and I actually would like to research the effects of TRX exercise classes on college/young adults on balance and functional mobility.

As a result, I am hoping to have research participants attend TRX classes 1-2 times per week for 4-8 weeks during the fall semester. I'm thinking this could be part of the Group X classes?

Would you be able to discuss this opportunity this week?? I'm willing to discuss any way to make this work as Dr, Kiss and I are hoping to nail final details down.

I know this isn't what we originally discussed with older adults, but I'm hoping my research results can be beneficial to Group X data as well!

Let me know what you think and a time to possibly meet? Your approval and help with this study are much appreciated, and I look forward to hearing back from you.

Thank you!

Lindsay Rausch

Appendix E

Email to Participants to Complete Sign Up and Pre-Testing

Good evening!

Firstly, thank you for agreeing to participate in my research study! Please read this email in its entirety as it contains a lot of information about what is to come next week.

This research study is studying: The Effects of TRX on Functional Mobility and Balance in College-Age Adults

It is 8 weeks in length: 1 week of pre testing, 6 weeks of TRX exercise classes (on Tuesdays and Thursdays 6pm-6:50pm at the Student Recreation Center), and 1 week of post-test FMS screening.

Week 1 starts next week with pre-testing! Pre-testing consists of a 30 minute time where you will be oriented with the Functional Movement Screen and Y Balance Test and then the screening will be completed with your involvement. Upon arrival for your scheduled pre-test screening time, you will be asked to complete an informed consent form and a PAR-Q form that provides you with the details of this study before you complete the screening.

Please use this private doodle poll link to sign up for ONE, 30 minute time slot next week. If none of these times work for you, please notify me so that we may schedule an alternative time. Once you sign up for a time, that time slot will be hidden from all other participants and your name will not be shared with anyone but the primary investigator (me) that you have chosen that time.
Schedule Your Week 1 Screening

Once you have signed up for your screening, I will send a follow up email confirming your time and directions to the Eppler Physiology Laboratory, where all the pre- and post-testing will take place. There is no previous experience or training or items needed before your arrival for your screening time; however, we ask that you wear comfortable, athletic attire and closed toe athletic shoes (much like the ones you would wear for the TRX classes).

Please let me know if you have any questions. I am excited to have you all as participants!

Best,
Lindsay

Appendix F

Email following up after the 10th exercise session before the last week of exercise sessions

Good day,

I am reaching out to you to remind you that we have two exercise sessions left of the research study! As a reminder, immediately following the 12th and last exercise session will be the test activities that will last approximately 15-30 minutes.

Your participation is greatly valued and we look forward to completing the 12th and last session. At the final two sessions, the 11th and 12th session, I will communicate to all participants how to schedule your post-test appointment, which shall last no more than 60 minutes. If you should have any questions, please do not hesitate to reach out to me at lrausch@bgsu.edu or 419-563-5070.

Sincerely,

Lindsay Rausch